

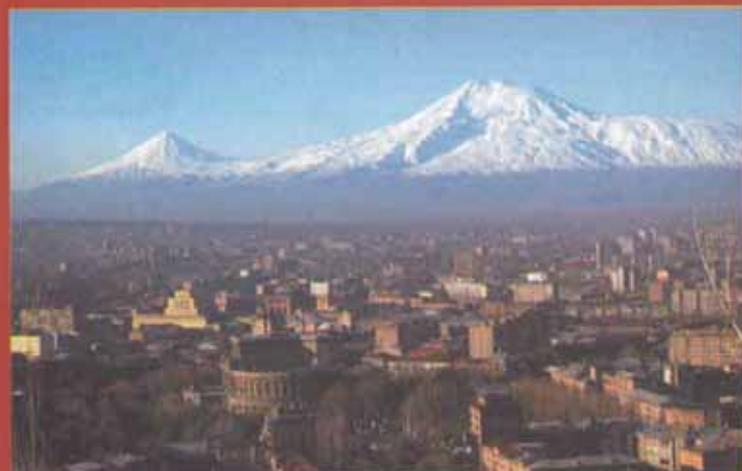
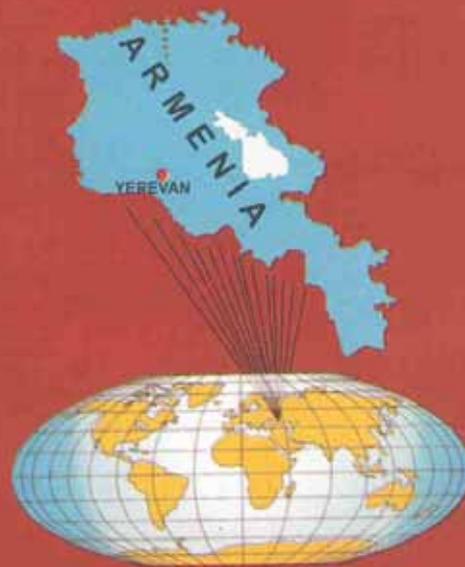


Association "For Sustainable
Human Development" / UNEPNatCom

GEO YEREVAN

ASSESSMENT OF THE LOCAL ENVIRONMENTAL CONDITIONS

2004-2006
(Summary)



Yerevan 2007

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Assessment of the Local Environmental Conditions
2004 – 2006 (Summary)

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PREAMBLE

This publication was prepared on the base of and as a continuation to the Report “ State of the Environment of Yerevan city for 2004-2005”, which was developed and published by Association for Sustainable Human Development/UNEP National Committee in cooperation with the RA Ministry of Nature Protection and a number of independent experts. The financial and methodological support of the Report has been provided by UNEP/GRID-Arendal, as well as the Charitable Tufenkyan Foundation in Armenia.

The fact that cities are the main sources of environmental pollution underlay the initiative of UNEP GEO-Cities preparing series of environmental reports on large cities of the world, based on the same structure, format and method, at the same time taking into account the particularities of each city.

For Armenia the problem is extremely vital, since Yerevan, as an administrative, business and cultural center of the country, is at the same time a source of environmental pollution and degradation. UNEP, UNDP and OSCE Report “Environment and Security” (2004) and the National Report “Environmental State of Armenia in 2002” (2003) also acknowledge Yerevan to be a “hot environmental spot”. The most urgent environmental issues of the city are: significant pollution of environmental media, especially the air basin (smogs), reduction of green zones and aridization of the territory, climate change, increase of constructions and traffic density, increase of seismic risks, waste management, etc.

Project “GEO-cities” is carried out in accordance with the “Agenda 21” (1992), based on the decisions of Governing Council of the UNEP and World Summit on Sustainable Development, 2002, «The Millennium Development Goals», etc. GEO-Yerevan Report was developed using also the experience of ICLEI – Local Governments for Sustainability and European initiatives “Aalborg Charter”, 1994, the European Campaign for Sustainable Cities, “Aalborg Commitments”, 2004, etc. The structure of GEO-Yerevan Report corresponds to the DPSIR framework: D – driving force, P – pressure, S - state and I – impact, R – response, undertaken for improvement of environmental situation and shift towards sustainable development.

Coordinator and editor of the Report – Doctor of geographical sciences, prof. of YSU, Chairperson of Association “For Sustainable Human Development” / UNEP National Committee **Karine Danielyan**

CHAPTER 1. INTRODUCTION

KEY PHYSICAL AND HISTORICAL CHARACTERISTICS

Historical data

Yerevan is one of the most ancient cities. According to archeological, geological and paleontological data the ruins of ancient monuments of culture located here are about one million years old. The monuments of the Stone and the Early-Iron Ages prove that all stages of evolution occurred in this region. Shengavit, Arin-Berd, Karmir-Blur and Tsitsernakaberd are the most ancient settlements in Yerevan, and caves of Avan and Hrazdan gorges were dwelled even at the dawn of the humanity.

The events of the 1st century BC, when proto-Armenian State Urartu started to prosper in the South-East of Armenian plateau, played a significant role in the history of Yerevan. In the year 782 BC, on one of the hills of nowadays Yerevan, King Argishti built a military-administrative center - fortress Erebuni. Thus, contemporary Yerevan is **2789 years old**. During excavations archeologists discovered a cuneiform by King Argishti that testifies the birth of the city: “With the power of God Khaldi, Argishti, the son of Menua, erected this gorgeous fortress and called it Erebuni...” In the cuneiform the letters “A” and “U”, as well as “B” and “V” were written by the same script. According to a hypothesis the names can be read also in the following way: “Urartu” – “Ararta”, “Erebuni” – “Erevani”.

According to archeological research, Erebuni was a large administrative center of Urartu up to VII BC, when this fortress lost its former value and was replaced in that sense by city-fortress Teishebaini that was also situated on the territory of contemporary Yerevan, in Karmir-Blur.

Despite the fact that up to the XV century A.D Erebuni – Yerevan was not the capital, it was famous as one of strategic and cultural centers of Armenia in general and Ararat valley in particular. The new history of Yerevan began in 1918, when the Republic of Armenia was founded on a small saved area of historical Armenia, and Yerevan, the former administrative center of Erivan Province of Russian Empire, became its capital. From 1920 till 1991 Yerevan was the capital of Soviet Republic of Armenia, as a part of USSR, and within that period of time turned into a large, modern and at the same time unique city. The independent Republic of Armenia, with Yerevan city as its capital, became the successor of the Soviet Republic of Armenia.

Yerevan is the 12th capital of Armenia. Its predecessors (Van, Armavir, Ervandashat, Artashat, Tigranakert, Vagharshapat, Dvin, Bagaran, Shirikavan, Ghars and Ani) were situated on the territory of the entire Armenian plateau. The capitals were moved from one city to another due to invasions and earthquakes, as well as in the result of losing territories.

Key geographic characteristics

Armenian capital Yerevan is situated at the north-east of Ararat valley, almost at the same distance from the two mountains - Ararat and Aragats, approximately in latitude 40 north and in the longitude 62 east. The left tributary of Araks River - Hrazdan River and its tributary (small river Getar) flow though the territory of the city. Artificial Yerevan Lake has been created on the Hrazdan River. The Area of its water surface is 170 ha. and its volume is 5,6 mln. cubic meters. According to the existing borderlines, the city occupies a territory of 227 square km., its extension from the north to the south is 16 km, and its “width” is 13,5 km.

Yerevan is situated at the altitude of 850-1420 meters above sea level (the differences of altitudes in the city are significant), annually the solstice reaches 2700 hours, the average annual air temperature varies from +8,8⁰ to +11,6⁰, while in July-August it varies from +22⁰ to +26⁰ C. The highest temperature ever registered was +41,8⁰ C (this limit was also reached in August of 2006; for the first time within the last 120 years such high temperature remained for an entire week). In winter the temperature reduces to minus 20⁰-30⁰ C. Average annual aggregated insolation in Yerevan makes up to 142 kcal/sqr.cm., which creates favorable conditions for photochemical smog.

The annual norm of precipitations varies from 300 to 350mm. Main precipitations occur in the spring and autumn. Rains, especially in summer, are brief cloudbursts. At average, the relative humidity in July is 45%, while in January it reaches 80%. Deeply continental climate is common for the city: hot long-lasting summers and a short cold winters. The spring does not last long, while the fall is usually long-lasting, mild and very colorful. The natural landscapes of the city are: semi-desert (predominant), steppe and dry-steppe. The main part of the city is situated in a hollow, which creates conditions for long-lasting fogs and inversions in autumn and winter.

By a straight line Yerevan is situated at a distance of 300 km. from the Black Sea, 450 km. from the Caspian Sea and 800 km. from the Mediterranean Sea.

According to the 2005 data, the population of the city makes up to 1 mln. 102,9 thousand people, the density of the population is 4859 inhabitants per 1 square km.

CHAPTER 2. SOCIAL-ECONOMIC AND POLITICAL CONTEXT

2.1 Growth and distribution of the population. The demographic dynamics.

During the Soviet period Armenia underwent intensive urbanization process, Yerevan being the biggest temptation. In the result of that process the level of urbanization in the Republic for 1920-1990 increased from 16,9% to 68,6%, the portion of Yerevan population in the total population of Armenia grew from 6,5% to 36,5%, and in cumulative urban population from 38,6% to 53,9%.

In the transition period the population growth in the country slowed down, moreover, some decrease in the number of the population was recorded: from 3287,7 thousand people in 1989 to 3215,8 thousand in 2005 (January). In 2001-2006 the portion of Yerevan population in the total population of the country made up about 34,3%. The aforementioned changes were conditioned mainly by labor migration and reduction of the birthrate. A little increase of mortality rate has also played a certain role in this statistics. Thus, for the last 20 years the birthrate in Yerevan has decreased 2-2,5 times, while the rate of mortality has increased by 1-3%.

