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Air Quality Governance in the ENPI East Countries

"Draft Programme for the National Ambient Air Monitoring Network in Georgia"

Activity 4 Report

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Summary

PROJECT TITLE:	Draft Report on air quality monitoring network for Tbilisi
CONTRACT NUMBER:	2010 / 232231
COUNTRY:	Georgia

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LIST OF ABBREVIATIONS AND ACRONYMS

Atmospheric Dispersion Modelling System	ADMS
Above Sea Level	a.s.l.
Degrees Celsius (centigrade)	^{0}C
Carbon Monoxide	CO
Methane	CH_4
Caucasus Environmental NGO Network	CENN
European Union	EU
European Neighbourhood Partnership Initiative	ENPI
Lead	Pb
Maximum Allowable Concentration	MAC
Metre	m
Millimetre	mm
Micrograms per cubic metre	$\mu g/m^3$
Milligrams per cubic metre	mg/m^3
Manganese dioxide	MnO_2
Ministry of Environmental and Natural Resources Protection	MoENRP
National Environmental Agency	NEA
Nitrogen dioxide	NO_2
Nitrogen oxides	NO_x
Non-methane volatile organic compounds	NMVOC
Ozone	O_3
Particulate Matter	PM
SEAP	Sustainable Energy Action Plan
Square kilometre	km^2
Sulphur dioxide	SO_2
Tonnes per year	t/y
Total Suspended Particulates	TSP
Volatile organic compounds	VOC

1. BACKGROUND AND OBJECTIVES

1.1. RATIONALE FOR A PROGRAM

A fundamental revision of Georgia’s ambient monitoring network is required to improve the balance in air quality regulatory and scientific objectives. These changes will address the transition from the existing national air quality standards over to the requirements within the EU air quality directives. The existing national ambient monitoring network has been based upon historic and out-dated analytical methods, developed in the early stages of air quality management programs. Current monitoring methods and sampling procedures used in Georgia only partly account for the harmful pollutants known to be present in Georgia’s ambient air and provide only a sub-sample of the daily changes in airborne pollutant concentrations. The current air quality network is therefore unable to protect the health of the population of Georgia as it is not representative of air pollution and human exposure levels across the nation.

A major requirement within the CAFE directive is the use of reference standard methods with appropriate sampling durations and the analysis of the full suite of air quality species as required under both the CAFE and Fourth Daughter Directives.

The EU Air Quality Directives require national monitoring programmes to use approved type sampling and detection methods and to monitor at the most appropriate locations. This avoids the multi-varied approach where an assortment of sampling systems and detection methods were previously deployed by nationally focussed networks, such as in Georgia. Use of such similar systems across the European network, and deployed at sampling locations which have been selected and evaluated using a uniform set of criteria provides a framework upon which all of the national air quality monitoring networks can be aligned.

In order to fully implement a National Ambient Air Monitoring Network which is compliant with the EU Air Quality directives and fulfils the need to protect the health of population of Georgia a programmed development of a national network is required. As a national network cannot be constructed as an entirety, it requires a staged development building up key capacities as well as technical understanding amongst the network participants. Various stages of the programme will involve staff recruitment, capacity-building and training, involvement of national institutions into the network, long-term institutional investment of staff and resources.

The programme detail and options and milestones shall be discussed further in this report.

Programme for developing an emerging national ambient air monitoring network will require:

- Selection and installation of new instrumentation and monitoring stations
- Development of a communications network
- Training and development of a data analysis and reporting system
- Management of Resources
- Modelling and assessment
- Preparation of national and regional institutes to support the National Ambient Air Monitoring Network
- Provision of opportunity for phasing the existing Ambient Air Monitoring Network with the revised and updated National Ambient Air Monitoring Network
- Requirements for a National Ambient Air Monitoring Network are significant and require resources, expertise, training and expert technical capacity

Programming the introduction of a National Ambient Air Monitoring Network will allow all of these needs to be addressed, the appropriate training and resources put in place whilst preparing the allocation of the budget required for a national ambient air monitoring network to operate as a uniform and sustainable national resource and without avoidable interruptions or resource failures.

1.2. GOAL AND OBJECTIVES

The principal goal of the national air quality monitoring network for Georgia is to improve air quality and minimize the risk to human health through the development of a representative and robust monitoring record of ambient air quality across Georgia.

A national air quality monitoring programme will allow the following key objectives to be met:

- Obtain the information required to design and implement air quality guidelines compliant with EU standards.
- Improve current air quality legislation, ambient air quality monitoring network as well as the assessment and reporting of ambient air quality data in line with requirement of the EU
- improve enforcement of national and international air quality regulations through better control mechanisms and improved capacity of national authorities.

1.3. PRELIMINARY AIR QUALITY ASSESSMENT SUMMARY

Preliminary assessment of air quality across Georgia was conducted for the pollutants regulated by the CAFE Directive and Fourth Daughter's Directive on ambient air quality.

The objective of the baseline assessment was to establish estimates for the overall distribution and levels of pollutants, and to identify air quality monitoring activities necessary to fulfil obligations to the Directives.

The data used in this assessment are as follows:

- 2008-2013 routine air quality measurement data (annual averages) generated by the National Environment Agency (NEA);
- Monthly average air quality data from February 2013 through February 2014 generated by the NEA;
- Short-term diffusive sampler measurement data for NO2, O3 and benzene for the cities of Tbilisi, Rustavi, Kutaisi, Zestaphoni, Chiatura and Batumi;
- National Emission Inventory Data for Georgia 2000-2012;
- Dispersion modelling of air pollutants emitted by point sources, area sources and mobile sources (NO_x, SO_2, $PM_{10}/_{2.5}$).

Based upon these measurements/surrogate information and guidance, it has been established that levels of air pollution in parts of Georgia are above or, where measurements are not available, likely to be above thresholds which require fixed measurements to be made for compliance with the CAFE Directive. These observations apply to the agglomeration zone identified in Georgia, Tbilisi.

Zones and agglomerations

Based on EU CAFE directive, EU Member States are obliged to designate zones and agglomerations for the purpose of assessing and managing air quality.

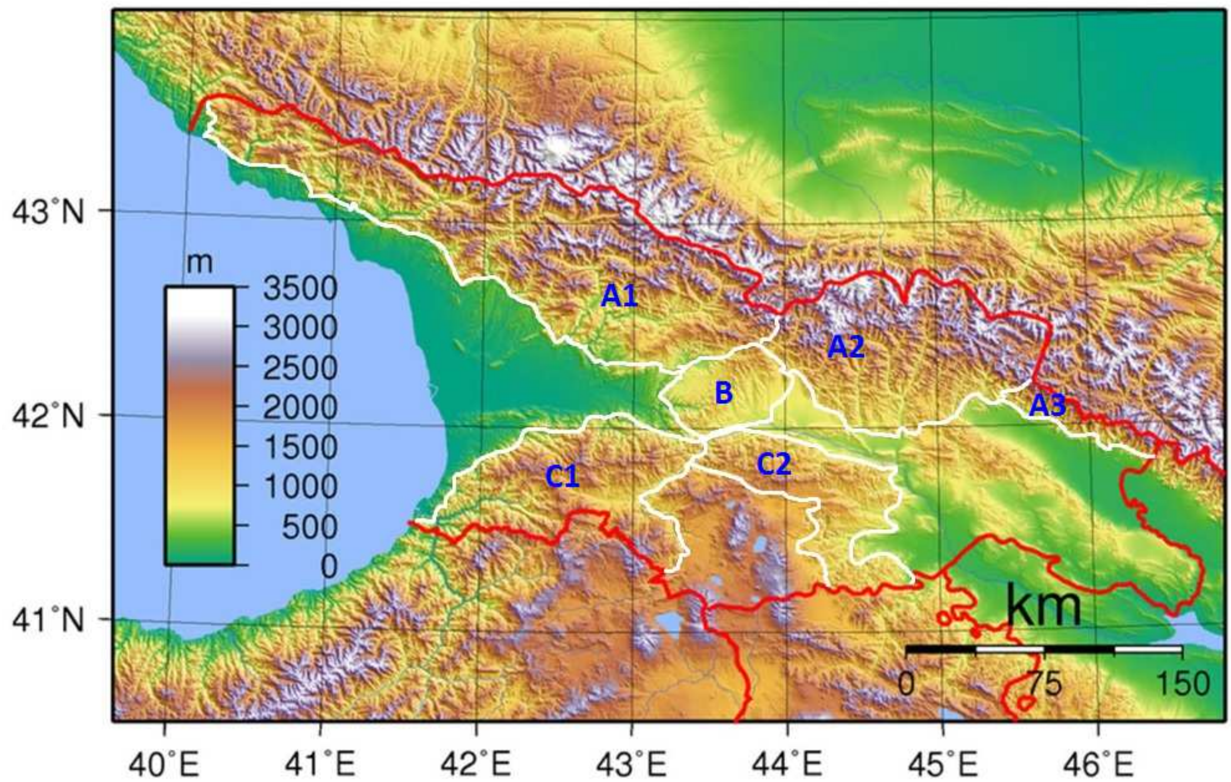
A number of criteria (variables) are used to design the zones and agglomerations, including: natural conditions, population size and density, pollution levels, air protection targets, etc. Zones can be different for various pollutants, allowing Member States to optimize air quality management resources, as there may be different sources or abatement strategies.

Under the preliminary air quality assessment conducted within the framework of the given pilot project, zones and agglomerations were defined by the group of experts, based on:

- Topography
- Climate
- Population Density
- Distribution of Point Source Emissions

In accordance with its topographic features, Georgia is characterized with diverse orography of well-defined elevated areas and lowlands. More specifically, the country contains three distinct mountainous features: A. Greater Caucasus; B. the Likhi Range, connecting Greater and Lesser Caucasus and; C. Lesser Caucasus. Greater Caucasus region is sub-divided into: A1 - Western Greater Caucasus; A2 - Central Greater Caucasus and; A3 - Easter Greater Caucasus, while the Lesser Caucasus in: C1 – Mountain Area of Lesser Caucasus and; C2. Trialeti Range. See below the major elevated orographic features

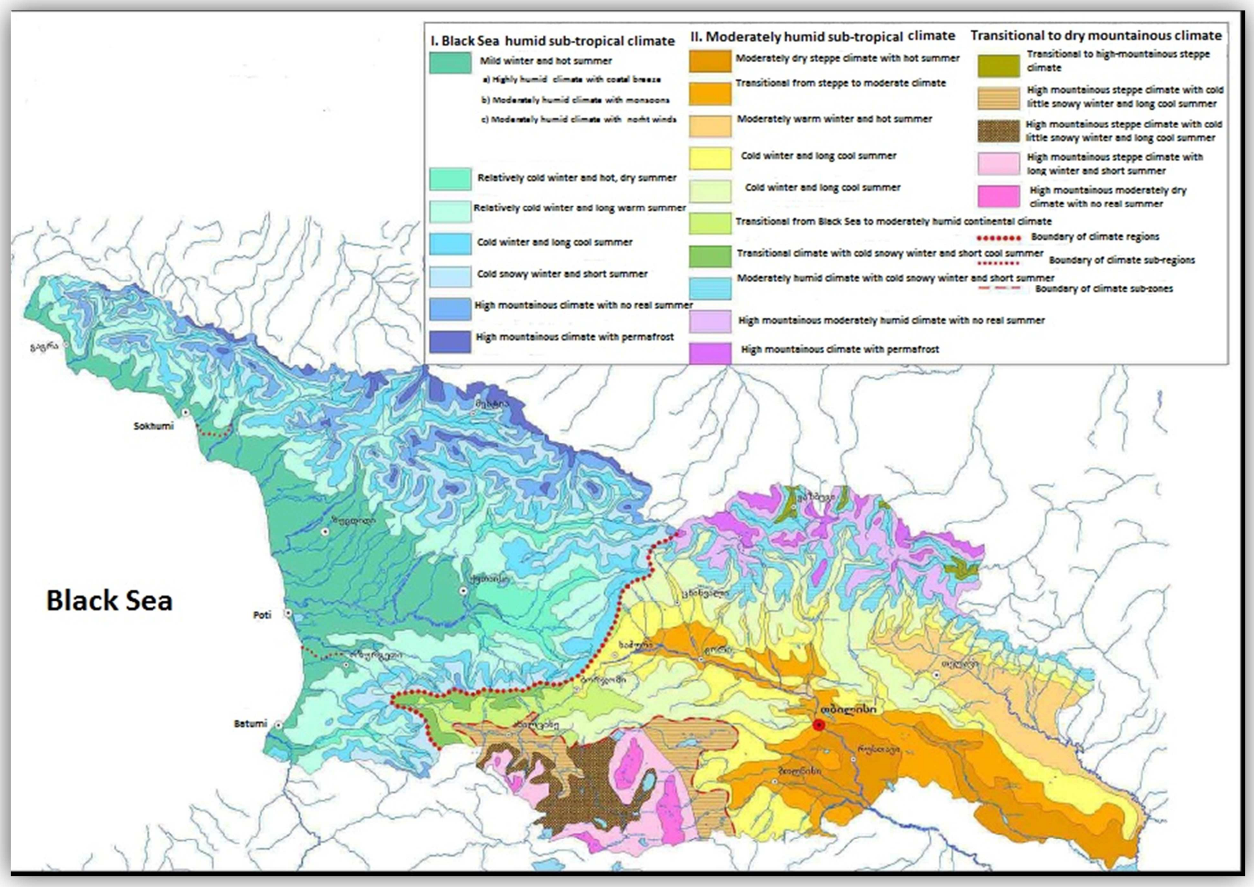
Figure 1. Topography and Major Elevation Areas Across Georgia



These are distinct from other lower lying areas of the country and can be seen to influence climate, land use as well as population density.

Georgia has a complex climate, largely defined by its varying elevation and proximity to the Black Sea. More specifically, the country is located in temperate humid sub-tropical zone, with two distinct climate areas: I. Black Sea humid sub-tropical and; II. Moderately humid sub-tropical area, which itself has 1 transitional to dry mountainous sub-zone. Within these larger climate zones almost every climatic belt is represented except for savannahs and tropical forests. To the North, the range of the Great Caucasus protects the country from the direct penetration of cold air. The circulation of these air masses mainly determines the precipitation regime all over the territory of Georgia.

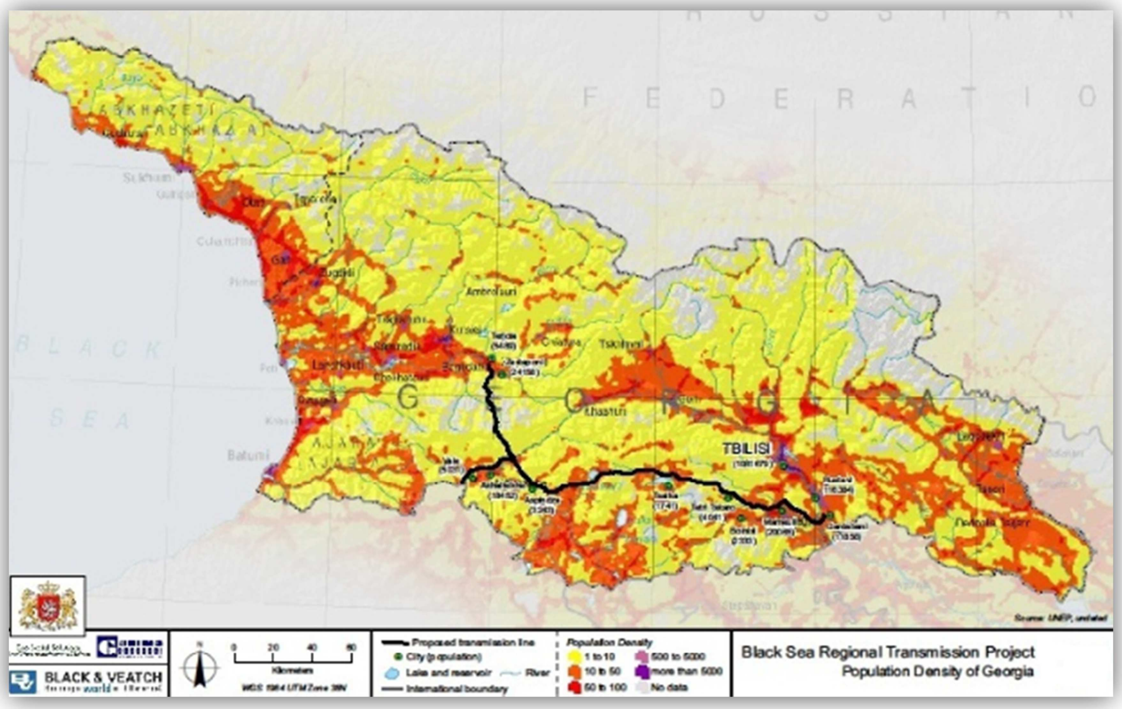
Figure 2. Climate Map of Georgia



Each microclimate has underlying influences on the requirement for certain emission type, e.g. heating, dispersion and pollution residence periods (e.g. drier conditions will allow ambient dust levels to remain high). These climatic variations were taken into account when distinguishing zones.

Regarding population density, high concentrations are marked on lowland areas, hills and foothills and at a lower extent, on low mountains. The figure below presents the map of population density.

Figure 3. Population Density Map of Georgia

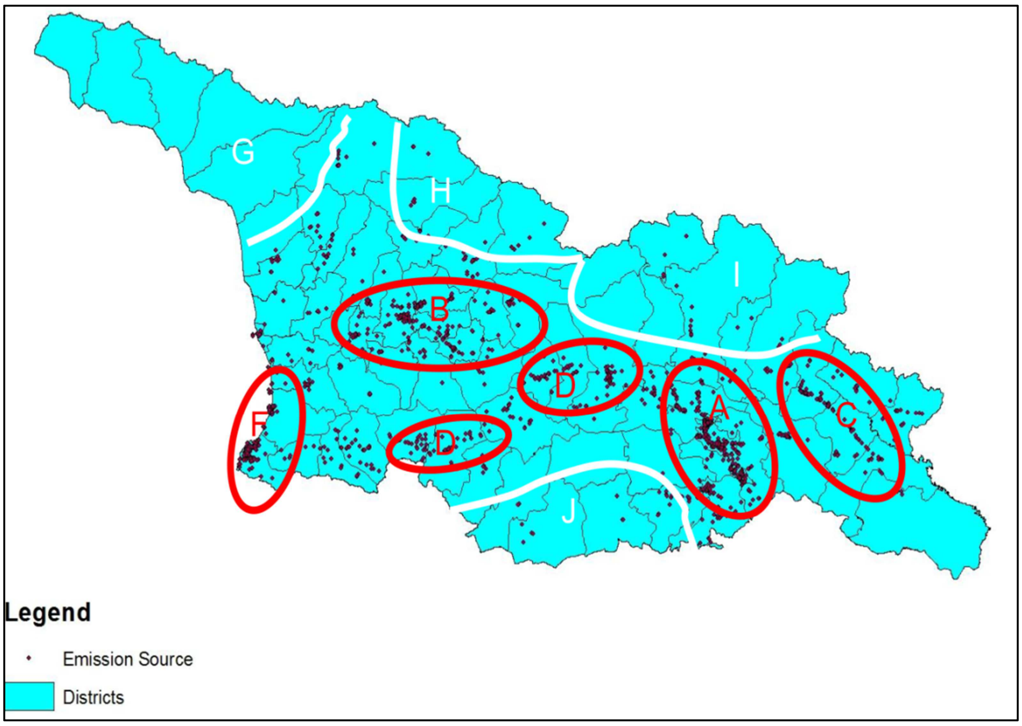


National inventory records of major point source emissions in Georgia imply that there are six concentrated areas of point source emissions in the country. These have identified and highlighted in red ellipses in Figure 4.

This concentration of point sources is noticeable around the areas of:
A - Tbilisi / Rustavi;
B - the combined areas surrounding Samtredia, Kutaisi and Zestaphoni;
C – Akhmeta mountainous area and the Alazani Valley;
D - Khashuri and Gori;
E - the combined areas of Vale and Akhaltsikhe and Atskuri; and
F - the combined areas of Batumi and Kobuleti.

The study has also identified four areas (G, H, I and J) with very low density of population and emission sources leading to the presumption of pollutant concentration falling below the UAT’s and thus, requirement for fewer sample points for fixed measurements in a zone.

Figure 4. High density areas of point source emissions



Based on above criteria, project experts have proposed eight zones and two agglomerations, which are given in map and table below:

Figure 5. Initially proposed zones and agglomerations in Georgia

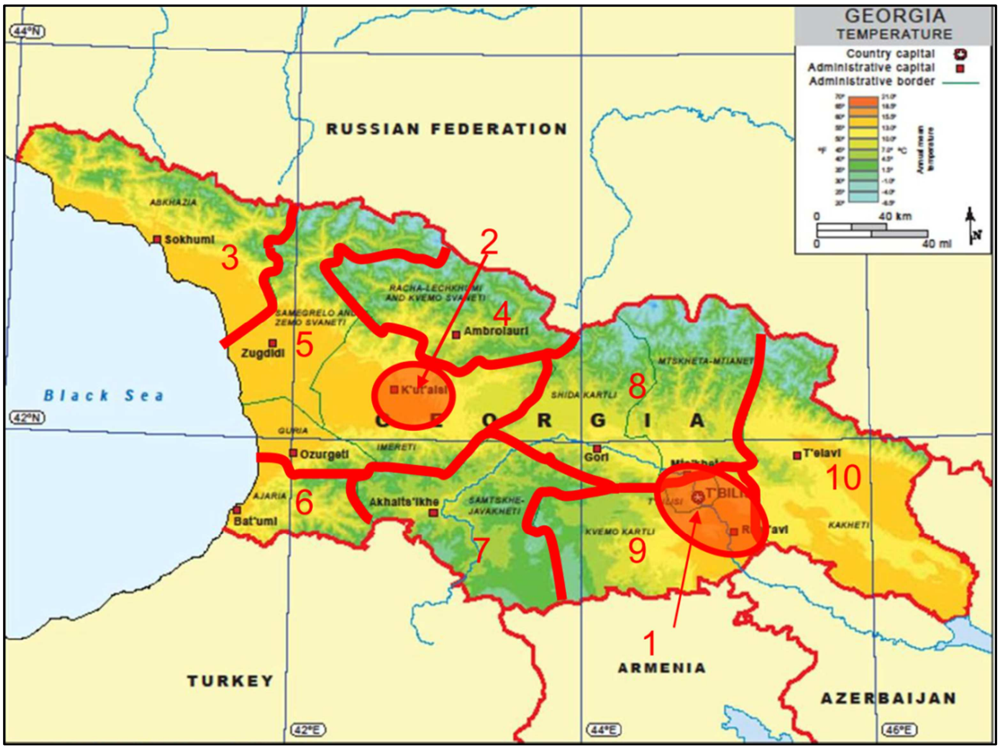


Table 1. Proposed Zones and Agglomerations in Georgia

Number	Area Description	Type
1	Tbilisi and surrounding Area, including Rustavi	Agglomeration

2	Combined areas surrounding Samtredia, Kutaisi and Zestaphoni	Agglomeration
3	Abkhazia	Zone
4	Racha-Lechkhumi and Kvemo Svaneti	Zone
5	Samegrelo and Zemo Svaneti	Zone
6	Batumi (including Kobuleti and rest of Adjara)	Zone
7	Akhaltsikhe-Vale-Atskhuri (Samtskhe-Javakheti)	Zone
8	Shida Kartli & Mtskheta-Mtianeti	Zone
9	Kvemo Kartli	Zone
10	Kakheti (Akhmeta and Alazani Valley)	Zone

Selection of the abovementioned zones and agglomerations have been discussed and agreed upon with key stakeholders. Such discussions resulted in the revisions in the suggested scheme, taking into consideration administrative (regional and municipal boundaries) division of the country as well as Georgia's regions' contributions to total emissions and emissions per square km (***please see figures below***), in addition to all criteria used by project experts.

Figure 6. Map of the 2012 Regional Contribution to Total Point Source Emissions (t/y)

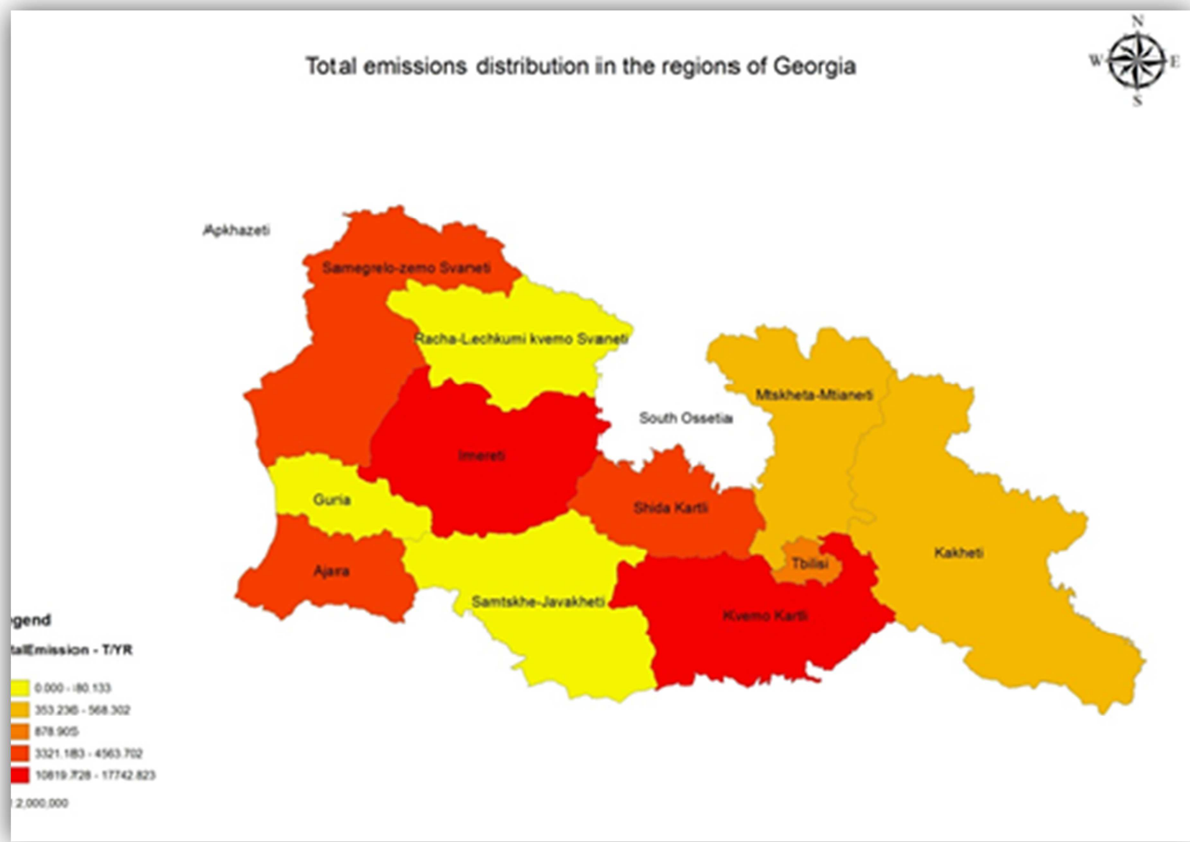
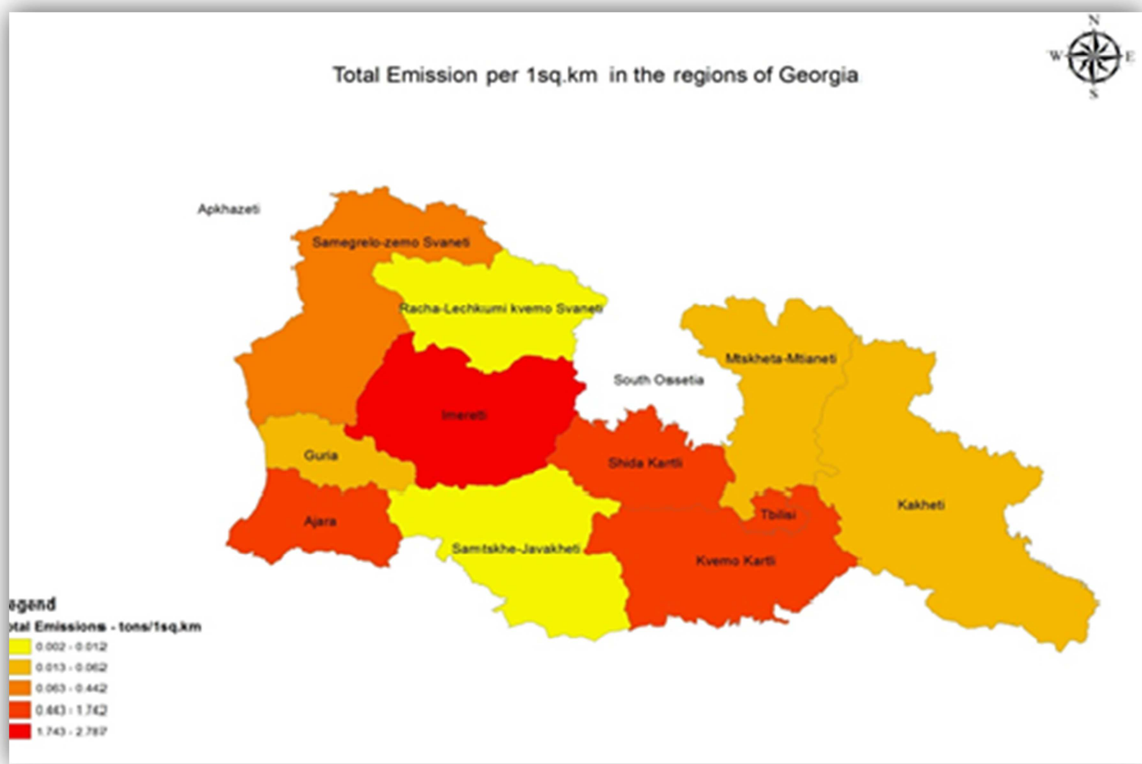


Figure 7. Map of 2012 Point Source Emission Distribution in Georgia (t/sq.km)



Thus, as a result of stakeholder consultation, nine zones and 1 agglomeration have been identified for the purpose of air quality monitoring and management in Georgia. Each zone reflects the varying characteristics of the state and its air quality and more or less in consistent with existing administrative setting of Georgia. This would provide clarity to the local governing bodies of the state of the regional air quality at the National Air Quality Action Planning Stage. Map and table of Georgian zones and agglomerations are given below.

Figure8.Agreed Zones and Agglomerations for Georgia

Table 2. Zones and Agglomeration of Georgia Agreed upon with Key Stakeholders

Zone/aggl. No	Area Description	Type	Criteria for selection	Comment
1	Abkhazia	Zone	Climate, administrative division	The area is autonomous republic and currently is a break-away region. There is no information available for Georgian government on emissions and air quality.
2	Racha-Lechkhumi, Kvemo and Zemo Svaneti	Zone	Topography, climate, population density, emission source and/or emission distribution, population size and density, administrative division	The area is distinguished with low population size and density as well as with low emission levels and emission source densities. Furthermore, topographically and climate-wise, the area belongs to the Greater Caucasus mountain regions, with sub-tropical humid climate having relatively colder winter. Administratively, Racha-Lechkhumi and Lower Svaneti belong to one region, while Zemo Svaneti is part of Samegrelo-Zemo Svaneti region
3	Samegrelo-Guria	Zone	Climate, topography, activity/emission type, amount and distribution, population size, administrative division	The area has common coast line, with developed sea and road transport and communications and oil terminals being operated currently. Administratively, Guria and Samegrelo are separate bordering regions

4	Adjara	Zone	Climate, topography, emissions, administrative division	The area is autonomous republic having coast line with developed sea and marine transport and communications and oil terminal being operated in Batumi
5	Imereti	Zone	Climate, topography, emission source concentration, total emissions and emission densities, population size, administrative division	The area is highly populated area with various industries in operation, including Ferro-alloys production, manganese production, food industries, transport and communications lines, concentrated mostly in urban areas and between them. These cities and towns are located very close to each other and could be considered as one agglomeration. Though, total population size of all these cities/towns is less than 1 million. Administratively, the area belongs to Imereti regional administration
6	Shida Kartli (including South Ossetia)	Zone	Climate, topography, emission type, amounts, density, emissions source density, population size and density, administrative division	The area has medium-level emissions and emission densities in comparison with other regions. Emission sources are mostly concentrated in urban areas (Kaspi) It belongs to a stand-alone administrative region of Shida Kartli, where break-away region South Ossetia is also included
7	Samtkhe-Javakhet	Zone	Climate, topography, emissions type, amount, density, emission source density, population size and density, administrative division	The area has relatively lower emission source concentration and very low emission levels. Topographically and climate-wise, it belongs to Lesser Caucasus mountainous areas with transitional from sub-tropical to dry continental climate. It also fully falls within Samtskhe-Javakheti region
8	Kvemo Kartli	Zone	Climate, topography, emissions type, amount, density, emission source density, population size and density, administrative division	Climate-wise and topographically, the area is pretty much uniform, mostly characterized with moderately dry climate. The area has high population size and density. Its administrative centre Rustavi has population size less than 1 million. Emissions are concentrated in the city of Rustavi with a number industries being operated there. Administratively, the area belongs to Kvemo Kartli region
9	Mtskheta-Mtianeti and Kakheti	Zone	Climate, topography, emission amounts and densities, administrative division	The area is characterized with moderate population density, with higher population concentration noted in lowland areas. Topographically and climate-wise, mountainous areas belong to Greater Caucasus with moderately humid sub-tropical climate characterized with cool shorter summer and cold winters. The area is marked with low emission levels and densities. Administratively, Mtskheta-Mtianeti and Kakheti are two

				distinctive regions
1	Tbilisi	Agglomeration	Topography, climate, emission type, amount and density, emission source density, population size and density (more than 1 million people), administrative division	Tbilisi is a self-governing city, Georgia's capital with population size over 1 million. Transport emissions are very high in the city and industrial emissions moderate, doe to absence of large industries in the city. Contrary, concentration of emission sources is high due to operations of a numerous small-size point, area and diffused sources. Air quality assessment showed exceedences of UATs in Tbilisi that needs strict air quality monitoring and management regime

Air quality assessment methodology and data sources

Preliminary air quality assessment covered the nine pollutants (SO_2, NO_2, NO_x, PM_{10}, $PM_{2.5}$, lead, benzene, CO, and ozone) considered within the EU Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe (the CAFE Directive). The study was based on the desk study of ambient air quality in Georgia. Data used included:

i) Long-term air quality monitoring data (2008-2013);
ii) emission inventories data compiled by the Air Protection Service of the Ministry of Environmental and Natural Resources Protection of Georgia (MoENRP) based on CORINAIR emission inventory methodology and emission registration forms;
iii) existing data on transport and municipal gas consumption patterns contained in Sustainable Energy Action Plans for Tbilisi, Rustavi and Batumi and Emission Inventory and Preliminary Modelling Study for Tbilisi;
iv) NO2, Ozone and Benzene two-week passive sampling measurement data carried out in June 2013;
v) modelling of pollutants' concentrations based on ADMS-Urban.

For all pollutants, except ozone (for which there is no limit values or assessment thresholds) the exceedance status has been determined using valid measured and modelled data available over a six -year period 2008-2013 and based on guidance provided by Annex II, Section B of the CAFE Directive.

A formal exceedance was deemed to have occurred if there was an exceedance of the assessment threshold on three or more years during the six year period, 2008-2013. In determining an exceedance of the assessment threshold, precedence has been given to measurement data where this is available, unless higher concentrations have been predicted elsewhere by model outputs.

For NO_2 and PM_{10} the assessment was based on the annual average threshold. For sulphur dioxide, the assessment was based on the 24-hour assessment threshold. For ozone, the minimum number of sampling sites is provided in Article 10 and Annex IX of the CAFE Directive.

The preliminary assessment method for $PM_{2.5}$ differed from that that for other pollutants since there is no datasets upon which to calculate assessment thresholds. In this case, the network size is based on the minimum number of sampling sites to assess compliance with the exposure reduction target (see Annex V, Section B of the CAFE Directive).

Emissions Inventory Data

Emission inventories carried out under preliminary study comprised aggregation and analysis, including spatial analysis of 2000-2012 emission inventories data compiled by the Air Protection Service of the Ministry of Environmental and Natural Resources Protection of Georgia (MoENRP) based on CORINAIR emission inventory methodology and emission registration forms as well as desk study and analysis of existing data on transport and municipal gas consumption patterns contained in Sustainable Energy Action Plans for Tbilisi, Rustavi and Batumi and Emission Inventory.

Emission inventories can supply valuable information on pollution sources and their emissions, as well as emission fluxes across a whole zone. Often, the first estimates of air quality limit values being exceeded are derived from emission inventory data. However emission inventories can be deficient, containing data which is either based upon incorrect emission factors or historic activity figures. Emission inventories can suffer from a lack of fundamental information. Emission factors can be difficult to obtain for certain sectors, and within this report, the national emission inventory data is one of the major sources of uncertainty. For most of the sectors emission quantities were calculated using simple, Tier 1, emission factors from CORINAIR Guidelines to estimate emissions of all relevant pollutants from each of these sources. There is a clear need of improved coverage of emission data especially for road vehicles, the oil and gas sector as well as domestic heating. This will provide more comprehensive information on sources and emissions in each zone.

Long term monitoring data

For this assessment 2008-2012 air quality monitoring data from continuous measurements conducted in the cities of Tbilisi, Rustavi, Kutaisi, Zestaphoni and Batumi as well as monthly data from February 2013 through February 2014 collected by the National Environment Agency (NEA) were used.

Air Quality data measurements in Georgia have historically been reported as monthly average concentrations of air pollutants. These are reported within monthly bulletins and are available at NEA-s web-site (http://meteo.gov.ge/radiation). Current reports cover the period from February 2013 through May 2014. Bulletins for previous years are stored at NEA’s office and are not currently available for the general public. Continuous monitoring at the Tbilisi station began in June 2013.

The major uncertainties of the measured air quality data are influenced by the non-reference sampling and detection methodologies used, chosen sampling durations falling outside of those applicable to CAFE directive limit values, lack of correction and validation of data.

Where stationary measurements are not representative of pollution occurring at nearby receptors additional uncertainties are also introduced. As the air quality close to receptors may be substantially different from air quality at the station, or the limited measurement time coverage may not have captured significant variations in pollutant concentrations. Further uncertainty may be introduced in the calibration of the monitoring equipment and the potential for instrument drift over time.

Modelling Data

For the development of the ADMS-Urban AQ model the following data was used: point source pollutant data distributed by the MoENRP (2013), natural gas usage for 4 cities (2013), traffic flow data (2013 estimation), vehicle emissions factors, and background data(2012).Background concentrations of pollutants were derived from the outputs of a preliminary study based upon EMEP/MSC-W modelled concentrations[1].

A series of geographical distributions of annual mean concentrations were derived and validated against the annual monitoring data gathered from the local monitoring station, where available.

The ADMS-Urban model was run for four major conurbations in Georgia (Tbilisi, Rustavi, Kutaisi, Zestaphoni, Chiatura), for the pollutants NO_2, SO_2, NO_x and PM_{10}. A single hourly meteorological dataset was used and model outputs were generated for annual averages and where appropriate 24 hourly averages and hourly averages only. Accordingly comparisons were made with the limit values and upper assessment thresholds for the various pollutants. The ADMS Model has been run over distinct separate area grids for each respective city.
Within each model a number of receptors were used for computing the concentrations field.

The main uncertainties of the modelling results used in this assessment report were linked to availability of reliable traffic frequency data and emission factors to calculate the emissions from traffic, correctness and completeness of the point source emission data as well as the quality of the meteorological observation data.

Passive sampling data

Passive sampling was conducted for NO2, benzene and Ozone in the cities of Tbilisi, Rustavi, Zestaphoni, Kutaisi, Batumi, Poti and Chiatura. In total, samples were taken at 60 locations, including 34 locations in Tbilisi, 7 locations in Rustavi, 5 locations in Zestaphoni, 4 locations in Kutaisi, 4 locations in Batumi, 4 locations in Poti and 2 locations in Chiatura. Of total samples, 60 samples were for NO_2, 10 samples – for O_3 and 4 samples – for benzene.

