GEO-Cities Tbilisi

An Integrated Environmental Assessment of State and Trends for Georgia's Capital City

OSCE UNEP ENVSEC Environment & Security

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The ENVSEC Initiative, comprising UNDP, UNEP, UNECE, OSCE, REC and NATO as an associated partner works to assess and address environmental problems, which threaten or are perceived to threaten security, societal stability and peace, human health and/or sustainable livelihoods, within and across national borders in conflict prone regions. The Initiative collaborates closely with governments, particularly foreign, defense and environment ministries, national experts and NGOs. Together with the stakeholders ENVSEC has carried out assessments and published reports illustrated by maps, for understanding the linkages between environment and security in the political and socio-economic reality of South Eastern Europe, the Southern Caucasus and Central Asia. Based on the assessments, the Initiative develops and implements work programmes aimed at reducing tensions and solving the problems identified.

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Foreword

It is my pleasure to present the first GEO-Cities report for a city in Georgia - the "GEO-Cities Tbilisi" - integrated environmental assessment of state and trends in our city. This report was developed with support of the Environment and Security (ENVSEC) Initiative and is the result of more than one year's hard work by many people: specialists from United Nations Environmental Programme (UNEP), Organisation for Security and Cooperation in Europe (OSCE), Ministry of Environment Protection, National Statistics Office, the Aarhus Centre, local and international environmental experts, Tbilisi City Hall and representatives of non-governmental organizations, academia and media representatives who participated in training workshops and public consultations.

GEO-Cities Tbilisi is the most comprehensive report on the state of, and trends in, the city's environment. Now all of those who are interested in the environmental "problematique" have this solid investigation at hand that provides relevant and rigorous multi-sectoral and multi-issue analysis of the environmental quality in Tbilisi. It is my hope that it can provide valuable inputs into the work of - first and foremost - Tbilisi City Hall, but also relevant state institutions and agencies, universities and non-governmental organizations.

Environmental quality is an integral part of city's welfare. Integration of environmental concerns into other sectoral areas should be at the top of Tbilisi's long-term development strategy. By subscribing to stricter environmental policies and investing in environmental infrastructure, we can achieve significant social and economic benefits for all Tbilisians. Among these benefits are better human health, economic savings for businesses and households through various efficiency programmes, improved logistics and reduced time spent in traffic, resilience to natural hazards and climate change, and the creation of a safer and more pleasant city for its inhabitants and guests. All these multi-faceted aspects of citizens' welfare are also an integral part of the competitiveness concept. By improving the city's infrastructure and investing in environmental protection, we can also make Tbilisi more attractive to foreign investment and tourism.

Finally, I believe that the findings of this study should materialize into a local environmental action plan led by Tbilisi City Hall, and also be integrated into Tbilisi's long-term strategic planning documents. We wish you pleasant reading!

Giorgi Ugulava

Mayor of Tbilisi

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List of Abbreviations

BEI	Baseline Emission Inventory
BOD	Biological Oxygen Demand
CEO	Caucasus Environment Outlook
CEV	Cluster expected value
DO	Dissolved oxygen
DPSIR	Driving Forces–Pressure–State–Impact–Response
EBRD	European Bank for Reconstruction and Development
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
FEV	Fuzzy expected value
GEF	Global Environmental Facility
GDP	Gross Domestic Product
GEL	Georgian Lari
GEO	Global Environmental Outlook
GHG	Greenhouse gases
GIS	Geographic Information System
GNERC	Georgian National Energy and Water Supply Regulatory Commission
GPS	Global Positioning System
GTZ	German Technical Cooperation Agency
GWP	Georgian Water and Power Company
HPP	Hydropower station
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IFI	International Financial Institutions
IDP	Internally Displaced People
IDA	International Development Association
IPCC	Intergovernmental Panel on Climate Change
MAC	Maximum allowed concentrations
MENR	Ministry of Energy and Natural Resources
MEP	Ministry of Environment Protection
NATO	North Atlantic Treaty Organization
NEA	National Environmental Agency
NGO	Non Governmental Organization
NRSS	Nuclear and Radiation Safety Service
OECD	Organisation for Economic Co-operation and Development
PAH	Polyaromatic hydrocarbons
PM	Particulate matter
QA/QC	Quality assurance and quality control
SEA	Strategic Environmental Assessment
SEAP	Sustainable Energy Action Plan
SCADA	Supervisory control and data acquisition system
TSP	Total suspended particulates
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNEP	The United Nations Environment Programme
UNOPS	United Nations Office for Project Services
UNFCCC	United Nation Framework Convention on Climate Change
VOC	Volatile organic compounds
WB	World Bank
WHO	World Health Organization

Executive Summary

Unmanaged population growth, fragmented urban environmental management and absence of a regular state of the environment reporting process are the main reasons for concern over the city of Tbilisi's future development. The **GEO-Cities Tbilisi process** was initiated in 2010 in order to enhance environmental dialogue among the main stakeholders in Tbilisi and to present a comprehensive view of the state and trends of Tbilisi's environment. The Report is also the first step towards informed decision-making and creation of effective and efficient urban environmental policies. The Report is part of UNEP's series of Global Environment Outlooks (GEO) at the municipal level, using the integrated environment assessment (IEA) approach. It is also the result of an intensive collaboration with the Ministry of Environment Protection, Tbilisi City Hall and public consultations with other stakeholders.

The **GEO-Cities Tbilisi report** aims to: (1) shed light on the state of the environment of Tbilisi, revealing its causes and consequences; (2) review what is being done about the state of the environment in Tbilisi and what still needs to be done to improve the current situation; and (3) illuminate potential futures for Tbilisi, depending on what environment-related policies may be developed and applied there.

Georgia's long and complex history has once again put **Tbilisi, an ancient city** founded in the 4th century AD, among the newly emerging hubs in the region. After an initial post-Soviet period decline resulting from armed conflict, civil turmoil and economic breakdown, Tbilisi's potential is back and the city has been re-establishing itself successfully in the last decade.

The **population** of Georgia's capital currently stands at 1,15 million inhabitants; after a decline in early the 1990s, the city's population is again rising steadily. Average population density after the expansion of municipal borders in 2006 is around 2,300 persons per square km, with a peak value in the Didube-Chugureti district with 7,855 persons per square km. As of 2010, Tbilisi also hosted 95,000 internally displaced people whose overall living conditions are unsatisfactory.

Tbilisi's economic importance for Georgia is indisputable: 64% of total goods and services are produced in the capital city and average household income is 45% higher in Tbilisi compared to the rest of Georgia. Industry, construction, trade, transport and telecommunications comprise the backbone of Tbilisi's economy. However, the unemployment level has still remained high during the last five years. Income inequality in Tbilisi is high, and among the poor and socially vulnerable, the unemployment level is even higher. For such persons, public environmental services such as water supply, sanitation and waste management may become unaffordable. Although economic growth since the second half of the 1990s has been stable and accelerated after the "Rose Revolution" in 2003, economic activity levels still have not reached those of pre-transition times. Currently, **Tbilisi's main industries** are wine production, production of other alcoholic and non-alcoholic beverages, food processing, and production of construction materials. Around 43% of all workers employed in Georgian industry work in Tbilisi. Although industrial production is on the rise, air pollution emission figures show a clear decoupling tendency - economic growth is accompanied with decreasing levels of pollution per unit of production. **Trade** turnovers have dramatically increased in the period 2002-2008. Tbilisi's imports have increased by a factor of nine and its exports have increased by a factor of five. Many abandoned industrial brownfields will be turned into new residential and commercial districts. On the other hand, application of corporate social responsibility concepts in the private sector is still very low. Despite increasing consumption levels, awareness about sustainable consumption is still low.

Construction (new buildings and renovation or rebuilding of old ones) has been one of the most rapidly growing economic sectors of Tbilisi in the last 10-15 years. 60% of the buildings in the old town of Tbilisi require urgent attention; therefore, this part of city is being renovated. The municipal border expansion of 2006 and the new **Tbilisi Development Master Plan** pave the way for construction activities in the newly acquired areas, but also raise environmental concerns. The construction industry increases noise, generates dust and construction waste and reduces the green cover of the city. This green cover has multiple functions, such as aesthetic, recreational, erosion prevention, climate change mitigation and air pollution reduction.

Georgia, once a jewel of tourism of the USSR, plunged into civil war in the beginning of the 1990s, and its **tourism industry** came to a halt. After the Rose Revolution, this sector is receiving great attention from national and local authorities. The number of tourists grows every year. Environmental pressures of tourism have neither been investigated nor considered yet; however, in the future the need for a more sustainable tourism industry may emerge.

Energy infrastructure was severely affected by the collapse of trade links in the Soviet Union, as Georgia

depended on other Soviet republics to satisfy its energy needs. No customer was left unaffected by the interruption of electricity and gas supplies during the 1990s and early 2000s. In addition to that, the situation was aggravated by massive debt accumulation on the side of consumers. Different parts of the energy infrastructure have now been privatized. Currently, the electricity supply is uninterrupted and consumption is gradually increasing. Electricity for Tbilisi is generated by a few hydropower stations and one thermal power plant. Central heating collapsed as a result of the crisis in the natural gas market. Individual heating solutions replaced them and natural gas consumption is also on the rise, with the household sector being the largest consumer. Application of renewable energy sources currently is limited to geothermal energy use for heating. The potential of wind and solar energy is just beginning to be explored.

In Soviet times, Tbilisi's **urban transportation** was well-developed and diverse; however, during the transition period, this smoothly operating system almost collapsed and eventually the number of private cars increased dramatically. A new mode of public transportation appeared and successfully competes with other means today - minibuses. Tbilisi City Hall has plans to modernize the public transportation system and optimize its operation, introducing trams and suburban railways, and expanding and re-routing national and international railway links. There are 325,000 automobiles in use in Tbilisi (most of them are more than 10 years old), which constitutes 41% of the entire vehicle fleet in Georgia.

Water supply and sanitation services have been privatized and modernized and currently provide an uninterrupted water supply. Tbilisi uses a combination of groundwater (60%) and surface water (40%). The Gardabani Regional Treatment Facility serves Tbilisi and Rustavi. Currently none of the wastewater treatment facilities can fully satisfy the demand for these services in Georgia, in terms of capacity and in treatment standards, including the one in Gardabani. At best, wastewater is treated only mechanically. Almost half of the sewage generated in the city is being illegally released directly into the Mtkvari River, bypassing the Gardabani Regional Treatment Facility. The Georgian Water and Power Company is obliged to stop untreated water discharges to surface water bodies by 2013 and to modernize the treatment facility to meet all international and Georgian standards by 2018. Water losses in the distribution network account for almost 50% of all extracted water for Tbilisi's use.

Solid waste management in the Soviet times was rather primitive and waste management legislation, national inventory and regular reporting did not exist. Only in 2006 did this issue receive proper political attention. A decree regulating waste management in Tbilisi was issued in 2007 and fees for waste were imposed. A modern, sanitary landfill has been in operation since 2010, and all of Tbilisi is served by waste collection services. Households generate 70-80% of all municipal waste in Tbilisi. The waste generation rate per capita was significantly below European rates – about 274 kg per capita per year in 2008. The former and now closed Gldani and Iagluja landfills await planned remediation activities and remain a serious environmental risk to humans and surrounding ecosystems. Industrial waste is not monitored and no policy exists for dealing with it. Medical waste policies need improvement. **Recycling** operates at very small scales. 100% of municipal solid waste collected from Tbilisi is sent to landfills.

The **air pollution monitoring** network drastically deteriorated in the whole country including Tbilisi in the early 1990s, and therefore the existing monitoring network cannot provide an adequate assessment of air quality in Tbilisi. Maximum Allowed Concentrations in Georgia are based on former Soviet standards of air quality. On Agmashenebeli Avenue (the only station functioning throughout the period of transition in Tbilisi), concentrations of CO, SO_2, NO_2 and particulate matter exceeded the national standards during 2004-2010. Concentrations of lead have decreased since 2008. Measurements of ground level ozone started in 2010 only and are within maximum allowed concentrations.

The **Mtkvari River** in Tbilisi is mainly polluted by nutrients, particularly by nitrogen ammonia, concentrations of which exceed by several times both permissible Georgian standards for human health and EU limits necessary to maintain fish ecosystems. The causes of this pollution may be direct discharge of untreated sewage and excessive use of nitrogen-containing fertilizers in agriculture. Therefore, properly operating Tbilisi's wastewater treatment facility downstream of Tbilisi will not be sufficient to solve the Mtkvari River pollution problems. Microbiological pollution in the lakes and reservoirs of Tbilisi is a result of poor sanitary conditions, illegal discharge of untreated wastewaters and poor maintenance of recreational zones.

In general, the total area covered by **green zones** in Tbilisi (disregarding recent municipal border changes) is very small compared to the built up-area and city population. Soviet legislation required green areas in a city with a population of more than 0.5 million to be not less than 15 square meters per person. In 1983, this number for Tbilisi stood at 13.0 square meters per person and in 2001 at 5.6 square meters per city dweller. Such a dramatic decrease in green areas in Tbilisi could be attributed to the acute energy crisis in Georgia in the mid-1990s, when city authorities were unable to control massive tree cutting by local residents for heating and cooking. Starting from the late 1990s, the area of greenery decreased due to an unregulated and chaotic construction boom. Currently, responsibility over the city's green areas is assigned to the newly-established

department of Ecology and Greenery at the Tbilisi City Hall. Local legislation foresees fines for violations against green areas of Tbilisi.

With regard to **noise pollution**, the main source is traffic; however, a comprehensive study of Tbilisi with noise pollution mapping does not exist. As concerns ionizing radiation sources, they have been managed reasonably well in Tbilisi and its surroundings. **Radiation** levels in the city do not exceed health norms. Some risks of human exposure to radioactive sources remain from the Soviet period; however, environmental authorities take all appropriate measures to detect, remove and safely store such sources.

There are only a few studies available documenting **impacts on the state of the environment and welfare of Tbilisi's inhabitants**. Studies on airborne and noise-related health problems in Tbilisi provide a fragmented picture at the moment. However, their results show that air quality degradation has already caused significant health problems for people living and working in Tbilisi. Diseases that are associated with **air pollution** are more frequent in Tbilisi than in the rest of Georgia. Lead pollution was determined to cause health problems for people living in more polluted areas of the city. As a result of high NO_2 concentrations, 150 early deaths and 65 cases of hospitalization due to airborne diseases can be expected to occur every year in Tbilisi. Current levels of particulate concentrations are predicted to lead to 450 cases of hospitalization related to respiratory diseases per year. This would also reduce people's average lifespan by eight months due to airborne chronic diseases. Children being a particularly vulnerable group are also likely to suffer from ozone and particulate matter pollution, to the extent of 12,000 cases of asthma and 13,000 cases of bronchitis per year. **Waterborne disease trends** are also surprisingly high; however, a more detailed investigation is needed to confirm the causes. **Climate change** is an impact as well as a mighty driving force for environmental changes. Tbilisi is especially susceptible to climate change impacts through extreme weather events that may trigger landslides, mudslides, inundation, windstorms and heat waves.

Currently there is no agency in the capital city with a full **mandate in the sphere of environmental protection**. The Committee for Environmental Protection and Regulation of Natural Resources under Tbilisi City Hall was abolished in 2005 and its functions were transferred to the Ministry of Environmental Protection. Environment-related affairs are scattered among different departments of the Tbilisi City Hall, Ministry of Environmental Protection and outsourced to private or public companies. In such circumstances, it is essential to have in-depth environmental policy planning and to ensure that environmental policies are incorporated in general urban planning documents.

National and local environmental policies that are in force have been reviewed and evaluated. Tbilisi does not have a pro-active and preventative air quality policy; fuel quality and industrial emissions control is weak and poorly implemented. Improvement of transport infrastructure is currently the main priority of Tbilisi City Hall, with development of a transit motorway system, moving the current railway transit route, overall modernization of the road network, parking policies and expansion of the current public transport system. Under the Covenant of Mayors Initiative, Tbilisi pledged to decrease CO_2 emissions by 25% by 2020 via introduction of electric public transport, reduction of electricity distribution losses, energy efficiency measures for the water supply system, a reduction of heat distribution losses in municipal and public buildings, efficient metering, a reduction of gas distribution losses, a wider application of geothermal energy for heating etc. Progress in the waste management sector is inhibited by the absence of a national framework policy, while the current municipal waste policy has no provisions for sustainable waste management practices, such as waste minimization, recycling and reuse. Water issues fall under different jurisdictions of many different governmental entities and collaboration among these is relatively poor. Water-related legislature is considered to be fragmented, inconsistent and even controversial.

There are a number of **essential policy measures** that are needed in order to pave the way for a more sustainable Tbilisi. First of all, the environmental monitoring network should be expanded to ensure adequate environmental data that can be fed into regular and comprehensive state of the environment reports (SoERs), having the aim to inform decision-making. Policy-making should become more open and transparent to encourage public participation. Air quality policy should involve multiple measures implemented by multiple collaborating institutions and it should ensure access to regular up-to-date air quality information. A national framework policy for waste management is needed with provisions for waste minimization, waste separation and recycling. A further exploration of renewable energy potentials is required for successful creation of a "low-carbon city". In the water sector, there is a need for a major shift from a centralized style of water resources management, to an integrated and river basin-focused approach. Also, significant investment is needed to modernize the sewage collection and treatment system. Finally, environmental policies should be seen in a wider perspective which also incorporates social and economic benefits of their implementation. Environmental policy should become an integral part of socio-economic development policies in Tbilisi.

Scenario analysis revealed that the **main driving forces** behind Tbilisi's future development scenarios are (1) Euro-Atlantic integration and (2) political ideologies and rhetoric, as well as soundness of public policies.

Environmental outcomes under four future scenarios for Tbilisi vary from (1) **Business As Usual**, where neo-liberal political rhetoric dominates and undermines sustainability goals, environmental authorities are further weakened and environmental quality in Tbilisi further worsens; (2) **Policy Harmony**, where Georgian policy-makers and public administration adopt a political agenda of sustainability and policy integration, and economic, social and environmental goals receive adequate attention; (3) **Tbilisi Dream**, where Georgia and Tbilisi receive a significant push from the European Union and gradually adopt the most progressive environmental legislation; and (4) **Great Depression**, where politicians and policy-makers lack a clear vision of Georgia's and Tbilisi's future and remain focused on short-term interests only, and thus Tbilisi's development stagnates with a gradual worsening of public services and environmental quality.

Finally, the value of **anticipated co-benefits of positive environmental policies** is explored, showing that policies that lead to improvements in the local environment have many spin-off effects that benefit the wider society and local economy in general.

INTRODUCTION

1. What is GEO-Cities?

Unmanaged growth of the urban population and ineffective urban environmental management in major cities were among the priority environment and security issues in the South Caucasus which national stakeholders from the region brought to the attention of the Environment and Security (ENVSEC) Initiative in 2004. The ENVSEC Initiative is a partnership of six organizations - OSCE, UNEP, UNDP, UNECE, REC and NATO (the latter as an associate partner) to address together environment and security challenges in Central Asia, the South Caucasus, Eastern Europe and South Eastern Europe.

The present report was developed in the framework of the ENVSEC project "Regional Cities - Integrated Environmental Assessment and Capacity Building in Tbilisi", in close collaboration with Tbilisi City Hall. The project is supporting Georgia in development of integrated environmental assessment (IEA) processes for major cities and in strengthening urban environmental planning. Such assessments provide comprehensive information on the state of urban environment which is essential for decision-making and awareness raising. Tbilisi City Hall and the Georgian Ministry of Environment Protection and Natural Resources are the main beneficiaries; however, it also may provide valuable inputs for the work of other state institutions and agencies, universities and non-governmental organizations.

The title "GEO-Cities" is a reference to the replication of UNEP's Global Environmental Outlook (GEO) approach (see below) at the municipal/urban level, and to the related series of reports which have been produced over the last decade. This approach encompasses the Integrated Environmental Assessment (IEA) methodology and also guidelines for state of the environment (SoE) reporting, environmental policy and governance. The GEO approach is used for assessing state of and trends in the environment at different geographic scales (global, regional, national, municipal or ecosystem level), together with capacity building activities targeted at a multi-stakeholder community of environmental policy actors.

The GEO-Cities Initiative first emerged in Latin America and the first GEO-Cities report was published for Mexico City in 2003. Since then, this environmental assessment and capacity building process has been implemented in major cities of Latin America. The GEO-Cities approach has also been replicated in some cities of Africa, Asia and the Pacific and European regions where UNEP is working. To date, only a few cities in Europe have completed GEO-Cities projects, including Donetsk, Ukraine (2007) (in Russian) and Yerevan, Armenia (2007) (in Russian and English), along with three smaller Armenian cities and Vitoria-Gasteiz, Spain (2009). All of these city reports can be found on the internet.

2. The GEO approach

GEO reports, whether conducted at global, regional, national, sub-national or local geographic scale, all aim to answer five principal questions:

1. What is happening to the environment and why?
2. What are the consequences for the environment and humanity?
3. What is being done and effective is it?
4. Where are we heading?
5. What actions could be taken for a more sustainable future?[1]

The methodology behind the GEO approach is called Integrated Environmental Assessment (IEA). IEA encompasses: 1) **D**rivers-**P**ressures-**S**tate-**I**mpacts-**R**esponses (DPSIR) theoretical framework; 2) scenario building for sustainable development; and 3) environmental policy analysis.

The advantage of using the DPSIR framework, in contrast to the sectoral assessment of environmental problems, is that it helps to better understand the situation by recreating the causal chain of events. Environmental issues very often are analyzed without full understanding of overall "cause and effect" relationships, a fact that may eventually lead to incomplete or misleading conclusions on how to respond. The DPSIR framework also allows to show complex relationships between different elements of the framework. This framework also helps to illuminate a few possible environmental policy response options for mitigation or adaptation that can target different elements of the framework.

Drivers usually refer to larger indirect forces on the environment, such as changes and trends in population, technology, economy, society etc. These can further be specified with concrete environmental **Pressures** taking place on the ground: land use changes, resource extraction, emissions of solid, liquid

1 GEO Resource Book. A Training Manual on Integrated Environmental Assessment and Reporting. 2007. United Nations Environment Programme (UNEP) and International Institute for Sustainable Development (IISD). URL: http://www.unep.org/ieacp/iea/training/manual/

and gaseous pollution, modification and movements of organisms. Usually those are grouped according to a specific economic sector which is generating those pressures: fisheries, agriculture, transport, housing, finance, trade, industry, energy, defence and others.

State of the environment and **trends** represent the third element of the DPSIR framework. **State** of the environment is a result of previously elaborated environmental drivers and pressures. The **state** of the environment is usually examined in all three environmental media; that is, air, land and water. In addition, other important elements of environmental quality can be analyzed – noise, radiation, green areas and biodiversity.

Impacts, resulting from a deteriorating **state** of environment, form the fourth element of the DPSIR framework. Discussion of impacts in IEAs varies depending on the object of study (ecosystems, urban environment, etc), geographical scale (global, regional, local) and data availability. In general, impacts can be divided into two large categories – **impacts** on humans and their well-being and **impacts** on ecosystems.

The last element of the DPSIR framework, **Responses**, encompasses various societal actions that help to reduce human and ecosystem exposure to environmental change factors. Public policies represent a collective **response** to environmental problems, but it is also relevant to review patterns of environmental governance – the potential of different actors to influence decision-making and the potential to mitigate and adapt to environmental change. Finally, science and technology may further facilitate mitigation and adaptation interventions".

In addition to a comprehensive SoE trends analysis based on the DPSIR framework, IEA has two additional components: scenarios and policy analysis. Scenario building attempts to answer the fourth question of "where are we heading?". Scenarios provide an insight into the future: what is going to happen if the current trends continue? What other, alternative futures are possible? The aims of scenario building are to stimulate long-term thinking, raise awareness, support decision-making processes and stimulate change. That paves the way for policy options and conclusions – "what actions could be taken for a more sustainable future?". Policy analysis includes assessment of the effectiveness of existing policies, policy coherence and policy gap analysis and recommendations for their improvement.

Another major difference from other assessment procedures is the participatory approach. It is often said that the GEO process is at least as important as the product itself. Indeed, without intensive collaboration with key institutions, this report would not have been possible and its findings and recommendations might lack legitimacy. Public disclosure and consultations were conducted with the aim of making the reporting process transparent, accurate, relevant and suitable to the needs of all stakeholders. In total there were three workshops, along with a few outreach and public consultation events organized within the framework of the GEO-Cities Tbilisi process. Finally, media outreach was conducted towards many societal stakeholders.

3. Preparation of GEO-Cities Tbilisi

The project was implemented in the framework of the Environment and Security (ENVSEC) Initiative by United Nations Environment Programme (UNEP) and the Organization for Security and Co-operation in Europe (OSCE), with in-kind support of the Ministry of Environment of Georgia and Tbilisi City Hall, and was developed by a group of national experts with the support of international experts. In this way, the IEA process for Tbilisi was aimed at building cooperation between science and policy, a sense of ownership of IEA results among different stakeholders, a network of key stakeholders to improve the current state of the environment and also capacity building in order to continue regular IEA-based reporting in the future.

This Report encompasses the **geographical territory** within the present administrative borders of Tbilisi. The official borders of Tbilisi were extended in 2006. As a result, some villages near to Tbilisi joined the capital (see map 1.3). Even though not all statistical and other data are available for newly-added suburbs at this moment, they are covered by the study as well, inasmuch as was possible.

Authors of the report have selected economic, social and environmental indicators following initial consultations with stakeholders on priority environmental issues[2]:

- Air pollution
- Solid waste
- Surface water pollution
- Noise and vibration
- Decrease of green area/recreational sites

Requests for official statistical data were prepared and sent to relevant national and local institutions: the Ministry of Environment Protection; the National Environmental Agency; the Ministry of Labour, Health and Social Affairs; Tbilisi City Hall; the National Statistics Office; the Ministry of Internal Affairs of Georgia; the Ministry of Justice; and the Georgian Water and Power Ltd. The data received were analyzed using methods of descriptive statistics. The report mostly offers a 10-year time perspective in terms of environmental and other data. However, in some cases data for only the last few years were available. Qualitative and quantitative research methods were

2 The five priority environmental issues in Tbilisi as discussed and agreed in the Geo-Cities Orientation and methodology Training Workshop held at the Hotel Ambasadori, Tbilisi, Georgia, 6-8 July 2010. See the workshop minutes at the URL: http://geocities-tbilisi.ge/failebi/9995-GEO-Cities_Tbilisi_Workshop_report_final.doc

applied to obtain data for the study.

Policy analysis was mainly carried out through analysis of Georgian legal documents. In addition, authors conducted interviews with officials and specialists from relevant institutions in order to complement quantitative analysis, to fill data gaps or to enhance policy analysis. Five interviews in total were held with representatives of Tbilisi City Hall, Tbilisi City Assembly; the Ministry of Environment Protection; a private company providing medical waste services; and the Ministry of Labour, Health and Social Affairs. During preparation of the Report, major environmental protection-related institutional and legislative changes have taken place. The report was updated accordingly, and thus the final version of the report reflects the actual situation as of mid-2011.

Tbilisi scenarios have been produced using a narrative-based, qualitative analytic approach. The preceding state and trends investigation and policy analysis has provided the bulk of the necessary material. Desktop research, policy studies and documents, scientific literature, guidelines and reports of similar studies have further helped to support the arguments and raise new insights.

The major **limitation** of this Report was a lack of data, both in terms of availability and quality. Environmental monitoring is carried out with only limited capacities, and the existing data were not sufficient to create a comprehensive picture of the state of environment in Tbilisi. Data on particular health and ecosystem impacts of specific environmental conditions are also very scarce. This lack of data relates both to limited resources and an insufficient policy framework; that is, there are no current provisions ensuring regular, goal-oriented environmental observation as a part of integrating environmental concerns into major decision-making.

4. Structure

The GEO-Cities Tbilisi Report starts with a brief overview of Tbilisi's history, geography, urbanization and administrative structure. ***Chapter two*** deals with the first two elements of the DPSIR framework – **drivers** and **pressures**. Demographic, social and economic drivers have been described. Environmental **pressures** are analysed through the lens of different forms of economic activities (construction, industry and etc.) and urban infrastructure (energy, water supply, and etc). Consequently, ***Chapter three*** analyses the **state** of the environment as a result of the previously elaborated environmental **pressures**. Types of air, water and land pollution have been investigated; assessment of noise, radiation safety and green areas complement the analysis. ***Chapter four*** unveils some of the **impacts** that can be documented as a consequence of deterioration of the environmental **state** in Tbilisi. ***Chapter five*** concludes the DPSIR framework with its last element – **responses**. An overview of local environmental governance is presented together with an analysis of selected environmental policies. ***Chapter six*** discusses **policy recommendations** for Tbilisi's sustainability in the future, and a healthy and human-friendly urban environment for all citizens. ***Chapter seven*** imagines Tbilisi's future through a set of **scenarios** or "potential futures", depending on what policy path(s) are ultimately followed.

Tbilisi, the capital of Georgia, is a significant political, economic and cultural centre not only in Georgia, but in Eastern Europe and the Caucasus region. Situated along the route of the historical Silk Road, Tbilisi still finds itself at a strategic location at the crossroads of Russia, Turkey, Armenia and Azerbaijan, Europe and Asia, and the Islamic and Christian worlds. Since emerging from the collapsing Soviet Union as an independent state in 1991 Georgia, with its commercial, financial and transport center in Tbilisi, is now becoming one of the most important transit countries for the flow of global energy, information and trade[3]. This chapter introduces the history and geography of Tbilisi. It also provides information on the climate, natural resources and ecosystems of the city, its urban expansion and present political and administrative structure. Information on the socio-economic life in Tbilisi and related drivers and pressures of environmental change, as well as the current state of the environment in the city is presented in the following chapters of this document.

3 Tbilisi Municipality. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd.

CHAPTER 1: Historical and Geographic Context

1.1 History[4]

Archeological artifacts reveal human settlements on the Tbilisi territory dating as early as the 4th millennium B.C. The history of Tbilisi as a city dates back to the second half of the 4th century A.D., when according to ancient records, a fortress was built during King Varaz-Bakuri's reign. The fortress was captured by Persians by the end of 4th century, but in the mid-5th century it was re-captured by the Georgian kings. Tbilisi was revived and rebuilt by the King of Kartli (Georgia) Vakhtang I Gorgasali, considered to be the founder of Tbilisi. The city derived its name from the old Georgian word 'tpili' which means 'warm' referring to the numerous sulphur hot springs. According to the old Georgian legend, King Vakhtang Gorgasali was hunting in the forest. Suddenly his falcon caught a pheasant. The birds fell into the hot spring and burnt to death. Impressed by the hot springs, the King gave orders to build a city on this site.

The history of Tbilisi as a Capital starts from the beginning of the 6th century A.D, when King Dachi I Ujarmeli, successor of Vakhtang Gorgasali, moved the capital from Mtskheta to Tbilisi according to his father's will. Located on a crossroad of major trade routes between Europe and Asia, Tbilisi had been an important cultural, political and economic centre of the Caucasus region throughout its history. At the same time, due to its favorable and strategic location, the city became an object of rivalry between neighboring powers. Tbilisi was occupied at least twenty times by external enemies: Persia, the Byzantine Empire, Arabia and the Seljuk Turks. The foreign domination of the city was maintained from the late 6th century through the 12th century. In 1122, after heavy fighting with the Seljiuks, the troops of the King of Georgia David the Builder liberated Tbilisi, making it the capital of the unified Georgian State. In the 12-13th centuries, Tbilisi became a dominant regional power and an important literary and a cultural center, with a thriving economy and a well-established social structure. This period is often referred to as "Georgia's Golden Age" or the Georgian Renaissance.

The "Golden Age" did not last more than a century. In 1236, after suffering crushing defeats to the Mongols, Georgia came under their domination. In the 1320s, the Mongols were expelled from Georgia and Tbilisi became the capital of an independent Georgian state once again. From the late 14th until the end of the 18th century, Tbilisi came under the rule of various foreign invaders again and on several occasions was completely burnt to the ground. In the 17th and 18th centuries, Tbilisi became the object of rivalry between the Ottoman Turks and Persia. Tbilisi made some cultural progress in this period and, as Persian control waned, became capital of united eastern Georgia under King Erekle II. Erekle II tried to seek the help of Russia to secure protection from the foreign invaders. This led to the most devastating assault on Tbilisi in 1795 by Agha Mohamed Khan. Tens of thousands of Georgians were killed and the city was burnt to the ground. In 1800, Russia unilaterally declared the merger of the Georgian kingdom of Kartl-Kakheti to the Russian Empire and in 1801 made Tbilisi the center of the Tbilisi Governorate.

After the Russian Revolution of 1917, Tbilisi served as the capital of the independent Transcaucasian Federation. Since the three Transcaucasian nations – Georgia, Armenia and Azerbaijan - declared independence in May 1918, Tbilisi functioned as the

4 The chapter has been prepared on the basis of the following literature: Georgian Soviet Encyclopedia, Volume IV; Ivane Javakhishvili, Selected Works in 12 Volumes, Tbilisi State University, Academy of Sciences of Georgian SSR, 1982, Volume III; http://www.sakrebulo.ge/index.php?lang_id=ENG&sec_id=7

Metekhi Church and Statue of Vakhtang Gorgasali
Photo provided by Tbilisi City Hall

Tbilisi State University
Photo provided by Tbilisi City Hall

capital of the Democratic Republic of Georgia until 25 February 1921. Under the national government, Tbilisi became the first Caucasian University City after Tbilisi State University was founded in 1918. On 25 February 1921, the Bolshevik Russian Army invaded Tbilisi after bitter fighting on the outskirts of the city and declared Soviet rule. Following the invasion, Tbilisi functioned first as the capital of the Transcaucasian Socialist Federative Soviet Republic, which included Armenia, Azerbaijan and Georgia, and later until 1991 as the capital of the Georgian Soviet Socialist Republic.

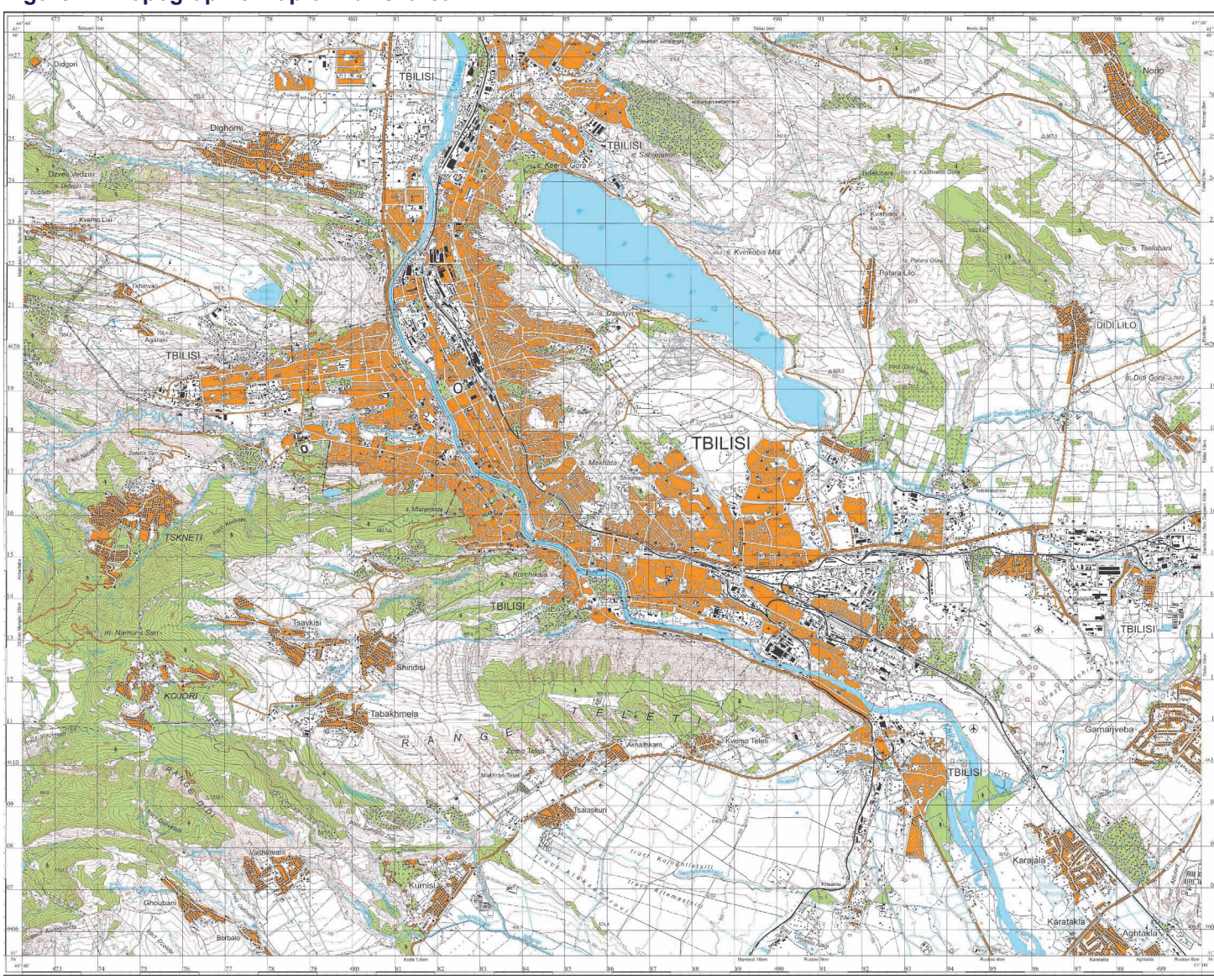
Since the break-up of the Soviet Union, Tbilisi has experienced periods of significant instability and unrest. Tbilisi witnessed a brief civil war lasting for two weeks from December 1991 to January 1992 and a major influx of refugees from the breakaway Autonomous Republic of Abkhazia in 1993. Many segments of society became impoverished due to unemployment caused by the crumbling economy and protracted recession. Widespread corruption, collapse of the energy sector and high rates of crime further contributed to decline of the quality of life in Tbilisi. Falsified parliamentary elections in November 2003 led to the mass protests growing into the so-called “Rose Revolution” that ousted Eduard Shevardnadze’s Regime. Since 2003, Tbilisi has experienced considerably more stability, a significant decrease of crime and corruption, diminished problems in energy supply, an improving economy and increasing tourist industry.

1.2 Geography

1.2.1 Geographic location

Tbilisi is located in the South Caucasus at 41° 43’ North Latitude and 44° 47’ East Longitude. The city lies in Eastern Georgia on both banks of the Mtkvari River (internationally called Kura River). The elevation of the city ranges from 380–770 meters above sea level and has the shape of an amphitheatre surrounded by mountains on three sides. To the north, Tbilisi is bounded by the Saguramo Range, to the east and south-east by the Iori Plain, to the

Figure 1-1 Topographic map of Tbilisi area



south and west by various endings (sub-ranges) of the Trialeti Range (see figure 1.1). The city stretches 33 km along the Mtkvari River and covers an area of 372 square km.[5]

The river divides the city into two parts, with the left side of the city exceeding the right in both territory and population. The part of the city which lies on the left bank of the Mtkvari River extends from the Avchala District to River Lochini. The part of the city which lies on the right side of the Mtkvari River on the other hand is built along the foothills of the Trialeti Range, the slopes of which in many cases descend all the way to the edges of the river Mtkvari. The mountains, therefore, are a significant barrier to urban development on the right bank of the Mtkvari River. This type of a geographic environment creates pockets of very densely developed areas, while other parts of the city are left undeveloped due to the complex topographic relief. The southeast part of the city is 350 meters above sea level, while the populated areas of the Mtatsminda slope are located at 550-600 meters above sea level.

The relief of Tbilisi is complex. The diversity of Tbilisi's relief is the result of its geo-morphological structure. The relief has been strongly transformed by anthropogenic impacts over the centuries. Among natural-tectonic events and processes are landslides, mudflows, erosion and floods. The principal factors hampering the development of Tbilisi and damaging city infrastructure are landslide-gravitational events and mudflows, historically taking place on the basin slopes.

5 In 2006 Parliament of Georgia approved new administrative boundaries of Tbilisi according to which some villages around Tbilisi joined the city. Due to this fact, Tbilisi's boundaries have changed significantly and the city's total area has extended to 500 km^2. However this change has not yet been fully reflected in the geographic, demographic, socio-economic, historical, environmental and other information and statistical data available for Tbilisi. Most of the information and statistical data in this document applies to Tbilisi within its older boundaries.

1.2.2 Climate

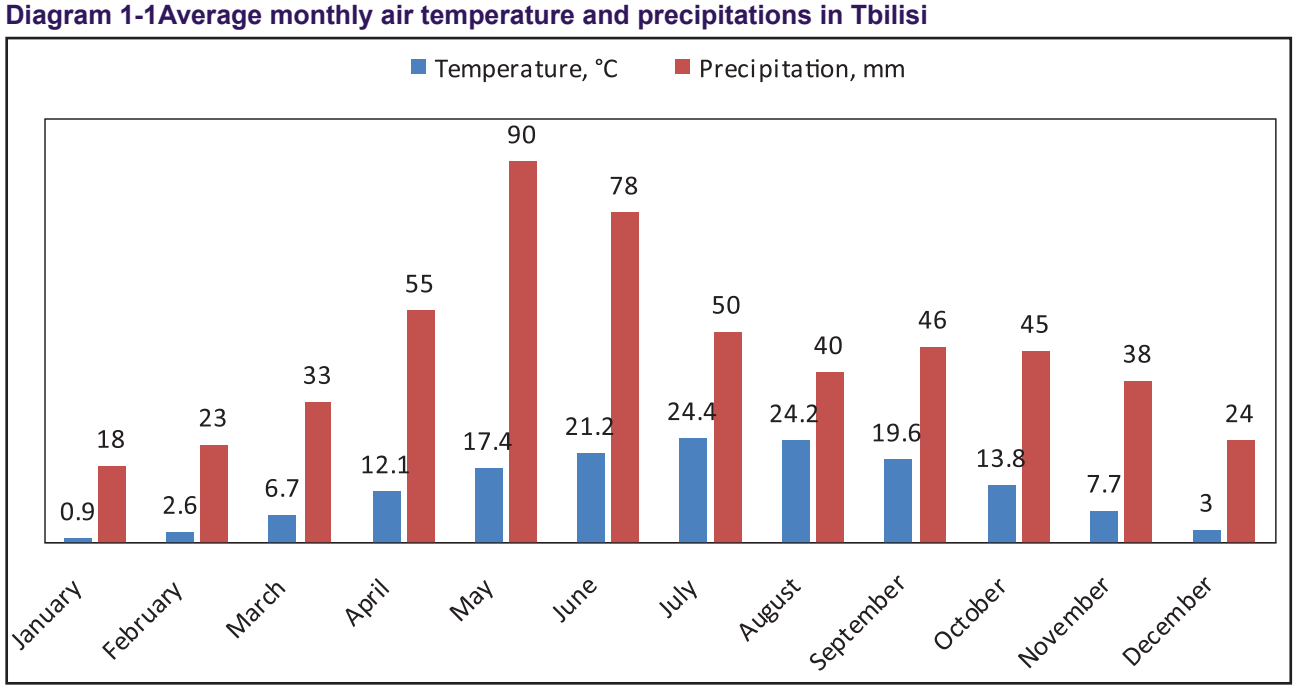
Tbilisi is located in the moderately humid climate zone[6] Tbilisi experiences relatively cold winters and hot summers. Because the city is bounded on most sides by mountain ranges, the close proximity to large bodies of water (Black and Caspian Seas) and the fact that the Greater Caucasus Mountain Range (further to the north) blocks the intrusion of cold air masses from Russia, Tbilisi has a relatively mild micro-climate compared to other cities that possess a similar continental climate along the same latitudes.

The average annual temperature in Tbilisi is 12.7 °C. January is the coldest month with an average temperature of 0.9 °C. July is the hottest month with an average temperature of 24.4 °C. The absolute minimum recorded temperature is −24.4 °C and the absolute maximum is 40.3 °C. The average annual precipitation varies in the range 450-650 mm. May is the wettest month (90 mm) while January is the driest (18 mm). Snow falls on average 15–25 days per year. Diagram 1-1 provides detailed information on average monthly temperature and precipitation in the city.

The surrounding mountains often trap the clouds within and around the city, mainly during the spring and autumn months, resulting in prolonged rainy and/or cloudy weather. Northwesterly winds dominate in most parts of Tbilisi throughout the year. The city is located between two folded mountain systems: southern slope of the Central Caucasus in the North and the folded system of Ajara-Trialeti in the South, creating a relief

6 Tbilisi Encyclopedia, Academy of Sciences of Georgia, Tbilisi, 2002

Diagram 1-1Average monthly air temperature and precipitations in Tbilisi



corridor from North-West to South-East. Southeasterly winds are common as well. In most of the territories of Tbilisi the average annual wind speed is 3-4 m/sec, in some open areas of the city, such as Digomi, Samgori and Saburtalo, it is 6-7 m/sec. The wind speed can exceed 40 m/sec in some particular cases.

1.2.3 Natural resources

Landscapes

Landscapes of Tbilisi are diverse: many regions of specific landscapes border each other in the surroundings of Tbilisi. That is why particular components of landscapes and the whole landscape itself are so diverse. The plains and hilly parts of Tbilisi's environs developed the landscape typical for the grasslands of Eastern Georgia, while the landscape of the Western and Northern parts is mainly woody and mountainous, creating altitudinal zones.[7] Due to human activities over the centuries, the original natural landscapes have been significantly modified within the territory of Tbilisi. Relatively untouched landscapes still remain in the zone of mountain forests, and partially in the areas unsuitable for development. In all remaining parts of the city there are modified, secondary natural or cultural landscapes.

Soil

Due to diversity of natural conditions and relief the soil of Tbilisi and its surroundings are of various types. Here are observed grey-brown, meadow grey-brown, humus-sulphatic, Alluvial, salty, forest brown and black soils.

Alluvial soils are prevalent along the River Mtkvari (Kura) and partially the River Vere on the forest terrace. They are abundant in the Digomi plain and Fonichala as well.

The brown grassland soils are one of the most prevalent types of soil in Tbilisi. The main mass is found in Digomi plain, (on both sides of the Georgian Military Road and Agmashenebeli Alley), the left bank of the River Mtkvari – Avchala, Didube, D. Agmashenebeli avenue and the area around it, Moscow Avenue and its surroundings, and land to the southeast of the Tbilisi Sea.

The brown grassland soils are of an earthy base. In terms of their agricultural characteristics, these soils are considered to be one of the best for grapes and fruit trees, as well as wheat, barley, corn, sugar beet, pulses and other crops.[8]

Erosion processes are observed in the surroundings of Tbilisi. As a result of these processes, a wide area is occupied by thin eroded soils with different types of bare land rocks. In the gardens and parks of Tbilisi, one also observes the soil cultivated to different degrees. This soil has lost its natural composition and now represents a cultural variation of the original soil.

Hydrological resources

Surface waters drain into the Mtkvari River which flows about 35 km through the city. The catchment area is about 3000 km^2. The hydrological regime of the Mtkvari River is formed mostly outside of Tbilisi and the effect of hydrological processes within Tbilisi on the river flow is minimal. Tributaries of the Mtkvari River on the territory of Tbilisi and their morphometrical characteristics are presented in table 1.1.

Because of urban expansion, large areas have been covered with asphalt. This significantly reduces infiltration of surface waters and increases runoff water discharges, which also changed river flow regimes. Expansion of residential areas and population growth resulted in increased discharges of municipal wastewaters in the rivers.

The water from the Mtkvari River was used for drinking and irrigation in Tbilisi in earlier times. Due to deterioration of the water quality, the river has not been used for these purposes in the city since the 20th century. Nevertheless, the River is still being used by the industrial and hydro-power sectors. There are two hydropower stations, "Zemo Avchala" and "Ortachala"stations, located on the Mtkvari River which supply electricity to the city (see Chapter 2.5.1.1).

There are number of lakes in Tbilisi. Among them

7 Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002

8 State of the environment of Tbilisi.Tbilisi Committee of Environmental Protection and Natural Resources, 2000.

Table 1-1 Morphometrical characteristics of tributaries of Mtkvari River

River	Length (km)	Watershed area (km^2)	Number of tributaries
Vere	34	200	42
Lochini	30	207	10
Digistskali	22	73	17
Gldaniskhevi	17	63	9
Orkhevi	14	34	
Khevdzmari	13	56	7
Tsavkistskali	9	21	

Source: Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002

Box 1-1 Lakes and reservoirs of Tbilisi

Turtle Lake is located on the outskirts of Tbilisi on the wooded northern slope of Mtatsminda Mount at an elevation of 686.7 m above sea level and fed by a small river Varazis-Khevi, a tributary to the Mtkvari (Kura). Its surface area is 0.034 km², while the catchment area is 0.4 km². Its maximum depth is 2.6 m. Lisi Lake is a small lake in the northwest of Tbilisi. The landscape is rocky and arid with shrub vegetation and plots of steppe. The lake itself provides a shelter for various waterbirds. In landscapes near the lake, one can find small reptiles, birds, foxes and hares, along with Mediterranean plant associations. In 1951 in the northeastern part of Tbilisi, a large reservoir (commonly known as the Tbilisi Sea) was built on the territories of salty lakes. The reservoir is fed by irrigation canals abstracting water from Iori River in the east of the city. Lakes and reservoirs in Tbilisi are used for recreation by Tbilisi's population.

largest are *Lisi Lake* and *Turtle Lake*. Waters in smaller lakes reduce significantly or disappear altogether in the summer.

Mineral resources

Sulfuric thermal waters are one of the major natural resources in Tbilisi. Thermal water springs have been found in many locations of the old town on both sides of the Mtkavri River. The springs with a temperature of 45C^0 and above have been used since ancient times in sulfur baths which Tbilisi was always famous for. Sulfuric thermal waters have also been used in the Balneology Clinic of Tbilisi. Geothermal waters with a temperature of 57-74 C^0 have been found in Lisi and Saburtalo areas.[9] These waters have been used for heating and hot water supply in some parts of the Saburtalo district (see chapter 2.5.1 on renewable energy).

There are some oil deposits in the surroundings of Tbilisi. Construction materials such as clay, limestone, and sands containing quartzite are also deposited here. Some of these deposits were used in earlier times for construction works in the city, and some of these are still being exploited.[10]

Flora and Fauna

Tbilisi is situated in the central floristic region of Transcaucasia. The flora of its surroundings includes 1643 species belonging to 623 geni and 107 families. According to a number of the dominant families and geni, the flora of Tbilisi surroundings is similar to Eastern Mediterranean, Southwest Asian and Transcaucasian flora. In some places one can find Northern broadleaf and boreal forest floral species.[11]

Flora. Tbilisi surroundings have a rich diversity of plant associations (phytocenoses), which can be explained by their particular geographic location. It has features of almost all types of terrain, which can be found in East Georgia. The most widespread are plants characteristic for semi-desert and steppe (plain), xerophyte shrubs, broadleaf forest and other vegetal species.

Semi-desert vegetation is mostly prevalent on the left side of the River Mtkvari (Kura), round Tbilisi Reservoir (Tbilisi Sea), Jvari (Cross) monastery, Gldani Village, as well as Gardabani and Marneuli plains, and around Kumisi Lake.

Tbilisi's environs (at Didi Lilo, Satskhenisi, QvedaSamgori, and "Tbilisi Sea") up to an elevation of 700 m. above sea level are mostly populated by steppic vegetation, which has developed mostly after the degradation of mezophilic open forests. Its basic component is Bluestem (Bothriocholaischaemum) and Caucasian Bluestem (Bothriocholacaucasicus).

Meadow vegetation in Tbilisi's environs is secondary and is prevalent in the upper and lower mountain forest zones and bottomland forests.

At an elevation of 500-800 m. above sea level in Tbilisi environs (in the vicinity of Mtskheta and Karsani), formerly widespread open dry forests still exist. Near Tbilisi hydrophilic and wetland vegetation can be also found.

Fauna. Tbilisi's environs were covered with forest in the past, but now there are mainly open slopes and plains. In some places there are still some shrubs and forest. Only a small part of the original abundance of different birds and animals is still found here.

302 species of birds have been identified in Tbilisi and its surroundings, 10 species of frogs (amphibians), 25 species of reptiles, over 20 species of fish, and 20 species of mammals. Currently there are not more than 50 species of birds,[12] including the Northern Goshawk, Eurasian Sparrowhawk, Kite, Shikra, a very rare Eastern Imperial Eagle, Owl, Hoopoe, Short-eared Owl and others. In the Tbilisi sky, there fly swifts, barn swallows and house martins.There are many sparrows, hooded crows, rooks in the streets; in parks and gardens there are chaffinch, oriole, jay. During migration there are many migrant birds, including the crane, heron, common greenshank**,** swan etc.

The following species of **mammals** are still found in Tbilisi's environs: Wolf, Fox *(Vulpesvulpes),* Central Asian Stone Marten *(Martesfoina),* Golden Jackal *(Canisaureus),* Wildcat *(Velissilvestris)*, Rabbit *(Lepuseuropeus)*, Squirrel *(Sciurus vulgaris)* and Transcaucasian Squirrel *(Sciurusanomalus)*. Among rodents found widely throughout Tbilisi and

9 Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002.

10 Environmental State of Tbilisi City. Committee of Environmental Protections and Natural Resources of Tbilisi. 2000.

11 Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002.

12 Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002.

its environs there should be noted the Wood Mouse (*Sylvimussilvatcus),* Black Rat *(Rattusrattus)* and Domestic Mouse *(Musmusculus).*[13]

Among invertebrates there are many butterflies, around 800 species in all.[14]

In the Mtkvari River and its tributaries, as well as in a number of reservoirs of Tbilisi's environs, various types of **fish** are found.

1.2.4 Urban expansion

Rapid urban expansion of Tbilisi began in the early 19th century after the Georgian kingdom of Kartl-Kakheti became a part of the Russian Empire in 1801. The city became the center of the Tbilisi Governorate (Gubernia). New buildings, mainly of European style, were erected throughout the town. New roads and railroads were built to connect Tbilisi to other important cities in Russia and other parts of the Transcaucasus (locally) such as Batumi, Poti, Baku and Yerevan. By the 1850s, Tbilisi had emerged as important political, trade and cultural center in the South Caucasus.

During the Soviet period the city continued to grow. A second wave of rapid urban expansion took place in the second half of the 20th century (from 1950 to 1980) when industrial facilities were built and additional workers migrated to the city. By 1990 industrial territories occupied 17.4% of the urbanized area of Tbilisi.[15] New districts such as Gldani, Mukhiani, Vazisubani, Didi Digomi and others were built during that period, with more than 100,000 inhabitants each, and served the purpose of satisfying the housing needs of new migrants. These districts often occupied valuable agricultural lands, which had previously supplied the capital with agricultural products.