Such abrupt decrease of the birthrate is conditioned by unfavorable socio-economic situation of the majority of the population due to the transformational economic decline, as well as by the labor migration of men of reproductive age (in Yerevan the population that has crossed the poverty line makes up 28%, while the same indicator for the country in general is estimated to be 38%). The given phenomenon leads to ageing of the population of the city.

Within the last years the demographic situation started to improve. The same trends are true for the indicator of life expectancy at birth. Within the last 3 years it went up to 73,4-73,5 years (average for men and women), thus approaching the level of 1988 (73,9 years). At the same time, the process of concentration of the population in the capital continues. According to the data of 2004 the density of Yerevan population is 4859 people per square km., which 45 times exceeds the average indicator for the country.

Data on natural movement of urban population, as well as the problem of growing concentration of the population in the capital, outlines the necessity to develop and implement an active demographic and migration policy in the country in general, and in Yerevan in particular.

2.2. Distribution of economic activity and its impact on the city structure. Economic dynamics. Urban development

Yerevan is the center of economic activity of the country, which has been gradually reviving from the abrupt decline that occurred at the first stage of reforms. Brief information on economic branches of the city is presented below.

Industrial production. For the year 2005 the volume of industrial production in the city in monetary terms reached 308 308,4 mln. AMD (685,1 mln. dollars), which corresponds to 47,5% of the cost of production produced in the country. The cost of consumed production has been 12 975 mln. AMD (28, 8 mln. dollars, 81% of the cumulative indicator in the country).

1595 large, middle-size and small industrial enterprises currently function in Yerevan. The majority of those are small (42,4%) and minor (50%) businesses. At the same time, the volume of industrial production produced by small and minor enterprises makes up only 15,2% of the total production volume, while the production volume of large enterprises is 79,7%.

Restructuring of industrial sectors took place along with abrupt reduction of industrial production during the transition period (1990-2006): before the reforms mechanical-engineering, chemical and building industries were the main portion of industrial production, while nowadays the productions of light and food industries prevail. Correspondingly, the negative impact on environment has been significantly reduced. Up to 50-51% of industrial emissions and discharges are treated

Out of the aforementioned 1595 enterprises 87,7% are the processing ones, 11,7% function in the power industry and 0,6% in minerals industry. The majority of the processing industries are enterprises that produce food products and drinks (584), various types of paper (239), metallurgic production (131), processing of timber and production of various wood products.

Trade. In 2005 retail turnover was 739 279,1 mln. AMD, i.e. at average 663 657 AMD per capita (1474,8 USD per capita), while the main share of the trade turnover attributed to the “Center” community.

Energy. Yerevan gets the electric power from an energy system with the following structure: electric power production by Thermoelectric power stations (27%), Hydroelectric power stations (33%) and Armenian Nuclear Power Station (40%).

Yerevan Thermoelectric power station is the only one that is situated in the capital. In comparison with 1990, the production of electric power by that station has reduced about 4 times. Since 1998 the majority of electric power consumption units of Yerevan have turned to gas consumption, and in the last 3-4 years the gas supply system of the city has been fully restored.

At average, Yerevan’s annual consumption of electricity, gas and hot water equals to 33 mln. AMD in monetary terms.

Agriculture. Some of agricultural production has been maintained in the suburbs of the city, with cumulative production in 2005 of: 735 tons of wheat, 7585 tons of vegetables, 7630 tons of fruits

and berries and 38,6 mln. eggs. At the same time, studies have revealed certain level of pollution in the city production.

Services sector. In 2005 the cumulative volume of provided services equals to 267 657,5 mln. AMD (594,8 mln. dollars), which is 84,8% of the country total. At average the indicator of provided services per capita in Yerevan 2,4 times exceeds the same indicator on the country in general. Service sector in Yerevan include mainly of transportation and communication (26,8% и 25,6%, correspondingly), finances (9,2%), education (7,7%), healthcare (6,3%), hotel and restaurant business (5,8%). The largest share of provided services attributed to the “Center” community due to the concentration of large services-providing companies downtown.

Transportation. Significant changes occurred within the transition period in the structure of transportation system of the city, as well. In 1990 transportation of passengers and goods were distributed in the following way: buses – 58%, underground – 22%, trolleybuses – 12%, trams – 5% and minibuses 3%. In 2004-2006, 90% of passenger and goods transportation fell at the share of minibuses.

Within the above-mentioned period of time, despite the protests of environmentalists, the city tram-lines were dismantled, which totally excluded the trams from passenger modal split; the time-worn trolleybuses were not renewed, which resulted in significant reduction of transportation by trolleybuses. Along with that the quantity of minibus routes increased abruptly. Thus, the transportation means in the city are currently the following ones: passenger cars – 88%, minibuses, buses and trucks – 12%

The reduction of the electrical transportation means and the predominance of cars is undoubtedly a negative development from environmental viewpoint. In 2006 this trend was somewhat broken: trolleybuses and modern buses started to be imported into the city.

In 2005 the total volume of passenger-goods transportation (without electric transportation means) made up 1 501 989 people, and passenger turnover - 1 494,1 mln. passengers/km. Transportation of goods decreased abruptly. In 2005, 487,6 thousand tons of goods was transported and the goods turnover equals 18,3 mln. tons/km., while the same indicators in 1995 made up 5,3 mln. and 101,4 mln. tons/km., correspondingly.

Yerevan Underground. The first Yerevan underground line was put into operation in May of 1981. This was the 8th subway in the former USSR, 25th in Europe and 61st in the world.

The construction of Yerevan Underground was launched in 1972. It was conducted in the conditions of extremely complicated topography, with height variations in 550 m., and in rather complicated geological conditions. Nowadays, Yerevan subway is comprised of 10 stations, has operational extension of 12,1 km; passenger turnover 50 thousand passengers a day. The one-way subway ticket costs 50 AMD (about 15 cents), while the net cost of transportation of one passenger is 87 AMD. The difference is subsidized from the state budget. The more new lines are introduced the less money will be allotted from the state budget.

Further development of the Yerevan underground was frozen for a long period of time, while this transportation means can significantly reduce the air pollution in the city. At present, the RA Government has made a decision to restore the development of the subway. Namely, by 2010 it is envisaged to build a new additional station and by 2020 – 3 more.

Urban development activities

The previous Master Plan of Yerevan was adopted in 1971 and provided more or less balanced combination of all priorities of development, including the environmental ones. By the beginning of 1991 the General Plan, which was envisaged to be implemented by the year 2000, was carried out only partially. In particular, only 34% of envisaged planting of greenery for public usage was fulfilled, and the plan for green areas of limited usage and special purposes was implemented by 60-80%.

During the subsequent years, in the conditions of military conflict, blockade and electric power crisis, all urban development activities were ceased. Intensive, usually “situational” construction of the city, particularly downtown, was launched in 1998, when the General Plan was acknowledged outdated in the light of new political and economic conditions of transitional period. This resulted in increase of density of construction and reduction of green areas in downtown, with corresponding environmental consequences.

The new Master Plan of Yerevan city was adopted in 2005. It is described in Chapter 5.

The city as a tourism area, issues related to architectural and cultural heritage.

International tourism is gaining larger value in economic and social life of Yerevan. The historical-architectural heritage of the city promotes the development of tourism, as well as museums, theatres, exhibitions, festivals, etc.

The city possesses significant cultural heritage that is comprised of four main chronological groups of monuments: a) archeological monuments, the most ancient ones date back to the Paleolithic Age – menhirs, monsters, ruins of settlements, fortresses, castles, caves; b) Middle Age – monasteries, churches, cross-stones, obelisks, bridges; c) constructions of the Empire period – residential, public and industrial constructions that date back to the 19th century and the beginning of the 20th century; and d) monuments of architecture and monumental arts of soviet period.

The current situation in the sphere of maintaining the cultural heritage of Yerevan seems to be the following: in terms of state protection the ancient and medieval historical and cultural monuments are in satisfactory condition. The state of soviet-period constructions is more or less stable, as well. However, the condition of cultural heritage of the 19th – the beginning of the 20th centuries remains most vulnerable, and despite the objective necessity of their protection they constantly remain in the risk group.

The increased rate of destruction of historical and cultural monuments of Yerevan in the end of 2004 aroused a wave of indignation in the society, which realized that the loss of historical core of the city would lead to elimination of irreplaceable national values, traditions and the environment, where each building creates a connection with the history. For several months the society voiced at events, rallies, assemblies, exhibitions and marches through civic and youth organizations, scholars, intellectuals and mass media for the protection of the national heritage. It exerted significant impact that led to positive trends on the way to problem solution.

The decision of the Municipality to allot a reserve area for creating an organized architectural-historical environment was a successful step towards maintenance of historical constructions of the city. In 2005, for the implementation of this idea, a large block was segmented from the territory of the Central Avenue. This given area was chosen because it is the only fragment of the city that has maintained the immanent historical constructions and unique architectural environment. Regeneration of the territory is aimed at creation of esthetically whole architectural-artistic

environment with historical buildings dismantled previously from other streets to add extra flavor to the area.

The tourist attractiveness of Yerevan is mostly due to numerous cultural-historical museums, as well as those of nature protection character and nature reserve Erebuni (see below). The State History Museum of Armenia, the Museum of Ancient Manuscripts (Matenadaran), National Art Gallery, Museum of Erebuni Fortress, Yerevan History Museum, Cascade Museum, Museums of world-wide known composer Aram Khachaturyan, artist Martiros Sarya, film director Sergei Parajanov, sculpture Yervand Kochar, the Children's Art Gallery, Gallery of Modern Art, Opera Theatre, Numerous Dramatic Theatres, Concert Halls, children's theatres and art exhibitions make their contribution to the rich cultural life of Yerevan, at the same time attracting foreign guests.

The organization and conduct of numerous *international festivals* also play a key role: the film festival "Golden Apricot", festival of theatres, youth festival of environmental films "Sun Child", pan-Armenian festivals and sport events (within the Armenia – Diaspora format) and other similar events.

2.3. Local political-administrative structure

Before 1996 Yerevan elected the City Council MPs through direct elections, which, in turn, elected the Mayor of the city from its members. Community heads of the city were appointed by the City Mayor and were accountable to the Municipality and the community councilors. All main functions of city management were concentrated in relevant departments of the Municipality, which provided a common administration policy of the city. The implementation of that policy was carried out by communities.