Assumptions and Definitions for Assessment Reporting

Georgia is composed of 1 agglomeration zone and 9 non-agglomeration zones.
For pollutants except ozone (for which there is no limit values or assessment thresholds), the exceedance status each zone has been determined using measured and modelled data available over a five year period 2008-2013 and based on guidance provided by Annex II, Section B of the CAFE Directive.
Measurement methods have not followed reference methods and do not include hourly or daily data summaries. Only monthly summaries of monitoring data were available.
Measurement data is generally available for the years 2008 to 2013. The supplementary assessment data is available for most pollutants for the years 2013.
Formal exceedance was deemed to have occurred, for each zone or agglomeration, if there was exceedance of the assessment threshold on three or more years during the five year period, 2008-2013.
In determining an exceedance of the assessment threshold, preference has been given to measurement data where this is available, unless higher concentrations are predicted elsewhere in a given zone by model outputs;
According to Article 7, Section 3 of the CAFE Directive, and the sampling criteria presented in Annex V, Table 1 of the CAFE Directive, the number of monitoring stations maybe reduced by up to 50 % where information other than fixed measurements is available. The preliminary assessment method for PM10 and PM2.5 differs from that for other pollutants since there is limited pre-existing historical datasets to calculate assessment thresholds. In this case, the network size is based on the minimum number of sampling sites to assess compliance with the exposure reduction target (see Annex V, Section B of the CAFE Directive).
No monitoring is required in cases where the ambient concentration is less than the lower assessment threshold.
For NO2 and PM10 the assessment is based on the annual average threshold.
For sulphur dioxide, the assessment is based on the 24-hour assessment threshold.
For ozone, the minimum number of sampling sites is provided in Article 10 and Annex IX of the CAFE Directive.

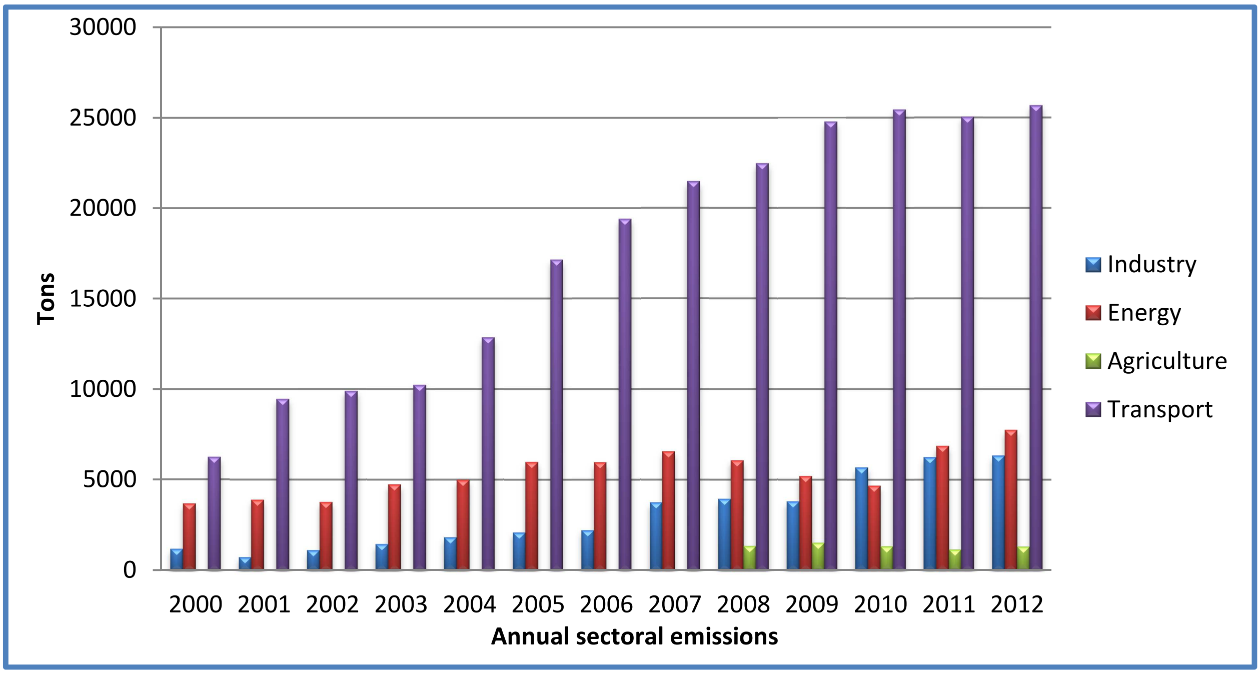
[1] With input from international experts.

1.4. ASSESSMENT FOR NO_2

NO_x Emissions

In accordance with emission trends, from2000 to 2012 NO_x emissions have been steady increasing, with transport sector contributing the largest share to total NO_x emissions, followed by energy and industry sectors.

Figure 9. 2000-2012 NO_x Emissions



As for points source NO_x emissions per Georgia’s regions, zones and agglomerations, in 2012 Kvemo Kartli zone was marked with the highest emissions, followed by Imereti and Shida Kartli zones. Below figure shows 2012 point source NO_x emissions per Georgia’s regions and proposed zones and agglomerations.

Figure 10. Distribution of 2012 NO_x emissions (tons) among regions of Georgia

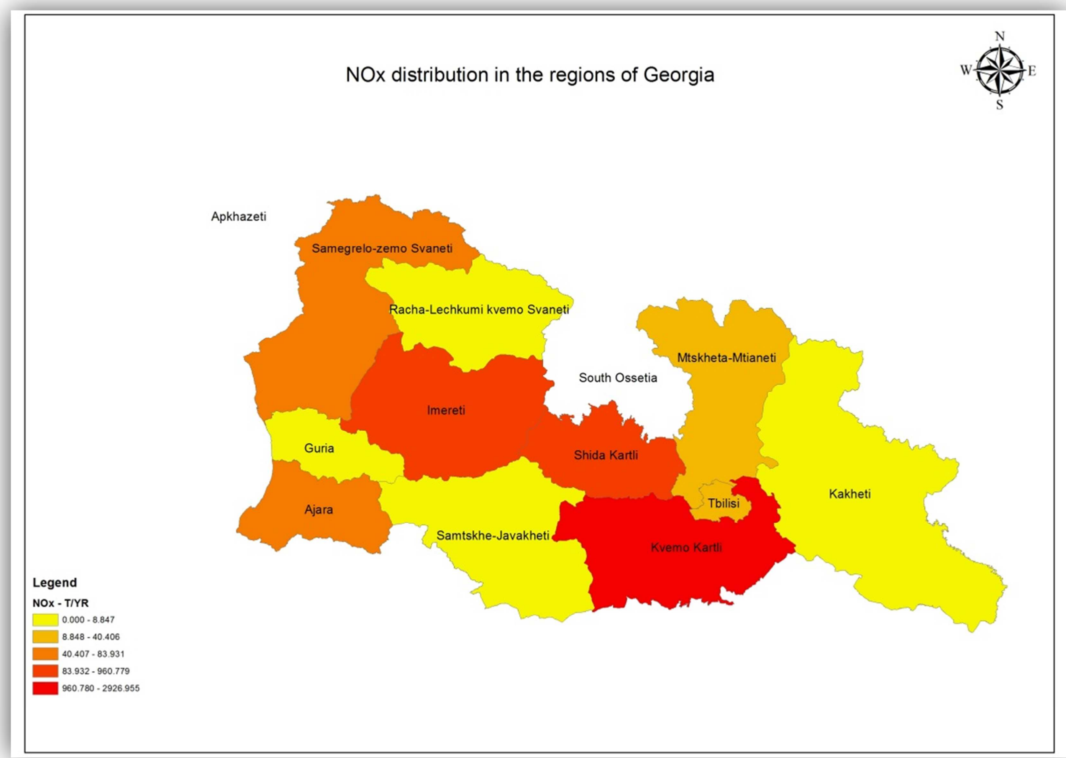


Figure 11. 2012 NO_X emissions (t/sq. km) per regions of Georgia

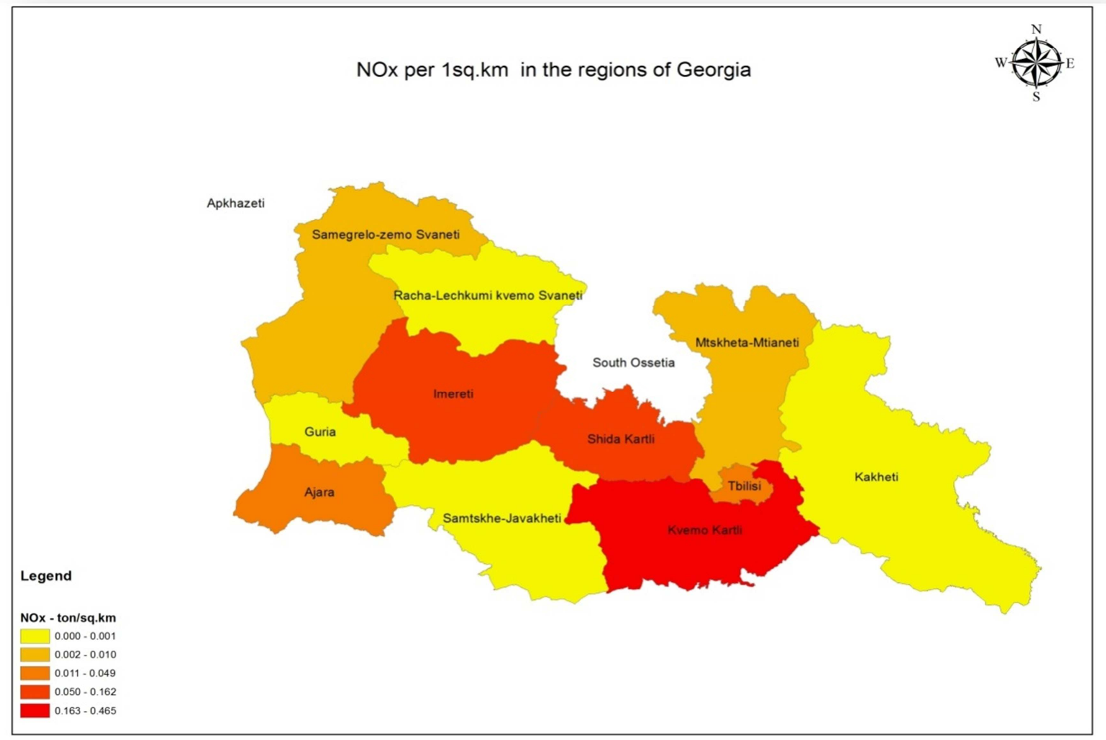
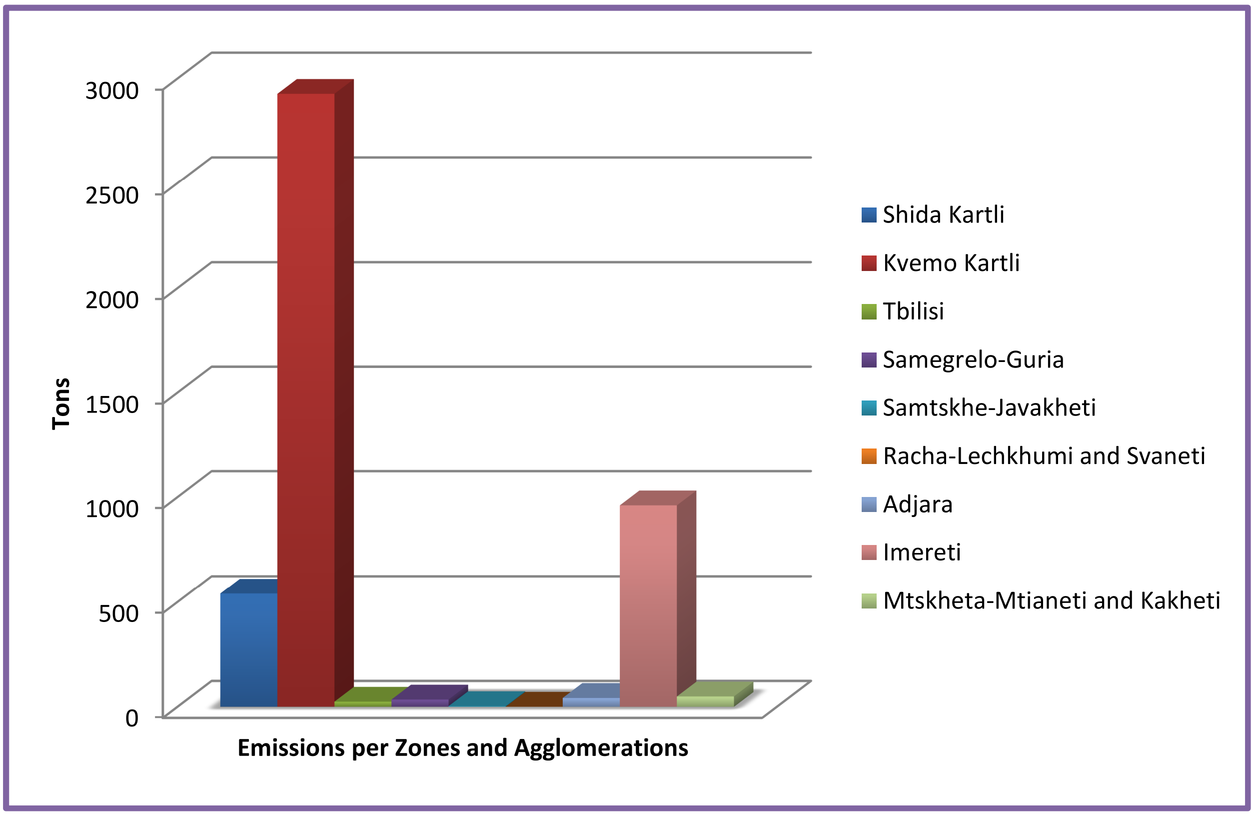


Figure 12. 2012 NOx Emissions Per Zones & Agglomerations



Long term monitoring data for NO_2

Nitrogen dioxide is continuously monitored in 5 cities within Georgia. Monitoring is undertaken using non-reference methods (with exception of the new Tbilisi station in 2013). With the exception to Tbilisi, air was sampled from only one sampling site per city. Therefore currently reported concentrations of ambient air should be viewed as the ones representing only part of the air-shed within each city and they do not characterise whole ambient air environment.

Table 3, below, contains a summary of the annual average concentrations of NO_2/NO_x monitored within the air quality network located across 5 Georgian cities from 2008 through 2013.

Table 3.2008-2013 Urban Air Quality Trend for NO_x [2]

Pollutant		Annual Mean, µg/m³						Georgia MACs, µg/m³		EU Limit values
		2008	2009	2010	2011	2012	2013*	Max (20-30 min.)	Daily average (24 hours)	
Batumi										
NO_2		120	100	97	130	139	147	200	40	Annually 40 µg/m³ One hour 200 µg/m³
Zestaphoni										
NO_2		50	40	44	47	46	46	200	40	Annually 40 µg/m³ One hour 200 µg/m³
Rustavi										
NO_2		80		49	84	103	113	200	40	Annually 40 µg/m³ One hour 200 µg/m³
Kutaisi										
NO_2		95	90	99	130	140	122	200	40	Annually 40 µg/m³ One hour 200 µg/m³
Nitrogen Oxide		70	70			120	110	400	60	
Tbilisi										
NO2	Kvinitadze St.	60	70	92	88	89	100	200	40	Annually 40 µg/m³ One hour 200 µg/m³
	Moscow St.						89			

The table above shows consistent exceedances of Georgian daily average MAC and EU annual average limit value for NO2 for almost every year and monitoring site.

As for monthly air quality profile, 2013 February-2014 February routine monitoring data were analysed *(see below)*, also revealing regular exceedances of Georgian daily average MAC and EU annual average limit values at all six monitoring sites. LATs were exceeded at Kvinitadze St, Tbilisi, Kutaisi, Rustavi and Batumi. At Batumi both the UATs for hourly NO_2 and the short-term MAC were exceeded. Though the NO_2 concentrations at the Zestaphoni monitoring station exceeded the EU

[2] Source: Ambient Air Pollution Yearbook, 2012, National Environmental Agency. SaqarTvelosteritoriazeatmosferulihaerisdabinZurebisweliwdeuli.garemoserovnulisaagentosgaremosdabinZurebismonitoringisdepartamentismonacemebi. 2012 weli

annual average limit value, they remained well below the LAT for hourly NO_2 and where consistently below 50 µg/m^3foreach of the months reported.

A similar pattern can be observed between the monthly nitrogen dioxide concentrations at Batumi and both of the Tbilisi monitoring stations, in which NO2 drops to a minimum during the month of November and rises towards the months of May and June. This implies that emission sources and meteorological condition are similar at each of those three sites.

Though ambient concentrations of NO2 are high at the Zestaphoni monitoring station, it is the least polluted of the six city monitoring locations. However the specific location of the air quality monitoring station at Zestaphoni could have some overwhelming influence upon the lower NO2 concentration such as its proximity to busy roads, etc.

Stemming from above analysis, we can conclude that levels of NO_2in and around the monitoring stations located in Batumi, Zestaphoni, Chiatura, Kutaisi, Rustavi and Tbilisi are above the EU annual average limit value, and in some instances at risk of exceeding the hourly limit value of 200 µg/m^3.

Figure 13. 2013 February-2014 February average monthly concentrations (µg/m3) of NO_2 measured at Batumi ambient air quality monitoring site

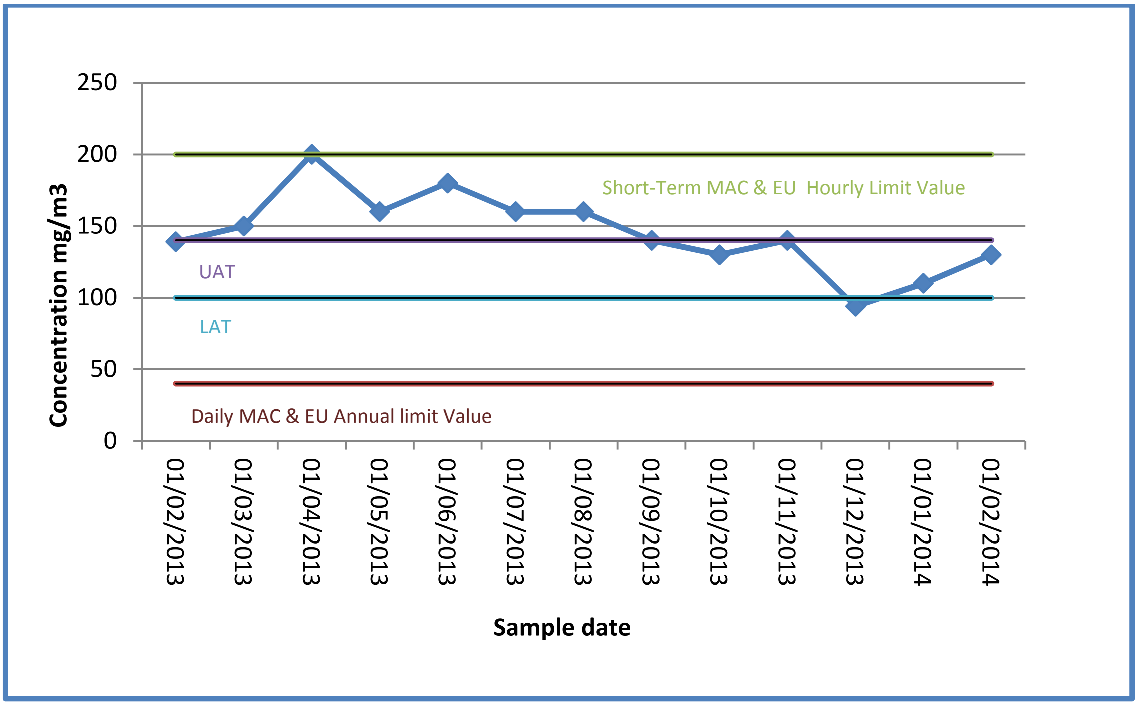


Figure 14. 2013 February-2014 February average monthly concentrations (µg/m3) of NO_2 measured at Zestaphoni ambient air quality monitoring site

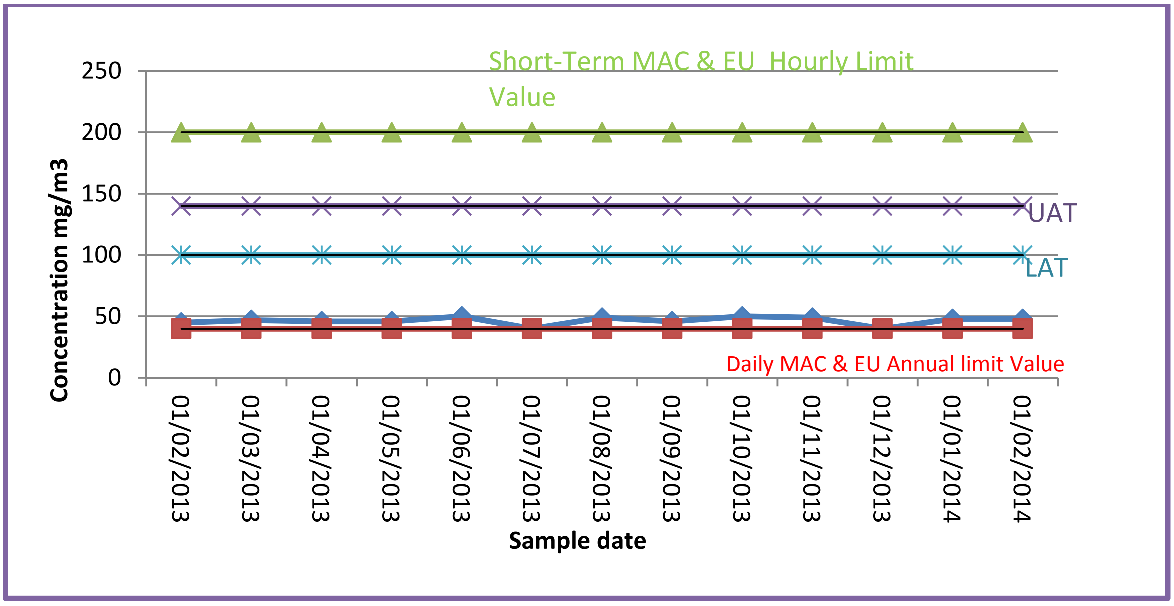


Figure 15. 2013 February-2014 February average monthly concentrations (µg/m3) of NO_2 measured at Rustavi ambient air quality monitoring site

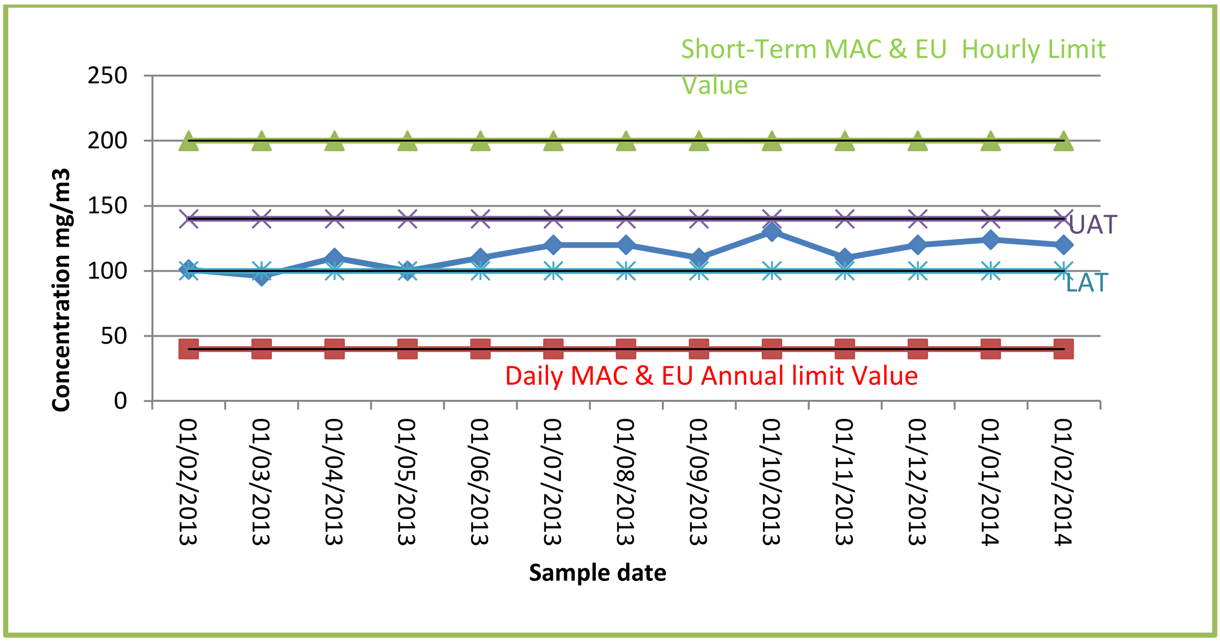


Figure 16. 2013 February-2014 February average monthly concentrations (µg/m3) of NO_2 measured at Kutaisi ambient air quality monitoring site

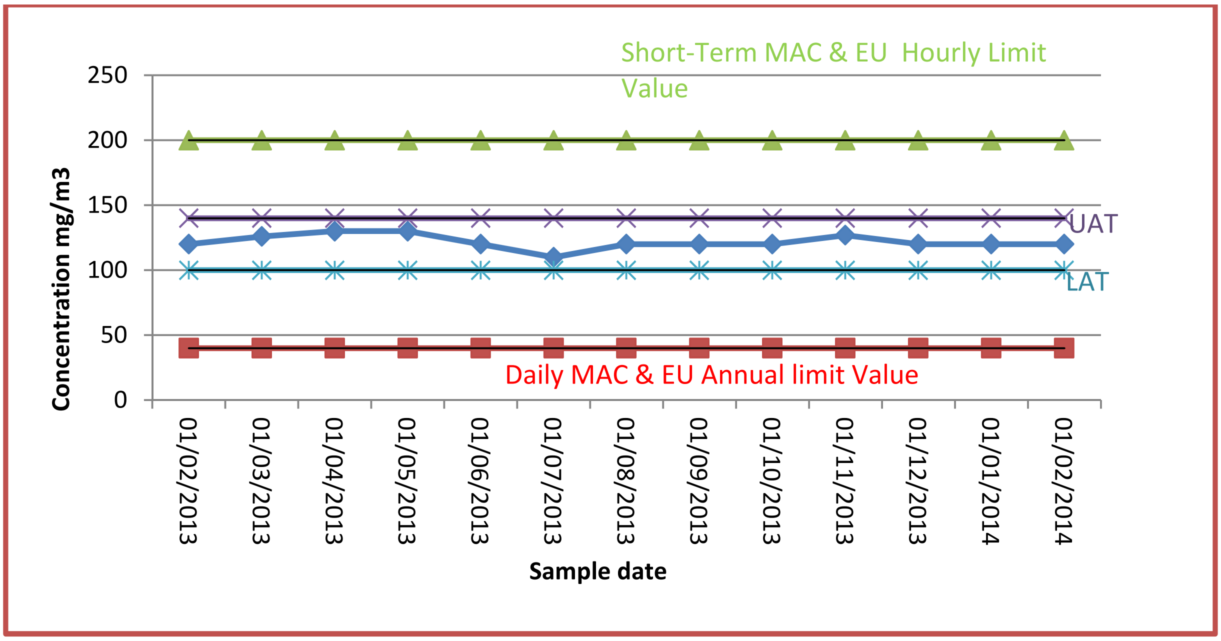
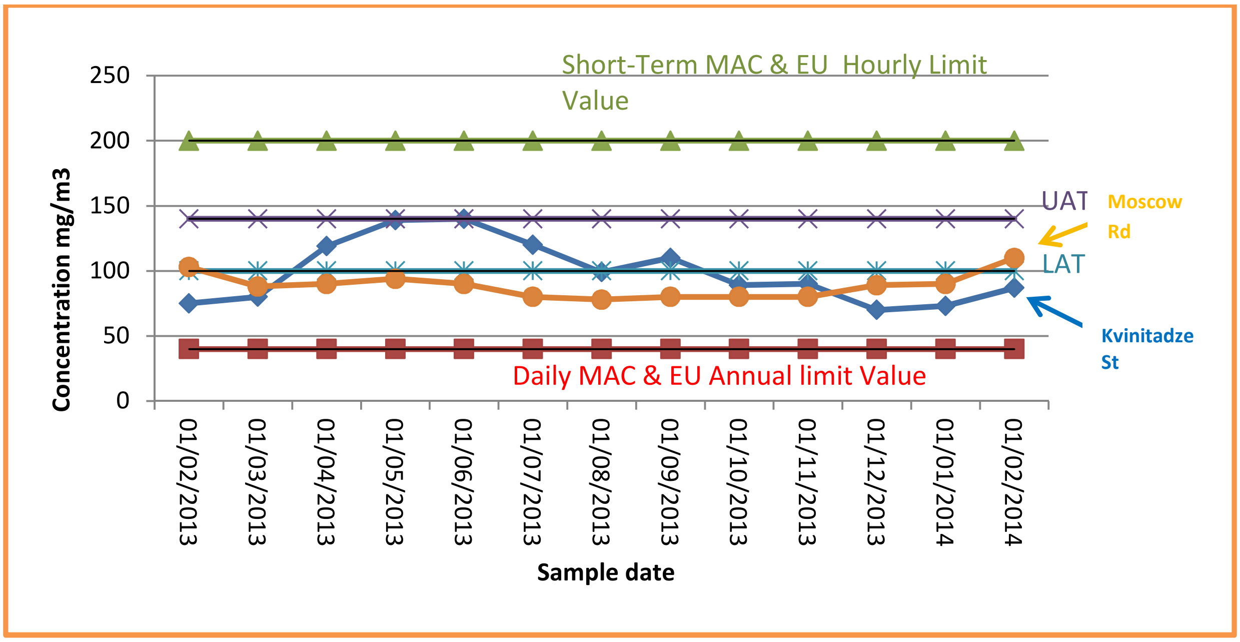


Figure 17. 2013 February-2014 February average monthly concentrations (µg/m3) of NO2 measured at Tbilisi ambient air quality monitoring site



Passive Sampling of NO_2

Passive sampling results illustrate that NO_2 concentrations appear to vary widely across the country ranging from 1.04 µg/m^{3}at a Cemetery site in Kutaisi to 94.03 µg/m^{3}at the Tbilisi - Rustaveli Avenue site (Roadside). Across Georgia, passive sampling for NO_2 performed at the end of June and beginning of July revealed that 4 sites had NO_2 concentrations greater than 60 µg/m^3 (the exceedance of hourly limit 200 µg/m^3 might be at risk), 12 sites had NO_2 concentrations between 40 and 60 µg/m^3, 4 sites had NO_2 concentrations between 36 and 40 µg/m^3, and 38 sites had NO_2 concentrations less than 36 µg/m^3.

Table 4. Results of NO2 Passive Sampling

City	X and Y Coordinates	Address	Area Description	NO_2 µg/m^3
Batumi	719849; 4612655	14 L. Asatiani St.	Kerbside	19.10
Batumi	719643; 4614603	Rustaveli St.- Nearby the theatre	Urban background	68.20
Batumi	721691; 4613418	55 Maiakovski St. - Terminal building	Suburban	55.73
Batumi	721265; 4611580	cable car station	Rural	4.02
Chiatura	357662; 4683887	next to the sewing building	Urban background	2.98
Chiatura	358188; 4682838	Chavchavavdze St.	Suburban	7.54
Poti	721672; 4672834	Entrance of the city - Kokaia Alley	Rural	18.50
Poti	720285; 4670157	Gegidze St.	Industrial	
Poti	721725; 4668489	St. Giorgi St. And Kolkheti St.	Suburban	8.97
Poti	721517; 4666965	The end of Baratashvili St.	Rural	3.46
Kutaisi	307323; 4681624	Next to the Parliament	Roadside	28.58
Kutaisi	307139; 4679183	Territory of Cemetery	Rural	1.04
Kutaisi	308393; 4680643	Chavchavadze Av.	Kerbside	44.55
Kutaisi	311924; 4682161	D Nidjaradze I St., #1 Kindergarten	Suburban	5.61
Zestaponi	335820; 4663667	Chikashua Laboratory	Suburban	6.51
Zestaponi	335802; 4664901	"Saqkabeli"	Industrial	50.19
Zestaponi	337276; 4663552	Agmashenebeli St.	Urban	31.85
Zestaponi	338321; 4662795	55 Machavariani St.	Suburban	8.68
Zestaponi	333006; 4661608	village Kvaliti	Rural	3.41
Tbilisi	486584; 4613880	Tbilisi 14	Kerbside	51.72
Tbilisi	486774 ; 4614183	Tbilisi 29	Kerbside	31.63
Tbilisi	0482534;1618410	Agmashenebeli St.	Kerbside	38.10
Tbilisi	0482582;4619181	Tsereteli St.	Kerbside	36.15
Tbilisi	0482982;4618952	Surami St.	Urban background	38.66
Tbilisi	0482968;4620078	Dadiani St.	Urban background	24.68
Tbilisi	0481914;4620935	Stanislavski St.	Urban background	31.16
Tbilisi	0479171;4618706	Budapesti St.	Urban background	47.58
Tbilisi	0481150;4618825	Bakhtrioni St.	Urban background	37.04
Tbilisi	0479171;4618706	Hippodrome	Road side	27.21
Tbilisi	0479016;4619419	Vasha Pshavela Av.	Road side	27.13
Tbilisi	0482824;4618209	Agmashenebeli Av.	Road side	59.36
Tbilisi	0483058; 468041	Tolstonokovi St.	Urban background	46.65

Tbilisi	0481285;4623607	G. Gogiberidzest. Park	Urban background	12.70
Tbilisi	0479985;4627009	Tavdadebulistr and Petritsi St.	Road side	14.53
Tbilisi	0484569;4627018	Gldani district. Mosulishvilist. Park	Kerbside	26.98
Tbilisi	0485298;4626981	Mosulishvilist. School #79 area	Suburban	33.74
Tbilisi	0485260;4624823	Temqa district	Urban background	24.50
Tbilisi	043678; 4624702	Chargali St.	Urban background	44.84
Tbilisi	0483280;4624997	Shatili St.	Urban background	22.76
Tbilisi	0476986;4618521	University - Maglivi building	Urban background	17.69
Tbilisi	483497; 4615710	Freedom Sq.	Kerbside	59.17
Tbilisi	483113; 4616166	1st School	Kerbside	42.14
Tbilisi	482494; 4617004	Rustaveli Av.	Kerbside	94.03
Tbilisi	482502; 4617274	Leo Kiacheli St.	Road side	53.25
Tbilisi	482161; 4617409	Kostava St.	Road side	80.78
Tbilisi	480938; 4617301	Abashidze St.	Suburban	51.68
Tbilisi	480268; 4617690	Zurab Arakishvili St.	Urban background	51.16
Tbilisi	479447; 4616434	Turtle lake	Suburban	9.57
Tbilisi	481163; 4617828	Mziuri Park	Roadside	29.67
Tbilisi	481825; 4617435	Melikishvili Av.	Urban	70.60
Tbilisi	494172; 4612152	Besarion Chichinadze St.	Suburban	19.19
Tbilisi	496457; 4615873	Lilo settlement	Suburban	14.37
Tbilisi	488119; 4615605	Dimitri Uznadzis St.	Urban background	34.28
Tbilisi	4876105;4616510	Teopane Davitiani St.	Suburban	28.37
Rustavi	497954; 4601590	Rustavi 1	Kerbside	14.08
Rustavi	498474; 4602342	Rustavi 2	Sub urban	14.89
Rustavi	501619; 4597497	Rustavi 3	Industrial	16.76
Rustavi	503900; 4595427	Rustavi 5	Industrial	20.32
Rustavi	504560; 4597282	Rustavi 6	Industrial	17.77
Rustavi	506989; 4602169	Rustavi 7	Rural	9.34
Rustavi	508572; 4598787	Rustavi 4	Industrial	16.76

Background Data for NO_2

Background concentrations of NO_x were derived taken from the outputs of a preliminary study based upon EMEP/MSC-W modelled concentrations[3].

Table 5. Summary of NO_x Background Concentrations

Substance	Annual average concentration (µg/m^3)

[3] With input from international experts.

NO_x	3.46
NO_2	2.43

Modelling Data for NO_2

Modelling results for NO2 ambient concentrations predicted:

- Annual mean concentrations to remain below 23.2 µg /m^3 and to vary between 3.04 to 23.2µg/m^3 in Kutaisi; at selected receptors hourly concentrations to range between 21.12 to 149.67 µg/m^3; annual averages to exceed EU air quality limit values along major roads throughout Kutaisi to lead to the exceedances of EU annual limit value of 40 µg/m^3,though the hourly limit value has been predicted to not be at risk of being exceeded; both lower and upper assessment thresholds for annual mean and hourly mean of nitrogen dioxide to exceed at limited receptor locations
- Annual mean concentrations to vary between 2.9 to 25.1µg/m^3 and the hourly concentrations between 6.05 to 105.23 µg/m^3 across large area of Zestaphoni; annual averages to exceed EU air quality limit values in areas close to a single point source to the west of Zestaphoni and along the two major roads passing through Zestaphoni, including the E60 to the west and the Gomi-Sachkhere-Chiatura-Zestaphoni road north east of the city, leading to high likelihood of exceeding the EU annual limit value of 40 µg/m^{3}at a limited number of receptors locations; Hourly limit values to fall well below the 200 µg/m^{3}limit value; Both lower assessment thresholds for annual mean and hourly mean to be exceeded at one receptor location in Zestaphoni and the upper assessment threshold for annual mean nitrogen dioxide to be exceeded within at least one selected receptor location in Zestaphoni
- Annual average concentrations in the area adjacent to the Gomi-Sachkhere-Chiatura-Zestaphoni Road in Chiatura and to vary within the range of 35-40 µg/m^3 within 200 meters both sides of roads to lead to exceedances of LAT, UAT and LV for annual averages; Elsewhere in Chiatura annual mean concentrations to remain below 3.61µg/m^3, with 15.49 µg/m^{3}hourly maximums to occur at selected receptor locations of Chiatura;NO_2 concentrations below EU hourly limit values
- Annual averages across Rustavi to vary between 2.44 and 46.32 µg/m3, with large areas of the city to experience NO_2 concentrations above 12.08µg/m^3 and below 21.37µg/m^3 and with peaks to occur in the vicinity close to the Georgia steel plant (46.32 µg/m3 within 200 metres of the plant stack) and at a receptor locations close to the E60 highway and the Rustavi-Gardabani-Vakhtangisi road ; Annual average concentrations to have a high likelihood to exceed EU annual limit value at a limited number of receptor locations and a very low likelihood to exceed EU hourly limit value (200µg/m^3)
- Explicitly busy road, junctions and those areas close to busy road and junctions in central Tbilisi to experience elevated concentrations and likely to exceed LAT, UAT's and LV for the annual mean LV due to busy traffic and close alignment of NO_x point, area and diffuse sources to the major roads of the city; approximately 10% of the citywide area and areas within 150 m of busy traffic routes (Agmashenebeli avenue) to exceed EU annual average limit value, about 30% of the citywide area and areas within 250 m of busy traffic routes to exceed EU annual average LV LAT and, about 15% of the citywide area and areas within 200 m of busy traffic roads to exceed annual average LV UAT.

Figures 18-22 below show spatial distribution of annual NO_2 concentrations across the cities modelled.