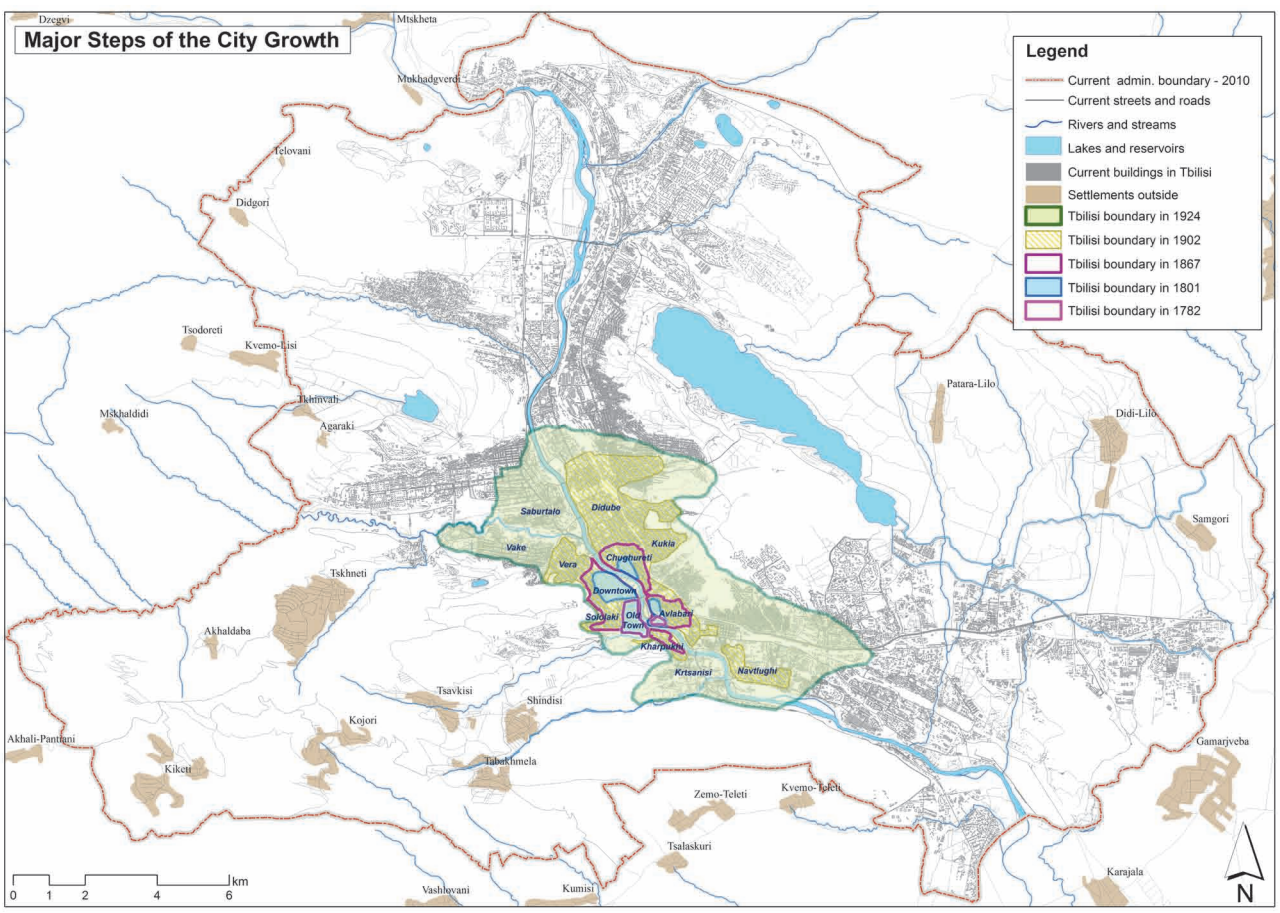
In recent years, expansion of human settlements in Tbilisi has been observed, mostly in Vake-Saburtalo district (Bagebi area) and Tskneti community. This expansion happened at the expense of forest lands and other green areas.

In 2006, the Parliament of Georgia approved new administrative boundaries for Tbilisi according to which some villages around Tbilisi, which earlier were recreation zones, joined the city. Due to this, Tbilisi's area increased from 378 km^2 to about 500 km^2. The city territories have expanded significantly to the southeast, southwest and northwest directions (see maps 1.2 and 1.3). The newly-added areas consist of agricultural, forest, recreation and residential zones. The main purpose for inclusion of the new

13 State of the Environment in Tbilisi 2000 Report. (http://www.ce-roi.net/reports/tbilisi/index.htm).
14 Tbilisi Encyclopedia, Academy of Science of Georgia, Tbilisi, 2002.

15 Background document of the Tbilisi Development Master Plan 2009. Tbilisi City Hall. http://www.tbilisi.gov.ge/

Figure 1-2 Major Steps of the City Growth



territories within the city administrative boundaries was to develop these areas. In 2009, Tbilisi City Hall approved a new master plan for the city – "General Long-Term Plan of Development of the Capital City". According to this master plan, agricultural and forest zones in newly-joined areas have changed their status to residential zones. It means that construction of residential buildings and development of relevant infrastructure is allowed now in these zones which will not happen without inflicting damage to the natural environment.

1.2.5 Political and administrative structure

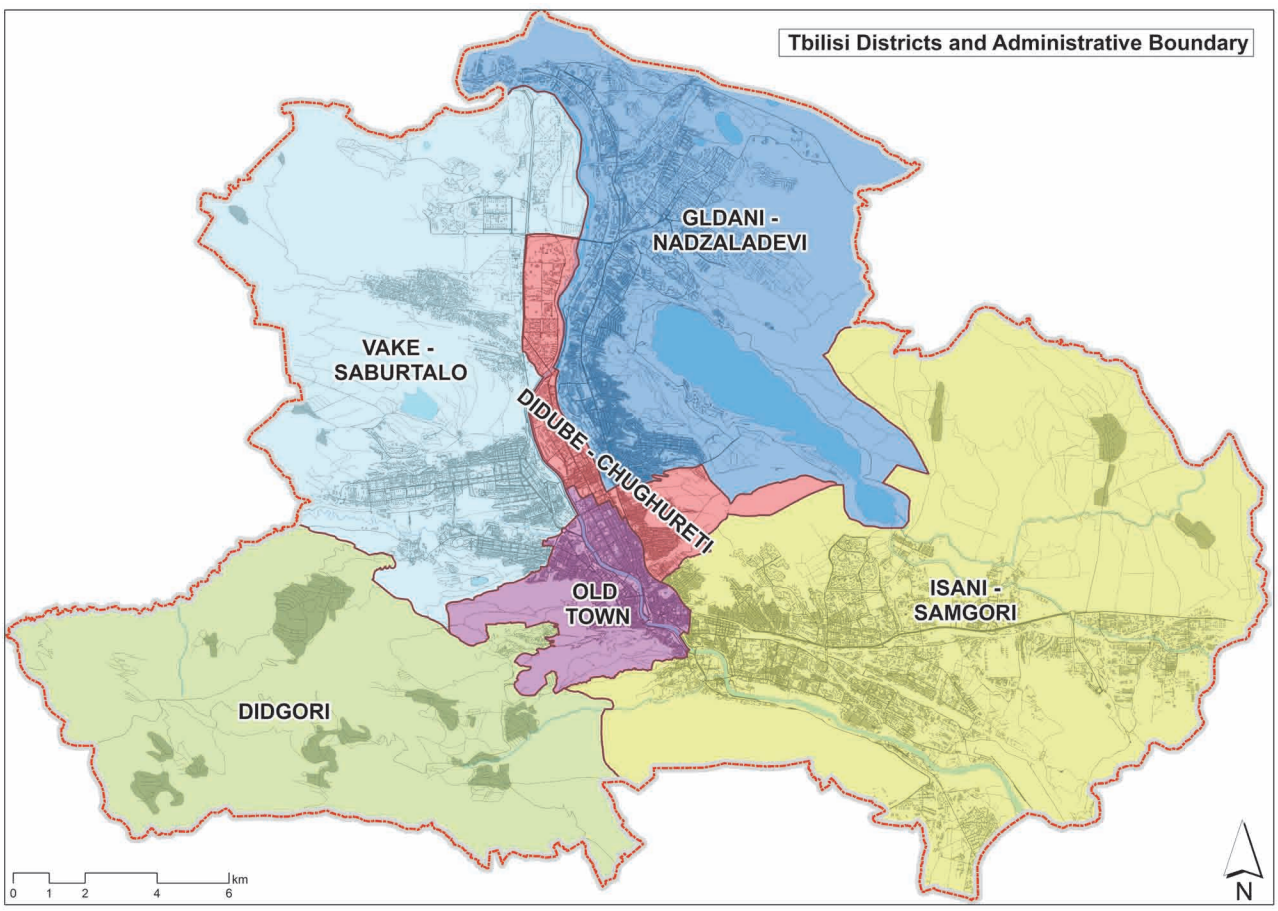
Tbilisi is governed by the Tbilisi Assembly ("Sakrebulo") and the Tbilisi City Hall ("Meria"). The City Assembly is elected once every four years. The Mayor is elected directly by the city population.

Administratively, the city is divided into districts ("raions"), which have their own local government with jurisdiction over a limited scope of affairs. This subdivision was established under Soviet rule in the 1930s. Since Georgia regained independence, the "raion" system was modified and reshuffled. According to the latest revision which took place in 2006, Tbilisi was divided into six major districts: 1) Old Tbilisi, 2) Vake-Saburtalo, 3) Didube-Chugureti, 4) Gldani-Nadzaladevi, 5) Isani-Samgori, 6) Didgori.[16]

For further sub-division of districts, residents of Tbilisi still use the informal system of division by historic neighborhoods. The names of the oldest neighborhoods go back to the early middle ages. The natural first level of subdivision of the city is into the Right Bank and the Left Bank of the Mtkvari River.

16 Old Tbilisi district was established on the bases of earlier Mtatsminda-Ktrsanisi district and a new Didgori district was established on the bases of newly added territories –nearby villages of Tbilisi municipality: Kiketi, Kojori, Betania, Tabakhmela, Shindisi, wavkisi, Tskneti, Okrokana

Figure 1-3 Administrative boundaries of Tbilisi



CHAPTER 2: Drivers and Pressures: socio-economic and political context

This chapter explains driving forces and pressures of environmental change in Tbilisi – the first two elements of the DPSIR framework. Driving forces are sometimes referred to as indirect or underlying forces of environmental impacts. Key driving forces include major factors such as economic growth, demographic change (population increase), consumption and production patterns, scientific and technological innovations, markets and trade, institutional and socio-political frameworks and value systems. Pressures refer to more specific factors, such as different sectors of the economy (transport, tourism, construction, trade, industry, private housing, natural resource extraction etc.) and related environmental pressures in the form of air and water emissions, waste generation, land uptake, resource extraction etc. From the environmental policy point of view, a pressure is the starting point from which to confront environmental problems. Awareness of pressure factors seeks to respond to the question: **Why are environmental impacts and changes happening?**

2.1 Demographic situation

2.1.1 Population growth

The population of Tbilisi continued to grow steadily throughout the past century and, according to official statistical data, reached its maximum level - 1.267 mln people by 1992 (see diagram 2.1). In the following years which were characterized by political unrest, armed conflicts in Abkhazia and South Ossetia, and a dramatic economic downturn in the country, Tbilisi's population started to decrease. The reduction is attributed to massive emigration of Tbilisi population to other countries due to the grave socio-economic conditions, massive unemployment, political instability and ethnic tensions. In the period between1992-2004, Tbilisi's population decreased by about 15% (see diagram 2.2).

Tbilisi's population stabilized in the period 2004-2005 at around 1.08 million persons. Some uneven growth has been observed since 2005 (see table 2.1). There are two major factors determining the pattern of population growth in the city in the last decade: (i) there is very little natural growth, as the low birth rate almost equals the mortality rate (see table 2.1); and (ii) net migration to the city is negative - migration from other parts of the country to the capital city has been offset by emigration from the city to foreign countries.[17]

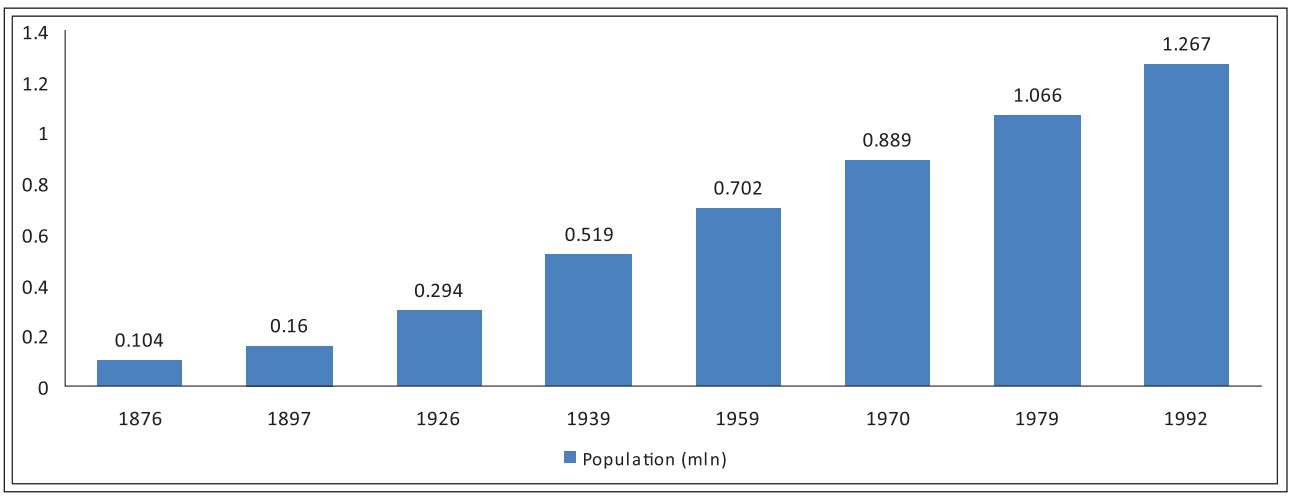
At present more than 25% of Georgia's total population lives in Tbilisi. For comparison, the share of Tbilisi's population in Georgia's total population was 19% in 1970.[18]

Before the expansion of Tbilisi's boundaries in 2006, average population density in the city was 2,937 persons per square km. The most densely populated

17 Tbilisi Municipality. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd.

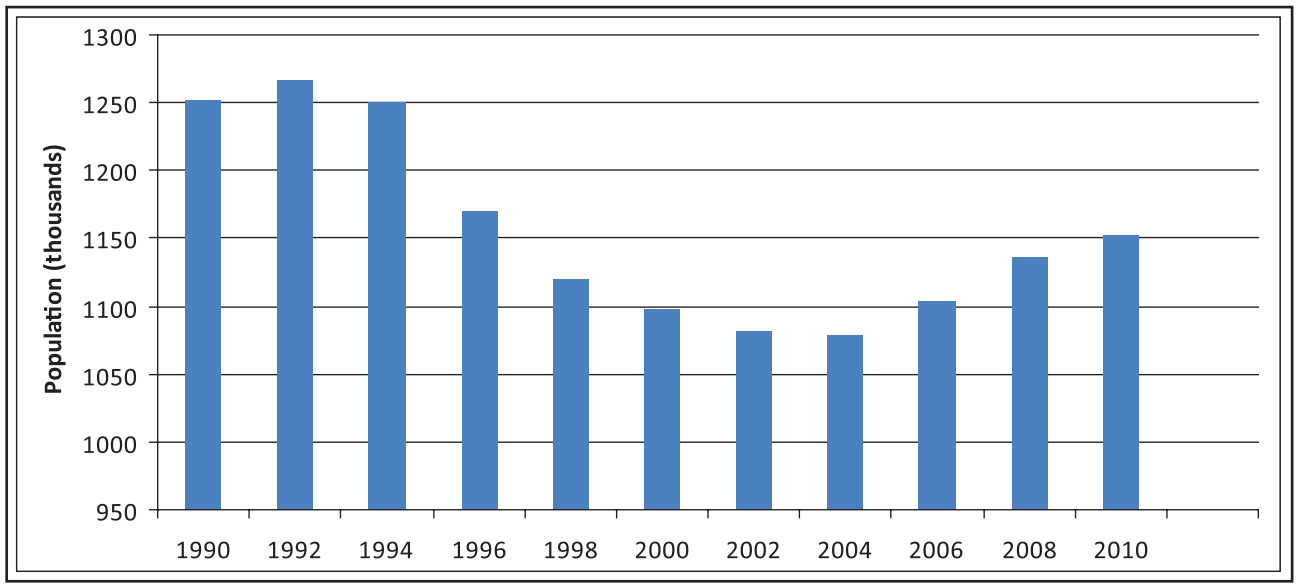
18 CEROI. State of the Environment in Tbilisi 2000. http://www.ceroi.net/reports/tbilisi/index.htm

Diagram 2-1 Population growth in Tbilisi in the period 1897-1992*



* Data on the population during 1897-1989 have been taken from the Tbilisi City Hall Document - Tbilisi Municipality Economic Development Plan (2006), www.tbilisi.gov.ge.; data for the period 1990-2010 have been provided by the National Statistics office of Georgia.

Diagram 2-2 Demographic trends in Tbilisi in the period 1990-2010



Source: National Statistics Office of Georgia.

Table 2-1 Number of live births, deaths and natural growth of population in Tbilisi (2000-2010)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Population (thousands)	1,097.5	1,088.5	1,081.7	1,079.1	1,078.2	1,079.7	1,103.3	1,101.1	1,136.6	1,136.6	1,152.5
Number of live births	15,380	15,648	16,057	16,058	16,059	16,060	16,061	16,062	16,063	16,064	-
Number of Deaths	11,690	11,408	11,465	12,597	12,424	11,164	12,454	12,040	12,123	12,397	-
Natural Growth	3,690	4,240	4,592	3,461	3,635	4,896	3,607	4,022	3,940	3,667	-
Population growth rate in Tbilisi	-0.9%	-0.8%	-0.6%	-0.2%	-0.1%	0.1%	2.2%	-0.2%	3.2%	0.0%	1.4%

Source: National Statistics Office of Georgia, The number of people as of 1 January is provided for each year

region was Didube-Chugureti district with 7,855 persons per square km. The least dense was the Isani-Samgori district with 2,323 persons per square km[19]. At present, after the expansion of the city boundaries, the average population density is about 2,300 persons per square km, and now Didgori is the least dense district where about 30,000 people live in different villages spread over a large area.

2.1.2 Ethnic groups

The population of Tbilisi has always been multi-ethnic. Different ethnic groups including Armenians, Assyrians, Azeris, Greeks, Jews, Kurds, Ossetians, Russians, Ukrainians and other ethnic groups have been living side by side with ethnic Georgians. In fact, Georgians were a minority in the city in the 19th century. Mass migration of the ethnic Georgian population to Tbilisi took place during the Soviet period. According to the 1926 Population Census only 38% (112,000) of ethnic Georgians lived in Tbilisi, while in 1989 this number reached 66% (824,000).

Massive emigration that occurred in the 1990s after the breakup of the Soviet Union has also affected significantly the ethnic composition of Tbilisi. Many ethnic minorities have also left the city and emigrated to other countries. This changed the statistics of the ethnic composition of the city. According to the latest population census (2002), ethnic minorities comprise 15.6% of Tbilisi's population. The largest ethic groups after Georgians in Tbilisi are Armenians, Russians, Azeris and Ossetians.

The vast majority of Tbilisi's population belongs to the Georgian Orthodox Church. The followers of the Russian Orthodox Church and Armenian Apostolic Church are

19 Tbilisi Municipality. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd. The figure on density here does not reflect expansion of Tbilisi administrative boundaries in 2006.

Table 2-2 Ethnic groups living in Tbilisi

	1876	1897	1922	1926	1959	1979	1989	2002
Total population (thousands)	104.0	159.6	233.9	294.0	694.7	1056.1	1246.9	1081.7
Georgians	22.2	42.2	80.9	112.2	336.3	656.4	824.4	910.7
Armenians	37.6	47.1	85.3	100.1	149.2	152.9	150.1	82.6
Russians	30.0	44.8	38.6	45.9	125.7	129.1	124.9	32.6
Ossetians		0.9	1.4	2.8	15.6	27.9	33.2	10.3
Ukrainians		2.7			10.9	12.6	16.1	3.3
Jews	1.3	2.9	8.8	8.9	17.3	14.8	13.5	1.6
Azeris			3.3	5.8	9.6	12.9	18.0	10.9
Kurds				2.5	12.9	23.4	30.3	2.1
Greeks	0.4	1.2	1.3	1.4	7.1	16.2	21.7	3.8
Other ethnic Groups	11.6	17.8	14.3	14.1	10.1	9.7	14.7	23.8

Source: Tbilisi City Hall Document Tbilisi Municipality Economic Development Plan (2006), www.tbilisi.gov.ge

also numerous. Catholics, Lutherans, Baptists and other Christian denominations are a minority. Followers of Islam are 8%. The city is historically known for its religious tolerance. This is particularly evident in Old Tbilisi, which is rich in churches, houses of worship and chapels of different confessions.

2.1.3 Internally Displaced People

Large-scale inflows of Internally Displaced Persons (IDPs), predominantly ethnic Georgians, followed conflicts in South Osssetia and Abkhazia in the early 1990s and the armed conflict between Georgia and Russia in August 2008. As reported by the Ministry of Internally Displaced People, about 95000 IDPs were registered in Tbilisi by August 2010. Most of them live in so- called “collective settlements” in grave social, economic and general living conditions. There were 756 “collective settlements” in Tbilisi.[20]

Collective settlements include Soviet-era hotels, kindergartens, schools, hospitals and other buildings, most of which have unacceptable living conditions. The sanitary conditions of these buildings are, in most cases, are poor. Most of them were in a very poor state even before the IDPs were settled there. Due to a lack of renovation or proper maintenance over the years, the state of these settlements and living conditions of IDPs have further deteriorated.[21] Although repairs were made in some cases with limited resources and with the assistance of international organizations, this has not changed the overall situation.

In the last few years the government launched an IDPs’ relocation programme. The Ministry of Internally Displaced People oversees the implementation of the programme. IDPs have been relocated from both the Iveria Hotel and the Adjara Hotel. They were offered monetary compensation (US$7000) in exchange for each occupied hotel room. IDPs were relocated from the Republican Hospital and some other buildings offering them compensation. Some other IDPs received an offer to resettle in different parts of Georgia where the government renovated and prepared special buildings for them. However, the process of relocation of IDPs is proving to be difficult: IDPs have become used to life in Tbilisi over the years. The city offers more job opportunities to them than any other place in Georgia. The majority of IDPs are engaged in small-scale trade and unskilled employment here, and have limited opportunities for permanent employment. Moreover, the unemployment level among IDPs is two to three times higher then among the rest of local population.[22] Nevertheless, many of the IDPs prefer to stay in Tbilisi even in the current dire living conditions, rather than move to new places where job opportunities for them would be more limited.

2.1.4 National and international migration patterns

Growth of Tbilisi’s population in the past century was largely due to internal migration of people from other parts of Georgia to its capital. For example, in the Soviet period (about 70 years between 1921-1990), the total population of Georgia increased 2.27 times.[23] During the same period, Tbilisi’s population increased about 5.5 times - from 234,000 in 1922 to 1.267 million people in 1992 - and this happened mostly due to migration to the city. The impetus for the migration was the fact that Tbilisi was becoming the major cultural, educational, industrial and commercial center of the country, attracting

20 The data was provided by the Ministry of Internally Displaced People from the Occupied Territories, Accommodation and refugees of Georgia

21 Tbilisi City Hall. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd.

22 Ibid.

23 Tbilisi City Hall. Background document of the General Plan of the Perspective Development of the Capital City. 2009.

workers, students and other categories of the workforce. International migration, mostly to other former Soviet countries, was relatively low during this period. The situation changed in the period after Georgia gained independence. In this period, international migration from Tbilisi significantly increased and outweighed internal migration to the city.

There are no reliable statistical data on the internal and international migration in Tbilisi for the last two decades. According to some estimates, about 300,000-400,000 people emigrated from Tbilisi to foreign countries. This number was not offset by the number of people immigrating to Tbilisi from other parts of Georgia, including IDPs.

The rates of internal and international migration must have been in balance for the last five years, as a result of which the reduction of population in Tbilisi has stopped, and some growth has even been achieved. It must be noted, however, that apart from those who are officially registered in Tbilisi and are reflected in the national statistics, there are students, workers and other people from different regions of Georgia, temporarily living but not registered in Tbilisi. Even though the employment level is low, the city still attracts people by providing more employment opportunities than the countryside.[24] According to some estimates, non-registered people living in Tbilisi may be in the range 200,000-300,000.[25]

24 Tbilisi City Hall. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd.
25 Ibid

2.2 Economic development

Development of Tbilisi as an industrial center intensified in the 1950s when the Soviet government launched the construction of a number of medium- and large-size industrial facilities in the city. The most developed industrial sectors were heavy machinery (including military), electronics and microelectronics, light industry, food processing, textiles, pharmaceuticals and perfumes. Industrial outputs were sold throughout the Soviet Union.

Political turmoil in the country and its capital city that followed the breakup of the USSR in the beginning of the 1990s brought Tbilisi's infrastructure and social-economic system to the brink of collapse. Economic activities drastically decreased, many industrial facilities stopped production due to losing traditional channels for supplying inputs and selling products in the markets of the former USSR. The energy supply to industry and households decreased to critical levels. In the period 1990-1994, the Gross Domestic Product (GDP) of Georgia plummeted by nearly 65%.[26]

Economic recovery in the country and its capital began in 1995 as a result of renewed political stability in the country, initiated privatization processes, and institutional and structural reforms. A new impetus for economic development was the "Rose Revolution" in 2003. The new Georgian government initiated comprehensive economic and institutional reforms which resulted in rapid economic growth. GDP began

26 United Nations Development Program. Human Development report: Georgia 1997. Publishing House Nekeri. Tbilisi, 1997.

Table 2-3 Dynamics of Georgia's GDP in 1990-1996

Year	1990	1991	1992	1993	1994	1995	1996
Change in GDP	-15.0%	-20.1%	-39.7%	-29.3%	-12.1%	3.3%	11.0%

Source: Human Development Report: Georgia 1997.

Table 2-4 Georgia's GDP in 2005-2009

	2005	2006	2007	2008	2009
GDP at current prices, mln GEL	11620.9	13789.9	16993.8	19074.9	17986.0
GDP at constant 2003 prices, mln GEL	9935.6	10868.0	12208.8	12491.4	12019.7
GDP real growth, %	109.6	109.4	112.3	102.3	96.2
GDP deflator, %	107.9	108.5	109.7	109.7	98.0
GDP per capita (at current prices), GEL	2689.1	3133.1	3866.9	4352.9	4101.3
GDP per capita (at current prices), USD	1483.5	1763.5	2314.6	2921.1	2455.2
GDP at current prices, mil. USD	6411.0	7761.7	10171.9	12800.5	10767.1
USD/GEL (period average)	-	1.78	1.67	1.49	1.67

Source: National Statistics Office of Georgia. http://www.geostat.ge

Table 2-5 Production of goods and services in Tbilisi and Georgia

	2006	2007	2008
Georgia total (mln. GEL, including subsidies)	7412.6	9645.4	7412.6
Tbilisi	4583.6	6212.8	4583.6
Tbilisi's share	61.8%	64.4%	64.6%

Source: National Statistics Office of Georgia. Statistical Yearbook 2009

Table 2-6 Gross value added of Tbilisi (at current prices, mln. GEL)

Economic Sectors	2006	2007	2008
Agriculture, forestry, fishery	1.4	1.0	1.0
Industry	734.8	741.6	757.2
Processing of products by households	43.3	65.5	65.6
Construction	635.9	784.2	643.3
Trade, repair of motor vehicles and household goods	1,498.2	1,636.2	2,204.4
Transport and Communication	1206.7	1333.8	1392.5
State management, defense and law enforcement	386.8	837.3	1,019.1
Education	157.0	151.7	167.9
Public health and social assistance	200.4	270.3	351.4
Other Services	789.5	1187.9	1311.2
TOTAL value added	**5653.9**	**7009.5**	**7913.6**

Source: National Statistics Office of Georgia. http://www.geostat.ge/

increasing, with a growth rate amounting 9-12% between 2005-2007 (see table 2.4). Armed conflict with Russia in August 2008 and the global economic crisis have severely affected Georgia's economic development. The real GDP growth rate was reduced to 2.3% in 2008 and it was negative (-5.8%) in 2009. Nevertheless, GDP grew 6.4% in 2010.[27]

The lion's share of economic development in Georgia is related to economic activities in Tbilisi. Tbilisi is the centre of economic, commercial and financial activity in Georgia. About 50% of Georgian companies function in the capital city.[28] The share of Tbilisi in Georgia's total production of goods and services was about 64% in 2007 and 2008 (see table 2.5).

The average monthly income of households in Tbilisi is about 45% more than that for Georgia as a whole (see diagram 2.3).

Industry, construction, trade, transport and telecommunications are the economic foundation of Tbilisi. More than half of the value of products and services in Tbilisi are produced in these sectors (see table 2.6).

2.3 Social profile

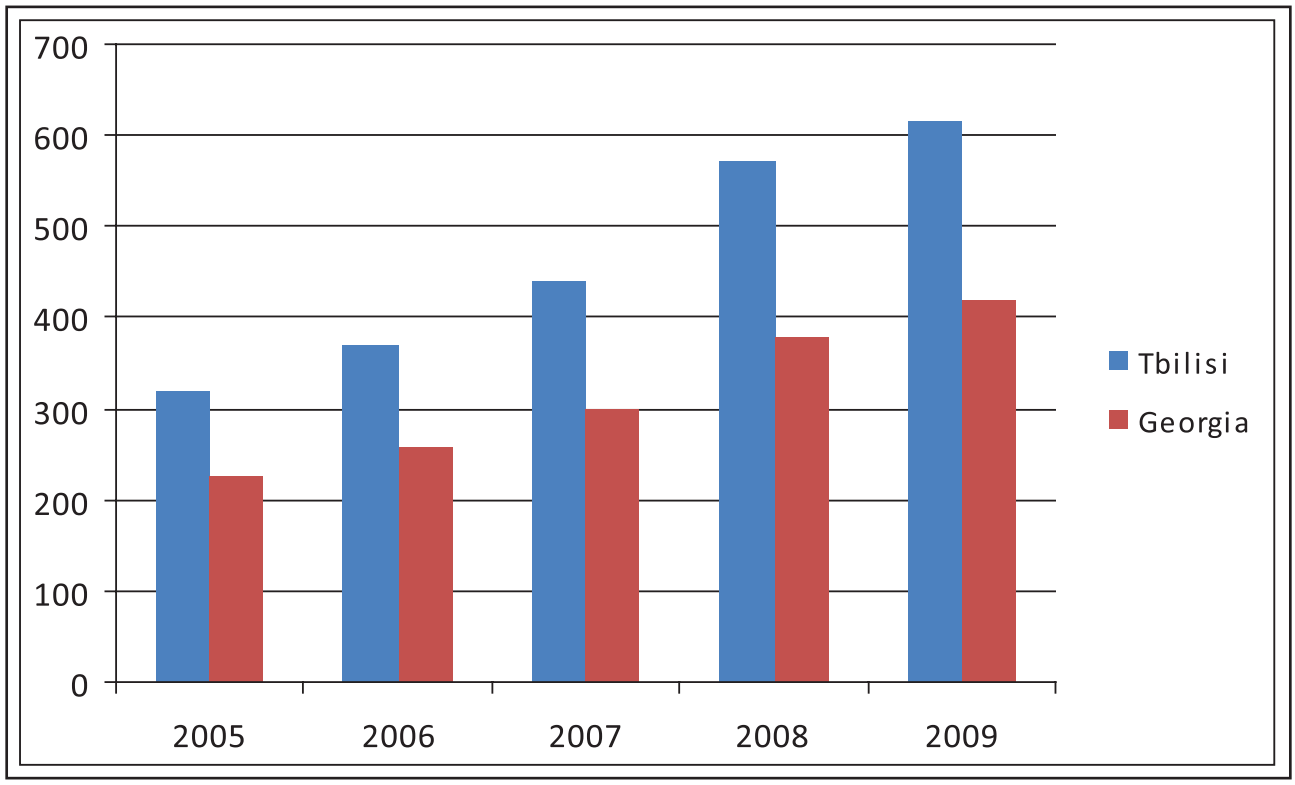
2.3.1 Poverty, unemployment and incomes

Poverty and unemployment rates are high in Georgia and its capital. Poverty levels in the country are provided in table 2.7. Specific statistical data on the poverty level in Tbilisi are not available.

According to official data, the unemployment rate in the last five years was around 30% in the city.[29] However, the real unemployment figure must be higher: due to the poor unemployment assistance system and the low rate of unemployment allowances, many of the unemployed are not officially registered. Many of

27 State Statistices Office, March 21, 2011
28 Tbilisi City Hall – 2010. http://www.tbilisi.gov.ge
29 National Statistics Office

Diagram 2-3 Average monthly income of households in Tbilisi and Georgia (GEL)



Source: National Statistics Office of Georgia. http://www.geostat.ge/

those who do work are engaged in unskilled labor and have low salaries.

According to the National Statistical Office, average cash income per capita in Tbilisi was 168 GEL (about US$100) per month and the monthly subsistence minimum for the average consumer was about 115 GEL (about US$66) in 2009.[30] Monthly per capita average income among officially registered socially vulnerable people was 32.1 GEL in 2006, which would amount to only 32.5% of the minimum living cost that year.[31] About one-fifth of Tbilisi's population receives a governmental pension, which range between 90-100 GEL (US$52-57) per month. [32]

There are no statistical data for income inequality for Tbilisi specifically. The Gini coefficient by cash income, which measures income equality, was 0.52 in 2008 for Georgia on average.[33] Generally speaking, income inequality is high in Tbilisi. There is no concentration of poor households in particular districts of the city. Both wealthy and socially vulnerable families can be found in all districts of the city. Table 2.8 below provides information on the average household (four members) income and sources of the income in Tbilisi.

On average, almost half of household expenditure is related to buying food products. In 2008, food-related cash expenditures for an average household in urban areas in Georgia, including Tbilisi, amounted to 44% of all consumption expenditures. For the population below the official poverty line, this figure was about 60%. This naturally limits expenditures for other needs such as health care, heating, transport, education and shelter (see table 2.9). The low income impedes investments in human capital development,

30 National Statistics Office of Georgia determines the lvel of monthly subsistence minimum for average consumer

31 Tbilisi City Hall. Tbilisi Economic Development Plan. Assessment of the Local Economy, 2007. www.tbilisi.gov.ge

32 National Statistical Office.

33 The Gini coefficient is a measure of the inequality of a distribution, a value of 0 expressing total equality and a value of 1 maximal inequality.

Table 2-7 Poverty Level in Georgia

	2004	2005	2006	2007	2008	2009
With respect to 60 percent of the median consumption (%)	24.6	24.1	23.3	21.3	22.1	21.0
With respect to 40 percent of the median consumption (%)	10.9	10.1	9.4	9.2	9.5	8.8

Source: National Statistics Office of Georgia. http://www.geostat.ge/

Table 2-8 Average monthly incomes of households in Tbilisi (GEL)

	2006	2007	2008	2009
Cash income and transfers	**368.5**	**439.2**	**570.7**	**614.4**
Wages	**213.6**	**266.0**	**339.5**	**357.0**
From self-employment	55.0	49.6	81.1	90.7
From selling agricultural production	0.5	0.1	2.8	0.5
Property income (leasing, interest on deposits, etc.)	2.7	8.1	6.1	8.8
Pensions, scholarships, assistances	30.3	37.6	59.4	65.6
Remittances from abroad	18.6	26.9	23.3	27.7
Money received from relatives and friends	47.7	50.8	58.5	64.2
Non-cash income	**13.3**	**13.4**	**15.8**	**13.1**
Income, total	**381.8**	**452.6**	**586.4**	**627.5**

Source: National Statistics Office of Georgia. http://www.geostat.ge/

Table 2-9 Average monthly expenditures per household in Georgia in urban areas (GEL)

	2006	2007	2008
Consumption expenditures in cash	**348.9**	**407.1**	**485.8**
Food, beverages, tobacco	171.3	187.0	211.0
Clothes and footwear	17.5	17.5	22.0
Household goods	11.4	15.9	16.9
Healthcare	27.2	33.0	41.2
Fuel and electricity	36.3	47.4	62.1
Transport	30.6	38.3	52.5
Education, entertainment and recreation	13.0	19.7	20.9
Other consumption expenditure	41.6	48.4	59.2
Non-cash expenditure	**23.0**	**21.7**	**27.2**
Consumption expenditure, total	**371.9**	**428.8**	**513.0**
Non-consumption expenditures in Cash	**40.4**	**43.4**	**65.9**
Agriculture	1.6	1.8	2.1
Social transfers	9.1	12.4	12.3
Saving and lending	24.3	24.4	42.2
Property acquirement	5.4	4.7	9.4
Cash expenditure, total	**389.3**	**450.6**	**551.8**
Expenditure, total	**412.3**	**472.3**	**578.9**

Source: National Statistics Office of Georgia. http://www.geostat.ge/

hampers productivity growth and reduces the chances of overcoming poverty. It also limits affordability for households to pay for improved environmental services such as water supply and sanitation, waste management, etc.

2.3.2 Public health

According to the 2002 census, the latest census in Georgia, 45.1% of the population in Tbilisi was male with the remaining 54.8% being female. The average age of the population was 35.8 years, with the

Box 2-1 Key health indicators for Georgia

Life expectancy at birth male/female (years)	**66/74**
Healthy life expectancy at birth male/female (years, 2003)	**62/67**
Probability of dying under five (per 1 000 live births)	**32**
Probability of dying between 15 and 60 years male/female (per 1 000 population)	**255/94**
Total expenditure on health per capita ($, 2006)	**355**
Total expenditure on health as % of GDP (2006)	**8.4**

Figures are for 2006 unless indicated. Source: World Health Statistics 2008

average age of the male population being 33.6 and for females, 37.6 years. There are no statistical data on life expectancy for Tbilisi specifically. However, at the country level, according to the World Health Organization (WHO), life expectancy at birth for males was 66 years in 2006, while for females this indicator was 74. Box 2.1 provides some key health indicators for Georgia.

Polyclinics, dispensaries, health centres, female consultation clinics, doctor ambulatories and hospitals (in-patient healthcare) make up the core of the primary health care system in Tbilisi. Table 2.10 provides data on the health care system in Tbilisi.

The Georgian health care system has inherited a substantial number of medical facilities and medical personnel from Soviet times. However, existing physical infrastructure, equipment and human resources are not able to ensure adequate quality of medical services. In 1995, the Georgian government began to reform the health care sector with the objective to improve the system and make high-quality health care services accessible for everyone. The reform still continues. The post-Rose Revolution government identified the hospital sector's rehabilitation as one of the primary targets for health care reform in Georgia. The governmental strategy is to turn the health care industry over to the private sector with the idea that this would lead to increased competition, higher investments in the sector and finally, the provision of better medical services.[34]

At present, nearly all health care providers are private actors, independent of the state except the centres for tuberculosis and infectious diseases, and mental hospitals. There are also various state programmes in the health care system for specified diseases covered from public funds. Much hospital stock has been sold to private investors for redevelopment and modernization. Mandatory social health insurance was introduced in 1995, but proved to be ineffective and was abandoned in 2007.[35] Private health insurance is being promoted by the current government as the main mechanism for the pre-payment of health services in Georgia. Private insurance coverage for households living below the poverty line and public schools teachers in Tbilisi are paid from public funds, but all other individuals are expected to purchase insurance coverage at their own cost. There are a number of private companies in the country offering medical insurance coverage; however, as unemployment is high and average households income is low, many people cannot afford to pay insurance premiums[36]. Out-of-pocket payments remain the main source of funding for the health care system in Georgia. This situation reduces access to appropriate medical services for much of the population.

34 Georgian National Investment Agency. Central Republican Hospital. Tbilisi, Georgia. November, 2009. http://uk.mfa.gov.ge/files/uk/Tbilisi,_Georgia_-_Republican_Hospital.pdf.

35 National Healthcare System Analysis Report 2001-2007, Ministry of Health. 2009. http://www.moh.gov.ge/

36 An insurance premium is the actual amount of money charged by insurance companies for active coverage.

Table 2-10 Selected indicators of healthcare system in Tbilisi

	2009
Number of hospitals	78
Number of hospital beds	4078
Independent women consultations, clinics and dispensaries	117
Number of physicians (excluding dentists)	10098
Number of paramedical personnel	7079

Source: National Statistics Office of Georgia

Table 2-11 Number of students and schools in Tbilisi at the beginning of school year

	2007/2008	2008/2009	2009/2010
Number of public and private schools	313	323	330
Number of students	167,374	179,460	173,942

Source: National Statistics Office of Georgia. http://www.geostat.ge/

Table 2-12 Number of higher education institutions

	Public institutions			Private institutions		
	2007/2008	2008/2009	2009/2010	2007/2008	2008/2009	2009/2010
Georgia, total	19	20	21	137	109	108
Tbilisi	9	9	9	100	80	75

Source: National Statistics Office of Georgia. http://www.geostat.ge/

2.3.3 Education

With a strong literary tradition that dates back to the beginning of the last millennium and historically well-respected higher educational institutions, academic achievement is socially prized in Georgia.[37]

The number of private secondary schools has significantly increased in Tbilisi during the last ten years. The number of students in private schools has also been increasing.[38]

The major Georgian universities and academic institutions are located in Tbilisi (see table 2.12). There are numerous public and private universities in the city which provide undergraduate and post-graduate education. The largest and the oldest university is the Ivane Javakhishvili Tbilisi State University, which was established in 1918. This university has five subsidiaries in different regions of Georgia, six faculties and over 60 scientific-research labs. There are other state universities with various faculties including social sciences, technology, medicine, agriculture, veterinary, foreign languages, culture etc. The number of private higher-education schools was significantly growing in the 1990s and beginning of 2000s. However, not all private institutions met high education standards and had adequate human resources and infrastructure. Therefore, there is a trend in recent years of closing down such institutions that do not meet recently introduced standards for higher education.

2.4 Overview of economic sectors

2.4.1 Industry

Industrial activities were drastically reduced in Georgia and its capital city after the breakup of the Soviet Union. Many of the industrial facilities in the city ceased operation. Some enterprises survived but have significantly reduced production or have shifted to the manufacture of other products.

Recovery of economic, including industrial, activities started in the second half of the 1990s and continued through the first decade of the new millennium (see diagram 2.4). Despite the revitalization, industrial production in Tbilisi still remains very low compared to its levels in Soviet times. Many large-scale enterprises in the sectors of heavy machinery, electric machines and microelectronics, textile and others either do not function or manufacture goods in very limited amounts. Currently, relatively well-developed industrial sectors are wine production, production of other alcoholic and non-alcoholic beverages, food processing (meat and dairy products, fruits and vegetables), production of construction materials (cement, asphalt).

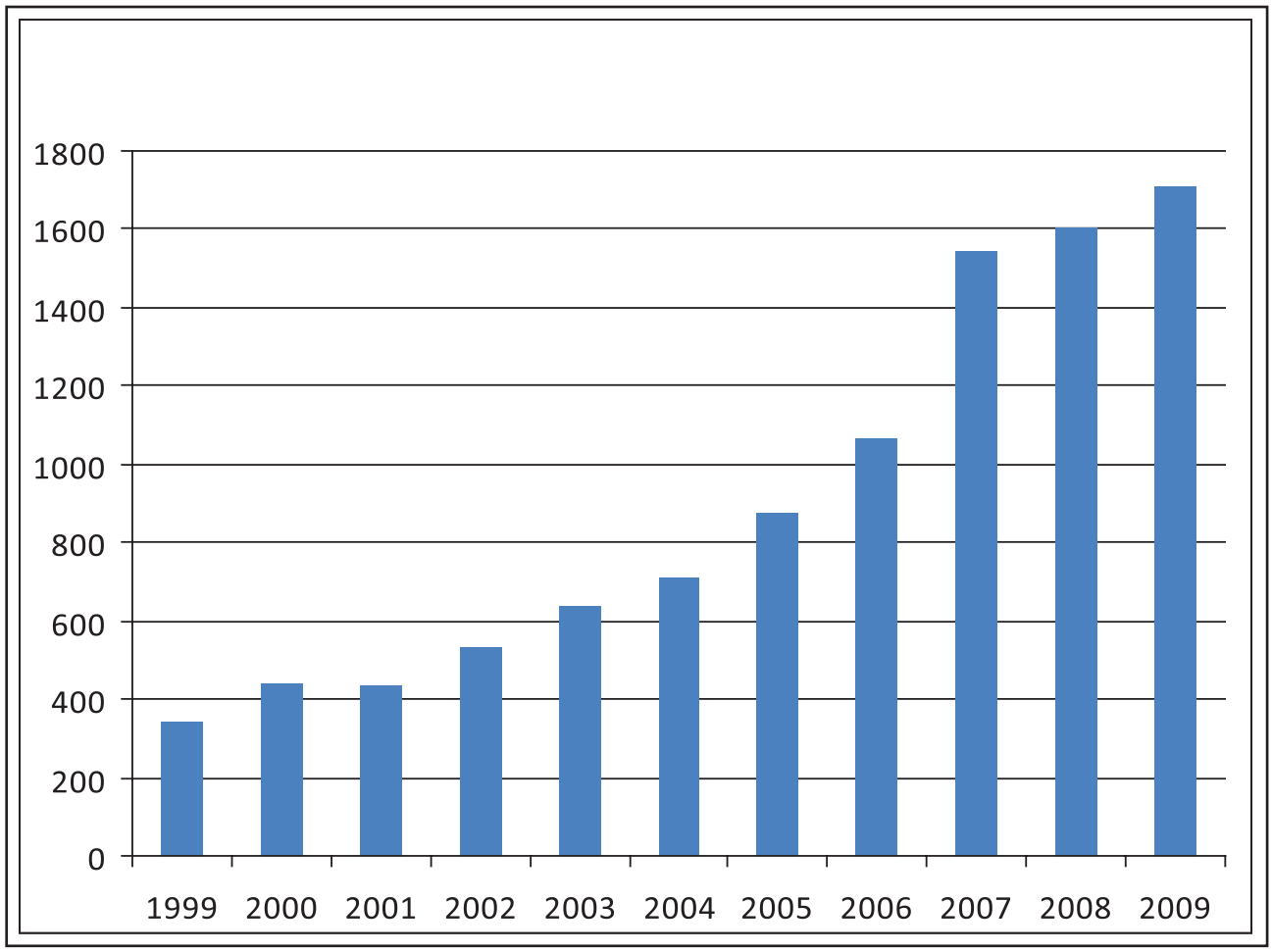
Along with the growth of industrial production in Tbilisi, the share of the capital city in the country's total industrial production is also increasing. At present, about 45% of Georgia's industrial products in monetary terms are produced in Tbilisi. About 43% of employees in the industrial sector of Georgia work in Tbilisi (see table 2.13).

Air pollution from the industrial sector was substantially reduced following the economic crisis in the 1990s and the closure of many large-scale industrial facilities. Despite the growth of industrial production achieved in the last decade, according to data provided by the Ministry of Environment Protection of Georgia (MEP), industrial air emissions continued to decline (see table 2.14). The reduction trend is illustrated in diagram 2.5.

Data provided by the Ministry on air emissions from 35 major stationary pollution sources suggests that 99% of total suspended particulates (TSP) borne in industrial processes have been captured in filters and

37 United Nations Development Program. Georgia Human Development Report 2008: The Reforms and Beyond. Tbilisi, 2008.
38 Tbilisi City Hall. Tbilisi Millennium Development Report. Tbilisi, Georgia 2007. Polygraph+ Ltd.

Diagram 2-4 Production in industrial sector in Tbilisi (in current prices, mln GEL)



Source: National Statistics Office of Georgia. http://www.geostat.ge/

recycled. However, all other pollutants such as SO_2, NOx, CO and hydrocarbons in industrial processes are emitted into the environment because of a poor state or non-existence of respective filters at the industrial facilities (see table 2.15).

Industrial facilities in Tbilisi are mostly located on the left bank of Mtkvari River along the railway that crosses the city from the northwest to the southeast.[39] Many of the facilities do not operate or operate at minimum capacity. According to the Tbilisi city development master plan approved by the City Assembly on 5 June

39 In the eastern part facilities are spread on a wider territory.

Table 2-13 Production and number of the employees in industrial sector

	1999	2001	2003	2005	2007	2009
Production (mln GEL, current prices)						
Georgia	989.2	1170.5	1594.3	2285.1	3583.3	3797.1
Tbilisi	342.1	431.5	634.7	871.1	1542.6	1711.2
Tbilisi's share (%)	34.6	36.9	39.8	38.1	43.0	45.1
Number of employees						
Georgia	119687	90392	82004	94324	88398	93039
Tbilisi	37801	29995	26354	32161	37036	39646
Tbilisi's share (%)	31.6	33.2	32.1	34.1	41.9	42.6

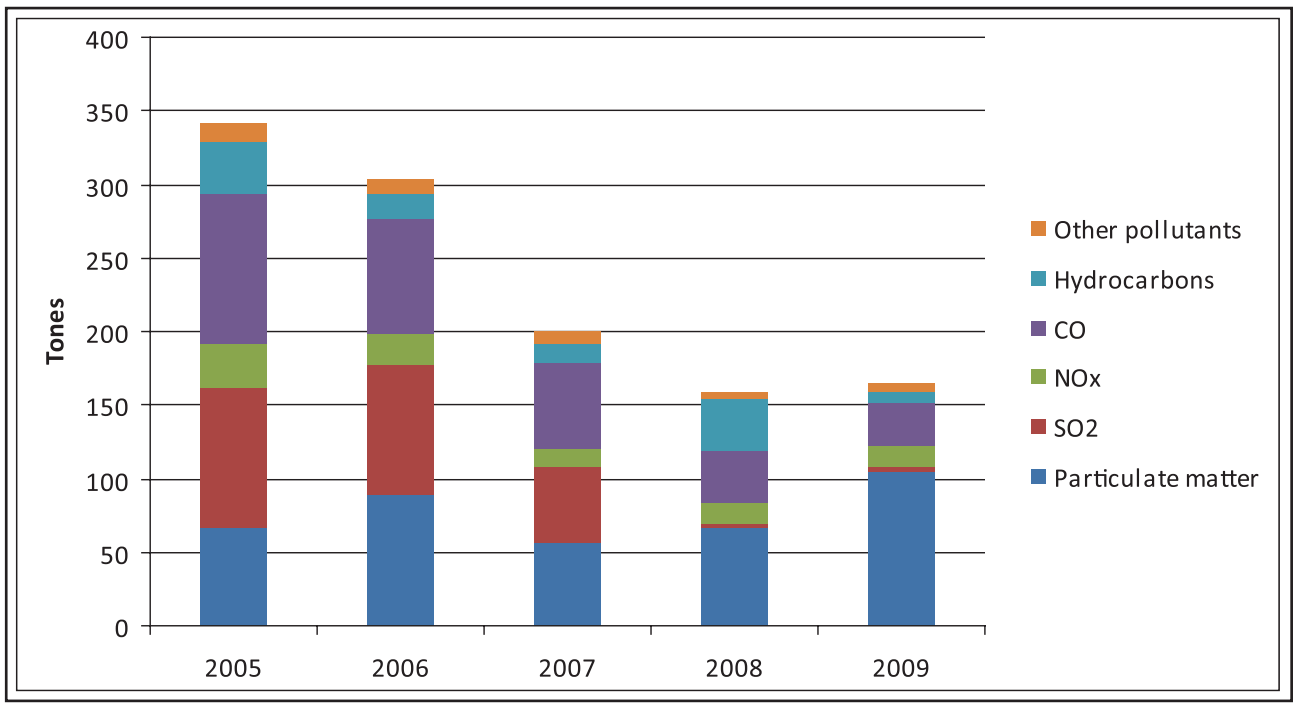
Source: National Statistics Office of Georgia. http://www.geostat.ge/

Table 2-14 Emissions of major pollutants from stationary sources in Tbilisi for the period 2005-2009 (Tons)

	2005	2006	2007	2008	2009
Particulate matter (PM)	66	89	57	66	105
Sulphur dioxide (SO_2)	96	89	51	3	3
Nitrogen oxides (NO and NO_2)	30	21	13	15	14
Carbon monoxide (CO)	101	77	58	35	30
Hydrocarbons	36	18	12	36	7
Other pollutants	13	10	9	4	5
TOTAL	342	304	200	159	163

Source: Ministry of Environment protection of Georgia

Diagram 2-5 Reduction of air emissions from stationary sources in Tbilisi for the period 2005-2009



Source: Ministry of Environment Protection of Georgia

Table 2-15 Air emissions from stationary sources in Tbilisi in 2009

Air pollutants	Amount of pollutants born in industrial processes	Among this				Filtration rate
		Going through the filters	Among this		Emitted into the air	
			Captured in filters	Recycled		
	Tons					%
Particulate matter (PM)	155267	15473	15422	14606	105	99.3
Sulphur dioxide (SO_2)	2.6	–	–	–	2.6	0
Nitrogen oxides (NO and NO_2)	14.2	–	–	–	14.2	0
Carbon monoxide (CO)	29.6	–	–	–	29.6	0
Hydrocarbons	6.7	–	–	–	6.7	0
Other pollutants	5.5	–	–	–	5.5	0

Source: Ministry of Environment Protection of Georgia

2009, the old railway will be decommissioned and a new railway route will be built in the north of Tbilisi and will bypass the central area of the city. Many of the old industrial facilities will be also decommissioned or moved to the eastern suburbs of Tbilisi. It has been planned that new business and commercial centres and residential buildings will be built on land of the current railway, related infrastructure and industrial facilities. According to the plan, the land which becomes available between the Central Railway station and Didube (some 73.2 ha) will be designated for urban development, while the cleared rail corridor between the Central station and Navtlughi station (about 6.5 km long, 10.2 ha) will be transformed into an urban traffic corridor. The municipality envisages installing a double-track light rail passenger system ("Eurotram" type) for the greater Tbilisi agglomeration, which would run from Mtskheta town in the northwest to Gardabani town in the southeast via Tbilisi Central, Airport and Rustavi town. This Light Rail would basically run on the same route as the current railway.

2.4.2 Construction

Construction has been one of the most rapidly growing economic sectors of Tbilisi in the last 10-15 years. The Tbilisi municipal authority promotes development of this sector. It has provided favorable investment conditions and streamlined the construction permit issuing procedures.[40] Table 2.16 provides some statistical data related to the development of the sector in recent years in the city.

The majority of constructions of new residential buildings have been taking place on the right side of Mtkvari River in Vake-Saburtalo district. Along with the construction of new buildings, reconstruction or replacement of old buildings with new ones has been taking place in many of the central parts of the city, especially in the Old Tbilisi District. The historical zone of the city, which mostly includes areas within the old city fence and where most of the monuments of cultural heritage are located, has been under the state control, and construction there is strictly regulated by the city government.

In 2009, the Tbilisi government initiated a program of rehabilitation of the old part of the city. The programme is called "New Life of Old Tbilisi".[41] The purpose of the programme is to improve the state of residential buildings and infrastructure in the old town which have been worn out and damaged, and are thus dangerous for human habitation. As reported, 60% of residential buildings in the old town have been worn out or wrecked.[42]

In 2009, the legislative body of the city Tbilisi Sakrebulo approved the Tbilisi development master plan.[43] By adopting this plan, much of the land in Tbilisi suburbs, mostly in the newly joined villages, that earlier had a status of agricultural or recreational lands have now acquired residential status where construction works can take place. According to the development master plan, construction of 1 million m^2 new residential space has been planned annually in the city for the period until 2015, to create dwellings for about 170,000 people. For example, in Tabakhmela village, which earlier was one of the recreation areas and now it is within the administrative boundaries of Tbilisi, the "Rakeen Development" company plans to build a complex of residential houses, hotels and commercial centers called "Tbilisi Hieghts.[44]

Due to the global economic crisis, construction activities in the private sector and investments in real estate have been significantly reduced since 2008. It is expected that the construction sector will continue to grow after the recovery.

Construction works have multiple impacts on the environment of Tbilisi and its suburbs, including noise, generation of dust and construction waste. However, the most significant damage to the environment is related to clearing of forests and green areas around and sometimes within the city. One example is the park in Digomi district, development of which began in 1934 on an area of 200 hectares. One of the functions of the park was to protect the city from winds. It also had recreational and agricultural functions. At present, most of the park has been cleared and residential buildings have been built there.

Construction and expansion of residential areas may have a negative effect on the air quality of and climate in the city. There are two major reasons for this:

1. Forests around Tbilisi have a function of air filtration, provision of oxygen and formation of a favorable climate in Tbilisi. Clearance of these forests and other vegetation, and construction of

40 Tbilisi City Hall – 2010. http://www.tbilisi.gov.ge
41 Tbilisi City Hall. www.tbilisi.gov.ge
42 Background document to Tbilisi Development Master Plan. www.tbilisi.gov.ge
43 Decision #6-17, June 5 2009, of Tbilisi Sakrebulo on ratification of the General Plan of Prospective Development of the Capital City
44 Rakeen Development. http://www.rakeen.ge/

Table 2-16 Selected indicators of the construction sector in Tbilisi

	2004	2005	2006	2007	2008
Number of buildings constructed	184	122	166	163	192
Space built (m^2)	99028	97048	95086	128400	269170

Source: Statistical Yearbook 2009.

buildings in their place, will negatively affect these functions.

2. The central part of Tbilisi is located in the Mtkvari River canyon. High and very steep ranges surround the city on the south and southwest, and foothills and lesser hills on the north and northeast. Therefore, winds mostly blow in a northwest to southeast direction, and vice versa along the Mtkvari River canyon. These winds have a crucial role in cleaning Tbilisi's air.

Also very important for the climate and air quality in Tbilisi is the following factor: in the summer season, hot air flows up and during nights cool air flows down from the hills surrounding Tbilisi to the lower parts of the city. This air movement is called "advection" in meteorology.

Construction of new buildings, especially along the Mtkvari River and also on the foothills of its surrounding hills and mountains prevents free wind and air movement in the city, which is the natural way of cleaning Tbilisi's air and also partly responsible for the city's climate.