When the RA Constitution was adopted in 1995, the capital received a status of a Marz (region). The City Mayor was now appointed by the decree of the RA President, just as heads of all other Marzes of Armenia, while the 12 communities of the city elected their heads and councilors. Many functions of the Municipality were transferred to community administrations, while functions and authority of relevant departments were simplified or radically reduced.

Although, theoretically this new system seemed more democratic, however, in practice the results turned out to be negative rather than positive. It turned out that many communities were not ready to implement the new functions envisaged for them, and with the elimination of relevant municipal departments the common management policy of city was broken. Moreover, an institutional chaos overwhelmed a number of spheres that could lead to irresponsibility and lack of accountability. This problem was particularly obvious in the sphere of greenery planting in the city.

In accordance with the Constitutional Amendments adopted by the 2005 Referendum, the city will recover the status of a single community, and the Mayor should be elected via direct or indirect elections. In 2006, a hot discussion developed around the ways of implementation of the Constitutional recommendation. A suggestion was brought forward to segregate the city into 8 small towns, each of them having a status of a separate community and a separate administration. 22 NGOs voiced their criticism of the aforementioned suggestion and brought corresponding arguments related to potential negative consequences for all spheres of public life of the city and especially for the environmental one. The necessity to optimize the city management within the framework of a common management policy was supported also by many other NGOs and mass media.

At present, a Draft Law on Yerevan City has been prepared and undergoes discussions at the Municipality and the RA Government. According to the Draft the city will remain as one

community, councilors will be elected via direct vote, then city deputies will elect the Yerevan Mayor, while community heads will be appointed. A number of structures that are vital for city management within the framework of a common policy will be recovered.

2.4. The analysis of local socio-economic factors

2.4.1 Water supply, consumption and drainage

The Hrazdan River and its tributary Getar River (with its tributary river Dzhrvezh) run through the territory of Yerevan.

The Hrazdan River . Its total length makes up 141 km., the territory of water basin – 2310 sqr. km., total height variation – 1090m, average annual runoff 9,7 cubic.m/sec., average perennial annual runoff – 705,6 mln.cubic m., flows into the Araks River. The length of the river within the boundaries of the city makes up 32 km. The sources of the river are various: subterranean springs, precipitation and melted snow. The Hrazdan Gorge practically crosses the whole city and serves as a rest and recreation zone.

The Getar River . It is a small river that runs almost through the center of the city (unfortunately, the most part of the river has been covered). Getar, as well as Dzhrvezh, is sustained mainly by the waters of melted snow and is full-flowing practically only in spring.

The Rivers Getar and Hrazdan play also an important mudflow derivation function. Unfortunately, with the current construction in the city this factor is often being neglected, which consequently leads to damage of those constructions in the period of spring floods.

Yerevan Lake is a water reservoir constructed in the city on the Hrazdan River, with the total volume of 5,6 mln. cubic m. and the water surface of 170 ha. Along with its regulatory function, in the 70's the water reservoir served as a rest zone, but due to intensive siltation and accumulation of pollutants the lake gradually lost its recreational function.

The city uses subterranean waters of contiguous territories and surface waters.

Table 1 presents data on general water withdrawals, consumption and drainage of Yerevan. It becomes obvious that water losses during transportation are huge (about 70%). Table 2 reflects the structure of water consumption by various spheres.

Table 1.

Water withdrawals, consumption and drainage in mln. cubic m. for 2002-2006							
	2000	2001	1640	2003	2004	2005	2006
Water intake	1640	454.9	953	444.2	418.3	407,5	
Water consumption	953	145.9		132.2	102.2	90,6	105,2
Water drainage		128.2	687	120.4	98.5	101,8	83,3
Losses, including	687	309		323,8	316,1		
In the main waterway			287,2	312,1	303,6		

Table 2.

	Water consumption by various sectors for 2002-2005 in mln. cubic m.				
	2001	2002	2003	2004	2005
Public water supply	46.3	66.7	57.1	49.3	37,3
Industrial	36.3	8.4	34.7	27,3	27.3
Irrigation	22.9	35.6	27.9	21,3	21.3
Agriculture	40.3	16.9	12.5	5.3	4,7
Losses at transportaion	307.9	287.2	312.1	303.6	300,1

Yerevan is supplied with **drinking water** owing to 23 water reservoirs that accumulate water from 13 sources. Table 3 reflects the drinking water withdrawals, consumption and losses in the city. The Table shows that losses in this field are great, as well, and make up 80%. This is mainly conditioned by the time-worn water-pipe network and illegal consumption of the water for irrigational purposes, since the city gets extremely insufficient supply of irrigational water. In the result of the above-mentioned time-worn network the quality of drinking water during the last decade has deteriorated. The water is polluted by suspended matters, but owing to adequate disinfection, outbreaks of diseases do not occur (with rare exception of breakdowns).

Table 3. Drinking water withdrawals, consumption and losses in cubic meters

	2004	2005
Water intake	367387	353630.4
Water consumption	72830.3	61822,9
Losses	294556,7	291807,4

Data that characterize water drainage and level of pollution of sewage are presented in the tables below.

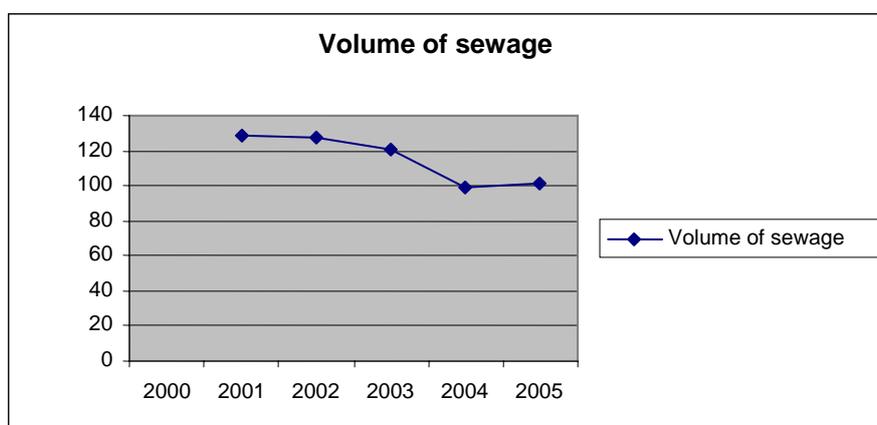


Fig. 1. Volume of sewage waters

Table 4. Pollution of sewage waters

<i>Pollutants / Years</i>	2004	2005
Suspended substances	13796	11438
Ammonium nitrogen	754.2	551.1
General phosphorus	172.6	551.1
Sulfates	22241	18134
Chlorides	13417	12384
Nitrites	19.4	81.8
Copper	63.4	54.5

2.4.2. Air emissions

The capital of Armenia has always been considered as a “hot environmental spot” particularly due to ecological characteristics of the air quality of the city.

During *the soviet period*, air of the city was “supersaturated” with harmful substances produced by industries, in particular chemical and construction ones without necessary treatment plants. Emissions from those industries, as well as those of electric energy industry (thermoelectric stations, boiler-houses) and cars, created smog. The allocation of the city in a hollow, high ultraviolet solar activity, poor precipitation to clean the air basin, frequent inversions and other natural-climatic conditions promoted the creation of smog, as well. The high concentration of ground level ozone (2-3 MPC) and formaldehyde proved the existence of photochemical smog of “Los Angeles type”. In foggy days the harmful emissions concentrated over the city, covering it and creating the effect of “London- type” smog.

Unfortunately, no special research has been carried out, but the existing data is sufficient to conclude that both types of smogs were periodically taking turns in Yerevan. During the warm seasons (approximately from May to October) conditions for photochemical smog prevailed, while in cold seasons (from November to April) favorable conditions for the London-type smog predominated. Complex measures were undertaken for sanitation purposes: massive green areas and water surfaces were created, which to certain degree improved the microclimate and the general environmental situation.

During *the transition period* the majority of industrial enterprises closed down, which abruptly aggravated the socio-economic situation, but resulted in treatment of the air basin of the capital. However, the construction business started to develop parallel to that and by reducing green areas exerted negative impact on the environment of the city, particularly on the air basin. The data provided below characterize the emissions of harmful substances into the air basin of Yerevan city and their composition.

Tabl.5.

<i>Emissions of harmful substances from stationary sources for 2000 – 2005 (in tons)</i>						
	2000	2001	2002	2003	2004	2005
Emissions from stationary sources	12390,1	2078,9	1578,1	1790,5	2174,9	2805,8
The quantity of trapped harmful substances	3020,4	2014,8	1578,6	491,7	2233	5956,2
The quantity of evolved harmful substances from stationary sources.	15410,5	4093,8	3156,7	2282,3	4407,9	8762

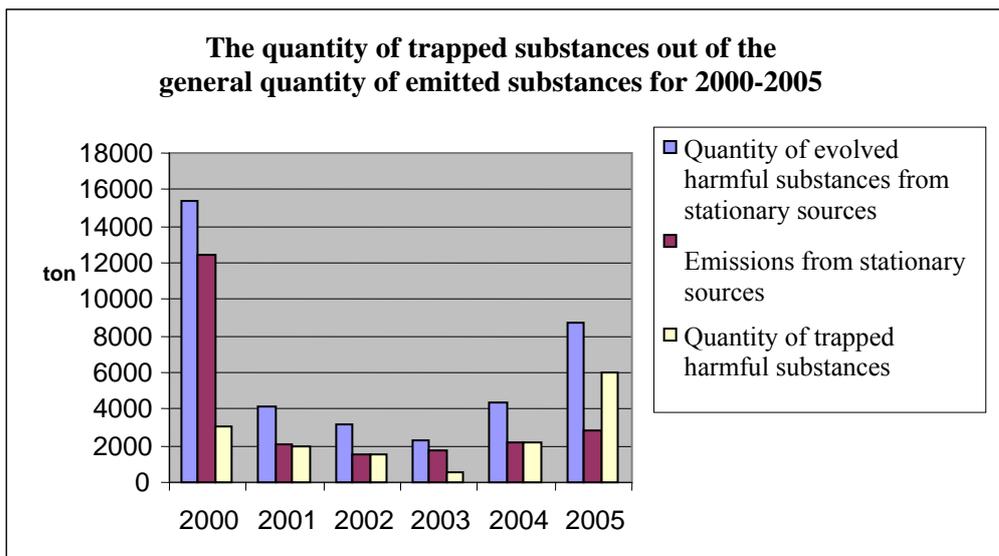


Fig. 2.