Figure 18.Modelled Annual Mean NO_2Concentration (µg/m3) Distribution across Kutaisi, Georgia

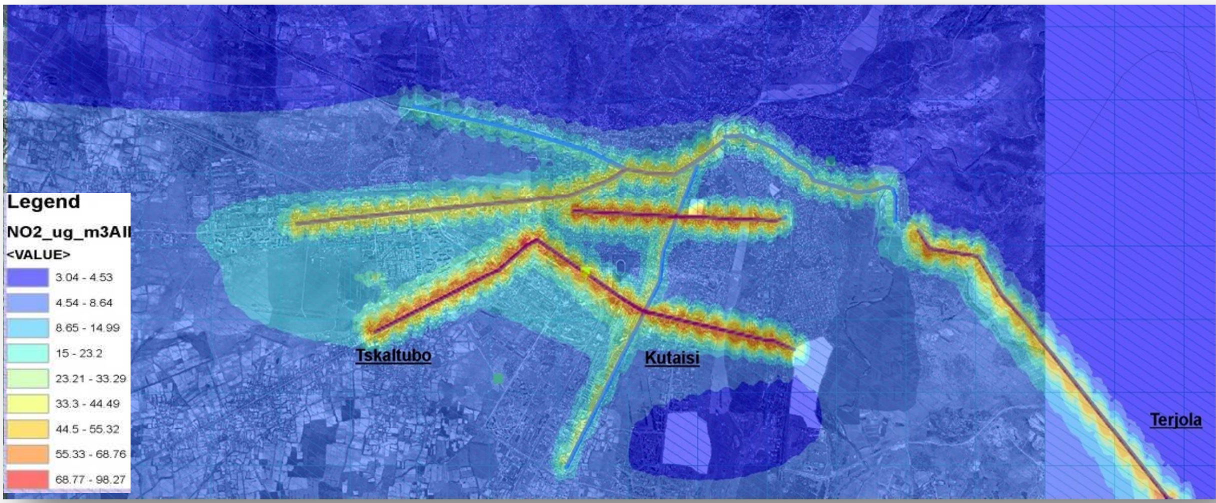


Figure 19.Modelled Annual Mean NO_2 Concentration (µg/m^3) Distribution across Zestaphoni, Georgia

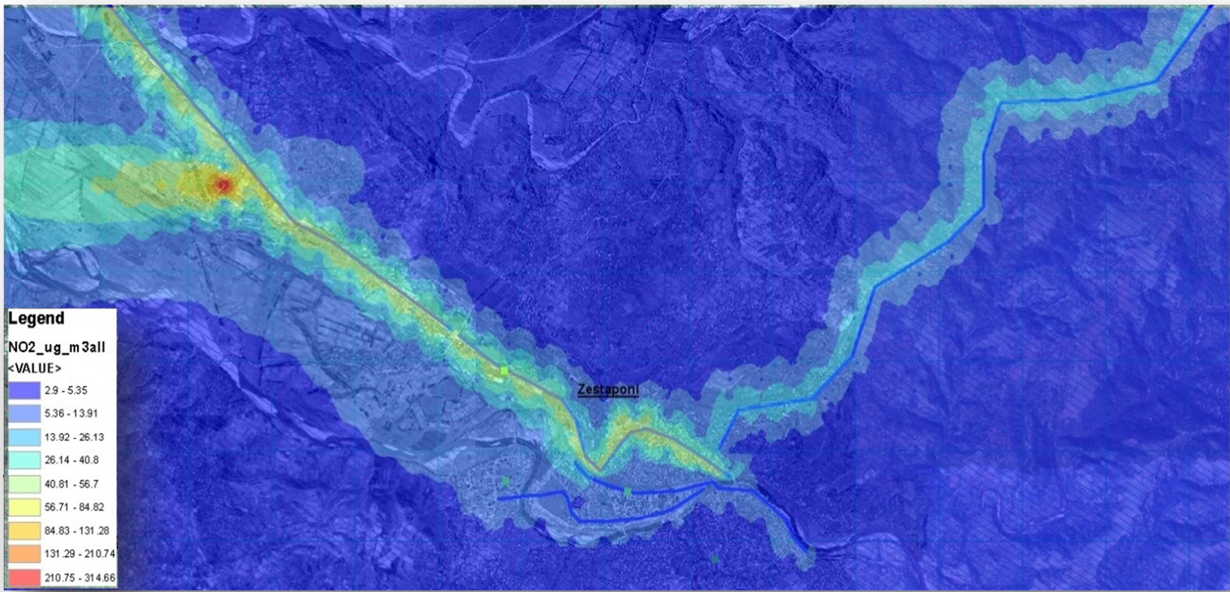


Figure 20.Modelled Annual Mean NO_2 (µg/m^3) Concentration Distribution across Chiatura, Georgia

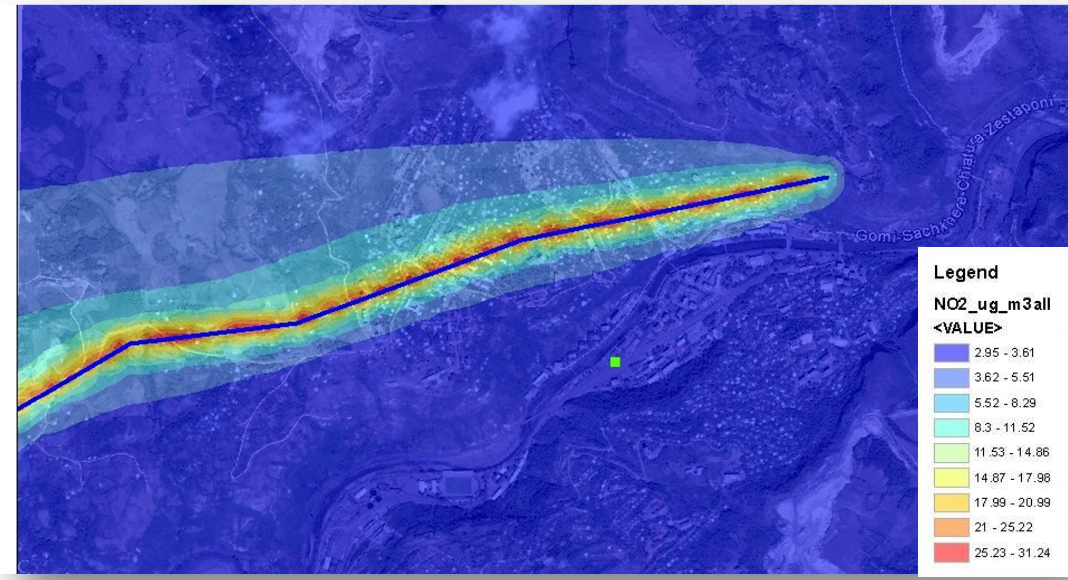


Figure 21.Modelled Annual Mean NO_2 Concentration ($\mu g/m^3$) Distribution across Rustavi, Georgia

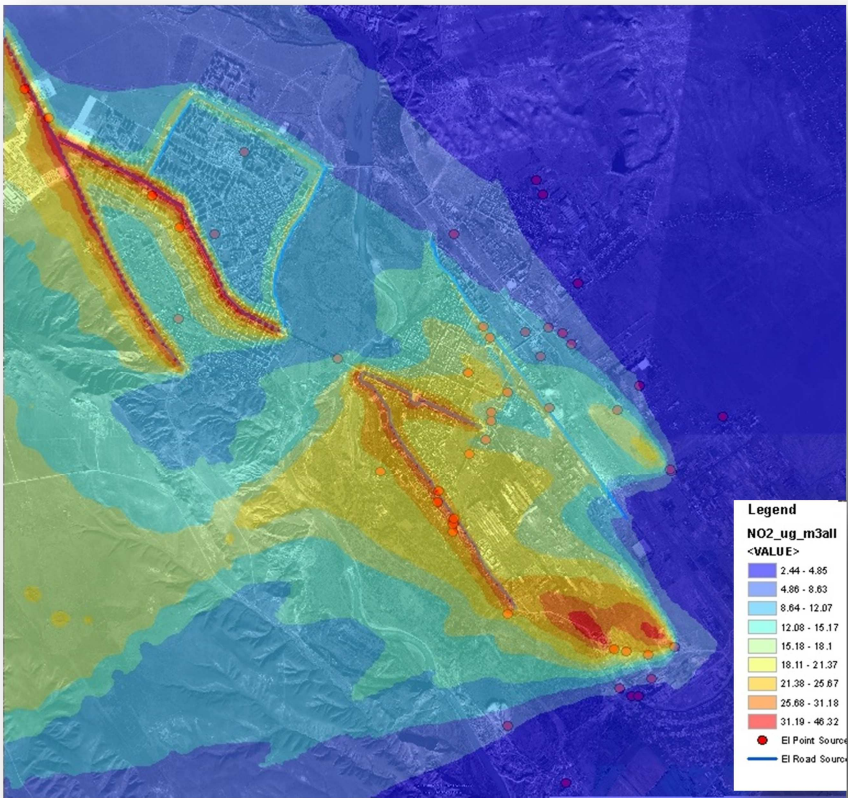


Figure 22.Modelled Annual Mean NO_2 Concentration ($\mu g/m^3$) Distribution across Tbilisi, Georgia

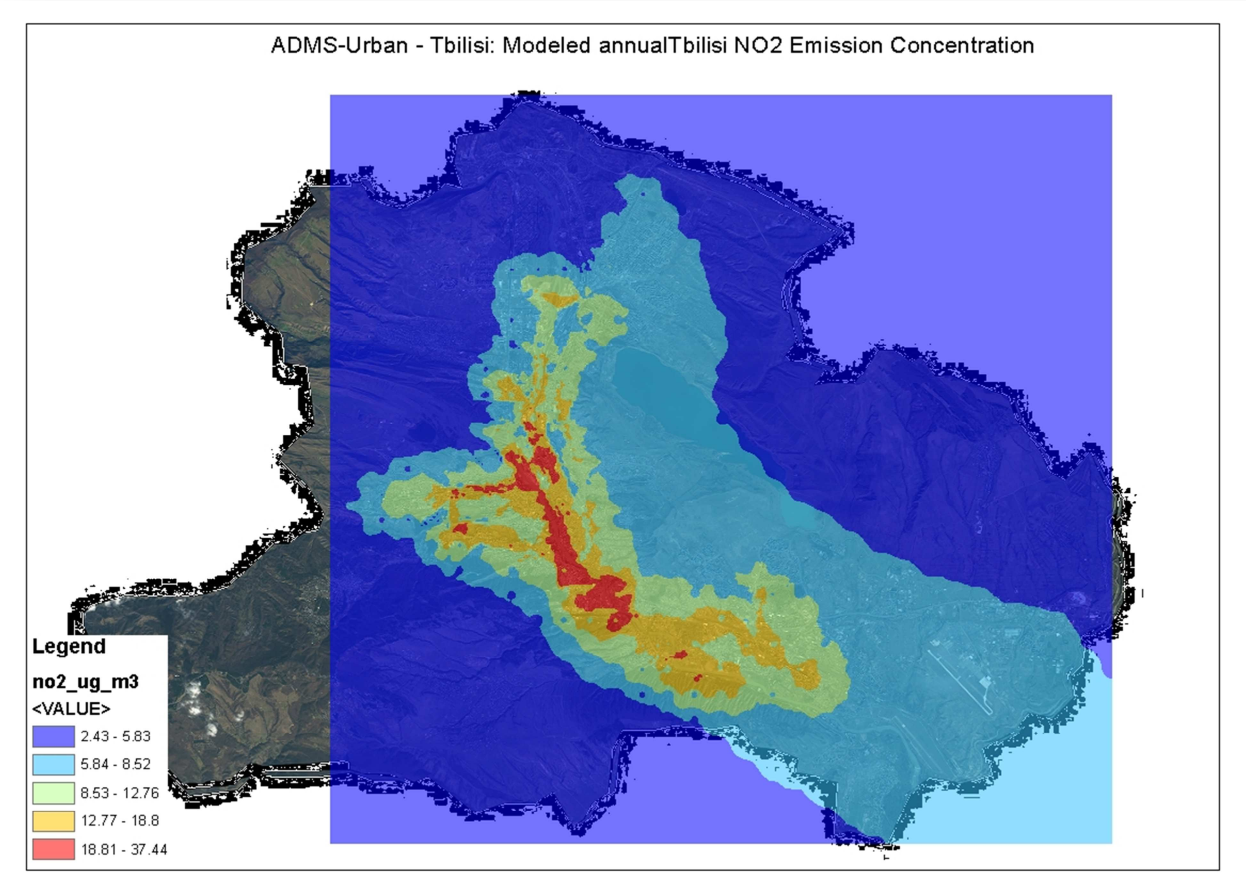


Table 6.Modelling output Concentrations of NO_2 ($\mu g/m^3$) at selected Receptors locations in Georgia

City	Receptor	NO_2 Annual Mean $\mu g/m^3$	NO_2 Hourly Maxima $\mu g/m^3$
Kutaisi	Cemetery	4.96	21.12
	Chavchavadze	69.80	149.67
	Sapichkia	8.60	26.67
Zestaphoni	"55"	3.22	6.05
	Agmashenebli	14.13	32.03
	Kvaliti	3.05	7.03
	Chikashua	4.91	16.02
	Saqkabeli	41.53	105.23
Chiatura	Chavchavadz	5.27	15.49
Rustavi	Rustavi 1	14.67	42.33
	Rustavi 2	10.11	29.57
	Rustavi 3	19.19	47.82
	Rustavi 4	2.43	2.43
	Rustavi 5	2.91	3.52
	Rustavi 6	2.92	3.55
	Rustavi 7	2.64	3.46
Tbilisi	Tolstonokovi St.	3.35	19.13
	Chargali St.	3.51	22.15
	Tbilisi - Lilo settlement	11.27	77.42
	Tbilisi – Besarion	13.79	114.46

	Chichinadze St.		
	Conjunction of Tavdadebulistr and Petritsi St.	16.09	120.74
	Mosulishvili St. School #79 area	16.51	112.37
	Temqa district	16.84	103.19
	Temqa	16.84	103.19
	Tbilisi - Turtle lake	17.74	124.15
	University - Maglivi building	18.94	126.65
	Tbilisi – Teopane Davitiani St.	20.56	118.54
	Shatili St. Nearby the Caucasus international University	24.17	122.65
	Gldani district. Mosulishvili str. Park	25.35	119.81
	Tbilisi – Dimitri Uznadzis St.	25.57	122.17
	G. Gogiberidze St. Park	29.89	137.21
	Tbilisi 29	31.15	125.70
	Dadiani St.	31.71	128.02
	Tbilisi - Mziuri Park	36.92	139.76
	Stanislavski St.	37.40	135.60
	Tbilisi - Freedom Sq	37.55	145.54
	Budapesti St.	37.77	130.93
	Hippodrome	37.77	130.93
	Tbilisi - 1st School	37.98	139.24
	Surami St.	39.16	137.25
	Vasha Pshavela Av.	39.33	164.15
	Bakhtrioni St.	41.33	134.10
	Tbilisi - Rustaveli Av.	44.93	146.14
	Tbilisi – Zurab Arakishvili St.	46.94	160.17
	Agmashenebeli Av.	48.36	141.24
	Tbilisi –Kostava St.	48.67	148.33
	Tbilisi - Leo Kiacheli St.	50.71	164.93
	Tbilisi - Abashidze St.	52.70	163.42
	Tbilisi 14	57.69	190.72
	Tsereteli St.	58.50	166.78
	Agmashenebeli Str.	62.51	171.60
	Tbilisi –Melikishvili Av.	83.69	222.80

Expert Judgments on Areas for which Insufficient Data is Available

For zones with no NO_x routine monitoring data, rough judgements on exceedances of UAT and LAT can be made based on emission source concentrations, total and per unit area emissions as well as based on passive sampling data, where available.

Presumably, zones with moderately low to very low population densities, low concentrations of emission sources and un-notable emissions levels may have air quality falling below the UAT and LAT and thus, requiring the least stringent assessment regimes. Moreover, these assumptions could be strengthened by surrogate passive sampling data, where available. More specifically, for zones such as Racha-Lechkhumi and Svaneti, Samtskhe-Javakheti, Mtskheta-Mtianeti and Kakheti and Shida Kartli only data sources are emission source concentration and emission levels. These data for all zones, except for Shida Kartli indicate low to very low emissions levels leading to the presumption of air quality being below the UAT and LAT requiring the least stringent assessment regimes. In case of

Shida Kartli total emissions as well as emissions per square kilometre are high, very close to Imereti emissions and presumably UAT is exceeded therefore, requiring stringent assessment regime, e.g. data measurements. For Samegrelo-Guria zone, apart from emissions data passive sampling data at urban and sub-urban locations of the city of Poti are available. All these data indicate on low NO_x emissions and NO_2 mean annual concentrations below EU annual average and hourly maximum LV, UAT and LAT in Poti, ranging from 7.54 μg/m^3 to 18.50 μg/m^3, with the maximum value close to annual average LV LAT. Therefore, Samegrelo-Guria region can be assigned only air quality modelling at the initial stage and then monitoring, supplemented by modelling and passive sampling. For Abkhazia no single set of data is available due to the de-facto breakaway regime in this area. Thus, data availability is closely related to the reintegration progress of this region; It is unlikely this to happen within next 5 years.

NO2 Concentrations Summary

Table 7. Summary of Assessment of Exceedances of EU LAT, UAT and LVs

NO_2 Concentrations μg/m^3							
Zone/Agglomeration	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Overall**
Abkhazia	-	-	-	-	-	-	
Racha-Lechkhumi, Kvemo and Zemo Svaneti	-	-	-	-	-	-	
Samegrelo-Guria: Poti	-	-	-	-	-	-	
Adjara: Batumi	> Annual UAT; >Hourly LAT	> Annual UAT; = Hourly LAT	> Annual UAT; < hourly LAT	> Annual UAT; < Hourly LV UAT	> Annual UAT; ≤ hourly UAT	***Routine measurement***: > Annual LAT, UAT, LV;>Hourly LAT, UAT, LV ***Passive sampling:***>Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	***Routine measurements:***> Hourly LAT, Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:***> Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV
Imereti							
Zestaphoni	> Annual UAT	> Annual UAT	> Annual UAT	> Annual UAT	> Annual UAT	***Routine measurements:***>Annual LAT, Annual UAT, Annual LV ***Passive sampling:***> Annual LAT, UAT ***Modelling:*** Hourly LAT, Annual LAT, Annual UAT, Annual LV	***Routine measurements:***> Annual LAT, Annual UAT, Annual LV ***Passive sampling:***> Annual LAT, UAT ***Modelling:*** Hourly LAT, Annual LAT, Annual UAT, Annual LV
Kutaisi	>Annual UAT; <	>Annual UAT; <	>Annual UAT; < Hourly LAT	>Annual UAT; > Hourly LAT	>Annual UAT; <	***Routine measurements:***>Ho	***Routine measurements:***>

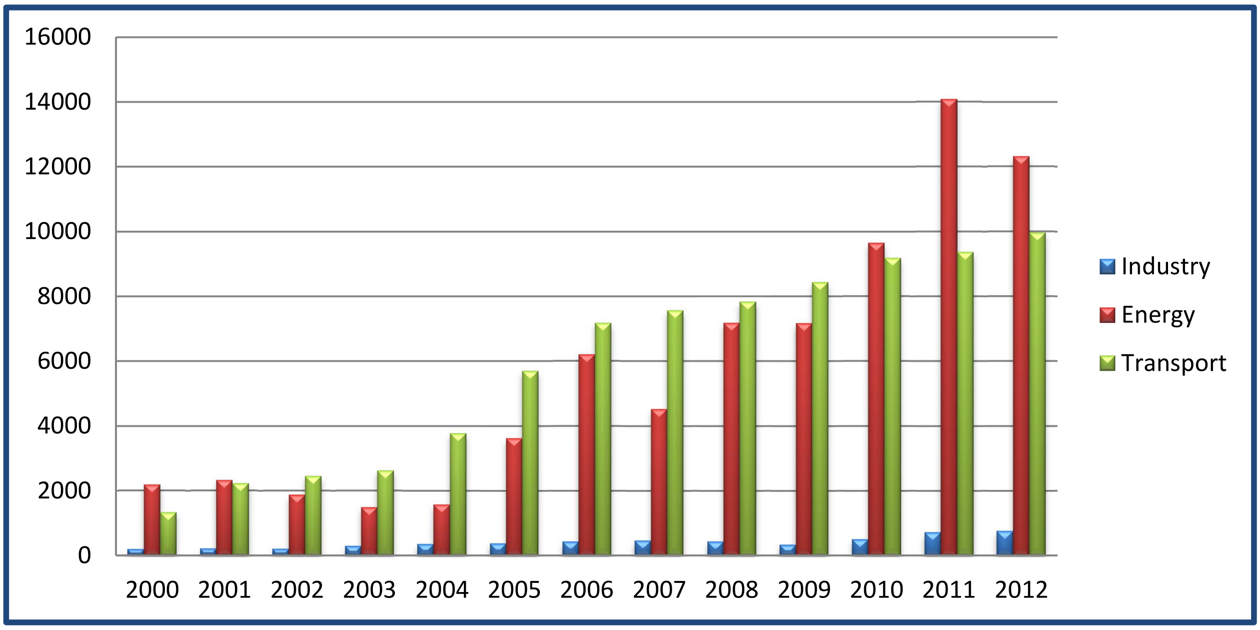
	Hourly LAT	Hourly LAT			Hourly LAT	urly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:***>Annual LAT, Annual UAT ***Modelling:*** Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV	Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:***>Annual LAT, Annual UAT ***Modelling:*** Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV
Chiatura	-	-	-	-	-	***Modelling:*** < Annual LAT, UAT, LV ***Passive sampling:***<Annual LAT, UAT	No exceedances
Shida Kartli (including South Ossetia)	-	-	-	-	-	-	
Samtkhe-Javakhet	-	-	-	-	-	-	
Kvemo Kartli (Rustavi)	>Annual LAT, UAT	>Annual LAT, UAT	>Annual LAT, UAT	>Annual LAT, UAT	>Annual LAT, UAT	***Routine measurements:***>Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:***>Annual LAT, Annual UAT ***Modelling:*** Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV	***Routine measurements:***> Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:***>Annual LAT, Annual UAT ***Modelling:*** Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV
Mtskheta-Mtianeti and Kakheti	-	-	-	-	-	-	
Tbilisi							***Routine measurement:***> Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Passive sampling:*** **>**Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV ***Modelling:***>Annual LAT< UAT, LV
Kvinitadze St.	> Annual UAT	> Annual UAT	> Annual UAT	> Annual UAT	> Annual UAT	***Routine measurement:***> Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	
Moscow Ave.	-	-	-	-	-	***Routine measurement:***> Annual LV	

1.5. ASSESSMENT FOR SO_2

SO_2 Emissions

In accordance with emission trends, since 2000 to 2012 SO_x emissions likewise NO_x emissions have been steady increasing, with transport sector keeping the leading position until 2010 and with energy sector overgrowing transport emissions for the period from 2010 through 2012.

Figure 23.2000-2012 SO_2 Emissions



As for points source SO_2 emissions per Georgia's regions, zones and agglomerations, in 2012 Kvemo Kartli zone was marked with the highest emissions, followed by Imereti and Shida Kartli zones. Below figure shows 2012 point source SO_2 emissions per Georgia's regions and proposed zones and agglomerations.

Figure 24. Distribution of 2012 SO_2 Emissions (tons) among Regions of Georgia

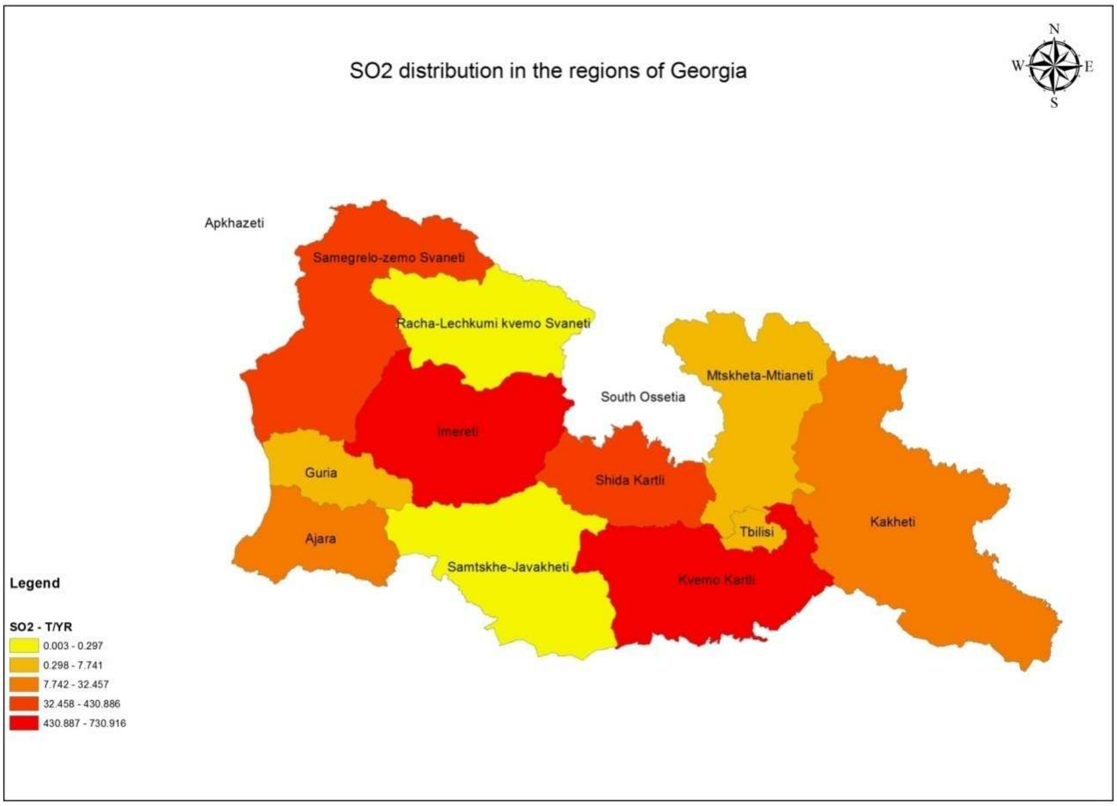


Figure 25. 2012 SO_2Emissions (t/sq. km) per Regions of Georgia

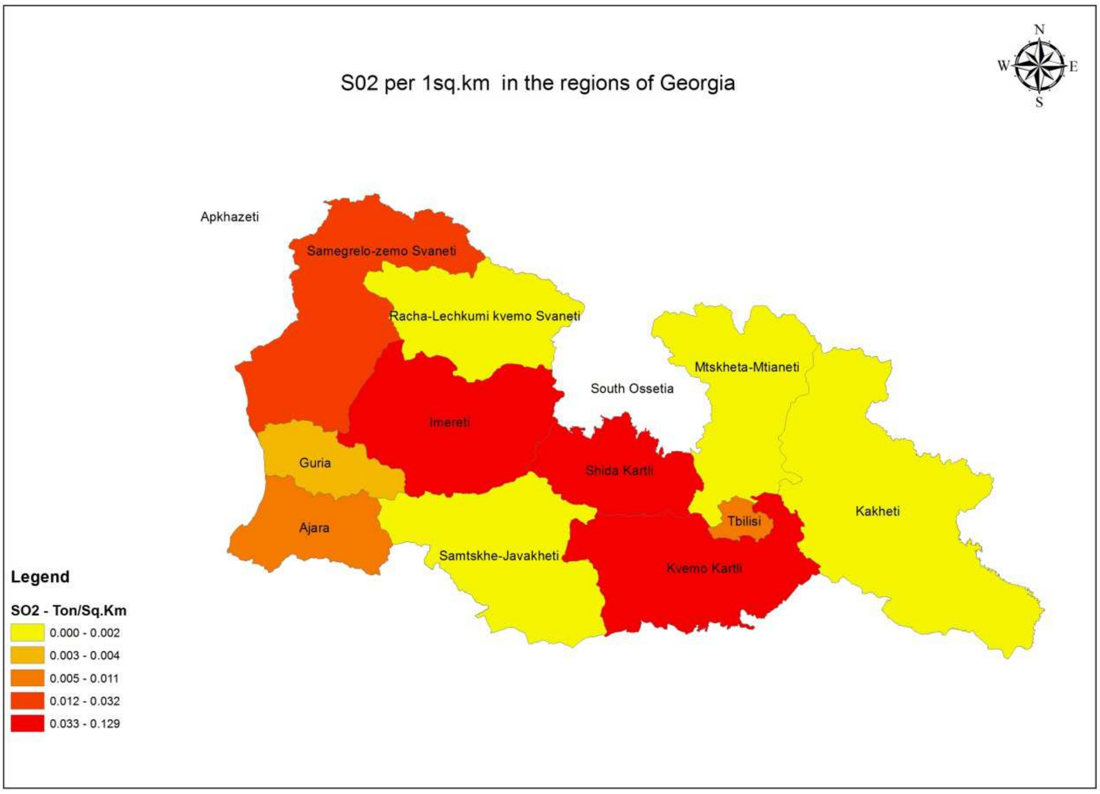
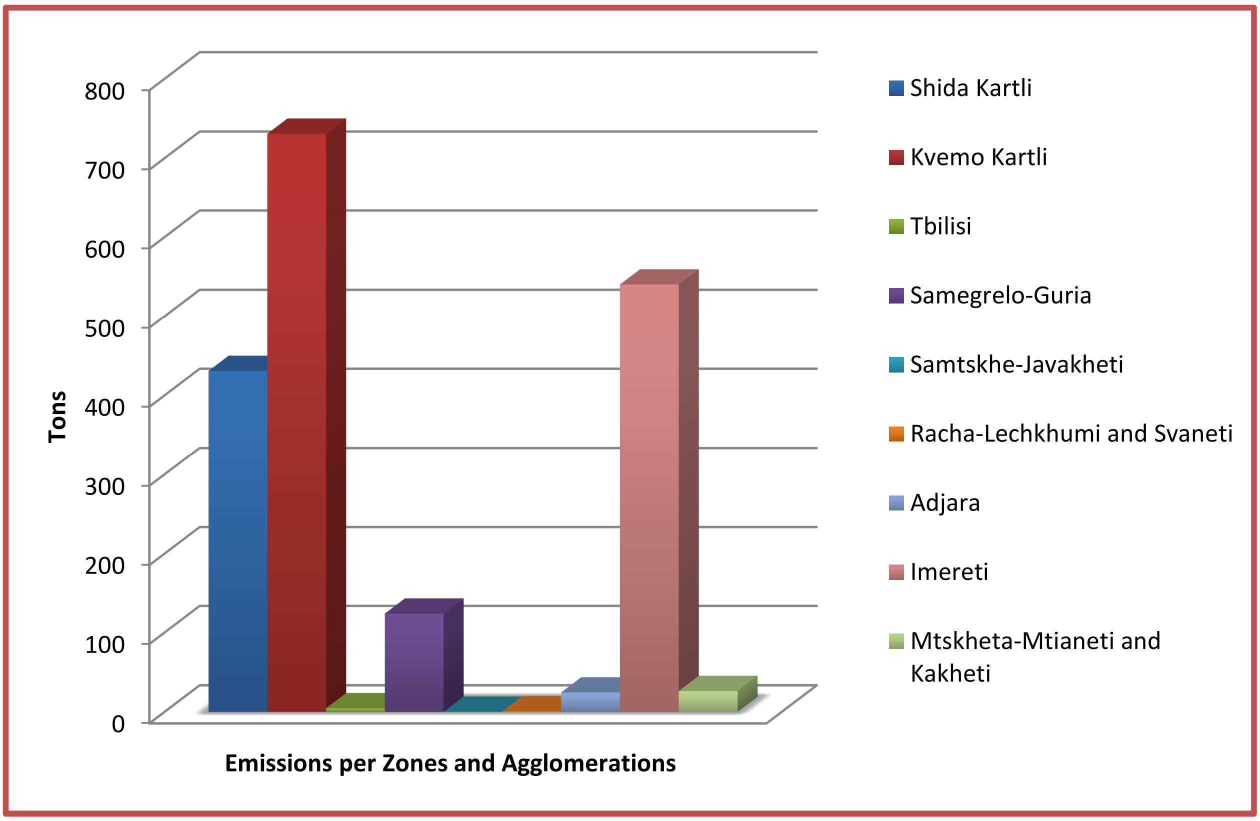


Figure 26. 2012 SO_2 Emissions Per Zones & Agglomerations



Long term Monitoring Data for SO_2

Sulphur dioxide is continuously monitored in 4 cities within Georgia. Monitoring is performed using non-reference methods (with exception of the new Tbilisi station from 2013).More specifically, sulphur dioxide monitoring methods used throughout Georgia, do not follow ISO reference methods and ambient air sampling is restricted to the mid-week day time periods only. This sampling arrangement excludes times within any given 24-hr period when local SO_2 emissions would diminish such hours between midnight and 6am, as well as weekend periods. Excluding periods when minimum pollutant concentrations would occur artificially raises the baseline SO_2 concentration, resulting in monitoring results averages appearing much higher than they may well be.

Table 8, below, contains a summary of the annual average concentrations of SO_2 monitored within the air quality network located across 5 Georgian cities from 2008 through 2013.

Table 8.2008-2013 Urban Air Quality Trend for SO_2[4]

Pollutant	Annual Mean, μg/m³						Georgia MACs, μg/m³		EU Limit values
	2008	2009	2010	2011	2012	2013*	Max (20-30 min.)	Daily average (24 hours)	
Batumi									
SO2	90	100	69	70	110	138	500	50	One day[5] 125 μg/m³

[4]Source: Ambient Air Pollution Yearbook, 2012, National Environmental Agency. saqarTvelosteritoriazeatmosferulihaerisdabinZurebisweliwdeuli. GaremoserovnulisaagentosgaremosdabinZurebismonitoringisdepartamentismonacemebi. 2012 weli

[5] Not to be exceeded more than 3 times a calendar year

										One hour[6] 350 µg/m^3
Zestaphoni										
SO2		112	110	120	120	120	127	500	50	One day125 µg/m^3
										One hour 350 µg/m^3
Rustavi										
SO_2		-	-	-	-	-	-	500	50	One day125 µg/m^3
										One hour 350 µg/m^3
Kutaisi										
SO_2		-	150	150	180	196	179	500	50	One day125 µg/m^3
										One hour 350 µg/m^3
Tbilisi										
NO2	Kvinitadze St.	130	120	98	90	90	119	500	50	One day125 µg/m^3
										One hour 350 µg/m^3

The table above shows systematic exceedancesSO_2 Georgian daily average MAC (50µg/m^3) every year at all monitoring sites, where this pollutant was measured (all cities except for Rustavi). EU limit values for SO_2 (125 µg/m^3 daily average and 20 µg/m^3 annual mean) were also exceeded every year in Kutaisi and in 2013 at all monitoring sites, except for Tbilisi.

As for monthly air quality profile, 2013 February-2014 February routine monitoring data were analysed *(see below figures 27-30)*, also revealing regular exceedances of Georgia daily average MAC and EU daily annual average limit values at all six monitoring sites. All city monitoring sites (Batumi, Zestaphoni, Kutaisi and Tbilisi) returned monthly SO_2concentrationsin excess of 100 µg/m^3. With Kutaisi experiencing the highest monthly SO_2average concentrations approaching 200 µg/m^{3}for the months of February, April and May 2013. At the sample locations, all of the above Georgia cities have been observed to routinely exceed SO_2 the daily MAC of SO_2 and well as the LAT, UAT and daily limit values in all four cities.

Figure 27. 2013 February-2014 February average monthly concentrations (µg/m^3) of SO_2 measured at Batumi ambient air quality monitoring site

[6] Not to be exceeded morethan24times a calendar year

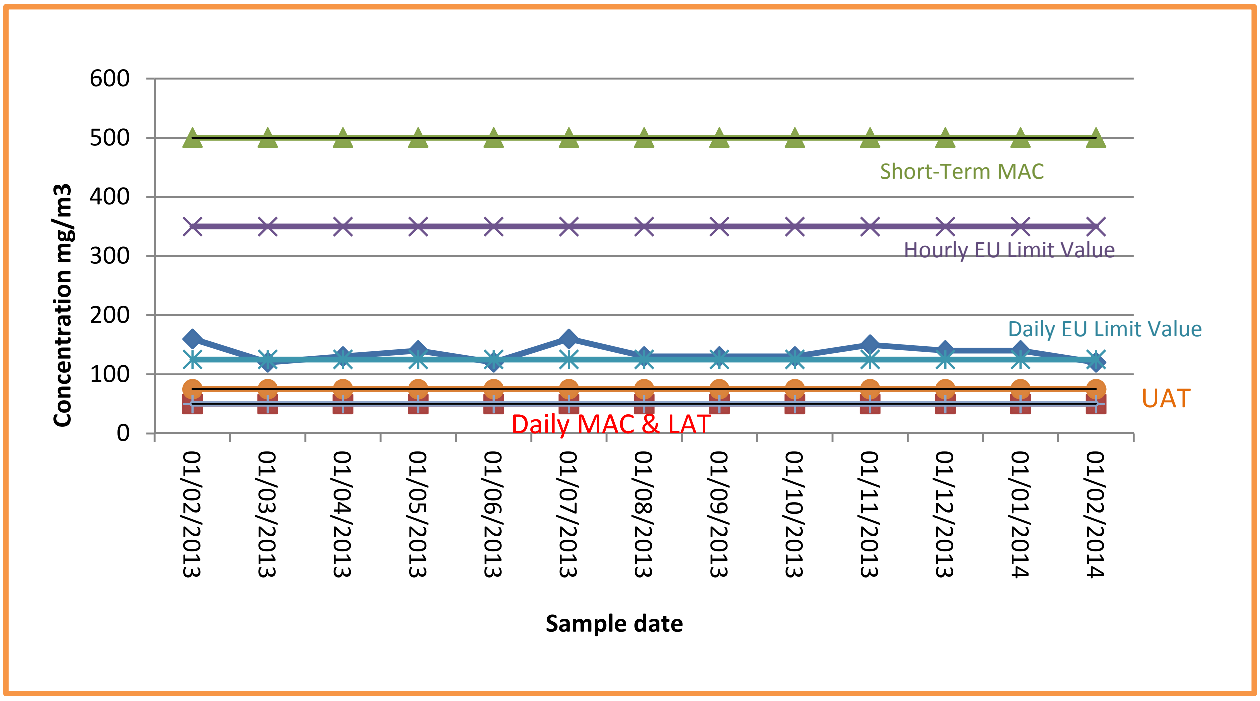


Figure 28. 2013 February-2014 February average monthly concentrations (µg/m^3) of SO_2 measured at Zestaphoni ambient air quality monitoring site

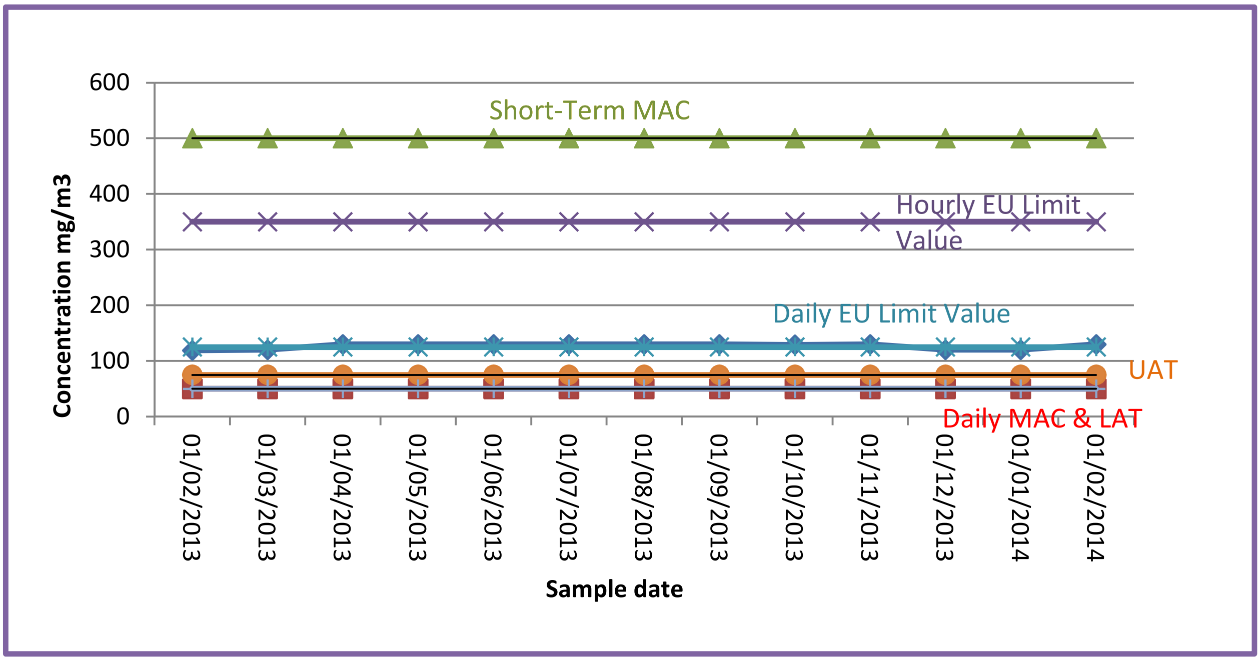


Figure 29. 2013 February-2014 February average monthly concentrations (µg/m^3) of SO_2 measured at Kutaisi ambient air quality monitoring site

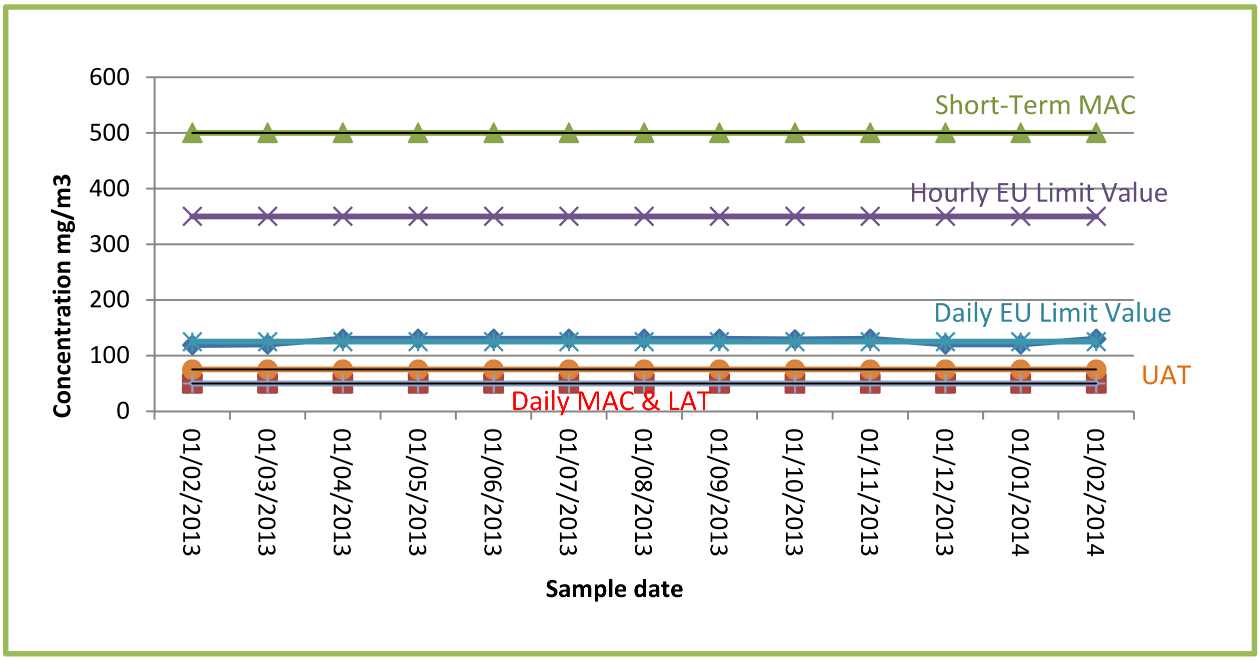
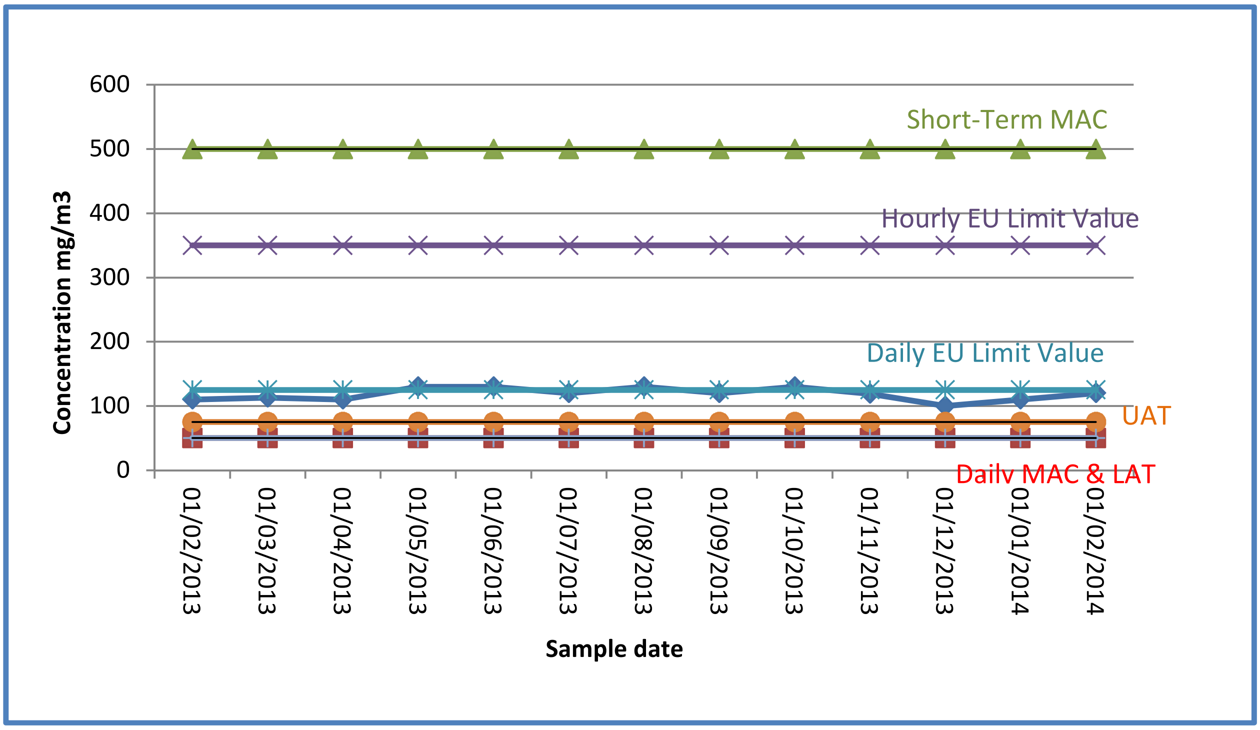


Figure 30. 2013 February-2014 February average monthly concentrations (µg/m^3) of SO_2 measured at Tbilisi ambient air quality monitoring site



Background Data for SO_2

Background concentrations of SO_2 were derived taken from the outputs of a preliminary study based upon EMEP/MSC-W modelled concentrations[7].