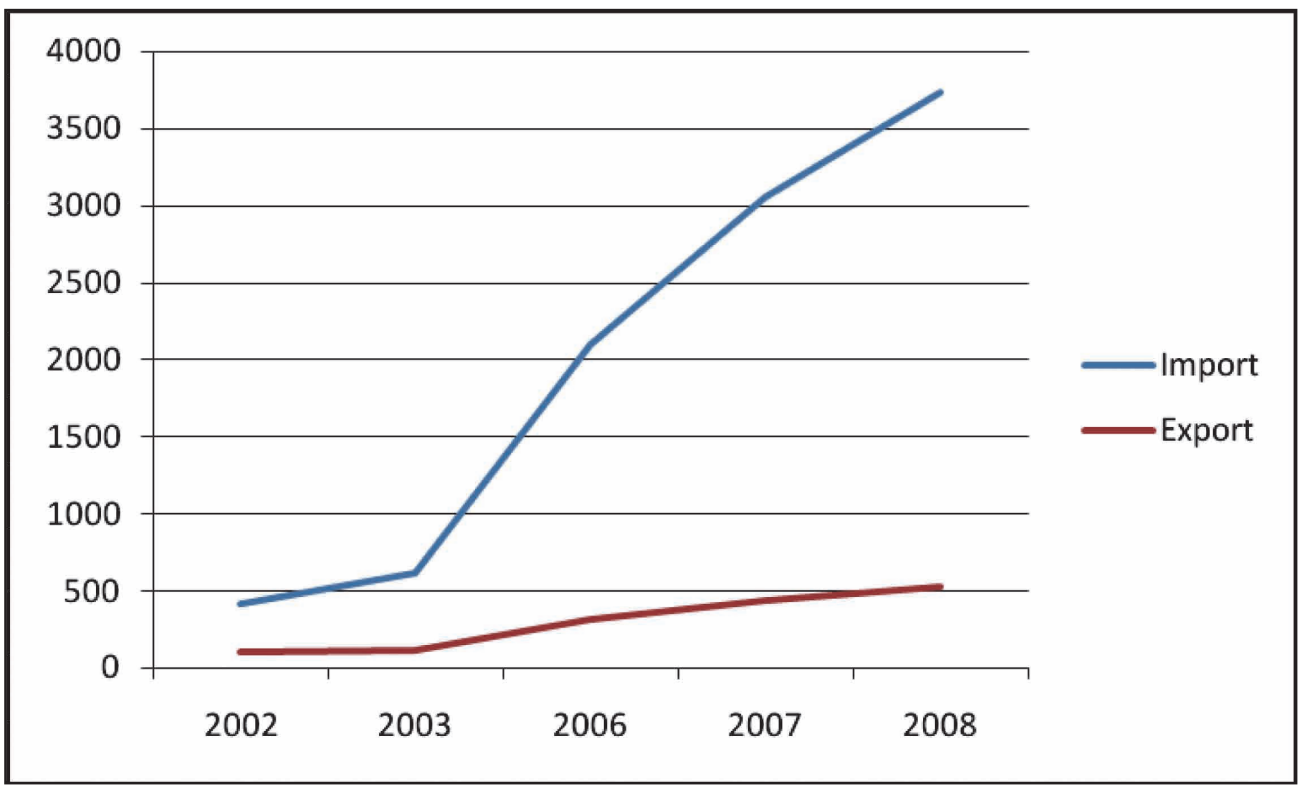
2.4.3 Trade

Tbilisi is the main trade centre of Georgia. Major retail stores and markets for various goods are concentrated in the capital city. There are seven large shopping centers and about 110 open air markets in the city, with a total area of 500-600 thousand square meters. The number of traders is about 19,000. A significant portion - about 20-25% of people - employed in Tbilisi are engaged in the trade sector, with 90% of those involved in retail and the remaining 10% in wholesale.[45]

Recent years have witnessed a steady growth

45 Tbilisi City Hall. Tbilisi Economic Development Plan. Assessment of the Local Economy, 2007. www.tbilisi.gov.ge

Diagram 2-6 Dynamics of foreign trade sector in Tbilisi (million GEL)



Source: © Tbilisi – City Development Strategy – City Profile

Table 2-17 Main trade partners of Tbilisi (2008)

Import		Export	
Country	Share (%)	Country	Share (%)
Azerbaijan	13.5	Azerbaijan	28.4
Ukraine	9.7	Armenia	16.4
Germany	9.7	Turkey	10.6
		Ukraine	7.7

Source: © Tbilisi – City Development Strategy – City Profile

in foreign trade activity carried out by companies registered in Tbilisi. During the 2002-2008 period, imports increased by a factor of nine, while exports increased by a factor of five (diagram 2.6). The gap has extended - imports now exceed exports more than seven times.

Petroleum and its products comprise 47% of the total goods imported to Tbilisi, followed by vehicles at 19%, and petroleum gases and hydrocarbons at 15%. The main groups of goods exported in 2008 were motor vehicles (21%) and fertilizers and chemical products (20%). Importing used and new motor vehicles from European countries, Japan and the United States and exporting them to neighbouring countries (Armenia and Azerbaijan) has become a growing business in Tbilisi. The vehicles are imported mostly through the Black Sea ports of Georgia. Azerbaijan is the main trade partner of Tbilisi, both in terms of importing and exporting of goods.

2.4.4 Tourism

In the days of the USSR, Georgia was the tourist mecca for the rest of the Soviet Union. Tourist numbers hit a peak of 3.2 million visitors in 1988.[46] As Georgia descended into civil war in the early 1990s, its tourism industry ground to a halt. A revival of the tourism industry followed the political stability in the country achieved by the mid-1990s. The new government which came to power after the "Rose Revolution" considers tourism as a priority sector for economic development. At present, the tourism sector is a robust and rapidly growing industry. In 2009, more than 1.5 million people visited Georgia. The share of the tourism sector in GDP is around 4%.[47] Diagram 2.7 provides information on the growth of economic activities related to tourism and restaurants in Tbilisi.

The capital city attracts about 46% of all tourists visiting Georgia based on registration in hotels.[48] The number of small and large-scale hotels has been increasing in the city. In the period between 2008-2009 the number of hotels increased from 92 to 113.[49] At present there are a number of foru- and five-star hotels, such as Courtyard Marriott, Tbilisi Marriott Hotel, Sheraton Metekhi Place and Radisson Blu Hotel functioning in Tbilisi. Some of these luxury hotels, such as the Intercontinental, Kempinski and Hyatt, are still under construction and will open in coming years. Also, a tourism and sports center with a complex of hotels has been planned to be developed in the area of Lisi Lake on 400 square meters.

There are numerous cultural attractions that can be found in and around the city of Tbilisi. These include various museums, art galleries, churches and many historical buildings and sites such as Metekhi, Narikala, Sioni and Anchiskhati churchs, sulpur baths etc. Most of these are concentrated in or near the old town. Tbilisi has various recreational sites as well that are at the same time important biodiversity sites; e.g., the Botanical Gardens and Tbilisi National Park.

As mentioned earlier, promotion of tourism and development of tourism infrastructure is a governmental priority in Georgia. However, existing

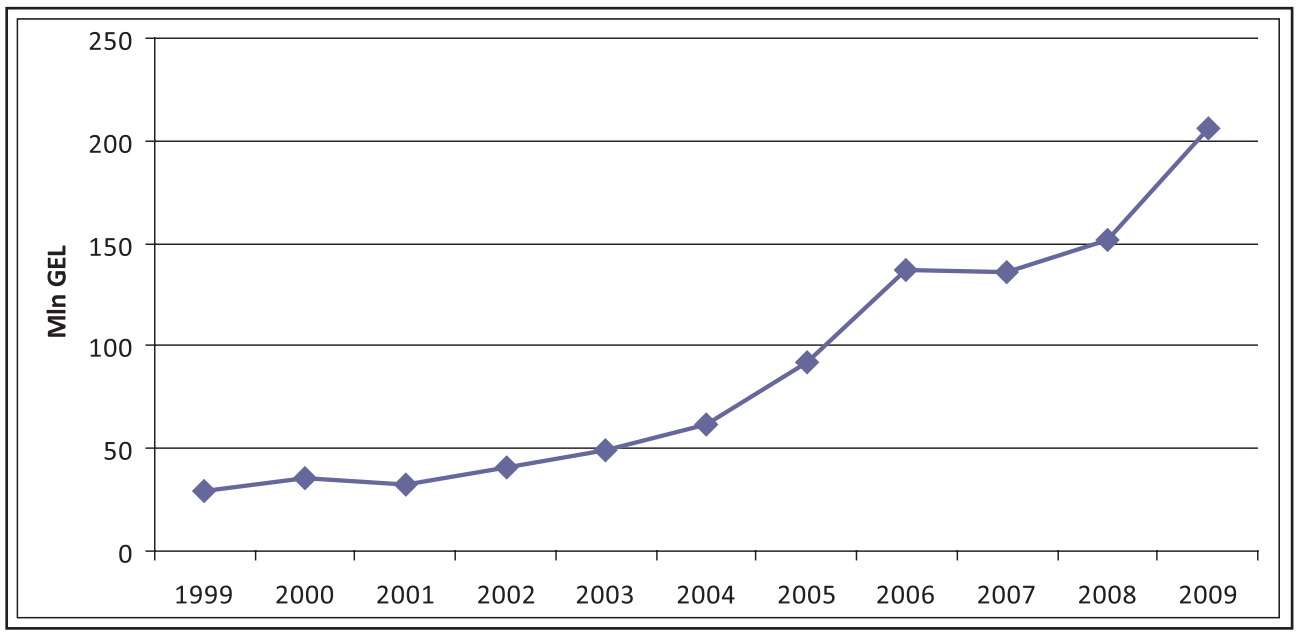
46 Tourism: Looking back to the glory days. Article by Quentin Peel. Published: October 31 2007 06:07. Financial Times, http://www.ft.com/cms/s/0/eb3c5e44-86a3-11dc-a3ff-0000779fd2ac.html#ixzz1FkK2nR79

47 Source: Department of Tourism and Resorts of Georgia

48 Tbilisi – City Development Strategy – City Profile, 2011.

49 Department of Tourism and Resorts of Georgia.

Diagram 2-7 Economic turnover in hotels and restaurants in Tbilisi



Source: National Statistics Office of Georgia. http://www.geostat.ge/

or potential negative environmental effects related to tourism development in Tbilisi have not been studied or assessed. The tourism industry, if not properly managed, may exert a significant pressure on the environment and infrastructure of the city. These pressures can be associated with increased demand on transport, waste generation, pollution of water, energy and natural resources consumption etc.

2.4.5 Agriculture

Agriculture was well developed in the suburbs of Tbilisi until the 1990s. The main agricultural goods produced included fruits, vegetables, meat and dairy products. The products were sold mostly to Tbilisi markets.[50] Agricultural production has decreased dramatically over the last two decades. According to statistical information provided by the National Statistics Office of Georgia, the value-added of agriculture in Tbilisi amounted to 1 million GEL in 2009 (see table 2.18). It is unclear whether these statistical data include agricultural ouptut in the villages that were joined to the city in 2006. In general, there is very litle information available on agricultural activities in the city and its surroundings. Moreover, there is limited information on environmental pressures related to this sector.

50 Academy of Science of Georgia. Tbilisi Encyclopedia, Tbilisi, 2002.

2.5 Urban Infrastructure

2.5.1 Energy

2.5.1.1 Electric power supply

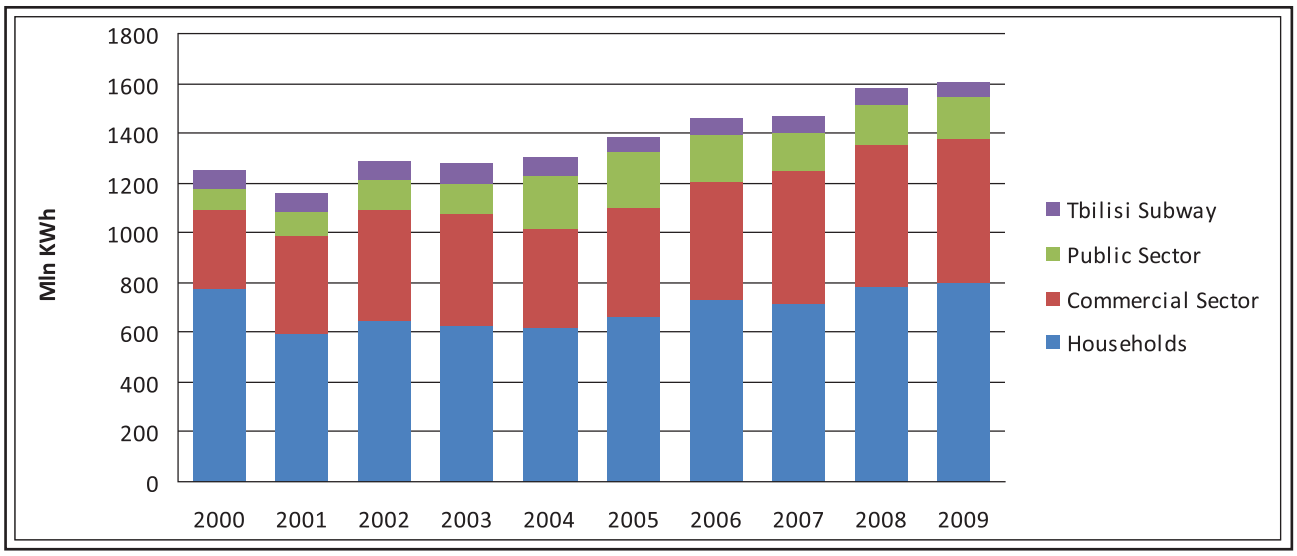
In the Soviet period Georgia imported most of its energy resources, including power, natural gas and oil from former Soviet republics. Following the breakup of the USSR, the energy sector in Georgia and its capital Tbilisi suffered a catastrophic collapse in the early 1990s. Power, oil and gas import and supply to industries and households dropped dramatically. At that time, no customer in Tbilisi had uninterrupted power supply. The capital had a scheduled power supply, there were daily blackouts, and in winter periods some areas in the city had no power for a number of days. Power sector assets were dilapidated and theft of electricity and corruption was rampant. Due to a lack of financial discipline in the sector, only a fraction of fees paid by customers was collected, resulting in a massive debt accumulation by the sector companies, making them unable to import needed power for the country from neighboring countries' systems, which in turn led to more power shortages. Following the "Rose Revolution", with support from the International Development Association (IDA) in the Electricity Market Support Project, the new government transformed the power sector into a financially viable, modernized, and functioning sector. For the last few

Table 2-18 Gross Value added of Tbilisi

	2006	2007	2008
Agriculture (current prices, mln GEL)	1.4	1.0	1.0

Source: National Statistics office of Georgia

Diagram 2-8 Power consumption in Tbilisi by different sectors



Source: Tbilisi City Hall. The data do not include losses in the network.

Box 2-2 Technical characteristics of hydropower stations located in Tbilisi and its surroundings

- **Zahesi** hydropower station on Mtkvari River, located at the Northern boundary of the city. Installed capacity – 36.8 MW, Average annual production – 180 mln kWh;
- **Ortachala** hydropower station on Mtkvari River, located in the south-eastern part of the city. Installed capacity – 18 MW, Average annual production – 85 mln kWh
- **Khrami I & Khrami II** hydropower stations installed on Khrami River, located in Tetritskaro Region. Total installed capacity – 222.8 MW, Average annual production – 368 mln kWh
- **Jinvali** hydropower station, installed on Aragvi River, located North of Tbilisi. Installed capacity – 130 MW, Average annual production – 440 mln kWh.

Source: Tbilisi City Hall Energy Efficiency Conception Paper, DRAFT, 12.12.2007

Table 2-19 Total power supply to Tbilisi and losses of electricity in the distribution network

	2008	2009
Total power supply (mln KWh)	1,897.31	1,863.52
Losses of electricity in the distribution network (mln KWh)	378.01	317.18
Share of the losses in the distribution network (%)	20%	17%

Source: Tbilisi City Hall, Economic Development Department.

years, this sector has delivered 24-hour uninterrupted power supply to its customers including households, the public sector, industry, transport and commercial entities. Households are the major power consumers in Tbilisi (see diagram 2.8). The Tbilisi subway is the largest single consumer of electricity.

Tbilisi receives electricity from a number of hydropower stations, located in the city or its surroundings (see box 2.2), and a thermal power station in Gardabani town located 39 km south-east from Tbilisi. Major environmental problems associated with the thermal power station are: air emissions from the natural gas combustion and thermal pollution related to discharges of cooling water into the Mtkvari River downstream of Tbilisi. There is no direct effect of the Gardabani thermal power station on the environment of Tbilisi.

Electricity in Tbilisi is distributed by the Joint-Stock Company Telasi. The major shareholder of Telasi is Inter RAOUES JSC of the Russian Federation. This is one of the largest distribution companies in the Georgian energy market. It owns high (110kv), medium (35-10kv) and low (6-0.4kv) voltage networks in Tbilisi. JSC Telasi distributes about 2 billion kilowatt-hours of energy to 416,500 individual, public and commercial customers per year.

Even though the power distribution network has been improving in the last years, it remains in a poor state after its deterioration in the 1990s. At present, losses in the distribution network of JSC Telasi ammount to 17-20%.

The EBRD is supporting the rehabilitation and expansion of the electricity distribution network in Tbilisi with a US$25 million loan to Telasi. The project is supported with US$250,000 in technical assistance from the EBRD Early Transition Countries Fund. The loan to Telasi will finance the rehabilitation and expansion of the company's medium- and low-voltage network and sub-stations, as well as introduction of a new supervisory control and data acquisition system (SCADA), which will enable the company to conduct remote monitoring over the network. This will lead to improved reliability, reduced losses and better quality of the electricity supply to Tbilisi.[51]

2.5.1.2 Natural gas supply and heating

Most of Tbilisi is supplied with natural gas. Natural gas has been used for heating and cooking in households, as well as for heating commercial and public buildings. It has also been used by industrial and commercial enterprises as a fuel. In Tbilisi natural gas is distributed by the Ltd "Kaztransgas".

Natural gas consumption in Tbilisi was more than 2.05 billion m^3 in 1989. Gas import and consumption dropped dramatically in the 1990s. The natural gas supply has been improved in recent years. Currently annual consumption is about 500 million cubic meters.[52] There is a trend of growing gas consumption in the city (table 2.20). The major consumer is the household sector.

The central heating system in Tbilisi collapsed in the 1990s due to the shortage of fuel and the lack of maintenance on the distribution network in the city. There is no central heating in Tbilisi at present. Households mostly use individual gas and electric heaters.

51 European Bank for Reconstruction and Development. http://www.ebrd.com/english/pages/news/press/2010/101215b.shtml

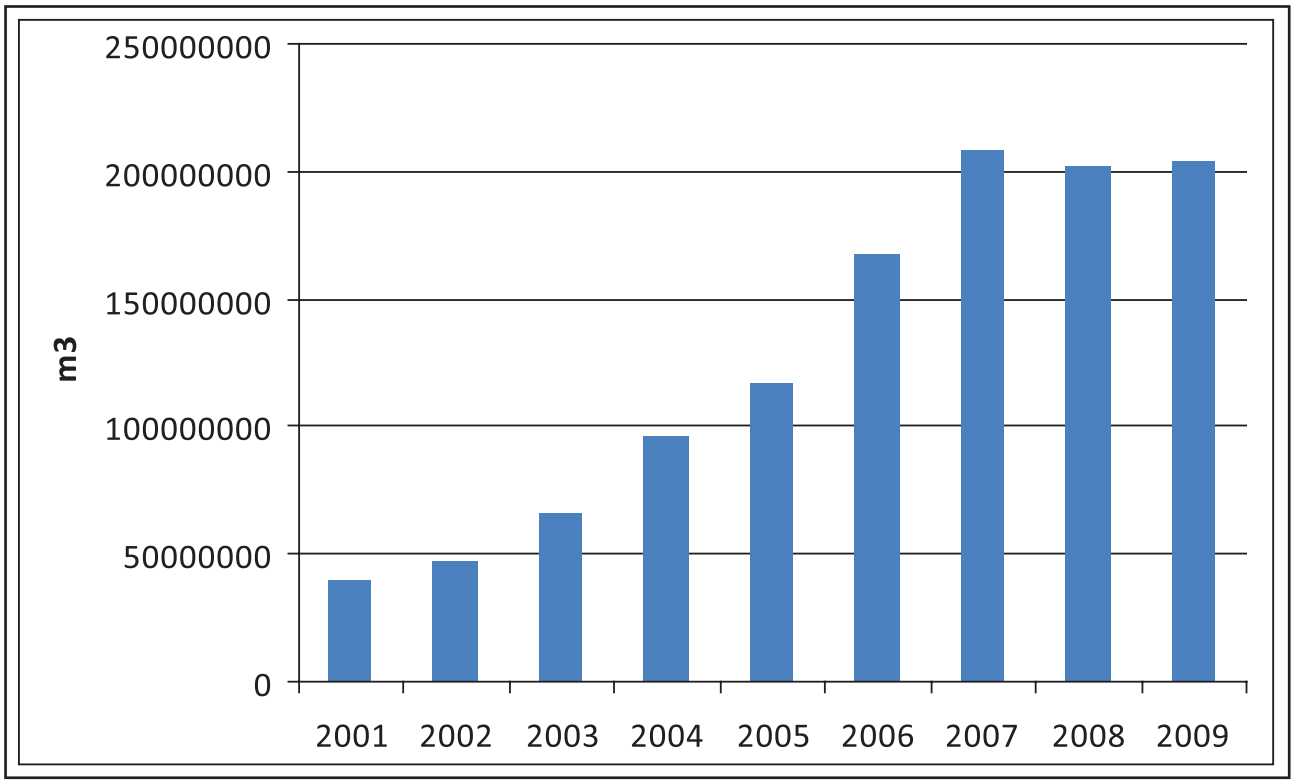
52 Tbilisi City Hall, Economic Policy Agency. *Tbilisi in Figures 2010.*

Table 2-20 Consumption of natural gas by households in Tbilisi

Year	Households sector consumption (m^3)	Number of households using natural gas
2001	39,514,988	153,602
2002	47,202,264	197,551
2003	66,346,740	234,465
2004	96,676,967	258,700
2005	117,577,961	278,139
2006	167,334,114	296,978
2007	207,793,483	300,205
2008	201,876,648	304,852
2009	203,571,665	311,177

Source: Tbilisi City Hall. Data has been provided by Ltd "Kaztransgas-Tbilisi"

Diagram 2-9 Consumption of natural gas by households



Environmental and health effects associated with heating and natural gas consumption in the city have not been studied or documented. However, it has been known that there were number of cases of intoxication and even deaths related to indoor air pollution (CO emissions) and gas leakages from gas appliances in houses.

As in the electric power distribution network, there are significant losses in the natural gas distribution network. The total length of the distribution network is 2450 km., part of which is underground. Most of the pipes underground have been seriously degraded because of corrosion and poor maintenance. According to the data provided by the distribution company, the losses due to gas leakages are in the range of 20-25%. The Kaztransgaz Company has been implementing a programme of replacement of old metal pipes with new plastic pipes. The company has been implementing a programme of daily monitoring of leakages and their elimination. Furthermore, the company intends to implement a project under the Clean Development Mechanism of the Kyoto Protocol of United Nation Framework Convention on Climate Change (UNFCCC) to reduce gas leakages.[53]

2.5.1.3 Renewable energy sources

In addition to the traditional energy resources, Tbilisi has a potential to use renewable energy sources. The most significant, although poorly utilised resource in this respect is geothermal energy. Table 2.21 provides information on thermal water resources in Tbilisi.

53 Kaztrasgaz-Tbilisi. http://www.tbilgazi.ge

Table 2-21 Thermal Water Deposits of Tbilisi

Name of Deposit	Number of Wells	Temperature (°C)	Discharge (m^3/day)
Tbilisi I	7	56-70	3760
Tbilisi II	5	38-48	111

Source: EBRD. http://ebrdrenewables.com/sites/renew/countries/georgia/profile.aspx

Geothermal waters have been used in the Lisi-Saburtalo area only where the Georgian company "Geothermia" supplies hot water and heat to about 7500 residents.[54] This system was developed in Soviet times and has been poorly maintained. Geothermal water used has not been recycled or reused; rather, it is discharged into the sewage system. Due to the absence of recycling, there are problems with reducing geothermal water debit in some wells. There is also no metering of water use.

In 2004, the Global Environmental Facility (GEF) provided financial assistance to the Government of Georgia for a project which promotes wider use of renewable energy resources for local energy supply in the country. The project includes the Saburtalo Pilot Geothermal Project in Tbilisi. The purpose of the pilot project is to supply geothermal water to the residential block buildings in Saburtalo district and to show the technical and economic feasibility of using geothermal water for heating. More specifically, the project envisages:

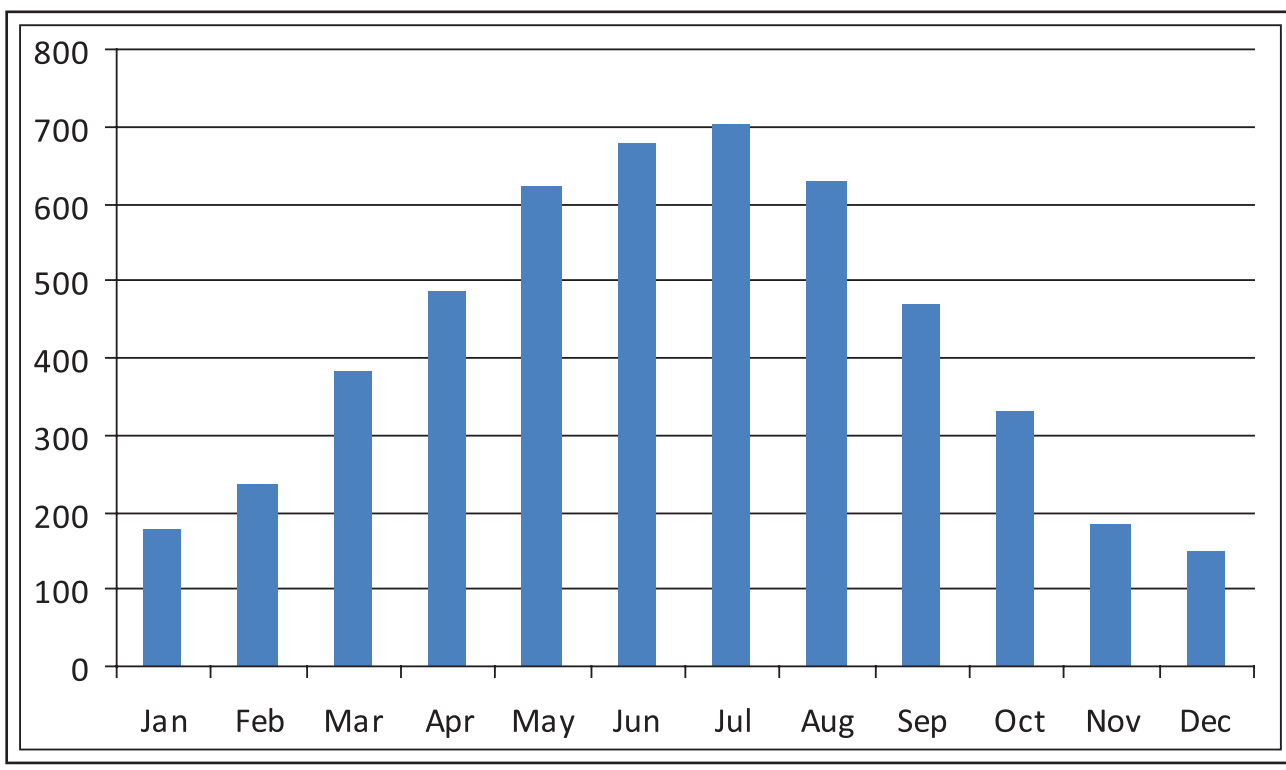
- installation of geothermal circulation;
- installation of a geothermal station where geothermal water will heat up the water-supply network water from 5-100 C^0 up to 55-600 C^0 through heat exchangers;
- expansion of the hot water supply network with an added 17000 residents;
- renovation of internal heat and hot water supply systems within the buildings; and
- creation of billing and metering systems.

It is hoped that succesful implementation of the project will be an impetus for wider use of geothermal energy for hot water and heat supplyin Tbilisi. According to some estimates, the energy potential of geothermal resources amounts to 1.4 TWh. Theoretically, this would be enough to provide 40% of the city with heat supply.[55]

54 G. Melikidze et al. Development of a Hydrodinamic Model for Tbilisi Geothermal Water Deposits in Lisi and Saburtalo Districts. Tbilisi, 2010.

55 Source: Codnis Samkaro. http://samyaro.org/geothermal-power.html

Diagram 2-10 Monthly and annual average solar radiation incident on horizontal surface in Tbilisi



Source: EBRD. http://ebrdrenewables.com/sites/renew/countries/georgia/profile.aspx

Tbilisi has a good potential for exploiting solar energy. On average, the duration of sunlight is 2112 hours per year.[56] Average annual solar radiation incident on horizontal surfaces in Tbilisi is about 5000 (MJ/m2). The solar energy resource potential for Tbilisi is presented in diagram 2.10. At present very little of the solar potential has been used for heating by individual households. There is also some potential for using wind energy. According to the Ministry of Energy and Natural Resources of Georgia, feasibility studies are under way for building wind power stations in Georgia. One power station potentially can be built in the Samgori plateau close to Tbilisi, with a potential capacity of 45 megawatts (power production 130 mln KWh per year).[57]

2.5.2 Transport

2.5.2.1 Transport Infrastructure

Transport infrastructure is one of the most important indicators of the quality of urban life. Tbilisi was characterized by its diverse transportation network from the very beginning. Back in 1904, the "Konka"[58] operating in Tbilisi was replaced by a tram moving on a narrow rail.[59] Buses appeared in the streets of Tbilisi from 1934 and they together with a subway continue to be an important transportation mode today. Trolleybuses were added to the transportation network in 1937. They were the most affordable means of transportation for the socially unprotected citizens in the 1990s due to low cost per ride (10 Tetri). Another transportation mode that appeared in the transportation network in 1958 was an air cable car operating in Rustaveli-Mtatsminda. A network of the air cable haulage expanded later in the direction of Lisi and Turtle lakes, Isani district and the university area in Saburtalo district.[60] At present, operation of the air cable haulage has been totally suspended, and there are no plans to rehabilitate and revive this transportation mode.

The transportation system more or less developed during the Soviet period almost totally collapsed in the 1990s. The subway rescued Tbilisi from full social and functional disintegration by keeping the sources of economic and social life alive. Eventually, liberalization of economic life and market relations have come to favor new means of transportation, such as minibuses that are still in operation today.

At the moment, optimization of public transport is being planned together with a French company. A tender was invited aiming to improve minibus service. Import of new technically fit minibuses is planned by the end of 2011. Simultaneously, development of electric transport is on the agenda, including administration of a modern tram system.[61]

Tbilisi Subway

The idea of launching a subway in Tbilisi arose in the middle of the 20th century. A subway division and its sub-units were established in 1965.[62] Six subway stations were opened in Tbilisi in January 11, 1966: "Rustaveli", "Marjanishvili", "Vagzlis Moedani", "Oktomberi" (was renamed later into "Nadzaladevi"), "Elektrodepo" and "Didube". In 1975, five stations were added to the system: "Leninis Moedani" (modern name – "Tavisuflebis Moedani"), "Avlabari", "300 Aragveli", "Isani" and "Samgori". Two additional sections came into function simultaneously in 1985 from "Samgori" to "Varketili" station and from "Didube" to "Guramishvili" station (today this station is named as "Guramishvili"). "Akhmetelis Teatri" was added to the line in 1989.[63] One more station - "Vazha-Pshavela" opened in 2002.

Ever since opening, the subway has provided service to a large of passengers. According to 2009-2010 data, the average number of passengers served daily is 206,000.[64] From 1 October 2010 a new ticketing system was introduced, and the subway fee can only be paid with a commuter Smart Card.

Bus

The bus together with the subway continues to be a main form of municipal transport. 476 buses of M3[65] category perform their daily work in the capital city. Among them, the number of greater capacity buses is 103 and the number of those of medium capacity is 373. The number of daily operational M2[66] category buses is 2464.

A new tariff system was introduced in buses and the subway of Tbilisi in October 2010. During the day the first trip costs 0.5 GEL, second trip - 0.3 GEL, and from the third trip onwards, the ticket price is only 0.2 GEL. The discount price is valid over 24 hours. Commuters can apply such a tariff system only if they use commuter Smart Cards. In addition, the Tbilisi Government introduced concessions for socially vulnerable groups of citizens. Students, pensioners of every category, victims of 9 April 1989 and employees of public schools and kindergartens pay 20 Tetri for a bus trip. Schoolchildren, war veterans and the blind travel free of charge.

56 Academy of Science of Georgia; Tbilisi Encyclopedia, Tbilisi, 2002
57 Ministry of Energy and Natural Resources of Georgia. http://www.minenergy.gov.ge/
58 Carriage operated by horse-drawn force
59 Georgian Academy of Sciences, "Tbilisi Enciclopedia", Tbilisi, 2002
60 ibid
61 Materials provided by Tbilisi City Hall, Transport Department
62 Hystory of Tbilisi, book I, Tbilisi "Science", 1987
63 ibid
64 Materials provided by Tbilisi City Hall, Transport Department
65 Large and medium capacity buses
66 Minibuses

Investigation of passenger flow has been carried out after which certain bus routes will be replaced with minibuses. According to 2009-2010 data, the average number of passengers served by M3 category buses daily is 163 000.[67]

Taxi

The taxi is the fastest and most convenient land transportation mode in Tbilisi, as in any other city. Taxis are the only means of transportation in the capital city which provides a 24-hour service. One can observe a great number of taxis in the streets of Tbilisi. Although one can hire a taxi in any place of the capital city, it is normally more convenient to call the operator of a taxi service company and have it come. There are several such companies in Tbilisi. The price per kilometer is around 0.40 GEL.

Railway

The first train in Georgia arrived at Poti from Tbilisi on October 10, 1872.[68] Today there are four railway stations in Tbilisi: Avchala, Didube, Navtlughi and Tbilisi Central Station. The capital city is connected to all the regions of Georgia by rail. Railway also connects it to Armenia, Azerbaijan and Russia. In the near future, the railway line will link Georgia to Turkey.

The recently opened railway station "Airport" is a fast, cheap and comfortable means of transportation. It links the central station with Tbilisi International Airport. For citizens residing in the neighborhood of the Airport, the Tbilisi Mayor's Office and the "Georgian Railway, Ltd" have built a new passenger electro-train platform which serves 8000 citizens daily. It is important to have a new train station in this area both for local residents and students of the Black Sea International University - a new educational complex that is being built on the adjacent territory. Trains will run six times daily, with a trip duration of 20 minutes. The new platform gave the train the function of a public transport mode, and so the cost of a trip for commuters was reduced from 2 Gel to 0.50 GEL.

Railway Modernization Project – Fast Railway "Georgian Railway" has begun the implementation of a railway modernization project. Modernization aims at establishing the highest security, enhancement of passenger capacity and reduction of travel duration (Batumi – Tbilisi in 3 hours). To achieve these goals, a complete modernization of the current railway infrastructure is being carried out. Railway line, power supply systems, railway facilities, bridges, supports and tunnels are being renovated and repaired on the main route. Modern alarm and dispatching systems will be installed.

Tbilisi Detour Railway This project anticipates removing a transit railway route from the city. As a result, 150 hectares of land will be released. This will support integration of the parts of the city which were divided by the railway infrastructure, reduce environmental problems caused by the railway and free the city centre from railway transport. By building a new ex-urban railway route, the Georgian Railway will enhance security and effectiveness of the railway service. The new Detour Railway will allow transportation of the oil cargo from Azerbaijan to Poti port, bypassing the city centre. The project also foresees disassembling of the railway infrastructure situated between the stations "Didube" and "Navtlughi". This will release an additional 86 hectares of land which will be used for new development of the city.

Baku-Tbilisi-Kars Project Baku-Tbilisi-Kars is a new transport corridor which will unite Azerbaijani, Georgian and Turkish railways. It will connect Georgia to Turkey directly. The corridor will open a cheaper and shorter gateway towards Europe and the Mediterranean, enhancing the function of the Georgian Railway as an alternative transport corridor between Europe and Asia. After implementation of this project, the Baku-Tbilisi-Kars railway will become a most important railway corridor promoting not only free commodity circulation between Georgia and Turkey, but also shipment of goods of Caspian (Azerbaijan and Central Asian) countries' oil and oil products first to the Turkish Mediterranean port Ceyhan for further access to the world market, and Europe through the Bosporus Strait. At the same time, European and Mediterranean counties will gain access to the countries of North, Central and East Asia by railway via Georgia and Azerbaijan. The project naturally anticipates operation of commuter trains and passenger transfers, which is also very important for Georgia to boost its importance as a tourist destination.

2.5.2.2 Emissions from the transport sector

Auto transport exhaust is a major source of air pollution in Tbilisi today. Exhaust gases contain more than 200 different highly toxic chemical substances, creating a very dangerous environment for the human organism, and causing diseases such as asthma, plevritis, lung cancer, stress, mental disorders etc.[69]

Auto transport is one of the mobile sources of air pollution. The level of air pollution caused by auto transport depends on type, average age, technical fitness of transport, type and quality of fuel, management of transportation flow, conditions of natural ventilation (general micro-relief of town, characteristics of its development, meteorological parameters, seasonality), working regime of engines and other factors.

67 Materials provided by Tbilisi City Hall, Transport Department

68 Academy of Science of the SSR of Georgia, Economic and Geographic findings of Vakhushti Bagrationi Geography, 1989

69 Shota Sidamonidze, PhD in Chemistry, "Auto transport exhaust, Environment and Human", Tbilisi 2002

Table 2-22 Number of automobiles registered in Tbilisi as of 2009[71]

	0-5 years	6-10 years	11-15 years	16-20 years	Above 20 years
Total	22192 (8%)	25950 (9.4%)	69055 (25.2%)	66916 (24.4%)	90328 (33%)
Light Automobiles	17766	23764	62147	57175	74205
Truck	1095	966	3186	3317	7259
Bus and Microbus	1085	481	2664	4855	6550

Table 2-23 Quantity of hazardous substances emitted by automobiles in 2009

	Quantity of emitted hazardous substances, tone per annum						
	Carbon Oxide	Nitrogen Dioxide	Sulphur Dioxide	Carbon Hydrogen	Tar	Benzo-piren	Carbon Dioxide
	CO	NO_2	SO_2	∑CH	C*	$C_{20}H_{12}$	CO_2
Auto-transport consuming gasoline	204700	11631	930	37218	279	0.1070	1492451
Auto-transport consuming diesel fuel	46922	13138	7507	20645	5631	0.1164	1204193
Auto-transport in Georgia	251622	24769	8438	57864	5910	0.2234	2696644
Auto-transport in Tbilisi[72]	103165	10155	3460	23724	2423	0.09	1105624

Source: Ministry of Environment Protection of Georgia

According to 2010 data, there are an average of 325 000 operational automobiles in Tbilisi (all types); this constitutes 41% of the vehicle fleet existing in the country.[70] The total length of roads and motorways of Tbilisi is 1200 km. The flow capacity of main and secondary roads of Tbilisi is 1500 cars per hour. It should be noted that the majority of automobiles in Tbilisi are old (see table 2-22) and correspondingly poorly maintained, which increases transport-induced emissions.

There are no data on emissions from auto transport in Tbilisi. However, taking into account that the number of cars in Tbilisi constitutes 41% of all vehicles in Georgia, it is possible to calculate emissions for Tbilisi based on emissions from transport in Georgia, which is presented in table 2-23.

Alternative roads are being built now in Tbilisi for the purpose of optimization of transport flow: a new arrangement of crossroads has been adopted and 19 intersections have been reconstructed. This kind of measure has facilitated reduction of traffic jams a great deal. Construction of overhead passing on Hero Square and circuit roads for trucks has been finalized. A project to build a bridge connecting Marshall Gelovani Avenue to Samtredia Street has been drafted as well.[73] These types of measures will ease traffic flow significantly. However, to reduce the negative impact of transport on the environment, it is necessary to ensure technical fitness of vehicles and control fuel quality - tasks that have not been undertaken so far.

2.5.3 Water Supply and Sanitation[74]

Withdrawal, purification and transportation of drinking water to a customer, as well as treatment of waste- and stormwaters in the capital region and surroundings is carried out by the 'Georgian Water and Power' (GWP), a private company and legal successor of formerly state-owned company Tbilisi Water, also known in Soviet times as the 'Tbil-Vodo-Kanal'. History of the water supply and sanitation system of Tbilisi however starts much earlier, specifically in 1862, when the city launched a small centralized water supply network based on filtrates of

70 Data of the Informational and Inquiry Systems exploitation Unit of the Informational Support and Analytical Division of the Informational and Analytical Department of the Ministry of Internal Affairs of Georgia, 2010

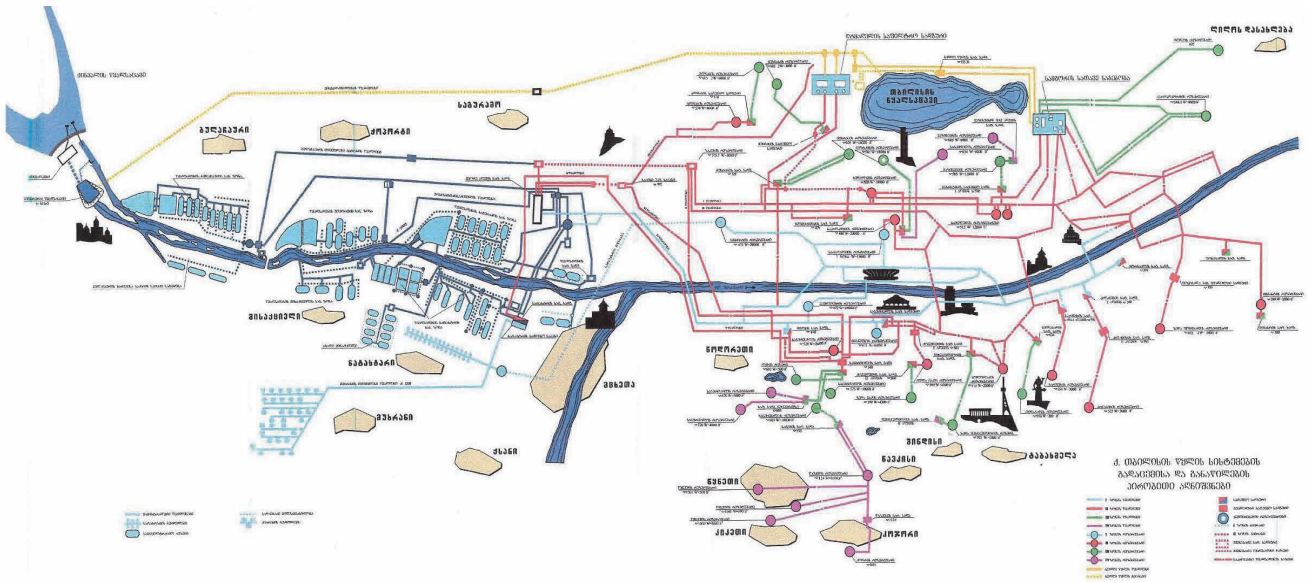
71 ibid

72 Emission from transport moving around in Tbilisi was evaluated on the basis of emission from transport operating throughout Georgia in view of assumption that the number of transport of Tbilisi is 41% of all the transport of Georgia

73 Information of Tbilisi Transport Municipal Department, 2010

74 Data and information for this chapter was provided by: Georgia Water and Power, LTD (www.georgianwater.com); OECD Study: Financial Strategy for W&WW Sector in Georgia, 2005; National Statistics Service of Georgia (www.geostat.ge)

Figure 2-1 Tbilisi water supply situation scheme



Source: www.georgianwater.com

the Mtkvari River and known as Korganovi Enterprise. Currently, GWP is a leading company on the water supply market of Georgia that provides high-quality service to the municipality of Tbilisi, as well as greater Tbilisi (neighboring districts), state institutions, industry and the commercial sector. The company delivers 21 m^3/sec highest quality drinking water without significant interruptions 24 hours a day. It serves about 400,000 customers, from which around 2000 are public and state organizations, about 15,000 commercial enterprises and the rest are in the residential sector[75].

2.5.3.1 Water storage and distribution

The city water supply system passes through all four main stages of production starting from water intake from natural reservoirs (surface and groundwater), primary purification at the company filtrate facilities, transportation of water to city limits and its further distribution to customers. As mentioned, the water supply system of Tbilisi uses a combination of surface and groundwater resources. Currently, the ratio of ground sources compared to surface waters is 60% to 40%. Groundwater intake mainly takes place in the Aragvi river basin, while two major reservoirs - Zhinvali and Tbilisi Sea - are used for surface intakes.

After bringing water up to standards, it is transported and collected in water supply and regulation tanks with a total capacity of 3,200,000 m2. These water supply tanks and 28 powerful pumping stations ensure a reasonable distribution of water transported to the city limits with necessary pressure. Having reached the town, water is treated once again, and then piped to 3600 km of the local network, which in addition is guaranteed with the use of 1000 smaller pumps.

75 Data provided by Georgian Water and Power LTD, Tbilisi, 2011

2.5.3.2 Water intake, purification and supply infrastructure

Construction of a water supply network in Tbilisi has undergone several stages, beginning from medieval times. As mentioned before, the modern period dates back to the mid-19th century. With the city's growth, the network was being rehabilitated, extended and new district networks built. Therefore, pipes differ in diameter (13 to 1400 mm) and material used: the branches are mainly arranged with steel pipes, while the main network is a combination of cast iron (about 35%) and steel pipes (about 65%). Polyethylene pipes have been installed lately.

84 service reservoirs are placed in 35 different places of the town at different marks (with a total capacity of 300,000 m3) to provide an uninterrupted water supply. All reservoirs are made of concrete and located underground. GWP operates 141 pressure pump stations with installed engines of 4 to 75 kW capacity. 65 pump stations are completely rehabilitated. Reconstruction of the rest of them is going on progressively.

The following surface and ground water intake sources help secure a regular and uninterrupted clean water supply to customers:

Zhinvali Reservoir is situated on the Aragvi River between the villages Ananuri and Zhinvali. Its main purpose is to provide drinking and utility water to the city and surrounding districts. The water is piped through a 42 km by 5.5 m diameter tunnel, with a debit of 12m^3/sec. The reservoir also provides irrigation water to Samgori farms (eastern outskirts of Tbilisi). The reservoir was put in operation in 1985, has a 102 m earthen dam, and a total designed capacity of 500 million

m^3. The reservoir in addition is used to generate power, with a capacity of 134 000 KW.

The Bodorna Buffer Tank is a part of the Zhinvali hydropower plant. It is situated on the upper end of the reservoir with a total capacity of 1 million m^3. A portion of the water runs to the riverbed of the Aragvi River, part feeds Mukhrani and Saguramo irrigation system, and some joins Tbilisi the main conduit to supply with water.

Bulachauri Water Conduit is located on both sides of Aragvi River near the village Bulachauri and occupies 242 hectares. Its debit is 3000 liters/sec on average of which 2000 liters/sec is supplied by gravity flow and 1000 liters/sec is pumped to the Saguramo separation chamber.

Choporti-Misaktsieli Water Conduit is located on both sides of the Aragvi River and occupies 975 hectares. Its debit is 1300 liters/sec on average and runs by gravity flow to the Saguramo separation chamber.

Natakhtari Water Conduit is located on the right bank of the Aragvi River and occupies 250 hectares. Water debit is 1300 liters/sec. The water flows by gravity to Tbilisi supply network directly. The debit of the **New Water Conduit of Natakhtari** is 900 liters/sec on average. It supplies the Saguramo separation chamber by line pump.

Saguramo Water Conduit is a key water supply system consisting of main water chambers and powerful pumping stations. It occupies 256 hectares and the volume of supplied water is 3000 liters/sec.

Artesian Water Conduit of Mukhrani Valley is located on the right side of Tbilisi-Kazbeghi highway and occupies 151 hectares. It serves 55 wells (currently 21 are in good condition) yielding 500 liters/sec and flowing into the Natakhtari separation chamber.

Tbilisi Reservoir is located in the northeast part of Tbilisi. The reservoir was opened in 1953 and originally was fed by waters brought (channeled) from the Iori River. The length of the reservoir is 8.74 km; maximum width - 1.85 km; maximum volume of the water is 308 million m^3; the deepest point reaches 45 m. After launching Zhinvali reservoir in 1985, the Tbilisi Reservoir receives waters brought from the Aragvi River as well.

In addition to these facilities, the Tbilisi water supply system consists of two water purification plants at Samgori (east of the city) and Ghrmaghele (in the west).

The total area of the **Samgori Purification Plant** equals 3000 m^2, with a capacity of 5.0 m^3/sec. There are 50 filters, six underground reservoirs and three pumping stations installed in the plant. The plant also has a chemical laboratory in order to control water quality regularly.

Grmaghele Purification Plant is a part of the Zhinvali hydro facility. The capacity of the filtrate is 5.0 m^3/sec. There are four reservoirs installed in the sanitary zone. Coagulation and chlorination lines are arranged in the filter stations. The station performs both mechanical purification of water and its further chlorination. Water quality is controlled by an automated laboratory that examines water in an on-line mode. The plant has been operational since 1985.

The Georgian Water and Power (GWP) company also generates power at Zhinvali and Tetrikhevi Hydroplants. Generated power is used both for in-house use: power supply for operating pumps, filtrates, administrative buildings, etc (consuming about 290-300 million kWh/year); as well as commercially. Both hydrostations are part of the unified power grid of Georgia.

2.5.3.3 Sewerage

Collection and treatment of sewage waters in the city are carried out by the Central Collector System (wastewater collection network) and the Gardabani Regional Treatment Facility, serving Tbilisi and Rustavi. The total length of the wastewater network is 72 km.

The treatment plant in Gardabani was constructed in 1979 with a designed capacity of 1.0 million m^3/day; however, it first was able to process only 80,000 m^3/day sewage. Since 1982 until the mid-1990s, the plant was operating at full capacity both for mechanical and biological treatments. However, due to economic difficulties and the related energy deficit (very high electricity demand for biological treatment), after the collapse of the Soviet Union, production capacity of the plant decreased to 600,000 m^3/day.

Currently none of the treatment facilities operate with the designed capacity in Georgia, including the one in Gardabani. Biological treatment is not employed anywhere. At best, wastewater is treated mechanically.

Construction of the **storm water drainage system** of Tbilisi started in 1835. In general, brick sewers were built into which utility and sanitary waters as well as rainfall flowed and emptied in to the Mtkvari River.

At present, Tbilisi's sewerage network includes collectors of 150 to 1200 mm in diameter which are built out of different materials, including brick, concrete, ceramic, cast iron, asbestos, cement and polyethylene pipes. The drainage system is self-flowing, but old and outdated, and would require major investments for rehabilitation. The total length of the system is 1600 km.

2.5.3.4 Water consumption and sewage treatment tariffs

The tariff established for water supply and sewerage system services includes not only operational costs

- water quality and service, but also rehabilitation, prevention and urgent maintenance costs. Since 2008 it is in the Georgian National Energy and Water Supply Regulatory Commission's (GNERC's) jurisdiction to establish water supply and sanitation tariffs and make any further amendments. Current drinking water supply, transportation and sewage treatment tariffs for residential and commercial sectors are the following:

1) for unmetered consumption - GEL 3.15 per capita per month, including VAT;
2) for metered consumption - GEL 0. 266 per 1 m^3 (from which delivery tariff for 1 m^3 water is GEL 0.196; and transporting and treatment tariff for 1 m^3 sewage - GEL 0.07, including VAT
3) for commercial consumption – GEL 4.40 per 1 m^3, including VAT[76].

2.5.4 Water Resources Use

Water Abstraction

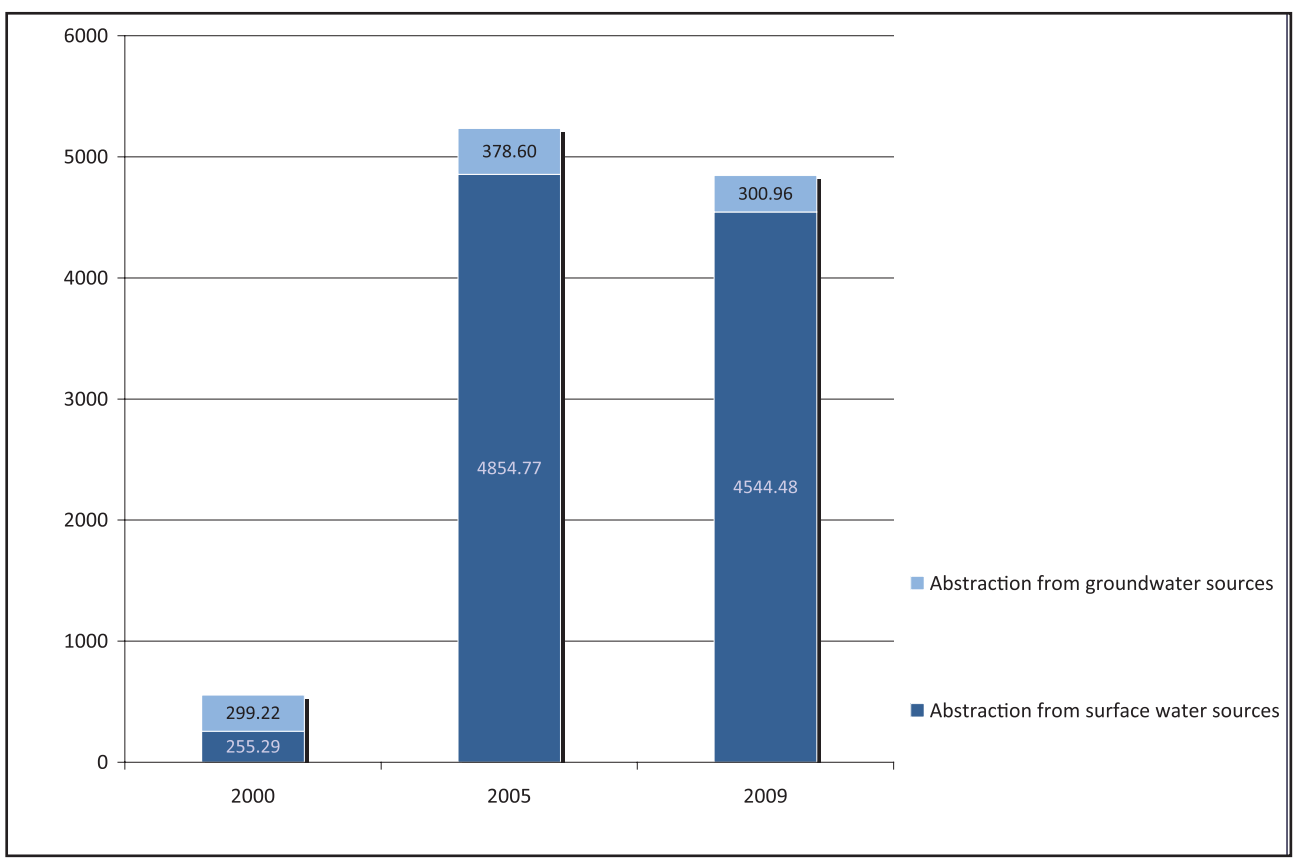
Fresh water resources in Tbilisi and its surroundings are used for different purposes and are being abstracted both from surface as well as ground sources (see the Diagram 3.19 below). In 2009 the number of registered water users included 29 large and mid-sized enterprises. The greatest amount of abstracted water is used by municipal/housing (drinking water supply and communal needs) and energy sectors. In fact, hydroelectric power generation is responsible for more than 90% of total water use in Tbilisi. On the other hand, it does not imply any significant water stress and hence, abstracted water is completely returned back to a given water body downstream of the hydropower plant (HPP). Until recently, water statistics did not include abstraction of water for hydro-energy use; therefore in the figures below we also exclude energy use. If taking these circumstances into account, the municipal water supply sector, and more specifically the 'Georgian Water and Power, LTD' emerges as an absolute leader of using freshwater resources in the city, accounting for about 95% of total abstracted water (Diagrams 2.11 and 2.12). Other major sectors consuming freshwater resources in the city are industry, transport, irrigation, recreation, fish farming etc[77].