Table 6. The dynamics of emissions into the Yerevan air basin by stationary sources (in tons) for 1990 and 2000-2005.

Pollutant /Year	1990	2000	2001	2002	2003	2004	2005
SO ₂	23269	302.1	262.8	273.6	299.2	407.1	473.5
NO ₂	14783	1021.1	765.9	506.5	581.1	573.3	853.9
CO	124826	512.7	476.2	427.8	530.0	462.3	422.6
Dust	3755	176.5	156.0	281.2	273.1	301.0	651

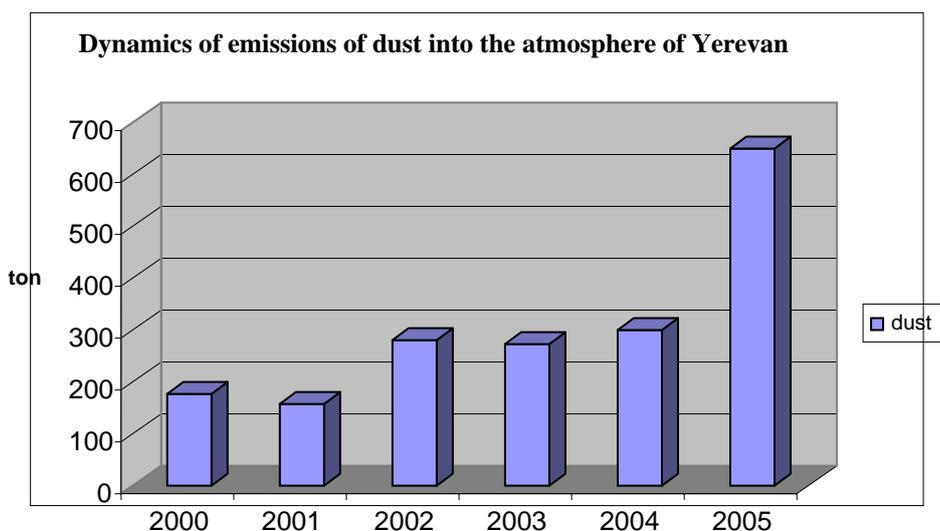


Fig. 3.

The emissions by automobile are following: in 2000 – 67 260 ton, 2001 – 61330, in 2005 – ~ 70 000 and in 2006 - ~ 70 000 ton.

2.4.3 Solid waste management

Annually 380 thousand tons of waste was formed in Yerevan before the beginning of the 90th. 252 thousand tons of those (76%) were household waste and 92 thousand tons (24%) – industrial waste. The situation with waste also changed due to abrupt reduction of industrial production during the transition period. Currently, annually 282 thousand tons of solid waste is formed in Yerevan. Only 11 thousand tons (3,9%) of it is produced by enterprises, the remaining 271 thousand tons (96,1%) is domestic.

Approximately 56% of industrial waste is subjected to economic circulation (recycling). The rest is neutralized, destroyed or buried.

Table 7. Industrial waste of Yerevan and its classification by hazardousness, 2000-2005

Industrial waste of Yerevan						
	2000	2001	2002	2003	2004	2005
Total waste produced	8355.1	7891.4	7645	7598.4	11004	16262,5
type 1	-	-	-	-	-	-
type 2				402.7	882.3	
type 3				57.9	296.3	
type 4				419923	343.9	
type 5				15676856	2449.9	
Household waste				9795	7032	
Quantity of waste estimated per capita	6.7	6.3	6.9	6.9	10	14,7

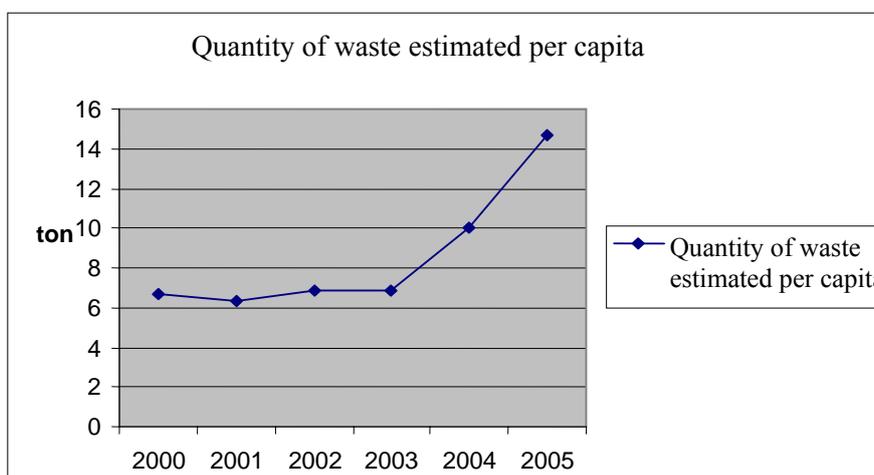


Fig. 4.

Unfortunately, the sanitary situation of Yerevan city has significantly deteriorated in the transition period.

In the city the garbage is collected from of 4600 multi-apartment buildings and 55 thousand private houses. Before the transition period the garbage was collected every day and sometimes even twice a day, while at present the frequency of garbage collection in various parts of the city is different: in some parts the garbage is collected on a daily basis, in other parts – once every 2-3 days. Illegal dumps can be seen here and there in the city. No organized sorting of garbage is implemented.

At present the waste management system is decentralized and many functions are transferred to communities and private companies. 12 companies deal with garbage collection (one per community). Fee for garbage collection is 100 AMD per capita. The fee collection rate, varies around 50%. The collected sum covers only 40-50% out of the total cost of the municipal expenditures. Almost the same amount is allotted from the state budget.

Waste dumps

The *main city dump* is located in the end of Nubarashen highway, at a distance of 8-9 km. from the center of the city and occupies a territory of 52,3 ha. At average the dump annually receives, accommodates and neutralizes about 200 tons of solid waste from Yerevan city. Over 7,5 mln. tons of solid household waste has been accumulated for over 50 years of operation. In the 70s it was envisaged to construct a large plant on household waste processing on the Nubarashen dump, but due to a number of reasons this project remained unfulfilled.

In general, we may certify that the necessary sanitary norms and standards for construction and municipal waste dumps management are not currently implemented.

Apart from the Nubarashen city dump, a small dump of 2,4 ha. exists at the Right-Bank community of Yerevan, which serves for the aforementioned community only.

The specific gravity of solid household waste makes up about 290 kg/m³. The composition and its dynamics are described below:

Table 8. Composition of the solid domestic waste in %.

Year	1989	2000
Food waste	40,9	24,4
Paper	11,6	13,3
Plastic	2,0	19,4
Glass	5.4	5.4
Textile	2.8	2.8
Metals	3.1	0
Construction garbage and other wastes	25.5	27.0

Also, a special dump for construction waste has been functioning since last year on a territory of 10 ha.

Apart from that, the city needs a specialized polygon for neutralization and burial of industrial waste (at present, the industrial waste is buried along with solid domestic waste at regular city dumps), as well as a new territory for construction of a modern polygon of solid domestic waste.

In addition to the above-mentioned information we would like to mention the issue of toxic chemicals landfill in several kilometers from Yerevan.

In 1982, a toxic chemicals (mainly pesticides) landfill with the length of 110m and width of 10-15 m. was created in the landslide zone near Yerevan. The landfill was situated without relevant preparation of the couch and with underlayer that leaked precipitation. Around 600 tons of toxic chemicals of 60 types have been buried there. 250 tons of those are persistent organic chlorine substances.

Obvious activation of landslides has been noticeable within the last years. The plot shift is estimated to be 12-15m. Besides, the toxic chemicals and products of their disassimilation were washed off by downpours into the Ararat artesian basin. Also, research has revealed a possibility of emission of toxic gases from the landfill.

In 2005-06 restoration and sanitation of water-drainage canals around the landfill were carried out and wire entanglement was installed along its perimeter, which to certain extent has decreased the risks of environmental pollution. Parallel to that, fundamental solution to this issue is being searched for and it is incorporated into the National Action Plan on implementation of Stockholm Convention.

CHAPTER 3. STATE OF ENVIRONMENT

3.1 Local ecosystems

Natural landscapes of Yerevan are: semi-desert (predominant), steppe and dry-steppe.

Only owing to the creation of artificial ecosystems with massive planting of greenery the territory of the city became suitable for inhabitation.

3.2. Analysis of ecosystem resources

Air

The data below shows that the air monitoring is rather limited. For instance, concentration of CO is not being measured, although it is an important indicator, especially since the main contribution into the air pollution is made by vehicles.

The comparative analysis of the statistical data presented below demonstrates the reduction of self-treatment ability of Yerevan air. Thus, for the period 1990-2006 emissions from stationary sources into the air basin of the city decreased by approximately 97%. According to official data, the dynamics of vehicle emissions shows a certain decline, as well. Thus, having about 40% of the country's vehicles concentrated in Yerevan, we may estimate that that figure has not exceeded 70 000 tons for 2005-2006.

**Table 9 . Dynamics of air pollution of Yerevan
(in numbers exceeding the maximum permissible concentrations).**

<i>Polluters/ Years</i>	1990	2001	2002	2003	2004	2005	2006
NO ₂	3.0	2.2	2.2	2.2	2,7	2.8	2,7
SO ₂	3.6	2.2	2.2	2.4	2.6	2.4	1,8
CO	5.0	-	-	-	-	-	-
Dust	4.2	3.3	3.6	4.0	2.7	2.0	2,3
Ground level ozone	1.1	-	-	-	2.8	2.2	1,9

Note. The data on dust for the last years does not reflect the real situation, because the samples were taken only from one spot situated at Nork Plato.