[7] With input from international experts.

Table 9. Summary of SO_2 Background Concentrations

Substance	Annual average concentration (µg/m³)
SO2	0.7

Modelling Data for SO_2

Modelling results for SO_2 ambient concentrations showed the following:

- Imereti region:
  - Imereti region has been recorded as having one of the largest emissions of SO_2across all of the regions of Georgia. Dispersion modelling outputs have not reflected this magnitude of SO_2 emissions in the resulting ambient air concentrations. At this stage hourly and winter distributions of SO_2 were not derived, due to current underlying uncertainties within the emissions data;
  - Annual average modelled concentrations of SO_2 in Kutaisi are lower than anticipated, not reflecting the emissions inventory and the current record of SO_2 monitoring data. Thus, the revisions to this model should be undertaken and updated;
  - Annual average modelled concentrations of SO_2 in Zestaphoni are is lower than anticipated, not reflecting the emissions inventory and the current record of SO_2 monitoring data. Thus, the revisions to this model should be undertaken and updated;
  - Annual average modelled concentrations of SO_2 in Chiatura are lower than anticipated, not reflecting the emissions inventory and the current record of SO_2 monitoring data. Thus, the revisions to this model should be undertaken and updated.
- Modelled concentrations of sulphur dioxide in Rustavi indicated that annual mean sulphur dioxide concentrations across large areas of Rustavi will remain below 9.05 $\mu g/m^3$. Sulphur dioxide concentrations across the city have been predicted to range between 0.70 to 133.97 $\mu g/m^3$. Concentrations at receptor locations within 1 kilometre to the major emissions source within the Rustavi Steel Plant in Rustavi, are predicted to be in excess of 20.57 $\mu g/m^3$ as an annual mean. Sulphur dioxide concentrations rise rapidly in areas very close to the Plant, with sulphur dioxide in ambient air reaching a maxima of 133.97 $\mu g/m^3$ within 200 metres of the plant stack. Elsewhere ambient concentrations of sulphur dioxide were predicted to remain close to the background, with no significant contribution from any diffuse or point sources in Rustavi.
- Estimated annual average concentrations of SO_2 for Tbilisi indicated that large areas of Tbilisi experience very low levels of SO_2, less than 5 $\mu g/m^3$. According to the modelling results the city's central area is free from SO_2, with no significant concentrations at any of the receptors locations, with annual average concentrations exceeding 45 $\mu g/m^3$. The pattern of SO_2 concentrations follows the principal roads into the city centre. As greater level of road traffic information was readily available for the city of Tbilisi, including vehicle category and fuel, which has high sulphur content. This is reflected in the predicted SO_2 annual average concentrations for Tbilisi, which imply that the dominant source of SO_2 in Tbilisi is vehicle emissions. This may not be the case and that a significant proportion of point source emissions may well need to be accounted in the emission inventory.

Figures 31-32 below show spatial distribution of annual NO_2 concentrations across the cities modelled.

Figure 31.Modelled Annual Mean SO_2 Concentration (µg/m^3)Distribution across Rustavi, Georgia

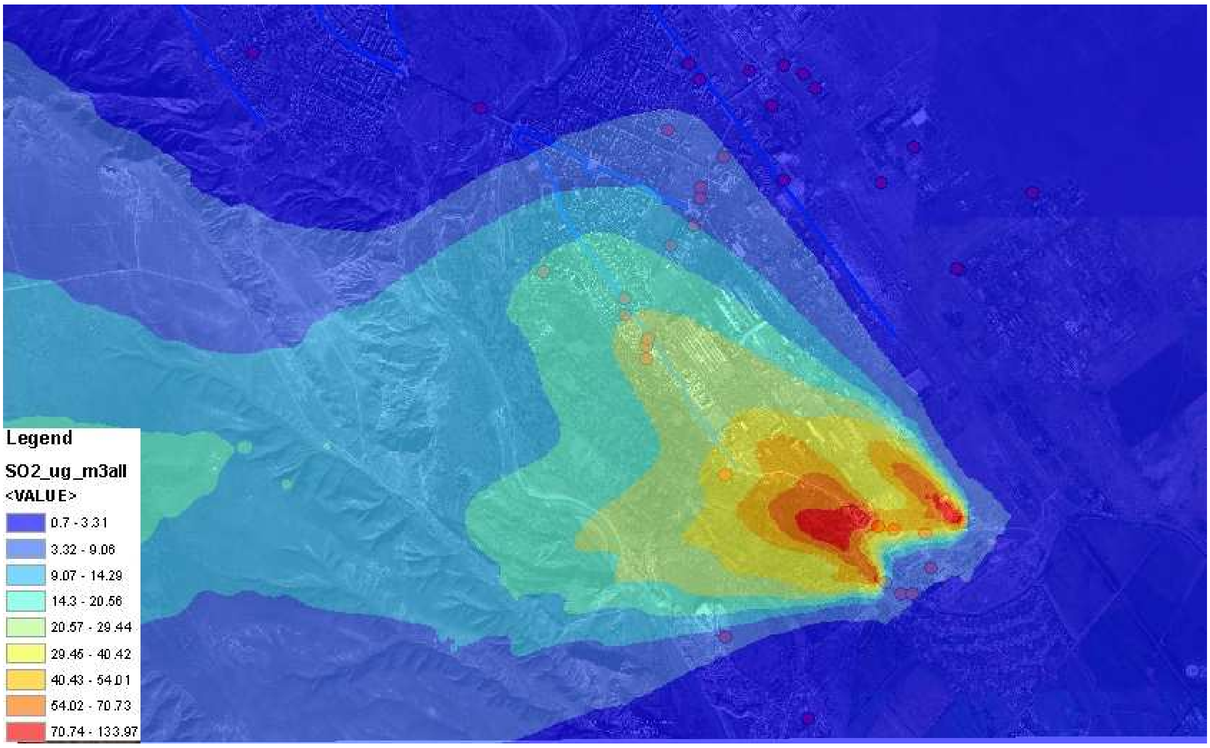
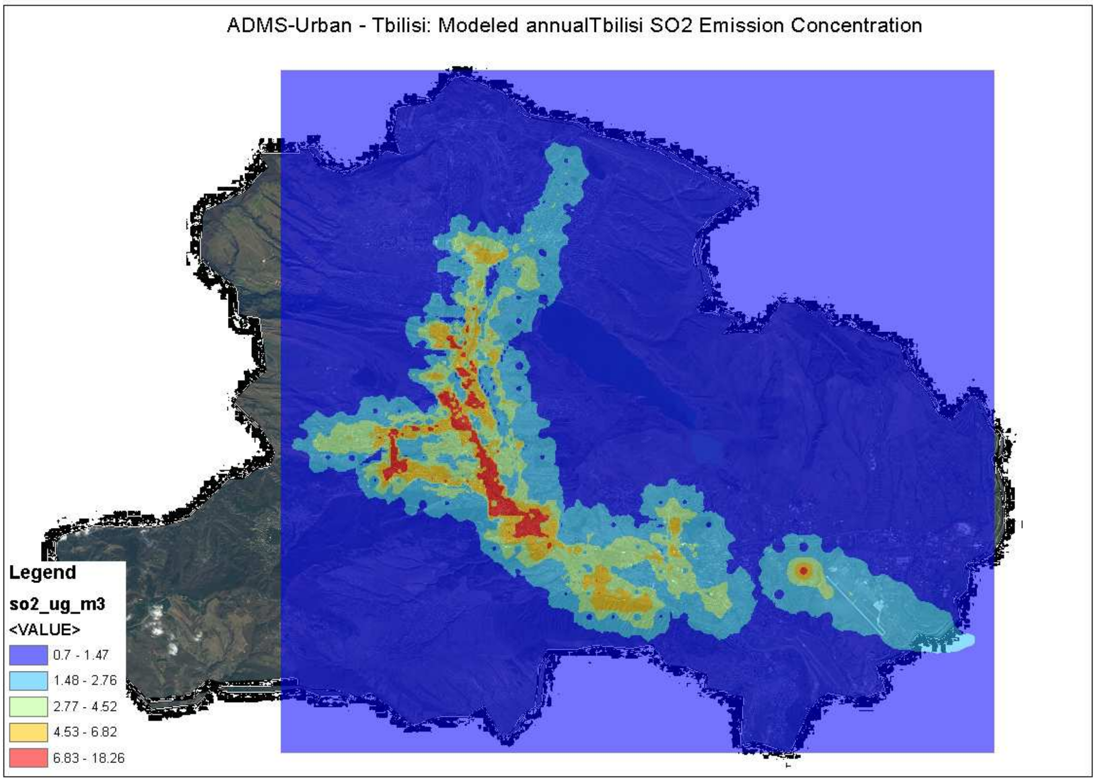


Figure 32.Modelled Annual Mean SO_2 Concentration (µg/m^3)Distribution across Tbilisi, Georgia



Expert Judgments on Areas for which Insufficient Data is Available

For zones with no SO_2 routine monitoring data, rough judgements on exceedances of UAT and LAT can be made based on emission source concentrations, total and per unit area emissions as well as based on passive sampling data, where available.

Presumably, zones with moderately low to very low population densities, low concentrations of emission sources and insignificant emissions levels may have air quality falling below the UAT and LAT and thus, requiring less stringent assessment regimes. More specifically, for zones such as Racha-Lechkhumi and Svaneti, Samtskhe-Javakheti, Mtskheta-Mtianeti and Kakheti and Shida Kartli the only data sources are emission source concentration and emission levels. These data for all zones, except for Shida Kartli and Samegrelo indicate low to very low emissions levels leading to the presumption of air quality being below the UAT and LAT requiring the least stringent assessment regimes. In case of Shida Kartli total emissions as well as emissions per square kilometre are high, very close to Imereti emissions and presumably UAT is exceeded therefore, requiring stringent assessment regime, e.g. data measurements. For Samegrelo-Guria zone, emissions are marked with moderately high levels that might indicate on exceedances of LAT.

SO_2 Concentrations Summary

Table 10. Results of Assessments of EU LAT, UAT and LV Exceedances for SO_2

SO_2 Concentrations $\mu g/m^3$							
Zone/Agglomeration	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Overall**
Abkhazia	-	-	-	-	-	-	

Racha-Lechkhumi, Kvemo and Zemo Svaneti	-	-	-	-	-	-	
Samegrelo-Guria: Poti	-	-	-	-	-	-	
Adjara: Batumi	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV; > 24 hour LAT, UAT	> Annual LAT, UAT, LV; > 24 hour LAT, UAT	> Annual LAT, UAT, LV; > 24 hour LAT, UAT	***Routine measurement data:***> Annual LAT, UAT, LV; > 24 hour LAT, UAT and LV	***Routine measurement :***> Annual LAT, UAT, LV; > 24 hour LAT, UAT
Imereti							
Zestaphoni	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV > 24 hour LAT, UAT	> Annual LAT, UAT, LV > 24 hour LAT, UAT	***Routine measurements:***>Annual LAT, UAT, LV; >24 hour LAT, UAT, LV; ***Modelling:*** No exceedance (underestimated)	> Annual LAT, UAT, LV > 24 hour LAT, UAT
Kutaisi	-	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV ***Modelling:*** No exceedance(underestimated)	>Annual LAT, UAT, LV; >24 hour LAT, UAT, LV
Chiatura	-	-	-	-	-	***Modelling:*** No exceedance (underestimated)	
Shida Kartli (including South Ossetia)	-	-	-	-	-	-	
Samtkhe-Javakhet	-	-	-	-	-	-	
Kvemo Kartli (Rustavi)	-	-	-	-	-	***Modelling:*** >Daily LAT Daily UAT Daily LV	***Modelling:*** >Daily LAT Daily UAT Daily LV
Mtskheta-Mtianeti and Kakheti	-	-	-	-	-	-	
Tbilisi	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	> Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV	***Routine measurement***: > Annual LAT, UAT, LV; > 24 hour LAT, UAT, LV ***Modelling:*** no exceedances (underestimated)	

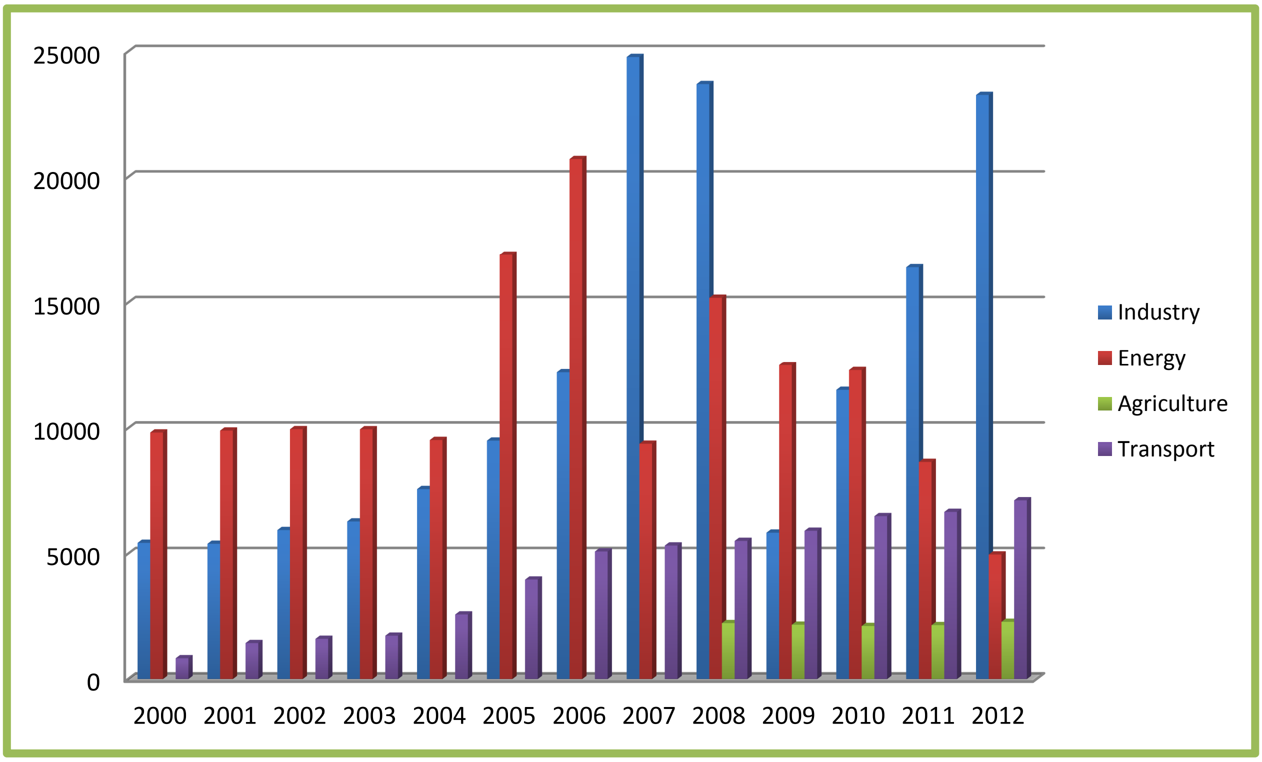
1.6. ASSESSMENT FOR PM_{10}

PM_{10} Emissions

In Georgia, instead of PM_{10} emissions total suspended particles (TSP) emissions are registered and reported. During the period 2000-2012 TSP emissions have been increasing steadily for all sectors, with energy sector contributing the largest share to total emissions until 2007, followed by industry and transport sectors. In 2007-2008 industry sector significantly overweighed power sector emission and dropped in 2009 due to decline of industrial output as a result of economic crisis as well as due to installation of efficient filters in Kaspi cement plant, one of the major dust polluters. In 2010 this sector has started restoring its capacities, with growing emissions, almost reaching 2008 levels in

2012. Transport emissions that are at the third place in terms of emissions levels have shown steady increase for all years.

Figure 33.2000-2012 TSP Emissions



As for point source TSP emissions per Georgia's regions, zones and agglomerations, in 2012 Kvemo Kartli, Shida Kartli and Imereti were marked with high emission levels, followed by Tbilisi and Adjara. Normalized data showed slightly different picture, with Tbilisi and Kvemo Kartli being the leaders, followed Adjara and Shida Kartli.

Figure 34. Distribution of 2012 TSP Emissions (tons) among Regions of Georgia

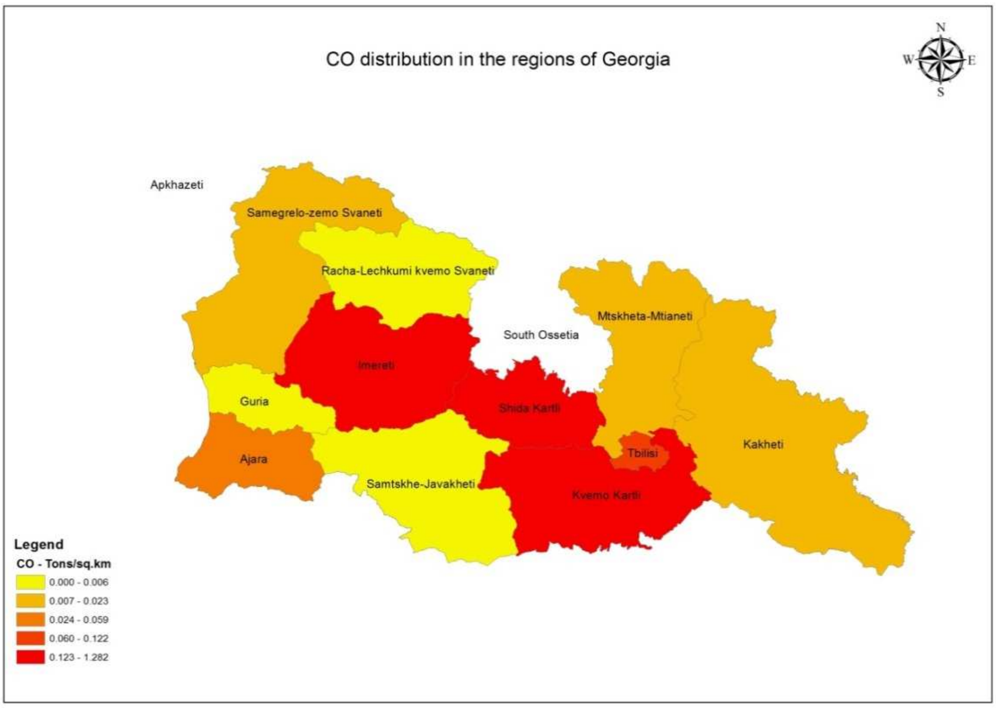
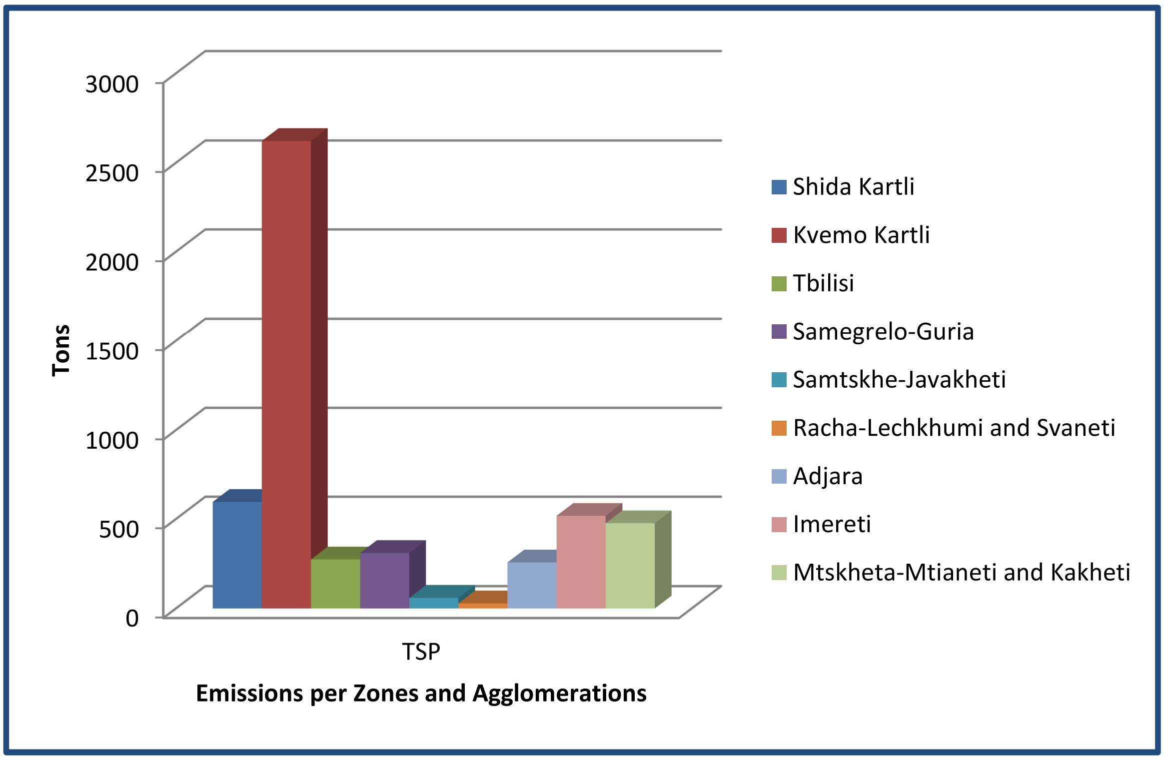


Figure 35.2012 TSP Emissions (t/sq. km) per Regions of Georgia

Figure 36. 2012 TSP Emissions Per Zones & Agglomerations



Long term Monitoring Data for PM_{10}

Georgian air quality network has only recently begun to monitor for PM_{10} within Tbilisi. At all of the national air quality monitoring stations, TSP has been monitored.

Table 11, below, contains a summary of the annual average concentrations of monitored dust within the air quality network located across 5 Georgian cities from 2008 through 2013.

Table 11.2008-2013 Urban Air Quality Trend for TSP/PM_{10}

Pollutant	Annual Mean, µg/m^3						Georgia MACs, µg/m^3		EU Limit values, µg/m^3
	2008	2009	2010	2011	2012	2013*	Max (20-30 min.)	Daily average (24 hours)	
Batumi									
Dust	500	500	890	630	490	453	150	50	50 - 24 hour 40 – annual average
PM_{10}(assuming a ratio of 1.35 TSP (dust) to PM_{10})	370	370	659	467	363	336			
Zestaphoni									
Dust	550	500	490	480	460	415	150	50	50 - 24 hour 40 – annual average
PM_{10}(assuming a ratio of 1.35 dust to PM_{10})	407	370	363	356	341	307			
Rustavi									
Dust	-	-	-	-	-	-	150	50	50 - 24 hour 40 – annual average
PM_{10}(assuming a ratio of 1.35 dust to PM_{10})									
Kutaisi									
Dust	970	900	750	890	900	760	150	50	50 - 24 hour 40 – annual average
PM10 (assuming a ratio of 1.35 dust to PM_{10})									
Tbilisi									
Dust (Kvinitadze St.)	780	500	430	500	500	693	150	50	
PM_{10} (assuming a ratio of 1.35 dust to PM_{10}) (Kvinitadze St.)	719	667	556	659	667	563			50 - 24 hour 40 – annual average

The table above shows consistent significant exceedances of Georgian daily average and maximum Macs for all for all years and monitoring sites. We may assume thatPM_{10}emissions constitute 35% of TSP and may presume that EU 24-hour and annual average LVs were exceeded consistently at all monitoring sites. Though, compared with modelling data measured values seem overestimated, due to the use of non-reference methods.

As for monthly air quality profile, 2013 February-2014 February routine monitoring data were analysed***(see below figures 37-40)***, also revealing regular significant exceedances of Georgia MACs for TSP and presumably, EU LVs average limit values.

Figure 37. 2013 February-2014 February average monthly concentrations (µg/m^3) of dust measured at Batumi ambient air quality monitoring site

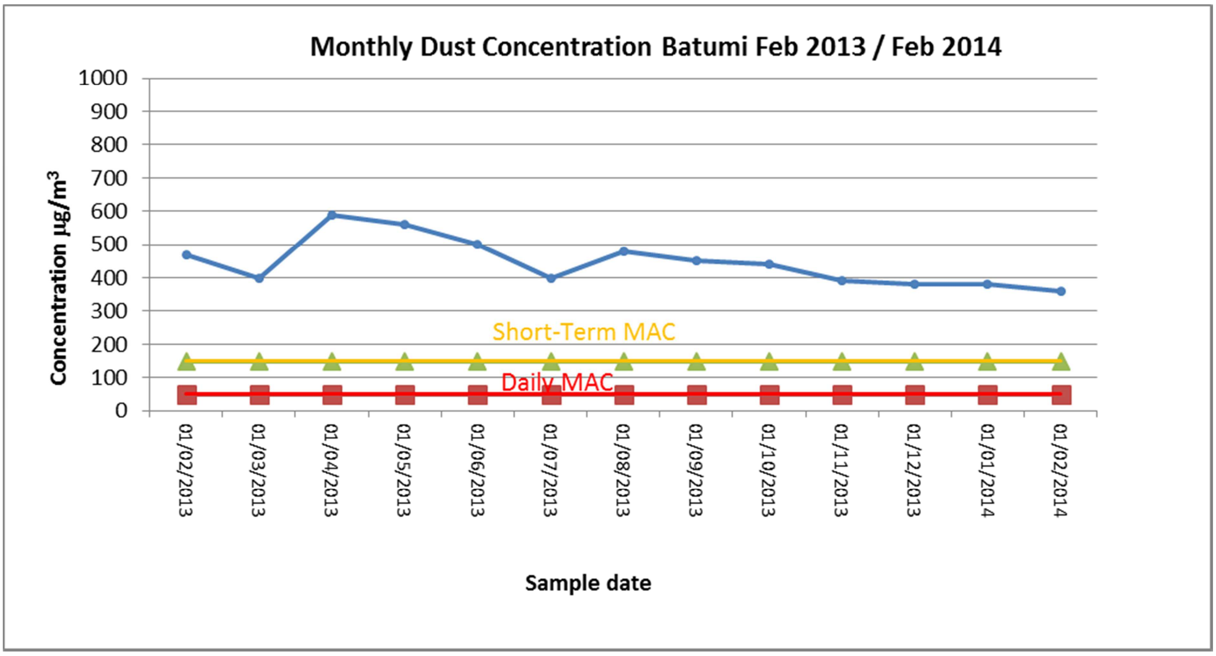


Figure 38. 2013 February-2014 February average monthly concentrations (µg/m^3) of dust measured at Zestaphoni ambient air quality monitoring site

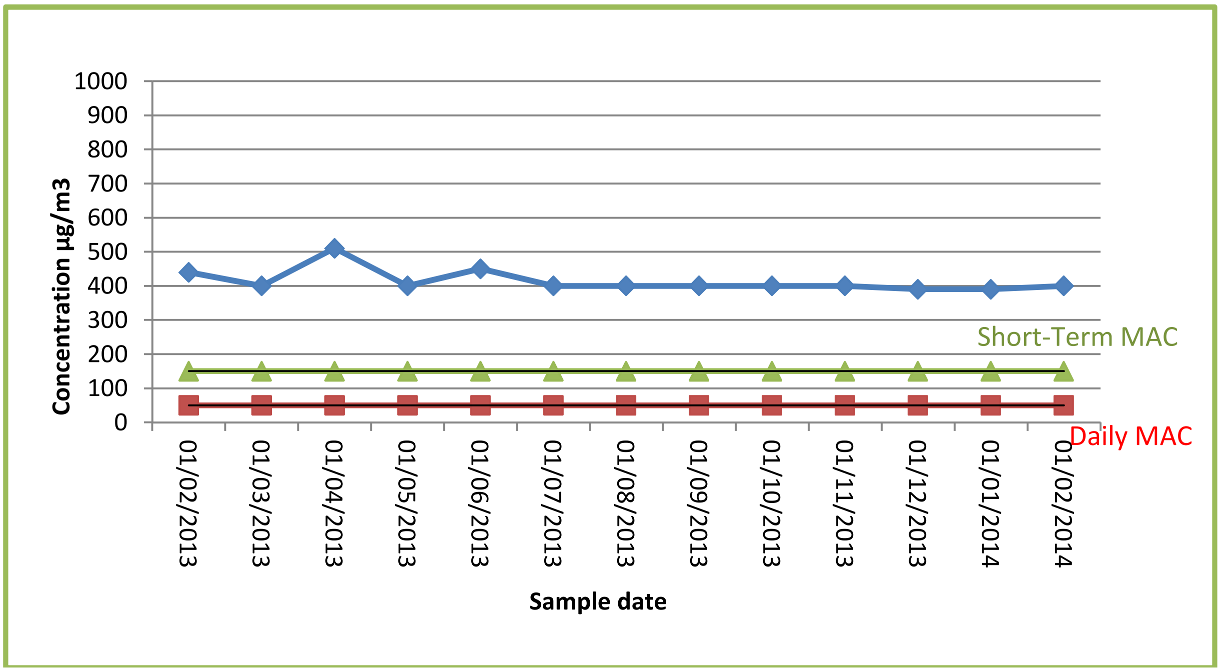


Figure 39. 2013 February-2014 February average monthly concentrations (µg/m^3) of dust measured at Kutaisi ambient air quality monitoring site

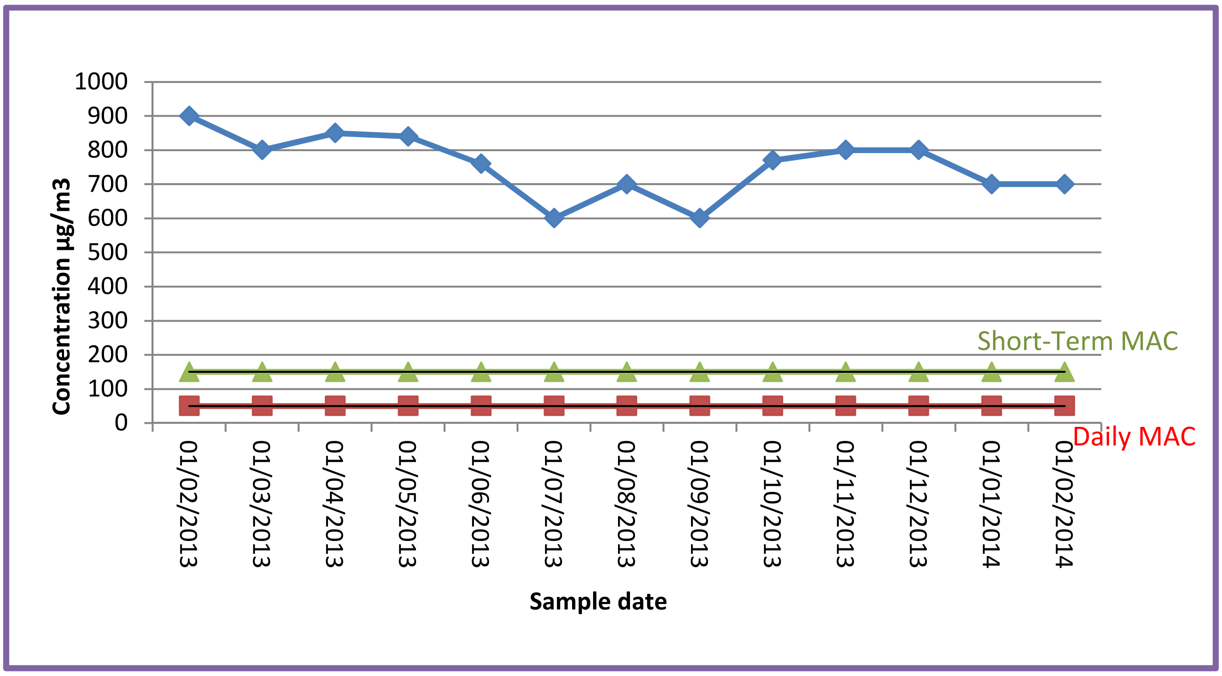
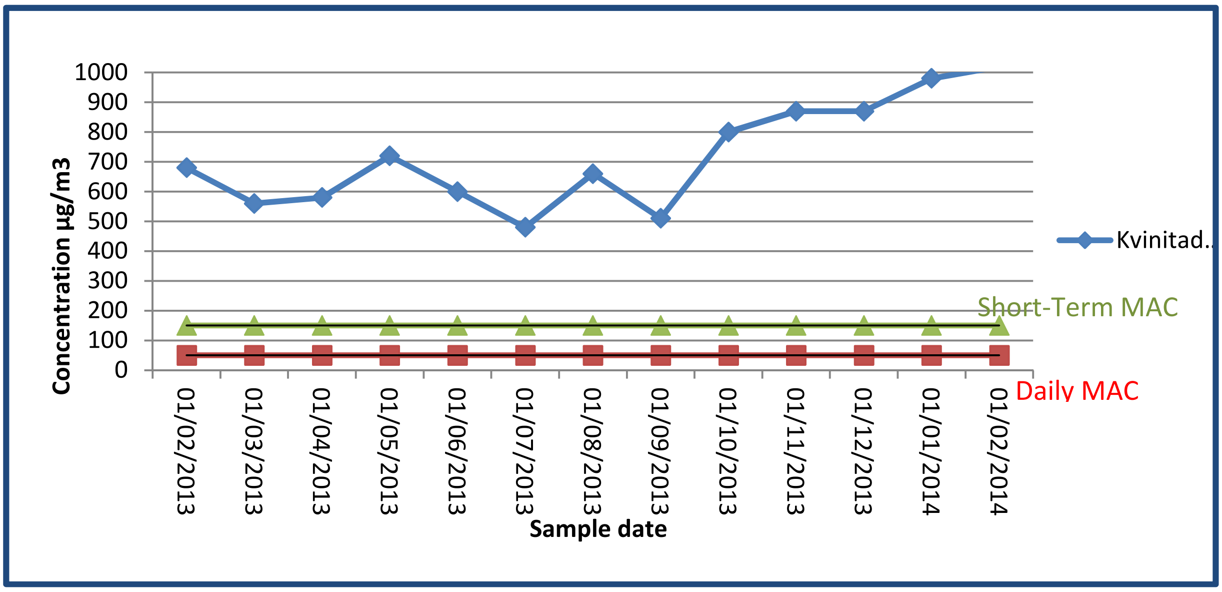


Figure 40. 2013 February-2014 February average monthly concentrations (µg/m³) of dust measured at Tbilisi Kvinitadze street ambient air quality monitoring site



Background Data for PM_{10}

Background concentrations of PM_{10} were derived taken from the outputs of a preliminary study based upon EMEP/MSC-W modelled concentrations[8].

Table 12. Summary of PM_{10} Background Concentrations

Substance	Annual average concentration (µg/m³)
PM10	10.8

[8] With input from international experts.