As is shown in Diagram 2.11 above, the two major sources of water abstraction (the ground and surface sources) are relatively equal in the city; water consumption for the energy sector is not considered. The vast majority of ground sources though are mainly used for the drinking water supply, as they are cleaner

76 Data provided by Georgian Water and Power LTD, Tbilisi, 2011

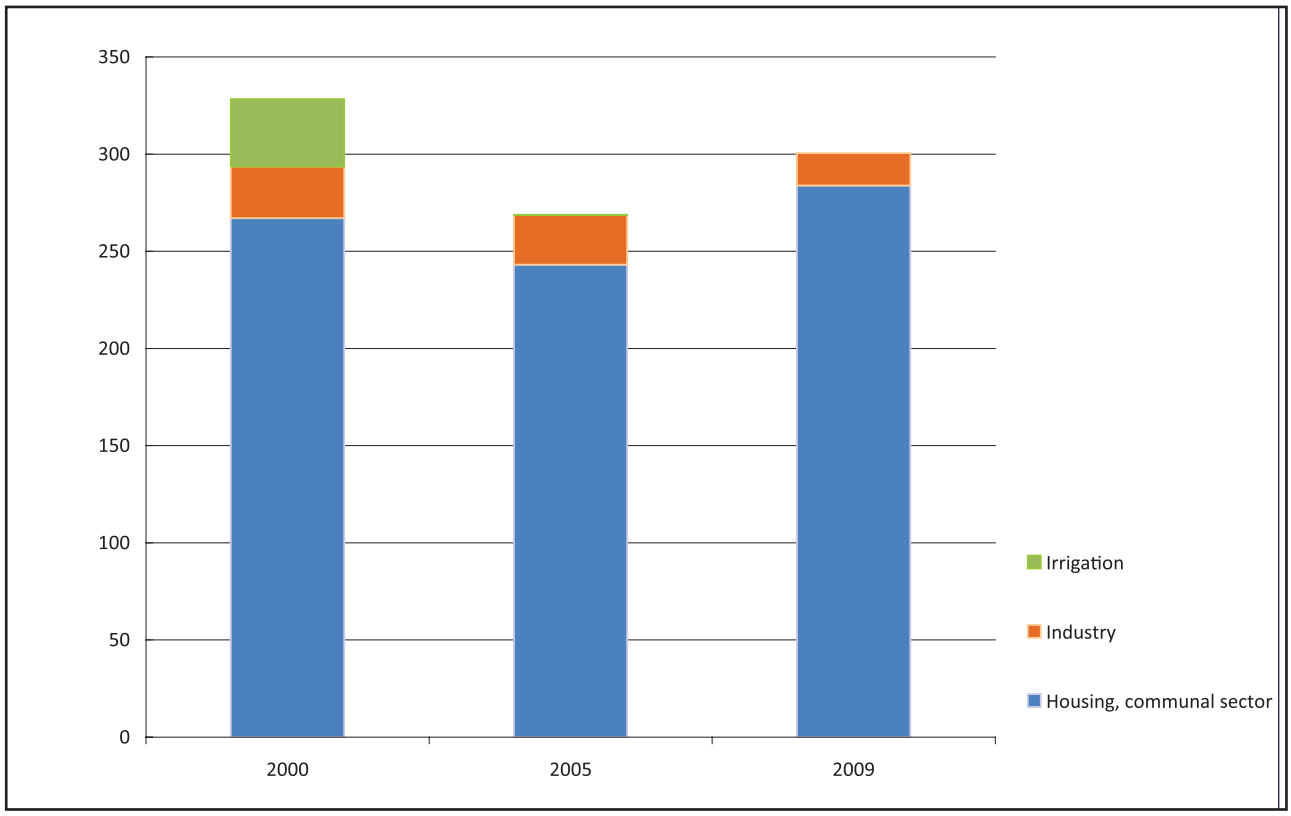
77 Data provided by Ministry of Environment Protection of Georgia, Division Water Protection, Tbilisi, 2010

Diagram 2-11 Annual abstraction of freshwater resources from ground and surface sources*



note: Statistics of 2000 does not include hydro power stations.

Diagram 2-12 Annual consumption of freshwater resources by sectors, excluding energy use



by nature and require less investment for purification. The current share of ground *vs*. surface waters use for drinking water supply in Tbilisi is 60 to 40 percent[78]

Water Discharge

The municipal sewage system, industrial sector and runoff water (or storm waters) collected throughout the city drainage network are the main point sources of discharge (either treated or untreated) to surface water bodies. Discharge to groundwater aquifers is forbidden according to Georgian legislation. An official source of information, the Water Resources Protection Division of the Ministry of Environmental Protection of Georgia, confirms that no such discharge is practiced in Georgia. Discharge from non-point sources of pollution usually comes from the agricultural sector, which is not too extensive in Tbilisi. Another source for non-point pollution might be poorly-maintained waste disposal at illegal landfills.

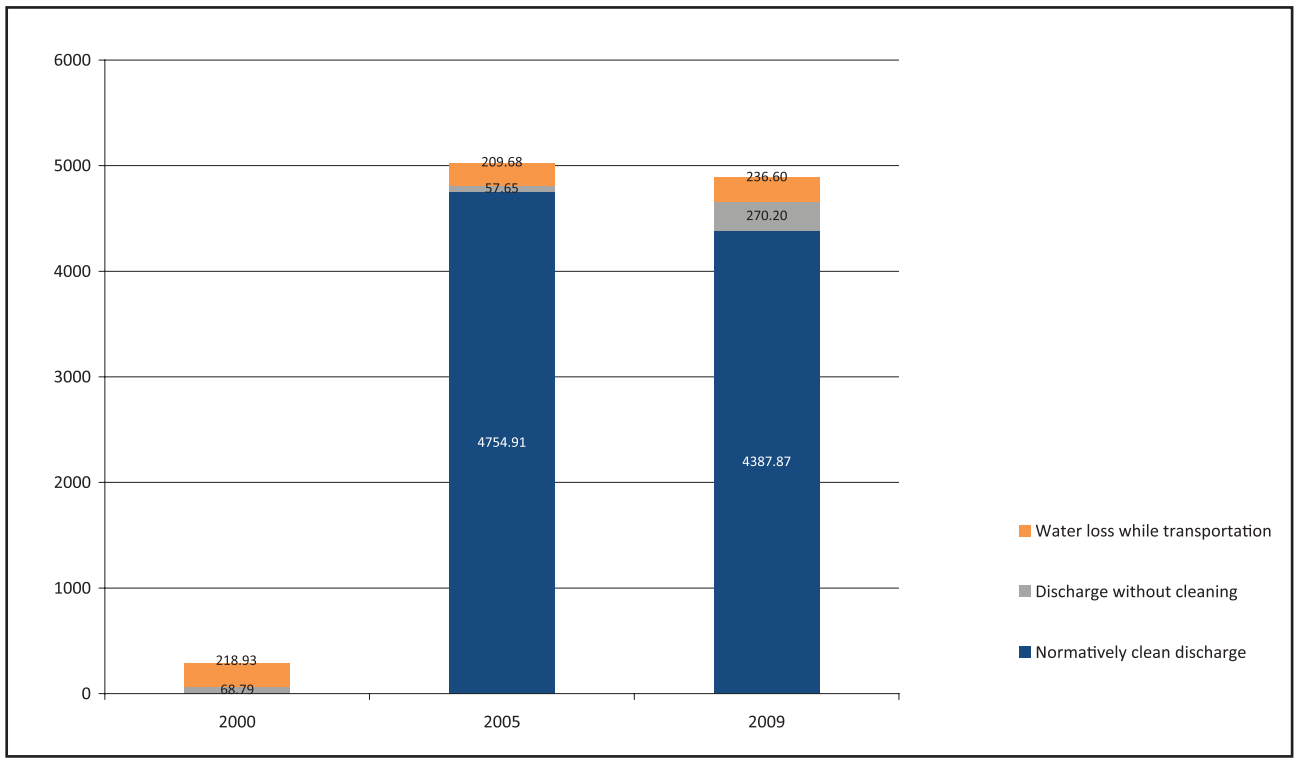
Diagram 2.13 shows official statistics of discharged waters in Tbilisi including water lost during distribution in the network. The amount of discharged waters includes waste water discharged to the Mtkvari River at Gardabani treatment plant. The sewage there is piped with the help of the Tbilisi-Rustavi sewerage collector. Therefore, formally no other direct discharge should take place within the city limits. However, the Water Protection Division of the Georgian Ministry of Environment Protection estimates that almost half of the sewage generated in the city is being illegally released directly into the river, bypassing the collector[79]. The large amount of normatively clean discharge in 2005 and 2009 shown on the figure above is a result of counting statistics for hydropower generation, which does not require any clearance after its use. The Gardabani treatment facility operates in a very low capacity and currently only mechanical (primary) treatment is available. According to the privatization agreement between the Government of Georgia and Georgian Water and Power, the owner is responsible for completely terminating discharge of untreated waters in surface water bodies by 2013 and rehabilitating the treatment facility to meet all international and Georgian standards by 2018.

Statistics on discharged water from 2000 do not seem consistent with the data of subsequent years. The reason for that is the inclusion of information from Zemo Avchala and Ortachala Hydropower Plants (HPP) in the 2005-2009 statistics. Discharge from HPPs is considered as 'normatively clean' according to the Georgian legislation; given that discharge after hydropower generation is not considered, the largest water user in the city is Georgian Water and Power, annual water abstraction by which was 537.55 million m^3 in 2009. From this number almost half, or about 236.60 million m^3, is accounted for by loss during transportation due to degraded infrastructure; about 283.58 million m^3 was used for drinking water supply to the housing and communal sector; 15.98 million m^3 for industrial purposes; and 269.60 million m^3 was

78 Data provided by Georgia Water and Power, LTD, Tbilisi, 2010

79 Makarova Marina, Ministry of Environment Protection of Georgia, Head of Division of Water Resources Management. Personal interview, 17 November 2010.

Diagram 2-13 Annual discharge of waste waters in Tbilisi*



note: Statistics of 2000 do not include hydropower stations.

discharged to the Mtkvari without any mechanical or biological treatment[80].

2.5.5 Solid waste management

During the Soviet period, municipal solid waste from the city was simply dumped in open landfills. Sometimes it was covered with soil, or otherwise, just pressed or redistributed over the landfill area. Landfill dumps used to be of a rather primitive construction, and were a source of pollution of air, soil and surface and underground waters. In addition, some small-scale recycling of glass, paper and organic wastes was practiced, and some small amount of waste was burnt.[81] There was no legal framework or planning for the waste sector. There was no system of national inventory and regular reporting on the waste situation, which explains the deficiency of historical statistical data on waste. After the collapse of the Soviet system, the waste situation even worsened. The absence of a strong administrative framework and lack of resources was reflected in the quality of waste services, which was mostly below satisfactory. For years the situation remained unchanged. Only after 2006 has the waste issue found its established place on the political agenda of the city government. In June 2006 the Tbilisi Waste Management Municipal Department was established. It united all waste-related responsibilities: waste collection, transportation, treatment and disposal, which before had been scattered across different administrative structures of the city government. In addition, since 2007 the Waste Management Department has been authorized to sanction waste-related administrative violations. In December 2006, local waste management rules were approved by a Decree of the Tbilisi Government. This provided a framework for local-level waste management, while national legislation on waste is still not in place. At the same time, an obligatory waste service charge for population and businesses was established by a Decision of the Tbilisi Sakrebulo. This has resulted in higher charge-collection rates, especially from businesses. Since 2006, the municipal solid waste situation in Tbilisi has significantly improved. A modern, sanitary landfill was constructed in 2010.

2.5.5.1 Municipal waste

70-80% of municipal waste is comprised of waste from households. Other sources of municipal waste are: offices, shops, supermarkets and trading centers, markets, administrative buildings, schools, restaurants, hotels and tourist establishments, street sweeping residuals, waste from gardens, squares and cemeteries etc.

Amounts and Composition

Historically there were no statistical data on waste generation. Waste amounts were calculated based on the recorded number of waste trucks delivering

80 Data provided by Ministry of Environment Protection of Georgia, Division of Water Protection, Tbilisi, 2010

81 Caucasus Environment Outlook (Geo) 2002, Chapter 2.8 Wastes and Hazardous Chemicals. Available at: http://www.grid.unep.ch/product/publication/CEO-for-Internet/CEO/

waste to the landfill dumps. This obviously resulted in large deviations, and left much room for speculation. Only in 2006 were scales installed at both landfills operating at that time in Tbilisi.

Presently, municipal waste generation in Tbilisi is estimated to be 850 tonnes per day and 350,000 tonnes per year[82]. This constitutes approximately 273.75 kg per capita per year, which is below the annual per capita waste generation rates in other European countries - 524 kg per person in 2008 on average in EU member states.[83] Due to the increase of population and economic development, waste generation is projected to increase by 2.25% per year[84].

Data on municipal waste composition in Tbilisi have been scarce. According to the few existing sources, waste composition has changed compared to 1989/1990 years. Namely, the share of organic waste, paper, carton and metal has decreased, while the percentage of plastic materials has considerably increased (see tables 2.24 and 2.25).

Still, data on waste composition may contain some inaccuracies. In addition, some fractions are overlapping. For example, 'residues' (40%) from the left column of the table 2.25 may contain significant amounts of organic waste, which could explain the considerable difference in amounts of organic waste for 2003 and 2010.

Waste collection and transportation

The improved legal and administrative framework of waste management at the city level has been reflected in improved waste management practices. Presently 100% of population, including newly added suburbs, is covered by waste collection services. A new sanitary landfill started operating recently.

There are two types of waste collection systems in Tbilisi. A *container system* covers 99% of Tbilisi's population, while 1% is served by a *bell system*.[89] The bell system is used in the old districts of Tbilisi, with narrow ascending streets and compact settlements. These areas are mostly inaccessible for waste trucks and in addition, there is not enough space for placing waste containers. Residents deliver waste to the trucks, which notify their appearance by bell ringing. Another method, the *bunker system*[90] existed until 2009. This system was used by about 25% of

Table 2-24 municipal waste composition in Tbilisi in 1990 and 2003 in vollumes

Waste composition (m^3) 1990[85]		*Waste composition (m^3) 2003*[86]	
Paper	34 %	Paper	19 %
Plastics	2 %	Plastics	26 %
Inert materials	4 %	Inert materials	3 %
Metal	5 %	Metal	3 %
Textile/Leather	5 %	Textile/Leather	6 %
Organic waste	42 %	Organic waste	19 %
Residues	8%	Residues	24 %

Table 2-25 municipal waste composition in Tbilisi in 2003 and 2010 in mass

Waste composition (kg) 2003[87]		*Waste composition (kg) 2010*[88]	
Paper	5 %	Paper	6 %
Plastics	6 %	Plastics	6 %
Inert materials	5 %	Inert materials	5 %
Metal	3 %	Metal	3 %
Textile/Leather	3 %	Textile/Leather	3 %
Organic waste	33 %	Organic waste	71 %
Residues	40 %	Residues	1 %
Green waste	3 %	Green waste	3 %
Hygiene	2 %	Hygiene	2 %

82 Bakuradze, Davit, acting Head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010
83 The European environment - state and outlook 2010: synthesis. European Environment Agency, Copenhagen,pg.73
84 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 63
85 Information from Tbilisi City Agency of Municipal Amenities, 2004; Blumenrother, Gerhard, 2003, "Analysis of the waste produced in Tbilisi", pg.17-24
86 Blumenrother, Gerhard, 2003, "Analysis of the waste produced in Tbilisi", pg.17-24
87 ibid
88 Gamma, scientific research firm, Tbilisi landfill construction and exploitation, feasibility study, Tbilisi 2010,pg55-56
89 Bakuradze, Davit, acting head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010
90 The bunker system used to be applied in multi store buildings: there was a waste chute located inside the building, through which waste was accumulated inside the bunker cabin, located at the first floor of the building. Each floor was provided with pull-out cases for disposing waste into the waste chute. Bunkers were emptied on average once a week.

population.[91] Presently, the bunker system has been totally eliminated.

The general improvement in waste collection over the last years is noticeable. Elimination of the bunker system removed a source of spreading rodents and insects. Overfilled containers and garbage accumulation in streets which was common in the past due to the limited number and size of containers is no more the case. The total number of waste containers increased dramatically in 2006 and doubled in the last two years. Presently there are in exploitation: 10,000 aluminum containers with a volume of 1.1 m^3; 1,591 plastic containers with a volume of 0.24 m^3; 560 plastic containers with a volume of 0.12 m^3; 1,839 street plastic bins with a volume of 0.05 m^3.[92] Containers are purchased annually. At present, the waste department owns 22,000 containers in total, including for replacement. Containers are emptied two to three times per day. Streets are cleaned regularly, depending on their category. The number of waste trucks has also increased dramatically. Presently there are 329 special vehicles. Among these, there are 158 waste trucks and three large waste transfer trucks.[93] Before 2006 waste trucks had not been renewed for 15 years. More than 300 vehicles existing then were completely outmoded.[94]

Large items collection

There is no organized system of large items (discarded furniture, large appliances etc.) collection in Tbilisi. Municipal waste trucks could not collect large items. However, the city municipal service does not possess special vehicles for collection of large items. According to the 2006 study, about 10 kg of large items per capita per year are generated in Tbilisi.[95]

Waste Disposal

The new sanitary landfill of Tbilisi, which is in operation since November 2010, is located northeast of the city on the territory of Gardabani municipality. The distance from the nearest districts of Tbilisi is 4.5-5.0 km. The landfill is isolated by natural barriers from all nearby settlements. The total landfill area is 94 ha. The area of the first cell of the landfill in operation presently is 14.9 ha.[96] The lifespan of the landfill is about 22-25 years, in case there is no waste separation. With waste separation, the landfill will last for 40-45 years.[97] The landfill is designed according to modern sanitary landfill standards. It includes an impermeable layer at the bottom, leachate collection system and landfill gas collection system. All these eliminate possible negative impacts on the environment. The landfill project envisions building of a manual waste separation area. Waste separation will ensure sorting out recyclable materials. This will increase landfill life span and reduce disposal costs. Moreover, recycling materials can generate additional income. In addition, the project foresees building a waste incinerator with the capacity of 300 kg/hour.[98] Waste incineration is intended for anatomical (human tissues, organs or body parts removed during surgery or other hospital procedures), veterinary and non-utilizable waste.

Since opening the new landfill, two existing landfills (Gldani landfill and Iagluja landfill) stopped receiving municipal waste. Closure/remediation activities are planned on both landfills in the nearest future. *Gldani landfill* is located 30 km north from the city center, just 700 m from residential buildings. The landfill has been in operation since 1972. The total area of the landfill is 8 ha. The capacity of the landfill was estimated to last until 2010. The landfill used to receive 60% of waste from the city. *Ialguja landfill* is located in Gardabani municipality, 50 km from the city center. It has been in operation since 1985. It used to receive 40% of waste generated in Tbilisi. The area of Iagluja landfill is five hectares. The capacity of the landfill was projected to last until 2012.[99] Due to their rather primitive construction, with no bottom sealing and leachate and gas collection systems, both landfills are associated with negative impacts on the environment. Emissions of harmful substances cause significant environmental pollution and raise health concerns. Leachate from the landfills leaks to natural ravines, causing pollution of surface waters. Because of difficult terrain of the landfills, it was impossible to fully cover the landfill area with soil, which has been causing permanent ignition and burning of waste, causing air pollution. Additionally, the Iagluja landfill has become problematic because of landslide processes having developed during the last year. In case landslide processes were to intensify further, there is a danger that one side of the landfill will collapse, and waste will end up in the Mtkvari River. Geological studies conclude that it is urgent to start closure/re-cultivation measures.[100]

Air pollution from landfills

Even though the old landfills of Tbilisi ("Gldani" and "Iagluja") do not receive any more waste, they remain as significant sources of air pollution due to permanent

91 Antadze Nino, Gugushvili Tamar, Characteristics of the waste management system in Tbilisi, Georgia, case study, December 2006, pg. 5

92 Bakuradze, Davit, acting head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010

93 Bakuradze, Davit, acting head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010

94 Antadze Nino, Gugushvili Tamar, Characteristics of the waste management system in Tbilisi, Georgia, case study, December 2006, pg. 53

95 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 81

96 Gamma, scientific research firm, Tbilisi landfill construction and exploitation, feasibility study, Tbilisi 2010, pg. 73

97 ibid., pg. 55

98 ibid., pg. 57

99 Materials provided by Tbilisi Waste Management Municipal Department for the UNDP Project "Support to the Ministry of Environment Protection in Improving the Environmental Planning Framework, 2006

100 Gamma, scientific research firm, Tbilisi landfill construction and exploitation, feasibility study, Tbilisi 2010, pg. 5

ignition processes and burning of accumulated waste that still continues there. Emission of harmful substances has been creating health risks for the population of Tbilisi, Rustavi and adjacent settlements. Located just 700 m from the nearest residential buildings, "Gldani" landfill has been a major concern of Gldani district residents for many years. In addition, due to natural decay of organic materials, landfills emit greenhouse gases such as carbon dioxide and methane.

Financial aspects

In 2006 significant investments were made to upgrade the city waste infrastructure. Since then, the waste management budget has been dramatically increasing. The waste budget for 2011 amounts to 50.8 million GEL.[101] The waste management budget is comprised of waste charges from population and businesses and municipal funding. User charges have been covering only a small part of the total waste budget. For instance, in 2003 waste charges covered 12.8% of the total costs; this figure stood at 11.7% in 2004 and 13.6% in 2005, while there were no significant capital investments made in the waste sector during these years. With a 100% charge collection rate, waste charges would cover respectively 42%, 41% and 54% of the total costs.[102] Since 2006 the situation has improved. Namely, obligatory waste charges were introduced, which improved waste collection rates, especially from businesses. As a result, income from waste charges constituted about 49% of the total waste budget in the years 2007, 2008 and 2009.[103] Still, current waste service costs mainly rely on government grants. Due to the general socio-economic situation, it has not been possible to establish a user fee-supported waste management system in Tbilisi.

In January 2011, per capita waste charges in Tbilisi increased from 1.2 GEL to 2.5 GEL.[104] Waste charges for businesses and organizations have been calculated based on their type and size. Since February 2011, Tbilisi citizens receive integrated bills for water, waste and electricity. Not paying one of the utility costs would result in suspending electricity supply. This will certainly increase the per capita waste charge collecton rate. Just recently, from July 2011 new rules for waste service charges entered into force. According to these rules, waste charges for the population will be calculated based on consumed electricity by a houesehold. Namely, waste charges will amount to 0.05 GEL per consumed 1 kvt-h electricity.[105]

2.5.5.2 Waste from construction materials

According to a 2005 study, 250-350 kg construction waste is estimated to be generated per capita per year in Georgia.[106] Due to increased construction/ rehabilitation activities in Tbilisi, waste from construction activities must have increased again in the last years.

Before 2006, there existed a large number of illegal construction waste dumpsites. However, since introducing high fines for illegal disposition of construction waste, cases of illegal dumping have considerably decreased. Since November 2007 to November 2010, in total 2571 cases of waste-related administrative violations were reported, from which the major share comprise cases for illegal disposal of construction waste.[107]

There are several officially allocated places for disposal of waste from construction materials in Tbilisi. From these the largest is a 100-ha bogged area located in Isani-Samgori district, on a bank of the Mtkvari River. It has been used as a construction waste site for 13 years. The landfill is operated by a private operator. According to 2005 data, the landfill receives approximately 600 m^3 of waste per day, which constitutes 330,000 tonnes per year.[108]

2.5.5.3 Industrial Waste

There are no special legal provisions or general rules for managing industrial waste in Georgia. Industrial waste is regulated through environmental impact permits. However, the permit system still needs strengthening. Especially problematic has been enforcement of permit conditions. In addition, there are no regulations for activities not requiring permits.

There are almost no statistical data on industrial waste. It is supposed that both old landfills of Tbilisi (see above) contain industrial waste from the 1970s-80s when industry was still operating at a high level[109]. Still, due to absence of disposal sites and treatment methods for industrial and especially hazardous waste in Georgia, many industries fail to report proper waste management plans.

101 Decision of Tbilisi Sakrebulo N12-72 of 18 November, 2010 on 2011 Budget of Tbilisi, Article 14
102 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 18
103 Bakuradze, Davit, acting head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010
104 Tbilisi Sakrebulo Decision N14-83 of 27 December 2010 amending Tbilisi Sakrebulo Decision N 6-34 of May 8 2007 on instruction of establishment of waste charges and paying waste charges
105 Tbilisi Sakrebulo Decision N7-38 of 24 June 2011 on waste service charges and rules for paying waste charges
106 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 59
107 Bakuradze, Davit, acting head of Tbilisi Waste Management Municipal Department, Personal Interview, November 4, 2010
108 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 59
109 Blumenrother, Gerhard, 2003, "Analysis of the waste produced in Tbilisi"

Table 2-26 Classification of medical waste in Georgia

class A	*non-hazardous waste* – waste close to municipal waste, which is not contaminated with infectious or toxic substances: food residues, paper, furniture, broken appliances, construction waste etc
class B	*dangerous waste* – infectious waste: materials or equipment that have been in contact with infected patients, excreta, pathological-anatomic waste: human tissues or fluids, all types of wastes from infectious divisions, waste from microbiological laboratories working with III-IV class pathogens, biological waste from vivariums
class C	*extremely dangerous waste* – materials that have been in contact with patients with especially dangerous infections, wastes from microbiological laboratories working with IV class pathogens, wastes from mycological and phthisiological hospitals, wastes from patients with anaerobic infections
class D	*Identical to industrial waste* – pharmaceuticals that are expired or no longer needed; cytostatic or other chemical materials, mercury containing materials or equipment
class E	radioactive waste – all wastes containing radioactive components

2.5.5.4 Healthcare Waste

Health care waste in Georgia is regulated by the ordinance № 300/n, of 16 August 2001, of the Ministry of Labor, Health and Social Affairs of Georgia on legalization of rules for collection, storage and treatment of waste from medical establishments. The document defines sanitary-hygienic and epidemiological standards for collection, storage, transportation and treatment of all types of waste from medical establishments and provides a classification of health care wastes based on its level of hazard (see table 2.26).

According to the mentioned document, waste belonging to the class 'A' (non-hazardous waste) and some belonging to the class 'B' (such as instruments, waste from microbiological laboratories and vivariums) can be disposed of on municipal solid waste landfills. Class 'B' (dangerous waste) and 'C' (extremely dangerous waste) should be subject to thermal destruction. Class 'D' (identical to industrial waste) should be transported, treated and buried as toxic industrial waste. Class 'E' (radioactive waste) is subject to rules and regulations set for radioactive wastes. It is prohibited to mix waste belonging to the different classes during collection or temporary storage and transportation.

Enforcement of the above-mentioned regulation had become problematic, so the responsible controlling agency indicated in the document (the Service of State Sanitary Supervision) was abolished in 2005. The Ministry of Labor, Health and Social Affairs of Georgia carries out periodic surveillance of license conditions in medical establishments. However, there are no clear provisions for overseeing health care waste management during this process.[110]

110 Giuashvili, Nia, Division of Noncontagious Diseases and Environmental Health, Centre for Disease Control and Public Health, Ministry of Labour, Health and Social Affairs of Georgia. Personal interview, December 28, 2010

Amounts

There are 98 in-patient health care facilities in Tbilisi (from which there are 78 hospitals) with a total number of 5,716 beds and 141 out-patient health care facilities.[111]

Data on health care waste generation in Tbilisi is limited. According to the findings of the 2006 waste inventory[112], 3,380 tons of health care waste is generated per year in the city (class A - 2,928 tons; class B - 354 tons; class C - 49 tons and class D - 48 tons). The study findings are derived from calculations based on waste generation standards, types of medical establishments, number of beds and average number of patients. Another study, the "Development of Health Care Waste Management Regulation System in Georgia" suggests using a healthcare waste calculation according to WHO standards for Eastern European countries (1.4 kg/in-patient*day and 0.2 kg/outpatient). According to these calculations, 1907 tons of health care waste are generated in Tbilisi per year. Among this amount, hazardous waste constitutes 723 tons. Hazardous waste consists of four categories: infectious waste (599.88 tons), sharps (needles, blades etc. 71.47 tons), pathological waste (13.51 tons) and chemical and pharmaceutical waste (21.85 tons).[113]

According to information provided by the health care waste operator "Express Diagnostics" Ltd, 1200-1300 kg of health care waste are generated per day in Tbilisi, comprising approximately 450 tons per year.[114]

111 Statistical Yearbook, 2009, – Health and Healthcare in Georgia, Chapter 2, Ministry of Labour, Health and Social Affairs of Georgia
112 UNDP Project "Support to the Ministry of Environment Protection in Improving the Environmental Planning Framework", 2006
113 Ministry of Labour, Health and Social Affairs of Georgia, Development of the Health Care Waste Management Regulation System - Georgia - Current Situation Analysis related to the Health Care Waste Management,2008.Pg. 53
114 Bochorishvili, Lika, Director, "Express Diagnostics" Ltd. Personal Interview, December 30, 2010

Collection and treatment

In general, there are three types of waste collected separately at the health care institutions in Tbilisi: municipal, infectious and anatomical. *Municipal waste* includes paper, plastic, kitchen waste etc. It is disposed in outdoor containers for municipal waste and regularly collected by municipal waste service companies. It is forbidden to mix health care waste with municipal waste. *Infectious waste* includes blood, pus, sharps, catheters and intravenous systems, materials and instruments that have been in contact with a patient. *Anatomical waste* includes human tissues, organs or body parts removed during surgery or other hospital procedures.

Infectious waste is collected by a health care waste service contractor company "Express Diagnostics" Ltd. They cover 90% of all health care institutions in Tbilisi. Health care waste is collected daily. The contractor takes away full plastic containers and replaces them with new, clean ones. There is no pre-treatment of infectious waste undertaken at the hospital. Sometimes a special disinfectant solution provided by the contractor is added to infectious waste containers. Collected infectious waste is autoclaved. After autoclaving, disinfected waste is taken to the Tbilisi municipal solid waste landfill.

Anatomical waste is collected by "Hermes" Ltd, and buried in a special cemetery. "Hermes" Ltd is a municipal company providing memorial services. It is a subcontractor company of the 'Express Diagnostics" Ltd.

There are no general guidelines at the hospital for safe collection and pre-treatment of health care waste. The contractor provides rules for separate collection of wastes belonging to the class 'B' and 'C'. However, these rules are not always followed.

Wastes belonging to class D and class E are not treated at all. There are no statistics on expired medicines, which supposedly end up in municipal waste containers. Radioactive waste such as cytotoxic waste and isotopes supposedly end up in the sewage system.[115]

2.5.5.5 Recycling

There is no organized separate collection of waste in Tbilisi. It is planned to construct a manual waste separation area at the new sanitary landfill. Recycling of sorted materials can generate additional income, and at the same time will reduce disposal costs and prolong the landfill's life span.

The high cost of recycling limits involvement of the private sector in recycling. There are small paper-recycling companies producing toilet paper. Plastic recycling mainly involves plastic shredding and exporting. Glass is recycled by a glass factory located in Ksani, 26 km from Tbilisi. Several companies produce lead from expired accumulators.

Even though waste accumulation rates in Tbilisi are below the European average, 100% of collected municipal solid waste is sent to landfills. In European countries, the percentage of landfilled waste has been decreasing dramatically due to high rates of recycling and reuse,[116] while in Georgia a lack of policies and high recycling costs have prevented taking actual steps on national or municipal levels up to now.

2.6 Chapter synthesis

Following the political instability, drastic economic decline, worsened social conditions and energy crises in the 1990s, Georgia and its capital have achieved significant progress in recent years. Environmental implications of these changes are multifaceted:

Air emissions from industrial facilities have been significantly reduced. Despite the revival of the industrial sector in recent years, air emissions from this sector continued to decrease. This is attributed to the continued reduction of air polluting industrial activities e.g. machinery, and growth of less polluting industries in the city. In contrast, air emissions from traffic have increased substantially due to the increasing number of vehicles. At present, according to data provided by the MEP, almost all air pollution emissions in Tbilisi are related to the transport sector (see table 2.27). The increase of air emissions from traffic is largely due to relatively cheap importing of used motor vehicles from the USA, Japan and European countries. 82% of motor vehicles in Tbilisi are more than 10 years old.

There are no data on air pollution from the construction sector and individual heaters widely used in the city. Nevertheless, it is evident that air pollution from construction with particulate matter has been increasing due to growing activities in this sector. Moreover, expansion of construction sites within and around Tbilisi often happens at the expense of clearing trees and vegetation, which negatively affects air quality in the city.

The water supply service has improved during recent years, both in terms of quality standards, as well as by supply schedules. Generation, purification and supply of drinking water, as well as treatment of waste- and stormwaters in the capital region and surroundings is carried out by Georgian Water and Power (GWP), a private company and legal successor of formerly state owned Tbilisi Water. GWP delivers 21 m^3/sec high-quality drinking water without significant interruptions 24 hours a day. The current share of households connected to a centralized water supply system is 100%, while the percentage of households connected

115 Giuashvili, Nia, Division of Noncontagious Diseases and Environmental Health, Centre for Disease Control and Public Health, Ministry of Labour, Health and Social Affairs of Georgia. Personal interview, December 28, 2010

116 The European environment - state and outlook 2010: synthesis. European Environment Agency, Copenhagen, pg.73-74

Table 2-27 Emissions of selected pollutants from stationary sources and motor vehicles in Tbilisi (Tons, 2009) [112]

	Carbon monoxide (CO)	Nitrogen dioxide (NO_2)	Sulphur dioxide (SO_2)	Hydrocarbons (∑CH)	Particulate matter (PM)
Motor vehicles	103165	10155	3460	23724	2423
Stationary sources	30	14	3	7	105

to the central sewage system is 97%. These figures in Soviet times (1989) were 96% for water supply and 87% for sewerage respectively.

The municipal sewage system, industrial sector and runoff water discharging to surface water bodies without treatment are the main point sources of pollution. As formal sources of the Ministry of Environment confirm, almost half of the sewage generated in the city is released directly into the Mtkvari River, bypassing the Tbilisi-Rustavi central collector network transporting sewage waters to the Gardabani treatment facility. Therefore, concentrations of nutrient pollutants are very high. The 10-year trends show pollution mainly by nitrogen ammonia and nitrite ions. Concentrations of these compounds exceeded Georgian maximum permissible standards several times for long periods, with a slight tendency to decrease during the last two-three years. Industrial sources of pollution cannot be determined clearly, as they mostly discharge wastewaters to a sewage system. Therefore, municipal and housing sectors are believed to be the major pollution sources in the city. Economic growth is not significantly reflected in the pollution trends. Heavy metals are mainly within the norms. Only iron ions show some increase during 2009 in downtown Tbilisi (the Vakhushti Bridge) that may be caused by boost of repair and small production enterprises (close proximity to monitoring point at the so called Eliava industrial marketplace).

There are no accurate historical data on **waste generation** in Tbilisi. Therefore, it is difficult to draw a clear picture of waste accumulation rates over time. The major source of municipal waste generation in Tbilisi is waste from households, which constitutes 70-80% of total municipal waste. Other sources of municipal waste are: offices, shops, markets, trading centers, schools, restaurants, hotels, gardens, squares etc. In total, 850 tons of municipal waste are generated per day in Tbilisi. On a per capita basis, this constitutes approximately 273.75 kg per year, which is less than annual per capita waste generation rates in other European countries – 524 kg. There are no exact data on generation of waste from construction materials. According to the 2005 study, it is estimated that on average 250-350 kg construction waste is generated per capita per year in Georgia. There are no data on industrial waste either. Health care waste is estimated to amount to 450 tons per year.

Data on municipal waste composition are scarce as well. However, it can be estimated that compared to 1989/1990 years, the share of organic waste, paper, carton and metal have decreased, while the percentage of plastic materials has increased considerably. A decrease of paper and carton in municipal waste is linked to diminished household incomes and welfare. A major source of the increased plastics fraction is plastic bottles used for non-alcoholic beverages. It is projected that municipal waste generation will be increasing by 2.25% per year due to growth of both the population and the economy.

Municipal waste management in Tbilisi has significantly improved over the last five years. A considerable number of problems existing in the municipal solid waste management system before 2006 have been resolved. However, there are still problems requiring attention at a national level. For example, problems with industrial, health care and hazardous waste require development of proper regulations and enforcement mechanisms. In addition, there are no policies and targets towards reduction of waste sent to landfills. Finally, it is essential to eliminate negative impacts induced by the old municipal solid waste landfills, meaning it is still necessary to plan and implement proper conservation/remediation measures.

117 Data on emissions from stationary sources have been provided by MEP. Emissions from motor vehicles have been estimated based on MEP data on total air emissions from motor vehicles in the country and the share of vehicles in Tbilisi.

CHAPTER 3: State of the Environment

Chapter 3 focuses on state of environment in Tbilisi – the third element of the DPSIR framework. State refers to the condition of the environment, resulting from pressures. It responds to the question: **what is happening to the environment?**

This Chapter discusses the most important components of the environment in Tbilisi - ambient air quality, water quality, green areas, noise and radiation safety. It also describes the current status of environmental pollution and, when possible, provides trends of changing environmental conditions over time; and describes major pollution agents and pollution 'hot spots' etc.

3.1 Ambient air quality

The National Environmental Agency (NEA) which is a subordinate organisation of the MEP is responsible for monitoring the state of ambient air quality in Tbilisi. The NEA was established in 2008 on the basis of the former Hydrometorological Department (Hydromet). In the Soviet period, Hydromet monitored air quality throughout the country. It had a relatively well-developed network of air quality monitoring stations in Tbilisi: there were eight observation points in the city. Air quality was tested in terms of concentrations of the following major polluters in ambient air: particulate matter (total suspended particulates or TSP), carbon monoxide (CO), nitrogen oxides (NO_2, NO) and sulphur dioxide (SO_2).[118] In addition to these parameters, samples were taken for benzapirene and heavy metals (lead, zinc, copper, chrome and manganese) at two observation points located near to industrial facilities.[119]

Hydromet faced severe financial problems in the 1990s, due to which its monitoring network in the country including Tbilisi drastically deteriorated. Many of the observation points ceased operation. The number of samples taken and parameters measured in the remaining stations were reduced. Problems emerged with quality assurance and quality control (QA/QC) in the chemical laboratories analyzing the air samples.

At present, the NEA monitors air quality in Tbilisi at three observation points located on Agmashenebeli, Tsereteli and Moscow Avenues. Air quality monitoring stations in the latter two points were installed in 2009 and, at present, only concentrations of CO and SO_2 are being measured. A relatively better situation is that of the observation point on Agmashenebeli avenue where the concentrations of the following parameters are being measured in ambient air: total particulate matter, carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), lead (Pb) and ground level ozone. Box 3.1 provides information on sources of origin, environmental and health effects of these pollutants.

Air samples at the observation points are taken three times a day and only on working days (sampling is not automated). Concentration of the pollutants is compared to the national standards of air quality to determine the degree of air pollution. The national standards called Maximum Allowed Concentrations (MAC) of harmful substances in ambient air were established by the Ministry of Labour, Health and Social Protection of Georgia in 2003.[120] Maximum Allowed Concentration of a substance in ambient air represents the concentration (averaged for a specific time period) below which the substance does not affect human health or the environment over a regular period or lifetime exposure. There are two types of MACs established: a) maximum one-time concentration (measured within 20-30 min, mg/m^3), and b) mean daily (24-hour) concentrations (mg/m^3). Average annual concentrations are also measured based on the mean daily concentrations.

It must be noted that MACs for air pollutants formally established in Georgia are based on former Soviet standards of air quality, and they in some cases differ from standards recommended by the World Health Organization (WHO) as well as standards adopted by the EU. Table 3.1 provides types and values of the MACs for selected air pollutants and respective standards of the WHO and the EU.

Due to the small number of monitoring stations, inability to measure concentration of all major pollutants in the air, outdated sampling equipment and absence of quality assurance and control in the laboratories of the NEA, the existing monitoring network cannot provide an adequate assessment of air quality in Tbilisi. It is also impossible to adequately model the actual spatial distribution of different pollutants in the city. Nevertheless, data provided by the NEA for this study suggest that air quality in many places in the city do not comply with national standards, especially in its central parts, avenues and streets where the traffic is intense. Diagrams 3.1-3.15 illustrate air pollution levels in the observation points in Tbilisi:

118 Georgian Center for Strategic Research and Development. Article by Mariam Shotadze: *Problem of Atmospheric Air pollution in Tbilisi – Priority National Problem.* Bulletin N80, September, 2003.

119 Hydromet itself could not undertake chemical analysis for benzapirene and heavy metals. It used to send samples to Russia for measuring concentration of these pollutants in the ambient air in Tbilisi.

120 Order # 297/N of the 16th of August, 2001 of the Ministry of Labor, Health and Social Affairs of Georgia "on the approval of environmental quality norms".

Box 3-1 Sources of origination, environmental and health effects of selected air pollutants

Solid particulates, often called dust, are released into ambient air as a result of various processes, such as fuel combustion (coal and oil) and cement production. Inhaling some types of solid particulates suspended in the ambient atmosphere may cause irritation of the respiratory tract (bronchial tubes, lungs). Dust consists of particulates of different sizes. The finest particulates, which are called fine dust particulates, are PM_{10} – particles of aerodynamic diameter 10 micrometers and less, and $PM_{2.5}$ – particles of aerodynamic diameter 2.5 micrometers and less. They represent the mixture of organic and non-organic compounds of different origin. They are one of the most harmful substances which cause respiratory tract diseases.They can penetrate deep into the lungs and remain there for a long period. The smaller the particles, the deeper they penetrate into human organs and the more harmful they are.

Sulphur dioxide is released into ambient air mainly due to the combustion of sulphur containing fuel. The main sources are power stations working on coal or fire oil, boiler rooms, metallurgical plants and diesel motor vehicles. Levels of sulphur dioxide higher than the permissible levels irritate the upper airways of the respiratory tract. Harmful impacts on the nasopharynx and mucous membranes can occur.

Carbon monoxide is a product of incomplete combustion. The main sources are motor vehicle exhaust (generated in the process of incomplete combustion due to insufficient temperature, or due to malfunction of the air supply system of the internal combustion engine). It is also emitted from energy production plants, in particular those using oil and coal combustion, and from the metallurgical industry. It suppresses transportation of oxygen by blood.

Nitrogen dioxide and **monoxide** are the products of fuel combustion at a very high temperature in abundance of oxygen. The main sources are motor vehicle exhausts, emissions from power stations and the burning of solid waste. At high concentrations in ambient air, nitrogen dioxide can irritate the lower airways of the respiratory tract, especially the lung tissue.

Lead and lead-containing substances are emitted into ambient air through fuel combustion in motor vehicles (burning of leaded petrol). They are also emitted from metallurgical plants. The poisoning impact of lead is revealed at molecular and cellular levels. It impairs nervous, mental and physical development.

Ground-level ozone is generated as a result of photo-chemical reaction between hydrocarbons, oxides of nitrogen and oxygen. It is one of the main components of smog – a major problem in all big cities. Ground-level ozone affects human health, crops and vegetation. High levels of ozone can damage the respiratory system.

Source: State of the Environment Report for Georgia 2007-2009, http://soegeorgia.blogspot.com/p/english-version.html

Table 3-1 Maximum allowed concentrations of harmful substances in ambient air, WHO and EU air quality standards

Polluting substance	Maximum allowed concentrations (mg/m^3)			Concentration averaging period
	According to Georgian national legislation	Recommendation of the WHO	According to EU legislation	
PM 2.5	-	0.01	0.025	1 year
	-	0.025	-	24 hours
PM 10	-	0.02	0.04	1 year
	-	0.05	0.05	24 hours
Total suspended particulates (PM)	0.5	-	-	30 min
	0.15	0.12	-	24 hours
Nitrogen dioxide (NO_2)	-	0.2	0.2	1 hour
	-	0.04	0.4	1 year
	0.04	-	-	24 hours
	0.2	-	-	30 min
Sulphur dioxide (SO_2)	-	0.5	-	10 min
	-	-	0.35	1 hour
	-	0.05	-	1 year
	0.05	0.02	0.125	24 hours
	0.5	-	-	30 min
Carbon monoxide (CO)	-	100	-	10 min
	-	10	10	8 hours
	-	30	-	1 hour
	5	60	-	30 min
	3	-		24 hours
Lead compounds	-	0.0005	0.0005	1 year
	0.0003	-	-	24 hours
	0.001	-	-	30 min
Ground level ozone	-	0.12	0.12	8 hours
	0.03	-	-	24 hours
	0.16	-	-	30 min

Source: State of the Environment Report for Georgia 2007-2009 http://soegeorgia.blogspot.com/p/english-version.html

Diagram 3-1 Average annual concentrations of total particulate matter (PM) on Aghmashenebeli Ave

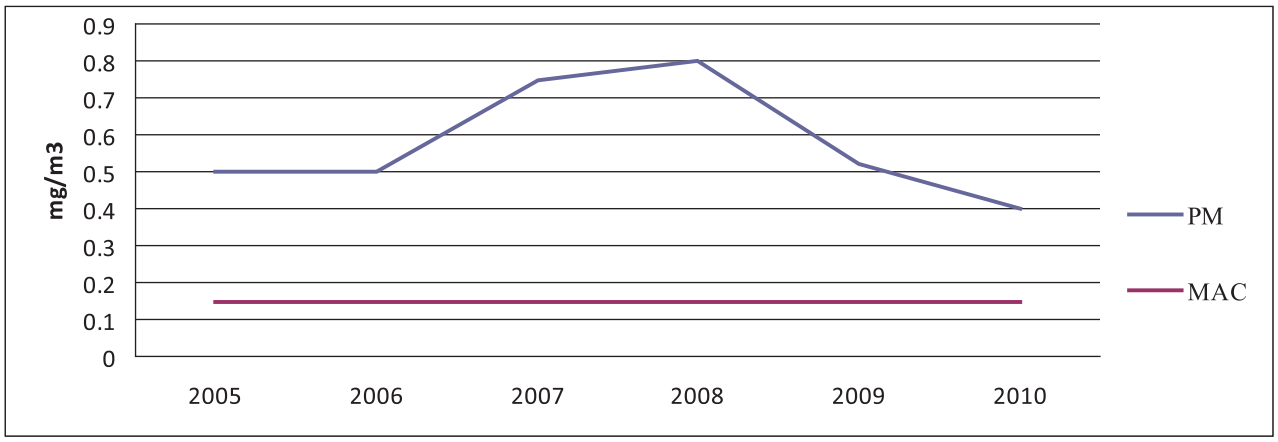


Diagram 3-2 Average monthly concentrations of total particulate matter (PM) on Aghmashenebeli Ave. for the period 2008-2010

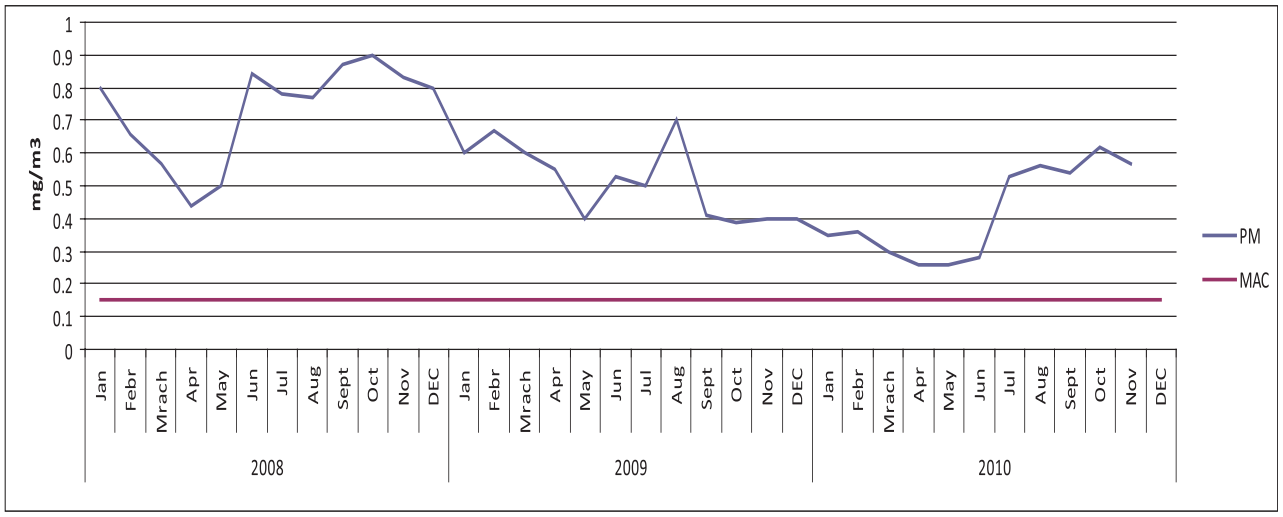


Diagram 3-3 Average annual concentrations of carbon monoxide (CO) on Aghmashenebeli Ave

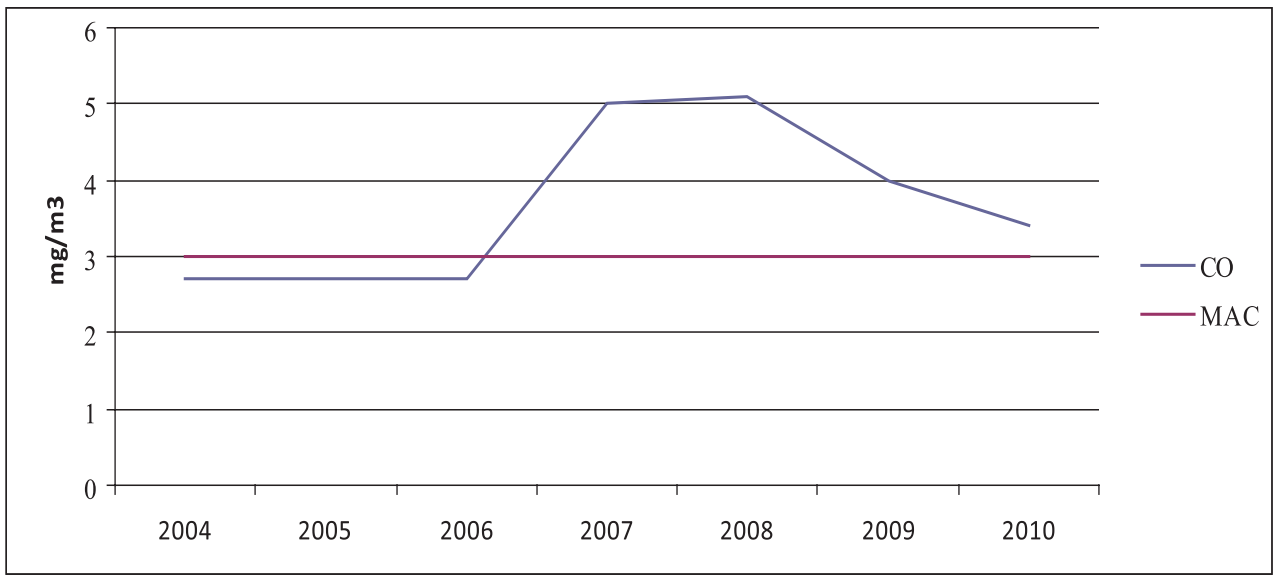


Diagram 3-4 Average monthly concentrations of carbon monoxide (CO) on Agmashenebeli Ave. for the period 2008-2010

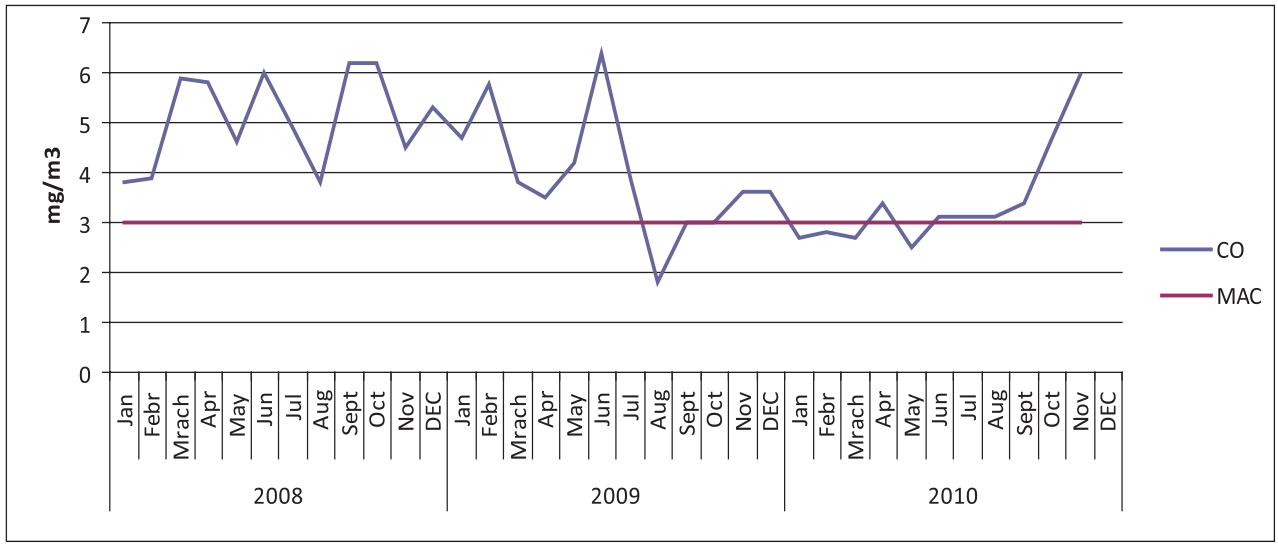


Diagram 3-5 Average annual concentrations of sulphur dioxide (SO_2) on Aghmashenebeli Ave

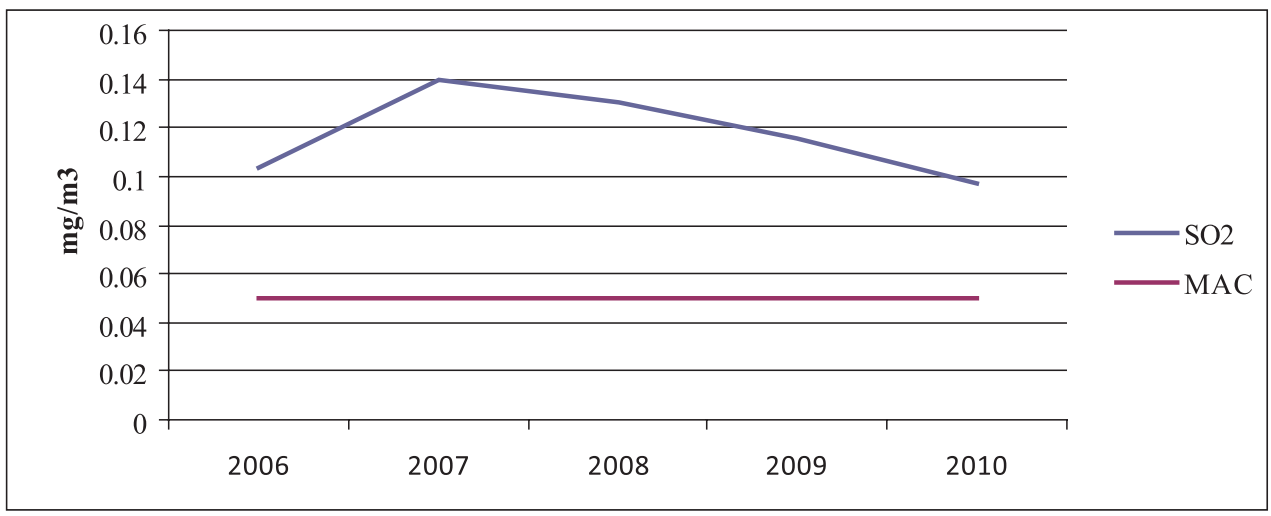


Diagram 3-6 Average monthly concentrations of sulphur dioxide (SO_2) on Aghmashenebeli Ave. for the period 2008-2010

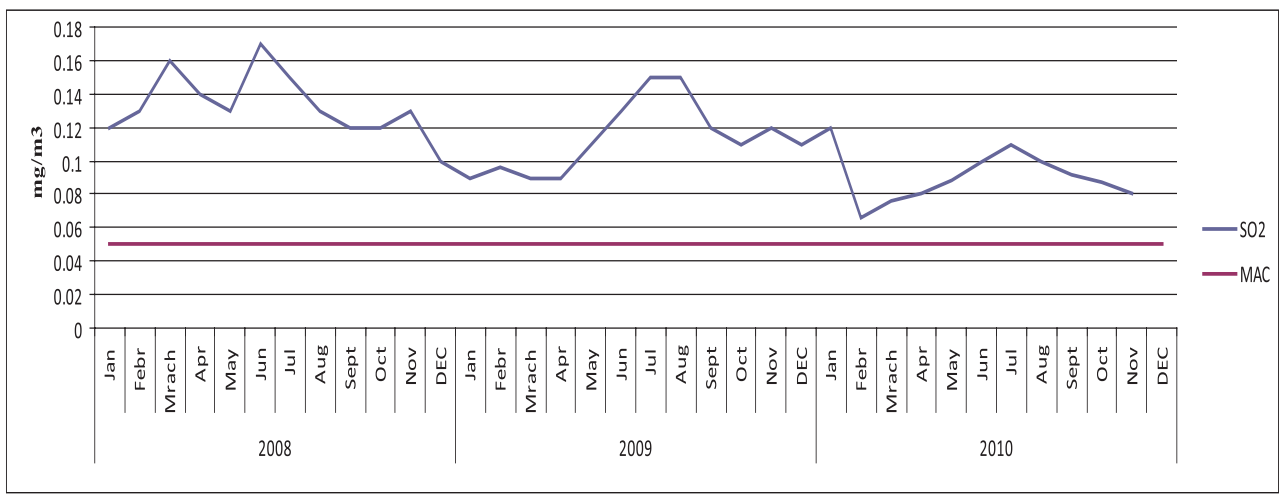


Diagram 3-7 Average annual concentrations of nitrogen dioxide (NO_2) on Aghmashenebeli Ave