The data of Table 9 reveals also the reduction of Yerevan air basin pollution. Unfortunately, the quantity of monitored substances has been abruptly reduced during the last years. At the same time, based on the existing data we may conclude that *in the result of abrupt reduction of green areas (see the section on biodiversity) and intensive construction without taking into account the wind rose, the self-treatment ability of the air basin has decreased*. Thus, the data of Table 10 reveal that while emissions from stable sources have reduced for 72-98% (and from vehicles – reduced for almost twice), the level of air pollution has reduced for 8-44% (however, the dust level reduction for 44% most probably is the result of incorrect monitoring, as described above). Moreover, the concentration of ground level ozone (Fig. 5) has increased approximately twice. Experiments with vegetative test-systems on revelation of mutagenic activity of pollutions ascertain the high level of air pollution of the city.

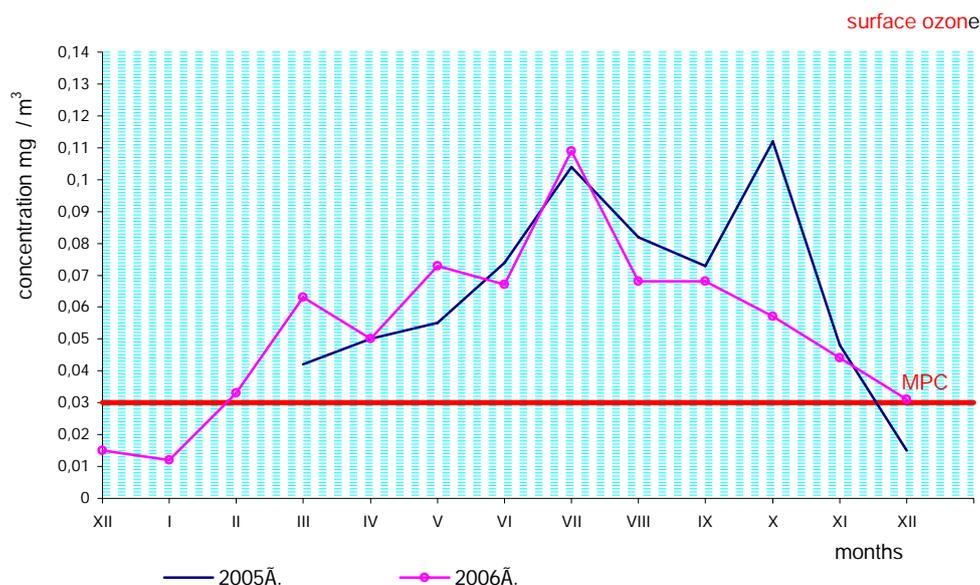


Fig. 5. Concentration of ground level ozone in 2005-06

Table 10. Correlation of dynamics of emissions from stationary sources and air pollution in Yerevan for 1990 / 2004-05. (in %).

Polluters	Reduction of emissions /in %/	Reduction of pollution level / in%
NO ₂	96	8
SO ₂	98	31
Dust	72	44

Water

Unfortunately, the official monitoring of water resources has also been conducted to extremely limited extent in terms of number of monitored substances, areas and samples. The existing data, however, reveals significant biogenic pollution, caused by domestic sewage.

In 2003-2006, 10-11 times excess of the maximum permissible concentration (MPC) of ammonia and 11-12 times excess of MPC of vanadium were constantly recorded in the samples from *the Getar River*. Research conducted by the RA National Academy of Sciences in 2002-2003 revealed also high concentration of chlorine, boron, cadmium (14 times MPC) and lead (12 times MPC).

Excess of average annual concentration of ammonia (30,6 times MPC) was observed in *the Hrazdan River* in 2004 (one-time excess – from 15,6 times MPC up to 60 times MPC). Extreme shortage of dissolved oxygen was reported three times. Significant excess of concentrations of nitrites, magnesium, vanadium and copper was also identified. Those trends remained in the subsequent years, we well. Thus, in 2006, the average annual concentration of ammonia exceeded MPC 29,3 times, that of vanadium – 13 times. Extreme shortage of dissolved oxygen has also been recorded. (see Fig. 6)

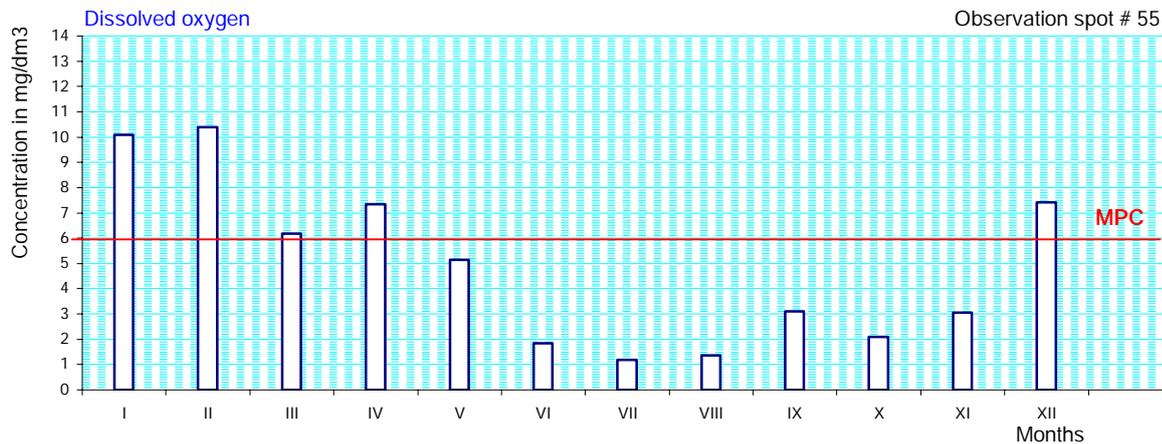


Fig. 6. Dissolved oxygen in the Hrazdan River in 2006.

Stable 10-11 times MPC excess of copper and 4 times MPC excess of vanadium and magnesium is constantly revealed in *Yerevan Lake*.

Detailed studies of waters of the Hrazdan River, the Getar River and the Yerevan Lake, conducted by institutes of the RA National Academy of Sciences, have led to the following conclusions:

- The Hrazdan River crosses the Yerevan border already being polluted by biogenic elements. However, the quality of the river water significantly deteriorates when the Getar River falls into it.
- The pollution indicators aggravate also after the inflow from the Aeration Station. Thus, before the station the quantity of dissolved oxygen varies from 8,0 up to 11,0 g/cubic m., while after the station it makes up 6,0-6,5 g./cubic m. This is most probably conditioned by the lack of relevant treatment at the station (after the electric power crisis of 1991-1995 no biological treatment has been implemented).
- The water of the Hrazdan River is considered “moderately polluted”, while the water of Yerevan reservoir is considered “polluted” and the water of the Getar River “largely polluted”.

Soil

The official statistics on soil pollution has not been conducted yet (currently, the Ministry of Nature Protection launches the implementation of that monitoring aspect), however, such research has been conducted by the Academy of Sciences of Armenia, American University of Armenia, etc.

According to results of the research the pollution of the territory of the city with heavy metals at average is considered moderate. At that, the indicators in different areas vary from the lowest – practically at background level, up to the highest level (particularly in industrial areas) that ten times exceeds MPC. Average composition of heavy metals polluting the city is the following:

Pb (6,4) - Ag (4,4) - Zn (3,7) - Cr (3,7) - Cu (2,1) - Ni (1,8) - Co (1,4) - Mo (1,4).

The given type of pollution is usually the result of emissions of vehicles, thermoelectric stations, as well pollution of atmosphere precipitation. A number of studies of heavy metal circulation in the system of soil-water-plant have shown their rather high concentration in plants.

Soil pollution with radionuclides also has mosaic representation. Thus, beta-radioactivity in the city varies from background concentration (~540 Bq/kg) to comparatively high numbers (919 Bq/kg). This type of pollution is mostly connected with the pollution of atmosphere precipitation.

Biodiversity

Greenery

First activities on creation of green circle around Yerevan were launched in 1962; however, they turned out to be not very effective due to the lack of irrigational system and dry climatic conditions. Intensive greenery planting started from 1938-39 on the slopes that surround the city on north-west, as soon as irrigational system was installed on those. In that period of time activities were undertaken to create two green circles around the city: the first one 16km.-long and 800m-wide and the second one 50km-long and 1000m-wide. The distance between the two circles is 1-2 km.

The separate plantings around Yerevan closed in for the first time in 1953. Greenery was planted on all foothills that surround the city and are currently included into its borders. Green circles changed the microclimate of Yerevan: moistened the air and freed it from dusty winds. The appearance of the city changed when its rocky slopes covered with dense greenery.

In 1955 the total territory of planted green circle of Yerevan reached 1500 ha. Active greenery planting continued in the city during the subsequent years, as well. In 1966 the area of planted greenery of public usage made up 501 ha., that of limited useage 375 ha., area of special purposes – 1025ha.

According to the *Master Plan adopted in 1971*, in the year 2000 the area of planted greenery of public usage should have reached 2453 ha. to ensure 21,1 sqr.m. per capita. The total territory of planted greenery was envisaged to reach 9665 ha. (87,8 sqr.m per capita) by the year 2000, via an Outlook Plan of greenery planting in Yerevan (1973), a Landscape organization scheme of Yerevan (1976) and Territorial Complex Scheme of Yerevan Nature Protection (1986). The greenery planting system project envisaged consistent and even distribution of greenery in accordance with the landscape peculiarities of Yerevan. Thus, to use contemporary terms, a complete framework of a sustainable city was supposed to be established.