Modelling Data for PM_{10}

Modelling results for PM_{10} ambient concentrations has shown the following:

- Imereti:
    - The region of Imereti has been identified as emitting a moderate density of total suspended particulates per square kilometre, though as one of the larger regions, produces a significant proportion of the national inventory of TSP. Concentrations of PM_{10} are expected to vary across the region, though remain relatively low.
    - Modelled concentrations of $PM_{10}$for Kutaisi indicate that the annual meanPM_{10}across large parts of Kutaisi would remain below 12.57 µg/m^3. Annual mean PM_{10} concentrations were predicted to vary between 10.82 to 29.42µg/m^3 and 24 hourly concentrations at selected receptor locations would vary between maxima of 11.10 to 26.87µg/m^3. Therefore it is predicted that PM_{10} concentrations would remain below the EU annual limit value of µg/m^{3}and the 24 hourly limit value is also predicted as not at risk of being exceeded. Modelling of PM_{10}concentrations in Kutaisi has predicted that the lower assessment thresholds for both the annual mean and 24 hourly mean of $PM_{10}$are likely to be exceeded at one receptor location in Kutaisi. The upper assessment threshold for both the PM_{10}annual mean and 24 hourly mean are highly unlikely to be exceeded within Kutaisi.
    - Modelled concentrations of PM_{10} have indicated that the annual mean PM_{10} across the majority of Zestaphoni would remain below 14.58 µg/m^3. Annual mean PM_{10} concentrations were predicted to vary between 10.80 to 22.80µg/m^3 and 24 hourly concentrations at selected receptor locations would vary between maxima of 10.84 to 17.01µg/m3. Therefore it is predicted that PM10 concentrations would remain below the EU annual limit value of 40 µg/m3 and the 24 hourly limit value is also predicted as not at risk of being exceeded. Modelling of PM_{10} concentrations in Zestaphoni has predicted that the lower assessment threshold for the 24 hourly mean of $PM_{10}$is unlikely to be exceeded. However, the lower assessment threshold for PM_{10} annual average is predicted as at risk of being exceeded. Both the upper assessment threshold for both the PM10 annual mean and 24 hourly mean are highly unlikely to be exceeded within Zestaphoni.
    - Annual mean PM_{10} across Chiatura would remain below 13.49 µg/m^{3}at all locations; Annual mean PM_{10} concentrations were predicted to vary between 10.81 to 13.49 µg/m^{3}and a 24 hourly maxima concentration was predicted not to exceed 11.07 µg/m^3. Therefore it is predicted that PM_{10} concentrations would remain below the EU annual limit value of 40 µg/m^{3}and the 24 hourly limit value is also predicted as not at risk of being exceeded. In addition, the lower assessment threshold and upper assessment threshold for both the annual average and 24 hourly mean of $PM_{10}$are both recognised as unlikely to be exceeded.
- Annual mean PM_{10} across the majority of Rustavi would remain below 11.13 µg/m^3. Annual mean PM_{10} concentrations were predicted to vary between 10.80 to 38.97 µg/m^3. Therefore it is predicted that there is a slight risk that PM_{10} concentrations would exceed EU annual limit value of 40 µg/m^{3}and a high risk that they would exceed the 24 hourly limit value at a limited number of locations. All potential exceedances are associated with major road routes through Rustavi and potentially attributed to vehicle emissions rather that the point source emissions of the Rustavi steel plant. PM_{10} concentration at receptors locations is also predicted as not at risk of being exceeded. In addition, the lower assessment threshold and upper assessment threshold for both the annual average and 24 hourly mean of $PM_{10}$are

both recognised as unlikely to be exceeded. All LATs and UAT for 24 hourly mean and annual mean are at risk of being exceeded in Rustavi at a limited number of receptor locations.

- Explicitly busy road, junctions and those areas close to busy road and junctions in central Tbilisi were predicted to experience elevated concentrations of air pollutants, particularly PM_{10}, likely to exceed LAT, UAT’s and LV for the annual mean PM_{10} species.

Figures 41-45 below show spatial distribution of annual PM_{10} concentrations across the cities modelled.

Figure 41.Modelled Annual Mean PM_{10} Concentration (μg/m^3)Distribution across Kutaisi, Georgia

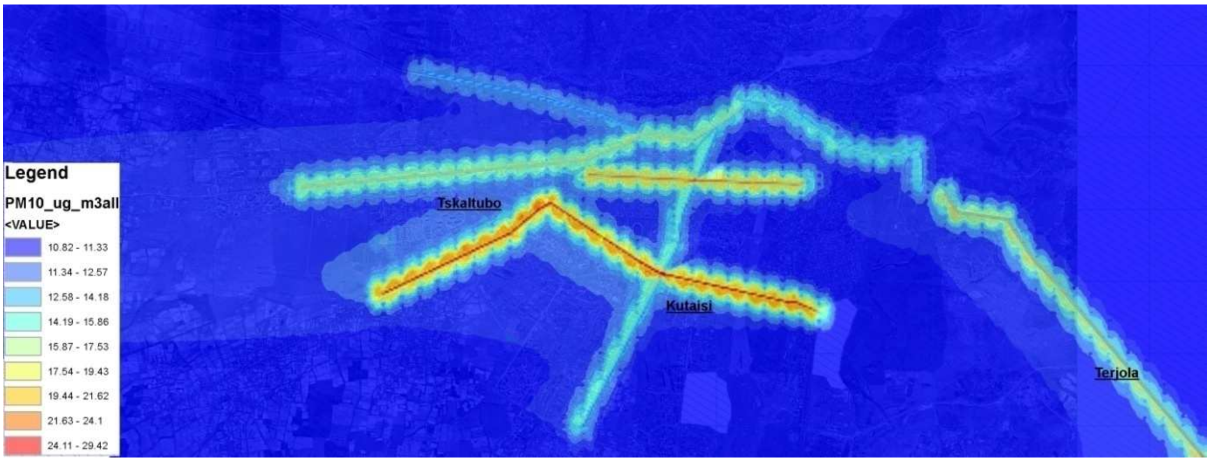


Figure 42.Modelled Annual Mean PM10 Concentration (μg/m^3) Distribution across Zestaphoni, Georgia

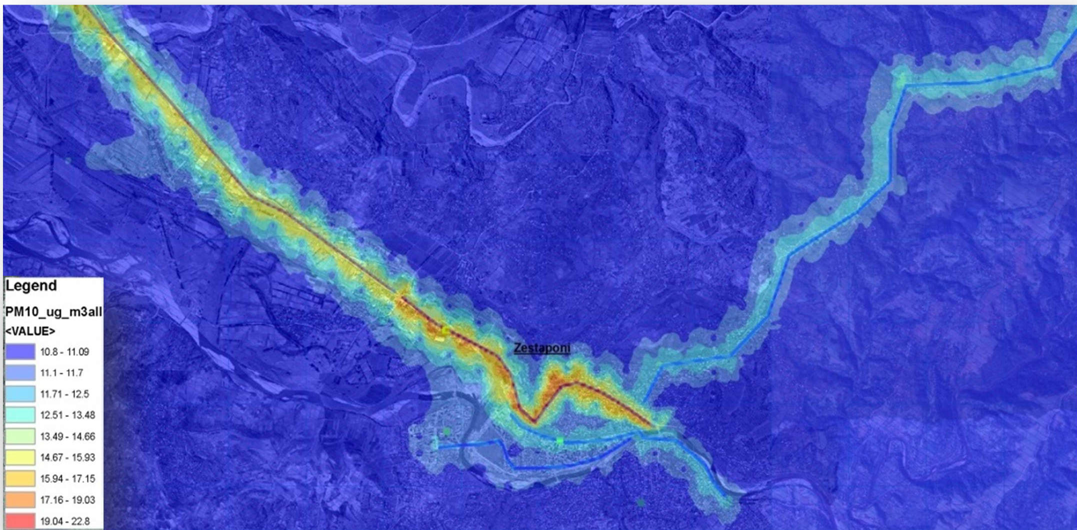
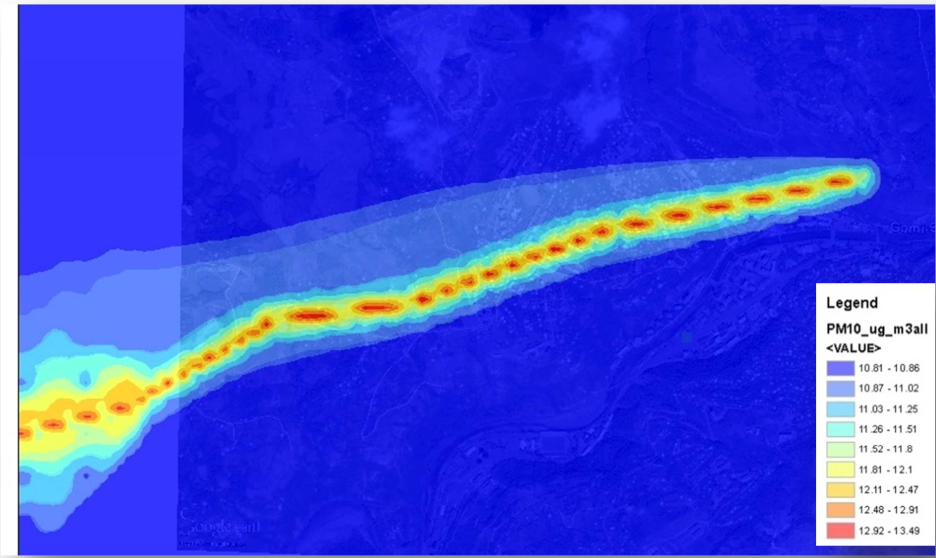


Figure 43.Modelled Annual Mean PM_{10} Concentration ($\mu g/m^3$) Distribution across Chiatura, Georgia



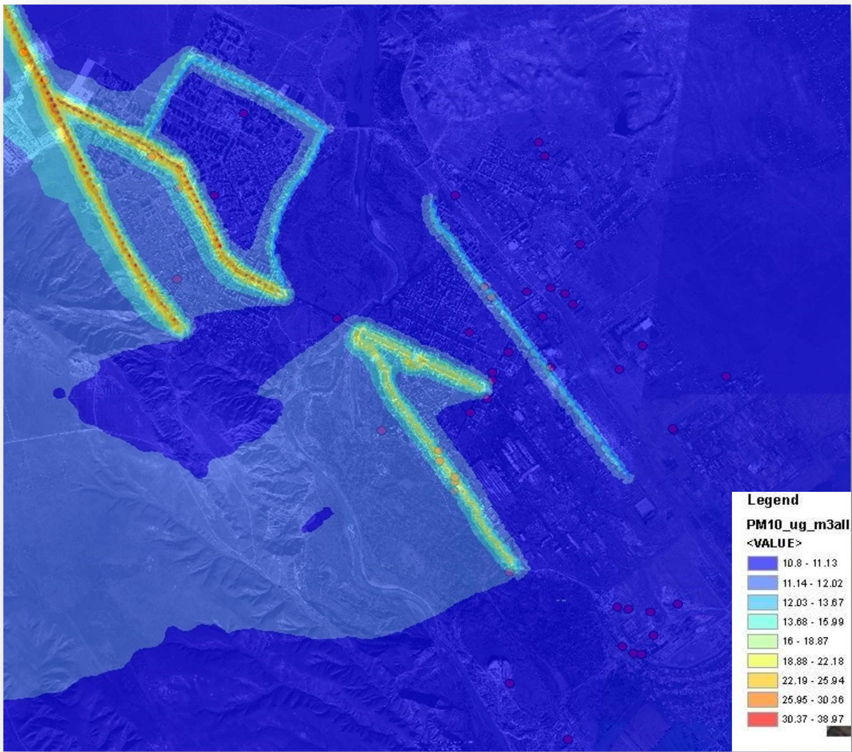


Figure 44.Modelled Annual Mean PM_{10} Concentration ($\mu g/m^3$) Distribution across Rustavi, Georgia

Figure 45.Modelled Annual Mean PM_{10} Concentration ($\mu g/m^3$) Distribution across Tbilisi, Georgia

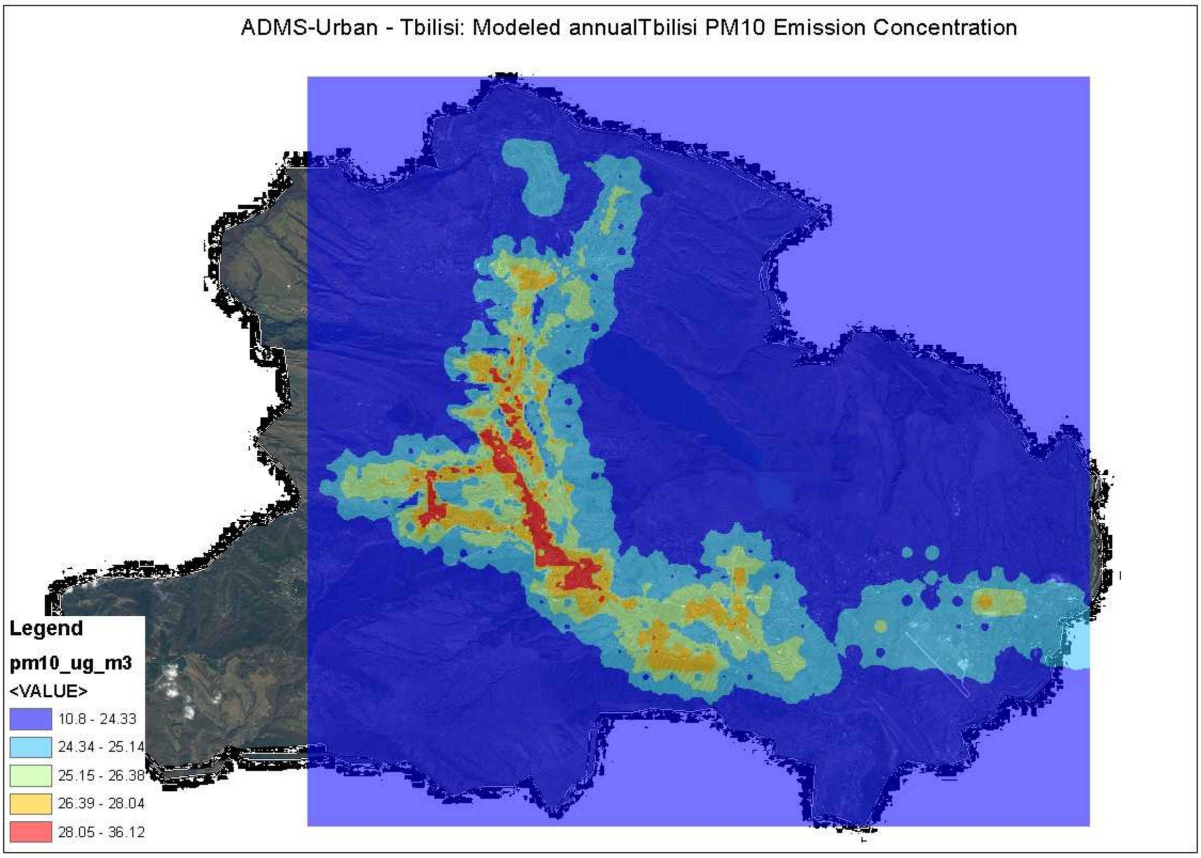


Table 13.Modelling output Concentrations of PM_{10}($\mu g/m^3$)at selected Receptors locations in Georgia

City	Receptor	PM10 Annual Mean µg/m³	PM10 24 Hourly Maxima µg/m³
Kutaisi	Cemetery	10.93	11.10
	Chavchavadze	21.49	26.87
	Sapichkia	11.19	11.57
Zestaphoni	"55"	10.82	10.84
	Agmashenebeli	13.00	13.89
	Kvaliti	10.81	10.82
	Chikashua	10.94	11.12
	Saqkabeli	14.94	17.01
Chiatura	Chavchavadz	10.92	11.07
Rustavi	Rustavi 1	10.93	11.10
	Rustavi 2	21.49	26.87
	Rustavi 3	11.19	11.57
	Rustavi 4	10.82	10.84
	Rustavi 5	13.00	13.89
	Rustavi 6	10.81	10.82
	Rustavi 7	10.94	11.12
Tbilisi	Tolstonokovi St.	10.85	10.94
	Chargali St.	10.87	11.03

	Tbilisi - Lilo settlement	31.52	47.08
	Tbilisi –BesarionChichinadze St.	12.17	13.32
	Conjunction of Tavdadebulistr and Petritsi St.	12.39	14.42
	Mosulishvili str. School #79 area	12.38	13.58
	Temqa district	12.28	13.33
	Temqa	12.28	13.33
	Tbilisi - Turtle lake	12.28	14.02
	University - Maglivi building	13.82	17.10
	Tbilisi –Teopane Davitiani St.	12.66	14.27
	Shatili str. Nearby the Caucasus international University	13.26	15.26
	Gldani district. Mosulishvili St. Park	13.94	16.27
	Tbilisi –Dimitri Uznadzis St.	13.35	15.44
	G. Gogiberidze St. Park	13.97	18.16
	Tbilisi 29	14.81	18.05
	Dadianis St.	13.81	16.26
	Tbilisi - Mziuri Park	14.60	18.66
	Stanislavski St.	14.56	17.19
	Tbilisi - Freedom Sq.	14.86	19.07
	Budapesti St.	14.43	17.39
	Hippodrome	14.43	17.39
	Tbilisi - 1st School	14.62	18.31
	Surami St.	14.80	17.52
	Vasha Pshavela Av.	16.05	23.30
	Bakhtrioni St.	15.87	20.06
	Tbilisi - Rustaveli Av.	15.65	20.59
	Tbilisi – Zurab Arakishvili St.	17.19	24.04
	Agmashenebeli Av	15.93	19.14
	Tbilisi - Kostava St.	16.41	21.32
	Tbilisi - Leo Kiacheli St.	17.11	23.88
	Tbilisi - Abashidze St.	18.82	25.06
	Tbilisi 14	22.42	29.74
	Tsereteli St.	21.22	30.70
	Agmashenebeli St.	19.48	24.80
	Tbilisi –Melikishvili Av.	30.72	44.63

Expert Judgments on Areas for which Insufficient Data is Available

For zones with no TSP routine monitoring and supplementary data, rough judgements on exceedances of UAT and LAT can be made based on emission source concentrations, total and per unit area emissions as well as based on passive sampling data, where available.

Presumably, zones with moderately low to very low population densities, low concentrations of emission sources and insignificant emissions levels may have air quality falling below the UAT and LAT and thus, requiring the least stringent assessment regimes. More specifically, for zones such as Racha-Lechkhumi and Svaneti, Samtskhe-Javakheti, Mtskheta-Mtianeti and Kakheti, Samegrelo-Guria and Shida Kartli only data sources are emission source concentration and emission levels. These data for the first three groups show very low emission levels and densities, leading to the assumption that PM_{10} 24-hour and annual LATs and UATs are not exceeded. Shida Kartli has relatively high emissions and Samegrelo-Guria moderate emissions, leading to the presumption of LATs being exceeded.

PM_{10} Concentrations Summary

Table 14. Summary of Assessment of Exceedences of EU LAT, UAT and LVs

NO_2 Concentrations µg/m^3							
Zone/Agglomeration	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Overall**
Abkhazia	-	-	-	-	-	-	
Racha-Lechkhumi, Kvemo and Zemo Svaneti	-	-	-	-	-	-	
Samegrelo-Guria: Poti	-	-	-	-	-	-	
Adjara: Batumi	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	***Routine measurement:***> Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV
Imereti							
Zestaphoni	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	***Routine measurements:***>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV ***Modelling:*** No exceedences	***Routine measurements:***> Annual LAT, Annual UAT, Annual LV ***Passive sampling:***> Annual LAT, UAT ***Modelling:*** No exceedences
Kutaisi	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	***Routine measurements:***>Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV ***Modelling:*** No exceedences	***Routine measurements:***> Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV ***Modelling:*** No exceedences
Chiatura	-	-	-	-	-	***Modelling:*** ***Modelling:*** No exceedences	***Modelling:*** No exceedences
Shida Kartli (including South Ossetia)	-	-	-	-	-	-	
Samtkhe-Javakhet	-	-	-	-	-	-	
Kvemo Kartli (Rustavi)						***Modelling:*** >Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT	***Modelling:*** >Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT
Mtskheta-Mtianeti and Kakheti	-	-	-	-	-	-	
Tbilisi							***Routine measurements:***> Daily LAT, Daily UAT, Daily LV, Annual LAT,
Kvinitadze St.	>Daily LAT, Daily UAT, Daily LV, Annual LAT,	>Daily LAT, Daily UAT, Daily LV, Annual LAT,	>Daily LAT, Daily UAT, Daily LV, Annual LAT,	>Daily LAT, Daily UAT, Daily LV, Annual LAT,	>Daily LAT, Daily UAT, Daily LV, Annual LAT,	***Routine measurements:***>Daily LAT, Daily UAT,	

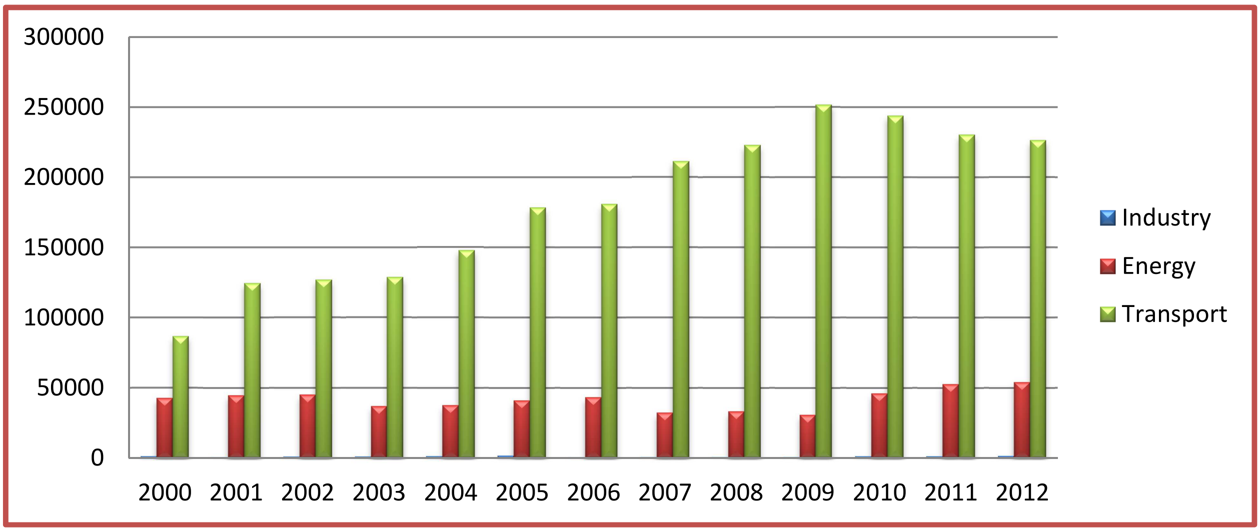
	Annual UAT, Annual LV	Annual UAT, Annual LV	Annual UAT, Annual LV	Annual UAT, Annual LV	Annual UAT, Annual LV	Daily LV, Annual LAT, Annual UAT, Annual LV ***Modelling:*** >Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV(at busy roads proximity)	Annual UAT, Annual LV ***Modelling:*** >Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV(at busy roads proximity)

1.7. ASSESSMENT FOR CO

CO Emissions

In accordance with emission trends, from2000 to 2012 CO emissions have been steadily increasing, with transport sector being a leader among others followed by energy sector. Transport emissions reached peaks in 2009 and then showed a slight decline.

Figure 46.2000-2012 CO Emissions (tons)



In 2012, the region of Imereti was recorded as having the highest emissions of CO from point sources in relation to all other across regions of Georgia. This was closely followed by Kvemo and Shida Kartli. Regional CO emissions data when normalized to the area of land in each region indicated a slightly differing hierarchy of CO emissions. With Kvemo Kartli appearing to represent the highest emissions, followed by Imereti and Shida Kartli zones. Figure below shows 2012 point source CO emissions per Georgia’s regions and proposed zones and agglomerations.

Figure 47. 2012 CO emissions (t) per regions of Georgia

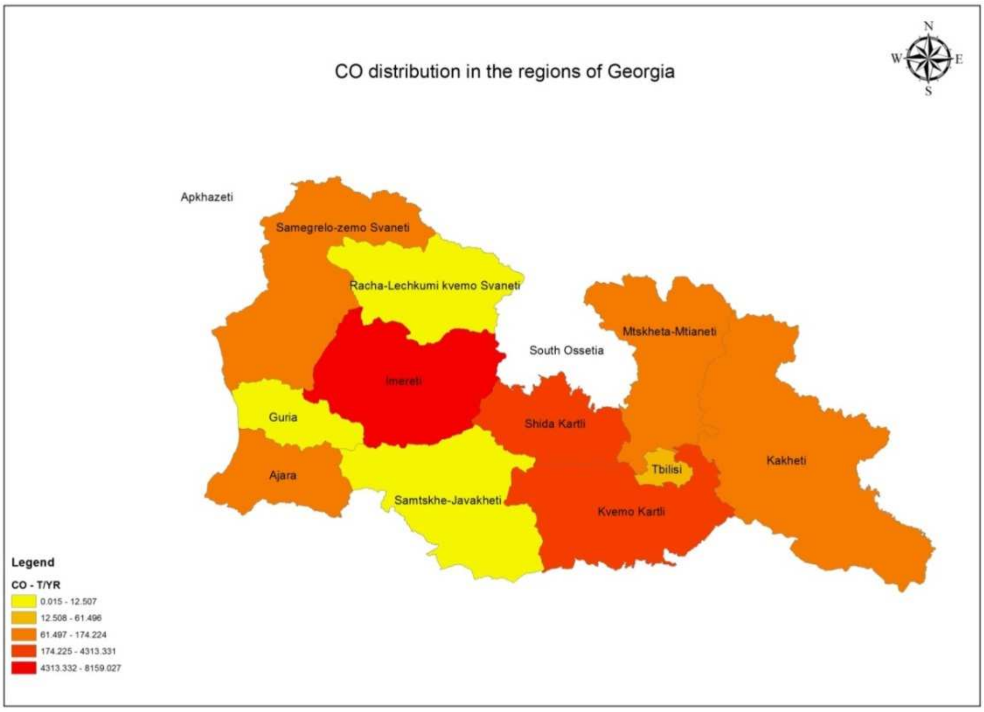


Figure 48.Distribution of 2012 CO Emissions (t/sq.km) among Regions of Georgia

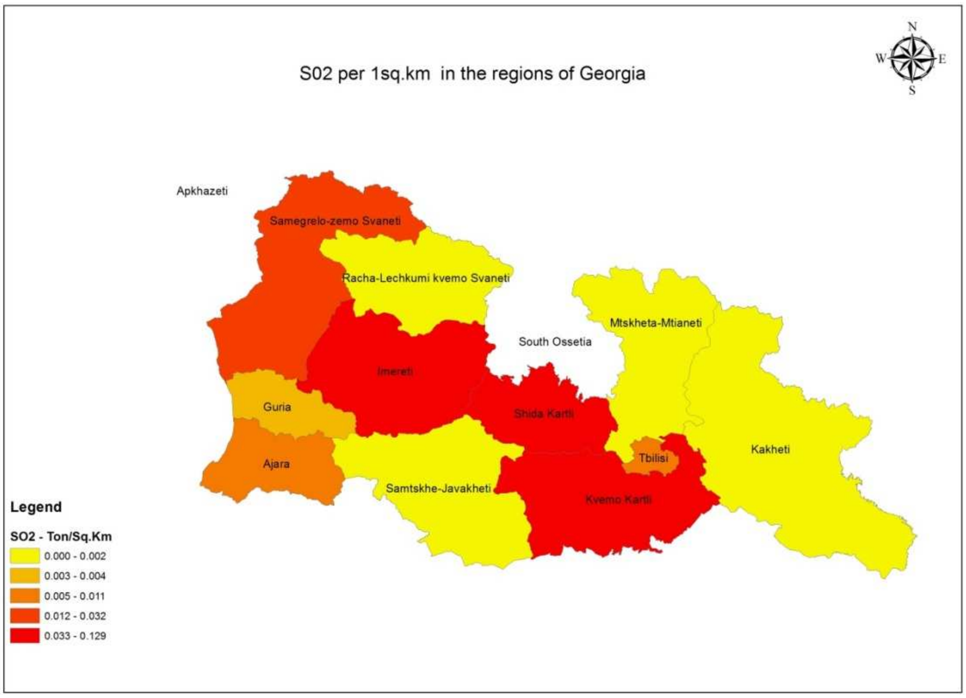
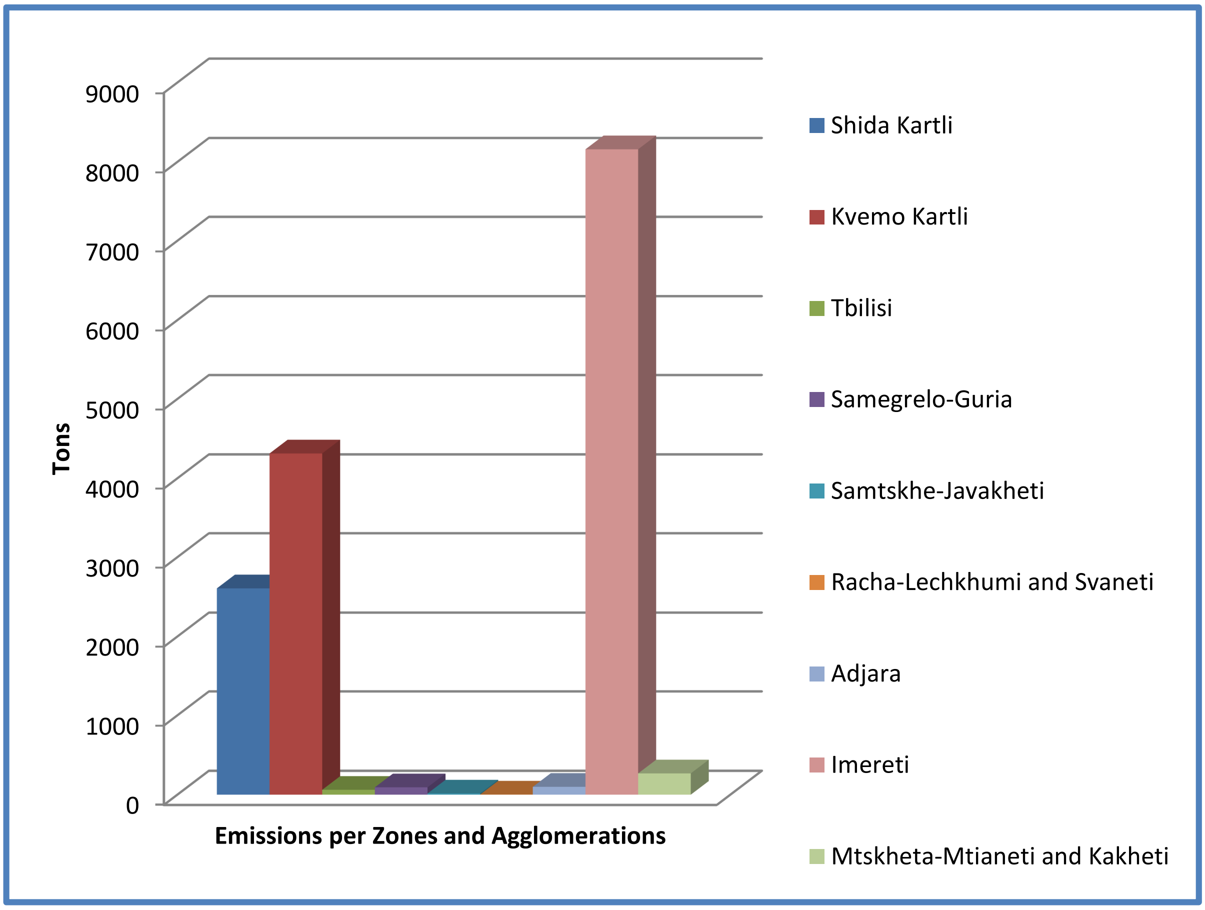


Figure 49. 2012 CO Emissions (t) per Proposed Zones and Agglomerations



Long term Monitoring Data for CO

CO is continuously monitored in 5 cities within Georgia, with the pollutant's concentrations measured only at single locations in all cities, except for Tbilisi, where CO concentrations are measured at 3 locations.

Table 15 below contains a summary of the annual average concentrations of CO monitored within the air quality network located across 5 Georgian cities from 2008 to2013.

Table 15.2008-2013 Urban Air Quality Trend for CO[9]

Pollutant		Annual Mean, $\mu g/m^3$						Georgia MACs, $\mu g/m^3$		EU Limit values
		2008	2009	2010	2011	2012	2013*	Max (20-30 min.)	Daily average (24 hours)	
Batumi										
CO		-	-	3,860	2,700	2,900	2,204	5,000	3,000	Maximum daily eight hour mean 10,000 $\mu g/m^3$
Zestaphoni										
CO				1,650	1,680	1,350	1,350	5,000	3,000	Maximum daily eight hour mean 10,000 $\mu g/m^3$
Rustavi										
CO		3,200		2,680	3,300	3,700	3,478	5,000	3,000	Maximum daily eight hour mean 10,000 $\mu g/m^3$
Kutaisi										
CO				4,660	4,900	4,800	3,182	5,000	3,000	Maximum daily eight hour mean 10,000 $\mu g/m^3$
Tbilisi										
NO2	Kvinitadze St.	5,100	4,000	3,600	2,800	2,970	3,333	5,000	3,000	Maximum daily eight hour mean 10,000 $\mu g/m^3$
	Moscow Ave.					2,600	2,557	5,000	3,000	
	Tsereteli Ave.					4,200	4,884	5,000	3,000	

The table above shows that Annual CO concentrations exceeded average annual MAC for Batumi in 2010, for Rustavi in 2011-2012, for Tbilisi in 2008-2010 and 2011 and for Kutaisi in 2010-2012. Annual average concentration of Ozone exceeded existing MAC only in 2011. Nevertheless, no single exceedance of EU LV was detected.

As for monthly air quality profile, 2013 February-2014 February routine monitoring data were analysed ***(see below)*** showing that CO concentrations were exceeded almost every month for

[9]Source: Ambient Air Pollution Yearbook, 2012, National Environmental Agency. SaqarTvelosteritoriazeatmosferulihaerisdabinZurebisweliwdeuli.GaremoserovnulisaagentosgaremosdabinZurebismonitoringisdepartamentismonacemebi. 2012 weli

Rustavi, Kutaisi and Tbilisi Tsereteli Avenue site, located on the road side. Average annual concentrations of CO were higher than MAC for all these cities. Though, EU LVs were not exceeded.

