

GEVORG NAZARYAN

**GEO ALAVERDI.
ENVIRONMENT AND URBAN
DEVELOPMENT**

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INTRODUCTORY

From the Ministry of Territorial Administration of Armenia



The policy and legislation of Armenia in the environmental protection field have been basically formed and improved during the last 15 years. According to the 15th article of the Constitution of Armenia the State ensures protection and recovery of environment, and the reasonable use of natural reserves. Armenia actively participates in the international cooperation processes, has signed and ratified a number of international and European conventions and agreements in environmental protection field.

In the framework of those agreements and conventions Armenia aims to prevent or restrict harmful impacts on human health and environment, liquidate over norm pollution of environment, lighten the dangerous consequences of global climate change, protect the biodiversity, ensure the necessary volumes of reproduction of renewable natural resources and conditions for maintaining the natural balance and support the natural and effective use of nonrenewable natural resources.

The environmental and natural resources protection and management issues of the Republic of Armenia mostly exist in the Lori Marz as well. In particular, effective management of forest resources, issues on domestic waste removal and management of harmful industrial wastes, effective management and use of water resources, prevention of land degradation, decrease of anthropogenic factors stimulating the desertification, improvement and effective use of grasslands.

This “GEO Alaverdi: Environment and Urban Development” report covers the abovementioned problems in Lori Marz of Armenia, describes the legal responsibilities of various stakeholder organizations in the given field, at the same time suggests and presents the best development scenario for Alaverdi town, and required means for priority issues.

The importance given to the implementation of the project “GEO Alaverdi” is proved by the fact that the ecological issues and challenges of Alaverdi town by their character and sizes have big influence to the whole ecological system of the South Caucasus, as the transboundary Debed River flows through the Alaverdi town and the forests of Alaverdi spread to the Georgia and Azerbaijan by forming entire ecosystem.

VACHE TERTERYAN
First Deputy Minister,
Ministry of Territorial Administration of Armenia

From the Ministry of Nature Protection of Armenia



The study “GEO Alaverdi: Environment and Urban Development” is one of the activities under the *Global Environmental Outlook for Cities Program* that started in 2000 in response to call by the United Nations Environmental Program’s (UNEP) Governing Council. “GEO-Alaverdi” was supported by the Environment and Security Initiative (www.envsec.org) with the special involvement by two organizations: UNEP/GRID-Arendal and OSCE Armenia Office. It aims

at integrated urban environmental assessment that analyses environmental conditions, and it's cause analyses so called pressures on the environment, the policy of reaction towards those pressures and the tools thereof, the trends and solutions for development. The special attention is given to development of scenarios of urban environment. The specialty of the Program that being of environmental nature, it performs on the discussion of the issues and makes its questions with consideration of the socio-economic factors, and demonstrates alternative options for solutions to the situation and development of the city, in parallel with protocol conclusions. We can say from the beginning that the study is not a goal of itself, but a systematized approach to development of recommendations for the solution of the existing problems.

The ecological situation of Alaverdi has always been in the center of attention of the local population. Especially, after the operationalization of the copper processing plant, the expediency of it has been continuously discusses in the context of environmental and health related issues; the population has faced the challenge of decision making and choice. The developments of last several years, the worsening of the socio-economic conditions and the existence of a limited number of employment vacancies do not leave any choice. The main employer for the city is the Plant, thus the issues of selection has become harder.

Some new problems have been added to the mentioned ones, as well, especially related to the management of waste and water resources. The quality of life degrades; serious danger awaits the human health. The data from the public health center of the city, for 2004-2008 is of significant concern, if compared to the analogical data from other settlements. The city needs support in developing an environmental strategy. The study “GEO-Alaverdi; Environment and Urban Development” is a warning to all of this and focuses the attention of both the public and the private sectors to the present and the future of the city.

The study has been performed in participatory manner, discussed with the public/community authorities of the city and the general population. It provides for a collective activity and can play a role in further developments.

The study is a result of constructive work performed by UNEP/GRID-Arendal and OSCE Yerevan, thus it would be preferable to have it play a role in other cities and communities of the Republic.

VICTOR MARTIROSYAN
Director of “Center of Environmental Programs” SNCO,
Coordinator of “Environment and Security Initiative”

From the Alaverdi municipality



Since April 2009, Armenia started the implementation of GEO-Alaverdi Program with the support from OSCE-Yerevan and funding of UNEP/GRID-Arendal. The purpose of the program was to prepare an Integrated Assessment Report for Alaverdi, with consideration of worldwide environmental perspectives, which was aimed at supporting the process of decision-making related to the city planning and increasing the public awareness on the environmental issues of Alaverdi.

Despite the short period of Program operation, it managed to play a significant role in correct expression of the real environmental picture and development of practical recommendations.