By 1991 the Outlook Plan on greenery planting of public use was implemented by 34%, and that of limited use and special purposes – 60-80%. The electric power crisis of the beginning of the 90's resulted in significant chaotic tree cuttings. In 1995-96 the energy crisis was overcome, but the tree cuttings continued for construction purposes. The reduction of greenery takes place also due to allocation of additional service units on the territory of green zones.

The spreadsheet below demonstrates the dynamics of green areas of Yerevan and their outlook envisaged by *the Master Plan adopted in 2005*.

Table 11 .Summarized indicators of Yerevan green areas for 1990 – 2004 and plans for 2020 (in ha.) (based on materials of the Master Plan 2005).

Functional purpose of the territory	1990	2003-2004	2020
public usage	928,3	540,3	2382,0
limited usage	2395,2	2951,3	3245,3
special purposes	2288,7	1460,1	2310,0
Total	5612,2	4951,7	9397,7

Losses of green areas for 1990-2003 are equal to 1216,6 ha (with the correction related to inclusion of new micro-communities into the territory of the city).

The table demonstrates that, according to the Master Plan of 2005, it is envisaged to significantly increase the quantity of green areas of the city and overcome the current deficit of 4446 ha. (including 1379,8 ha. of green areas of public use). At that, while today 44,8 sq.m. of green territory is estimated per capita, by the year 2020 this indicator should reach the figure of 78,3 sq.m per capita. The General Plan recommends to restore the green areas and conduct new greenery planting, mainly in the suburbs. The General Plan acknowledges that the over-construction of Yerevan downtown seriously impedes the accomplishment of normative indicators of greenery planting, so the emphasis is made on the greenery planting in the suburbs.

The types of greenery species in Yerevan are rather diverse. The city has aboriginal species of plants, as well as those introduced from other botanic-geographical parts of the world, particularly xeromesophytes and thermomesophytes. About 250 representatives of North American, Eastern Asian, European and Siberian dendrofloras are among the city greenery: *Acer negundo*, *Juniperus virginiana*, *Robinia pseudoacacia*, *Amorpha fruticosa*; *Biota orientalis*, *Sophora japonica*, *Populus bolleana*, *Chaenomeles japonica*, etc.

Unfortunately, aboriginal trees and bushes are not sufficiently used during plantings: only 77 species, i.e. about 25% out of the total number of dendroflora species of the Republic.

Fauna

Vertebrates occupy an important place in the ecosystem of Yerevan. Among those are representatives of ichthyofauna, amphibians, reptiles, birds and mammals.

In everyday life, inhabitants of the city mainly deal with *birds*. From 1923 to 1964 the bird fauna of Yerevan and its suburbs included representatives of about 140 species. In the 90's the bird fauna of the city and its suburbs grew up to 180 species, the main part of which was still comprised of perching-birds, such as sparrows, tomtits and thrushes. The increase of the number of species is connected with the creation of the green ring of artificial plantings around the city in 1940-70, increase of green areas within the city itself, as well as with the inclusion of new urbanized territories into the city and attraction of periaqueductal and wader birds to Yerevan Lake and other small artificial local reservoirs.

Losses of huge green areas, at first during the energy crisis of the transition period (1991-1995), and later on in the result of intensive urban development, have exerted negative impact on the avifauna, as well. Currently, the number of species has decreased to 170; some of them are included into the Red Book of Armenia.

The situation with avifauna of parks is particularly troublesome. Due to loud music and other noises that are disturbing and stressful for birds, a complex of song-bird species has been irreversibly lost. In urban conditions, where use of pesticides is limited or forbidden, the group of insectivore birds (tomtits, thrushes, woodpeckers, nightingales, redstarts, swallows, martins, etc.) plays a significant role by cleaning the greenery from pests. When flying over Yerevan, martins and swallows eliminate thousands of tons of mosquitoes, midges, flies, beetles, moths and other flying insects during the season of reproduction.

It is obvious that restoration of the diversity of bird species is directly connected with the restoration and development of green areas of Yerevan.

Just like any urban fauna, that of Yerevan *mammals* (about 30 species) is formed due to the wild animals that dwell around the city and the Hrazdan River Gorge. Among that group are insectivore animals, such as hedgehogs and about 10 species of non-migratory and migratory bats. The caves, which are their main habitation place, have significantly reduced in number due to the radical transformation of the city. Nowadays, the appearance of foxes, wolves, martens, and other large beasts is a rather rare phenomenon, but before the 60's the forests around the city were full of them and city inhabitants even hunted them sometimes.

The quantity and number of species of *fish, reptiles and amphibians* have also significantly decreased.

Invertebrates are abundant in Yerevan. The most studied ones are beetles, including endemics of the territory of the country and even Yerevan.

The Botanical Garden, as well as *Zoological Garden* of the city play significant role in biodiversity of Yerevan. The Botanical Garden promotes also the scientifically-justified greenery planting in Yerevan to significant extent.

Reserve "Erebuni" is situated very close to Yerevan, only 8-10 km. away from museum Erebuni. The reserve practically has a worldwide value as a zone of protection of a unique Cereals genofond, especially that of relic wild wheat. Three of wild wheat species of the 4 known grow on the territory of the reserve. The combination of the wild relic wheat and the Urartu fortress Erebuni is not accidental. It testifies that this territory is one of the cradles of the contemporary human civilization.

The State Museum of Nature and Zoological Museum function on the territory of the city. They play a significant role in environmental education in the sphere of biodiversity.

Urban development

Yerevan is situated at an area periodically subjected to seismic impact that activates secondary natural processes. Statistics reveals abrupt increase of seismic activity rate in the region. While in the past one powerful earthquake took place once every 50 years, beginning from 1967 the time intervals have been 7, 5, 2 and 1 years and in 1992 it happened even twice. Thus, another powerful earthquake on the territory of Armenia is a possibility (with a magnitude of $M \geq 5.5$). At the same time, Yerevan city is built-up mainly with buildings and constructions, envisaged for to 7-8 seismic risk force by the MSK-64 scale.

According to the new map of seismic zoning of Armenia adopted in 1995 (taking into account the Spitak earthquake experience) the level of seismic danger for Yerevan is estimated to be 9 seismic impact force. This significantly exceeds the design values, envisaged at construction of the existing buildings in the city and the risk of destructions in case of an earthquake is significant.

Intensive deformations of buildings of Achapnyak and Nork have been observed within the last years, since they were constructed without consideration of geological-geomorphologic peculiarities. In particular, over 200 four-story buildings constructed in Achapnyak in the 60's were subjected to significant deformations and are currently being dismantled.

Landslides have been observed at Nubarashen cemetery and mortuary of toxic chemicals (see the section on waste), which are immediately near the city and were constructed without relevant geological examination. Thus, Yerevan is subjected to a serious risk of toxic contamination.

A construction boom is happening currently in Yerevan, which is a positive phenomenon. However, it causes concerns, because it is often conducted without taking into account the existing construction norms. Moreover, Yerevan has no contemporary detailed engineering-geological map, which is vital because the physic-mechanical characteristics of soil, especially downtown, have undergone significant changes within the last 20 years (particularly due to construction and subway operation).

Reconstruction of buildings via adding new floors is another issue, since it is often carried out without considering the risks of additional pressure on the existing construction. Basements are also being reconstructed, usually via damaging or elimination of some support-frames. And finally, the constant increase of density of constructions in Yerevan during the last decade, especially downtown, at the expense of green areas leads to changes of the microclimate of the city (see the section on consequences).

3.3. Summary of the state of environment

The aforementioned facts testify that the environmental state of Yerevan is rather unfavorable, which has also been confirmed through polls conducted among its population.

Even in *the soviet period* the city was considered to be a “hot environmental spot” first of all due to the development of resource-intensive and environmentally hazardous industries that lacked efficient treatment plants. The condition of the air basin was particularly poor: all indications of the Los-Angeles type smog (photochemical) or those of the London type smog were periodically recorded in the city. Intensive greenery planting in the city softened the problem to certain extent. The waste and sewage management system did not comply with contemporary standards either.

With *the transition period* the economy of Yerevan, especially the industry, underwent significant decline, which resulted in reduction of industrial emissions, discharges and wastes. Within recent years, certain restorations of the city economy have been conducted parallel to a shift towards less environmentally hazardous productions and do not result in significant increase of environmental pollution (currently, 96-97% of emissions in Yerevan are produced by vehicles, and their quantity in the city keeps growing).

At the same time, during the electric power crisis and in the result of the subsequent urban development activities the city has lost almost the 1/3 of its green areas. Apart from that, the increase of construction density in Yerevan has led to:

- Poorer aeration of the territory,
- The streets are not envisaged for the constantly growing traffic, thus traffic jams are a common case nowadays in the center of the city and cars have to operate in the mode of “starting-braking”, which increases the volume of emissions.

The correlation of data on emissions into the air basin of the city and the air pollution parameters testifies that *the air basin has lost its self-treatment ability* mainly due to the significant reduction of green areas. Namely, despite significant reduction of emissions, the air pollution remains at a rather high level. Moreover, the data on the monitoring of surface ozone testifies the formation of *photochemical smog*.

The pollution of surface waters and soil of the city is significant, as well. The current system of waste management also requires solutions, as well as the significant loss of biodiversity, in particular song-birds.

Summarized information on environmental condition of the territory of the city is presented on the map-scheme 1 (on the inner part of the cover). It is obvious that the most environmentally comfortable zones are the territory of Nork plateau and the Hrazdan River Gorge, while the most uncomfortable ones are the downtown and the southern and southern-western industrial communities – Charbakh and Shengavit, which coincides with the results of numerous additional studies conducted by the National Academy of Sciences and Universities of Armenia.

The situation with the downtown is explained by the well-known fact that cities function as “islands of heat” and the temperature in the center is usually higher than in the suburbs. Thus, the average monthly temperature in Yerevan downtown is 0,5 – 1,5 degrees C higher than in the southern parts of the city and 2,5 – 3,5 degrees C higher than in the northern parts. This promotes the movement of air currents from the suburbs towards the center and concentrates the most part of pollution there. In the Yerevan case, the situation is aggravated by the “overconstruction” of downtown and the location of the main part of the city in a hollow.