Figure 50.2013 February-2014 February average monthly concentrations (µg/m³) of CO measured at Batumi ambient air quality monitoring site

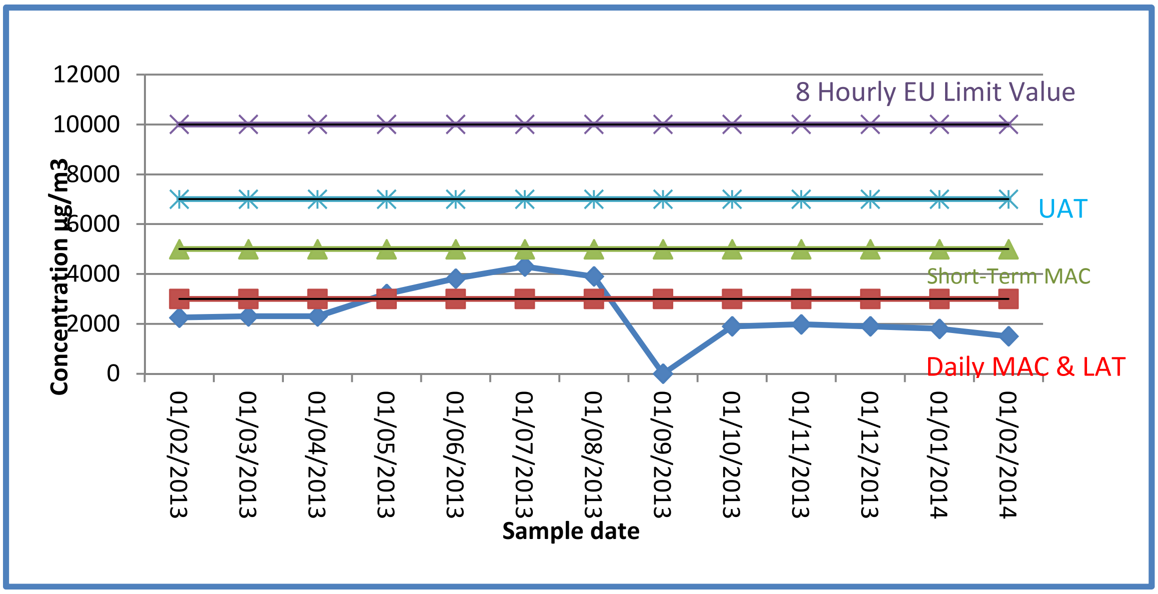


Figure 51.2013 February-2014 February average monthly concentrations (µg/m³) of CO measured at Zestaphoni ambient air quality monitoring site

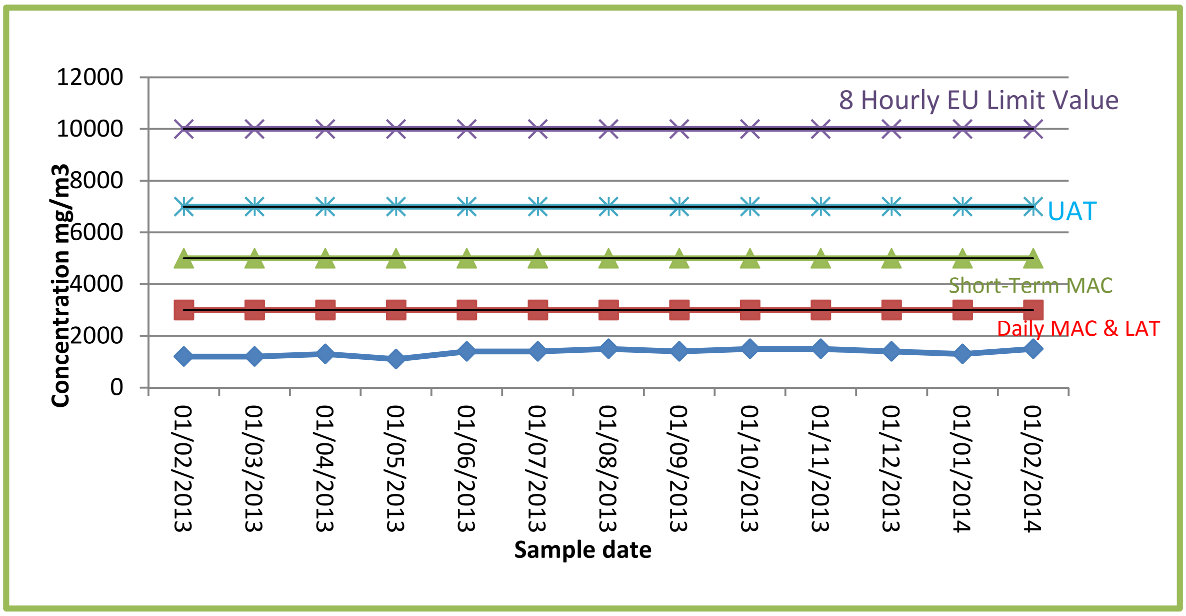


Figure 52.2013 February-2014 February average monthly concentrations (µg/m³) of CO measured at Rustavi ambient air quality monitoring site

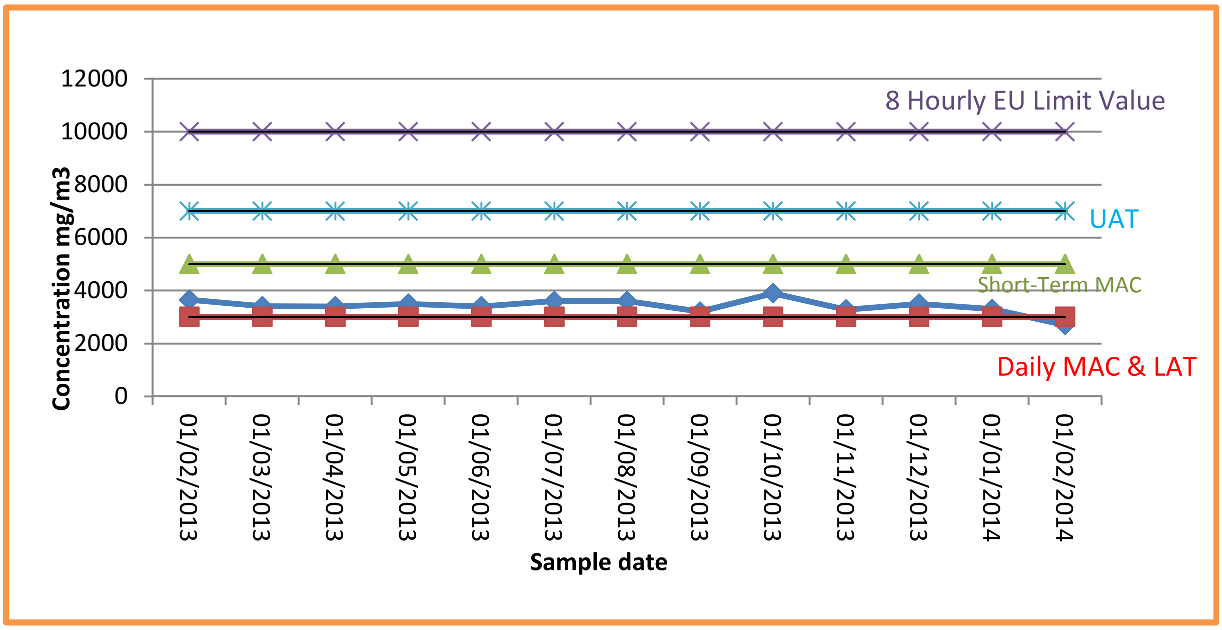


Figure 53.2013 February-2014 February average monthly concentrations (µg/m^3) of CO measured at Kutaisi ambient air quality monitoring site

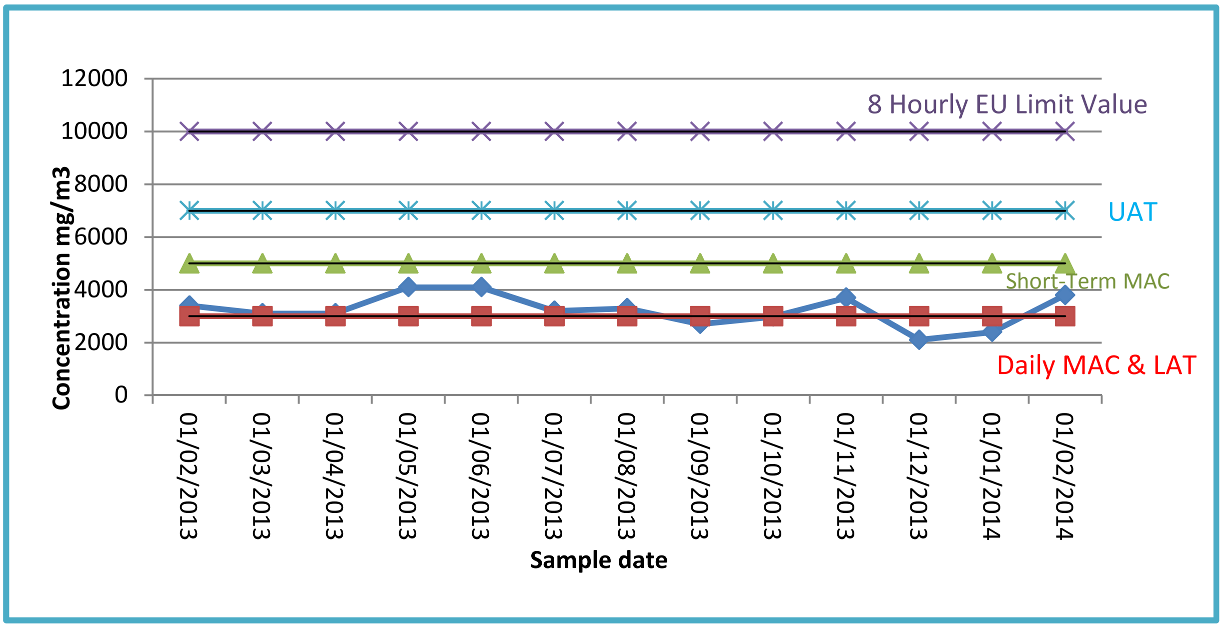
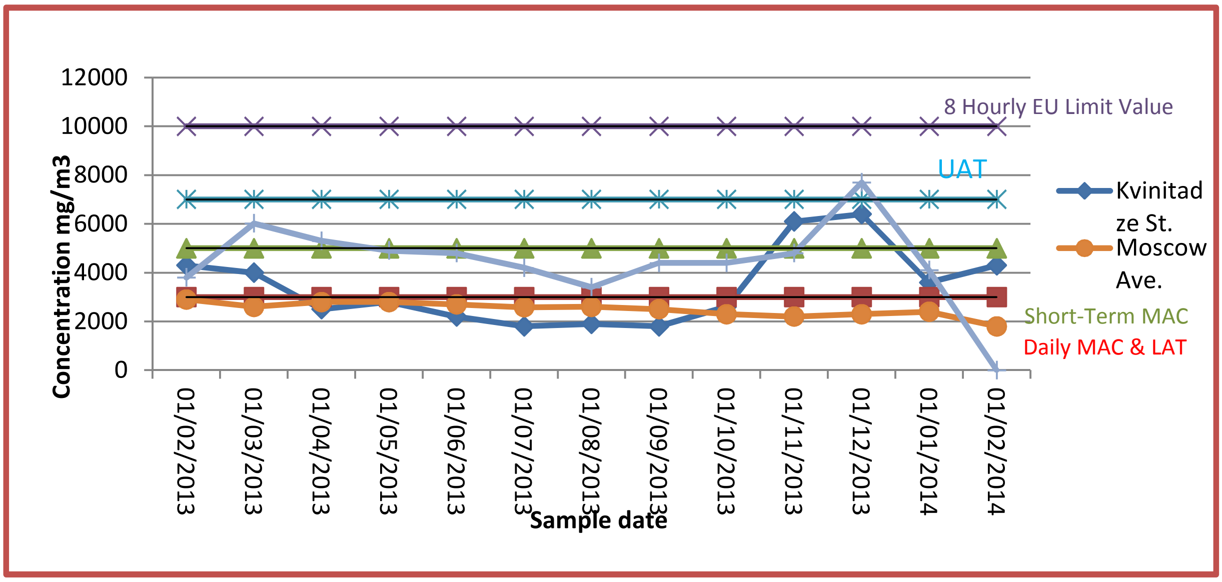


Figure 54.February-2014 February average monthly concentrations (µg/m^3) of CO measured at Tbilisi Kvinitadze Street and Moscow Ave ambient air quality monitoring site



CO Concentrations Summary

Table 16. Summary of Assessment Exceedances of EUCO LAT, UAT and LVs

NO_2 Concentrations µg/m^3							
Zone/Agglomeration	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Overall**
Abkhazia	-	-	-	-	-	-	
Racha-Lechkhumi, Kvemo and Zemo Svaneti	-	-	-	-	-	-	
Samegrelo-Guria: Poti	-	-	-	-	-	-	

Adjara: Batumi	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances
Imereti							
Zestaphoni	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances
Kutaisi	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances
Chiatura	-	-	-	-	-		
Shida Kartli (including South Ossetia)	-	-	-	-	-	-	
Samtkhe-Javakhet	-	-	-	-	-	-	
Kvemo Kartli (Rustavi)	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances
Mtskheta-Mtianeti and Kakheti	-	-	-	-	-	-	
Tbilisi		No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances
Kvinitadze St.	>LAT	No exceedances	No exceedances	No exceedances	No exceedances	No exceedances	
Moscow Ave.					No exceedances	No exceedances	
Tsereteli Ave.					No exceedances	No exceedances	

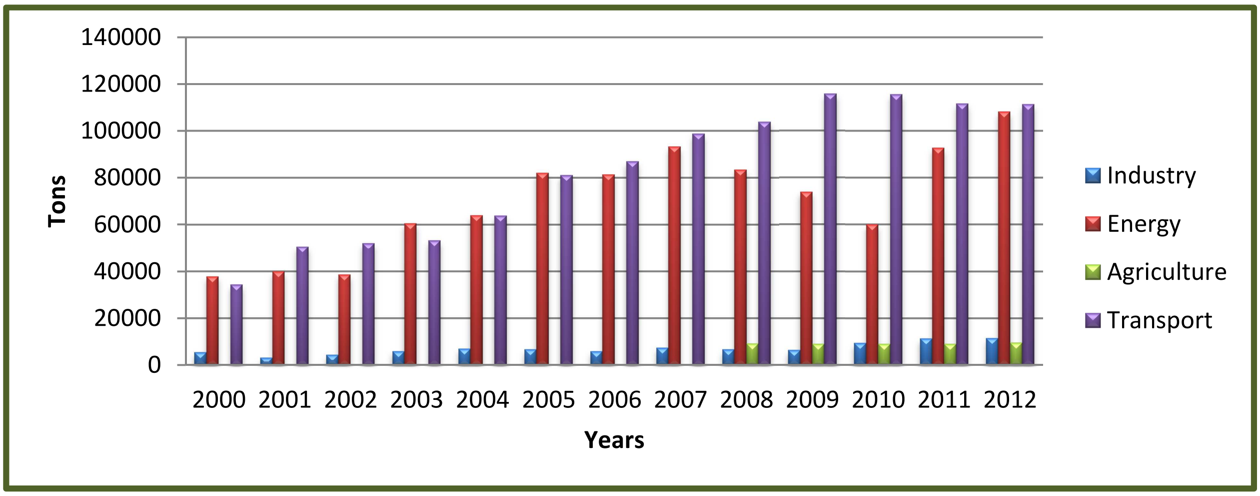
1.8. ASSESSMENT FOR OZONE

Ozone Emissions

Traditionally, ozone emissions are not registered and reported by industrial facilities in Georgia. However, Air Protection Service under the Ministry of Environment and Natural Resources Protection makes annual estimations of O_3 emissions based on CORINAIR methodology.

In accordance with 2000-2012 emission trends, ozone emissions have been steadily growing with transport having a leading position, followed by energy sector

Figure 55.2000-2012 O3 Emissions (tons)



As for ozone emissions per regions and proposed zones and agglomerations, such data does not exist. However, rough estimates of the spatial distributions of ozone may be derived through detecting and tracing emissions of its precursors, e.g. NO_x and VOCs. As discussed above, the region of Kvemo Kartli has the highest emissions of NO_x, closely followed by Imereti and then Shida Kartli regions. Tbilisi and Adjara have moderately high NO_x emissions.The Imereti region has the highest emissions of VOCs in terms of both total emissions and emissions per square km, followed by Adjara and Samegrelo by total emissions and sharing leading position with Tbilisi and Adjara by per unit area emissions. Samegrelo-Guria also has relatively high total emissions and emission density. VOC emissions are typicaly associated with emissions from transport sources, power plants as well as oil and gas storage, including fugitive emissions from a numerous fuel stations concectrated in major cities.

Figure 56.Distribution of 2012 VOCs emissions (tons) among regions of Georgia

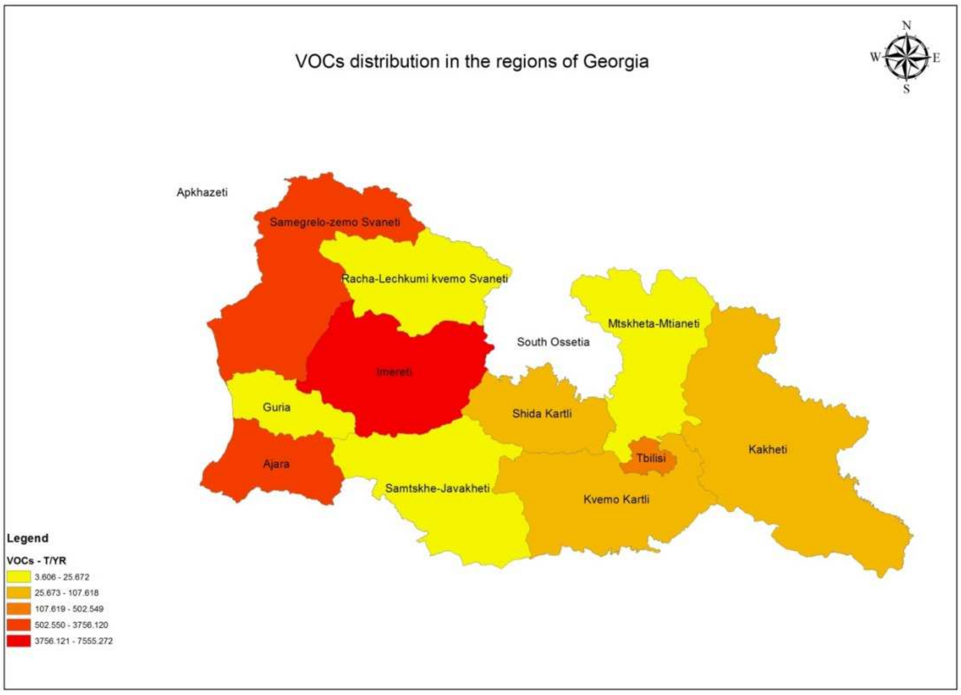


Figure 57.2012 VOCs emissions (t/sq. km) per regions of Georgia

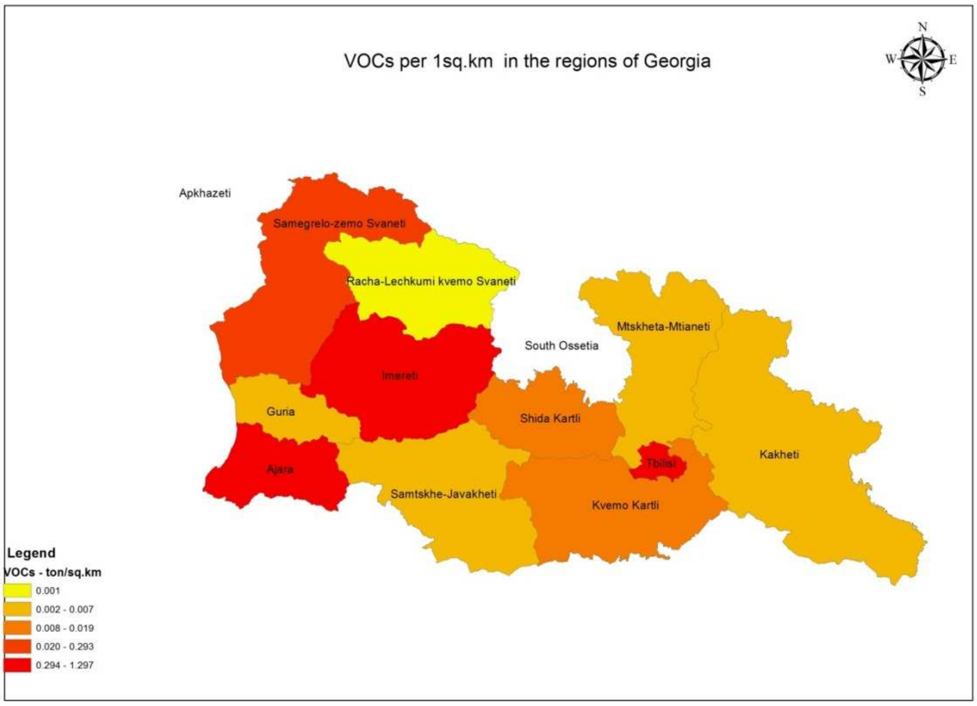
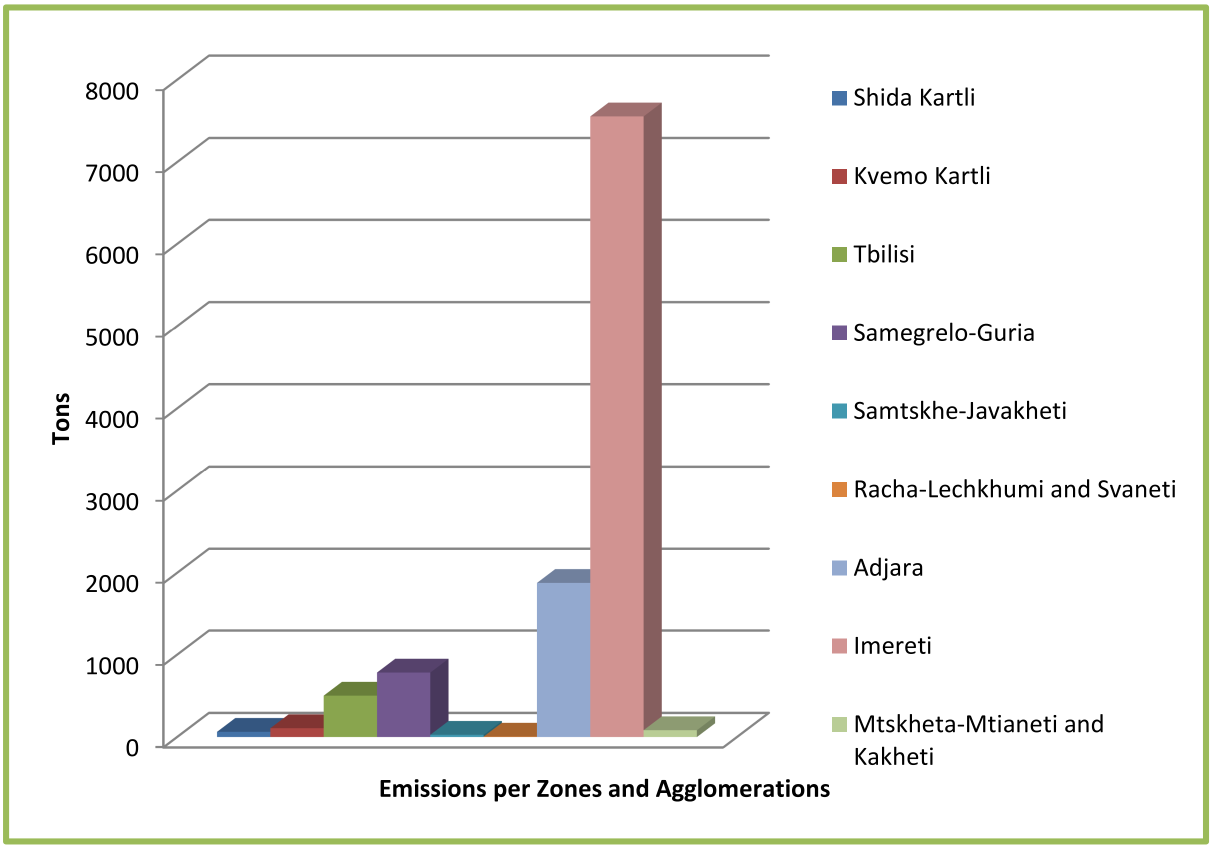


Figure 58. 2012 VOCs Emissions (t) per Proposed Zones and Agglomerations



Long term Monitoring Data for O_3

Ozone is continuously monitored only at 1 manual sampling Kvinitadze site and 1 automatic monitoring site in Vahslijvari that has just recently been added to the network. In February 2013-February 2014 annual concentrations of this pollutant were below or equal to Georgian MAC (30µg/m^3) for all months, except for August through October 2013 exceeding it about 1.8-3.1-fold at Kvinitadze manual sampling monitoring site. As for annual concentrations, MAC exceedance was only detected in 2011. No exceedance of EU 8-hourly LV was detected for all year's reports as well as for all months from February 2013 through February 2014.

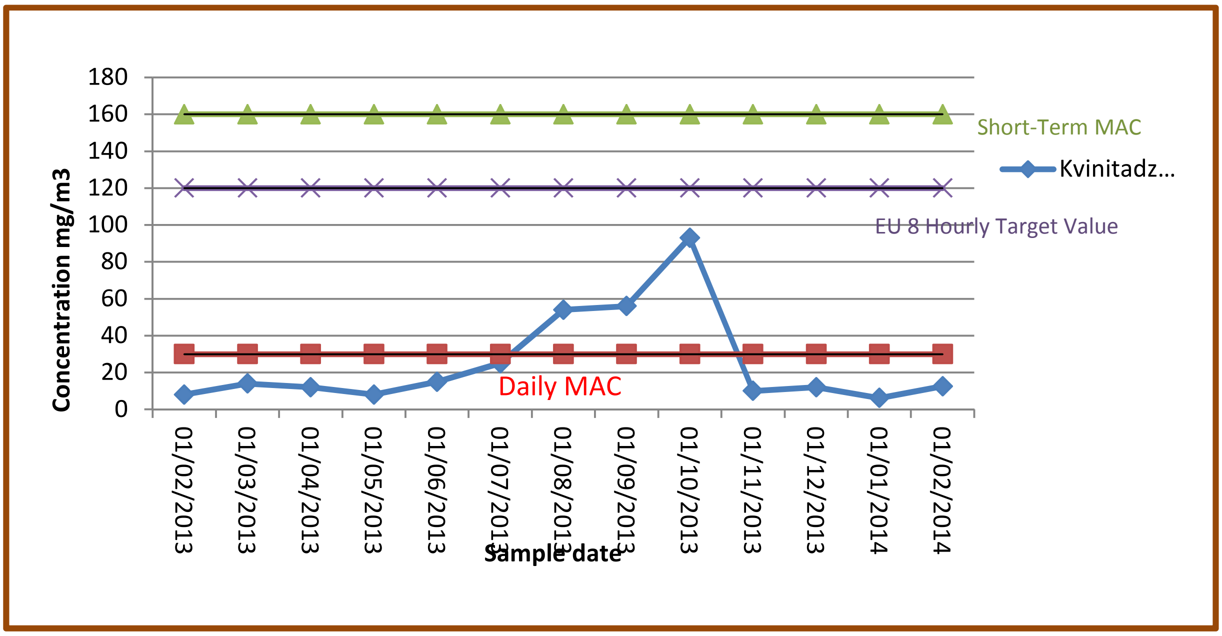
Table 17 below contains a summary of the annual average concentrations of Ozone for 2008-2012. Monthly profile of 2013 ozone concentrations is also given below on graph 59 below.

***Table 17.2008-2013 Urban Air Quality Trend for O_3*[10]**

Pollutant		Annual Mean, µg/m^3						Georgia MACs, µg/m^3		EU Limit values
		2008	2009	2010	2011	2012	2013*	Max (20-30 min.)	Daily average (24 hours)	
Batumi										
Ozone		-	-	-	-	-	-			
Zestaphoni										
Ozone		-	-	-	-	-	-			
Rustavi										
Ozone		-	-	-	-	-	-			
Kutaisi										
Ozone		-	-	-	-	-	-			
Tbilisi										
Ozone	Kvinitadze St.	-	-	13.6	34	13	-	160	30	120 µg/m^3max. 8-hour average value

Figure 59.2013 February-2014 February average monthly concentrations (µg/m^3) of O_3 measured at Tbilisi Kvinitadze Street ambient air quality monitoring site

[10]Source: Ambient Air Pollution Yearbook, 2012, National Environmental Agency. saqarTvelosteritoriazeatmosferulihaerisdabinZurebisweliwdeuli. GaremoserovnulisaagentosgaremosdabinZurebismonitoringisdepartamentismonacemebi. 2012 weli



Ozone Passive Sampling Results

O3 was measured during two-week period of June, 2013 at 11 rural background locations of Tbilisi, Rustavi, Zestaphoni, Batumi, Kutaisi and Poti, with 3 samples taken in Batumi, 6 samples in Tbilisi, Zestaphoni and Kutaisi, 2 samples in each city and 2 samples in Rustavi and Poti, 1 sample in each city.

The results of passive monitoring of ozone suggest that ozone concentrations are elevated at the selected sample sites. Average 2-weekozone concentrations at the sample sites ranged between 62.59 to 160.99 µg/m^3. This suggests that the EU ozone LV of 120µg/m^3that must not be exceeded more than 25 days per calendar year averaged over 3 years, may be at risk of exceedance at least at one passive sampling site (Kutaisi).

Ozone Concentrations Summary

Table 18. Summary of Assessment exceedances of EU Ozone LAT, UAT and LVs

NO_2 Concentrations µg/m^3							
Zone/Agglomeration	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**Overall**
Abkhazia	-	-	-	-	-	-	-
Racha-Lechkhumi, Kvemo and Zemo Svaneti	-	-	-	-	-	-	-
Samegrelo-Guria: Poti	-	-	-	-	-	-	-
Adjara: Batumi	-	-	-	-	-	-	-

Imereti	-	-	-	-	-	-	-
Zestaphoni	-	-	-	-	-	-	-
Kutaisi	-	-	-	-	-	-	-
Chiatura	-	-	-	-	-	-	-
Shida Kartli (including South Ossetia)	-	-	-	-	-	-	-
Samtkhe-Javakhet	-	-	-	-	-	-	-
Kvemo Kartli (Rustavi)	-	-	-	-	-	-	-
Mtskheta-Mtianeti and Kakheti	-	-	-	-	-	-	-
Tbilisi	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kvinitadze St.	N/A	N/A	N/A	N/A	N/A	N/A	

1.9. ASSESSMENT FOR BENZENE

Traditionally, benzene emissions are not registered and reported by industrial facilities in Georgia. However, levels of benzene emissions can be roughly judged by VOCs emissions, as benzene is part of VOC group. To this point of view, attention should be given to the regions with high VOCs emissions levels, including Imereti Adjara, Tbilisi. Samegrelo-Guria also has relatively high total emissions and emission density. Presumably, high VOCs emissions are associated with emissions from transport, power plants and oil and gas storage and transportation infrastructure, including fugitive emissions from a numerous fuel stations concectrated in major cities.

As for air quality monitoring data, benzene is not measured in Georgia. There is only limited two-week passive measurement data at three locations in Kutaisi, Batumi and Poti are available for June 2013 indicating at lower ambient concentrations than EU annual LV 5.0 µg/m^3.Benzene concentrations ranged from 0.85 to 4.03µg/m^3.

1.10. ASSESSMENT FOR LEAD

Traditionally, lead emissions are not included in the inventories in Georgia. Furthermore, very limited measurement data only is available with only one monitoring site in Tbilisi (Kvinitadze St.). Below table 19 shows annual average concentrations of lead for the period of 2008-2012 and the figure 60 monthly ambient lead concentrations for the period of February 2013 through February 2014.

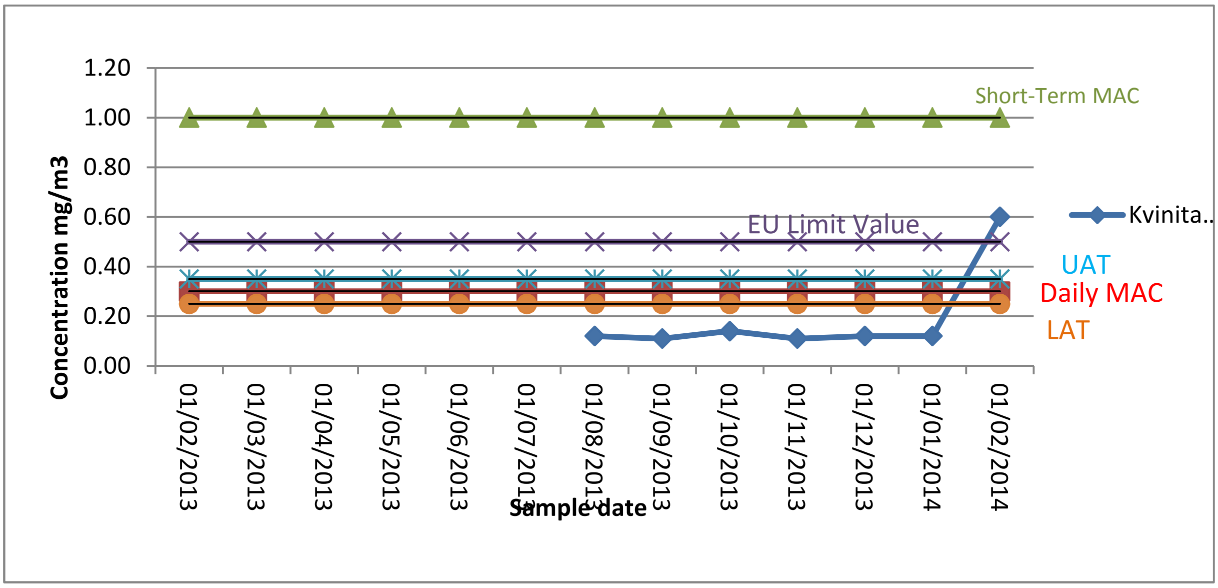
Table 19.2008-2013 Urban Air Quality Trend for Pb[11]

Pollutant	Annual Mean, µg/m^3						Georgia MACs, µg/m^3		EU Limit values
	2008	2009	2010	2011	2012	2013*	Max (20-30	Daily average (24 hours)	

[11]Source: Ambient Air Pollution Yearbook, 2012, National Environmental Agency. saqarTvelosteritoriazeatmosferulihaerisdabinZurebisweliwdeuli. GaremoserovnulisaagentosgaremosdabinZurebismonitoringisdepartamentismonacemebi. 2012 weli

								min.)		
Tbilisi										
Ozone	Kvinitadze St.	0.33	0.22	0.2	0.21	0.13		1	0.3	0.5 µg/m³annual mean

Figure 60. 2013 February-2014 February average monthly concentrations (µg/m³) of Pb measured at Tbilisi Kvinitadze street ambient air quality monitoring site



Long-term lead concentration data show no exceedances of EU LAT, UAT and LV for all years except for 2008, when LAT was exceeded. Monthly data for February 2013 through February 2014 also show no exceedance of EU LAT, UAT and LV, except for month of February 2014.

1.11. ASSESSMENT OF 4TH DD SPECIES IN GEORGIA ZONES

Measurement and supplementary (emissions, passive sampling, modelling) data on 4th DD species, including As, Cd, Ni and BaP are not available in Georgia therefore, it is impossible to assess the air quality status of Georgian zones for these pollutants.

1.12. SCOPE OF PARTICIPANTS AND KEY OPERATING PRINCIPLES

Participation and engagement of a number of organisations would be required to insure the quality and consistency of the air quality network. The Ministry of Environment and Natural Resources Protection would provide the policy and regulatory framework for efficient and effective operation of air quality monitoring network. In addition budgetary financing of the network will be administrated by the Ministry of Environment. Central to the network is the function of the day to day management, data acquisition, management of site an instruments, data analysis and reporting provided by the NEA team. The NEA monitoring team will fulfil the role of Local Site Operator (LSO), this includes basic service of instrument, including fortnightly checks, filter changes, span gas checks, simple repairs, refreshment of consumables and replacement of some spare parts. All repairs and interventions to instruments and devices which may invalidate instrument warranties will be conducted by the maintenance and servicing team. It is entirely feasible that this function could be delegated outside of the NEA monitoring team and performed by another public body or private sector company.

The role of equipment maintenance and servicing is essential to the operation of the monitoring network. Due to the complexity and sensitivity of the monitoring instruments as well as the bespoke nature of data acquisition systems, this role is highly specialized and suited to be contracted out to a specialized unit who can prove significant experience of such operations. It is highly likely that only an international or regional body may have sufficient experience to adequately fulfil the role of the equipment maintenance and servicing provider. It is highly probable this role could be contracted to the equipment supplier for the period of the monitoring equipment warranty.

All gas analysers require calibration gases to be used, and calibration gas suppliers are an essential partner within the network, this could be in the form of a national reference laboratory, with a minimum requirement that calibration gas suppliers meet both ISO 17025 and ISO 9001 accreditation. Overarching all of this is the attainment of the EU data quality objectives to which the national network must comply. An independent QA/QC audit team will need to be assigned, who are neither part of the air quality monitoring team, calibration gas supplier or the service and maintenance contractor.

Figure 61.Georgia’s National Air Quality Network and QA/QC Support


European Union, Data Quality
Air Quality Team, NEA
Ministry of Environment
National Reference Laboratory Standards & verification
Equipment Maintenance, Servicing & Calibration supplier
Independant QA/QC Audit Team

2. CURRENT NETWORK ASSESSMENT

2.1. REQUIREMENTS FOR AMBIENT AIR MONITORING NETWORK

Georgian ambient air quality monitoring and assessment is regulated through a combination of Framework Law on Environmental Protection, the Law on Atmospheric Air Protection and a number of relevant sub-laws (regulations). The former of which states(Article 27, Title VII)that the System of Ambient Environment Quality Monitoring is the:

> *'combination of analysis and prognosis of information received through regular observations on ambient environmental quality'.*

And Article 20, Title VII of the Air Protection Law, defined **Ambient Air Quality Monitoring** as:

> "*a system of routine air quality data collection, analysis and forecast/prognosis".*

The Ministry of Environmental and Natural Resources Protection and Natural Resources is required to coordinate the national ambient air quality network monitoring ambient air quality across the country on a regular basis. Part of this duty includes ensuring that all environmental quality monitor results, including air quality monitoring, are made accessible to the general public.

The operational approach taken to establish the national ambient air quality monitoring network currently operated in Georgia[12] is set out in the 'Guidelines for Air pollution Control' (РД 52.04.186-89), developed by the Main Geophysical Observatory of St. Petersburg, and Guidance Documents РД 52. 04-56-89 and РД 52. 04-57-95. These documents include requirements for:

i) Network design;
ii) Network minimal operating standards;
iii) Ambient air sampling methods;
iv) Chemical analysis methods of ambient air pollutants;
v) Minimal requirements for data storage and processing;
vi) Data analysis and reporting

Within Article 20, Title VII of the Law on Atmospheric Air Protection Georgian, the regions of Georgia were divided into categories/classes based upon their ambient air pollution levels as set out in. These classes are:

i. Extremely polluted regions;
ii. Significantly polluted regions;
iii. Polluted regions; and
iv. Non-polluted regions.

Pollution levels should be classified using Pollution Indices for air pollutants, defined in a Governmental Order (# 484) which set out rules for calculating pollution indices. In order to calculate the overall pollution index, the five pollutants with the highest individual pollution indices are required.

In order to ensure the reliability of the pollution index, it is necessary to have at least 75% of required annual measurements. Furthermore, measurements should meet the following minimum requirements:

i. duration of single (one-time) measurement should be 20-30 minutes;
ii. minimum number of measurements should be 4 within 24-hour period;

[12] Guiding documents are available at: http://ohranatruda.ru/ot_biblio/normativ/data_normativ/44/44486/

iii. maximum time lag (interval) between two measurements should be 6 hours;
iv. measurements should be conducted at 01:00hr, 07:00hr, 13:00hr and 19:00hr.

Pollution indices are required[13] to be calculated for both administrative districts (municipalities) and settlements based on air quality monitoring data. The municipalities and settlements to be selected for pollution indices calculation are identified by the magnitude of their pollution levels.

Pollution indices should be calculated for Tbilisi, Kutaisi, Rustavi, Batumi and Zestaphoni in accordance with the November 2013 Order of the Minister of Environment.

The National Environmental Agency (NEA), the legal entity in charge of ambient air quality monitoring in Georgia, is obliged to publish a list of the regions and settlements with their classified pollution levels together with relevant pollution indices before 1st of March of each year.

Ambient air quality standards are defined as maximum allowable concentrations (MACs) of a number of harmful substances in the ambient air. These are set out in the # 297 Order of the Minister of Labour, Health and Social Protection on Ambient Environment Quality Standards.

More specifically, MAC’s are defined as the concentration of a single substance into the ambient air (averaged for a specific time period), below which the given substance does not affect human health over a regular period or lifetime exposure.

Of the two types of MACs established are the one-time maximum concentration with an averaging time of 30 minutes and the mean 24-hour concentration with an averaging time of 24 hours. The first type relates to the short-term acute health risks/effects of human exposure to specific chemical substance. The second – to the long-term chronic health risks/effects of human exposure to a specific chemical substance. The minimum time period of a single measurement is 20-30 minutes and minimum number of daily measurements is 4.

Values obtained through single measurements (20-30 minute averaging time) are compared to one-time maximum limit values and, daily averages of single measurements – with 24-hour average limit values. Annual average values of pollutant concentrations are also calculated and compared with daily average MACs.

The order # 38 of the Minister of Health sets MACs for 605 substances, including some of the pollutants regulated by EU directives.[14] Table 20 below contains MACs for substances regulated by EU directives as well as for pollutants specific to certain Georgian cities (e.g. manganese):

Table 20. Maximum Allowable Concentrations (MACs) for Selected Chemical Substances

Substance	Chemical Formula	MAC (mg/m^3)	
		One-time maximum (averaging time: 20-30 min.)	Daily average (averaging time: 24 hours)
Nitrogen oxide (II)	NO	0.4	0.06
Nitrogen dioxide (IV)	NO_2	0.2	0.04
Sulphur dioxide	SO_2	0.5	0.05
Carbon monoxide	CO	5	3
Ground-level Ozone	O_3	0.16	0.03
Dust (TSP)	TSP	0.15	0.05

[13] In accordance with the article 20, Title VII of the Law on Atmospheric Air Protection
[14] The regulation bans emissions of 16 substances into the air.

Lead and its inorganic compounds (calculated based on Pb content)	Pb	0.001	0.0003
Mercury	Hg	-	0.0003
Arsenic and its inorganic compounds (calculated based on As content)	As	-	0.003
Cadmium and its inorganic compounds (calculated based on Cd content)	Cd	-	0.0003
Magnesium and its compounds (calculated based on the content MnO_2)	Mn	0.01	0.001
Nickel	Ni	-	0.001
Benzene	C_6H_6	1.5	0.05
Benzo(a)pyrene	$C_{22}H_{12}$	-	0.1 µ/100 m^3

In accordance with Georgian Laws on Environment Protection and Ambient Air Protection air quality standards shall be determined every 5 years, though standards have not been renewed since 2003, except for the standard for nitrogen dioxide (NO_2). The maximum value of $NO_2$was increased from 0.085 mg/m^3 to 0.2 mg/m^3, bringing it in line with the EU hourly limit value and the standards recommended by the WHO.

Georgian air quality legislation lacks the strict assessment protocols set out in both the CAFE-Directive (2008/50/EC) and the 4th Daughter Directive (2004/107/EC).This includes its selection of species detected and the ambient air quality limit attainment values it regulates, delineation of air quality management districts, network design and operations standards, sampling, analysis and reporting requirements.

Air quality regulations in Georgia do not contain air quality limits for a number of substances regulated by EU directives, including PM_{10} and $PM_{2.5}$. Existing MACs are not in line with EU limit values in terms of allowed ambient concentrations of pollutants and averaging times. Georgian MACs are only health-based standards, not taking into consideration impacts on ecosystems and habitats. The NEA's, national agency responsible for ambient air quality monitoring, technical guidelines on air quality control are based on old Soviet standards and regulations, which are not compatible with those within the EU Air Quality Directives. There are plans for the Georgian government to adopt two regulations which will align national ambient air quality standards and monitoring systems with EU requirements.

2.2. CURRENT NETWORK SUMMARY

Current air quality monitoring network in Georgia consists of 8 air quality monitoring sites/stations located in 5 cities of Georgia. Of these, four sites are situated in Tbilisi. Other cities, including Rustavi, Kutaisi, Batumi and Zestaphoni have only 1 monitoring station each.

All sites except for one are non-automated stations defined as ***"basic stationary monitoring sites"*** by the Soviet technical guidance documents. They do not meet the EU classification criteria for "urban background station". Given the majority of these sites are located on major roads; they fall under the category of "road-side monitoring stations" based on the EU criteria.

One fully automated station has been installed located in Tbilisi and its location can be categorised "urban background station"

The following pollutants are monitored regularly across the national network: TSP (dust), SO_2, NO_2, CO, O_3, Pb, MnO_2, and NO. In addition, the automated station measures PM_{10}, $PM_{2.5}$ and NO_x.

In addition to the ambient air quality monitoring sites, measuring concentrations of a limited number of pollutants, a single regional/global background (EMEP) station is located in Abastumani.

This station is dedicated to measuring cations and anions in precipitation, and PM_{10}, Ozone and Main Ions in the air.

Were the current air quality network assessed against Soviet ambient air technical methods then the density of existing monitoring network in Georgia would be deemed inadequate. As the monitoring network coverage is not sufficient enough to generate a representative urban air quality data for modelling purposes.

Looking at the specific Soviet requirements, Tbilisi, with its population size over 1.1 million should have 10-20 stationary or kerb-side (road-side) monitoring stations, while it has only 4; Kutaisi, Rustavi and Batumi with population size over 100,000 should have 2-3 sites each instead of 1. However Zestaphoni, with a population size below 50,000 currently has 1 site, which is in line with technical guidelines though, due to high industrialization level of the city, the number of sites might be increased.

Air quality monitoring site locations in Georgia were selected during Soviet times based on meteorological conditions, industrial activities, traffic flows and spatial planning specific at the time. The current locations do not necessary reflect the existing situation in terms of pollution sources and urban development.