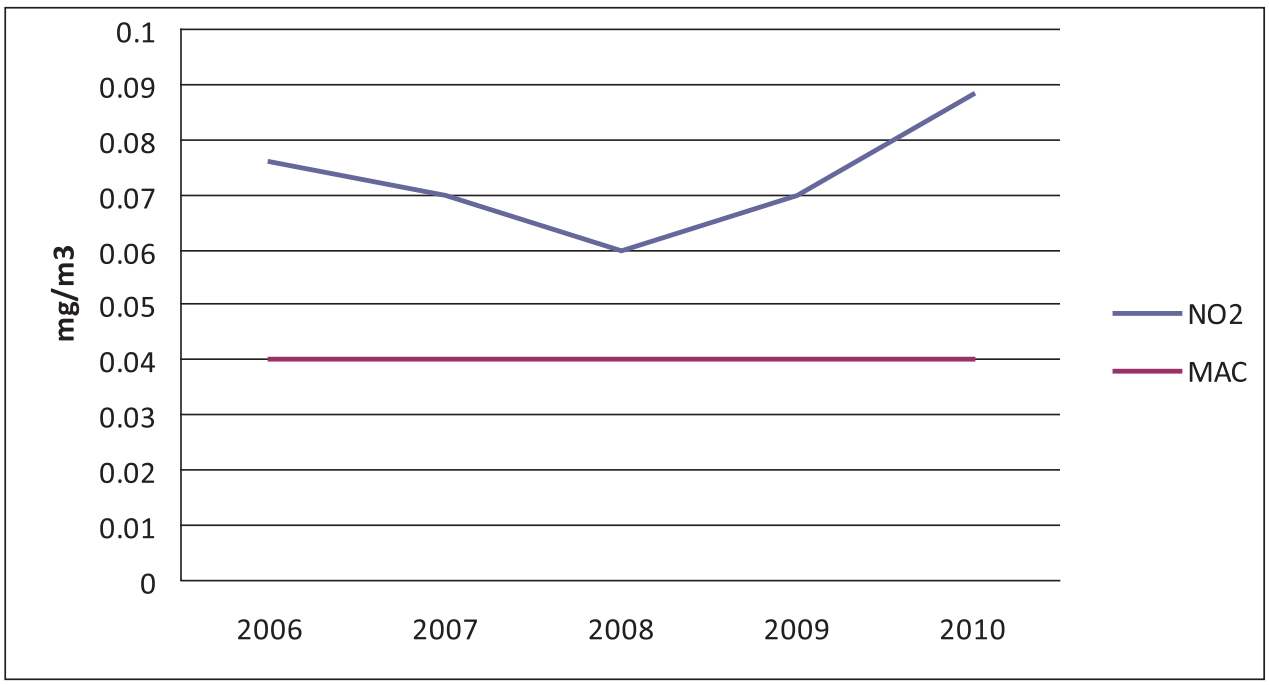


Diagram 3-8 Average monthly concentrations of nitrogen dioxide (NO_2) on Aghmashenebeli Ave. for the period 2008-2010

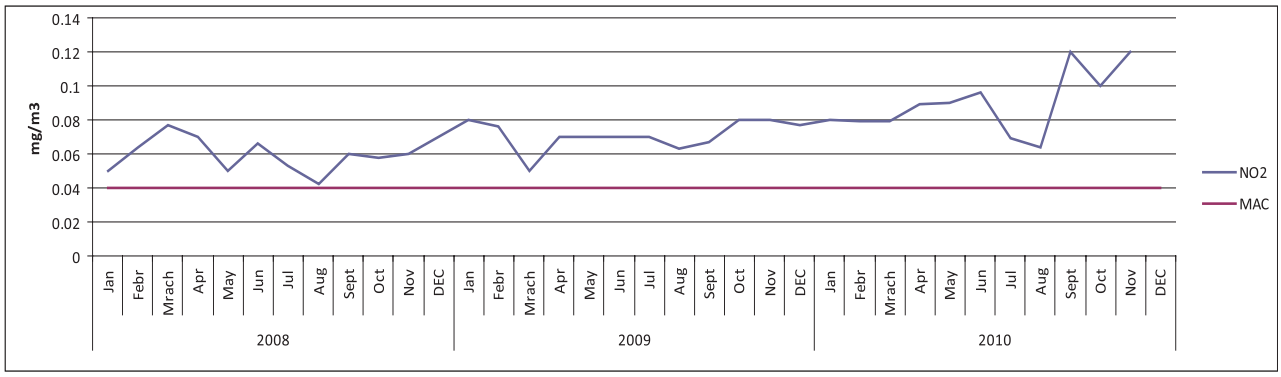


Diagram 3-9 Average annual concentrations of lead (Pb) on Aghmashenebeli Ave

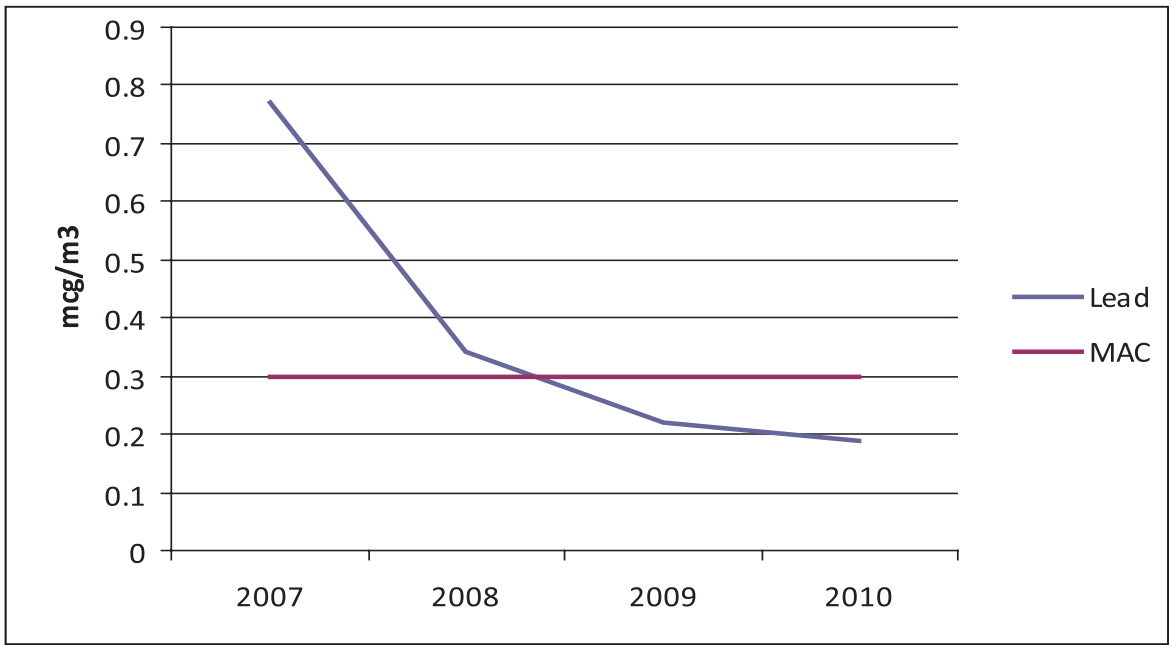


Diagram 3-10 Average monthly concentrations of lead (Pb) on Aghmashenebeli Ave. for the period 2008-2010

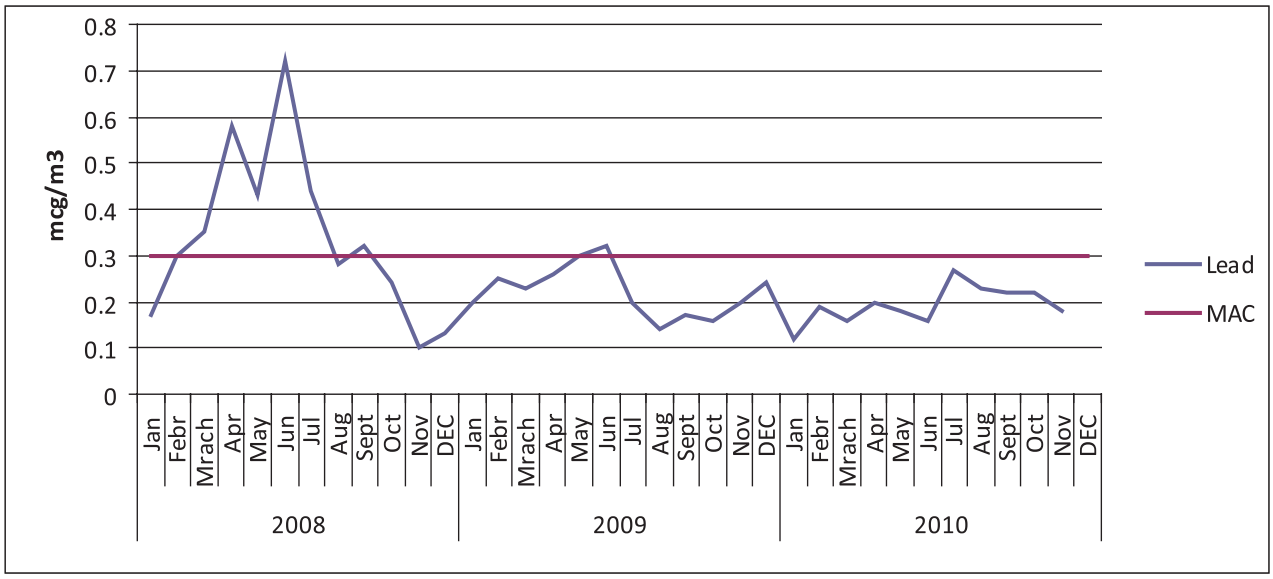


Diagram 3-11 Average monthly concentrations of ground level ozone on Aghmashenebeli Ave. (2010)

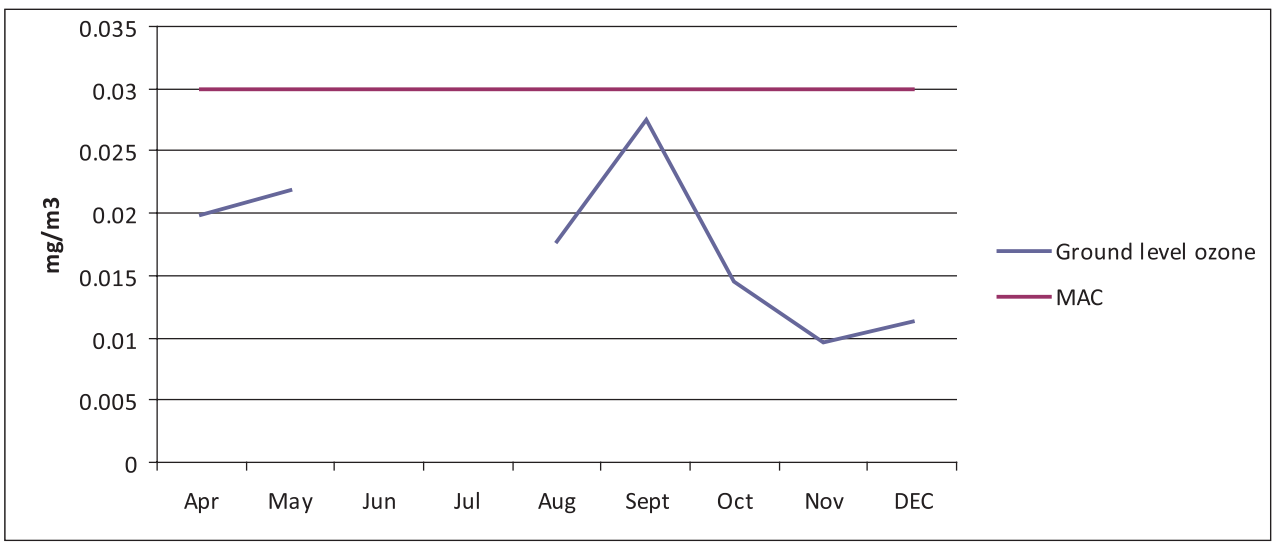


Diagram 3-12 Concentration of carbon monoxide (CO) on Moscow avenue (2010)

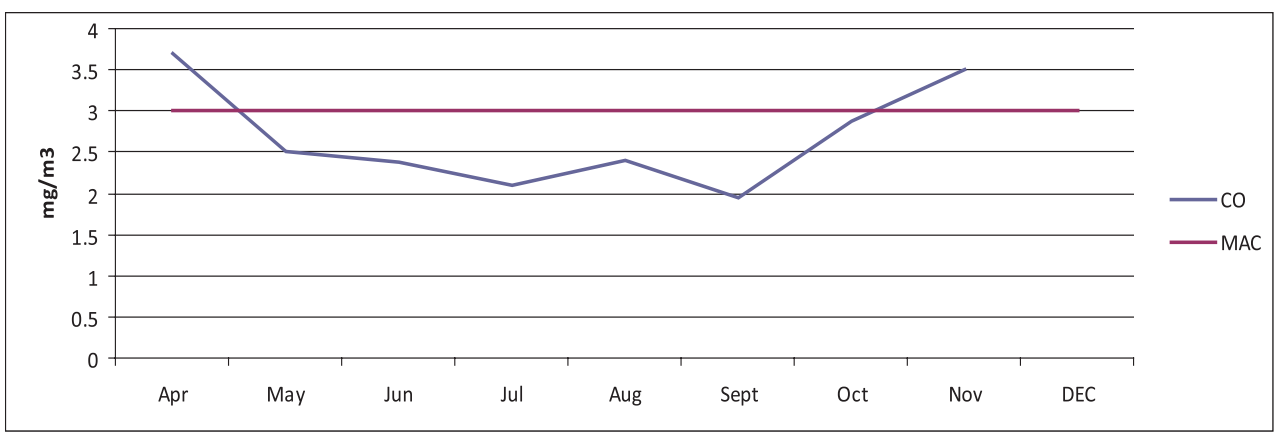


Diagram 3-13 Concentration of nitrogen dioxide (NO_2) on Moscow avenue (2010)

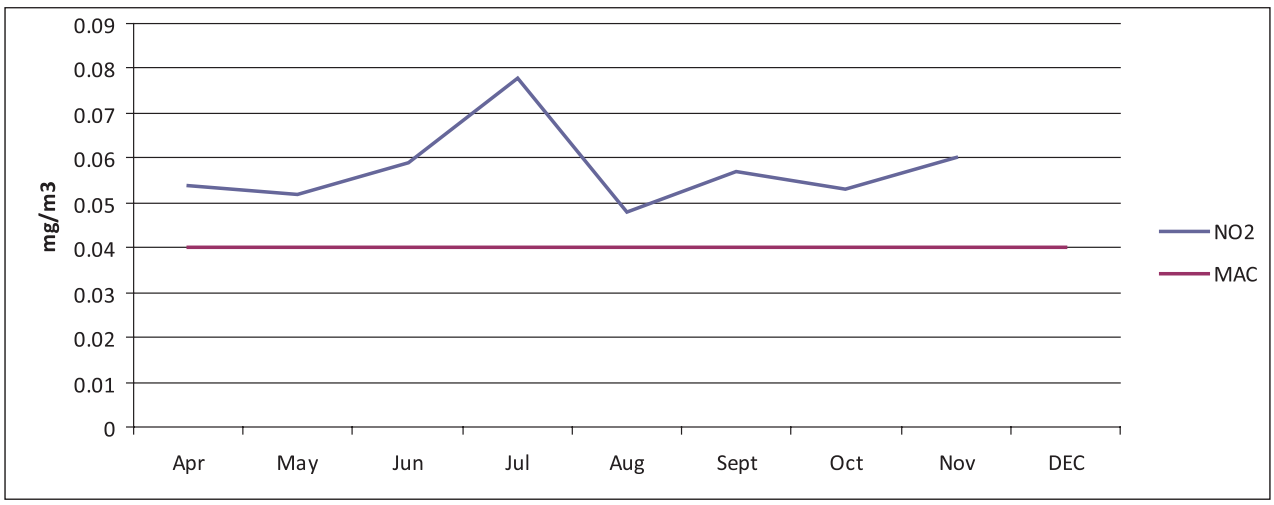


Diagram 3-14 Concentration of carbon monoxide (CO) on Tsereteli avenue (2010)

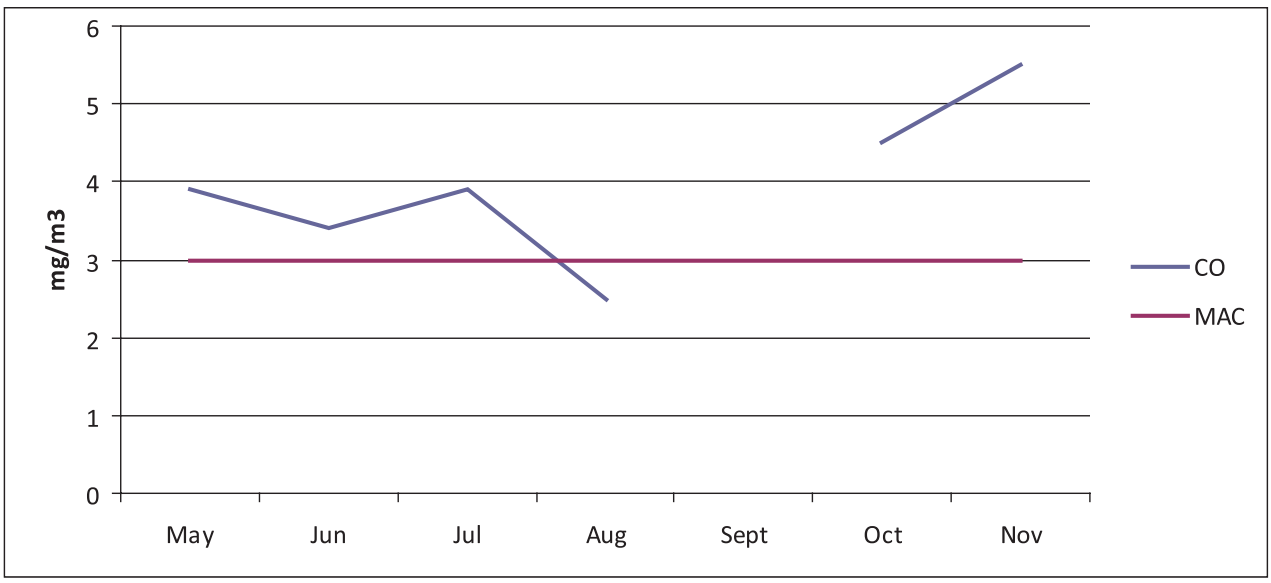


Diagram 3-15 Average annual concentration of nitrogen dioxide (NO_2) on Tsereteli avenue (2010)

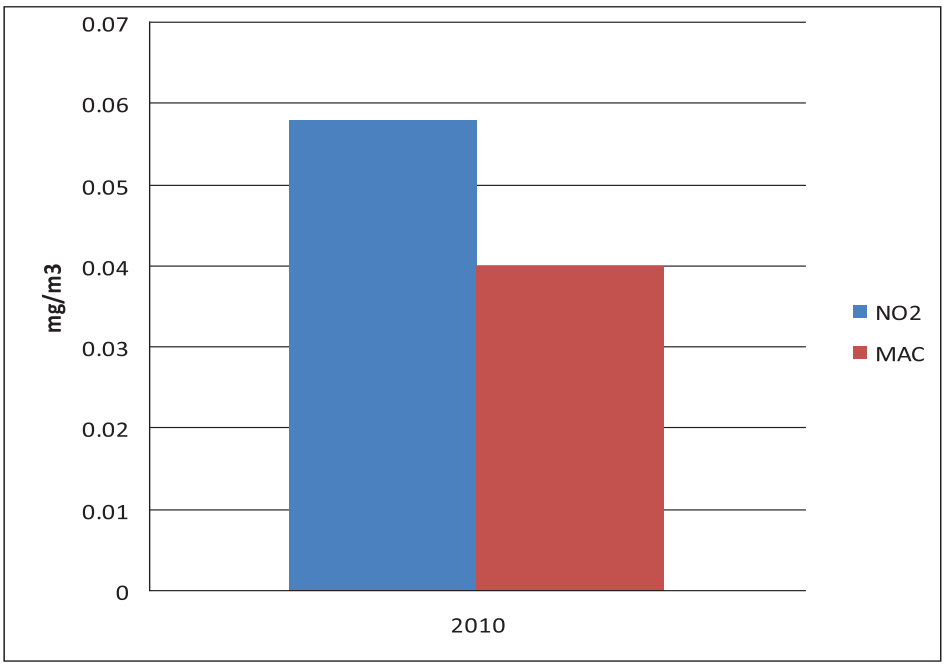


Diagram 3-16 Average yearly concentration of total particulate matter (PM) on Agmashenebeli Ave

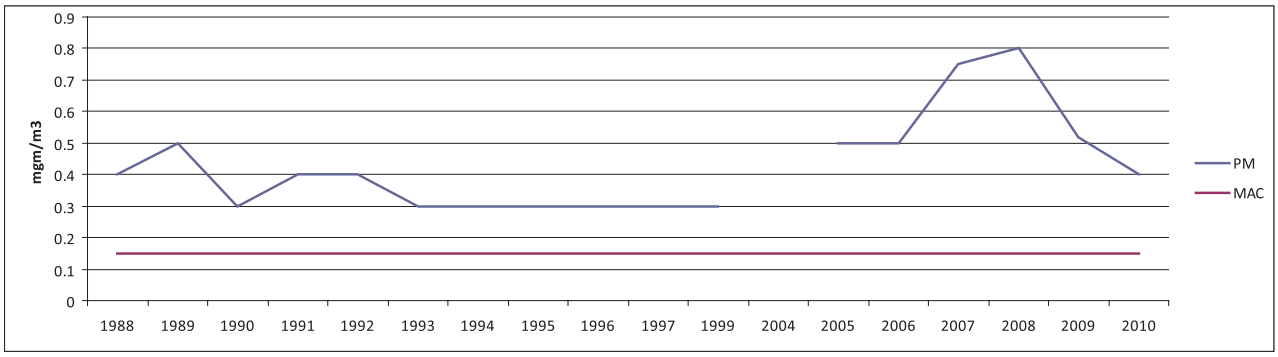


Diagram 3-17 Average yearly concentration of nitrogen dioxide (NO_2) on Agmashenebeli Ave

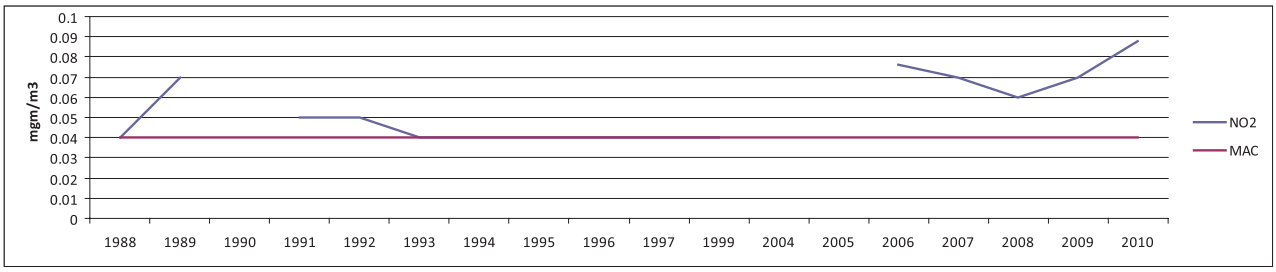
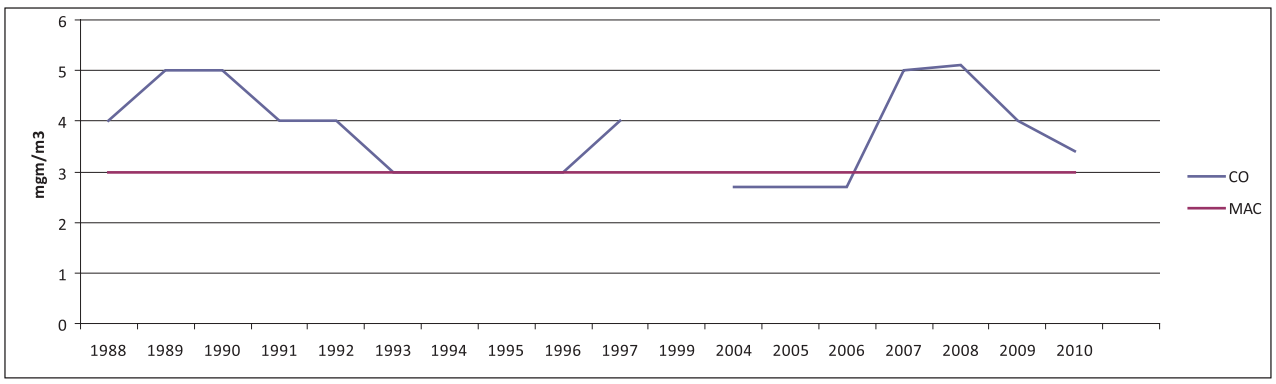


Diagram 3-18 Average yearly concentration of carbon monoxide (CO) on Agmashenebeli Ave



The following conclusions can be made based on the available information concerning ambient air quality in Tbilisi:

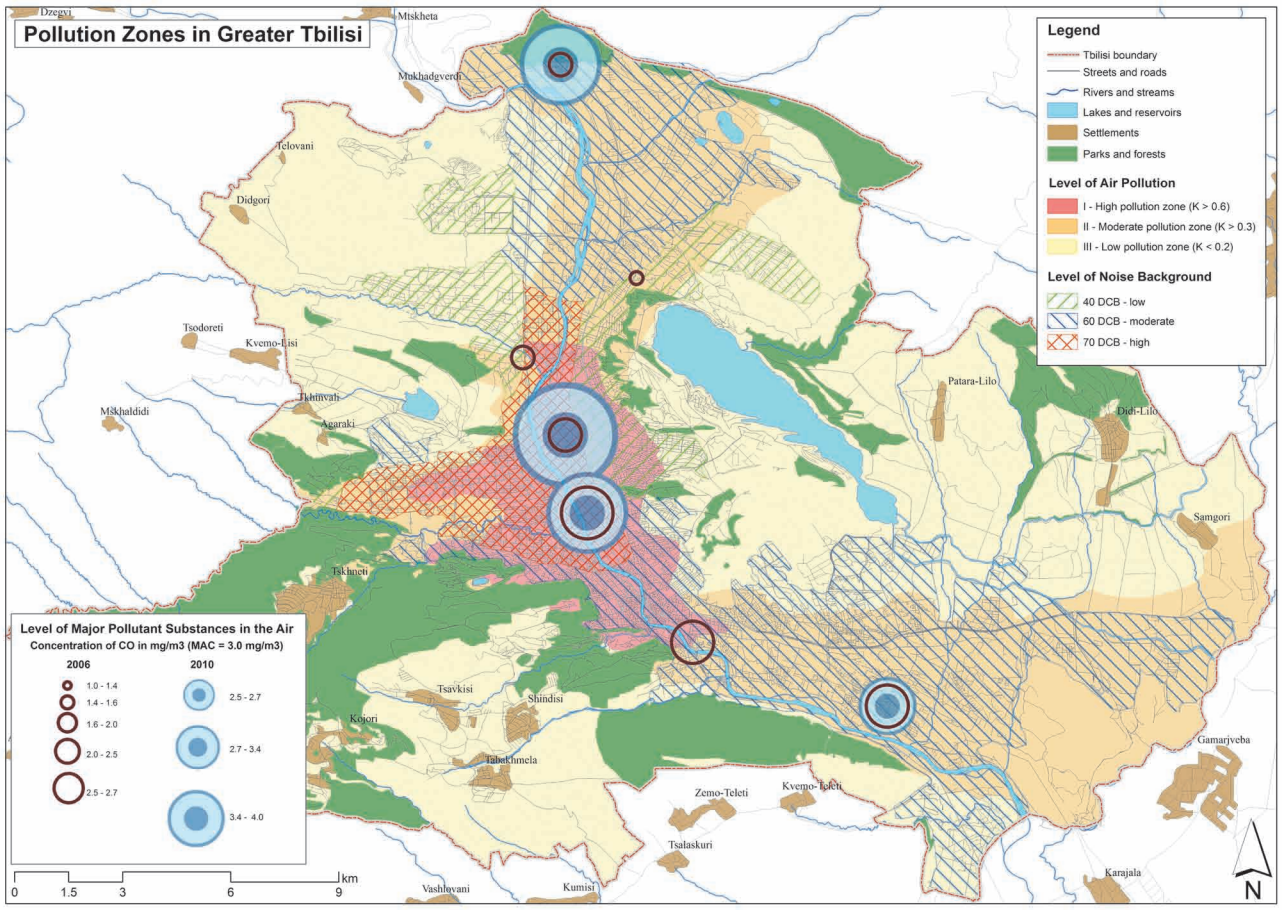
- On Agmashenebeli Avenue which is located in the central part of Tbilisi, and where the traffic is quite intense, concentrations of CO, SO_2, NO_2 and particulate matter in the air exceeded the national standards for the period 2004-2010. Concentrations of lead have decreased here since 2008, and are now slightly lower than the national standard. Measurements of ground level ozone started in 2010 only on Agmashenebeli Avenue and, according to the NEA data, the concentration of this pollutant is within the MAC.
- Based on the data for 2010, CO and NO_2 concentrations were above national standards on Tsereteli Avenue where the traffic is dense.
- In 2010, concentrations of CO were mostly within the national standards on Moscow Avenue, which is remote from the centre of Tbilisi. However, NO_2 levels exceeded the national norms in this place.

Diagrams 3.16-3.18 provide information on air quality on Agmesenebeli Avenue for the period 1988-2010.[121]

These diagrams suggest that after the reduction of air pollution with CO and NO_2 in the 1990s, which happened as a result of a reduction in industrial activities, concentrations of these pollutants in the ambient air of Tbilisi have increased to 1980s levels again. The pollution level of total suspended particles (TSP) at present is higher than at the end of 1980s. The high level of air pollution in Tbilisi is attributed to increased emissions of pollutants from the transport sector. As mentioned in chapter 2.5 of this document, air emissions from industrial facilities have been significantly reduced, while emissions from traffic

121 For the monitoring point located on Agmashenebeli Avenue, air quality data were available for the period 1988-1999 in the study *Air Pollution Problem in Tbilisi: the National Environmental Priority*. The Georgian Centre of Strategic Research and Development, Bulletin N80, September 2003. Diagrams 3.1-3.18 have been developed based on these data and the data provided by the NEA for 2004-2010 for this assessment.

Figure 3-1 Pollution Zones in Greater Tbilisi



have increased substantially due to the increased number of motor vehicles in the city. Moreover, data on emissions from stationary and mobile sources provided by the MEP suggests that almost all air pollution in Tbilisi is related to vehicle traffic (see table 2.26).[122]

Based on existing limited data presented above, figure 3.1 illustrates air pollution zones in Tbilisi.

3.2 Water resources

3.2.1 Hydrological Characteristics of Surface Water Bodies

Hydrological characteristics of Tbilisi and the surrounding area are generated by complex climatic, topographic and geologic conditions of the Eastern Mtkvari Depression, also known as the Tbilisi Depression. The physical geographical province that includes the Tbilisi Depression occupies the valley of the Mtkvari River from Zemo Avchala to the eastern outskirts of the Teletri Range. Asymmetric positions of the left and right banks of the river, as well as the high inclination of surrounding slopes (391 m above sea level at lowest point next to the Queen Tamar Bridge and 766 m at highest point of the Mtatsminda Park plateau) caused very intensive erosion-denudation and accumulation processes in the geological past[123], that ultimately resulted in formation of two different hydrological regimes for the left (Northeast to South-Southeast) and right sides (North-Northwest to South-Southeast) of the city. The right bank, which in addition is higher in altitude, has steeper slopes and thus the surface here is characterized by more intensive and abundant small streams and ravines. Because of high rainfall and morphological inclination, these rivers can cause great damage when precipitation exceeds seasonal or daily maximums. The surface on the left side of the Mtkvari Depression is much softer. The tectonic structure here is covered by alluvial sediments, and therefore the topography is slightly disturbed by lowland streams, dry ravines and alluvial terraces[124].

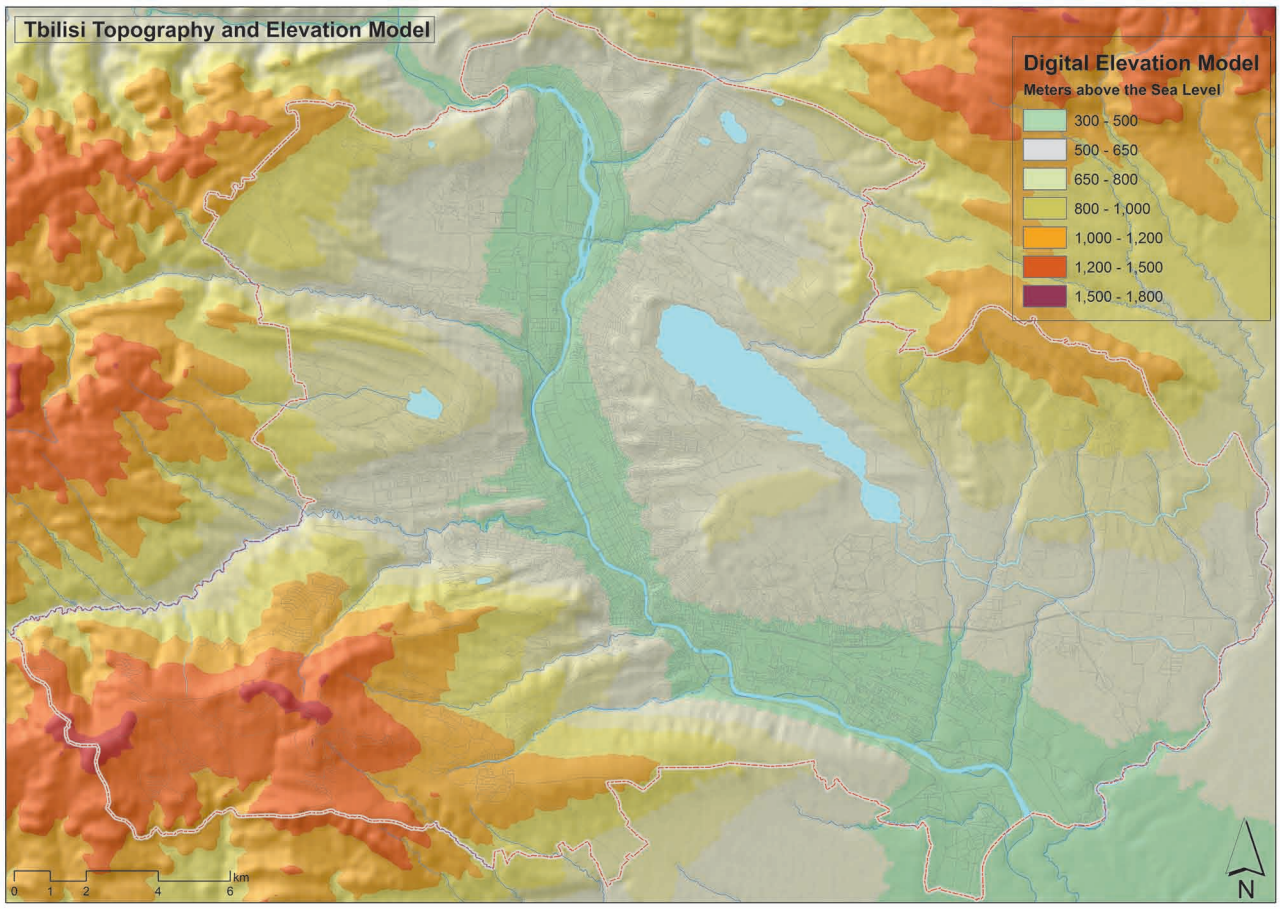
The Mtkvari River belongs to the Caspian Sea basin. It originates in the Gyol Highland in Turkey at an altitude near 2000 m above sea level. The total length of the Mtkvari River is 1515 km with a watershed basin of about 180,000 km^2. The length of the river in Tbilisi city limits is 38 km and the watershed area is 3,000

122 These data include emissions from industrial facilities and motor vehicles. Emissons from other sectors, e.g. construction, landfills, are not included.

123 Maruashvili Levan, Geomorphology and Paleogeography of the Lower Kartli, Publications of the Institute of Geography of the Academy of Sciences of Georgian SSR, Vol. 8., Tbilisi 1957.

124 Maruashvili Levan, Physical Geography of Georgia, TSU Publications, Tbilisi 1964.

Figure 3-2 Tbilisi Topography



km^2. The average inclination of the Mtkvari within the city limits is 2.4%; the lowest point above sea level is located at 320 m[125].

In terms of hydrographic characteristics, the Mtkvari is a very dynamic river. Right after leaving the narrow canyon by Mtskheta and entering Tbilisi near the Digomi Valley, the river forms a very broad floodplain and numerous small-to-medium size islands. However in the 1930s, the city began construction of a concrete protection wall (levee) across the river, which currently limits 26 km of the river bed within a 4-5 m height concrete wall. Therefore, the only natural hydro-dynamic process ongoing for the time being is vertical erosion[126].

Other hydrographic characteristics of the Mtkvari River within the city limits are as follows: the width of the river bed varies from 25 m (at Metekhi Bridge) to 120 m; the width of the stream between the bank protection walls is 40-80 m; depth during shallow flow is 1-2 m and during rapid flow 3-4 m. However, after being inundated by the Ortachala HPP dam in 1961, the depth of the River from the dam to the mouth of a Mtkvari tributary (the Vere River) increased to 5-10m, while the stream velocity changed to 0.5-0.8 m/sec. During high flows, the River reaches the top of the protective wall. The depth of the water stream during this period exceeds 6-7 m in general, but is 12-13 m near the Metekhi Bridge, while the stream velocity reaches 6-7 m/sec value[127].

The Mtkvari River is fed by mixed type of sources, including melted snow and seasonal rains; it is characterized by seasonal floods during spring and the early summer period (April, May, June). However, unpredicted flash floods may happen in autumn as well, but in winter water flow is stable and low. Seasonal distribution of the Mtkvari flow in Tbilisi shows the following trend: 48.5% of the annual flow comes during the spring season; 26.9% in the summer; 13.7% in the autumn and 10.9% in the winter[128].

The hydrological monitoring station in downtown Tbilisi is located in close proximity to the Queen Tamar Bridge. Flow monitoring here has been carried out since 1862 and currently takes place twice a day. Mean annual water discharge of the Mtkvari at Tbilisi is calculated as 204 m^3/sec; the volume equals to 6.43 km^3. The historic maximum of the Mtkvari discharge level in Tbilisi was observed on 19 April 1968 during

125 Data provided by National Environmental Agency, Department of Hydrometeorology, Tbilisi 2010.
126 Committee of Environmental Protection and Regulation of Natural Resources, Municipality of Tbilisi, Environmental Assessment Report of Tbilisi, 2000, pg. 45.
127 Data provided by National Environmental Agency, Department of Hydrometeorology, Tbilisi 2010.
128 Committee of Environmental Protection and Regulation of Natural Resources, Municipality of Tbilisi, Environmental Assessment Report of Tbilisi, 2000, pg. 45.

the devastating flash flood, with a flow rate of 2,450 m^3/sec (recurrence – once in 150 years).[129]

As mentioned above, tributaries of the Mtkvari River are distributed unevenly; most of them are small streams or seasonal ravines. The largest tributaries include the Vere, Dighmistskali (right tributaries) and Gldaniskhevi (left tributary).

The Vere River is the largest one among the Mtkvari tributaries by area of watershed and water flow. The length of the river is 38 km; the watershed area equals 178 km^2. The river originates at an altitude of 1670 m above sea level and falls to the Mtkvari at the altitude of 397 m; the average altitude of the basin is 1060 m; and the mean annual average water discharge is 0.98 m^3/sec. The maximum water discharge was observed on 1 April 1969 and equaled 149 m^3/sec. Maximum water discharge calculated for 1% flow equals 240 m^3/sec.

Another important Mtkvari tributary from the right side of the basin, ***the Dighmistskali River***, is 22 km long; the watershed area equals 85 km^2. The river originates at 1400 m above sea level and falls to the Mtkvari to an altitude of 415 m; average altitude of the basin is 765 m; mean annual water discharge is 0.25 m^3/sec. Maximum water discharge calculated for 1% flow equals 50.2 m^3/sec.

The Gldaniskhevi River is the largest left tributary that joins the Mtkvari River in the northwestern part of Tbilisi. The length of the river is 17 km. It originates on the southern slope of the Saguramo Range at an altitude of 1180 m above sea level. The watershed area equals 62.5 km^2; the average altitude of the basin is 994 m; mean annual water discharge 0.20 m^3/sec. Maximum water discharge calculated for 1% flow equals 41.9 m^3/sec[130].

There are very few natural lakes in Tbilisi and its surrounding area. Most of these are small in size, volume and water table area; therefore their use is mostly of recreational importance only. Among natural lakes, the largest one is ***Lisi Lake***, located in the northwest part of Tbilisi at an altitude of 624 m above sea level. The water table area of the Lake equals 0.47 km^2; its watershed area is 16 km^2, and it has a maximum depth of 4 m and a volume of 1.22 million m^3. The lake is fed mostly by snow and groundwater sources. ***Turtle Lake*** is located on the northern slope of Mount Mtatsminda, at an altitude of 687.7 m above sea level. The area of the water table is very small at 0.034 km^2; its watershed area is 0.4 km^2 and maximum depth 2.6 m. The Lake is of landslide origin. ***Gldani Lake*** is another relatively large lake, located in the northern part of the city, near Gldani village. The length of the Lake is about 900 m and its width 300m. The Lake is mostly fed by precipitation and salt water springs. There are also a few other seasonal lakes in Tbilisi, most of which dry out during the summer period[131].

Samgori water reservoir, also known as the ***Tbilisi Sea***, plays an important role in the hydrological balance of the city and its surrounding area. The water table of the reservoir is 11.6 km^2; the volume of the water is 308 million m^3, and it has an average depth of 26.6 m and a watershed area of 38.0 km^2. The reservoir was built in the 1950s by filling up a natural depression of three smaller salt lakes located in the northeast part of the city with fresh waters diverted from the Iori River via the Zemo Samgori irrigation canal. Currently, the reservoir is used to regulate the irrigation system of the Samgori Valey, as well as for drinking water supply and recreational purposes[132].

3.2.2 Quality of Surface Waters

Water quality monitoring of surface water bodies in Tbilisi, and in Georgia in general, is carried out by the National Environment Agency (NEA) of the Ministry of Environment Protection. Monitoring is mostly conducted on the Mtkvari River at three locations: 1) Zahesi, at the city entrance near the Zemo Avchala HHP; 2) the Vakhushti Bridge in downtown Tbilisi; and 3) Gachiani, downstream of the Mtkvari, outside of the city limits. 33 major parameters are tested and analyzed regularly (once a month) at these locations. In addition, the NEA carries out seasonal monitoring of microbial parameters for recreational waters at Tbilisi Sea, Lisi and Turtle Lakes.

As 10-year trends show, the Mtkvari River in Tbilisi is mainly polluted by nutrients, particularly by nitrogen ammonia, concentrations of which exceed both permissible Georgian standards for human health and EU limits necessary to maintain fish ecosystems (see diagrams 3.19 and 3.20) by several times in all three monitoring locations (upstream, downtown and downstream). High levels of nitrogen ammonia in most cases is a result of direct discharge of untreated sewage waters into the water bodies. Another indirect cause could be use of nitrogen containing fertilizers in agricultural crops upstream of Tbilisi. Unreasonably high concentrations of nutrients in the Mtkvari undermine sufficiency of the sewerage network and wastewater treatment facility in Tbilisi. Concentration of another dangerous component for fish life, nitrite ions, exceeds only EU limits and is within the limits of Georgian standards[133] (here as well EU limits are considered for fish ecosystems only).

129 Data provided by the National Environmental Agency, Department of Hydrometeorology, Tbilisi 2010.
130 Data provided by the National Environmental Agency, Department of Hydro-meteorology, Tbilisi 2010
131 Committee of Environmental Protection and Regulation of Natural Resources, Municipality of Tbilisi, Environmental Assessment Report of Tbilisi, 2000, pg. 51
132 Data provided by the National Environmental Agency, Department of Hydro-meteorology, Tbilisi 2010
133 Data provided by the National Environmental Agency, Department of Pollution Monitoring, Tbilisi, 2010

Diagram 3-19 Concentration of ammonia ions in the Mtkvari at Tbilisi

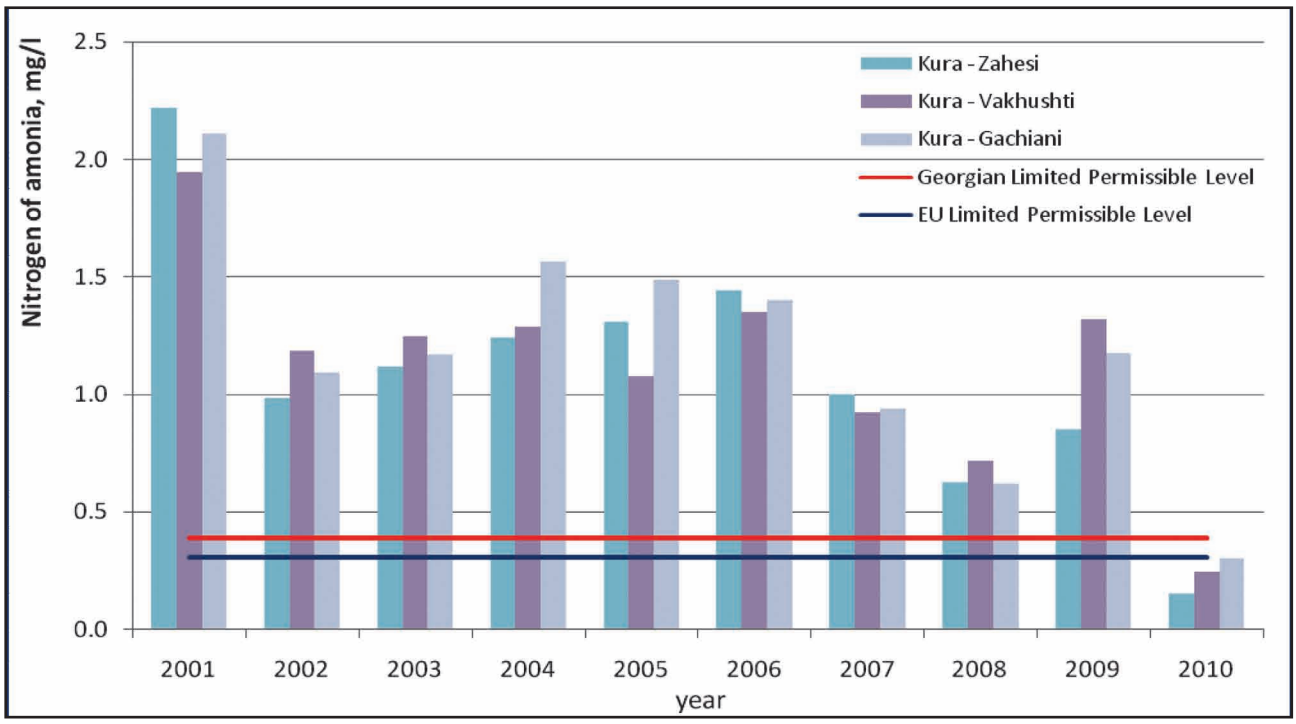
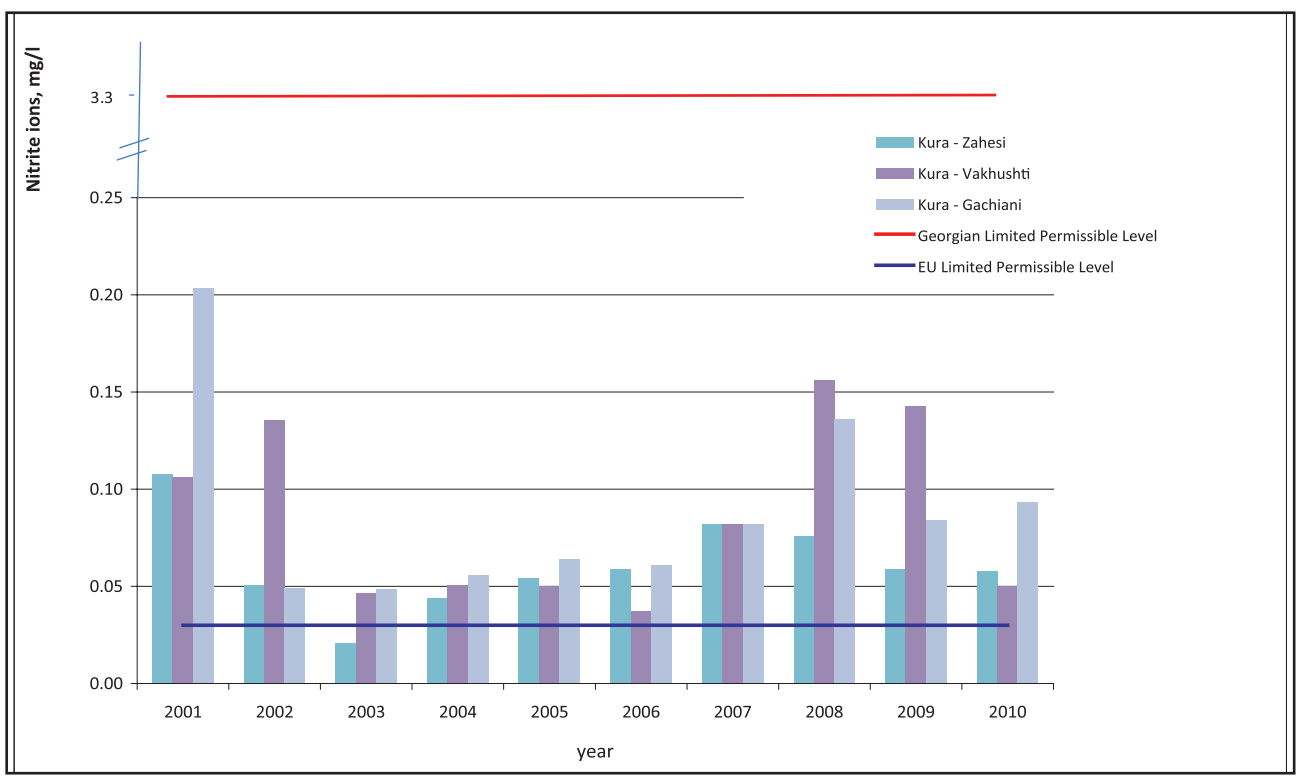


Diagram 3-20 Concentration of nitrite ions in the Mtkvari at Tbilisi



High concentrations of Biological oxygen demand (BOD-5) were observed also in all three locations, especially at Vakhushti and Gachiani (2008-09). On the other hand, concentrations of dissolved oxygen (DO) are within the permissible limits of both Georgian and EU standards (dissolved oxygen is measured as a minimum essential level required to maintain fish and aquatic ecosystems and, contrary to the other component, a high concentration of DO is a sign of better quality of water). This is most likely due to the relatively high velocity and high level of water (diagrams 3.21 and 3.22) that help to neutralize nutrient pollutants and prevent formation of a dangerously low level of dissolved oxygen. Concentrations of other nutrients - nitrate ions and phosphate ions - are also within the permissible limits (diagrams 3.23 and 3.24)[134].