CHAPTER 4. CONSEQUENCES OF THE ENVIRONMENTAL CONDITION

4.1. Consequences for ecosystems

As already mentioned above, Yerevan is mainly situated in the *semi-desert area*. The natural landscape has been significantly altered to create favorable conditions for inhabitation. Significant biodiversity has developed in the green areas and water reservoirs created in and around the city. In particular, many species of local fauna were attracted: mammals and birds.

However, the loss of a significant quantity of green areas has led to serious losses of biodiversity. This fact, in combination with the *global climate change* and low albedo of densely built-up territories, has led to significant microclimate changes in the city (see Fig. 7).

To evaluate the climate change in Yerevan we have used the data on temperature and precipitation for the period of 1955-2004 (as reference data we have used that of 1961-90). Within that period of time, i.e. almost 50 years, the air temperature in Yerevan has increased for 0,725°C, while for Armenia in general this figure made up 0,4°C. Figure 7 shows that within the last 9 years temperatures above the norms have been observed, with the biggest upspring in 1999 (1,6).

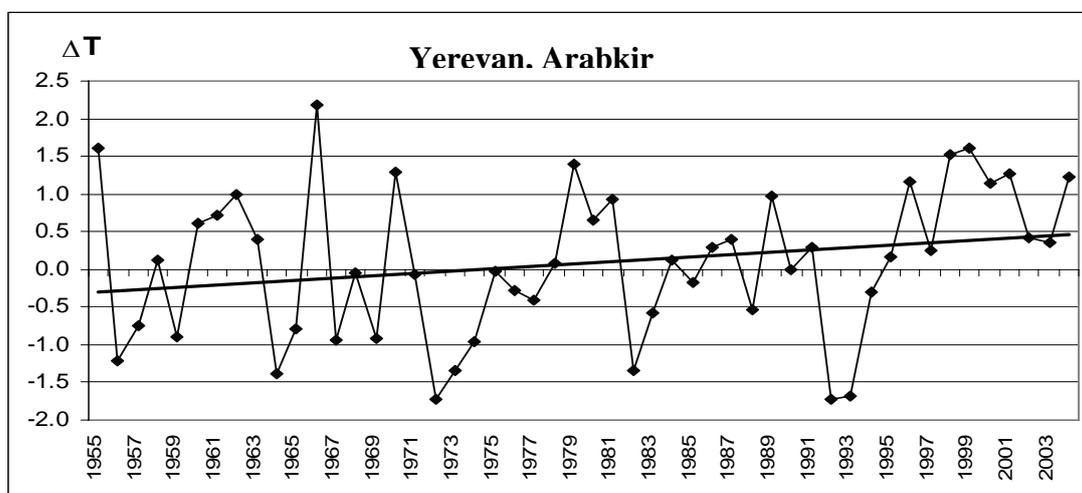


Fig. 7. Anomalies of average annual air temperature in Yerevan in correlation with the norms (1961-1990 – 11,5°C) for the period of 1955-2004.

In this given aspect the year of 2006 has broken all records, when the temperature in Yerevan was 8 degrees over the norm. Such high temperature has occurred for the first time within the last 120 years and lasted for a week (up to 41,8 degrees). The temperature at night was also significantly high (26-28 degrees C), while normally at August nights the temperature lifted maximum up to 23 degrees C.

We may ascertain that in the result of the aforementioned phenomena, the semi-desert is returning to the capital with all relevant consequences: with its flora and fauna. The city is gradually being “conquered” by scorpions and snakes – the natural inhabitants of the semi-desert. Thus, we may establish the fact that the desertification risks have abruptly increased in the city.

4.1. Consequences for human health

The contribution of the anthropogenic factors into formation of ailments of the population currently makes up from 10 to 57% . We will note only a number of well-known facts: carbonic oxide impedes the process of oxygen absorption in blood, lead exerts negative impact on circulatory, nervous and urogenital systems, nitric oxides affect the respiratory system, ozone also causes diseases of the respiratory system and suppresses the immune system of the organism, dioxins formed at waste-burning are extremely toxic for the organism, etc. At the same time, the loss of greenery of the city that served as a natural “air filter” against toxic substances and pathogenic microorganisms, aggravates the situation.

An increase of cases of health anomalies in infants have been recorded in Yerevan and some regions of Armenia within the last years. In Armenia, the contribution of the three main congenital anomalies into the diseases that lead to disabilities in children of 0 to 14 years-olds is significant and one of the highest indicators in the European region.

Formation of neoplasms particularly in children is an issue of concern. Within the last 15 years the intensive indicator of that disease has grown almost twice. Within the last decade, cases of asthma have also increased twice; allergies are widespread, as well. Yerevan occupies a leading position among 11 regions of Armenia on several health indicators (congenital anomalies, neoplasms, perinatal mortality), which is to certain extent conditioned by environmental factors.

Thus, according to the data of 2000, the number of difficult deliveries made up 817 or 9,3% out of 9423 pregnant women under medical observation, miscarriages - 241 (2,5%), stillborns - 50 (0,53%); according to the data of 2003 the number of difficult delivers made up 1955 (17,95% out of 10890 pregnant women under medical observation), miscarriages - – 219 (2%), stillborns - 75 (0,69%). Tuberculosis rate has also increased in the city. Outbreaks of enteric infections related to breakdowns at water supply system have also been recorded.

Table 12. Dynamics of morbidity with some nosologies.

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

Unfortunately, within the transition period no systematic scientific research has been carried out in the sphere of environmental health in Armenia, while some of the above-mentioned data

demonstrates that the health of Yerevan population is subjected to significant risks. In the light of relevant international documents ratified by Armenia we may assume that activities in this sphere will be restored and developed to the required extent.

4.2. Consequences for the built-up environment (urban vulnerability). Exposure to natural and man-caused calamities.

Above we have already mentioned the processes of *climate change and desertification risks* that exert negative impact on living conditions and raise “urban vulnerability”.

Apart from that, the city is prone to *mudflows*, while Getar and Hrazdan Rivers fulfill an important mudflow derivation function. Unfortunately, at current construction in the city that factor is sometimes neglected, which leads to damages to those constructions during spring floods. Thus, the damage exerted by spring floods to Yerevan in 2004 equals to 470 mln. AMD (about 1 mln. dollars). First of all the floods affected a number of restaurants and cafes on the bank of the Hrazdan River. The partially covered bed of the Getar River is also a threat in this sense (currently the covering of the river-bed continues). In case of a mudflow the river-bed-covering constructions may be destroyed or flooded by flows of water, mud and stones. A regulatory reservoir has been constructed at the upper river, but as experience shows, often the power of spring mudflows is underestimated.

The *landslides at Nubarashen cemetery and mortuary of toxic chemicals* (mainly pesticides), which are extremely close to the city, are also a risk of possible toxic contamination of the territory. Measures undertaken within the last years on insuring the safety of the mortuary are insufficient.

Armenian Nuclear Power Station is situated at a distance of 28 km. from the city with a temporary polygon of radioactive wastes burial. That is why constant safety measures for prevention of a calamity are implemented.

And finally, revaluation of relief sustainability has led to wrecking *deformations* of some buildings (mainly in Achapnyak) and increase of *seismic risks* in the city in general. The Center of the city is especially exposed to seismic risks due to intensive and dense constructions within recent years.

CHAPTER 5. POLITICAL INTERFERENCE AND INSTRUMENTS

5.1. City and urban environment management structures.

As mentioned above, the current city management system in the mode of a Marz has not justified itself. In particular, the transition to many functions of city management to communities has led to the deterioration of the situation, especially in the sphere of greenery planting and sanitation (with rare exceptions).

According to Constitutional amendments adopted through a national referendum in 2005, Yerevan was granted back its status of a community. At present, a Draft Law on Yerevan has been developed and undergoes discussions, which envisages significant optimizations of city management structures and significant attention is given to the environmental sphere.

5.2. Implementation of the policy and instruments in this sphere.

The development (2002-2004) and adoption (2005) of the new *Master Plan of Yerevan* is one of the most significant events in this sphere. The main items of that fundamental document should

serve as a base for further urban development document on zoning, development of infrastructures and individual projects.

The goal of the Master Plan was the preparation of an urban development strategy up to 2020 for creation of favorable living conditions and provision of sustainable development. The following objectives were set for accomplishment of the above-mentioned goal:

1. optimization of the planning structure;
2. optimization of the transportation and engineering infrastructures;
3. development of environmentally-friendly productions, including
 - a) exclusion of industrial zone expansion,
 - b) re-profiling or removal of agricultural productions from the city
4. improvement of living conditions for the population and modernization of housing
5. restoration and insurance of sustainability of natural complexes,
6. reduction of environmental risks for human health,
7. protection of historical and cultural heritage

The Master Plan is envisaged for 1,200 mln. people within the framework of the existing administrative borders of the city.

With the support of UNDP and REC CEE and with participation of the public, NGO Transparency International implemented a project on SEA of the Master Plan. A number of recommendations produced in the framework of the project were adopted and the Master Plan was modified.

The evaluation of the main directions of the Master Plan revealed that their impact in the context of environmental situation improvement is rather positive. At the same time, the NGO expresses concern that a number of main goals, particularly reduction of air pollution and expansion of green areas, may not be accomplished due to the trend of increasing the density of construction, tallness of buildings and concentration of population, as well as the build-up of green areas. Besides, the greenery planting is envisaged mainly in the suburbs, while the center of the city needs it to the utmost extent.

Concrete programs

The RA Government has adopted a number of decisions on *reinforcement of the control system over vehicle emissions*, which is the main pollution source of Yerevan air basin. In July of 2005, the RA Government issued its Decision №1033, which approved the “*Program of Measures aimed at reduction of vehicle emissions*”, developed by the Ministry of Nature Protection.