Too few of the existing stations monitor pollutants regulated within the EU air quality directives, and some not all stations e.g. ozone, PM_{10} and $PM_{2.5}$, and other not monitored at all, e.g. heavy metals (except for lead), benzene, etc.

With exception to the new monitoring station in Tbilisi, all monitoring stations in Georgia do not capture extreme/peak values, or collect either 1 hourly or even 24 hourly data averages. This results in key averaging periods being missed, e.g., calculating either 1- or 8-hour values for pollutant limit values or MACs (e.g. ground-level ozone), in addition preventing the implementation of alert thresholds.

The current network relies upon a manual system where measurements are made three times a day during day-time and contrary to the technical standards (sampling at 1 am) no night-time measurements are made. Three day time measurements may potentially generate a representative picture for higher day time concentrations, but fails to capture the average concentration over 24-hour. In addition, the exclusion of weekends from the measurement program further diminishes the reliability and representativeness of data.

The existing fixed measurement stations are simple mobile laboratory booths, which do not meet key technical requirements in terms of ventilation, climate control, height from ground level, etc. The principal measurement technique using absorption filters is an obsolete method requiring the replacement of expensive filters.

The current air quality monitoring programme therefore satisfies neither the requirement of the Soviet technical guidelines nor those of the EU Air Quality Directives.

Georgia’s regions and areas have not, as yet, been divided into zones/ agglomerations or districts for the purpose of air quality management, as previous monitoring data was insufficient to provide a clear and comprehensive understanding of ambient air quality across each region.

Member states are obliged under EU requirements, to operate a minimum of 1 rural background station per 50,000 km^2 or 1 station per 25,000 km^2 for complex terrains. In Georgia, the EMEP background station in Abastumani that measures regional (trans-boundary) and global backgrounds could be used for measuring rural background and assessing impacts of regional long-range transport and urban plumes. Data obtained from this site, could be successfully applied for ecosystem impact studies, assessing regional and long-range transport of pollutants ozone hot spots.

The current budget of the NEA is severely limited, as is its staff resources. In addition the NEA's technical capabilities and existing infrastructure are not sufficient to conduct full-scale routine monitoring of ambient air in Georgia in line with EU requirements.

2.3. Sampling and Analytical Methods

Current air quality pollutant measurements are conducted three times a day during working days, based on methodologies presented in the following documents:

- ✓ *Guidelines on Air pollution Control*, developed by the Main Geophysical Observatory of St. Petersburg (РД 52.04.186-89 Руководствопоконтролюзагрязненияатмосферы);
- ✓ *Guidance Document* RD 52. 04-56-89 (Руководящий документ РД 52. 04-56-89);
- ✓ *Guidance Document* RD 52. 04-57-95 (Руководящий документ РД 52. 04-57-95).

Dust: Total airborne dust (TSP) concentrations are measured using the gravimetric method with filter sampling techniques using FPP-15 filter.

NO/NO_2: Determination of concentrations of NO and $NO_2$is provided by photo-colorimetric method.

SO_2: Determination of concentration of SO_2 is provided by photo-colorimetric method.

CO: Concentration of carbon monoxide is measured by electrochemical method using gas analyser "Paladi 3".

Lead: Atomic absorption method and AFA-HP-20 filters are used for sampling of lead.

MnO_2: Photo-colorimetric method and AFA-HP-18 filters are used for measurement of manganese dioxide.

O_3: The concentration of ozone is determined by "3.02 P-A" ozone analyser.

In addition to stationary measurement equipment, the Environmental Pollution Monitoring Department has a series of portable measurement devices to carry out express analysis of pollutants' concentrations.

In terms of problems with laboratory analysis, the central analytical laboratory continues to experience shortages of laboratory chemicals, with lengthy procurement processes and budget restrictions on purchasing necessary stock chemicals and standard solutions.

2.4. Air quality assessment/modelling

At present, air quality modelling is not used as a complementary or supplementary tool for ambient air quality monitoring. It is a tool more frequently applied by a limited number of consulting and engineering companies or environmental NGOs during the assessment of impacts of emission sources within EIAs and as part of the environmental permitting process. Consultants engaged in air quality modelling are engaged in calculating emission limits and/or in compiling emission inventories. The majority of consultants, with the exception of CENN, use the dispersion model "Ecology-City-St. Petersburg" based upon the Russian method OND-86: **"Calculation of concentrations of harmful substances in the atmospheric air, contained in the emissions from pollution source(s)"**. CENN uses ADMS-Urban.

The "Ecology-City-St. Petersburg "model can calculate maximum and mean annual surface concentrations of pollutants from either fixed or mobile sources. The model makes use of local meteorological data, where it is available".[15]However the current version of the "Ecology-City-St. Petersburg "model used in Georgia can only calculate maximum ambient air concentrations.

None of the relevant units of the Ministry of Environment, engaged in managing ambient air quality apply air quality modelling tools for assessing the air quality. GIS technologies are not commonly used within the Ministry. Though urban air quality modelling software has recently been made available to the NEA (Database Department), a shortfall in technical capabilities within the Agency has resulted in its failure to be applied in practice.

2.5. Data Transfer and Reporting

Ambient air quality data is collected, processed, analysed and reported by the NEA through its Department for Environmental Pollution Monitoring. More specifically, daily logs of site measurements in all cities other than Tbilisi are kept by local operators and then sent to Tbilisi on a monthly basis via fax or e-mail.

The local operator in Batumi has an e-mail communication with the central office. Samples from Tbilisi non-automated stations are transferred to the central chemical laboratory and analysed there. Data logs from continuous monitoring site are automatically transferred to the central monitor, located at the main lab of the NEA.

Daily data are entered in the central database maintained at the Database Department of the NEA. Based on daily logs, the agency develops monthly reports on environment pollution containing a summary overview of the state of the ambient environment, including information on ambient air. Hard copies of these reports are available at the NEA, while electronic versions of monthly bulletins are posted on the NEA's website: *http://meteo.gov.ge/radiation.*

On an annual basis, the agency develops yearbooks on environmental pollution, which are kept by the NEA and, contrary to national legislation, not shared with wide public. The annual report contains meta-date about each monitoring station, including methodology, existing equipment, number of measurements conducted on each station for each pollutant. Information about concentrations and trends are also contained in the reports, including: main air pollution sources in each city where monitoring is carried out, annual means and maximum concentrations of each measured pollutant at each station, number of exceedances of MACs for each pollutant at each station (number of measurements), trends of annual means for each pollutant in each city for last 5 years and monthly means of each pollutant in each city for the last years.

On a three yearly cycle the Ministry of Environmental and Natural Resources Protection produces a State of the Environment Report (SoE), within which information on the national ambient air is included. The report is made available on the MoENRP's website and in theory, widely available to the public. A new SoE is currently being developed.

With exception to the yearbooks and SoE reports a limited number of few sporadic air quality studies are also available.

The current method of manually transferring air quality monitoring data, its processing, analysis and reporting, can often run into delays on the transmission of daily data logs from each of the manual monitoring sites for Data from the Tbilisi Vashlijvario Meteo Station continuous monitoring station are automatically uploaded to the central monitoring server. Though data transfer from the site to the central computer can often be delayed by several hours to up to several days.

Before 2012, NEA's monthly bulletins for 2009 to2012 were regularly posted on the web-site of the Arhus Centre. In 2012, due to the restructuring of the MoENRP the centre has stopped functioning. Its web-site was also deactivated. Since 2013 the NEA has started posting monthly bulletins at

[15] Source: *http://expo.fmi.fi/aqes/public/Air_quality_monitoring_cooperation_St._Petersburg_Evaluation_report.pdf*

www.meteo.ge. Though, these reports are uploaded with delays. The monthly bulletins do not contain detailed data generated at automated urban background station. Only summarized information is included in the monthly reports. Furthermore, annual reports are neither published as hard copies nor posted on the NEA’s web-site. Annual pollution indices are not calculated and published, since these values require at least 75% of annual data received through full-scale monitoring (4-time measurements within 24 hours) of pollutants' concentrations. In addition, the NEA has no system by way of alert/warning system for vulnerable groups of population during unfavourable meteorological and ambient air conditions (heat waves, temperature inversions, etc.).

Data for emission inventories are also stored within the MoENRP’s Environmental Inspectorate and Air Protection Service and not available on-line. This limits the NEA’s ability to combine air quality measurements with assessments. Likewise, daily air quality monitoring data generated and kept by the NEA is not readily available to other relevant units of the Ministry of Environment and Natural Resources Protection or, to the wider public. Therefore the NEA’s ability to plan both short and long-term air quality management measures is hampered by this lack of access to key emissions data. When available, it is apparent that emissions data is incomplete, with primary information fields such as traffic flow, car fleet, and fuel consumption absent. A relatively complete dataset is available for Tbilisi due to the information gathered through the work of several international projects looking at Tbilisi’s energy, climate change, transport and, air quality management. As an exception to other cities in Georgia, Tbilisi city municipality has a relatively greater capacity in comparison to similar bodies of other cities to collect attribute/input data at the city level.

2.6. QUALITY CONTROL/QUALITY ASSURANCE (QC/QA)

Quality control of chemical analysis is conducted by blank samples. Uncertainties are detected by the AQC software developed by Human Dynamics Consortium and X-Kortipakka used by the Finnish Environmental Institute SYKE. This procedure is limited to ion chromatography method within in the central national laboratory. Standard Operations Procedures (SOPs) containing measurement and laboratory safety requirements in line with ISO standards have been developed for water quality monitoring that are currently being translated into Georgian. Such SOPs are a basic requirement for any QA/QC system, and none specific to air quality monitoring currently exist in Georgia. A plan is in place to correct this omission with air a plan to develop air quality specific sampling SOPs.

The NEA wholly lacks the technical capacity to operate, calibrate, service and maintain a national air quality monitoring network and as well as staff and operate an analytical laboratory.

As an example, the Department for Environmental Pollution Monitoring retains a single vehicle for all environmental (water and air) monitoring and servicing visits. In addition, this same vehicle is also used for spot checks of environmental quality that are requested by the Environmental Inspectorate as part of environmental compliance monitoring and control activities. No reference laboratory exists in Georgia from which a calibration reference may be made providing a cross-check of the accuracy of measurements.

Standard Operating Procedures (SOPs) have not been developed for air quality monitoring in Georgia. It is apparent that ISO standards are not followed and no national reference calibration standards are maintained. Therefore on that basis alone, all air quality measurements made within Georgia contain an inherently high level of uncertainty, as the accuracy, precision, validity and reliability of data collected are neither tested nor examined.

3. REQUIREMENTS FOR AMBIENT AIR MONITORING NETWORK ACCORDING TO THE EU AIR QUALITY DIRECTIVES’ PROVISIONS

3.1. PURPOSE AND APPROACH

EU air quality directives (2004/07/EC and 2008/50/EC) stipulate that states should assess concentrations of major air pollutants such as particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen dioxide (NO_2) in outdoor air to against legally binding limits, and where prescribed pollution thresholds are exceeded, monitoring of ambient air should be put in place. Ambient air, according to the directives, is outdoor air at ground or near ground level

When monitoring ambient air, EU directives demand that a ‘Common Approach’ is followed, specifically relating to:

- Measurement method used
- Location and number of sample points
- Concentration thresholds

The common approach is defined as a set of prescribed technical and quantitative methods required for the operation of a national air quality monitoring network. These include use of ‘Reference Method’ detection systems following internationally established (ISO) and standardised sampling and detection method, mandatory sampling at ‘Urban back ground locations’ and where levels are representative of the exposure of the general urban population and the detection to a threshold concentration.

3.2. REFERENCE METHODS

Reference methods for the measurement air pollutants (specified in Annex VI of Directive 2008/50/EC and 2004//07/EC)) are based upon Standard Methods developed by CEN and are outlined in Table 21 below:

Table 21. CEN Air Quality Standard Method

Pollutants	Reference standard	Method Description	Year
(NO_x)	EN14211:	Chemiluminescence Detection	2005
(SO_2)	EN14212:	Fluorescence Detection	2005
(O_3)	EN14625:	UV Photoionisation	2005
(CO)	EN14626:	Infra Red Detection	2005
(PM_{10})	EN12341:	Gravimetric determination by weight difference	1999
($PM_{2.5}$).	EN14907:	Gravimetric determination by weight difference	2005
(Benzene)	EN14662	Gas chromatography and photo ionisation Detection	2005
PAH’s and B(a)P	EN12884	High Volume Sampling and detection using Gas Chromatography / Mass Spectrometry	2005
Pb, As, Cd & Ni	EN14902	Pumped samples onto a filter and determination by Inductively Coupled Plasma Atomic Absorption/ Atomic Absorption	2005
Gaseous Mercury	EN 15852	Fluorescence Detection	

These standards describe in detail how analysers are to be tested, approved for use, calibrated and their on-going performance determined. These harmonised procedures allow Member States to reliably and consistently quantify the uncertainties associated with their measurements of air pollution.

For the gaseous analysers, the relevant Standard Methods include a requirement for type testing and approval.

For particle monitoring (PM_{10} and $PM_{2.5}$) compliance is achieved by either using a reference method device or ensuring that all analysers used in the network have been demonstrated as being satisfactorily equivalent to a reference method. The details of the compatibility test with a reference procedure are contained in method documents EN 12341.1:1998 and EN14907: 2005.

3.3. Location and number of sample points

EU air quality directives stipulate that there be a minimum number of monitoring stations per 'zones' or 'agglomerations' of a member state. This is in order to establish a uniform distribution of monitoring sites across member states.

Member states are obliged to assess ambient air quality within their territory, the territory can be divided into zones which reflect their population, population density and land area, and agglomerations.

Ambient air can be assessed within a zone using:

- continuous measurement at a fixed location sampling
- a combination of continuous measurement at a fixed location sampling and modelling techniques and or indicative measurement
- modelling techniques or objective-estimation techniques or both.

Where a particular pollutant concentration has been identified as being below the lower assessment threshold at the preliminary assessment stage, then monitoring may be replaced by either modelling or other objective techniques such as emission inventories to assess ambient air quality.

Therefore the limiting factor in determining how many monitoring station are required within an ambient air quality monitoring network, is the number of zones and agglomerations within that state that exceed the lower or upper limit values, rather than the size of the national population or the condition of its air quality.

Two assessment thresholds are used to determine exactly what intensity and type of ambient air quality sampling will used in the long-term within each zone or agglomeration. Air pollutants are assessed as to whether their concentration falls below the 'lower assessment threshold (50% of the limit value)', above the 'upper assessment threshold (70% of the limit value)' or between upper and lower assessment thresholds.

- Upper Assessment Threshold- a pollution level above which long-term 'fixed measurements' are required;
- Lower Assessment Threshold- a pollution level below which only air quality modelling and /or 'indicative measurements' are required.
- Fixed measurements – samples collected from fixed monitoring sites, either continuously or by random sampling;
- Indicative measurements – samples collected which meet data quality objectives, though are less strict than those required for fixed measurements.

3.4. CONCENTRATION THRESHOLDS

Air quality is assessed against 'target values', 'limit values' for human health and 'critical levels' for ecosystem protection.

- Target values – a concentration which should not be exceeded where possible
- Limit Values – a statutory concentration not to be exceeded across a set time
- Critical levels - a level above which direct adverse effects may occur on some receptors, such as trees, other plants or natural eco-systems but not on humans.

EU Limit values are legally binding EU parameters that must not be exceeded these are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedances allowed per year, if any. Some pollutants have more than one limit value covering different endpoints or averaging times.

In order to successfully assess impact air pollutant impacts, LV averaging times vary according the health impacts of a particular pollutant.

Table 22. European Air Quality Directive limit and target values for the protection of human health

Pollutant	Limit Value	Concentration measured as	Margin of Tolerance[16]
PM_{10}	50 µg/m^3 not more than 35 times a year	24 hour mean	50%
	40 µg/m^3	Annual Mean	20%
$PM_{2.5}$	Target value 25 µg/m^3	Annual Mean (Calendar year)	20%on11June2008,decreasingonthenext1Januaryand every12monthsthereafterbyEqualannualpercentagestoreach0%by1January2015
	Limit Value 20µg/m^3	Annual Mean (Calendar year)	0%
Nitrogen Dioxide	200 µg/m^{3}not to be exceeded more than 18 times a year	1 hour mean	0% after 31 December 2009
	40 µg/m^3	Annual Mean (Calendar year)	50% on 19 July 1999, decreasing on 1 January 2001 and every 12 months thereafter by equal annual percentages to reach 0% by 1 January 2010 after 31 December 2009

Pollutant	Limit Value	Concentration measured as	Margin of Tolerance[16]
Ozone	Target of 120 μg/m^3 not to be exceeded on more than 25 days per year per calendar averaged over 3 years	Maximum 8 hour mean	None
Sulphur Dioxide	350 μg/m^3 not to more exceeded more than 24 times a year	1 hour mean	150 μg/m^3 (43%)
	125 μg/m^{3}not to more exceeded more than 3 times a year	24 hour mean	None
Polycyclic aromatic hydrocarbons	1 ng/m^3 B(a)P	PM_{10} Fraction over a calendar year	None
Benzene	5 μg/m^3	As annual average	0% after 31 December 2009
Arsenic	6 ng/m^3	PM_{10} Fraction over a calendar year	0%
Cadmium	5 ng/m^3	PM_{10} Fraction over a calendar	0%

Pollutant	Limit Value	Concentration measured as	Margin of Tolerance[16]
		year	
Nickel	20 ng/m^3	PM_{10} Fraction over a calendar year	0%
Carbon Monoxide	10 mg/m^3	Maximum daily running 8 hour mean	60%
Lead	0.5 µg/m^3	Annual mean (Calendar year)	100%

Limit and target value averaging times for the protection of vegetation and ecosystems (Table 23) are in addition to those for human receptors and include annual averages for Oxides of Nitrogen and Sulphur Dioxide. Due to the historically high concentrations of Sulphur Dioxide in ambient air over the winter periods in Northern Europe and increased fossil fuel use during that period, an additional Sulphur Dioxide winter average averaging period (1Octoberto31March) has been identified for the purposes of protection of vegetation.

The limit value for ozone, known as AOT40, is the accumulated ozone exposure over a threshold of 40ppb (80 µg/m^3) during hours of sunlight between spring and summer. This sum is takes into account that a high concentration of ozone over a long-period has the potential of damaging habitats.

Table 23. European Directive Limit and target values for the protection of vegetation and ecosystems

Pollutant	Limit Value	Concentration measured as
Oxides of Nitrogen	30 µg/m^3	Annual Mean (Calendar year)
Sulphur Dioxide	20 µg/m^3	Annual Mean (Calendar year) & Winter (1 Oct to 31 March)
	125 µg/m^{3}not to more exceeded more than 3 times a year	Winter average
Ozone: protection of vegetation & ecosystems	Target of 18,000 µg/m^3 based on AOT40[17] to be calculated from 1 hour values from May to July and to be achieved, so far as possible, by 2010	Average over 5 years

3.5. MINIMUM NUMBER OF SAMPLING POINTS FOR EACH RELEVANT POLLUTANT SPECIFIED IN BOTH DIRECTIVES

The minimum number of sampling points within a zone or agglomeration are specified in both the CAFE-Directive 2008/50/EC (Annex V and IX),Table5,and the 4th Daughter Directive 2004/107/EC (of and section IV Annex III),Table 6.

Where concentrations exceed the lower assessment threshold, the minimum numbers of sampling points per zone / agglomeration are:

- 1 for pollutants exceeding LAT NO_2, SO_2, CO, PB, Benzene
- 1 for PM_{10} and $PM_{2.5}$exceeding LAT, 2 for PM_{10} and $PM_{2.5}$exceeding UAT
- 1 for Cd, Ni, and As, and
- 1 for B(a)P

All of the above are indirectly proportional to the population size of the zone / agglomeration.

The minimum number of ozone sample points is:

- 1 for zones with a population greater than 250,000 and are deemed suburban/ rural or a population greater than 500,000 and are deemed urban/ suburban;

1 rural background station per 50,000km^2or per 25,000km^2 of complex terrain, or for a rural background station per 100,000$km^2$where the long-term objective is met.

3.6. PM_{10}AND $PM_{2.5}$MONITORING STATIONS

Where $PM_{2.5}$ and PM_{10} are being measured at the same rural background locations these measurements shall count as two separate sampling points.

The total number of $PM_{2.5}$ and PM_{10} sampling points in a Member State shall not differ by more than a factor of 2.

Table 24. Minimum Number of Sample Points for Diffuse Sources within an agglomeration or zone required under both 1999/30/EC (Annex IX), 2000/69/EC (Annex VII), and 2004/107/EC (Annex V)

Minimum Number of Sample Points for Diffuse Sources within an agglomeration or zone								
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			
	Pollutants except PM	PM (2) (sum of PM_{10} and $PM_{2.5}$)	As, Cd, Ni	B(a)P	Pollutants except PM	PM (2) (sum of PM_{10} and $PM_{2.5}$)	As, Cd, Ni	B(a)P
0 – 249	1	2			1	2		
250 – 499	2	3	1	1	1	2	1	1
500 – 749	2	3			1	2		
750 – 999	3	4			1	2		
1,000 – 1,499	4	6	2	2	2	3	1	1
1,500 – 1,999	5	7			2	3		
2,000 – 2,749	6	8	2	3	3	4	1	1

2,750 – 3,749	7	10			3	4		
3,750 – 4,749	8	11	3	4	3	6	2	2
4,750 – 5,999	9	13	4	5	4	6	2	2
> 6,000	10	15	5	5	4	7	2	2

Table 25. Minimum Number of Sample Points for fixed measurements for zones and agglomeration attaining the long-term objectives required under both 1999/30/EC (Annex IX), 2000/69/EC (Annex VII), and 2004/107/EC (Annex V)

Minimum Number of Sample Points for fixed measurements for zones and agglomeration attaining the long-term objectives			
Population of agglomeration or zone (thousands)	Agglomerations (urban and suburban) or zone (thousands)	Other zones (suburban and rural)	Rural background
< 250		1	1 station/ 50,000km^2 as an average density overall zones per country
< 500	1	2	
< 1,000	2	2	
< 1,500	3	3	
< 2,000	3	4	
< 2,750	4	5	
< 3,750	5	6	
> 3,750	One additional station per 2 million inhabitants	One additional station per 2 million inhabitants	

Half of the monitoring stations should be located in suburban areas when sampling in agglomerations, with at least one station should be located where highest exposure of the population is likely to occur.

When sampling at a rural background with complex terrain, at least one monitoring site per 25,000km^2 is recommended.

3.7. Minimum number of point source sampling points

When determining the number of fixed measurement sampling points for assessing the contribution of pollution in the vicinity of point sources, the emission densities, distribution patterns of ambient air pollution and potential exposure of the population should all be taken into account.

3.8. Compliance with the PM2.5 Exposure Reduction Target

The assessment of compliance with the $PM_{2.5}$ exposure reduction target requires a minimum of sampling points of one sampling point per million inhabitants. This can be summed over adjoining agglomerations and additional urban areas in excess of 100,000 inhabitants, and include sampling points required to assess impacts upon human health.

3.9. Protection of Vegetation

Where maximum concentrations exceed the upper assessment threshold, there should be a minimum of 1 station every 20,000km^{2}for the Protection of Vegetation in zones other than agglomerations. If maximum concentrations are between upper and lower assessment threshold there need only be a minimum of station every 40,000km^2.

3.10. Measurements at Rural Background Locations

In addition to the assessment of pollutants for purposes of protection of both human health and ecosystems, fixed measurements shall be made at one sampling point every 100,000 km^{2}at rural background locations away from significant sources of air pollution. These may set up one or in agreement with adjoining Member States, several common measuring stations, covering the relevant neighbouring zones, to achieve the necessary spatial resolution and measurement of $PM_{2.5}$ must include at least the total mass concentration and concentrations of appropriate compounds to characterise its chemical composition (the following to be included SO_4^{2-}, Na^+, NH_4^+ Ca^{2+} NO_3^-, K+ Cl^-, Mg^{2+}, organic carbon, elemental carbon, as a minimum).

3.11. Data quality objectives for ambient air quality assessment in EU directives

Minimum requirements for the quality of data acceptable to Directive 2008/50/EC are termed Data Quality Objectives. These include uncertainty, minimal data capture and minimal time coverage.

Data Quality Objectives for fixed measurements (long-term), such as a permanently located continuous monitor are set out in Table 26, and data quality objectives for indicative measurements (short-term) are set-out in Table 27.

Where a pollutant concentration is well below the lower assessment threshold (as set out in part A, Annex II of the CAFE Directive) then it is acceptable to use indicative measurements instead of continuous measurements for benzene, lead and particulate matter. Random measurements may be used where it can be demonstrated that combined uncertainty meets the quality objective of 25%, the time coverage is still larger than the minimum time coverage for indicative measurements; and random sampling is evenly distributed over the year in order to avoid skewing of results.

Table 26. Data quality objectives for the fixed measurement of ambient air quality assessment in National Networks

Objective Criteria	SO_2, NO_2 and NO_x and CO	Benzene	PM_{10}, $PM_{2.5}$ and Pb	Ozone and related NO and NO2	B(a)P	AS, Cd, & Ni	PAH's other than B(a)P, total gaseous Hg	Total Deposition
	Fixed Measurements							
Uncertainty	15 %	25 %	25 %	15 %	50 %	40 %	50 %	70 %
Minimum data capture	90 %	90 %	90 %	90 % during summer	90 %	90 %	90 %	90 %
				75 % during winter				
Minimum time coverage					33 %	50 %		
- Urban Background and traffic	-	35 %	-	-				
- Industrial sites	-	90 %	-	-				

Table 27. Data quality objectives for indicative measurement of air quality assessment in National Networks

Objective Criteria	SO_2, NO_2 and NO_x and CO	Benzene	PM_{10}, $PM_{2.5}$ and Pb	Ozone and related NO and NO_2	B(a)P	AS, Cd, & Ni	PAH's other than B(a)P, total gaseous Hg	Total Deposition
	Indicative Measurements							
Uncertainty	25 %	30 %	50 %	30 %				
Minimum data capture	90 %	90 %	90 %	90 %				
Minimum time coverage	14 %	14 %	14 %	> 10 % during summer	14 %	14 %	14 %	33 %
Objective estimation Uncertainty	75 %	100 %	100 %	75 %				

4. NEW AIR QUALITY MONITORING NETWORK (AQMN)

4.1. Introduction

The Preliminary Assessment for Georgia shows that ambient air quality is between good and poor depending of the specific location. Current monitoring practices within the national network, with the exception of a single continuous station at Vashlijvario in Tbilisi are inferior in the quality of the detection methods used, sampling practices and species monitored, and geographical coverage. Potentially all of the former result in grossly misleading results emanating from the network as a whole.

Data acquisition, transfer, collation, validation and reporting practices in the current network appear to be ad-hoc and inconsistent with significant data delays, resulting in the detection and reporting of any instrument errors being hindered. In order to begin to bring the network up to an acceptable standard meeting the data quality objectives of both the CAFE and Fourth Daughter Directives, key institutional and technical capabilities first need to be addressed.

4.2. Role of the Air Quality Network

Air quality networks management and maintenance is one of the key responsibilities of the Environmental Pollution Monitoring Department within the NEA.

The primary objective of an air quality network management team is to ensure that all QA/QC procedures within the air quality network are maintained to a high quality, ensure that the data generated is suitable and used in such a way that it protects the health of the population. Where standards of measurement and traceability are robust and that data made available to the public and reported to the Commission meets the legal obligations of the Air Quality Directives.

Overall, the air quality monitoring management team aims are to:

i) Inform the public about air quality in near-real time
ii) Check if statutory air quality standards, objectives, target and limit values are met
iii) Assess effects of air pollution on health and the environment
iv) Provide information for local air quality review and assessments
v) Inform and support the development of cost-effective planning solutions and identify long-term trends and sources of pollution.

Monitoring Requirements for Compliance the Assessment for SO_2, NO_2 and PM_{10}

Successful implementation of the CAFE directive requires all air pollutants at concentrations above LATs to be monitored using a suitable reference method. Currently SO_2, NO_2 and PM_{10} have been assessed as at risk of exceeding LATs and in some cases, UATs and LVs.

The following table contains details of the instruments required to monitor for SO_2, NO_2 and PM_{10} as a consequence of exceedences described in the Preliminary Assessment Report for Georgia.

Table 28.Instruments required monitoring for SO_2, NO_2 and PM_{10} as a consequence of exceedances

Species	Exceedence Type	Concentration Value	Monitoring Instrument	Reference Standard

SO_2	Daily Average LAT,	62.5µg/m^3	Fluorescence Detection	EN14212
	Daily Average UAT	87.5 µg/m^3		
	Daily Average LV	125 µg/m^3		
NO_2	Annual average LAT	20	Chemiluminescence Detection	EN14211
	Annual average UAT	28		
	Annual average LV	40 µg/m^3		
PM_{10}	Daily average LAT	25µg/m^3	Gravimetric determination by weight difference, (or equivalence method as per EN 12341)	EN12341
	Daily average UAT	35µg/m^3		
	Daily average LV	50µg/m^3		
	Annual average LAT	20µg/m^3		
	Annual average UAT	28µg/m^3		
	Annual average LV	40µg/m^3		

4.3. MONITORING REQUIREMENTS FOR OZONE TARGET VALUE AND LONG-TERM OBJECTIVES

Assuming the long-term objective for ozone is not attained within Georgia, the minimum number of sampling points for fixed continuous measurement of O_3in Georgia's zones and agglomerations is defined by Section A, Annex IX of the CAFE Directive. In the case of the agglomeration of Tbilisi, with a population between 1 to 1.5 million inhabitants, three ozone monitoring stations would be required, at least two of which to be positioned in a suburban area. Assuming the remainder of Georgia is defined as 9 separate zones, then as a minimum between 1 to 2 ozone monitoring stations could be required per zone, resulting in between 9 to 18 additional ozone monitoring stations. However redefining the rest of Georgia as a single zone when assessing compliance against the ozone target value alone, would reduce the number of ozone stations required down to a maximum of 6 for the remainder of Georgia.

Should Georgia achieve the long-term objectives for ozone, and retain supplementary assessment methods such as modelling, then the required number of stations could reduce to as low as 3, excluding Tbilisi.

In addition to the above, a single rural background O_3monitoring station would be required at all times, regardless of the whether objectives were attained or not.

Table 29.Instruments required monitoring for O_3 as a consequence of assumed Target value exceedances

Species	Exceedence Type	Target value	Monitoring Instrument	Reference Standard
O_3	Target value daily 8 hour mean	120µg/m^{3}not to be exceeded more than 25 days per calendar year, average over 3 years	UV Photoionisation	EN14625
	Target Value AOT40	18,000µg/m^3.h average over 5 years		
	Long-term objective maximum daily eight hour mean within a	120µg/m^3		

	calendar year			
	Long-term objective AOT40, May to July	6,000 µg/m³.h		

4.4. Monitoring Requirements for the Assessment of the $PM_{2.5}$ Exposure Reduction Target

One $PM_{2.5}$ sampling point per million inhabitants within an agglomeration or urban area over 100,000 is required under Section B of Annex V of the CAFE Directive, with an additional monitoring station for every urban area exceeding a population of 100,000. This would equate to $PM_{2.5}$having to be monitored at four separate monitoring stations across Georgia, Tbilisi, Kutaisi, Batumi and Rustavi.

Table 30.Instruments required to monitor for $PM_{2.5}$ Target Value and National Exposure Target in Georgia

Species	Exceedence Type	Concentration Value	Monitoring Instrument	Reference Standard
$PM_{2.5}$	Target Value	25µg/m³	Gravimetric determination by weight difference, (or equivalence method as per EN14907)	EN14907:
	Exposure concentration Obligation	20µg/m³		
	National Exposure reduction target	18µg/m³		

4.5. Maximum and Minimum Air Quality Monitoring Stations In the Georgia National Monitoring Network

Due to the fact that firm evidence of the exposure of Georgia's population to air pollutants is lacking, the existing national monitoring network uses non-reference detection methods and a day time bias sampling programme. Appropriate dispersion modelling data is emerging, though not available for the country as whole. In the absence of validated monitoring data, emissions data may be extrapolated to indicate areas of potential unhealthy exposure by the population, though should not be used in isolation as evidence of where to place to sampling stations as part of a wider national monitoring network.

In assessing the number and location of monitoring stations within the proposed national monitoring network a combination of tools were applied. These were national monitoring data (both as received and bias adjusted), dispersion modelling data and passive sampling data. Geographical coverage of each of the assessment tools was limited to a set number of locations, centred around major conurbations or major areas of industry. For the moment, regions of Georgia which did not contain assessment areas were assumed to be complaint with EU air quality limit values.

As part of the assessment scope a maximum air pollution scenario and minimum air pollution scenario were derived. These relate to the range of the scale that the initial national network, in terms of how many station and how many species will be sampled.

It was assumed that the species to be considered would be restricted to SO_2, NO_2/ NO and $PM_{10/2.5}$.This was in response to the monitoring data available and the risk associated that it was amongst those species that an exceedance was most likely.

The maximum scenario used evidence from a minimum of two out of three data sources (monitoring, modelling , passive sampling) to assign whether an LAT, UAT or LV were at risk of being exceeded. Where less than two data sources were available, then greater weight was given to the data source which indicated a risk of an exceedance.

The minimum scenario used an identical approach, though reduced the monitoring concentrations by a factor of 0.43. This factor was applied as it represented the factor between passive sampling results and the monitoring data. A single bias factor of 0.43 was applied nationally for clarity.

In the absence of a statistical relationship between hourly and daily SO_2 concentrations, against annual average SO_2 concentrations in Georgia, a conservative assumption was made that maximum daily SO_2 concentrations would achieve a magnitude of a factor of 3 of the annual average.

Therefore an assessment of compliance against SO_2 daily concentrations was made by multiplying the annual average by a factor of 3.

Table 31. Varying Predictions of CAFE Directive LV’s, LAT and UAT Exceedances across Georgian Cities applying the three Assessment Methods

Assessment Method	SO_2	NO_2	PM_{10}	CO	O_3
Batumi (Zone 4)					
Continuous Monitoring	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	Hourly LAT, Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A
Modelling				N/A	N/A
Passive Sampling		Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	N/A	N/A	N/A
Zestaphoni (Zone 5)					
Continuous Monitoring	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	
Modelling		Hourly LAT, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A	N/A
Passive Sampling		Annual LAT, Annual UAT,	N/A	N/A	N/A
Chiatura (Zone 5)					
Modelling	No exceedances	No exceedances		N/A	N/A
Passive Sampling				N/A	N/A
Kutaisi (Zone 5)					
Continuous Monitoring	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV		N/A
Modelling		Hourly LAT Hourly UAT, Annual LAT,		N/A	N/A

		Annual UAT, Annual LV			
Passive Sampling		Annual LAT, Annual UAT,	N/A	N/A	N/A
Rustavi (Zone 8)					
Continuous Monitoring	N/A	Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV		No exceedances	N/A
Modelling	Daily LAT Daily UAT Daily LV	Annual LAT Annual UAT Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT	N/A	N/A
Passive Sampling		No exceedances	N/A	N/A	N/A
Tbilisi (Agglomeration)					
Continuous Monitoring	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	Hourly LAT Hourly UAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	
Modelling	No exceedances	Annual LAT, Annual UAT	Annual LAT, Annual UAT	N/A	N/A
Passive Sampling		Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	N/A	N/A	N/A

Table 32.Cities in Georgia where Ambient Air Species monitoring is required assuming a Maximum Scenario under the CAFE Directive

Assessment Method	SO_2	NO_2	PM_{10}
Batumi (Adjara)			
Continuous Monitoring	Daily UAT	Hourly LV, Annual LV	Daily LV, Annual LV
Passive Sampling		Hourly LV, Annual LV	
Zestaphoni (Imereti)			
Continuous Monitoring	Daily UAT	Annual LV	Daily LV, Annual LV
Modelling		Annual LV	
Passive Sampling		Annual LAT, Annual UAT	
Kutaisi (Imereti)			
Continuous Monitoring	Daily LV	Hourly LV, Annual LV	Daily LV, Annual LV
Modelling		Hourly UAT, Annual LV	Annual LAT
Passive Sampling		Annual LAT, Annual UAT	
Rustavi (Kvemo Kartli)			
Continuous Monitoring		Hourly LV, Annual LV	
Modelling	Daily LV	Annual LV.	Daily LAT, Annual UAT

Passive Sampling		Annual LAT	
Tbilisi (Agglomeration)			
Continuous Monitoring	Daily UAT	Hourly LV, Annual LV	Daily LV, Annual LV
Modelling	No exceedances	Annual LAT, Annual UAT	Annual UAT
Passive Sampling		Hourly LV, Annual LV	

Table 33. Varying Predictions of CAFE Directive LV’s, LAT and UAT exceedances across Georgian Cities applying the three Assessment Methods, though reducing continuous monitoring results by the factor 0.43 (factor between NO_2 passive sampling and national annual average continuous monitoring results)

Assessment Method	SO_2	NO_2	PM_{10}	CO	O_3
Batumi (Zone 4)					
Continuous Monitoring	Daily LAT, Daily UAT	Hourly LAT, Hourly UAT Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A
Modelling				N/A	N/A
Passive Sampling		Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	N/A	N/A	N/A
Zestaphoni (Zone 5)					
Continuous Monitoring	Daily LAT, Daily, UAT, Daily LV	No exceedances	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A
Modelling		Hourly LAT, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A	N/A
Passive Sampling		Annual LAT, Annual UAT,	N/A	N/A	N/A
Chiatura (Zone 5)					
Modelling	No exceedances	No exceedances		N/A	N/A
Passive Sampling				N/A	N/A
Kutaisi (Zone 5)					
Continuous Monitoring	Daily LAT, Daily, UAT, Daily LV	Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	N/A
Modelling		Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV	Annual LAT	N/A	N/A
Passive Sampling		Annual LAT, Annual UAT,	N/A	N/A	N/A

Rustavi (Zone 8)					
Continuous Monitoring	N/A	Annual LAT, Annual UAT		No exceedances	N/A
Modelling				N/A	N/A
Passive Sampling		No exceedances	N/A	N/A	N/A
Tbilisi (Agglomeration)					
Continuous Monitoring	Daily LAT, Daily, UAT, Daily LV	Hourly LAT Hourly UAT, Annual LAT, Annual UAT, Annual LV	Daily LAT, Daily UAT, Daily LV, Annual LAT, Annual UAT, Annual LV	No exceedances	
Modelling				N/A	N/A
Passive Sampling		Hourly LAT, Hourly LV, Annual LAT, Annual UAT, Annual LV	N/A	N/A	N/A

Table 34.Cities in Georgia where Ambient Air Species monitoring is required assuming a Minimum Scenario under the CAFE Directive

Assessment Method	SO_2	NO_2	PM_{10}
Batumi*(Adjara)*			
Continuous Monitoring		Hourly UAT Annual LV	Daily LV, Annual LV
Passive Sampling	N/A	Hourly LV, Annual LV	N/A
Zestaphoni *(Imereti)*			
Continuous Monitoring			Daily LV, Annual LV
Modelling		Annual LV	
Passive Sampling	N/A	Annual LV	N/A
Kutaisi*(Imereti)*			
Continuous Monitoring	Daily LAT	Hourly UAT, Annual LV	Daily LV, Annual LV
Modelling		Hourly UAT, Annual LV	Annual LAT
Passive Sampling	N/A	Annual LAT, Annual UAT,	
Rustavi *(Kvemo Kartli)*			
Continuous Monitoring		Hourly UAT Annual UAT	N/A
Modelling	Daily LV	Hourly UAT, Annual LV	Daily LAT, Annual UAT
Passive Sampling	N/A	Annual LAT	N/A
Tbilisi (agglomeration)			
Continuous Monitoring	Daily LV	Hourly LV,Annual UAT	Daily LV, Annual LV
Modelling	No exceedances	Annual LAT, Annual UAT	Annual UAT
Passive Sampling	N/A	Hourly LV, Annual LV	N/A

The number of monitoring sites required to meet CAFE directive criteria under a maximum scenario are outlined in Table 34 and the minimum scenario in Table 35. Air quality monitoring stations have been identified as required in 3 of the 9 air quality zones, and in the agglomeration of Tbilisi.

Pollutant monitoring stations can where applicable be equipped with PM_{10} and $PM_{2.5}$ instruments, thereby meeting the requirement for particulate monitoring stations, whilst reducing the infrastructural requirements and staff resourcing of operating separate stations.