134 Data provided by the National Environmental Agency, Department of Pollution Monitoring, Tbilisi, 2010

Diagram 3-21 Biological oxygen demand (BOD-5) in the Mtkvari at Tbilisi

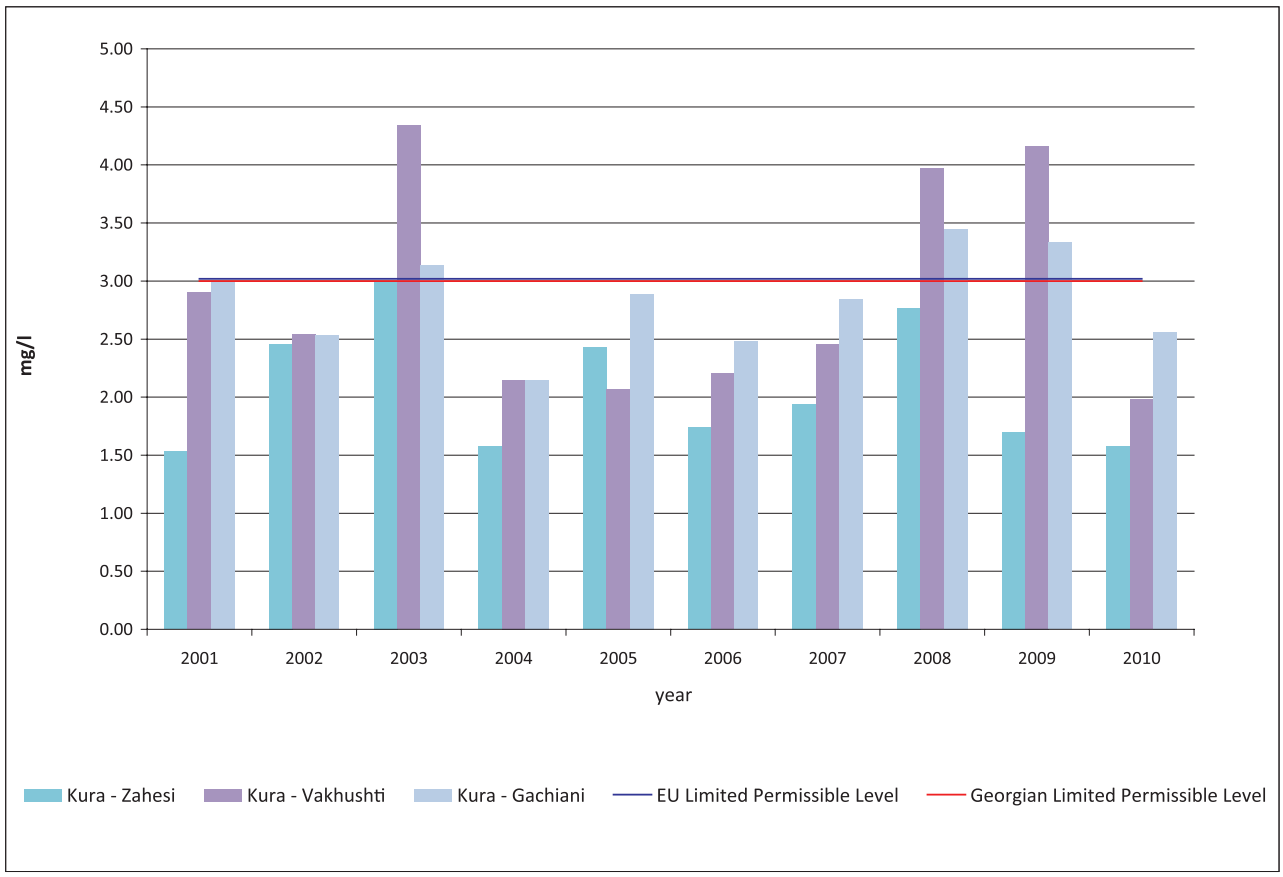


Diagram 3-22 Concentration of dissolved oxygen in the Mtkvari at Tbilisi

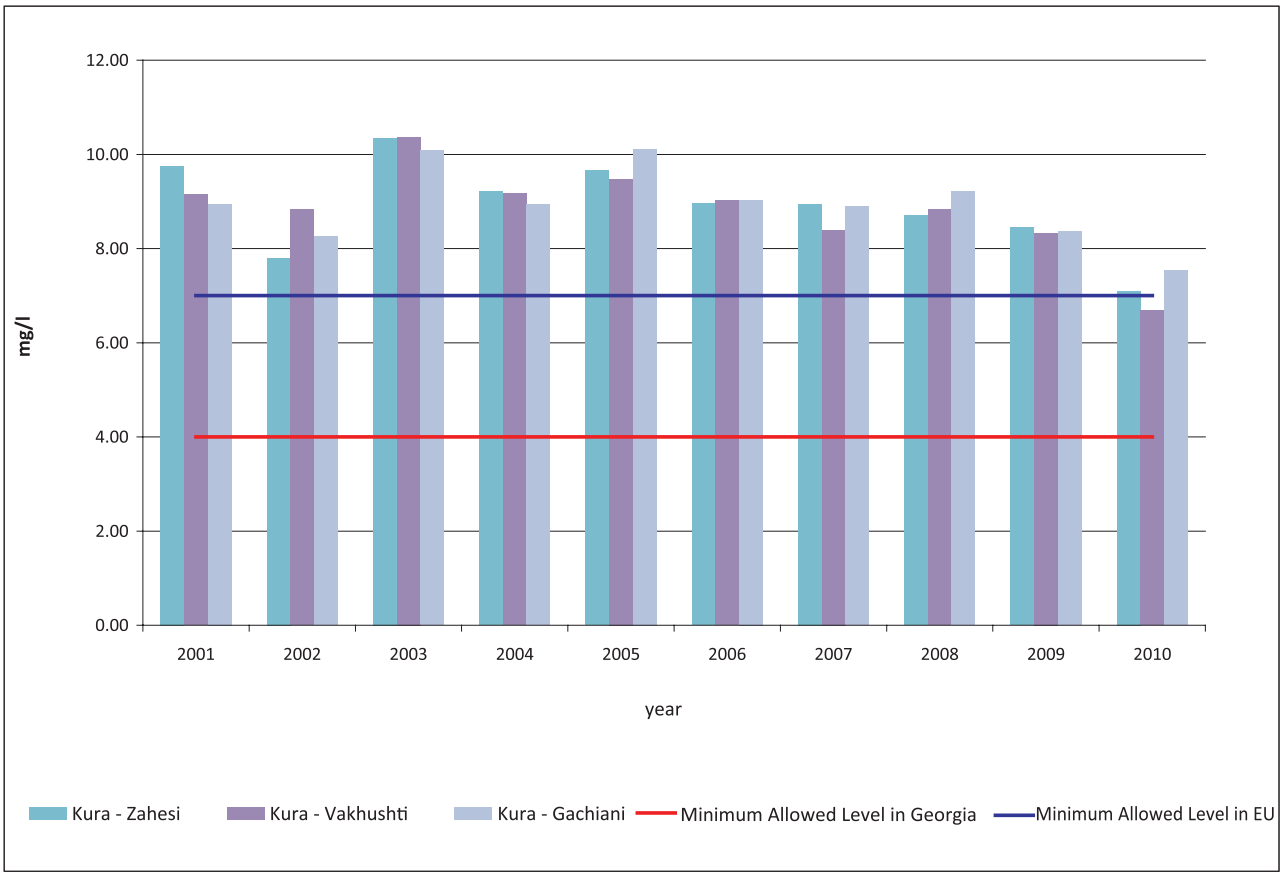


Diagram 3-23 Concentration of nitrate ions in the Mtkvari at Tbilisi

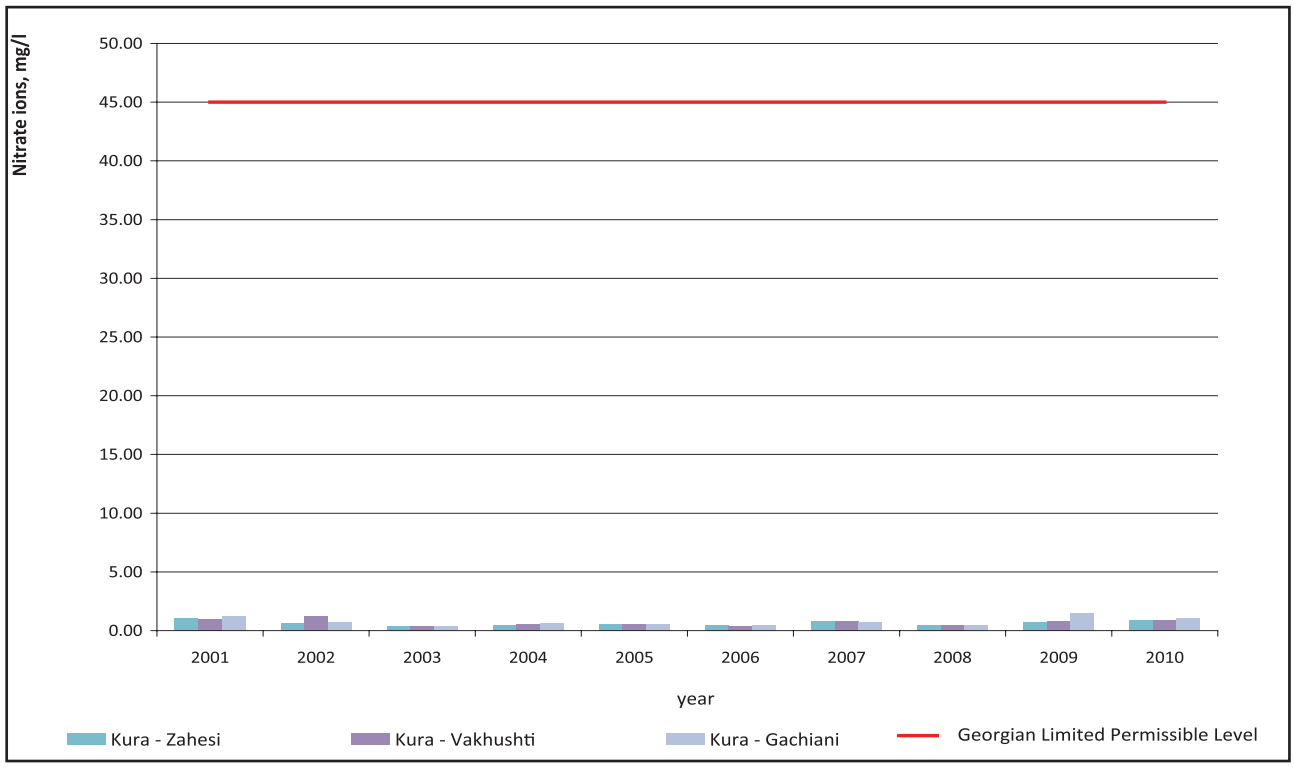
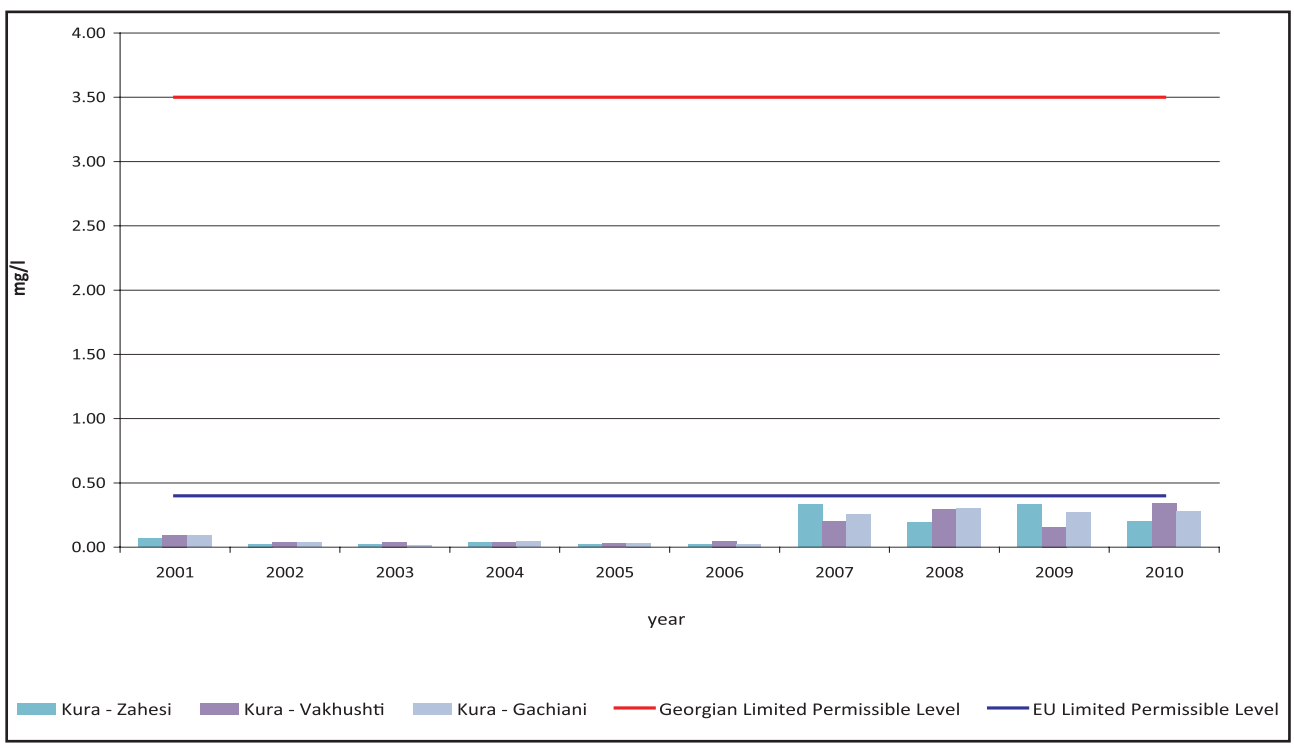


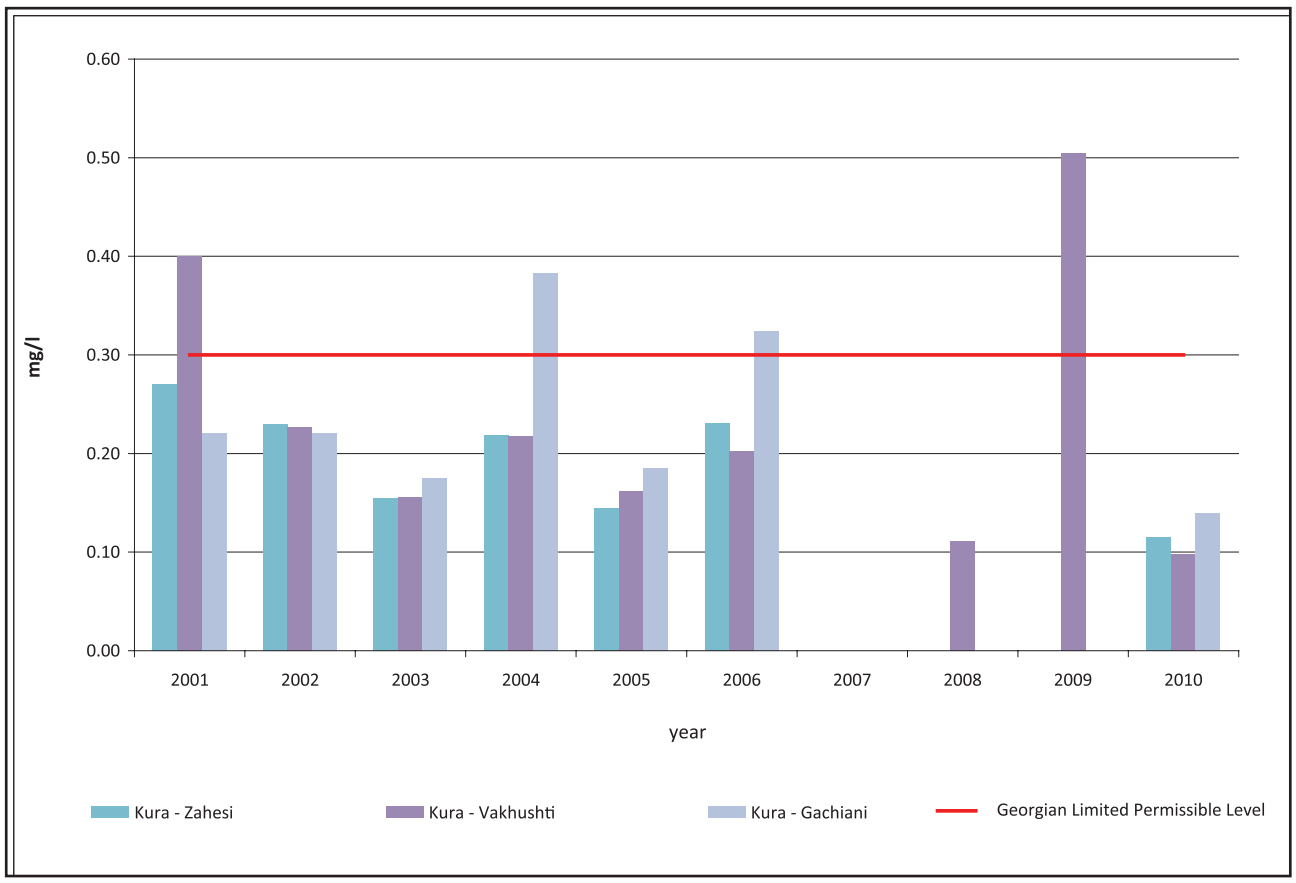
Diagram 3-24 Concentration of phosphate ions in the Mtkvari at Tbilisi



Concentrations of heavy metals during the last decade do not seem to be a significant issue in the city. Only iron shows a slightly elevated concentration, sporadically exceeding national limits at downtown Tbilisi (the Vakhushti Bridge) in 2001 and 2009; and at Gachiani in 2004 and 2006 (diagram 3.25). Other regularly measured heavy metals: copper, manganese, zinc and nickel are well below the national and EU limits[135].

135 Data provided by the National Environmental Agency, Department of Pollution Monitoring, Tbilisi, 2010

Diagram 3-25 Concentration of iron ions in the Mtkvari at Tbilisi



As mentioned above, the National Environmental Agency carries out some seasonal monitoring at certain water bodies of recreational importance, being the Tbilisi Sea and Lisi and Turtle Lakes. Besides regular physical-chemical parameters, E. Coli bacteria is tested, as it causes serious harm to a human health. As described in the National Report on State of the Environment of Georgia 2007-2009: *"**Escherichia coli** is a bacteria generally found as a normal and harmless part of the intestinal flora of the human beings and many other animals. However, in other parts of the body it can cause serious diseases, such as urinary tract infections, bacteremia, and meningitis. Pathogenic cultures of E. coli, which get into the gastrointestinal tract can cause acute diarrhea, especially in children under 5 years). Human excrements from untreated municipal wastewaters or animal wastes are considered the primary sources of Escherichia coli in water bodies"*[136]

Diagram 3.26 below shows that the problem remained serious for Lisi Lake during the bathing season of 2009. The Lake recently experienced some acute problems of hydrological balance fall, mostly caused by natural processes, but also unregulated water withdrawal for agricultural use. At some point, the two other monitored water bodies did not seem safer for recreation either.

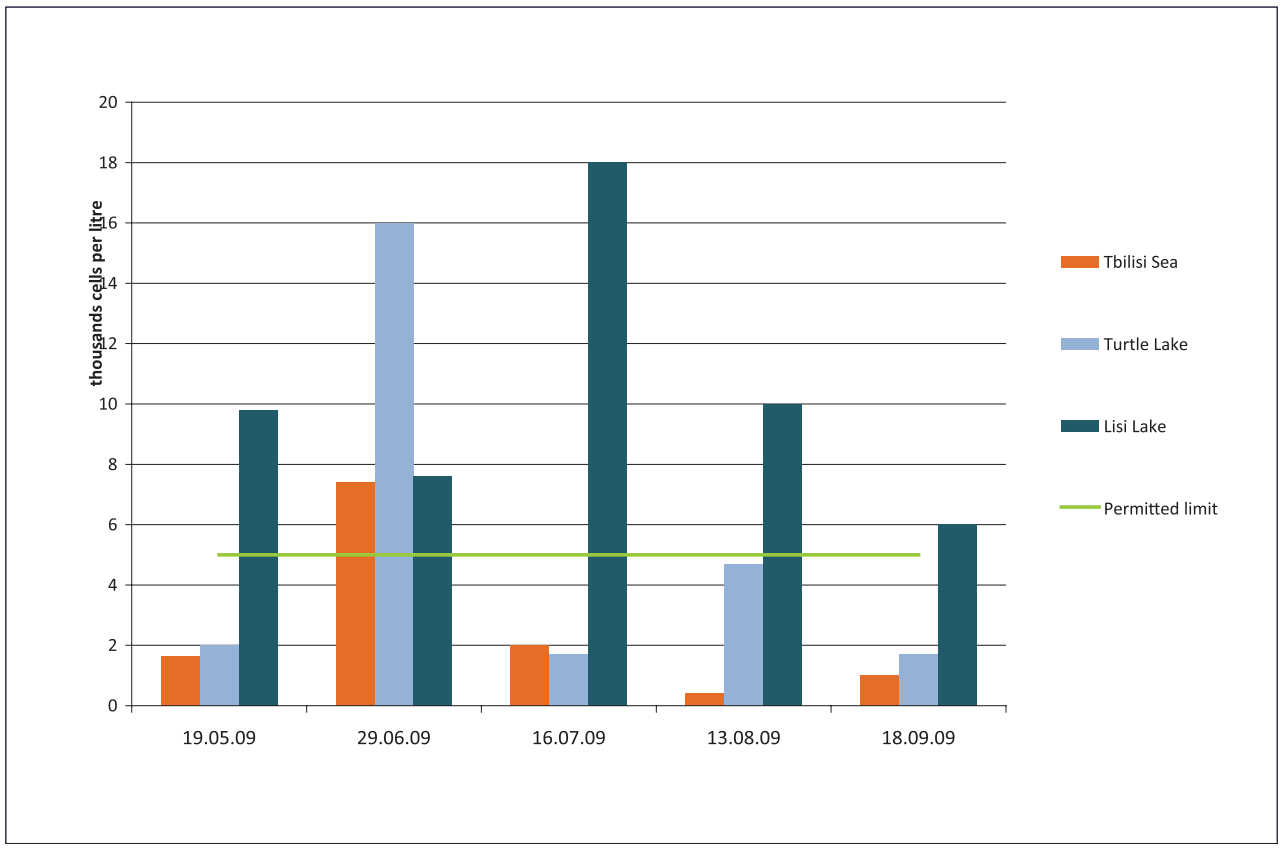
The Ministry of Environment Protection considers poor sanitary conditions, illegal discharge of untreated wastewaters in the water bodies, and poor maintenance of recreational zones, including absence of adequate protection means (fencing against domestic animals as an example) as major reasons for a high level of bacterial and microbiological pollution in the lakes and reservoirs of Tbilisi[137].

From the major trends that affect the quality of surface waters in Tbilisi, the overall high level of nutrient pollutants in the Mtkvari, especially nitrogen ammonia and nitrite ions, should be highlighted. However, the trend in concentrations of nitrite ions have been diminishing recently. The main source for those pollutants is considered to be direct discharges of untreated, or partly treated wastewaters to water bodies. However, another source of high concentration of nitrogen ions can be the use of nitrogen fertilizers for crop production upstream of Tbilisi. Concentration of ammonia within the city in general exceeds the standards established to protect human health. Consequently, BOD-5 exceeds the normative levels too at most sampling locations, especially at Vakhushti Bridge (downtown). Concentrations of E. coli in the lakes and reservoirs of Tbilisi during the summer periods are also significantly high, which undermines their use for recreational purposes.

136 National Report on State of the Environment of Georgia 2007-2009, Ministry of Environment Protection of Georgia, Tbilisi 2011.

137 ibid.

Diagram 3-26 Number of the bacteria E. Coli at recreational lakes of Tbilisi during the 2009 bathing season



3.3 Green areas

Green cover in Tbilisi and surroundings are represented both by natural landscapes and man-made recreational zones – parks, public gardens, greenery spaces with planted trees and other decorative vegetation along the streets and districts of the city. Natural ecosystems in Tbilisi are very scarce, because of active economic and agriculture activities since the very early stages of its development. Natural vegetation cover (mostly forest) remains on the outskirts and the areas with complex topography where human activities have been more or less restricted. In other easily accessible areas, where human impact was significant, the natural vegetation cover has been replaced by so-called "cultural landscapes". One such example was planting coniferous vegetation on steep slopes of landslide risk zones in the mid-1960s to prevent intensive erosion of the southern slope of mount Mtatsminda. From the existing natural ecosystems, the eastern part of the city is characterized by dry hilly steppe, while the western and northern parts by mountain forests[138].

The total area covered by parks, public gardens and greenery zones in Tbilisi is very small compared to the built up-area and population living in the city. According to normative acts designed in Soviet times and still in effect, the required green area per inhabitant in a city with a population of more than 0.5 million should not be less than 15 sq. m[139]. In the case of Tbilisi, this number never has been higher than 13.0 m^2 (in 1983). Unfortunately, an updated figure for this indicator does not exist. However, according to the latest City Master Plan, in 2001 this number was closer to a much lower value of 5.6 m^2 per city dweller[140]. Such a critical decrease could have been caused by the acute energy crisis in Georgia in the mid-1990s, when city authorities were unable to control massive tree cutting by local residents for heating and cooking. By the end of the 1990s and beginning of the 2000s, green areas again underwent extreme pressure of an unregulated and chaotic construction boom, turning parks and public gardens into building lots.

Until recently, regulation and greening of the city was the responsibility of 'Tbilgamtsvaneba' (a company owned by the city municipality) and the Culture Department of the Municipal Cabinet, which used to carry out management and economic activities. Large parks of the city (so-called parks of culture and recreation) were supervised by the Department of Culture that in 1994 moved back to the

138 Committee of Environmental Protection and Regulation of Natural Resources, Municipality of Tbilisi, Environmental Assessment Report of Tbilisi, 2000, pg. 70

139 Committee of Environmental Protection and Regulation of Natural Resources, Municipality of Tbilisi, Environmental Assessment Report of Tbilisi, 2000, pg. 67.

140 Municipal Service of Spatial Planning and Development, Summarized Concept for Urban Development in Tbilisi, Draft Paper, Tbilisi, 2003, pg. 53.

'Tbilgamtsvaneba'[141]. The current situation is more or less stable, with green areas being monitored and regulated by the municipal Service of Ecology and Greenery Planting and the newly established unit under the Municipal Inspectorate Service. According to a recent amendment to the Civil Code of Georgia, administrative violation causing damage to parks, public gardens and any green areas in the city is subject to a GEL 500 fine for first-time damage, and increases to GEL 1000 and other criminal charges for further violations[142].

The Service of Ecology and Greenery Planting has been coordinating tree planting in different districts in the city, covering an area of 450 m2 in total. In addition, 40 squares were rehabilitated. It is planned to move Tbilisi Zoo from the city centre to the suburban area and to create a recreational complex and a park on the territory of the present Zoo and the Mziuri Park. It is also planned to totally rehabilitate Vake Park and to restore a 100 ha forest area in the surroundings of Tbilisi in Tsavkisi.

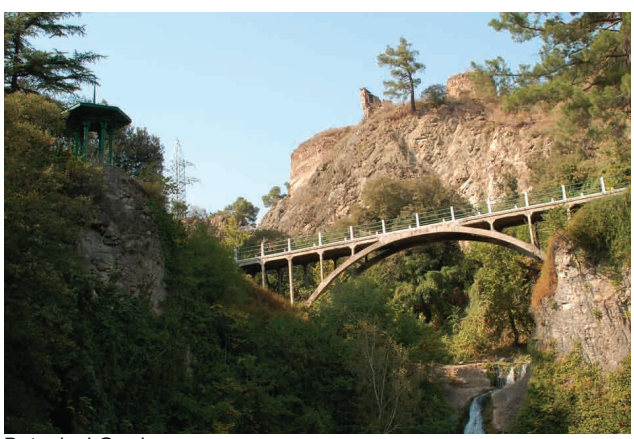
The largest and most significant city parks (except Vake Park) are Mtatsminda Park, Lake Lisi Park and Tbilisi Sea Park, located rather far from residential areas and therefore less accessible to ordinary citizens on a daily basis. In general the situation of green spaces is very difficult in the city. According to the City Master Plan, in 2003 Tbilisi counted seven registered recreational and cultural parks with a total area of 267 ha, nine public parks with the total area of 91 ha, seven gardens (20 ha), six boulevards (9 ha), as well as a number of green spots, or 'square gardens' (212 ha) and street greenery plantings (390 ha)[143]. One of the distinctive Tbilisi parks is the Botanical Gardens. The history of the garden began in the eighth century. It features a unique microclimate, attractive landscapes and is an integral part of old town Tbilisi. The total area of the Gardens includes 275 hectares; green crops compose 190 hectares of unique vegetative cover[144].

141 http://ceroi.net/reports/tbilisi/issues/green_areas/state.htm .
142 http://www.tbilisi.gov.ge/ .
143 Municipal Service of Spatial Planning and Development, Summarized Concept for Urban Development in Tbilisi, Draft Paper, Tbilisi, 2003, pg. 53-54.
144 http://ceroi.net/reports/tbilisi/issues/green_areas/state.htm .

The green cover of the city and surrounding area also includes the Tbilisi National Park located at 25 km distance north of the city in the Mtskheta-Saguramo direction. The total area of the Park is 24,368 ha. It was established on the basis of the previously existing Saguramo Strict Nature Reserve founded in 1957. One can find 675 species of grass and woody plants in the Park, among which 104 species are trees and shrubs. The dendroflora of the Park is unique due to representation by Colchis species of the Tertiary period, such as: Black Sea holly *(Ilex colchica),* Persian ivy *(Hedera colchica)* and Pastuchov's ivy *(Hedera pastuchowii),* European cranberry bush *(Viburnum opulus)*, Butcher's Broom *(Ruscus ponticus),* yew *(Taxus baccata),* Caucasian rhododendron *(Rhododendron caucasica),* etc. Among forest species, the Park is dominated by Georgian oak, Oriental beech, Caucasian hornbeam, ordinary ash-trees, and Oriental hornbeam and crabapple trees. The fauna of the park is very diverse. The most widespread species include the Red fox *(Vulpes vulpes)* and Gray wolf *(Canis lupus)*; Beech marten *(Martes foina),* hare *(Lepus europaeus)* and weasel *(Mustela nivalis)* can be found nearly anywhere; and such large animals as the Prey lynx *(Lynx lynx)* and Brown bear *(Ursus arctos)*. Other ungulate animals found in the park include Roe deer *(Capreolus capreolus)* and famous Caucasian Red deer *(Cervus elaphus).* Among ornitofauna, widespread species include the Eurasian jay, Blackbird and several species of woodpeckers. Among birds of prey, the most numerous are the Sparrowhawk, Imperial eagle *(Aquila heliaca)*, Greater spotted eagle *(Aquila clanga)* and Levant sparrowhawk *(Accipiter brevipes)*. There are about 12 reptile species inhabiting the Park. Among the most widespread is the European legless lizard, as well as Grass snakes, Yellow-bellied racer and Smooth snake[145].

As mentioned above, green areas in Tbilisi are distributed unequally and are located at considerable distance from the most populated districts, making their accessibility rather difficult. Calculating green space per built up area and city dweller is a relatively simple exercise. However, the question is what to

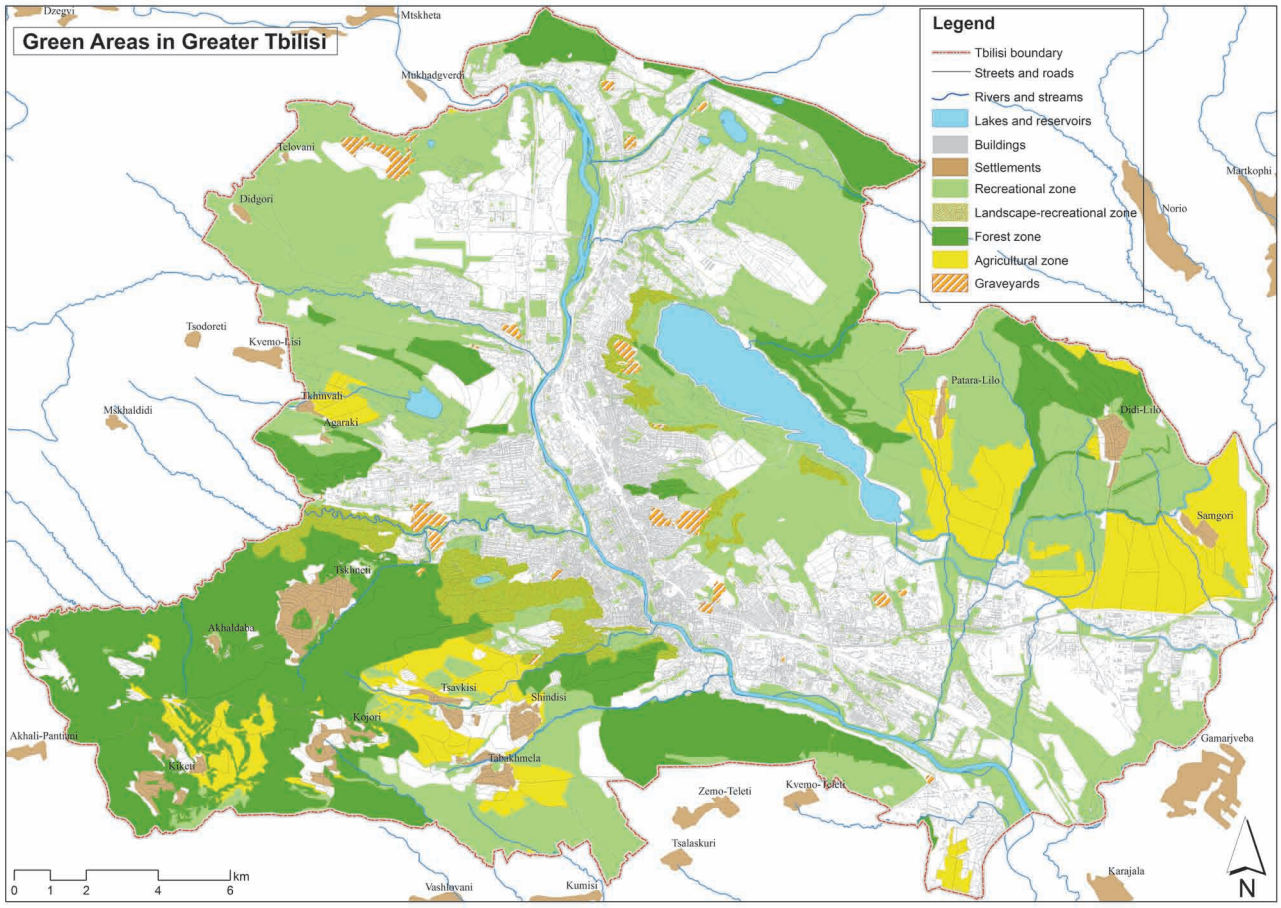
145 http://www.dpa.gov.ge/index.php?site-id=5&page=2&id=274 .



Botanical Garden
Photo provided by Tbilisi City Hall

Vake Park
Photo provided by Tbilisi City Hall

Figure 3-3 Green Areas in Tbilisi



include as a baseline and where to put the boundaries for calculation. The official city limits in Tbilisi have changed recently, increasing at the expense of neighboring rural districts of Gardabani and Mtskheta. This on one hand has altered the total balance of green areas within the administrative boundaries of Tbilisi Municipality in a positive way (fig 3.2). However, the latest should not be taken as improvement of ecological conditions in the city itself, since the population number, as well as the green cover in the immediate proximity of the dwelling zone and built-up area has not changed.

The latest City Master Plan of 2009 among others classifies functional land use zones for three types of green areas: Landscape-Recreational Zone, Recreational Zone, and Forestry Zones. If calculating total area for all three zones and considering this figure as the sum of green space, it adds up to 266.37 km^2, or 26,637 ha (landscape-recreational zone – 1,394 ha; recreational zone – 16,043.5 ha; forestry zone – 9,200 ha)[146].

Another possible way to calculate the balance of green space in Tbilisi and its effect on an urban environment, for a city characterized by a semi-dry to dry environment of inter-mountain gorges with very low natural atmospheric inversion, is to follow the so-called watershed approach; i.e., locate the city's boundary line closest to the built-up area watershed hilltops. The old municipal boundary line (if excluding the recently added district of Didgori) more or less closely follows this approach. To give the most accurate picture, however, requires digitizing the precise natural boundaries of the area, as well as taking into account other indicators, such as types of vegetation, relative biomass, climatic conditions, wind directions etc.

3.4 Noise

Noise is one of the important physical factors influencing the natural environment and human health. In Georgia, the norms for impact of noise on human health were established by Order #297/N "On the approval of environmental quality norms" of 16 August 2001 by the Minister of Labor, Health and Social Affairs. In particular, this document establishes the permissible limits of noise at working places, the premises of public buildings and residential sites.

Road traffic is the basic source of noise in Georgia. On the basis of measurements, it has been determined that, on the main streets and highways in Tbilisi, noise exceeds the permissible limits during rush hours (see Table 3.2). At certain sections of main highways and streets, noise reaches 78 dB, whereas on central highways 75 dB is the permissible threshold level between 7 and 11 p.m., and between 11 p.m. and

146 GIS calculations by the author; source of GIS data: The Perspective Master Plan of Tbilisi, 2009.

Table 3-2 Traffic flow noise characteristics in some streets and highways in Tbilisi

The place where noise was measured	Level of noise (dB)			
	2002	**2003**	**2004**	**2005**
Paliashvili St.	-	72	70	70
I. Abashidze St.	-	73	73	73
Varaziskhevi	80	78	80	80
Kostava St.	-	76	75	75
Melikishvili St.	76	77	76	76
Vazha-Pshavela Ave.	-	75	76	76
Al. Kazbegi Ave.	-	76	-	-
Rustaveli Ave.	76	76	77	77
Pushkini St.	-	77	-	-
D. aghmashenebeli Ave.	76	77	-	-
Tamar Mefe Ave.	-	75	-	-
Tsereteli Ave.	-	-	76	76

Source: The Institute for Environmental Protection, 2002

Table 3-3 Averaged data of the noise level in Digomi residential community at 8 sites, March 2004

The place of measurement	Noise level during the day (dB)	Noise level at night (dB)
In the vicinity of Traumatology Hospital	26	24
Northwest angle of the residential part of the Digomi community	30	26
Northeast angle of the residential part of the Digomi community	38,5	30
The square between the movie theater and the market	41,5	29
The third quarter, close to building # 33	22	22
The confluence of Friendship Avenue and the Military Highway	49,5	32
The confluence of Friendship Avenue and the River Bank	41,5	31
Southeast angle of the residentail part of the Digomi community	39,5	30

Source: The data of the Institute of Geophysics of the Georgian Academy of Sciences, 2004.

7 a.m., the permissible threshold level is 65 dB.[147] The highest index number 78-80 dB is recorded in Varaziskhevi. In table 3.2, one finds measurements made by Georgian Institute of Environment Protection in 2002-2005 in some streets and highways in Tbilisi.

The given data confirm an assumption that at residential and public buildings located along main streets and highways in Tbilisi, the level of noise is above established standards. Based on the same data, one can conclude that after the reconstruction works done in 2004, the noise level has changed in the streets surrounding the so called "Triangle". In particular the noise index increased by 1-2 dB in Varaziskhevi, while in Melikishvili Street due to an average speed reduction, it decreased by 1 dB. The noise level in Kostava Street also decreased by 1 dB. One can draw no conclusions for the Heroes' Square reconstruction, since no data are available.

Within the context of the German Technical Cooperation Agency (GTZ) project "Land Management" for another GTZ project "Caucasus Women's Network", the Tbilisi municipality implemented a pilot project called "Multi-

147 Order # 297/N of the 16th of August, 2001 of the Ministry of Labor, Health and Social Affairs of Georgia "on the approval of environmental quality norms".

Table 3-4 Averaged data of the noise level at 10 sites of old Tbilisi territory, December 2005

Place of measurement	Noise level during the day (dB)	Noise level at night (dB)
Avlabari square	48,5	36
Metekhi turning	24	22
Mirza Shapi street	22	21
Gorgasali square (at Metekhi bridge)	44	32
K.Leselidze street (at the turning to Erekle street)	45,5	34
L.Gudiashvili square	38	30
Confluence of Machabeli and Lermontov streets	39,5	31
Freedom square	41,5	35
Vertskhlis street #32	32	26
The right bank of the river Mtkvari, adjacent to Anchiskhati	41	33

The source: The data of the Institute of Geophysics of the Georgian Academy of Sciences, 2005

Purpose Cadastre of Tbilisi". For this purpose, the Institute of Geophysics of the Georgian Academy of Sciences made test measurements during the day and night time in residential neighbourhood at eight points of the Digomi residential area in windless weather conditions. The results of this study are given in table 3.3.

The above-mentioned averaged data do not exceed the noise standards established for the residential zone. In particular, the permissible threshold level is 55 dB in daytime at a two-meter distance from residential apartment houses and 45 dB at night.[148] On the roads within this community, it is 55 dB in the daytime and 45 dB at night.[149] The increased level of noise at defined daytime periods is basically caused by the movement of heavy trucks and buses. After business hours and especially after sundown, they are no longer in circulation. Simultaneously, the traffic intensity decreases.

In December 2005, noise levels were measured at 10 points of old Tbilisi at different times of the day. The study was performed by Institute of Geophysics of the Georgian Academy of Sciences within the frame of the Georgian Cultural Heritage Protection Fund project "State Programme for Old Tbilisi Rehabilitation and Development". The results of the study are given in table 3.4.

In this instance, the averaged data do not exceed the standards established for residential zones. The intensity of noise at defined periods of time is basically caused by increased traffic.

The above measuring which is also reflected on map 3.1 has been done only at some points and cannot be seen as representative for all noise pollution in the city. It is necessary to conduct a comprehensive study of the noise levels generated by traffic flows and conduct an overall noise mapping for Tbilisi. As can be concluded from the data available, the main source of noise pollution in the city is traffic. Despite the fact that the number of vehicles has increased in Tbilisi, the growth of noise intensity caused by motor transport is to a certain extent related to the large number of old-fashioned and malfunctioning vehicles. Formerly, vehicle noise characteristics were checked annually at eco-diagnistic stations. It was prohibited to drive motor vehicles that produced noise above permitted standards. At present, these eco-diagnostic stations are not in operation. The characteristics of vehicle noise have not been checked for the last 10-15 years.

Industrial facilities are also a source of noise. Usually, large industrial facilities are required to have an environmental impact permit. Accordingly, in the process of environmental impact assessment, noise standards should be taken into account and mitigating measures planned, although there are no concrete effective mechanisms for enforcing these standards. Moreover, small industrial enterprises that don't need environmental impact permits - such as gas filling stations, wood and stone-cutting machine tools, compressors, etc. - often produce intensive noise during operation. While designing such facilities, noise protection issues have never been taken into account.

3.5 Radiation safety

Introduction

Ionizing radiation, which is often referred to as "radiation", is the emission of sub-atomic particles or electromagnetic waves energetic enough to detach

148 ibid
149 ibid

Table 3-5 Mean annual values of gamma-radiation doses in ambient air in Tbilisi, 2007-2010

	2007	2008	2009	2010
Mean annual value (micro-roentgen/hour)	13	13	14	14

Source: National Environmental Agency of the Ministry of Environment Protection of Georgia

electrons from atoms or molecules, thus ionizing them. Examples of ionizing radiation are x-rays and gamma-rays. Other types of radiation with less energy which cannot generate ions are called non-ionizing radiation. Radio-waves, microwaves and visible light are examples of non-ionizing radiation.

Exposure to ionizing radiation causes damage to living tissue, and high doses can result in mutation, radiation sickness, cancer and death. Therefore, radiation safety norms have been developed in compliance with levels that allow avoiding possible harm.

The main source of human-made radiation sources comes from radioactive materials, x-ray tubes and particle accelerators. These sources have many practical uses in medicine, research, energy, defense, construction, industry and other areas, but they also present a health hazard if used improperly. Medical procedures, such as diagnostic X-rays, nuclear medicine and radiation therapy, are by far the most significant source of human-made radiation exposure to the general public. Of lesser magnitude, human beings are exposed to radiation from the nuclear fuel cycle in atomic energy, which includes the entire sequence from mining and milling of uranium to the disposal of the used fuel. Nevertheless, if an industrial accident occurs, there is a very high risk of public exposure to dangerous doses of ionizing radiation. In a nuclear war, gamma rays from fallout of nuclear weapons would probably cause the largest number of casualties.

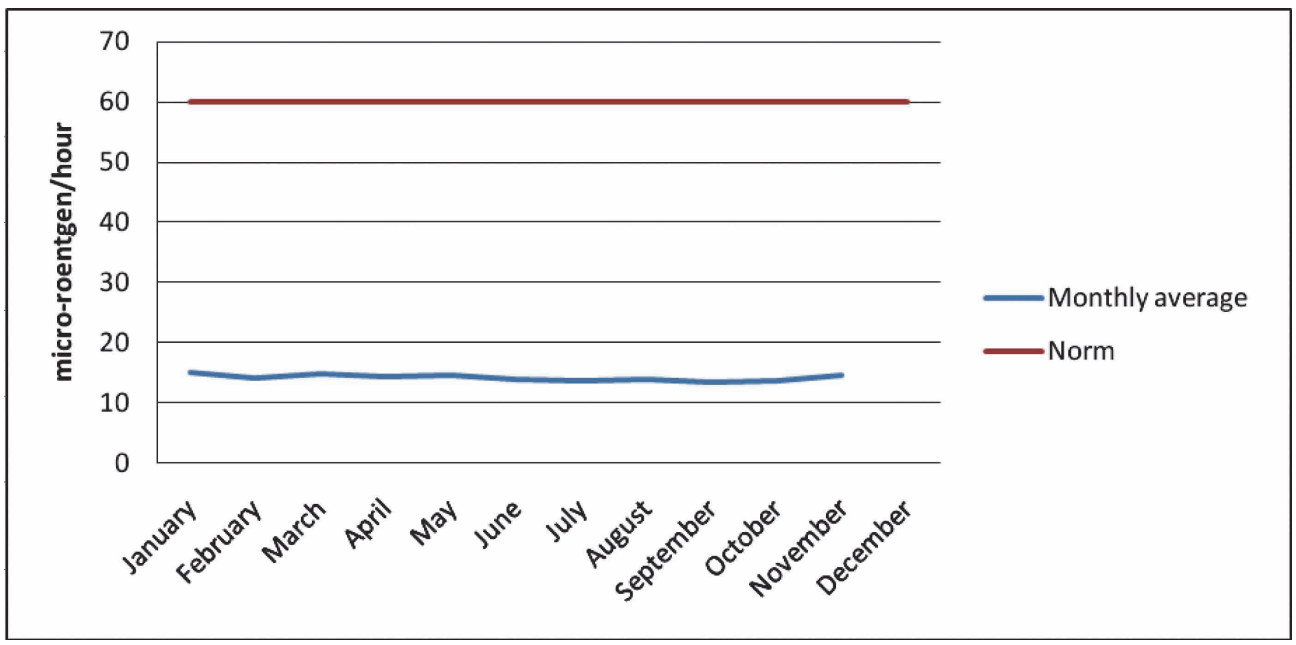
Sources of ionizing radiation and radiation levels in Tbilisi

Sources of human-made ionizing radiation can be found in Tbilisi and its surroundings. However, most of these sources are under strict control and do not pose a risk to human health or the environment. Background radiation values in the air, which have been regularly monitored by the National Environmental Agency (NEA) in Tbilisi's environment, are within the national norms (see table 3.5). The national norm of exposure to ionizing radiation in Georgia is 60 micro-roentgen/hour, a level below which human health risk is considered to be minimal.[150] The NEA measures radiation levels in Tbilisi every day. Diagram 3.27 provides more detailed information on monthly average radiation levels in the air in Tbilisi.

A scientific-research nuclear reactor in Mtskheta, near Tbilisi, was operated from the 1960s until the 1990s. It is now closed and with the support of the International Atomic Energy Agency (IAEA) is in the process of being decommissioned. The former site for the disposal of radioactive wastes that was operated during the Soviet period and was located to the east of Tbilisi in

150 Source: *State of the Environment Report for Georgia 2007-2009. http://soegeorgia.blogspot.com/p/english-version.html*

Diagram 3-27 Mean monthly values of gamma-radiation doses in the ambient air in Tbilisi for 2010



the village of Saakadze (Gardabani municipality) has been closed since the 1990s. The background levels of radiation are within the permissible levels at both of these facilities.

In the Agrarian Radiology and Ecology Scientific-Research Institute which is located in Zahesi settlement, a suburb in the northwest of Tbilisi, there is a temporary storage place of radioactive substances. At present, as reported by the Georgian Ministry of Environmental Protection, total radioactivity of all sources here is 210'000 Curie. These radiation sources are not in use at present. All the sources have been stored safely in lead containers.

The main man-made sources of ionizing radiation have been used for medical, scientific or industrial purposes in Georgia and Tbilisi, in particular. As reported by the MEP, about 750 organizations possessing or using ionizing radiation sources were registered in Georgia by January 2010. Many of these organizations function in Tbilisi. These organizations possessed or used ionizing radiation sources including 2011 generators, 1300 "sealed" and 215 "unsealed" sources of ionizing radiation.[151] Activities of these sources varied from 1 mille-Curie up to 35'000 Curie.

The handling and storage of sources which are in use are regulated by national legislation - the Law of Georgia on Nuclear and Radiation Safety (1999). Import and export of ionizing radiation sources is subject to permission by the Ministry of Energy and Natural Resources (MENR).[152] The Nuclear and Radiation Safety Service (NRSS) of the MENR maintains a register of data on import, export, transit and transportation of radioactive sources within the country. It is also responsible for issuing licenses to and inspecting those organizations that have engaged in activities related to the use of radioactive sources.

Unused sources are given the status of radioactive waste and stored in a temporary repository. Nuclear fissionable material must be stored under strict control. The NRSS conducts regular monitoring of these materials. The temporary repository of radioactive substances came into operation in 2007 and has among its roles to assure the safe storage of radioactive wastes.

Detection, removal and safe storage of uncontrolled and disused radioactive sources remaining since the Soviet period are still in progress. Management of these sources during the period of disintegration of the former Soviet Union appears to have been very poor, with many being lost or discarded in an inappropriate manner (especially by military facilities of the former Soviet Union). The NRSS is responsible for the detection and neutralization of uncontrolled radioactive sources remaining since the disintegration of the Soviet Union. In 1996, 11 soldiers were affected by radioactive sources containing Cesium-137 on the territory of Didi Lilo military training base which earlier was a Soviet Army base.[153] As reported by the NRSS, tens of uncontrolled radioactive sources have been found in Tbilisi since then. About one-third of these sources were found without proper containers. At present, all these sources have been stored safely in appropriate storage places.

To prevent and restrict illegal use and transit of nuclear and radioactive substances, the use of portable detectors at check points on the Georgian border commenced in 2008-2009. The level of control on the transit of nuclear and radioactive substances is considered adequate. The capacity to deal with emergency response to radiological accidents has been developed to some extent in the country; however, future improvements are required.[154]

In summary, ionizing radiation sources, including radioactive wastes, have been managed reasonably in Tbsilisi and in its surroundings. Radiation levels in the city are within norms. Some risks of human exposure to radioactive sources remaining from the Soviet period which may have been improperly disposed of in various places still exist. However, environmental authorities take all appropriate measures to detect, remove and safely store such sources.

3.6 Pollution "hot spots"

Gldani Landfill

As discussed in Chapter 2.5.4, two old landfills of Tbilisi – Gldani and Iagluja, even though being closed down, still continue to be pollution "hot spots" due to ongoing burning processes and constant release of pollutants into the environment. Since our report is focused on the capital, only Gldani landfill will be discussed in this Chapter (Iagluja landfill is located outside the Tbilisi administrative borders, in Gardabani municipality).

The Gldani landfill is located in the northern part of the city, 30 km from the city centre. The distance to the nearest residential buildings is 700 m. The area of the landfill is eight hectares. Together with seven hectares, conserved earlier, this constitutes 15 hectares in total. Average depth of the disposed waste is 15-20m. Minimal and maximal depth is 3m and 30 m respectively.[155] The landfill used to receive 60% of

151 Sealed is when a radioactive source is disposed in a capsule for unlimited time, or mixed with non-radioactive material in a way to avoid accidental leakage or separation. The unsealed sources are, as a rule, of low activity and used for scientific purposes.

152 Ionizing radiation sources are not produced in Georgia. A small amount of the sources in use today remain from the Soviet period. Sources needed for various purposes are imported. Some spent sources are being handed back to the foreign producers for further handling.

153 Information was provided by the NRSS.

154 State of the Environment Report for Georgia 2007-2009. http://soegeorgia.blogspot.com/p/english-version.html .

155 Materials provided by Tbilisi Waste Management Municipal Department for the UNDP Project "Support to the Ministry of Environment Protection in Improving the Environmental Planning Framework, 2006.

wastes from the city. It has been officially closed since November 2010.

The landfill was built in 1972; it is unlikely that any environmental conserns were taken into consideration in its design. The landfill claimed to have a leachate collection system initially. However, studies do not reveal the presence of any collection pipes[156]. Even if collection pipes are there, leachate catchment and treatment have not been undertaken. There is no landfill gas collection system either.

Waste disposal operations have been rather simple. Waste was delivered to the landfill, pressed and redistributed over the landfill area with bulldozers. Sometimes waste was covered with soil. However, there was no coordinated management of landfill area and its surface. It was hard even to distinguish the boundaries of the landfill. Surface water runoff was not managed either. As a result, slopes of the landfill were rather steep, and barely accessible for trucks, which made it difficult to extinguish landfill fires.[157] Due to natural ignition of landfill gas, constant burning was common even on rainy days. The smoke over the landfill was easily visible even from afar. It is thought that some part of the waste was burnt deliberately, to reduce the amount of waste.[158] The emission of harmful substances caused by landfill waste burning has been causing health impacts for the adjacent Gldani district population for years.

Rainwater, as well as small streams flowing from the upper part of the waste dump, have been easily seeping through the entire landfill area, likely producing considerable amounts of leachate. The absence of an isolating layer at the bottom and a leachate collection system raise substantial concerns, that the leachate seeping through the landfill layers has been a constant source of environmental pollution. However, there are no studies on groundwater conditions to estimate the level of groundwater pollution from the landfill.[159]

Even though Gldani landfill is officially closed, it remains a source of severe environmental pollution. Ignition processes and burning are ongoing. Leachate waters continue to be released into the environment. In order to neutralize this pollution “hot spot”, it is necessary to plan and undertake proper landfill conservation/remediation measures. In addition, it is essential to carry out periodic monitoring of the surrounding environment, in order to reveal any signs of waste-induced pollution and adjust impact mitigation measures accordingly.

156 Georgian-German Technical Collaboration, *Situation Analysis of the Waste Management Sector in Tbilisi and Recommendations for its improvements;* Pg. 8-9.

157 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 49; Georgian-German Technical Collaboration, *Situation Analysis of the Waste Management Sector in Tbilisi and Recommendations for its improvements,* Pg. 8.

158 Georgian-German Technical Collaboration, *Situation Analysis of the Waste Management Sector in Tbilisi and Recommendations for its improvements,* Pg. 7.

159 Tbilisi Waste Management Concept, 2006, German Society for Technical Cooperation (GTZ), pg. 49; Georgian-German Technical Collaboration, *Situation Analysis of the Waste Management Sector in Tbilisi and Recommendations for its improvements.*

Gldani Landfill
Photo by Kety Gujaraidze

CHAPTER 4: Environmental Impacts

Chapter 4 provides information about the impacts caused by the state of the environment on natural ecosystems, human health, quality of life of citizens etc. This information helps to answer the question: **What are the impacts of the state of the environment?** It is important to emphasize that contemporary environmental and socioeconomic trends (described in the previous chapters) may also have significant local, national and even international repercussions. Environmental impacts caused by Tbilisi's urban activities also extend beyond its formal administrative boundaries. The scope of this Report is limited to the analysis of environmental impacts only within the current boundaries of Tbilisi city.

In particular, the chapter will cover the following issues: human health effects caused by air pollution-related diseases and water-borne diseases; trends of microclimate changes in the city and related health risks; and trends and causes of natural hazards of an extreme hydrometeorological character.

4.1 Impacts on environment and human health caused by air and water pollutions

4.1.1 Impacts on human health caused by air pollution and related diseases

In general, air pollution negatively affects human health, ecosystems and living organisms, and damages agriculture crops, buildings and historical monuments. These effects result in social and economic costs and losses such as human lives, costs associated with medical treatment, lost workdays due to air-borne diseases, poorer agriculture crops, diminished aesthetic values of touristic places, and reduction of the value of recreational areas etc.

In the context of Tbilisi, the most significant impact of air pollution, perhaps, is adverse effects on human health. Damage to buildings and historical monuments which is a significant problem in European and North American cities and which happens due to acid rain is not an issue here.[160] Air pollution in Tbilisi reduces the potential of the city to attract more tourists and it may hinder tourism's development in the future. However, studies exploring this problem are not available at this moment.

It is difficult to assess health and other effects related to air pollution in a certain environment. This is due to the complexity of factors that affect human health in conjunction with poor air quality. Identification of direct linkages between air pollution and human health effects require long-term observations on air quality and specific epidemiological studies. These kinds of studies have not been conducted in Georgia for a long period of time. Nevertheless, statistical data of the National Center of Disease Control and Public Health suggests that the number of registered diseases which, among other factors, can be associated with poor air quality, such as lung and **larynx** cancer, respiratory, blood and vascular diseases have been increasing in Georgia and its capital, in particular.[161] Moreover, the number of registered diseases is higher in Tbilisi, when compared with the average across Georgia.

Some studies related to air quality and human health in Tbilisi are available from the mid-1990s and beginning of 2000s. From the earliest study carried out by Georgian experts in 1995-1997, the health of people living on Agmashenebeli and Tsereteli Avenues was explored. The control group for the study were people living on Nutsubidze Plateau, where the air is relatively clean. The study found that lead content in the blood of about 25% of people studied was three times higher than the level recommended by the WHO. The content of lead in urine and hair was also high. 60% of people studied contained high levels of carboxyhemoglobin[162] in the blood. The study also found pathologies of the cardio-vascular system, especially hypertensia (high blood pressure), heart diseases, stenocardia and other types of pathologies among 21% of the people studied. These pathologies were especially higher among people over 40 years of age. In the group of children who lived close to avenues with heavy traffic, the content of lead in hair and urine was much higher than that for children living in the cleaner area. In this group, 78% children had different blood pathologies, and 25% had heart problems. In contrast, the study found many fewer pathologies in the control group.[163]

160 Acid rain is caused by emissions of sulfur dioxide and nitrogen oxides that react with water molecules in the atmosphere to produce acids. It can have harmful effects on plants, aquatic animals and infrastructure through the process of wet deposition. Acid rain can also damage buildings and historic monuments, especially those made of rocks such as limestone and marble containing large amounts of calcium carbonate. Regions with significant impacts from acid rain around the globe include most of Eastern Europe from Poland northward into Scandinavia, the eastern third of the United States, and southeastern Canada.

161 Ministry of Labor, Health and Social Affairs of Georgia, National Center of Disease Control and Public Health. *Health Protection, Georgia, 2009, Statistical Year Book.* Tbilisi. 2010.

162 Carboxyhemoglobin is a compound formed in the blood when inhaled carbon monoxide occupies the positions on the hemoglobin molecule normally taken by oxygen, resulting in cellular oxygen starvation.

163 Georgian Center for Strategic Research and Development. Article by Mariam Shotadze: *Problem of Atmospheric Air pollution in Tbilisi – Priority National Problem.* Bulletin N80, September, 2003.