Along with that, the Municipality of Yerevan launched the implementation of a number of programs in 2005-2006 in cooperation with community administrations, Ministry of Nature Protection and other ministries and departments. Among the most important ones are:

- *Certification of the existing green areas, their classification by functional importance, definition of borders, development of greenery planting projects, etc.*
 - *Restoration of green areas on territories that have lost their greenery due to various reasons.*
- Intensive activities have been carried out since 2005 on reconstruction and expansion of the irrigational network and subsequent greenery planting on those territories.
- *Reconstruction of the city nursery-garden of decorative plants.*
 - *Shift to sustainable waste management.*

A Concept on Yerevan solid waste management has been developed with the support of German specialists, which will underlie relevant reforms in the aforementioned sphere.

- *Improvement of the environmental condition of Yerevan Lake.*

Development of the project on treatment of Yerevan Lake's bottom from perennial masses of sludge and their removal has been launched in 2006.

- *Utilization of greenhouse gases formed at the Nubarashen dump.*

The Municipality is launching a project on collection and utilization of greenhouse gases formed at Nubarashen dump with the aim of producing electricity. The project is carried out within the framework of the program "Mechanisms of Clean Development" based on the Kyoto Protocol and in cooperation with the Ministry of Nature Protection and with the support of Japanese Government.

- *Optimization of the transportation structure, in particular, replacement of some minibuses by buses and trolleybuses and construction of a new subway station.*
- *Construction of new highways that would avoid the center of the city.*

Along with the aforementioned measures, the following activities are prioritized in the framework of The Master Plan implementation urgent measures for 2006-2020 (approved by Government in 2006):

- Development of a list of specially protected territories within the city, definition of their borders and the protection regime,
- Development and implementation of a project on restoration and reconstruction of Yerevan sewage aeration plant,
- Development of a program on processing solid domestic waste,
- Reconstruction of Yerevan Zoo,
- Implementation of a scheme of protection of historical and cultural heritage monuments, etc.

5.3. Public participation in environmentally important decision-making.

The civil society of the city constantly voices for the improvement of the environmental situation in the city and maintenance of the architectural-cultural heritage. The NGOs, which established the NGO Coalition for Protection of Yerevan Green Areas in the beginning of 2002, are among the most active civic organizations attempting to introduce necessary improvements to the urban development policy. Since the circle of environmental problems keeps expanding, the union was transformed into Civic Environmental Coalition that consists of 35 NGOs and reacts to urgent issues via creation of relevant working groups: SOS Yerevan, SOS Shikahogh, etc. The Aarhus Center, established by OSCE, the Ministry of Nature Protection and NGOs, plays a significant role in raising public awareness.

Since 2002 the Coalition has held a number of events dedicated to the environment of Yerevan, such as rallies and demonstrations, pickets, roundtables with participation of stakeholder ministries, the Municipality and community administrations, press conferences, radio and television debates, public hearings, etc. The Coalition submitted a package of documents to the Authorities, which points out that a number RA Laws and signed and ratified international environmental conventions are violated in the process of implementation of the urban development policy. A film "The City on the Way to Desertification", dedicated to environmental problems of Yerevan, was shot and broadcast on TV. Court cases have been filed, as well.

Those activities prevented the build-up of only several green areas. In 2005, two representatives of the Coalition were included into the Urban Development Council at Yerevan Municipality and have been trying to ensure the adoption of environmentally-friendly decisions. Parliamentary hearings dedicated to the environment of Yerevan were held in February of 2006 at the initiative of the

Coalition and the Forum of NGOs and political parties, in cooperation with the Standing Parliamentary Committee on healthcare, nature protection and social issues. The Coalition developed and distributed a package of recommendations to the participants of the hearings; several of those were considered by the Municipality, such as the conduct of inventory of Yerevan's green areas, development of a wide-scale program on greenery planting in Yerevan, etc.

As mentioned above, the Coalition also managed to ensure the adoption of positive decisions related to recovery of the status of a single community of Yerevan.

The NGOs continue to insist on the necessity to form a special inter-ministerial commission on the environment of Yerevan. The National Assembly of Armenia has once more initiated the conduct of parliamentary hearings dedicated to environmental problems of Yerevan.

CHAPTER 6. POSSIBLE DEVELOPMENT SCENARIOS

Based on the aforementioned information we may consider 3 possible scenarios of future development of the situation in Yerevan, namely:

1. Pessimistic (the worst-case) scenario

Intensive, chaotic and dense build-up of Yerevan continues along with elimination of green areas and historical monuments. Traffic significantly exceeds the capacity of roads, which leads to constant traffic jams.

The industrial production has also been gradually reviving, but without relevant treatment plants. The waste management remains at the same level. The city is distinguished with constant smogs, high pollution of surface waters and soil, the microclimate deteriorates. Seismic risks keep growing, as well as those of aridization, desertification and urban vulnerability. The morbidity rate among the population keeps going up.

All this leads to environmental and social collapse of Yerevan.

2. Stagnant (moderate) scenario

The chaotic build-up and losses of green areas of the city are ceased. Urban development is carried out within the framework of the Master Plan and projects on zoning of the territory. The objectives of greenery planting are met partially, while the density of constructions keeps growing. The system of measures aimed at environmental improvement is conducted to a limited extent. Citizens of Yerevan are insufficiently involved in the discussions and decision-making related to environmental issues, so the implemented measures are not very efficient.

The environmental situation in Yerevan is unfavorable, but not critical. The Center of the city continues to face the risk of environmental calamity.

3. Optimistic (the best-case) scenario

A Local Council on Sustainable Development is established at the Municipality, which is necessary for the city and is derived from the international conventions signed and ratified by the Republic of Armenia. The City signs the Aalborg Charter "European Cities towards Sustainable Development" and Aalborg Commitments, gets actively involved into ICLEY international processes (Local

Government for Sustainability), MUE-25 (Managing Urban Europe – 25) and sustainable landscape planning coordinated by CEMAT.

Local Agenda 21 is developed for Yerevan on the base of the positive experience of environmentally friendly cities and recommendations presented in Chapter 7. Measures on the implementation of the Master Plan and the entire socio-economic activity in the city are carried out in accordance with principles and approaches of Local Agenda 21. Civil society is actively involved into the development and implementation of Local Agenda 21.

Yerevan is no longer a “hot environmental spot” and becomes an environmentally favorable city with a relevant microclimate. The solicitous approach to the cultural heritage recovers. Public health improves. A more favorable base for socio-economic development is created, especially for the development of international tourism.

CHAPTER 7. SUGGESTIONS AND RECOMMENDATIONS

Below are presented the main suggestions and recommendations on improvement of the environmental situation of Yerevan, decrease of the vulnerability of the city towards the negative factors of natural and man-caused character and public health risks.

- Strengthen the control over implementation of environmental legislation and international conventions signed and ratified by the Republic of Armenia, as well as National Action Plans on their realization and “The Master Plan implementation urgent measures for 2006-2020”;
- Develop economic mechanisms of environmental management via reinforcement of measures corresponding to the principle “polluter and resources-consumer pays” and addition of encouraging measures for environmentally-friendly productions;
- Reinforce and further develop the monitoring system of Yerevan, which at present does not reveal the comprehensive picture of the environmental situation in the city;
- Maximally develop the remaining tram-lines and trolleybus networks;
- Activate the implementation of the contemporary system of collection, processing, utilization and burial of wastes; develop and implement a pilot project on differentiated collection of solid domestic waste;
- Activate the prevention of surface water pollution in the city, restoration and expansion of Yerevan aeration plant, reduction of water losses within the network and increase of the potable water quality;
- Reinforce the control over observance of urban development norms, develop a detailed engineering-geological map of Yerevan;
- Undertake necessary measures on regulation of maintenance and use of cultural heritage, in particular, create a special fund for restoration and reconstruction of historical and cultural monuments of the 19th century – the beginning of 20th century. The fund should be created at the Municipality of Yerevan, with participation of the civil society;
- Conduct the inventory of green areas of the city and review the leasing agreements with those, who don’t fulfill their responsibilities on maintenance of greenery;
- Institutionally improve the current system of green areas, recover the Greenery Planting Department at Yerevan Municipality, optimize the system of greenery planting indicators;
- Revise the city construction concept, according to which the most environmentally unfavorable part of the city – the Center, continues to be built-up with tall buildings and the density of constructions keeps growing (sometimes at the expense of green areas), while the compensatory greenery planting is envisaged mainly for the suburbs at the most favorable northern part;
- Envisage the formation of a common, uninterrupted green network of the city – the framework of its sustainability;

- Improve and implement a complex of measures directed at the reduction of the urban vulnerability and prevention of possible natural and man-caused calamities;
- Maximally take into account the aforementioned issues at zoning and detailed planning, derived from the Master Plan of 2005;
- Raise public awareness, as well as that of decision-makers, on environmental problems of the city and their possible solutions;
- Recover the systematic scientific research in the sphere of environmental health, reinforce and develop the monitoring of the health of Yerevan population;
- Introduce changes into the Decision of the RA Government №193 (May 30, 1999) “On the Limits of Envisaged Activities Subjected to Environmental Impact Assessment” (items 7 and 10), which significantly limits the frameworks of environmental assessment;
- Speed-up the adoption of the Law on Environmental Impact Assessment;
- Raise public participation level in the processes of making environmentally important decisions and their implementation, as well as encouragement of environmentally-friendly activities;
- When developing, discussing and adopting the Law on Yerevan (in accordance with the Constitutional amendments approved by the 2005 referendum) take into consideration all the necessary institutional changes, which will promote the solution of above-mentioned issues and considerable improvement of the environmental state of the capital;
- Establish a Sustainable Development Council at Yerevan Municipality, which will develop the Local Agenda 21 and coordinate its implementation, providing large public participation at all stages;
- Sign the Aalborg Charter “European Cities towards Sustainable Development” and the Aalborg Commitments, integrate into international network of sustainable cities and use the rich international experience in transition of Yerevan towards sustainable development.

CONTEST

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This publication has been prepared on the base of and as a continuation to the Report “ State of the Environment of Yerevan city for 2004-2005”, which was developed and published by Association for Sustainable Human Development/UNEP National Committee in cooperation with the RA Ministry of Nature Protection and independent experts.

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