Table 35. Number of Monitoring Stations required against Zone and Agglomeration Populations alone for the Maximum Scenario

Number	Region	Population	Land Area (km^2)	Min Number Monitoring Stations				Information Supporting Assessment
				Max Concentrations exceed UAT		Max Concentrations are between the LAT and UAT		
				Pollutant (except PM)	$PM_{10+2.5}$	Pollutant (except PM)	$PM_{10+2.5}$	
1	Abkhazia	180,000[1]	8,660					No data
2	Racha Lechkhumi, Kvemo and Zemo Svaneti	51000[2]	4954					No data
3	Samegrelo	407,100[2]	7440					No data
	+ Guria (Poti, Kulevi, Sufsa)	140,300[2]	2033					
4	Adjara region	393,700[2]	2,900	2	3			Monitoring / Passive Sampling
5	Imereti Region	109,000[2]	6,552	1	2			Monitoring Modelling/ Passive Sampling
6	Shida Kartli + South Ossetia	314,600[2]	6,200					No data
7	Akhaltsikhe (Samtsikhe Javakheti)	214,200[2]	6,413					No data
8	Kvemo Kartli	511,300[2]	6,528	2	3			Monitoring / Passive Sampling
	including Rustavi	(122,900)						
9	Mtskheta – Mtianeti	479,500[2]	6,785					No data

	Kakheti	47,000[2]	11,379					
10	Tbilisi	1,1727,700[2]	726	4	6			Monitoring Modelling/ Passive Sampling

1 http://www.britannica.com/EBchecked/topic/1358/Abkhazia
2 National Statistics Office of Georgia, Number of Population as of January 1, 2010-2012

Table 36. Number of Monitoring Stations required against Zone and Agglomeration Populations alone for the Minimum Scenario

Number	Region	Population	Land Area (km^2)	Min Number Monitoring Stations				Monitoring / Modelling Data
				Max Concentrations exceed UAT		Max Concentrations are between the LAT and UAT		
				Pollutant (except PM)	$PM_{10+2.5}$	Pollutant (except PM)	$PM_{10+2.5}$	
1	Abkhazia	180,000	8,660					No data
2	Racha Lechkhumi, Kvemo and Zemo Svaneti	51000	4954					No data
3	Samegrelo	407,100	7440					No data
	+ Guria (Poti, Kulevi, Sufsa)	140,300	2033					
4	Adjara region	393,700	2,900			1	2	Monitoring Modelling/ Passive Sampling
5	Imereti Region	109,000	6,552	1	2			Monitoring Modelling/ Passive Sampling
6	Shida Kartli + South Ossetia	314,600	6,200					No data
7	Akhaltsikhe (Samtsikhe Javakheti)	214,200	6,413					No data
8	Kvemo Kartli	511,300	6,528	2				Monitoring Modelling/ Passive Sampling
	including Rustavi	(122,900)						
9	Mtskheta – Mtianeti	479,500	6,785					No data
	Kakheti	47,000	11,379					
10	Tbilisi	1,1727,700	726	4			3	Monitoring Modelling/

								Passive Sampling

Monitoring Objectives and Spatial Scales

The national ambient air monitoring network monitoring objectives will include an assessment of all species which are considered to be at risk of exceeding LAT's, UAT's or LV's. At this stage the monitoring objectives are focused on the protection of human health from both point source and dispersed emissions. Generally risks to human health from such emissions to air in Georgia are at their greatest in the urban and suburban atmosphere. Therefore the ambient air quality network will be focused upon the urban and suburban atmosphere within Georgia.

The approach used in identifying both the minimum and maximum network design was to combine monitoring, modelling and passive sample data together as assessment tools.

One further step taken within the minimum approach was to challenge the magnitude of the historical ambient air quality monitoring data, through the use of short-term passive sampling results. The outcome of this assessment approach resulted in the existing network monitoring data being reduced by a factor of 0.43, thereby scaling back the extent of any exceedances of LATs, UATs and LVs, and reducing the proportion of monitoring stations required to meet the EU CAFE directive requirements.

Due to limited monitoring data availability, the spatial scale of the network suitability assessment was limited to a series of urban centres within which monitoring data, dispersion modelling and / or passive sampling results were made available. These urban centres were assumed to represent typical exposure scenarios of a large proportion of the urban population within each of the regions of Imereti, Adjara, Kvemo Kartli and the city of Tbilisi.

4.6. Monitoring Site Locations

Ambient air quality monitoring data availability was limited to the current locations where the existing, though inadequate, air quality sampling network stations are located. Therefore it is apparent that the new air quality network will be biased towards the locations already occupied by the current network.

Evidence suggests that air quality is currently very poor in both Tbilisi and Rustavi, and at risk of exceeding as a minimum LAT's in all locations where an air quality sampling station is currently located.

It is therefore recommended that the ambient air quality network is developed in the same host cities where air quality has been assessed as currently either at risk of exceeding LATs, UAT's or LV's.

4.7. Network Requirements

It is apparent that a lack of air quality monitoring capacity in Georgia will provide a significant challenge to the NEA in meeting the full requirement of the CAFE Directive and the Fourth Daughter Directive. Therefore, the pollutant species being considered within the proposed air quality monitoring network at this stage have been limited to those which current assessment data is available. Therefore from the pollutants routinely required to be monitored according to both the CAFE Directive (SO_2, NO_2, NO_x, CO, Pb, Benzene, O_3, PM_{10}, $PM_{2.5}$, SO_4^{2-},NO_3^- Na^+ K^+ NH_4^+, Cl^-, Ca^{2+}, Mg^{2+}, elemental carbon, organic carbon and ozone precursors) and the Fourth Daughter Directive (As, Cd, Hg, Ni and PAHs) only SO_2, NO_2, NO_x, CO, O_3, PM_{10} and $PM_{2.5}$ have been considered within the national ambient air quality network design.

4.8. Minimum Scenario National Network Requirements

The national network requirements under a minimum assessment scenario are outlined in Table 36 below. Eight monitoring locations are required under this scenario, with 7 particulate monitoring locations required, to be a sum of PM_{10} and $PM_{2.5}$. Using single instruments capable of measuring both PM_{10} and $PM_{2.5}$ will reduce this requirement down to 4 PM instruments. Four monitoring stations are required to be installed within the agglomeration of Tbilisi. This scale of network is comparative to the spatial coverage of the current national air quality network, which consists of 4 monitoring sites in Tbilisi and four monitoring locations in urban areas elsewhere.

Co-locating PM instruments with the NO_2 and SO_2 instruments will also reduce the number of monitoring stations required, down to 8.

Table 37.Regional Distribution of National Air Monitoring Stations in Georgia

Zone Number	**Potential Monitoring Locations**	**Min Number Reference Monitoring Stations**			
		If Max Concentrations exceed UAT		If Max Concentrations are between the LAT and UAT	
		Pollutant SO_2, NO_2	$PM_{10+2.5}$	Pollutant SO_2, NO_2	$PM_{10+2.5}$
1	Imereti Region: Kutaisi Zestaphoni Chiatura	1	2		
5	Adjara region: Batumi			1	2
8	Kvemo Kartli: Rustavi	2			
10	Tbilisi	4			3

4.9. Maximum Scenario National Network Requirements

The national network requirements under a maximum assessment scenario are outlined in Table 37 below. Nine monitoring locations for non-PM pollutants are required under this scenario and14 particulate monitoring locations of PM_{10} and $PM_{2.5}$. Using single instruments capable of measuring both PM_{10} and $PM_{2.5}$ will reduce this requirement by 50%, down to 7 PM instruments.

Co-locating PM instruments with the NO_2 and SO_2 instruments will also reduce the number of monitoring stations required, down to 9.

Four monitoring stations are required to be dedicated to the agglomeration within Tbilisi. This scale of national monitoring network is slightly larger than the spatial coverage of the current national air quality network, which consists of 4 monitoring sites in Tbilisi and four monitoring locations in urban areas elsewhere.

Table 38. Regional Distribution of National Air Monitoring Stations in Georgia

Zone Number	Potential Monitoring Locations	Min Number Monitoring Stations			
		If Max Concentrations exceed UAT		If Max Concentrations are between the LAT and UAT	
		Pollutant SO_2, NO_2	$PM_{10+2.5}$	Pollutant SO_2, NO_2	$PM_{10+2.5}$
1	Imereti Region: Kutaisi Zestaphoni Chiatura	1	2		
5	Adjara region: Batumi	2	3		
8	Kvemo Kartli: Rustavi	2	3		
10	Tbilisi	4	6		

4.10. Supplementary Monitoring to the National Monitoring Network

Several regions of Georgia (Abkhazia, Racha Lechkhumi, Kvemo and Zemo Svaneti, Samegrelo, Guria, Akhaltsikhe, Shida Kartli, South Ossetia, Kakheti and Mtskheta – Mtianeti) currently have little or no record of air quality being monitored within their boundaries. Due to a combination of resources constraints, low populations and a lower density of point sources within these regions, it has had to be assumed that these regions therefore have a lower risk of air quality LV's being exceeded with a lower risk of local populations being exposed to unacceptable levels of air borne pollutants. However all of the above assumptions currently remain untested, and will require justification within any future Preliminary Assessment of Georgian air quality.

In order to provide an air quality monitoring record with sufficient geographical coverage to test the above assumptions, whilst meeting the CAFE Directive data quality objectives for indicative measurements, a proposal to distribute supplementary monitoring across the low risk regions has been developed (Table 38). Monitoring methods include passive sampling for NO_2, SO_2 and Benzene, and indicative combined particulate monitoring for both PM_{10} and $PM_{2.5}$. Lead sampling and analysis has also been included to determine any underlying risks associated with exposure to residual lead occurring from historic metal processing sites.

It is proposed that passive sampling for SO_2 and NO_2 should continue for a minimum of 12 months at all suggested sampling points. This would provide a solid monitoring record against which an air quality assessment of those regions can be undertaken. It is also proposed that passive sampling for Benzene, indicative sampling for PM_{10} and $PM_{2.5}$ as well as lead sampling be undertaken for a minimum of 8 weeks over a 12 month period. This would ideally be achieved through 4 two week monitoring campaigns providing an even distribution of sampling across the year, thereby meeting the CAFE directive data quality objectives for indicative measurements.

Table 39. Regional Distribution of Supplementary Monitoring points in Georgia

Zone Number	**Potential Monitoring Locations**	**Supplementary Monitoring points** Max Concentrations are either below LATs or no monitoring data exists	
		Pollutant SO_2, $NO_{2,}$ Benzene*	$PM_{10+2.5}$* and Lead*
2	Abkhazia Region	Passive sample points	Indicative Monitoring Points
	Sokhumi	3 $NO_{2,}$ 2 SO_2	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample
3	Racha Lechkhumi, Kvemo and Zemo Svaneti Regions	Passive sample points	Indicative Monitoring Points
	Ambrolauri	3 $NO_{2,}$ 2 SO_2	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample
4	Samegrelo + Guria Regions	Passive sample points	Indicative Monitoring Points
	Poti	3 NO_2, 2 SO_2	1 Combined $PM_{10/2.5}$ sampler Lead filter sample
	Sufsa	3 NO_2,2 SO_2	1 Combined $PM_{10/2.5}$ sampler
	Zugdidi	3 NO_2, 2 SO_2	Combined $PM_{10/2.5}$ sampler
6	Akhaltsikhe Region	Passive sample points	Indicative Monitoring Points
	Akhaltsikhe	3 NO_2, 2 SO_2, 1 Benzene	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample
7	Shida Kartli + South	Passive sample points	Indicative Monitoring Points

	Ossetia Regions		
	Gori	3 NO_2, 2 SO_2, 1 Benzene	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample
	Java	3 NO_2, 2 SO_2	1 Combined $PM_{10/2.5}$ sampler
9	Kakheti + Mtskheta – Mtianeti Regions	Passive sample points	Indicative Monitoring Points
	Mtskheta	3 NO_2, 2 SO_2	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample
	Telavi	3 NO_2, 2 SO_2, 1 Benzene	1 Combined $PM_{10/2.5}$ sampler 1 Lead filter sample

* Minimum 14% time coverage for each year as 4 x 2 week sampling periods evenly across a year.

Operating Schedules

In order to embark upon a sustainable national ambient air quality monitoring network, an operational schedule needs to be first realized and then put in place. Limiting factors in developing and sustaining the national air quality network are capital budgets, operational revenues, availability of suitable technical skills and a communications infrastructure capable of data telemetry. All of the above would, as a minimum, require 24 months to train and put in place suitably qualified staff.

Once in the national ambient air quality network is in place, a series of routine operations, actions and reports would then take place at pre-determined intervals and on an ad-hoc basis when interventions are required (Table 39). The table presents the possible National Monitoring Network Schedule of routine operations, actions and reports.

Table 40. National Monitoring Network Schedule of routine operations, actions and reports

<table>
<tr><td>Frequency</td><td>Routine Action</td><td colspan="4" bgcolor="#c0c0c0">Key Tasks and their Role</td></tr>
<tr><td></td><td></td><td bgcolor="#c0c0c0">Data Technician</td><td>Sampling Technician</td><td>Instrument Engineer</td><td>Calibration Technician</td></tr>
<tr><td rowspan="4">Daily</td><td>Communication with air quality stations</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
<tr><td>Acquisition of data</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
<tr><td>Visual screening air quality data</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
<tr><td>Gravimetric filter changes (not required if an equivalent method is used)</td><td></td><td bgcolor="#c0c0c0"></td><td></td><td></td></tr>
<tr><td rowspan="2">Bi-Weekly</td><td>Site inspection</td><td></td><td bgcolor="#c0c0c0"></td><td></td><td></td></tr>
<tr><td>Span calibration of gas instruments
In-line filter changes</td><td></td><td bgcolor="#c0c0c0"></td><td></td><td></td></tr>
<tr><td rowspan="2">3 months</td><td>Data ratification and validation</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
<tr><td>Instrument calibration
Calibration gas renewal</td><td></td><td></td><td></td><td bgcolor="#c0c0c0"></td></tr>
<tr><td rowspan="2">6 months</td><td>Site Audit</td><td></td><td></td><td bgcolor="#c0c0c0"></td><td></td></tr>
<tr><td>Routine Service and Maintenance</td><td></td><td></td><td bgcolor="#c0c0c0"></td><td></td></tr>
<tr><td>12 months</td><td>Annual data compilation and reports to national government and EU</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
<tr><td>3 years</td><td>Assessment of long-term objectives</td><td bgcolor="#c0c0c0"></td><td></td><td></td><td></td></tr>
</table>

Sampling and Analytical Methods

The national ambient air quality network sample and analytical methods are largely pre-determined by the CAFE directive requirement that strict data quality objectives (DQO) are to be met. Within these DQO's is the requirement that 'Type Approved' methods are used, which typically involve reference analytical methods (Table 40).

Table 41.Reference Air Quality Detection Methods

Pollutants	Reference standard	Method Description	Year
(NO_x)	EN14211:	Chemiluminescence Detection	2005
(SO_2)	EN14212:	Fluorescence Detection	2005
(O_3)	EN14625:	UV Photoionisation	2005
(PM_{10})	EN12341:	Gravimetric determination by weight difference or equivalent	1999
($PM_{2.5}$)	EN14907:	Gravimetric determination by weight difference or equivalent	2005

All required air quality monitoring sampling and detection equipment can be installed within a single air quality monitoring enclosure. Air quality sampling will be collected automatically in as similar manner as possible at each of the monitoring stations. An air sample is continuously drawn through a single centralised manifold for all gas analysers (SO_2, NO/NO_2 and O_3) using a centralised pump, sub-samples are then piped into each of the gas analysers. Independent sample manifolds are used by the PM_{10} and $PM_{2.5}$detectors using dedicated pumps.

Samples are collected at a minimum height of 1.5 metres, though where a large sampling enclosure is employed at heights up to 5 metres in height. All air quality monitoring sample flow rates will be calibrated using a single reference flow meter.

All detectors operate automatically and, with exception to the checks and occasional filter changes, require no manual intervention.

Data is collected automatically on each of the monitoring sites, either using a data logger and/or central data acquisition server. Using either GPRS/3G mobile telephone communications channels, data can be continuously uploaded to a dedicated IP address or digitally downloaded via a modem/ router to a central data server.

4.11. Integration of existing Networks into the AQMN

The locations of the existing monitoring network stations have been reported as not compliant with EU classification criteria for "urban background station" and are categorised as "road-side monitoring stations" (section 2.2 above). It is therefore proposed that the EU compliant national air quality monitoring network be located within the same cities as the existing monitoring stations, though that sampling locations be tested for their compliance with the category of urban background station. Where an existing sample station fails this test, then an alternative, more suitable location is sought.

5. THE QUALITY CONTROL SYSTEM

5.1. REFERENCE METHODS FOR ASSESSMENT OF CONCENTRATIONS AND STANDARDIZATION

Ambient air reference methods provide concentration data which is of known (or traceable) accuracy, precision, repeatability and uncertainty. As they are universally applied, they therefore provide a standardised approach to obtaining ambient air quality data. The CAFE and Fourth daughter directive has stated strict data quality objectives which are easily achievable using reference methods. In addition both the CAFE and Fourth Daughter Directives require measurement to be made using a reference (or equivalent) detection method.

When designing an ambient air quality monitoring network which meets the requirements of both the CAFE and Fourth Daughter Directive careful selection of monitoring equipment is essential. A reference measurement method for each pollutant species is available from CEN, or is in the process of being completed by CEN (e.g. EN 12341 for the measurement of PM_{10}).

A primary requirement in both the CAFE and Fourth Daughter Directive is the principle that a sampling operation should be able to demonstrate compliance with the limit and guide values as stated in the Directives. This means that detection limits and averaging times must be suitable. Non-reference methods may not allow sample averaging times to comply with the limit and guide values. Likely future needs for monitoring, in terms of shorter averaging periods and/or lower detection limits, should also be borne in mind.

5.2. QUALITY ASSURANCE FOR AMBIENT AIR QUALITY ASSESSMENT: DATA VALIDATION

It is recommended to use a similar approach in Georgia to that which is used in EU member States, according to the EU Directive.

Monitoring data collected from EU national networks are required to be collected from frequently calibrated devices, fully validated and ratified, and subject to scrutiny against data from monitoring stations nearby.

All networks are required to operate to minimal quality standards which allow data to meet data quality objectives. In order to meet minimum quality assurance and quality control criteria, air quality networks operate within parameters set out in their respective national quality plans. These form the foundation upon which acceptable precision, accuracy, completeness, comparability, and representativeness can be determined if not assured (Table 41). National quality plans require the following criteria to be determined:

Table 42.Foundation of a National Air Quality Monitoring Plan

Foundation of a National Air Quality Monitoring Plan	
Quality Control Procedure	Data scrutiny and instrument performance checks & maintenance procedures, including calibrations & flow-checks
Quality Assurance	Audit procedures involving external review and internal personnel. Requires Assesses effectiveness of the QC program

	• Data quality, • Data completeness, • Data accuracy, • Data precision, and • representativeness of data.
Analyser Zero and Span Verifications	Fort-nightly rapid checks of monitoring device responses using ‘zero-air’ and analytical standards
Calibrations	Routine multi-point calibrations of monitoring devices against suitable analytical standards
System Audits	Third party checks on written procedures, data recording, data storage, handling, calculation methods and reporting
Equipment Service and Repairs	Routine (6-monthly) servicing of all instruments and monitoring station infrastructure. Establishment of service contracts with specialist supply companies, with set response times to repair all instrument failures or replace instruments
Future Network Intercalibration and site audits	Check network conformity by calibrating all devices against a universal reference, i.e. national reference standard. Devices must conform within the maximum margin of deviation . Check operation and condition of all monitoring sites through annual audits
Inter-calibration Procedures	Clear written SOP for all intercalibrations, use of reference standards and criteria with which to reject a device on poor performance
Data ratification	Screening data against minimum criteria, scaling against long-term drift, removal of suspect or invalid data, verification against other relevant data

All monitoring data are required to be traceable to a national primary reference standard, where calibration standards certify standards with a known minimal standard preparation tolerance. Measurements need to be collected and calculated in such a way as to be of a known and documented quality.

All data shall be comparable, meaning that the data shall be produced in a similar and scientific manner using standard methodologies for sampling, calibration, auditing, and collection of data. In order to assure that measurements are comparable designated reference or equivalent methods compliant to CEN Standard requirements are required to be used.

All data shall be representative of the parameters being measured with respect to time, location, and the conditions from which the data are obtained. The use of standard methodologies contained in this manual should insure that the data generated is representative.

6. DATA REVIEW, VERIFICATION, VALIDATION

6.1. COLLECTING THE DATA FROM THE MONITORING SITES

Air quality data as well as meta data (meteorological and station status, alarms, etc.) will be transmitted continuously via a GPRS or3G communication system from each air quality station to a Central Station computer which is to located within the NEA Air Quality Team office .

This data is automatically transferred into the central data archive and is then be immediately available as provisional data. Ratification of the data is undertaken at a later date.

This data are validated, but not fully ratified, and hence are described as provisional data. The process for collecting, validating and disseminating the provisional data is described below.

6.2. VALIDATION OF AIR QUALITY DATA

When concentration data is collected from station it is typically stored in small packages, typically of fifteen minute averages or less, upon a central data management system database. Data which has not been screened or scaled (raw data) can keep in its original form in a separate database. This allows the complete raw record of all air quality station concentrations to be easily traceable.

As they are performed air quality instrument calibrations are often input directly into the data management system, allowing the raw values to be calculated using calibration factors.

Manual raw data screening should be undertaken every three months periods in order to validate the scaled data.

6.3. DISSEMINATION OF PROVISIONAL DATA

All provisional data, together with data identified as suspect should undergo full ratification, after being scaling against the calibration concentrations. This ratification process should include the reinstatement of suspect data if deemed to be genuine. Following the ratification process, the ratified dataset should be overwritten with the fully ratified data.

It is the fully ratified data from the air quality network which is then used to formally report any air quality trends and annual concentrations averages.

7. DATA TRANSFER AND PUBLIC REPORTING

Georgia is currently striving to comply with achieving EU air quality reporting requirements. In preparing to achieve this standard, Georgia may wish to begin to develop an EU compliant reporting standard, in the time frame that the other EU member states are expected to meet.

Among the principal obligations of Member States information and reporting requirements is the commitment to inform the public of:

- cases where the air quality alert thresholds are exceeded;
- the identity of competent authorities and bodies responsible for implementing the directive; and
- the plans and programmes for attaining limit value in zones where prescribed limit values have been exceeded.

Where there is a risk of air quality limit values being exceeded following significant pollution originating in another State, then the Ministry of Environment and Natural Resources Protection in Georgia must communicate this risk to that neighbouring State with a view to finding a solution.

Table 42 below contains an outline of the Air Quality annual report required by the European Commission from each Member state.

Table 43.Required to be reported to the European Commission by Member States

Member states are required to report to the Commission on
Competent authorities and bodies responsible for implementing the directive;
National standards, criteria and techniques that are more stringent than Community standards or that relate to pollutants not covered by Community legislation;
Lists of zones and agglomerations drawn up pursuant to Articles 8 and 9;
Methods used for the preliminary assessment of air quality;
Cases where limit values and alert thresholds are exceeded, and reasons for the occurrence;
Plans and programmes adopted pursuant to Article 8, and (every three years) progress in implementing the plans or programmes;
Measures taken to attain target value for zone that exceeds that set by the Commission;
Transposition, with texts of the main provisions of national law adopted in the field covered by the directive (Art. 13); and
Every three years, information on reviews of the levels in zones and agglomerations referred to in Articles 8 and 9 of the Directive

Complete and efficient data collection and reporting are essential components of air quality management. Air Quality Directives requiring air quality monitoring to be undertaken impose a duty to report to the Commission on their implementation and to report the results and the degree of compliance to both the Commission and the public. The format of this reporting is specified by Directive 91/692/EEC on standardising and rationalising reports on the implementation of certain directives relating to the environment, which amends the reporting requirements in original directives.

Competent authorities are required to ensure that reporting is undertaken in accordance with the requirements of this directive.

Data should be subject to quality control before it can be accepted as part of an archive of data, which can then be used for the analysis of high pollution episodes or the detection of trends in air quality over time. Where data needs to be supplied rapidly (for example, to warn the public regarding ozone levels) it may be impossible to complete all the quality assurance procedures. Where this occurs, the data should be accompanied by a statement to this effect.

Data on emission rates from sources (and surrogate data such as traffic flows) are also of value, for example in building up a picture at the national and regional level of the causes of high pollution episodes.

8. AMBIENT AIR QUALITY MONITORING NETWORK PROGRAM

Currently the air quality monitoring network is largely operated by the small Department for Environmental Pollution Monitoring, within the NEA. The department manages the stations, collects, processes, analyses and reports air quality data to the Ministry of Environment. Some assistance is received from the Database Department of the NEA, where the central database is maintained.

This process falls short of the basic governance required to maintain quality control and transparency of data rules, as there is no independent assessment or audit of the data quality or consistency of records, or screening of the data for the presence of systematic errors or data manipulation.

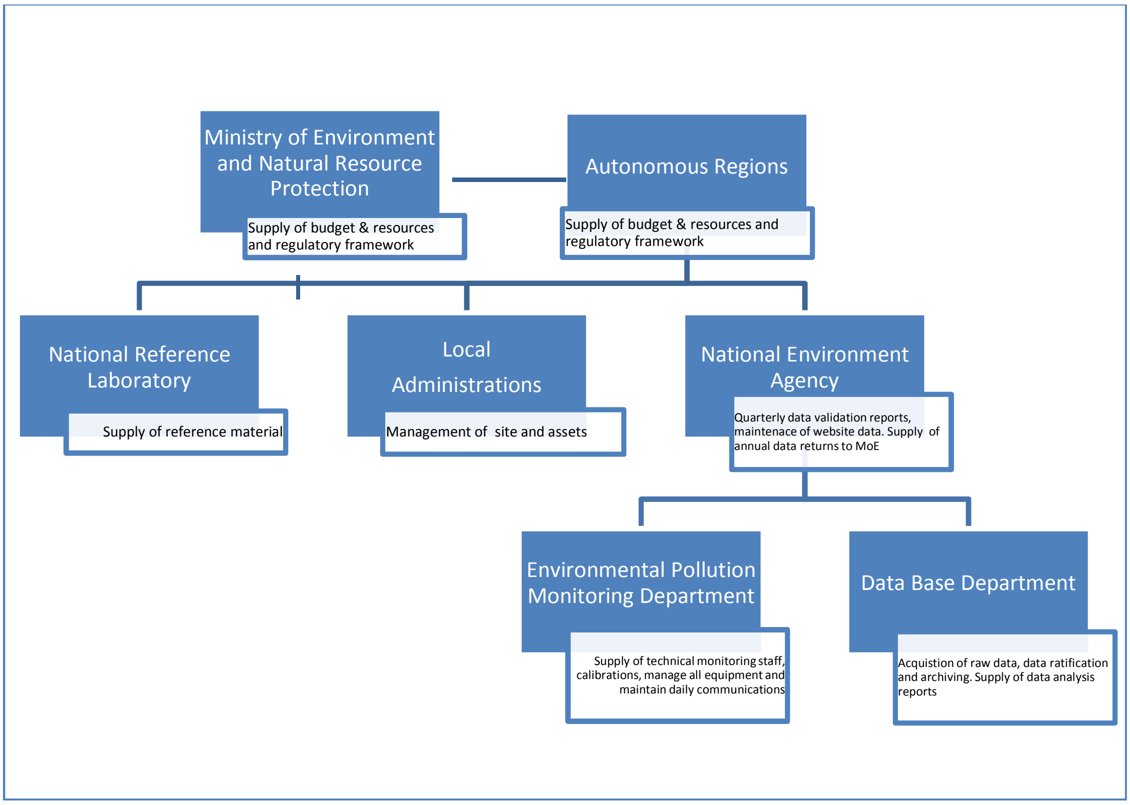
The proposed national air quality monitoring network is anticipated as significantly expanding in terms of instrumentation, rate of data transfer and telemetry, data quantity, complexity of data validation processes and data analysis. Therefore the national air quality monitoring network will require input from a wider partnership of specialists, stakeholders and regulatory bodies.

Division of the individual roles and responsibilities across the national air quality monitoring network are outlined the graphical representation below (Figure 62). Entirely new roles have been proposed for the Autonomous Regions, National Reference Laboratory and Local Administrations. These new roles support the introduction of a national quality assurance and quality control system, as well the additional support required to operate complex and sensitive equipment at multiple sites.

Local Administrations duties would effectively be custodians and managers of the site as an asset, e.g. assist in site selection, secure sites from their own land portfolio, provide security, attend to power interruptions, etc. Local Administrations will not be expected to participate in any technical duties, access to all monitoring instruments will be restricted to NEA sampling only.

National reference laboratory will provide the calibration back-stop to all field measurements, providing six-monthly on-site calibrations as well as certifying all calibrations gases and flow meters prior to their use by field staff. All other roles will be operated as they currently are in the existing network.

Figure 62.Organisational Chart Georgia's National Air Quality Monitoring Network



8.1. PROGRAM FOR A NATIONAL AIR QUALITY MONITORING NETWORK

A programme for developing an emerging national ambient air monitoring network will require:

- Selection and installation of new instrumentation and monitoring stations
- Development of a communications network
- Training and development of a data analysis and reporting system
- Management of Resources
- Modelling and assessment
- Preparation of national and regional institutes to support the National Ambient Air Monitoring Network

There is an opportunity to faze the existing Ambient Air Monitoring Network into the updated National Ambient Air Monitoring Network. The requirements for establishing a National Ambient Air Monitoring Network are significant and require resources, expertise, training and expert technical capacity
The following five stage action plan and event dates are necessary in order to establish a national air quality monitoring network by 2020 and to ensure that the air quality network fulfils basic QA/QC requirements, such ISO17025 for traceability of measurements.

Preliminary Stages to Complete by March 2015

- Complete Feasibility Study to establish a National Air Quality Monitoring Network
- Complete Air Quality Monitoring Station Pilot Project
- Identify national staff resources and training needs

Preparatory Stages to Complete by December 2015

- Identify monitoring equipment, site infrastructure and communication infrastructure needs
- Secure/ identify capital budget, training and annual operating budget for the national Air Quality Monitoring Network

Foundation Stages to Commence by June 2016

- Tender an opportunity for the supply of equipment for the pilot project sites in Tbilisi
- Embark upon national staff training/ recruitment programme for the NEA, Environmental Pollution Monitoring Department
- Secure sites and infrastructure for individual Air Quality Monitoring Network pilot sites
- Agree Terms of Reference between NEA, Ministry of Environment and Natural Resources Protection and Autonomous Regions
- Secure management contract with Local administrations as well as equipment servicing and maintenance supplier
- Establish central data archive team in NEA, Database Department

National Reference Laboratory to Commence by June 2016

- Identify supplier of national reference laboratory service
- Training needs analysis and mentoring scheme with existing European national reference laboratory service
- Calculation of Uncertainty Budgets throughout all pollutant species against CAFE directive Data Quality Objectives
- Site Audits and Commissioning of Accredited Body

Final Stages to Commence by January 2018

- Tender an opportunity for the supply of equipment for the remaining air quality monitoring sites
- Expand national staff training/recruitment programme for the regional NEA, Environmental Pollution Monitoring Department
- Secure sites and infrastructure for remaining individual Air Quality Monitoring Network sites
- Secure management contract with Local administrations as well as equipment servicing and maintenance supplier

Site audits by an external accredited inspection body are required to ensure that all standard operating procedures and relevant records are being met.

8.2. SUMMARY

Programming the introduction of a National Ambient Air Monitoring Network will allow all of these needs to be addressed, the appropriate training and resources put in place whilst preparing the allocation of the budget required for a national ambient air monitoring network to operate as a uniform and sustainable national resource and without avoidable interruptions or resource failures.

9. IMPLEMENTATION ISSUES

9.1. SCHEDULE AND BUDGET FOR NATIONAL AMBIENT AIR MONITORING SYSTEM IMPLEMENTATION

There is a balance between establishing a National Ambient Air Monitoring programme which is easily achievable with a modest budget, whilst providing a network which is sufficiently sophisticated with effective spatial coverage which is relevant and functional to the people of Georgia, though at a considerable and potentially unsustainable budget.

Central to the programmed development of a National Ambient Air Monitoring network is the level of priority and commitment given to the network by central government. The programme schedule, outlined in section 8.1 above, includes commitment to invest both capital and human resource upon which the network could be founded. Should the programme be achievable, resulting in the final capital investment by 2018, then a long-term financial commitment of between approximately Euro 160,000 for the minimum scenario and approximately Euro 220,000 for the maximum scenario by the Georgian Government would also be required each year to sustain the operation. The initial investment required in broad terms (these are dealt with in detail in the Report of Activity 4- task 2 of this Pilot Study) to develop a minimum scenario would be Euro 1,000,000 and for the maximum scenario Euro 1,700,000 would be required.

Accumulative cost of a full monitoring programme until 2024 including staff time, consumables, training, etc., would be in the region of Euro 3,600,000 for the minimum scenario and Euro 4,800,000 for the Maximum scenario.

However, though the level of budget, effectively dictates the programme, the nature of the monitoring undertaken and eventually the spatial scale of the network.

9.2. ADMINISTRATIVE CAPACITY: NATIONAL QUALITY ASSURANCE AND DATA ANALYSIS

Currently the only quality assurance of raw analytical environmental data practiced routinely in Georgia is limited to the analysis of ion chromatography samples within in the central national laboratory. There is likely to be an existing capability for quality assurance and quality control skills and experience within the Georgian NEA. However several recent re-organisations within the NEA as well as budgetary constraints would have dispersed such skills and disrupted any residual QA/QC systems.

Therefore, at this stage it has to be assumed that the capability and capacity for Quality Assurance within the Environmental Pollution Monitoring Department and that for Data Analysis within the Data Base Department of the NEA are low. Therefore a renewal of QA/QC practices and data analysis skills are required, which includes both staff training as well as systems design.

Support, assistance and validation of the QA/QC system for the air quality monitoring network could be sought from the Georgian Accreditation Centre. With the air quality monitoring QA/QC process potentially being granted ISO 17025 accreditation from the Georgian Accreditation Centre.

9.3. DATA AVAILABILITY AND DATA ANALYSIS NEEDS

Inherent to the output of the national air quality monitoring network will be the continual supply of raw monitoring data from all monitoring stations to a central server via telemetry. Due to the vast quantity of information, all data continuity measures, such as validation and ratification will need to be semi-automated where possible. Periodic analysis of data will be required manually by suitably trained technical staff.

Detailed data analysis of the fully ratified air quality data will be required as evidence informing national policy on air quality management. Data analysis of this type is highly skilled and needs to be completed by air quality scientists who have a firm understanding of both atmospheric chemical processes and meteorological experience. In order to appoint a Georgian national practitioner with either the right skill set or abilities to undertake these duties, a detailed job description for this role should be assembled and reviewed by an international expert.

9.4. FUTURE ISSUES

The programmed development of a national continuous ambient air quality monitoring network faces serious challenges in terms of its sustainability and the ability of existing national institutes to both understand as well as promote the strict data quality objectives required by the EU Air Quality Directives.

National air quality monitoring networks are established via a large initial capital investment, which attracts short-term interest and resources, such as technical staff and an initial budget for running costs. In time political and fiscal interest in an air quality monitoring can reduce, which often results in under resourcing and network failures.

The national ambient air quality monitoring network as discussed within this report for the sake of simplicity has excluded a number of pollutant species, such as those within the Fourth Daughter Directives, and a number of those contained within the CAFE directive (e.g. SO_4^{2-},NO_3^- Na^+ K^{+-} NH_4^+, Cl^-, Ca^{2+}, Mg^{2+}, elemental carbon, organic carbon and ozone precursors). Once the sufficient skills and technical understanding have been established then further iterations of the national air quality monitoring network will be then be possible. Further development of the national air quality monitoring network will allow these pollutant species to be considered and where necessary routinely monitored as part of an expanded air quality monitoring network.

10. CONCLUSIONS

10.1. Programme Goals

Principal programme goal for the national air quality monitoring network for Georgia is to develop a representative and robust monitoring record of ambient air quality across Georgia. This will allow several key strategic and public health objectives to be met should this principal goal be met.

10.2. Minimum Network Requirements

Where concentrations exceed the LAT threshold then the minimum number of sampling points per zone or agglomeration will be 1 for pollutants exceeding LAT NO_2, SO_2, CO, PB, Benzene; 1for PM_{10} and $PM_{2.5}$exceeding LAT, though 2 for PM_{10} and $PM_{2.5}$exceeding UAT and 1 for heavy metals (Cd, Ni, As) anode for B(a)P. Ozone requirements differ to other pollutants.

10.3. Minimum Scenario

The national network requirements for the minimum scenario have indicated that eight monitoring locations will be required, with 7 particulate monitoring locations, though use of single instruments capable of measuring both PM_{10} and $PM_{2.5}$ will reduce this requirement by 50%, down to 4 PM instruments. Co-locating PM instruments with the NO_2 and SO_2 instruments will also reduce the number of monitoring stations required, down to 8. Four monitoring stations are required to be dedicated to the agglomeration within Tbilisi.

10.4. Maximum Scenario

The national network requirements for the maximum scenario have indicated that nine monitoring locations will be required, with 14 particulate monitoring locations, though use of single instruments capable of measuring both PM_{10} and $PM_{2.5}$ will reduce this requirement by 50%, down to 7 PM instruments. Co-locating PM instruments with the NO_2 and SO_2 instruments will also reduce the number of monitoring stations required, down to 9.Four monitoring stations are required to be dedicated to the agglomeration within Tbilisi.

10.5. Supplementary Monitoring

Resource constraints, low populations and a lower density of point sources within certain regions of Georgia , has led to the assumption these regions (Abkhazia, Racha Lechkhumi, Kvemo and Zemo Svaneti, Samegrelo, Guria, Akhaltsikhe, Shida Kartli, South Ossetia, Kakheti and Mtskheta – Mtianeti) have a low risk of air quality LV's being exceeded. Therefore no air quality monitoring stations will be deployed within these regions. In order to provide some credible record of air quality within these low – risk regions passive sampling network shall be deployed. This network will sample SO_2 and NO_2 for a minimum of 12 months, providing a solid monitoring record and other pollutant species will be monitored in order to meet the CAFE directive data quality objectives.

10.6. Network Operating Schedule

The development schedule for a national air quality monitoring network is limited by capital budgets, operational costs, availability of suitable technical skills and a communications infrastructure capable of data telemetry. A minimum of 24 months alone would be required just to train and recruit qualified staff. If the implementation of the programme is commenced in January 2015, components of the new monitoring network could be expected to start its operation in 2018.

Once the national ambient air quality network is in place, a series of routine operations, actions and reports would then occur at pre-determined intervals. These routine operations will depend on the specific technical and operational characteristics of the Network. In general these could amount to daily screening of data, and fortnightly checks of all sites and instruments, monthly span calibrations and six monthly calibrations.

10.7. Network Organisation and Programme

The current air quality network falls short of basic quality control and data governance practices.

A significant anticipated expansion in the network will require input from a wider partnership of specialists, stakeholders and regulatory bodies. These stakeholder inputs include entirely new roles, such as those of Autonomous Regions, National Reference Laboratory and Local Administrations.

A programme for developing an emerging national ambient air monitoring network will require:

- Selection and installation of new instrumentation and monitoring stations
- Development of a communications network
- Training and development of a data analysis and reporting system
- Management of Resources
- Modelling and assessment
- Preparation of national and regional institutes to support the National Ambient Air Monitoring Network

A five stage action plan to establish a national air quality monitoring network has been proposed, with the final stage to be completed by 2020:

1. Preliminary Stages to Complete by March 2015
2. Preparatory Stages to Complete by December 2015
3. Foundation Stages to Commence by June 2016
4. National Reference Laboratory to Commence by June 2016
5. Final Stages to Commence by January 2018

10.8. Implementation and Future Issues

Central to the programmed development of a National Ambient Air Monitoring network is the level of priority and commitment given to the network by central government. This commitment includes an initial investment of both capital and human resource upon which the network could be founded.

There is a risk of the national monitoring network failing due to under resourcing, should the programme not receive sufficient political and financial support.

Once sufficient skills and technical understanding have been established within Georgia, then an upgrading of the national air quality monitoring network would allow additional fourth daughter directive pollutant species, where necessary, to be routinely monitored, as part of an expanded air quality monitoring network.