A second study related to air quality and health in Tbilisi was conducted by international experts in 1999-2000 under the UNDP/UNOPS project on phasing out of lead in gasoline in Georgia. This project conducted, through modeling, an assessment of lead content in blood and related human health effects in Tbilisi. The model estimated that with lead content in gasoline (50mg/l) used in Georgia at that time, lead content in blood would have been higher than the norm recommended by WHO (10 mcg/l) in all groups of people. An especially high lead content in blood would have been found in the group of people living in the center of Tbilisi.[164]

It needs to be noted that according to the decision of the Georgian Parliament of 22 July 1999, import and use of leaded gasoline (gasoline with lead content higher than 13 mcg/l) has been prohibited in Georgia. Nevertheless, leaded gasoline still accounted for 10% of all gasoline sold on the market in Georgia in 2000, and 90% of lead emissions in the air was from motor transport.[165] This was found in the study implemented under the phasing out of lead in gasoline in Georgia. No other comprehensive study on lead content in gasoline has been carried out since that period in the country. At present, laboratory control of the quality of imported gasoline is very poor. Therefore reliable information on lead content in gasoline used in Georgia and related air emissions of lead from motor vehicles is not available.[166]

A third study was conducted in 2001-2002 by the British company "AEA Technology". This study assessed negative health effects from nitrogen dioxide (NO_2). The study used results of measurements of NO_2 concentration and other pollutants in the air in Tbilisi. The study estimated through modeling that about 14% of Tbilisi's population (165000 people) would be exposed to levels of NO_2 concentrations above the norm established by the EU (0.04 mgm/l). The most polluted parts of the city were Tsereteli, Agmashenebeli and Rustaveli avenues, as well as areas around the Central Train Station and Isani district. It was estimated that with current levels of NO_2 concentration in the air, 150 early death cases and 65 cases of hospitalization due to airborne diseases would be expected per year in Tbilisi. In addition to NO_2, health effects of other pollutants were also assessed. It was estimated that as a result of current (at that time) concentrations of fine suspended particulates, sulphur dioxide, nitrogen oxides and ozone, 450 cases of hospitalization would be expected related to respiratory diseases. The models assessed that the high levels of concentration of fine particles in the air would result in the reduction of people's average lifespan by eight months due to airborne chronic diseases. An especially vulnerable group is children. In this group, air pollution with fine particulates and ozone would cause about 12'000 cases of asthma and 13'000 cases of bronchitis per year.[167]

In summary, earlier available studies on airborne health problems do not provide an adequate picture of the issue at this moment. Nevertheless, results of these studies and recent trends of increasing emissions from traffic suggest that air quality degradation has long since become a significant problem for people living and working in Tbilisi, as well as for people visiting the city for a certain period of time. A great number of people, especially those living in the central parts of the city, are exposed to poor quality air that is harmful to human health. The most vulnerable groups are children, elderly people and those with a weak immune systems.

Because of poor air quality coupled with other environmental problems (e.g. noise), more and more city dwellers try to stay outside of Tbilisi, especially in the summer season. Wealthier people buy or build houses in villages around the city. This trend most likely will continue and intensify in the coming decades in the wake of global warming. This movement provides incentive for expanding the city beyond its current boundaries and puts more ecological pressure on the surrounding countryside, which currently offers essential recreational functions for Tbilisi city dwellers.

4.1.2 Impact on human health caused by water-borne diseases

Analysis of how water pollution from industrial and municipal waste, poor sanitation and malfunctioning of water supply systems is reflected on human health requires area-specific and population-targeted studies that are very limited in Georgia. The only available source for health data currently is the National Center of Disease Control and Public Health that conducts statistical analyses on a national level. Only selected indicators are being processed on a local or municipal level.

The Table 4.1 above shows the general picture of various infections and parasitic diseases in Georgia among children and overall. Another table (Table 4.2) is the only available breakdown of the given information for the capital area, which includes the total number of cases, as well as incidents in the population per 100,000 inhabitants. However, there

164 NORCE and MEP, 2000. The Norwegian Consortium for Energy and Environment – NORCE in Association with the Ministry of Environment Protection of Georgia (MEP), UNDP/UNOPS, GEO 2110, Country Programme for Phasing out of Lead in Gasoline in Georgia. Volume 1: Assessment of the Existing Situation and Development of Baselines, Final Report, Tbilisi, Georgia, 2000.

165 Georgian Center for Strategic Research and Development. Article by Alexander Mindorashvili: *State of the environment in Georgia and Related Social Problems*. Bulletin N100, December, 2006.

166 Georgian Center for Strategic Research and Development. Article by Avto Budaghashvili : Air Quality and Air Emission Sources, prepared for the Bulletin N106, December 2007, available at: http://aarhus.ge/index.php?lang=eng&page=243

167 AEA Technology, 2002, Technical Assistance with Development of Air Quality management Plan and Health Effect Study for Tbilisi – Final report.

Table 4-1 Infectious and Parasitic Diseases, Total in Georgia 2008-2009[168]

	2008		2009	
	Total	Among children	Total	Among children
Salmonelose	160	97	166	66
Shigelose	103	74	96	76
Other bacterial infections	957	663	855	578
Among which: Escherichiosis (E.coli)	747	508	626	439
Amoebiasis	4	0	4	1
Diarrhea of infectious origin	10987	7282	9926	6572
Total viral hepatitis	5915	1051	4644	399
Viral hepatitis A	888	511	389	176
Viral hepatitis B	1732	18	1634	15
Viral hepatitis C	2117	6	1968	4
Other viral hepatitis	1178	516	653	204

Table 4-2 Infectious and Parasitic Deceases, Incidents in Tbilisi 2008-2009[169]

	2008				2009			
	Total		Among children		Total		Among children	
	number of cases	incident per 100 000	number of cases	incident per 100 000	number of cases	incident per 100 000	number of cases	incident per 100 000
Total Infectious and parasitic deceases	16576	1497.8	7524	3961.9	17765	1551.0	5781	2957.0
Among which: infectious diarrhea	2203	1991.1	1465	771.4	1388	121.2	872	446.0
Viral hepatitis A	222	20.1	108	56.9	81	7.1	22	11.3
Viral hepatitis C	624	56.4	1	0.5	742	64,8	1	0.5

are no statistics on potential sources of these diseases, and thus it is difficult to judge whether there are waterborne infections and parasitic diseases among them. Moreover, drinking water supply and sanitation are centralized in Tbilisi and as reported, supplied drinking water is of high-quality. In addition, these statistics show only the total number of patients recorded and treated in the clinics of the Capital area, which does not necessarily prove origin of the infections. To clarify the situation, one should consider the fact that almost 40% percent of patients nation-wide and almost all residents from neighboring rural districts are being treated in Tbilisi, which affects statistics of the total in-patient care. Unfortunately, a more detailed analysis that would help linking certain health statistics to locations is not available for the moment.

168 Ministry of Labor, Health and Social Affairs of Georgia, National Center of Disease Control and Public Health. *Health Protection, Georgia, 2009, Statistical Year Book.* Tbilisi. 2010.

169 Ministry of Labor, Health and Social Affairs of Georgia, National Center of Disease Control and Public Health. *Health Protection, Georgia, 2009, Statistical Year Book.* Tbilisi. 2010.

4.2 Microclimate changes on a city level

There is very little known on climate change trends and consequences on any specific city in Georgia. The UNFCCC National Communication, which is the official report on climate change trends, mitigation plans and adaptation mea sures practiced in Georgia, is a broader document focusing on a country-wide GHG emissions, but also on vulnerability assessments of some specific regions (the Black Sea coast, Lower Svaneti and Dedoplistskaro district). There is, however, some modeling done by a UNDP-funded regional climate change study group regarding urban heat wave trends in major South Caucasian cities, including Tbilisi. The study assesses one of the important indicators of climate change – the *Heat Index*, that is a combination of air temperature and relative humidity during warm periods of a given year.

Table 4-3 Values of Heat Index (human thermal comfort)[170]

RH (%)	Temperature (°C)															
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
90	28.04	30.73	33.75	37.08	40.72	44.68	48.95	53.54	58.45	63.67	63.67	75.06	81.22	87.71	94.51	101.6
85	27.85	30.22	32.89	35.87	39.14	42.71	46.58	50.76	55.22	59.99	65.06	70.43	76.1	82.07	88.34	94.91
80	27.67	29.74	32.1	34.74	37.67	40.88	44.37	48.14	52.21	56.54	61.17	66.08	71.28	76.75	82.51	88.56
75	27.48	29.28	31.36	33.69	36.3	39.17	42.31	45.72	49.39	53.33	57.53	62.01	66.75	71.76	77.03	82.57
70	27.29	28.86	30.67	32.73	35.04	37.6	40.41	43.47	46.78	50.34	54.15	58.21	62.52	67.08	71.89	76.95
65	27.11	28.46	30.03	31.84	33.88	38.66	38.66	41.41	44.38	47.58	51.02	54.69	58.59	62.73	67.09	71.69
60	26.93	28.08	29.45	31.03	32.83	34.84	37.07	39.52	42.18	45.05	48.14	51.44	54.96	58.69	62.64	66.81
55	26.74	27.73	28.92	30.31	31.89	33.67	35.64	37.81	40.18	42.75	45.51	48.47	51.63	54.98	58.53	62.28
50	26.56	27.42	28.45	29.66	31.05	32.62	34.36	36.29	38.39	40.68	43.14	45.78	48.59	51.59	54.77	58.12
45	26.38	27.13	28.03	29.09	30.32	31.7	33.24	34.94	36.81	38.83	41.02	43.36	45.86	48.52	51.34	54.33
40	26.21	26.86	27.67	28.61	29.69	30.91	32.28	33.78	35.43	37.22	39.14	41.21	43.42	45.77	48.27	50.9
35	26.02	26.63	27.36	28.2	29.17	30.26	31.47	32.8	34.26	35.83	37.53	39.34	41.28	43.34	45.53	47.83
30	25.84	26.42	27.09	27.87	28.75	29.73	30.82	32	33.28	34.67	36.16	37.75	39.44	41.24	43.13	45.13

Table 4-4 The classificaton of the heat index in terms of public health impacts[171]

Fahrenheit	Celsius	Notes
80–90 °F	27–32°C	Caution – fatigue is possible with prolonged exposure and activity
90–105 °F	32–41°C	Extreme caution – sunstroke, heat cramps, and heat exhaustion are possible
105–130 °F	41–54 °C	Danger – sunstroke, heat cramps, and heat exhaustion are likely; heat stroke is possible
over 130 °F	over 54 °C	Extreme danger – heat stroke or sunstroke are likely with continued exposure

The table below demonstrates how Heat Indices are 'translated' to an actual feeling of human comfort when the temperatures (C^0) are combined with the Relative Humidity (%) and what type of health risks these may imply. Application Notes by Campbell Scientific, Inc. describe the Heat Index as: "High humidity combined with hot temperatures reduce the body's ability to cool itself, increasing the risk of heat exhaustion, heat stroke, and other heat-related health problems. The Heat Index, also referred to as apparent temperature, is an estimate of the temperature (in °F) that would similarly affect the body at normal humidity (about 20 percent)"[172].

For example, when air temperatures reach 30 to 35 C^0 degrees in July and August (rarely considered extreme for Tbilisi), it may become dangerous, or extremely dangerous conditions if combined with a relative humidity of 60 to 90%, imposing a very high health risk for people vulnerable to cardio-vascular disorders, as well as for elderly persons and children.

The team gathered daily meteorological data for warm months (May, June, July, August and September) of the 1955-1970 and 1990-2007 time sequences and, using PRECIS[173] statistical analysis, generated a forecast for 2020-2049. The calculation was based on the Global Climate Model – ECHAM[174]. For the same five warm months of a year (May to September) the model considered graphic image of a daily average temperature, relative humidity and the heat index of each month. The calculations included two alternative measures: *the fuzzy expected value* (FEV) and *the cluster expected value* (CEV) that estimated the consistency of the most typical values of Heat

170 Source: Regional Climate Change Impacts Study for the South Caucaus Region, UNDP/ENVSEC project: Regional Climate Change Impacts Study for the South Caucasus Region, 2011

171 Source: Regional Climate Change Impacts Study for the South Caucaus Region, UNDP/ENVSEC project: Regional Climate Change Impacts Study for the South Caucasus Region, 2011

172 Campbell Scientific, Inc., *Application Notes, 2001-2002*. Logan, Utah: http://www.campbellsci.com/documents/technical-papers/heatindx.pdf .

173 http://www.metoffice.gov.uk/precis/

174 http://www.dlr.de/pa/en/desktopdefault.aspx/tabid-2559/3824_read-5749/

Table 4-5 Comparison of "dangerous" days in Tbilisi of two periods (1955-1990 and 1990-2007) in the past and one period (2020-2049) in the future[175]:

	Tbilisi		
	1955-1970	1990-2007	2020-2049
Normal	1338	1349	1525
Warm	796	843	1161
Very Warm	310	545	1527
Hot	4	17	287
Very Hot	0	0	0
Extremely Hot	0	0	0
Total number of dangerous days	314	562	1814

Indices for the calculated time sequence.

Analysis of the calculation and forecast models show that four out of six classes of Heat Indices have risen during the period 1990-2007 and are expected to increase dramatically for one of three critical classes (orange/ hot class with caution of extreme risk) during the coming decades.[176]

4.3 Increase of natural hazards of an extreme hydro-meteorological character

Extreme hydro-meteorological conditions may engender natural hazards that severely disturb economic growth and affect human lives. Climate change is one of the major causes in the activation of geo-dynamic processes. It is expected that Georgia, widely known to be affected by acute geological processes, tectonic conditions, climate and topography, will suffer more from a projected increase of weather extremes.

As elsewhere in Georgia, geo-dynamic processes are very active in Tbilisi and its surroundings, where pressures on a fragile environment are triggered by a large number of human and economic activities. Special risk factors for gravitation landslides, mudflows, erosion and denudation processes are due to heavy engineering structures, misplaced construction and massive buildings and other infrastructure. There are about 60 landslide zones (locations) observed in Tbilisi, along with a total of 20 km' length of damaged slopes caused by intensive gravitation processes[177]. As detected by a team studying geological hazards from the National Environmental Agency, an absolute majority of active landslides detected in the city are the result of inappropriate planning and construction of civil infrastructure and building blocks. The earthquake of 25 April 2002 with its epicenter in Tbilisi that significantly damaged the city's infrastructure also resulted in activation of geo-dynamic processes. At the moment, the most active landslide zones include: the northern slope of Mtatsminda hill; the Nutsubidze Plateau; the slopes of Mukhatgverdi hill; a large area across the right bank of the Vere River, starting from Tamarashvili Street to Varaziskhevi – the so-called Vake Landslide; the Khevdzmari ravine near Gldani Village, etc.[178] (see map 4.1).

Among other geodynamic processes causing measurable impacts on the economy and population of Tbilisi are mudflows that originate during extreme weather peak (heavy rainfalls) in the dry ravines of the high hills surrounding the city. The total network of dry ravines in the Tbilisi area is very abundant and covers about 240 km in total length. 52 ravines comprise an extreme danger of mud-transforming dynamic, including: Gvazauri, Java, Lotkin Hill, Kinalchich Str., Samarsaxevi, Leghvtakhevi, Funicular, Solololaki, Mamadaviti, Niaghvari, Vere, Varazi, Gagarin Str., Lisi, Nutsubidze Hill, Bagebi, Abanotubani and Saidabadi; as well as small rivers: Gldanula, Khevdzmara, Dighmistskali, Vere, Leghvtaxevi, Norioskhevi, etc. (see map 4.1). These small rivers and ravines cause distortions to traffic flow and damage to street networks during extreme rainfalls. There are also cases with a lethal outcome for humans. The most recent of these was recorded on 14 May 1980, when extreme precipitation resulted in the collapse of a 12-m high earthen dam on the Vere River that transformed into a 3-4 m stone- and mud wave, destroying buildings and

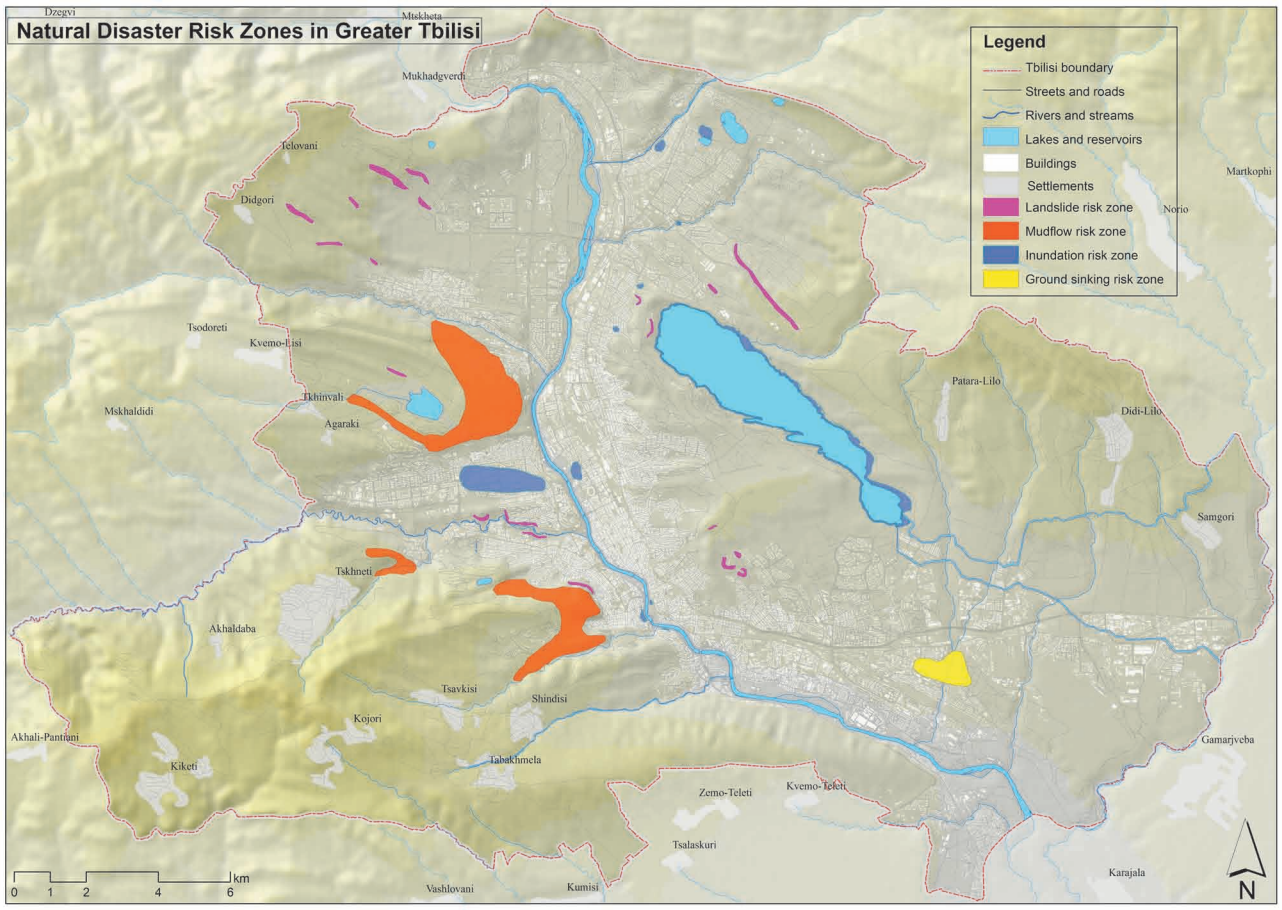
175 Source: Regional Climate Change Impacts Study for the South Caucaus Region, UNDP/ENVSEC project: Regional Climate Change Impacts Study for the South Caucasus Region, 2011

176 Regional Climate Change Impacts Study for the South Caucaus Region, UNDP/ENVSEC project: Regional Climate Change Impacts Study for the South Caucasus Region, 2011

177 Data provided by National Environmental Agency, Department of Geological Hazards and Geological Environmental Management, Tbilisi 2010.

178 Data provided by National Environmental Agency, Department of Geological Hazards and Geological Environmental Management, Tbilisi 2010.

Figure 4-1 Natural Disaster Risk Zones in Greater Tbilisi



infrastructure on its way, and causing deaths as well[179].

As stated above, the geological preconditions responsible for shaping natural hazards in Tbilisi are abundant. Predicted climate change is likely to increase the occurrence of extreme weather events in the region. Current statistics on the frequency of hydro-meteorological extremes in Tbilisi as provided by the National Environmental Agency, however, do not show significant growth. A slight increase is observed for the length of a drought period starting from 1999, as well as a number of cases of windstorms with a velocity of more than 25 m/sec (six cases in 1995; 12 in 2005; 14 in 2006)[180].

Nevertheless, a more important factor stimulating extreme geo-dynamic processes is peak discharges, or amount of precipitation and resulting water flow that occurs in a relatively short period, but if considered within an average daily or monthly amount does not diverge from normal conditions. In such occurrences, the local soil and geological structures are unable to absorb unusual amounts of moisture, resulting in mudflows and landslides. Therefore it is absolutely vital to apply detailed geological engineering expertise during planning and construction at sensitive areas in the city. These areas, known and very well-defined in the past, need to be regularly updated, as the situation tends to change very quickly and in a negative way. Therefore, large-scale hydro-geological and engineering geological monitoring should be re-established on a city level.

179 Data by National Environmental Agency, Department of Geological Hazards and Geological Environmental Management, Tbilisi 2010.

180 Data by National Environmental Agency, Department of Geological Hazards and Geological Environmental Management, Tbilisi 2010.

CHAPTER 5: Responses: urban environmental governance in Tbilisi

Responses refer to actions that are directed to prevent or reduce negative impacts on the environment, mitigate and restore damage imposed on the environment and improve the quality of life of the local population. It responds to the question **what is being done to mitigate or reverse environmental problems?** Responses may include regulations, economic instruments, changes in administrative strategy, education and public participation instruments etc.

The chapter describes the local political-administrative structure of governance in Tbilisi; the institutional structure of environmental governance; and provides reviews of spatial planning and strategic planning activities; environmental policies; and public participation in urban environmental governance.

5.1 Local political-administrative structure

According to the "Georgian Law on the Capital City of Georgia Tbilisi", local governance in Tbilisi is carried out by means of a representative body, the Tbilisi City Assembly, and the system of executive bodies, Tbilisi City Hall[181]

The Tbilisi City Assembly consists of 50 members. 25 members among them are elected according to single mandate majority electoral places and the other 25 members are elected according to the 10 electoral places on the whole territory of Tbilisi in accordance with the proportion rule.[182] The Assembly approves the Provision of Tbilisi City Hall; it reviews and approves the Tbilisi Budget; ratifies the general plan of prospective development of the capital city and the strategy of city development. It is part of the authority of the Assembly to impose local taxes and duties, divide the territory of the capital city into zones, and specify regulations of land use on a zonal basis etc.[183] The term of authority of the Assembly is four years.[184] Commissions of the Assembly are: the Revision Commission and the following permanent commissions: Commission for Legal Issues; Commission for Property Management and Finances and Budget; Municipal Utilities Commission; Commission for Health Care and Social Issues; Commission for Urban Planning; Commission for Investment Policy and International Relations; Commission for Sport and Youth Issues; Commission for Human Rights and Public relations; **Environmental Protection Commission**; Education and Culture Commission; Commission for Denomination and Symbols.[185]

Tbilisi City Hall is a system of executive bodies of the local authority consisting of Tbilisi Government and the governments of Tbilisi districts.[186] The Mayor of Tbilisi is the highest official of Tbilisi and the leader of the Government. The Mayor is elected via a direct election for a term of four years.[187] The Tbilisi Government is a collegial body that facilitates implementation of decisions of the Assembly and the Mayor.[188] The Municipal Departments of the Tbilisi City Hall are: Transport Department; Legal Department; Department for Municipal Acquisition; Department for Social Service and Culture; Department for Municipal Amenities; Supervision Department; Economic Policy Department; Financial Department and Department for Ecology and Greenery Planting.

The city of Tbilisi consists of six administrative parts (districts). These are: Vake-Saburtalo, Gldani-Nadzaladevi, Didube-Chughureti, Isani-Samgori, Old Tbilisi and Didgori. Each district is divided into neighborhoods, sectors, quarters and micro-regions. Territorial bodies of the Tbilisi City Hall are set up by the decision of the City Assembly for the purpose of optimization of management in administrative units and facilitation of social services to citizens.[189] Setting up territorial units aims at receiving any type of social, legal or municipal service by a citizen in his/her neighborhood in a simplified and timely manner. Each territorial unit is managed by the representative of a head of a district government (gamgebeli) who lives in the same neighborhood. The representative of a gamgebeli reports directly to him/her. Leaders of territorial units attend meetings of the City Government where they speak about the problems of their districts and offer ways to resolve them. There are 30 such units in six regional governments throughout the city.

5.2 Institutional Structure of Environmental Governance

5.2.1 Historical Review

The first-ever environmental body in Georgia – the State Committee for Nature Protection – was established in 1975. The main function of the

181 Georgian Law on the Capital City – Tbilisi, February 20, 1998, Article 4.
182 ibid., Article 11.
183 ibid., Article 12.
184 Electoral Code of Georgia, August 2, 2001 Article 108.
185 Georgian Law on the Capital City – Tbilisi, February 20, 1998, Article $14^{1.}$
186 ibid., Article 4.
187 ibid., Article 22.
188 ibid., Article 23.
189 Organic Law of Georgia on Local Governance, December 16, 2005, Article 38.

organization was implementation of State control in the field of environmental protection and inter-branch coordination. To undertake similar works in regions, they would establish zonal inspections and hydro-chemical laboratories. The Tbilisi Zonal Inspection was founded in 1976 in Tbilisi. It was capable of carrying out inspections and compiling a protocol on violation of the law in any 24-hour period if needed. Along with enhancement of the role of the office in the sphere of environmental protection, the status of the office changed and the name was formulated as "Tbilisi City Hall Committee for Environmental Protection and Regulation of Natural Resources" in 1989. The organization was financed from the City Budget and was getting methodical instructions from the Ministry of Environment. This entity was in charge of approving environmental documents of enterprises, undertaking tests, agreeing upon technical reports on enterprise inventory and emission limits, and ensuring monitoring on implementation. This organization used to undertake an ecological examination of environmental impact assessment documentation for certain categories of activities. The database reflecting environmental status prepared in that period served as the cornerstone for a 1999 evaluation of ecological status of the capital city.[190]

The Municipal Committee for Environmental Protection and Regulation of Natural Resources ceased to function on 5 September 2005. The corresponding mandate was assigned to the Ministry of Environment of Georgia. It was intended to set up a Tbilisi regional department of the Ministry of Environment, but this idea never was implemented.

5.2.2 Mandate in the sphere of environmental protection

Environmental governance in Georgia is highly centralized. The Ministry of Environment Protection implements environmental permitting, environmental monitoring and state environmental control. Currently there is no agency in the capital city with a full mandate in the sphere of environmental protection. Certain environment-related responsibilities, such as transport and waste, are attributed to the corresponding departments of the City Hall. Water supply and sanitation infrastructure is owned and managed by a private water service company. On 27 July 2009, a Municipal Department of Ecology and Greenery Planting was established. The Department is responsible for planning, arrangement and maintenance of green spaces in Tbilisi.[191] The competences of the Department are mainly focused on green areas and do not include other environment-related spheres.

In such circumstances, it is essential to have environmental policies as part of general urban planning documents. The present General Plan of Prospective Development of the Capital City addresses a number of environmental issues; however, it is rather broad and does not go into details of specific environmental problems. It is essential to have more in-depth environmental policy planning, including the implementation phase, which will give a clear indication of responsible entities for conducting each planned action.

It is crucial to have good coordination between national environmental authorities and decision-makers at the municipal level, in order to ensure integration of environmental considerations in major decisions which affect the city. In addition as mentioned above, it is necessary to expand and enhance environmental monitoring networks and, most importantly, ensure interpretation and use of the monitoring data as environmental indicators, so that decision-makers can properly plan and implement relevant policies.

5.3 Review of spatial planning and strategic planning activities

5.3.1 Historical Review

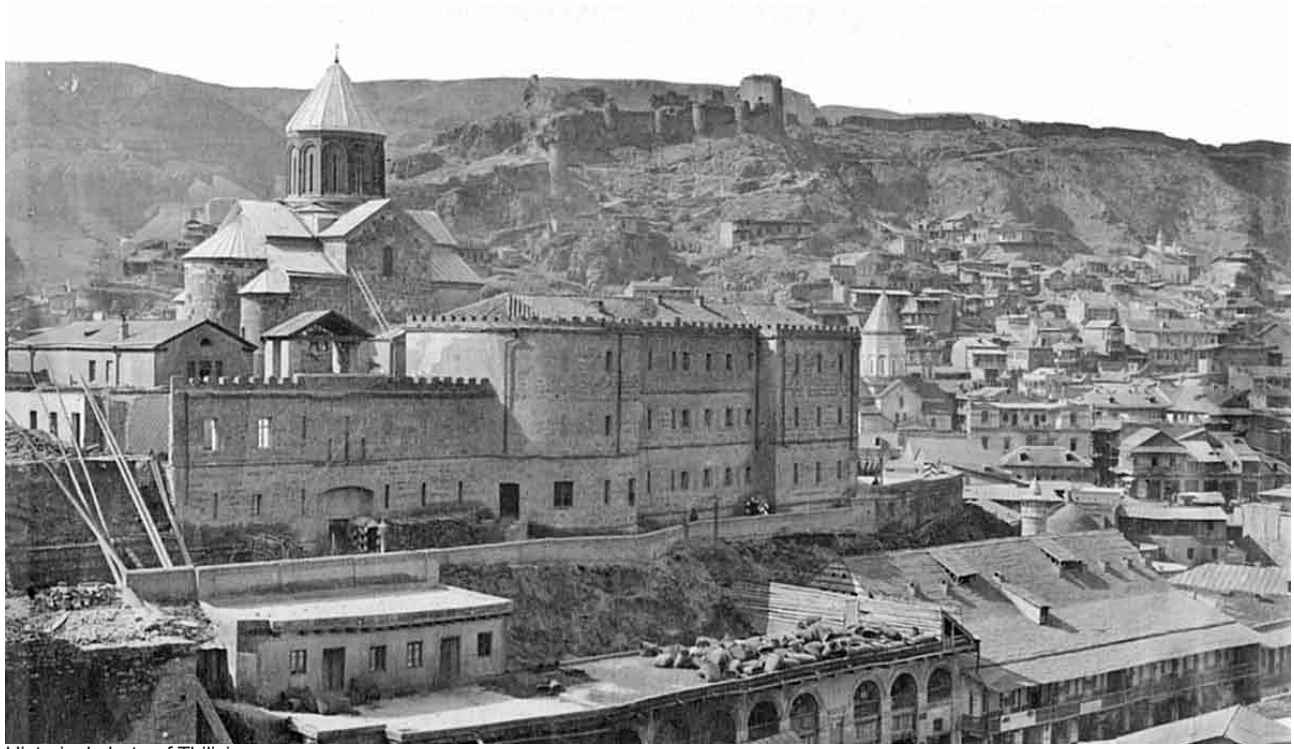
The physical layout of Tbilisi and the character of its development are mainly conditioned by the relief of the city. Tbilisi is a typical linear town with a complex landscape. The natural environment and topography played an important role in its development. In this respect, the Mtkvari River is of special importance. It is considered to be the axis of urban development of Tbilisi. The narrow and lengthened shape of the City is conditioned by the fact that the terraced banks of the Mtkvari rest against sharp slopes on both sides. Consequently, in the process of city development, two large and structurally different parts have been identified: the Right Bank and the Left Bank. These banks are connected to each other by bridges. The left bank stretches over 40 km of territory and the right bank occupies only 20 km. At the widest part, which is in the central region on Saburtalo-Nadzaladevi line, it exceeds 7 km width, while it narrows to 1.5 km at Metekhi. Therefore land use is one of the most important issues for city planning.[192]

City planning is directly related to the past town development. From the second part of the 19th century, Tbilisi began to develop into one of the largest towns of the Russian Empire. However, development went on chaotically in accordance with private property interests of the privileged and rich layers of the society and the colonial interests of Tsarism. That is why the capital city of Georgia inherited many samples of irregular planning, narrow and unmaintained streets,

190 "Ecological Status of the City of Tbilisi", Tbilisi City Hall Committee for Environmental Protection and Regulation of Natural Resources, 2000.

191 Provision of Ecology and Greenery Planting Municipal Department of Tbilisi City Hall, approved by Order # 38 of Tbilisi City Hall.

192 V. Lezhava, 2003, Ecological Planning of Tbilisi



Historical photo of Tbilisi
Photo provided by Tbilisi City Hall

densely populated quarters and neighborhoods lacking elementary comforts.[193]

After the advent of Soviet power, efforts were taken to improve city planning. In this period, projects of different neighborhoods, interconnecting roads and living quarters were designed. Some of those projects were partly accomplished later. But the city still did not have an overall concept of city development and a unified plan. In the beginning of the 1930s, when the population of the town surpassed 400,000, the necessity of reforms in urban planning became obvious. 69% of buildings at that time in Tbilisi were one-floor houses, and 29.1% were two-floor dwellings. A large number of small quarters of irregular shape and inadequate streets were often unusable for intensive traffic.

The beginning of a new period of Tbilisi's development relates to elaboration of the first general plan in the history of the town in 1933. Designers of the plan retained the historically developed planning structure of the City. The plan included an approximate 20-30 years' period of reconstruction based on anticipated growth of the population up to 725,000 citizens.[194] Some of these planning ideas and the concept of linear development of the city designed at that time are still relevant today.

The development of Tbilisi accelerated and was enhanced in the years following the Second World War, corresponding to the period of wide-scale construction in the Soviet Union. Work on elaboration of a new general plan for the period of 1951-1966 began in 1948. It was based on the planning principles set out in the previous plan, but was however more schematic. Development still suffered from a lack of an overall integrating vision and a pompousness that overwhelmed other styles in the architecture of buildings.[195]

Along with further expansion of the territory of Tbilisi and increase of its population, it became necessary to develop a new general plan. A general plan for the reconstruction and prospective development of Tbilisi was approved in 1970. The plan anticipated the period 1968-2000. A project for development of Tbilisi's territory in a new direction was drafted. Specifically, development of the city was anticipated on the side of the "Tbilisi Sea"[196]. Complete implementation of this general plan was not achieved. The country underwent a drastic social, economic and political transformation after disintegration of the Soviet Union, affecting every aspect of social life, including urban development. This period is related to chaotic, illegal constructions and illegal modifications of facades of buildings, damaging the overall appearance of the city to a certain extent.[197]

5.3.2 General Plan and Strategy of Prospective Development of Tbilisi

Since 1970, there has been no general plan or strategy for Tbilisi's development. Only in 2009 did it become possible to prepare a general plan for prospective

193 Academy of Science of the SSR of Georgia, Economic and Geographic findings of Vakhushti Bagrationi Geography, 1989.
194 Ibid.
195 ibid.
196 "Tbilisi Sea" is an artificial water reserve situated in the eastern part of the City. Its neighborhood represents a recreational zone. It was built in the 1960s and continues to play an important role in the development of Tbilisi.
197 V. Lezhava, 2003, Ecological Planning of Tbilisi

Historical photo of Tbilisi
Photo provided by Tbilisi City Hall

development of the capital city. It took the Architecture Office two years to prepare it in cooperation with developers and representatives of other, international organizations. After discussions and amendments, the general plan was approved by a decision of the Tbilisi Assembly.[198] Supervision on implementation of the general plan for Tbilisi is carried out by the Tbilisi City Assembly and the Architecture Office of Tbilisi City Hall.

The General Plan defines basic parameters of land use and development, aspects of protection of environment and cultural heritage, transportation, engineering and social infrastructure, economic development and other issues. Chapter 6 of the Plan on Protection and Development of Landscape and Ecological Environment outlines priority issues related to environmental protection (further discussed in Chapter 5.4 below). The General Plan foresees relocating industrial enterprizes from the city centre to the territory adjacent to Lilo Market. Besides that, regulation of transportation infrastructure and relocation of the railway beyond the central part of the city are being considered. The released territory - about 150 hectares - shall be used for building a multi-functional center. In addition, preservation and restoration and in some cases creation of historic-cultural heritage is a priority objective of the General Plan.[199] A particular place in Tbilisi city planning is allocated to preservation and restoration of the old city. Namely, among the priorities of the Tbilisi city development are: restoration and reconstruction of old Tbilisi; development of a new infrastructure; restoration of the old infrastructure; development of tourism; and rehabilitation of buildings having a cultural heritage status.[200]

Work has been in progress since February 2010 to define and adopt an integrated strategy for the long-term development of Tbilisi. After adoption of the plan, Tbilisi will have a unified strategic document of development, facilitating dynamic development of the capital city and enhancement of efficiency of current reforms.

5.4 Review of Environmental Policies

State environmental governance at the national level is undertaken by the Ministry of Environment of Georgia. Today none of the structures of Tbilisi City has a mandate for implementation of environmental policy at the level of the capital city. Certain environmental-related responsibilities are scattered among different local or national institutions. In addition, issues related to the environment are mentioned in the General Plan of Prospective Development of the capital city. Specifically, the general plan aims at undertaking the role of a complex coordinating document in the process of resolution of ecological problems of the city, with an ultimate goal to improve the environmental policy and lessen anthropogenic impacts on environment.[201] The general plan includes the following priorities: reorganization of industrial and communal zones; creation of green spaces; ensuring 11m^2 of green space per citizen; development of green buffer zones; restoration of deteriorated territories; improvement

198 Resolution #6-17 of Tbilisi Counsil, 5 June 2009, on ratification of a general plan of prospective development of the capital city.
199 ibid, Chapter VII, Article 8.
200 Materials provided by the Department of Economic Policy of the Tbilisi City Hall.
201 Decision #6-17 of Tbilisi Assembly on ratification of the general plan of prospective development of the capital city, Article 7.

of waste management infrastructure; abatement of acoustic discomfort in recreation zones on public and private territories; modification of profile; modernization and shutting down of ecologically hazardous and technologically outdated enterprises and creation of green buffer zones between enterprises and inhabited areas.[202] To achieve these priorities in practice, it will be necessary to elaborate concrete mechanisms for implementing them at a local level.

5.4.1 Air pollution

5.4.1.1 Governmental policy to address air pollution from transport

Auto transport is one of the major sources of air contamination in Tbilisi. Decree #124 of the Government of Georgia on quality standards of fuel dated 31 December 2004 is the only document at national level on protection of the atmosphere from auto transport exhaust. The document specifies a minimum octane rating of different grades of petrol and ecological characteristics of petrol, such as the level of lead, level of sulphur, and share of benzol and aromatic carbohydrates. However, this decree cannot be implemented since there are no mechanisms to control the petrol quality. In addition to that, there presently is no mandatory technical examination of automobiles. As a result, at this moment regulation of air pollution caused by auto transport exhaust is not undertaken.

Transport-related policy at the level of the capital city is basically focused on improvement of transport infrastructure. Certain measures such as optimization of the bus and microbus network, promotion of electro-transport etc. will have a positive impact on air pollution caused by transport exhaust. However, mere regulation of transportation routes and improvement of roads cannot lessen the negative impact of auto transport on the environment. For this purpose, it is necessary to ensure the technical fitness of vehicles and adequate quality of fuel consumed. In addition, it is important to encourage a reduction of private transport in parallel to the development of public transport.

5.4.1.2 Governmental policy to address air pollution from stationary sources

Air protection and related issues are regulated by the Law of Georgia on Protection of Ambient Air and by 15 subordinate regulations adopted according to provisions of the Law.

For the purpose of air protection, Georgian legislation defines the Maximum Allowed Concentrations (MAC) of harmful substances in ambient air. These standards for selected pollutants were presented in table 3.1 of this document. The Ministry of Environment of Georgia establishes emission limits for air polluting industries based on these standards. Emissions from industrial facilities should be limited to levels that do not result in concentrations of harmful substances in ambient air beyond maximum allowed concentrations. Such limits are defined individually for facilities subject to environmental permits (the limits are defined during the permitting process), while the emission norms of the remaining small enterprises, as well as from motor transport, are established by relevant technical regulations. The Environmental Inspectorate is responsible for enforcing the environmental regulations. This institution is entitled to impose administrative sanctions on companies not complying with emissions standards. However, pollution monitoring capacities of the Inspectorate are limited. Therefore, as a rule, they react when there are public complaints about pollution. In such cases, the Inspectorate collaborates with the Environmental Monitoring Agency of the MEP, which has air quality measurement capacities, to determine the levels of pollution and to check whether pollution levels exceed national standards.

It must be noted that a regulation relating to the establishment of sanitary zones around industrial facilities and other such sites was cancelled in 2007.[203] This regulation required the establishment of areas and zones around industrial facilities within which developments and other activities, including human settlements, were restricted. Absence of such regulations may have negative environmental consequences unless industrial facilities strictly comply with the emission limits established by environmental authorities. This also requires development of an air quality monitoring network around industrial facilities.

The Tbilisi Development Master Plan adopted on 5 June 2009 suggests that the Tbilisi City Hall strategy is to dismantle old industrial polluting industries located in the central part of Tbilisi, mostly those located along the current railway, or move them to the eastern suburbs of the city (see chapter 2.4.1). At present, however, there is no documented municipal policy in Tbilisi addressing air quality problems in the city.

5.4.2 Transport

According to the general plan for prospective development of the capital city, improvement of the Tbilisi motorway infrastructure is basically related to development of a transit motorway system. This anticipates moving the current transit railway route out of the city.[204] As for regulation of inner-city

202 Ibid.

203 Order of the Ministry of Labour, Health and Social Affairs of Georgia N236/n (6/10/ 2003) on the approval of "Sanitary Protection Zones for Enterprises, Buildings and Other Objects and their Classification".

204 Decision #6-17of Tbilisi Assembly on ratification of the general plan of prospective development of the capital city, Article 2,

transport infrastructure, there are the following priority measures identified in the general plan:

- Building additional subway access points in current metro stations;
- Reconstruction of the road network;
- Balanced functioning of public and private means of transportation on inner-city municipal roads;
- Organizing territorial zones for parking cars and moving under a limited regime (according to types of automobile, time, days, etc.);
- Building of inner-city municipal linear motorways and transversal linking roads;
- Further development of subway systems, fast carriages, cable ways, motorway and pedestrian bridges and tunnels;
- Identification of a public and business walking zone and development of walking areas;
- Arrangement of above-ground and underground parking systems, ensuring one parking space per each registered automobile.

According to Tbilisi's 2011 budget[205], improvement of transport infrastructure is the main priority in 2011-2014. For this purpose, repair work on central roads and secondary roads is being carried out. Building of new motorways, crossroads, and above and underground parking areas is also under way. Optimization of bus routes has been completed based on the results of investigation of passenger flow. Some bus routes will be replaced by comfortable microbuses. Revival of electro-transport was also included among the priority issues; development of subway infrastructure was projected, modernization of subway carriages etc. Besides that, a unified traffic control center equipped with modern technology is to be designed. The center will allow counting vehicle flows in real time and directing a flow in another direction if required. This measure aims at discharging excess traffic from streets and motorways, the safe and comfortable movement of transport and pedestrians, and the free movement and regulation of transport in the capital city.

The Transport Department of Tbilisi City Hall is responsible for fulfilling different functions foreseen by legislation in the field of transport. The main function of the service is coordination, administration, management, regulation and control of "Tbilisi Transport Company" Ltd. Apart from this, the terms of reference of the service include: preparation of proposals on feasibility and development of bus stops, temporary parking places and other infrastructure and development and improvement of transport routes; undertaking measures necessary to discharge excess passenger flows in Tbilisi's transportation network; carrying out measures defined by legislation in order to ensure payment of permit fees for regular municipal passenger transfer; design and introduction of regulations focused on traffic improvement in streets, squares and highways within the administrative territory of Tbilisi; undertaking controls of auto transport parking on roads and city municipal auto transport etc.

Article 9.

205 Decision of Tbilisi City Assembly N12-72 of November 18 2010 on Budget of city of Tbilisi for the year 2011.

5.4.3 Energy efficiency

There is significant potential for increasing energy efficiency in Tbilisi and reducing environmental impacts related to energy production and use, including emissions of greenhouse gases (GHGs). This issue has been recognized by the city government, which has been taking initial steps to address the problem.

In March 2010, the Mayor of Tbilisi signed the Covenant of Mayors, an initiative of the European Commission that aims at reducing Carbon Dioxide (CO_2) emissions by at least 20% until 2020. In order to achieve this goal, the Tbilisi City Hall elaborated a "Sustainable Energy Action Plan (SEAP)" for Tbilisi, which was approved by the city government on 28 March 2011.[206]

Three main energy sectors are covered by the Tbilisi SEAP: transport, buildings and infrastructure (municipal waste and waste water management treatment, street lighting, electricity and gas distribution networks, and green spaces). Based on the Baseline Emission Inventory (BEI) for 2009 and the projection of the increase in CO_2 emissions by 2020 conducted within the framework of the Tbilisi SEAP, strategies and main actions for each sector were elaborated.

Transport Sector

According to the BEI of 2009, the major source of CO2 emissions in Tbilisi is from the local transport sector. Rehabilitation and further development of transport infrastructure was identified as the short-term strategy (2011-2015) for this sector. It will result in a partial decrease of CO2 emissions from the transport sector.

The mid-term strategy (2012-2018) is to increase the share of public transportation within the total passenger turnover. Special attention will be paid to the development of an electric transport network, since the energy intensity of electric transport (such as tram and subway) per passenger and per kilometer is much better compared to other modes of public transport. Also, it is envisaged that in the future the emission factor of electricity will decrease significantly, due to national government plans to significantly increase its hydropower generation share in the electricity generation sector.

The long-term strategy (2018-2020) of the transport sector aims at decreasing the mobility of private cars

206 Sustainable Energy Action Plan – City of Tbilisi. Approved on 28 March 2011 Decision No. 07.10.237.

and encouraging low emission cars by means of various restrictions and incentives (it is implied that this will happen by the time the public transport and street infrastructure is well-developed and meets society's need in terms of speed, convenience and accessibility).

Building Sector

The Strategic Plan of Tbilisi identifies several energy efficiency measures to be carried out. Among these are a reduction of electricity distribution losses, energy efficiency measures for the water supply system, a reduction of heat distribution losses in municipal and public buildings, efficient metering, and a reduction of gas distribution losses. However, no special attention is paid to the building sector and energy efficiency measures within the sector.

In the SEAP of Tbilisi, the building sector is identified as the second largest emitter of GHGs after the transport sector. The heat sub-sector has been identified as having a very serious potential for GHG emissions reductions. Within the short-term strategy (2011-2015), the plan is to increase efficiency of heating systems and the share of renewable energy in the heating (geothermal energy, biomass and solar energy) sub-sector within the municipal building stock (e.g., kindergartens, polyclinics et al.).

The mid-term strategy (2014-2017) plans to apply the same measures to public buildings that are not under administration of the Tbilisi Municipality (schools, state agencies etc); while in the long-term strategy (2015-2020) energy efficiency will be increased, and the share of renewable energy in heating will grow in the residential building stock. Other energy efficiency actions will be carried out as well.

The objectives for the building sector of the SEAP include:

- Improving thermal properties of building stock;
- Changing existing energy consumption practices;
- Creating an enabling environment for the implementation of all the above measures;
- Increasing the share of renewable energy sources in heat supply;
- Reducing energy expenditures in all categories for consumers in buildings; and
- Achieving average energy consumption and utilization patterns which are in line with the minimum EU standards.

Municipal Infrastructure Sector

The strategy for municipal infrastructure covers six sub-sectors and aims at capturing methane (CH4) from municipal landfills (closed as well as new ones) and waste water treatment plants, burning or using captured methane as an energy source, increasing energy efficiency and the share of renewable energy in the outdoor lighting sector, and developing green spaces throughout the city.

The rapid economic development of Tbilisi, its population growth rate and increasing GDP per capita were taken as the main assumptions while developing the reference scenario for 2020. It has been estimated that, in case the actions proposed in the SEAP are implemented, the overall CO_2 emissions in Tbilisi will be reduced by 25% by 2020.[207]

5.4.4 Waste Management

Waste-related national legislation is rather limited in Georgia. A national law on waste has still not been adopted; neither is there a national strategy or policy on waste. One of the instruments of waste regulation is the **Law on Environmental Impact Permit,** according to which waste disposal and incineration, including hazardous waste treatment and disposal, requires an environmental impact permit.[208] Besides this, for all development proposals which require an environmental impact permit, developers are obliged to prepare waste management plans as part of an the environmental impact assessment report. **The Law of Georgia on the Transit and Import of Wastes into and out of the Territory of Georgia** prohibits import and transit of hazardous and radioactive municipal, industrial or other wastes, and import or transit of non-hazardous and non-radioactive wastes listed in Annex IV Group A of the Basel Convention.[209] The ordinance № 36/n of the Ministry of Labor, Health and Social Affairs on establishment of sanitary rules and norms concerning municipal solid waste landfill construction and exploitation[210] establishes sanitary rules and requirements for construction, exploitation, monitoring and conservation of municipal solid waste landfills. However, the document is already outdated and does not fulfill modern waste management requirements. The ordinance № 91 of The Ministry of Environment Protection and Natural Resources on legalization of the instructions concerning rules on atmospheric air protection during landfill exploitation[211] prohibits open burning of waste on landfills (Article 9) and defines rules for temporary disposal of harmful solid waste on a landfill (articles 11, 13). The ordinance № 300/n of the Ministry of Labor, Health and Social Affairs of Georgia on legalization of rules for collection, storage and treatment of waste from medical establishments[212]

207 Sustainable Energy Action Plan – City of Tbilisi. Approved on 28 March 2011 Decision No. 07.10.237.

208 The Law of Georgia on Environmental Impact Permit, December 14, 2007, Article 4.

209 The Law of Georgia on the Transit and Import of Wastes Into and Out of the Territory of Georgia, November 16, 1997, Article 2.

210 The ordinance №36/n of February 24, 2003, of the Ministry of Labor, Health and Social Affairs on establishment of sanitary rules and norms concerning municipal solid waste landfill construction and exploitation.

211 The ordinance №91 of October 23, 2001, of The Ministry of Environment Protection on legalization of the instructions concerning rules on atmospheric air protection during landfill exploitation.

212 The ordinance № 300/n of August 16 2001, of the Ministry of Labor, Health and Social Affairs of Georgia about legalization of

defines sanitary-hygienic and epidemiological standards for collection, storage and treatment of waste from medical establishments.

While there is no clear policy and vision on waste management at a national level, the Tbilisi government has been trying to solve municipal waste management problems on a local level, as this issue is among those falling under the exclusive authorities of local governments.[213] In December 2006, the Tbilisi Government adopted local waste management rules,[214] which provided a framework for municipal waste management on the city level. An administrative framework for municipal waste management was improved as well. The Tbilisi Waste Management Municipal Department, which is now under the Municipal Department of Municipal Amenities, was established in June 2006. It united all responsibilities relating to municipal waste management that had been scattered between different structural units in the past. These reforms resulted in a significantly improved waste management situation in Tbilisi. Municipal solid waste problems have been resolved to a great extent. However, gaps still remain in terms of proper regulation of industrial, healthcare and hazardous waste. In addition, there are still no provisions for sustainable waste management practices, such as waste minimization, recycling and reuse.

5.4.5 Water management

Management of water resources in Georgia is not carried out by one single organization. The management mandates are shared among several agencies, including central government and local authorities. Since 2004, Georgia's water sector has undergone multiple reforms, distributing functions of water resources' management from institution to institution. The latest reform (March 2011) strictly divided functions of water resources' management from enforcement measures to protect the environment, and as a result has established two 'new' ministries: the Ministry of Environment Protection (MEP) and the Ministry of Energy and Natural Resources (MENR). Permitting for water withdrawal, however, was already abolished in 2007, while licensing to use groundwater resources (considered as a 'fossil' or geological resource) was a prerogative of the Ministry of Economic Development. On the other hand, environmental permitting has also recently been subject to serious reforms, the idea of which was to simplify existing procedures and apply a 'one window' principle. As a result most permitting procedures, including water use permits (permit for water abstraction and permit for discharge into water), were unified in one Environmental Impact Permit.[215]. Other parts of water management, i.e. protection of surface and ground waters, as well as policy control and quality and quantity monitoring, are still the responsibility of the Ministry of Environment Protection. More precisely, pollution and hydrological monitoring are carried out by the National Environmental Agency, a quasi-independent institution, or legal entity of public law established in 2008 under the MEP structure.

In general, links between the institutions involved in water management in Georgia are very weak. As water management mostly is conducted in a centralized way, the capacity and competencies of local institutions in this realm are very limited. After the abolishing of regional branches of the Ministry of Environment Protection, these limitations became even more visible. On the contrary, the role of the other newly-established state institution - the Ministry of Regional Development and Infrastructure - is increasing. This Ministry, with its subordinate Regional Development Agency of Water Supply, was made responsible for water supply and sanitation for most urban areas excluding Tbilisi. Later, the agency was reinforced as the United Water Supply Company of Georgia. The Ministry of Labor, Public Health and Social Safety is responsible for development of water quality indicators[216] in accordance with environmental legislation, including standards and technical regulations for drinking water safety.

Although the previous water law (introduced in 1997) has undergone many amendments, it is generally still in effect. According to this law, the MEP defines state policy on protection and use of water resources, and guarantees protection of rivers and lakes from negative impacts that might affect human health and natural ecosystems. The Ministry should be responsible for setting and enforcing pollution thresholds[217]. In fact, however, functions of the MEP have been diminishing significantly in recent years. There is a real problem with the existing water legislation, which from some perspectives appears to be rather fragmented, inconsistent and controversial. [218] Hence, it does not offer the potential for effective water resources' management, neither in terms of tools for applying preventive measures against excessive water use, extreme pollution loads, etc. The existing water law is turning out to be inadequate for current circumstances, especially with modified licensing and environmental permitting system, tax code of Georgia and other modern legislation[219]. Currently work for drafting a new water law is under way by MEP and the relevant parliamentary committees.

rules for collection, storage and treatment of waste from medical establishments.

213 The Organic Law of Georgia on Local Self-Government, December 16, 2005, Article 16.

214 Approved by the Decree of the Goverment of Tbilisi N 02.17.62, December 1, 2006.

215 National Environmental Action Plan (NEAP), Draft Water Policy paper, 2010

216 ibid.

217 Major findings of the assessment of transboundary rivers, lakes and ground waters in the Caucasus. Draft UNECE Paper, July 2010.

218 National Environmental Action Plan (NEAP), Draft Water Policy paper, 2010.

219 ibid.

One of the major challenges the water sector will have to face in the coming years is to change from a centralized style of water resources management to an integrated and river basin-focused approach, which was long advised by various water experts and numerous donor-funded water projects. This, among others, may be guaranteed by country's obligation to gradually accept the EU's Water Framework Directive, as one of the pre-conditions to sign an eventual associate membership agreement with the European Union.

5.5 Public participation in urban environmental governance

5.5.1 Instruments for public information and public participation in decision-making at national level

Issues of public information and public participation in decision-making on environmental issues are regulated by the Aarhus Convention[220] and by national legislation.

Pursuant to Article 37 of the Georgian Constitution, everyone has the right to live in a healthy environment.[221] Also, everyone has the right to receive complete, objective and timely information on the state of the environment. Specific rules for the requesting and dissemination of public information, including information on environmental matters, are defined by the General Administrative Code of Georgia.[222]

Georgia is a Party to the Aarhus Convention since 2000. The Aarhus Convention obliges the signing Parties to ensure public access to environmental information and public participation in environmental decision-making. The Aarhus Convention requires provision of three types of participation. These are:

- Participation in decisions on specific activities;
- Participation concerning plans, programmes and policies relating to the environment; and
- Participation during the preparation of executive regulations and/or generally applicable legally-binding normative instruments that might have a significant effect on the environment.

Among these requirements, the national legislation of Georgia regulates only participation in decision-making on specific activities. Specifically, participation of this type is regulated in the framework of the environmental impact permit procedure. The law specifies the list of activities that are characterized by significant negative impacts on the natural and social environment.[223] Before giving consent to undertake such an activity, the law requires the preparation of an environmental impact assessment (EIA). On the basis of an EIA report, an authorized body makes a decision to issue or refuse an environmental impact permit. The law obliges the developer to ensure timely public information, holding a public hearing on the EIA report and receiving comments from the public and taking them into consideration as required.[224] However, this procedure contains a number of drawbacks that are conditioned by both legislative and executive problems. According to the established procedure, the relation of the decision-making body and the public is mediated by a developer. This makes participation ineffective, as it prevents the public from having feedback from the decision-maker. In addition, developers mostly cannot ensure a high quality of public information and engagement. As a result, the level of public participation is typically low.

Georgian national legislation does not regulate participation in drafting plans and programmes, which is one of the requirements of the Aarhus Convention. Subsequently, the law does not foresee public participation in compiling documents such as the general plan for prospective development of the capital city and naturally, there are no mechanisms of public participation in place. The law does not require public participation in the process of elaboration of normative documents either.

5.5.2 Instruments for public information and public participation at local level

A new chapter – *Participation of citizens in implementation of self-governance* – was added to the Organic law of Georgia on Self-Governance in 2010.[225] The goal of this amendment was promotion of public participation and engagement in the process of decision-making at the local level. Specifically, according to this law, the bodies of the local authority are obliged to publicize draft decisions; the procedures and time of their review; agenda of meetings of the Council and the commissions of the Council; venue and date of meetings; approved normative and other administrative acts; deadlines and procedures of appeals against them; and the period and procedures of participation of citizens in the process of monitoring fulfillment of decisions etc.[226] A minimum of 1% of voters registered in the territory of a local self-governing administrative unit are entitled to prepare and submit a draft resolution of the Council, or suggest the proposal on cancellation of a normative act of the Council or make amendment and changes

220 Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. Place and date of accession to the convention: Aarhus, Denmark, June 25, 1998. Date of ratification by the Georgian Government: February 11, 2000.
221 The Constitution of Georgia, August 24, 1995, Article 37.
222 The General Administrative Code of Georgia, June 25, 1999.
223 The Law of Georgia on Environmental Impact Permit, December 14, 2007, Article 4
224 ibid., Article 6, 7.
225 Organic law of Georgia on Local Self-Governance, December 16, 2005, Chapter X[1].
226 ibid., Chapter X[1] Article 58[1].

in it.[227] Besides that, a voter registered on the territory of a local self-governing administrative unit has the right to participate in meetings of the Council and the commission of the council and attend hearings of the reports of high officials of the local authority and the members of the Council without limitation.[228] The law also foresees accountability of the bodies of local self-governance towards the public. Specifically, an official person of local governance and a member of the Council are obligated to hold a public meeting at least once a year and report to the public/voters on accomplishments. In the course of hearings on the report, they are also obliged to answer questions put to them by the public/voters.[229]

The agenda of the Tbilisi City Assembly sessions is published on the City Assembly website. However, public participation in the Assembly sessions is rather low. In practice, there have not been cases of participation in the sessions of the City Assembly's Commission of Environmental Protection. There has been a certain level of activity in other spheres, for example health care, but mainly from the side of professionals and not the general public.[230] This can be explained by the fact that the public is not adequately informed about participation rights and the particular mechanisms of participation.

5.5.3 Participation case study – Tbilisi Landfill Project

As was mentioned above, there are a number of drawbacks in the procedures for public participation in decision-making on specific activities. These drawbacks in the end have a negative impact on project implementation. This can clearly be seen in the example of the EIA process of the project on Tbilisi's new sanitary landfill located in Gardabani municipality (detailed information on the landfill can be found in Chapter 2.5.5.1, pg. 47). Initially, the landfill was planned to be built in the village of Norio, Gardabani District. An environmental impact permit on the project's implementation was issued without prior agreement with local residents. Due to an active confrontation between the project developers and the residents, the project was halted and a new territory was selected for the landfill eight km from the initially planned site. Tbilisi City Hall had to submit the project one more time to obtain an environmental impact permit, spending additional time and resources. In this specific case, information and engagement of the residents at an earlier stage would have revealed the problems and avoided a second costly EIA procedure. In order to save time, the re-submitted project was exempted from the environmental impact permit procedure. Consequently, the public participation component of the procedure was also skipped. Therefore, citizens were not able to receive information and present their opinion. As a result, the project has remained controversial for many citizens. Disagreement was partly caused by the fact that the residents did not have adequate information about the project and its potential impacts on the environment.

For this reason it is important that public involvement is initiated at an early stage of planning. This will help to prevent the spread of inaccurate information about projects and allow for the identification of public needs, encourage consideration of their opinion and finally, help to avoid controversies. Furthermore, public participation helps a decision-making body to obtain additional information from the local population to enhance the quality of decisions made.

5.5.4 Public Councils

To encourage public engagement in decision-making, public councils have been organized at the Ministry of Environment and the Tbilisi City Assembly.

The Public Council of the Tbilisi Assembly was established on 16 May 2008. It consists of 20 members. The members are well-known people: architects, doctors, teachers, theatre figures, writers, journalists, etc. The council has an advisory function. The members of the council are supposed to meet several times a month and present their views and recommendations to the Tbilisi Assembly and the Tbilisi City Hall in regard to current problems of the capital city. However, only one meeting of the council has been held so far.[231]

The Public Council of the Ministry of Environment was established on 5 March 2009. The council consists of well-known personalities as well. The Council is an advisory body to the Ministry whose functions include: preparation of proposals and recommendations on environmental issues, ensuring public involvement in decision-making processes and helping to enhance environmental awareness of the public. Different environmental issues of current importance have been set forth at the council meetings at the initiative of the members. However, only four meetings of the Council have been held in total over the period of 26 January 2009 – 28 February 2009.[232] There have not been meetings since February 2009 up to now. Instead, a couple of events focusing on raising environmental awareness have been organised, such as clean-up and planting actions, photo galleries etc.[233]

227 ibid., Chapter X[1] Article 58[2].
228 ibid., Chapter X[1] Article 58[3], 58[4].
229 ibid, Chapter X[1] Article 58[4] .
230 Giorgi Chachanidze, Deputy Head of the Tbilisi City Assembly Commission of Environment Protection, telephone interview, March 18, 2011.
231 Source: Tbilisi City Assembly http://www.sakrebulo.ge/index.php?lang_id=ENG&sec_id=190 .
232 Protocol # 1- #4 of the Public council of the Ministry of Environment Protection, http://moe.gov.ge/index.php?lang_id=GEO&sec_id=73
233 Eka Bendeliani, Head of the Service of Public Relations of the Ministry of Environment Protection, personal interview, December 26, 2010.

CHAPTER 6: Policy Options

6.1 Air quality

Motor transport is the main source of air pollution in Tbilisi. The high volume of emissions from the motor transport sector is the result of many factors, including poor organisation and regulation of traffic, poor fuel quality and aging vehicles. In order to decrease emission levels, joint actions from different authorities are needed. Such actions include the following:

- Improvement/optimization of traffic management in Tbilisi;
- Establishment of an age limit for imported cars;
- Introduction of economic instruments/taxes which will stimulate import of newer vehicles and provide a disincentive for the import of old motor vehicles;
- The gradual phasing in of stricter motor fuel quality and vehicle emission requirements, along with enforcement of those requirements;
- Introduction of regulations for mandatory use of catalytic converters;
- Re-introduction of an annual technical inspection of cars, including emission testing of motor vehicles;
- Improvement of public transport in the city; and
- Development of electric transport infrastructure and promotion of alternative modes of transport.

Even though total air emissions from the industrial sector are very limited in Tbilisi, air pollution from particular industrial facilities may cause significant environmental problems in their neighborhoods unless emission standards are met. In this regard, the situation is complicated by the fact that a regulation which is related to the establishment of sanitary zones around industrial facilities and other sites was cancelled in 2007.[234] This regulation required establishment of areas and zones around industrial facilities within which developments and other activities, including development of human settlements, were restricted. The absence of such regulations may have negative environmental consequences, unless industrial facilities strictly comply with the emission limits established by environmental authorities. To ensure compliance with air emission limits by companies which have the potential to significantly pollute the air, regular monitoring of air quality around such industrial facilities is needed. This also requires strengthening capacities of the Environmental Inspectorate to ensure the effective control of emissions from enterprises.

As mentioned earlier in Chapter 2 of this document, the Tbilisi municipal government has a plan to decommission or move many industrial facilities currently located along the railway to the eastern parts of the city. Even though this change will improve the environment in the central part of the city, it should not shift problems from one place to another. An over-concentration of industrial facilities in the new areas should be avoided. Industrial facilities should be built far enough away from settlements, offices, hospital, green areas etc.

In addition to measures targeted at reducing emissions from the transport and industrial sectors, actions have to be taken to mitigate the problem of air pollution by:

- restricting construction and infrastructure developments in designated green areas of the city and its surroundings;
- development of new green areas or restoration of degraded green areas in the city and its surroundings, e.g. around Lisi Lake and Tbilisi reservoir; and
- restricting construction of multi-storey buildings, specifically along the Mtkvari River canyon and in the upper parts of mountains around the city, which could hamper winds and thus the natural refreshment of the air and regulation of climate in Tbilisi.

These measures are important taking into consideration the observed trend of average annual temperature increase over the last decades in Eastern Georgia (where the Capital city is located), and expected acceleration of global warming in the coming decades.[235]

In addition, it is necessary to eliminate emissions of harmful substances induced by waste- burning processes at the old municipal solid waste landfills, “Gldani” and “Iagluja” (see Chapter 2). The Tbilisi municipal government must ensure the proper rehabilitation of these landfills.

Finally, it is essential to develop an effective and efficient network of air quality monitoring stations, which requires a further expansion and modernisation of the current air monitoring network. This will also help to assess the affected population in the city and to design and undertake measures for their protection. In this regard, the following needs to be done by the environmental authorities:

- Widening of the current air quality monitoring network in Tbilisi. This should include selection of additional monitoring points in the city which would

234 Order of the Ministry of Labour, Health and Social Affairs of Georgia N236/n (6/10/ 2003) on the approval of “Sanitary Protection Zones for Enterprises, Buildings and Other Objects and their Classification”.

235 Second National Communication to the UNFCCC of the Ministry of Environment Protection of Georgia, Tbilisi, 2009.

help to provide better information on the state of air quality in the city and installation of air quality measurement stations at these points;

- Installation of automated air quality measurement stations at selected points;
- Purchasing at least one mobile air quality measurement laboratory in order to measure air quality in different points of the city;
- Purchasing air quality modelling software and building capacity of specialists for its use;
- Widening of the spectrum of polluting substances, for which concentrations will need to be measured at different air quality observation points. This should include pollutants such as ground level ozone, fine dust particles (PM_{10}, $PM_{2.5}$), volatile organic compounds (VOC), polyaromatic hydrocarbons (PAH) and lead; and
- Ensuring timely and easy public access to air quality information through creation of an internet portal and website.[236] The data should be presented in a format that would help the general public to easily understand how clean or polluted air is in the city.

It is also recommended that national air quality standards and air quality measurement methodologies be revised in line with EU requirements and practices.

6.2 Energy

It was mentioned in Chapter 5 of this document that there is a significant potential to increase energy efficiency in Tbilisi and to reduce environmental impacts related to energy production and use, including emissions of greenhouse gases (GHGs). In March 2010 the Tbilisi municipal government made a commitment under the Covenant of Mayors to reduce emission of greenhouse gases 25% by 2020. The Tbilisi City Hall has developed a Sustainable Energy Action Plan (SEAP) for meeting this objective. The SEAP addresses three main energy sectors – transport, buildings, and infrastructure (see Chapter 5.4.3). Implementation of the SEAP will be a major challenge for the Tbilisi municipal government in the coming years, in relation to making Tbilisi a "lower carbon city".

In addition to measures targeted at increasing the energy use efficiency, the SEAP includes some actions for promoting the use of renewable energies in Tbilisi, such as solar and geothermal energies and bio-waste. In fact, there is significant potential for a wider application of these resources by households and the service sector (e.g. schools, hospitals). For instance, as mentioned in Chapter 2 of this document, available geothermal energy resources in Tbilisi, theoretically would be enough to provide 40% of the city with heat. However, the use of geothermal energy in many districts of the city may not be technically or economically feasible, and studies would need to be undertaken to assess the wider use of geothermal energy in Tbilisi. It is hoped that succesful implementation of the Saburtalo Pilot Geothermal Project which is being implemented with the financial assistance of the Global Environmental Facility will be an impetus for the promotion of the use of geothermal energy in Tbilisi.

There is also a high potential for the use of geothermal and solar energy in Tbilisi. This potential has been poorly explored thus far. At present, very little of the solar potential have been used for heating by some individual households. The Tbilisi government could assess by awareness-raising, including an information campaign and pilot projects, and creating an enabling regulatory framework to promote wider use of solar energy in households and service sectors.

6.3 Water

As mentioned in Chapter sections 2.5.3, 2.5.4 and 3.2.2, the municipal sewage system, industrial sector and runoff storm waters are main point sources of pollution for surface water bodies (rivers, small streams, natural lakes and artificial water reservoirs). From non-point or diffusive sources, the major pressure is coming from intensive fertilizer use in the past for crop agriculture. Another potential source is non-maintained solid waste landfills located (sometimes illegally) adjacent to rivers and other water bodies/ rivers. In addition, illegitimate and unregulated water withdrawal from water bodies (as was practiced at Lisi Lake and Tbilisi Sea) may distort the hydrological balance, leading to severe bacteriological pollution problems.

Currently, monitoring of surface water bodies is carried out at a relatively small scale, and mostly covers the Mtkvari River only, while bacteriological monitoring is not conducted regularly at all. In addition, chemical and physical sampling of water quality does not include testing for pesticides, one of the deadliest compounds of agricultural and industrial pollution. Monitoring of groundwater aquifers has not been carried out at all for 20 or more years.

Considering all the reasons cited that are the cause of degradation of water resources in Tbilisi, and the state and limited capacity of the existing observation network, the main recommendations which could improve the situation are the following:

- It is desirable to extend the water quality sampling network to new locations in the city, particularly to extend sampling points to the main tributaries of the Mtkvari (Vere, Dighmistkali, Gldaniskhevi and Lochiniskhevi). These small river ravines, with still remaining natural vegetation, are considered

236 At present the air monitoring data are available to the public through the Aarhus Centre's web-page. However, it is provided to the Centre only once in a month. Moreover, interpretation of the data is difficult or even impossible for non-specialists.

as potential recreational areas for greater Tbilisi. Therefore, maintaining good water quality in these areas is of great importance.

- Sampling for pesticides and oil products should be introduced in the monitoring network to detect pollution loads from the agricultural, industrial and transport sectors.
- A full inventory of water pollution point sources for the Mtkvari River, as well as its tributaries, should be conducted using GIS and GPS technologies.
- Since full-scale chemical monitoring requires a considerable amount of funding, where possible a combination of chemical and biological monitoring should be practiced for assessing ecological conditions of smaller streams and other water bodies.
- Regular bacteorological monitoring of recreational waters should be introduced, where possible on a daily basis, but at least during the bathing season.
- Preventive measures should be applied to avoid discharge of animal manure and solid wastes to reservoirs.
- Most importantly, solid investments are required to rehabilitate wastewater treatment facilities, as well as the sewage collection system and drainage network in the city.

6.4 Waste

As mentioned in chapter 2.5.5, the waste situation has considerably improved in Tbilisi over the last five years. However, there are still issues to be addressed at both the national and local levels.

First of all, it is essential to develop a national strategy and policy on waste, and develop the corresponding national legislation. Existing scarce regulations are mostly outdated and need to be adjusted to the current circumstances and modern standards.

Environmental impact permitting plays a key role in waste regulation at present in Georgia. Therefore, it is essential to ensure the permit system is functioning properly at all levels. Producer responsibility towards waste should be clearly reflected in EIA reports and permit conditions. It is also necessary to ensure regular surveillance of permit conditions, which is an essential part of the permit system. Furthermore, activities not requiring environmental impact permits presently are not subject to *any* waste regulations. This issue should be addressed correspondingly. In addition, it is advisable to encourage low waste production and recycling by means of establishing financial incentives for industries.

A new sanitary landfill began operation in Tbilisi in November 2010. It is essential to ensure proper operation of the new landfill in accordance with the EIA report and the permit conditions. Surveillance of permit conditions is the responsibility of the Inspectorate of Environment Protection. However, the role of the Tbilisi Government is also important in terms of controlling waste operations at the landfill site.

It is very important to ensure proper conservation/ remediation of old landfills in order to eliminate/ mitigate environmental risks related to these landfills. In addition, periodic monitoring of soil, air and underground water has to be undertaken, to estimate environmental pollution caused by the landfills and to plan/re-adjust mitigation measures.

It is necessary to support development of modern technologies of hazardous waste treatment/disposal. It is advisable to organize a separate collection system for hazardous municipal waste, in order to divert hazardous waste from the municipal landfill and to ensure its special treatment/disposal.

Medical waste regulation/control needs improvement. Requirements to waste collection/treatment at hospitals should be reflected in medical license requirements. In addition, hospitals should develop clear waste management plans and related rules for their personnel to follow.

6.5 Green Areas

As mentioned in sub-Chapter 3.3, the current green space in Tbilisi available per inhabitant is very limited. In 2001, when the latest inventory was carried out, this number amounted to 5.6 m^2 per inhabitant, compared to 13.0 m^2 in the early 1980s. Consequently, one of the major challenges for the city's development in the coming decades will be planning activities to respond to the need for more green space, one of the most important indicators in calculating the overall condition for a healthy and safe environment in the largest and most densely populated urban area of the country. The Perspective Plan for Development of the Capital Town (2009), or more commonly called the Tbilisi Master Plan, proposes to increase this number to 11.0 m^2 per inhabitant. Since Tbilisi follows a linear shape in its growth, and development across the Mtkvari River it is very difficult to maintain evenly-distributed natural landscapes and green spaces throughout the city. Therefore, it is important to develop green zones and recreational areas across the Mtkvari and its major tributaries, and that follow downhill ravines of the surrounding mountains. Hence, major recommendations for functional regeneration of the City's greening policy are as follows:

- Conduct a detailed GIS inventory of green zones, with the perspective of planning potential future green areas, and restricted zones 'red-lined' to prohibit development;
- Identify areas of municipal recreation, agricultural, communal and cultural-educational functions;

- Develop arterial greening branches across the Mtkvari River and major city avenues, with perpendicular wedges of green 'streams' of downhill smaller ravines and Mtkvari tributaries;
- Build natural connection 'bridges' among the city parks, linear green areas, recreation areas etc. to encourage free movement (of people, fauna and flora);
- Plan for immediate expansion of the recreational and cultural landscape zones towards and adjacent to the Lake Lisi and Tbilisi Sea areas;
- Plan for prospective "green islands" across the railway zone to be freed up as a result of shifting the existing rail and related infrastructure outside of city limits;
- Increase green buffer zones surrounding the city; plant vegetation appropriate for local conditions on downhill slopes around built-up areas; and
- Introduce legislative initiatives that will strictly define construction/development limits in the City's Master Plan and related official documents, and which will as a result be reflected in immediate measures preventing development from resulting in environmental damage/harm.

6.6 "Co-benefits" of environmental policies, or why being green pays off

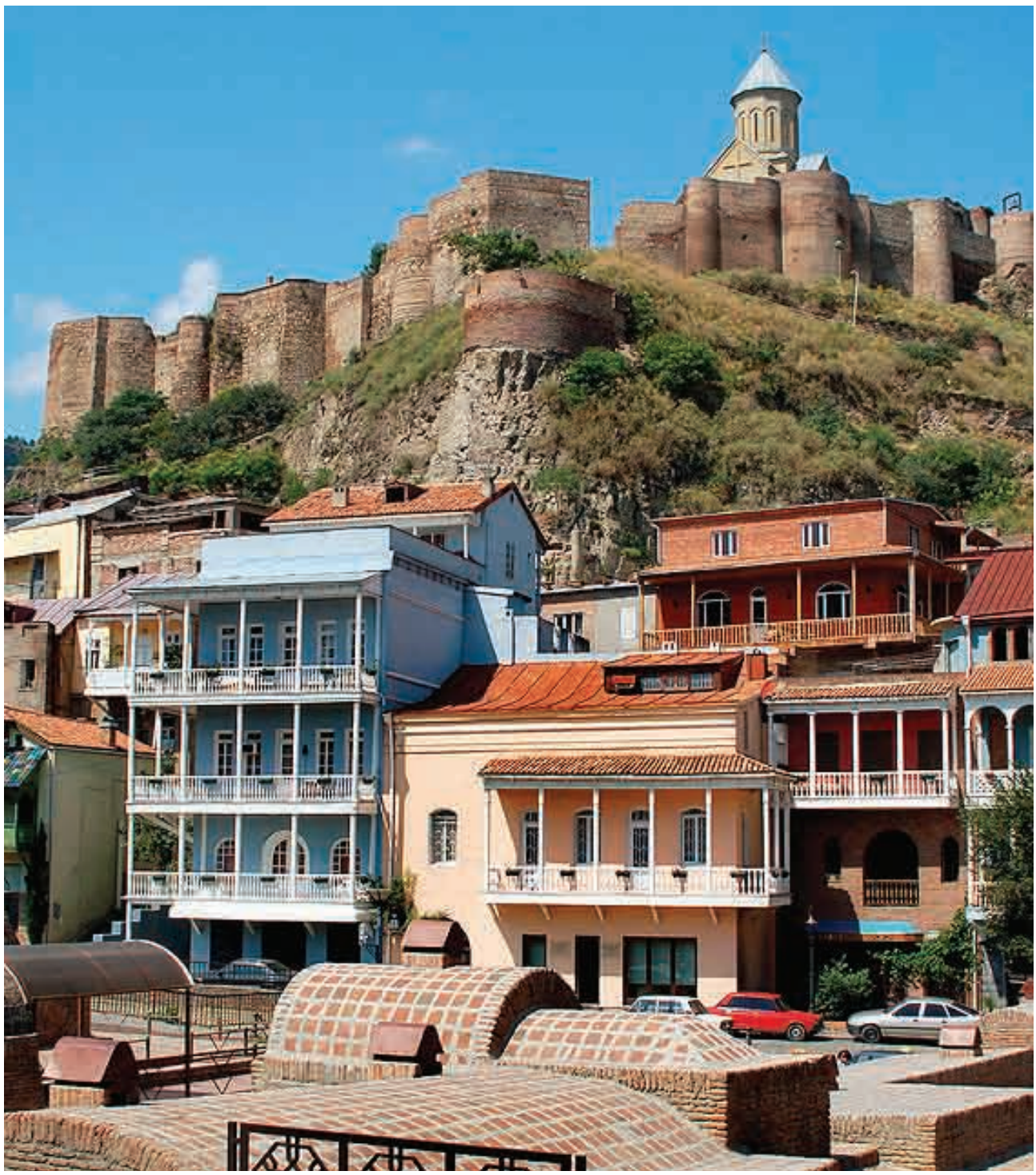
In summary, environmental problems in Tbilisi should not be seen as stand-alone issues. Environmental issues form an integral part of a complex range of factors that influence general well-being of a city's inhabitants. Urban environmental management in Tbilisi needs to undergo a transition from seeing urban environmental issues as isolated, stand-alone and cost-bearing problems, to **integrated** urban management practices where economic, social and environmental goals become mutually supportive:

- Air pollution issues that are mainly caused by urban transport should be seen through the lens of enhancing sustainable urban mobility. Sustainable mobility can be achieved by first of all, promoting and improving infrastructure or sustainable modes of transport – walking, cycling and public transport. Other means of transportation should be controlled and/or limited through establishment of vehicle emission standards, fuel quality standards, low emission zones and congestion charging policies, just to name some examples. Making sustainable urban transport a reality is likely to contribute to better general health, increased physical activity and higher productivity of a city's inhabitants, a decrease in public and private expenditures on health and other social services, a decrease in the number of traffic accidents, economic and social benefits as a result of reduced congestion, an increase in real estate prices, improved social cohesion and poverty reduction.
- Energy efficiency policies in electricity and heat production and consumption are another excellent example of multiple benefits achieved simultaneously. Energy savings not only reduce air pollution and greenhouse gas emissions, but also reduce energy bills for households and businesses, alleviate poverty, improve the trade deficit and decrease energy dependence. Greenhouse gas reductions may be successfully marketed and sold in international markets, bringing in financial resources for further infrastructural improvements. Shifting from supply-side management to demand-side management is essential for reaping the full potential of energy efficiency policies. High environmental performance of buildings is in general associated with lower energy bills and even with additional incomes (in the case of small-scale renewable energy applications), and thus increases in real estate prices.
- Green areas act as pollution and greenhouse gas sinks; their importance in flood, erosion or mudslide prevention, climate regulation in urban areas, general health, physical activity of inhabitants and social cohesion are indisputable. Expansion of green areas and greening of buildings (rooftops, balconies, terraces, patios etc.) is in general associated with lower temperatures during heat waves and thus lower cooling energy demand, as well as higher real estate prices in the proximity of green areas. There are also recreational and even spiritual values to consider for certain green areas.
- If sustainable waste management principles are fully implemented in practice, the municipal financial burden of waste management can be significantly decreased with only a fraction of municipal waste reaching landfills. In order to achieve that, it is necessary to initiate policies of waste reduction and waste separation at source. New business opportunities can be sought in recycling, composting, energy production from landfills and other organic waste, such as wastewater sludge.
- Cities can proactively contribute to their water and energy supply through rainwater collection systems and small-scale renewable energy applications (solar water heaters on rooftops, photovoltaics for electricity generation and small-scale wind energy generators).
- Last but not least, transition to sustainable urban management is likely to contribute to the creation of new work places, many of which may be considered as "green jobs".

Advanced studies are needed in Tbilisi in order to prove the above-mentioned relationships; however, UNEP's Green Economy Report[237] also warns that improper urban management may slow down or inhibit further economic development. Due to their "footprint" (resource consumption and waste production impacts), urban areas globally may be seen as major drivers of environmental degradation. However, they also possess the greatest potential for environmental and general welfare improvements due to their scale, density, productive capacities and innovation potential[238]. Initial investment sums may seem to be a stumbling block; however, advanced cost-benefit analysis of current trends compared to a desired state may be the first step towards securing necessary political will and commitment. Decentralization of governance, sound policy-making, partnerships with the private sector and international development assistance can further facilitate that "Sustainable Tbilisi" becomes a reality.

237 United Nations Environment Programme. 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. URL: www.unep.org/greeneconomy

238 ibid



Old Town
Photo by Khatia Psuturi

CHAPTER 7: Outlook 2020 - four scenarios for Tbilisi's near-future development

7.1 Introduction

Over the past two-three decades the world has witnessed the emergence of multiple global crises strongly related to climate change and unsustainable production and consumption that lead to declining capacity of ecosystems. The effects of these crises are felt worldwide and have specific implications for the achievement of sustainable development and the Millennium Development Goals. While it is clear that Governments and the international community face multiple and serious challenges, the situation also presents genuine opportunities for a dramatic shift from what can be termed "business as usual". Most of these "normal" activities are urban-based, and therefore cities are where the interwoven challenges of quality of life and sustainable development must primarily be addressed.

Cities occupy just 2 % of the world's surface, but at the same time, are home to half of the world's population, and are responsible for three-quarters of natural resources consumed globally.[239] Taking into account the complexity of urban challenges and difficulties in managing these, it is crucial for policy makers to have imagination about what today's decisions will cause in different sectors in the future. To minimize the risks for future development, different forward-looking techniques in modern planning and management can be employed. Among these are scenarios for future developments which are "plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces".[240]

This Chapter explores the implications of the challenges by considering different environmental development scenarios for Tbilisi, representing alternative futures that might appear stemming from the current situation and policy choices made and implemented in coming years.

Georgia is following a pro-Western course and aims to enter Western institutions. Tbilisi is a business hub and policy crossroads of the country, and also plays an important role in the region. Like other cities, Tbilisi is also the focus of many environmental challenges, where quality of life is determined by a wide mix of socio-economic, political and environmental factors.

239 Local action for biodiversity, UNEP, UNECE, UN-HABITAT, 2008.
240 Leemans, R. Scenarios of a Sustainable and Desirable Future: Lessons from the Millennium Ecosystem Assessment. Power point presentation, February 2, Burlington, VE, USA.2006.

In general, the state of development of any system is formed and reformed based on the pressure of global and local driving forces, such as globalization, climate change, economics, demographics etc., and response to these challenges by system managers, authorities and the public. Because of a scarcity of resources (financial, human, technological, knowledge) and management behavior (practice), these responses are not always adequate. The goal of scenarios is to broaden the view of decision-makers and other stakeholders on possible future developments, and provide support to make appropriate decisions today, taking into account possible future results.

Thinking about the future requires thinking in alternatives. The future is full of uncertainty, many alternative development paths are possible and many unpredictable things can happen. Scenarios are powerful tools in this regard as they help to "think outside of the box". Scenarios are neither predictions nor forecasts. Scenarios are like an "ordinary lantern" with a capacity of a broad view in darkness. Predictions or forecasts are more like "laser pointer" with narrow and fixed views. Besides these strengths, the development of scenarios also has weaknesses (see Box 7.1).

Forward-looking studies, such as scenarios[241] and outlooks, have been widely conducted in international organizations, governments, companies and non-governmental organizations over the last few decades. The long-term emission scenarios of the Intergovernmental Panel on Climate Change (IPCC)[242] are well-known.[243] They have been widely used for the analysis of climate change, its impacts and mitigation options, and to support international negotiations on setting long-term targets. Another example is the Millennium Ecosystem Assessment[244], which developed scenarios to analyze outcomes for global ecosystem services in different future situations. The United Nations Environment Programme (UNEP)[245] uses its Global Environment Outlooks (GEO)[246] scenarios to frame its long-term analyses. Major

241 http://glossary.eea.europa.eu/terminology/concept_html?term=scenario
242 http://www.ipcc.ch/
243 Emissions Scenarios. Summary for Policymakers/ IPCC Special Report. WMO/UNEP-2000.
244 Ecosystems and human well-being: Scenarios. Volume 2. (Edited by S.R. Carpenter and others)Island-press 2005.
245 http://www.unep.org/
246 Global Environmental Outlook 3 and 4. UNEP. www.unep.org/geo/

Box 7-1 Scenarios SWOT analysis

Strength	Weaknesses
• Alternative development options/targets • Consequent policy recommendations. • Complex thinking • Easily understandable • Outside/inside view of the system	• Large number of uncertainties • Requires more resources and capacity • Absence of internationally agreed methodology. • Absence of future-looking indicators. • Lack of information support
Opportunities	**Threats**
• Opportunity for “Pareto optimal” decision (achieve at least one goal, without hampering other goals) • Improve planning discipline/methodology • Improve system effectiveness	• Limited institutional capacity • Marginal views may not be taken seriously and rejected by decision-makers • Inappropriate link between mega and local trends. • Use of poor or not systemized statistics/ information.

international organizations such as the World Bank[247], the International Energy Agency[248] and the Organisation for Economic Co-operation and Development (OECD)[249] also frequently publish long-term projections and analyses[250]. The European Environmental Agency (EEA)[251] has also prepared several environmental assessment reports[252]. With support of partner organizations, important environmental assessment reports with future-looking options were prepared for the Caucasus, Georgia and Tbilisi:

- Environmental Performance Review of Georgia[253]
- Tbilisi Millennium Development Report[254]
- Environment and Security: Transforming Risks into Cooperation "The Case of the Southern Caucasus”[255]
- Caucasus Environment Outlook, (CEO-2002)[256]
- Tbilisi State of Environment Report[257]

247 www.worldbank.org
248 World Energy Outlook 2008. International Energy Agency, Geneva 2008. http://www.iea.org/
249 http://www.oecd.org
250 OECD Environmental Outlook to 2030, OECD 2008.
251 http://www.eea.europa.eu/
252 Europe’s Environment. The fourth assessment. EEA/OPOCE. 2007
253 Environmental Performance Review of Georgia, UNECE, New York and Geneva 2003 and 2010. www.unece.org
254 Tbilisi Millennium Development Report. Tbilisi Municipality/ UNDP, Tbilisi 2007. www.tbilisi.gov.ge
255 Environment and Security: Transforming Risks into Cooperation “The Case of the Southern Caucasus” UNEP, 2004.
256 Caucasus Environment Outlook (CEO) 2002. UNEP, New Media Tbilisi 2002. www.grid.unep.ch/product/publication/CEO-for-internet/
257 Tbilisi State of Environment Report, UNEP/GRID-Arendal, 2000. www.ceroi.net/reports/tbilisi

7.2 Methodology

Ideally the development of scenarios or any other future-looking assessment reports should be based on an analysis of both qualitative information and quantitative data, reflecting different approaches such as the Driving Forces–Pressure–State–Impact–Response (DPSIR) model. This chapter is, inter alia, based on the use of DPSIR applied in previous chapters.

The Tbilisi municipality has no statistics division and the general environmental statistics that are published in the Statistical Yearbook of Georgia based on data provided by the Ministry of Environment are not reliable, display major gaps in time-series data and are not consistent with internationally or regionally-agreed indicators as recommended by the United Nations Economic Commission for Europe (UNECE)[258].

Due to the above-mentioned it was not possible to conduct modeling and develop quantitative scenarios. The scenarios are based mainly on narrative qualitative analyses of key environmental trends and driving forces using findings of other experts in GEO-Cities Tbilisi and desk studies of different policy documents, scientific literature, guidelines and reports of similar studies.

The short timeframe covered by the three scenarios (present-2020) was chosen because of ongoing rapid changes in Georgian and Tbilisi developments and for easy imagination by decision-makers and the general public about their near-term future. In addition, this

258 Guidelines for the Preparation of Indicator-Based Environment Assessment Reports in Eastern Europe, Caucasus and Central Asia, UNECE 2007.

timeframe is long enough for taking into account the findings and recommendations of this report and making adequate policy responses to current and possible challenges.

7.3 Four scenarios of Tbilisi's future development

The four scenarios of Tbilisi's potential future development are entitled:

1. **"Business as Usual"** (roughly analogous to "Markets First" in UNEP GEOs-3/4, "Market World" in CEO).
2. **"Policy Harmony"** (similar to "Policy First" in GEOs-3/4, "Status Quo" in CEO).
3. **"Tbilisi Dream"** (which can be linked to "Sustainability First" in GEOs-3/4).
4. **"Great Depression"** (corresponds to "Downfall" in CEO).

7.3.1 Business as Usual

General. Under the "Business as Usual" scenario, current environmental, demographic and economic trends unfold without major changes.

Economic and political developments. Liberal market forces drive Tbilisi's development, where key characteristics include continuity of and convergence toward today's institutions and policies. The self-correcting logic of competitive markets is expected to cope with problems as they arise. Sustainability issues are addressed more through rhetoric than action: materialism and individualism spread as core human values, and traditions are gradually disappearing**.** Small businesses are threatened by monopolistic companies. The number of tourists increases, especially business visitors. Energy policies are guided by supply-side management and energy demand increases, while there is only a limited focus on energy efficiency and savings.

The Georgian Government does not fulfill NATO requirements, nor provisions for EU associate membership and the process of admission to both entities is slowed. The European integration process focuses only on extension of the internal market. There is no effective political dialogue with Russia, but negotiations are ongoing vis-à-vis economic issues.

Environmental policy. The Georgian government considers environmental protection a sort of secondary issue, the Ministry of Environment is very weak and consequently there is no effective environmental policy under the Tbilisi municipality. Environmental self-monitoring by enterprises is not regulated, and only selective inspections (once a year) are the main instrument for compliance monitoring. Applying environmental assessment tools, including those involving public participation in decision-making, is seen as prolonging administrative procedures and therefore as delaying investments in the country. The long-term benefits of the application of such tools for the environment and society are ignored. Ecological awareness throughout society is not improved; environmental education is incorporated into formal education curricula only on a limited basis**.** The Environmental Impact Assessment **(**EIA) process is selective and only implemented for projects financed by International Financial Institutions (IFIs).

Social and demographic issues. Income inequalities continue to grow and the social security system is greatly weakened. Overall household consumption increases, and there are no incentives to change social and individual behavior. Some social groups regularly over-consume, while others have no access even to basic needs. The health care and education systems are under-funded, which increases the number of private entities with high prices and services that are unreachable for the majority of citizens. Tbilisi's

Box 7-2 Decisions which support the development of this scenario

- In February 2011, as a result of planned restructuring functions, the Ministry of Environment Protection and Natural Resources of Georgia was downgraded, with some of its agencies being subordinated to other ministries. The NGO community in Georgia has expressed concern over the decision to downscale the Ministry. The new name of the agency is the Ministry of Environment Protection.
- Recently, residents of Tbilisi have more frequently protested tree-felling in the city. Trees are being cut down in streets and avenues, as well as yards. At times, the felling assumes a widespread character and dozens of trees are cut down simultaneously. In some cases, the trees are being cut down in order to make room for road expansion. Another reason is the cancellation of up to 50 recreational zones in the city last year, which provided a "green light" to those wishing to dispose of trees. The population's complaints regarding the allergenic plane trees are given as an additional reason by the municipality.

Source: Caucasus Environmental NGO Network (CENN) Electronic Bulletin #130. www.cenn.org

population growth is greater than today, and there is an overall trend towards urbanization, which brings more people into Tbilisi for temporary jobs. Life expectancy increases, while the unemployment rate increases to 20%

Without adequate policy support, environmental conditions deteriorate, leading to more people living in poorer quality areas from an environmental perspective.

Urban infrastructure. Municipal infrastructure assets deteriorate due to continued use of an ageing inherited system, where maintenance is reactive and little attention is given to long-term performance or cost savings. Infrastructure construction projects are fragmented and do not apply a "best practices" approach. Increased capacity requirements for transport infrastructure require greater use of underground space. Tunnel and underground parking infrastructure is planned in and around Tbilisi, however; these are built on a piecemeal basis only. The expected disruption caused during utility maintenance, renewal and upgrading (through trenching and patching operations) continues with consequent high environmental and social costs ensuing.

Urban development encourages economic and cultural activity. Construction of tall buildings increases in the central areas of Tbilisi (Vake, Vera and Mtatsminda sub-districts) without proper landscape planning, causing many problems due to old infrastructure's deterioration and contributing to poorer air circulation, particularly in warmer periods and in the downtown area.

Water availability is limited, and resources are under increasing pressure due to increased abstraction and water demand across all sectors (industry, commerce, residential and leisure use). New resources are created to feed a centralized supply system; however, water supply and waste water disposal are operated at a high cost to the consumer, and part of population cannot pay their water bills. Water networks have a high degree of leakage (around 35%) and increased volumes of waste water and storm water volumes. Use of water per capita/day is still very high at approximately 600 liters. A small increase in efficiency is seen through adoption of water meters and saving devices in some parts of Tbilisi. In some areas (especially in villages around Tbilisi which recently became part of the city), there are limited water and sanitation services. The same can be said about waste-related services. Industrial plants continue their operation without having their own water treatment facilities.

Two old official and highly polluting municipal landfills are closed, but few conservation measures are taken. A new official landfill begins operating without appropriate sanitary standards. There is limited recycling activity and no waste separation. Waste production has increased significantly due to market requirements for packaged goods. This leads to more waste collection. The number of illegal or unregulated landfills increases.

Public transport deteriorates, mainly due to continuing use of old vehicles and inadequate management. Both traffic volumes and passenger cars per capita strongly increase. The importation of secondary cars without catalytic convertors continues, and consequently, air pollution from transport increases.

Public sector resource allocation for Tbilisi green areas decreases especially in Digomi and Vake sub-districts, and Tbilisi national park, reflecting public values and concerns of business about restriction on commercial activities. Natural habitats and their ecological functions gradually erode. The area of land managed for biodiversity decreases from current levels, as weaker designations are given to facilitate expansion of the built environment. The size of the total forested area around the city decreases, and the structure and composition of tree species worsens.

7.3.2 Policy Harmony

General. Overall, the "Policy Harmony" scenario means integration of environmental and social considerations into economic development policies.

Economic and political developments. Under this scenario, economic reform with high income and economic growth are achieved concomitantly; comprehensive and coordinated government actions are initiated for poverty reduction and environmental sustainability. There is a very strong and decisive decentralization in parallel with central government interventions and redistribution of functions(?). Tbilisi local taxation is dominated by the revenue side of the budget, while the implementation of locally-determined priorities, plans and programmes receives only supplemental support from the central government's budget. Tbilisi becomes the financial and business hub of the region, and the number of tourists and business visitors increases.

Georgia joins NATO and fulfills as well all requirements for EU associate membership. A respectful dialogue between Georgia and Russia is started. Approximation of Georgian environmental legislation with EU directives is an ongoing process.

Environmental policy. The Georgian Government revises its approach to environmental structures and a strong environmental ministry is created. Consequently, Tbilisi municipality establishes an effective, target-oriented environmental division with a robust mandate and comprehensive functions. Use of Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) for major projects becomes not only a common, but standard practice. There are no limits in accessing environmental information and knowledge about the

Box 7-3 Recent environmentally-friendly initiatives of Georgian and Tbilisi Governments which support development of this scenario

- In March 2010, the Mayor of Tbilisi signed the Covenant of Mayors, an initiative of the European Commission that aims at reducing Carbon Dioxide emissions by at least 20% until 2020.
- The French company "SYSTRA" began work on a design study for the development of the Tbilisi tramway network and urban development for the Georgian capital. The agreement was signed in Paris by the Mayor of Tbilisi and the Managing Director of SYSTRA in December 2010.
- In his speech at the UN climate change (Cancun, Mexico 2010) conference, President Saakashvili expressed the ambition of Georgia to become a carbon-neutral country and emphasized the governmental plan that aims to develop electric transport in the country. "We are launching a program that will lead to a cleaner transport industry. And public institutions will lead by example. The Georgian Government will, starting from this year, replace official traditional cars with electric ones", he stated.
- The President also stated: "Georgia is making great strides in developing its renewable energy program. We have established a friendly investment environment that has led to billions being poured into renewable energy sources, especially hydropower", he said, sharing the rapid progress of the country with more than 80% of the electricity production coming from renewable sources.

Source: CENN Environmental Bulletin #127-128. www.cenn.org

local state of the environment is freely accessible from home computers. The direct participation of citizens at all levels of decision-making is thus further strengthened.

Robust provision of environmental services through stable public funding and management mechanisms is often secured through innovative public-private development schemes and forward planning; a high rate of accessibility to these services is achieved. Signed in March 2010, the Covenant of Mayors[259] is fully implemented and local carbon dioxide emissions are reduced by 20%. Aside from that, Tbilisi municipality is cooperating with other European initiatives focusing on sustainable development of urban areas.

Social and demographic issues. A trend towards urbanization, combined with slower population growth than today, leads to more compact city settlements with higher dwelling densities. The unemployment rate is reduced to 15-20 %. Environmental education is practiced in curricula at all levels of formal education. The health care system is more accessible to the population, and a health insurance system is widely introduced. Overall household consumption increases, and there are serious incentives to change social and individual behavior.

Urban infrastructure. There is no net increase in the built environment: policy supports the restoration of eroded land and uses it for recreational activities. The percentage of sub-standard housing drops due to a new low and a popular consensus drives increased community and civic involvement, along with satisfaction in living arrangements/space(?). Environmental conditions improve, including local air quality through the construction of appropriate infrastructure, traffic management and a ban on cars without catalytic convertors.

Sustainable practices drive land-use management, including spatial planning, and strong control is exercised over different types of land use functions. Traditional mosaics of old Tbilisi landscapes are at least partially recovered. Green areas and recreational infrastructure development are generally greater than at present, with a preference for actions that are low-cost.

Exhaustion of surface and groundwater has been stopped and water withdrawals reduced to acceptable levels. Due to reforms in the Tbilisi water sector, adoption of some water-saving devices and elimination of water leakages in central pipes, water requirements per capita/day decrease from 800 to 300 liters.

Long term planning and capital availability enables the development of a mixed portfolio of sewerage/drainage options. Costs are passed on to the user through increased taxation. Wastewater generation stabilizes, although there is an increase in pollutant concentration, and sedimentation issues arise. Georgian Water and Power (GWP) meets its contractual obligation and in 2018, the Tbilisi-Gardabani treatment facility is refurbished according to international standards.

Energy demands have increased while fossil fuel supplies have decreased, supplemented by renewable power. Moreover, improved energy efficiency, smart metering and energy certification requirements in offices and industry are brought about through extensive tightening of building regulations. Waste amounts per capita increase, but strict policies for utilization are in place; more wastes are being treated and recycled. Waste separation is organized in municipal landfills. In the transport sector, support is given to electric modes of public transport. There is a strong shift in freight transport from road to rail, thanks to a new Azerbaijan-Georgia-Turkey railway.

Conclusion. The "policy harmony" scenario provides

259 Covenant of Mayors. www.eumayors.eu

Box 7-4 European initiatives focusing on sustainable urban areas development:

- The **Thematic Strategy on the Urban Environment**[260] aims for better implementation of existing EU environmental policies and legislation at local level through exchange of experience and good practice between Europe's local authorities, in order to achieve a better quality of life through an integrated approach concentrating on urban areas. Its principles and approaches are reflected further in other strategies such as the Thematic Strategy on Air Pollution.
- The **Leipzig Charter on Sustainable European Cities**[261] demonstrates a further commitment to making European cities healthy, attractive and sustainable places to live and work in.
- The renewed **Sustainable Development Strategy for the EU**[262] calls for the creation of sustainable local communities with a high quality of life, attention to urban transport and greater cooperation between urban and rural areas.
- The renewed **Lisbon Strategy**[263] sets as a priority the high quality of urban environments to make Europe a more attractive place in which to invest.
- The **Europe 2020 Strategy**[264] builds on the Lisbon Strategy and sets out a broader approach aimed at achieving a resource-efficient Europe. This means decoupling economic growth from the use of resources, supporting the shift towards a low carbon economy, increasing the use of renewable energy sources, modernizing transport sector and promoting energy efficiency.
- **The Green Paper towards a new culture for urban mobility**[265] opens a debate for a new urban transport culture centered on a joint effort to make towns and cities greener and less polluted, as well as safe and more accessible for all citizens.
- The Communication **Cohesion Policy and cities: the urban contribution to growth and jobs in the regions**[266] is designed to help national, regional and city authorities in the preparation of the new round of cohesion policy programmes.
- **Aalborg Charter**[267] is one of the most famous policy statements for local sustainable development, signed by more than 2'500 local and regional authorities.
- The **Sustainable Cities and Towns Campa**ign[268] aims to help local governments across Europe to mainstream sustainability and best practice.

great opportunities for self-sustained development with balanced economic, social and environmental policies. But it also demonstrates that EU membership is not a panacea in the building of a prosperous future for Tbilisi.

7.3.3 Tbilisi Dream

General. Under the "Tbilisi dream" scenario, it is expected that Georgia joins NATO and the EU, and these facts determine overall policy and development of Georgia and its capital Tbilisi.

Economic and political developments. New economic arrangements and fundamental changes in values result in changes to the character of Tbilisi's urban development. A high level of economic growth allows poverty to be reduced to a minimal level. EU policies and strategies guide formulation and implementation of relevant policies and actions in Georgia. The Georgian Government starts successful negotiation with de facto governments of conflict regions with EU structures actively participating. The search for a deeper basis for human social prosperity is a central theme of the Tbilisi government. Aside from the "Covenant of Mayors", Tbilisi joins most European initiatives focusing on urban development (see Box 7.4 below).

Georgia modernizes its public sector (tax accounting, internal security, health care and social security systems) through capacity building, financial and technical assistance from the EU. The quality of life in general converges towards average standards within the rest of the EU. The number of tourist and business visitors from EU countries increases considerably; city tours are well-organized including the popular site of "First Europeans" near Tbilisi. Because of new requirements for obtaining visas, the number of tourists from non-EU countries decreases.

Environmental policy. A strong and effective environmental agency is created for the Tbilisi municipality .The Three "Rs" principle (reduce, re-use, and recycle) drives city environmental policy, improving the overall quality of life. Environmental management systems in enterprises become commonplace, while corporate social and environmental responsibility becomes stronger. Introduction of EU environmental policies leads to short-term difficulties in adjustment (e.g., more than 300 EU environmental legislative

260 Thematic Strategy on the Urban Environment. COM (2005), European Commission, 2006.
261 Report on the follow-up of the territorial agenda and the Leipzig Charter: towards a European action programme for spatial development and territorial cohesion. European Parliament, Committee on Regional Development, Kallenbach, G., 2008.
262 Renewed EU Sustainable Development Strategy. European Council, Brussels. 2006.
263 Lisbon Strategy 2000/2010, www.ec.europa.eu/information_society/Europe/2010/ect_and_Lisbon/
264 Europe 2020 Strategy. www.ec.europa.eu/europe2020/
265 The Green Paper towards a new culture for urban mobility COM (2007), European Commission, 2007. http://eur-lex.europa.eu
266 Cohesion Policy and cities: the urban contribution to growth and jobs in the regions. COM (2006) 385 final, European Commission, 2006c. http://eur-lex.europa.eu
267 http://www.aalborgplus10.dk/default.aspx/
268 http://www.sustainable-cities.eu/

acts which are relevant for Georgia), but in the long-term there are benefits - some quite near-term - for the future development of the country.

The city's climate change strategy is fully implemented, including mitigation and adaptation measures. Clean air prevails in most settlements, while respiratory diseases caused by air pollution decline.

Social and demographic issues. There is no net change in the land occupied by the built environment. Dwelling density is roughly what it is today on the city scale, because of higher brownfield regeneration than today and integrated settlement patterns. However, lower population growth and immigration of temporary residents from Tbilisi allows for "town-within-a-city" development, leaving more open space within the city. The shift in values supports much greater civic participation in decision-making. Education and health care systems are guided by relevant EU policies.

Georgia reduces its public debt to meet the "Maastricht criteria"[269], raises employment rates and reforms education and health care systems. Secondary education remains largely public, but higher-level education and the health care system involve the private sector. Poverty and homelessness diminish, while life expectancy increases, especially for men.

Urban infrastructure. Environmentally acceptable infrastructure developments financed with support of the EU Cohesion and Structural funds take place, along with compliance with EU environmental directives and national environmental standards.

Compared to current levels, the number of green and recreational areas is higher (free land around Tbilisi, plus around 100 ha. of reclaimed land in the centre of Tbilisi because of railway bypass). Generally higher levels of public sector support for urban green areas and biodiversity in turn supports increased levels of conservation "volunteerism". Air and water pollution are reduced, with ecological sustainability featuring strongly in landscape/development plans. Greater functional habitat connectivity and an overall increase in area of ecologically functional habitats improves opportunities for the public to enjoy positive wildlife experiences near to Tbilisi, namely in the Saguramo protected area, Algeti protected area and Tbilisi National Park.

Water withdrawals are reduced to sustainable levels, thus arresting exhaustion of surface and groundwaters. There is a reduction in water demand (200-250 lit/per capita) and increased emphasis on water efficiency and re-use. Slower population growth rates lead to significant reductions in water stress. Most generated waste water is treated by applying best available technologies with reference to the EU Urban Waste Water Directive[270].

The process of deforestation around Tbilisi is gradually reversed, thanks to effective and extensive reforestation and afforestation programs and funding. Sustainable forest management practices become common.

Waste amounts (especially packaging) per capita increase, but rates of recycling and utilization remain slightly lower than the EU average. Waste separation is organized at the household level.

Construction businesses strictly follow the relevant standards of the EU and energy consumption levels of buildings are considerably reduced. Public electrical transport becomes the main carrier of citizens, and the Tbilisi municipality establishes car-free streets and cycling routes.

Conclusion. The future development under the "Tbilisi dream" scenario is determined and driven by EU policies. It shows the benefits of eventual/ultimate EU membership, as well as difficulties and obligations which will appear during the accession process.

7.3.4 Great Depression

General. Under the "Great Depression" scenario, there is an absence of clear vision of the overall situation. Policies are based mainly on "public relation" (PR) technologies and focus on short-term results that will define near-future developments.

Economic and political developments. Due to unclear policies and high political risks for investments, economic growth declines. Limited and unimaginative government attempts to deal with the problem producing few concrete results. A few government-loyal business groups effectively keep local markets closed and prevent the expansion of competition that would bring down prices and increase the availability of goods for local consumers. Small businesses continue to grow at a moderate pace, but do not expand enough to transform local economic or political systems. In particular, small companies face great difficulties. Because of crime and insufficient touristic infrastructure, the number of tourists drastically decreases. Imports constitute 90% of the trade balance of Tbilisi. Economic growth trends decrease considerably; in some sectors stagnation/ recession appears.

Security situation also deteriorates.

Environmental policy. The Ministry of Environment has been abolished and some its functions are distributed among different agencies. The Environmental Department of Tbilisi municipality performs only green area services in central parts of the city. No EIA procedures for governmental projects and no public participation in decision-making are observed.

Incompetent and fragmented responses to

269 Treaty on European Union/ EU Official journal C 191, 29 July, 1992. http://eur-lex.europa.eu

270 Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment. http://eur-lex.europa.eu

environmental problems worsens the situation. Environmental issues become the lowest priority. In general, air pollution declines (because of economic decline), but water pollution and the number of illegal landfills increases.

Social and demographic issues. There is a powerful sense of unrealized expectations and relative deprivation affecting Georgian society. Shortcomings in the social sector are a key element in this equation. After years of growth, optimism and steadily improving political stability and governance, society experiences a succession of blows to prosperity, stability and security at all levels. A few social-economic reforms take place. Higher education and health care services are unreachable for the majority of population. Life expectancy begins to decline again, especially for men. The official unemployment rate reaches 40%.

Growing discontent with the incumbent elites, the population will generally remain politically apathetic and make few efforts to engage in public life. Efforts by motivated individuals to encourage greater participation in political parties, social watchdog organizations and environmental groups will generally fall flat. Most individuals will be focused on improving their private economic situation rather than seeking to enact broader social progress.

Urban infrastructure. Because of the failure of a majority of building companies in 2008-2011, conservation of unfinished buildings is without any standards. Later some of them are finished, but people are afraid to buy apartments without being sure about the quality of building materials. Multi-story buildings built in the 1950s are in poor condition and require more energy for heating. Air pollution from domestic heating increases.

Due to the absence of appropriate building standards for infrastructure construction and maintenance, there are catastrophic failures sometimes leading to deaths/injuries of people. There are serious problems are with the drinking water supply and sanitation. No local wastewater treatment facility is operating within the city. The Tbilisi municipal landfill operates without appropriate standards. Several illegal and uncontrolled landfills appear. The process of deforestation around Tbilisi is continuing, with people using wood from local forests as a source of heating. The number and quality of green and recreational areas decreases as a result.

There is no inspection or monitoring of transport emissions. The percentage of cars classified as “old” (>15 years) reaches 70%. There is a suspension of programmes introducing urban electric transport and construction of the Tbilisi railway bypass.

Conclusion. Taking into account the current policies of Georgia, especially consolidated efforts of the whole society to join Euro-Atlantic structures, the “Great depression” scenario seems rather unrealistic; however, the scenario shows the possible consequences of marginal development and might be useful as a warning for decision-makers and other stakeholders.

Conclusions

As can be seen from the Scenarios («potential futures») above, Tbilisi could take many paths towards its future, whatever lies ahead in reality. In fact, the future of Tbilisi and its citizens will depend very much on how driving forces - both internal and external (to Tbilisi and to Georgia) - play out. Whereas the municipal authorities may not have any control over external factors, they can still shape or at least influence factors of local origin. Given the comprehensive analysis as presented in this Report, the next steps are for Tbilisi City Hall and other local stakeholders to decide a future course of action and elaborate a concrete, detailed and realistic environmental action plan.

Tbilisi City Hall is not alone in this mission. Consultation, involvement and support of all stakeholders is necessary for efficient and effective urban environmental policies to succeed. Stakeholders include non-governmental organizations, schools and universities, businesses, youth organizations and relevant sectoral authorities at all levels of governance, starting from the ministries and ending with local district officials. Social and economic co-benefits of environmental policies should be mainstreamed in order to strengthen the positions of environmental authorities and promote environmental policy integration in other sectoral areas such as transport, business, industry, health care et al. In short, Tbilisi's future is ultimately in the hands of Tbilisians themselves.

But what about the present? This report «GEO-Cities Tbilisi 2011» clearly illustrates what are the main problems facing the city today and in the near future. What is more important, this document (and its related Executive Summary) also identifies response measures which are necessary to reduce, reverse and eventually eliminate the known environmental problems: Air pollution; Solid waste; Surface water pollution; Noise and vibration (from vehicular traffic); and Decrease of green space and recreational sites.

Re-thinking and re-making of Tbilisi's urban transport is the key to solving air pollution, noise and vibration problems. Currently Tbilisi is at the forefront in terms of municipal waste management regulation in the country, because a national waste management policy does not yet exist. A framework national policy on waste management is necessary to set national goals, provide the means to advance waste management practices in other Georgian cities and give further incentives for Tbilisi to reduce, reuse and recycle waste. The state of Tbilisi's waters will improve after a full modernization of water supply and sanitation infrastructure, control of agricultural and landfill run-off and other such pressures existing close to water bodies. Finally, integration of environmental concerns into land-use planning and rehabilitation and expansion of green areas will make the city more pleasant not only for its inhabitants, but also for tourists and other visitors.

Finally, there can be no progress without data. Only regular and extensive environmental monitoring, data collection and disclosure can enable tracking of progress towards future targets. Environmental data are crucial for drafting efficient and effective environmental policies. There is no way to measure the success (or failure) of environmental policies if there are no data to support the required analyses. In the end, it will take improved environmental monitoring and data, related analyses and targeted policy development, implementation and enforcement - all of which require a strong political will and at least adequate funding - to move forward on environmental problem-solving and/or mitigation, for a more healthy and sustainable Tbilisi in the future.

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GEO-Cities Tbilisi is the most comprehensive report on the state and trends of Tbilisi's environment prepared to date. The analysis integrates social, economic, political and territorial aspects of urban development, and also provides policy options that could be taken to improve the city's environment. GEO-Cities Tbilisi can thus be seen as the first step towards informed decision-making and creation of effective and efficient urban environmental policies in Georgia.

OSCE UNEP ENVSEC Environment & Security