Initially, a Working group of interested experts was formed for the defined purpose. The group involved representatives from the RA Ministry of Territorial Administration, RA Ministry of Nature Protection, Alaverdi municipality, NGOs, industries and Alaverdi Aarhus Center. At the first session of the Working group, held on the 1st of May 2009, the members of the group presented their opinions and attitudes towards the existing environmental issues, and discussed the positive and negative developments of the city.

The result of that meeting emanated the development of the Report “GEO Alaverdi, environment and urban development”, which was then reviewed and amended by the experts of the Working Group and afterwards adopted thereby on the 28th of August. I think that this Report is crucial both for the Municipality of Alaverdi and other structures and agencies involved in public administration, for performing practical steps aimed at streamlining of future programs, understanding of urgent issues and improvement of the current ecological condition. Alaverdi faces a hard choice today – an everyday worsening environmental condition on one side (which strongly impacts the human health and quality of life of the population) and the danger of further aggravation of the socio-economic situation in the community, related to the closure of the ACP Armenia Program and lack of any other employment opportunities. Even though, since 1770, Alaverdi exists as a settlement and then as a working community due to a plant established therein, and is considered a metallurgical center, the work and the report of the Team of Experts show that the optimistic scenario is possible only in case of diversification of economic risks, and development of alternative sectors, based on the local resources and rich cultural heritage. Alaverdi must do its best to avoid the pessimistic scenario and take the road to the optimistic one.

Alaverdi must be observed by the international community as a complete and demanded touristic site, as well as a center for industry, culture and sports.

Alaverdi must have such a system of environmental and health care norms, which will be released from the condition of maximal burden and overload, with our support, to be afterwards transferred to the next generations, without significant alterations.

ARTHUR NALBANDYAN
Mayor of Alaverdi



Dear Reader,

Environmental concerns have been on the OSCE's agenda since 1980s and comprise an important part of its comprehensive concept of security. The OSCE recognizes that environmental degradation, unsustainable economic development, and unequal access to natural resources can have a direct impact on the stability and security of states. Therefore, OSCE

participating States have committed themselves to promote international cooperation on environmental matters, abiding by principles of sustainable development and to exchanging information on the state of their environment.

To address multifaceted character of environmental sources of human insecurity, three organizations with different mandates, expertise, and networks — the Organization for Security and Cooperation in Europe (OSCE), United Nations Environment Programme (UNEP), and United Nations Development Programme (UNDP) — joined together to form the Environment and Security Initiative (ENVSEC).

At the national level in Armenia, ENVSEC was urged by national authorities to address the impacts of the legacy of the Soviet mining industry. The revitalization of the mining industry offers excellent opportunities for employment and wealth creation, yet mining also poses considerable danger while polluting streams and rivers with dangerous contaminants. Abandoned and orphaned mining sites present particular threats to the health of ecosystems in Armenia.

I must underline that the major driving force behind the success of ENVSEC is partnership. It was with this understanding in mind that the ENVSEC, OSCE Office in Yerevan, with the UNEP financial contribution in partnership with the Alaverdi Municipality, Ministry of Territorial Administration and the Ministry of Nature Protection conducted the “GEO-Alaverdi: Environment and Urban Development” study in 2009. The study is suggested to be instrumental for decision-makers, civil society in their quest of find the solution to difficult problems. The academic community and civil society organizations were involved in consultations, making part of the working group and contributing to the study.

Alaverdi is located in the North-Eastern side of Lori province of Armenia. The area is located at the baseline of the gorge of the Debed River with a lot of tourist attractions. There are rolling hills, snow capped mountains, gushing streams and many such natural attractions. At the same time this is an industrial and mining hub. The area represents a high concentration of mining activities and old Soviet industrial complexes, and a full range of industrial hazards to the environment.

The publication being presented to you by the ENVSEC partners is a project concept work collaboratively with national authorities, local communities and civil society to assess and recommend premeditative solutions to these threats.

Sincerely yours,
Ambassador Segey F. Kapinos
Head of the OSCE Office in Yerevan

CHAPTER 1. INTRODUCTION. KEY PHYSICAL CHARACTERISTICS OF ALAVERDI CITY

Location. One of the largest industrial cities of Armenia – Alaverdi is located in the picturesque valley of Lori, on the bank of Debed River, surrounded by mountain ridges. Alaverdi is one of the middle sized cities of the Republic. It is located at about 167 km from the Capital, and a distance of 44km from the regional (Marz) center, in the northern part of the Republic of Armenia.

The largest portion of export and import ways, as well as the railroads of the RA passes through Georgia-Alaverdi-Yerevan highway.

The area of the community territory is 12.0km², by spreading over the both banks of Debed River. The community administrative territory is within the Marz of Lori. Alaverdi City also includes Sanahin, Akner and Madan rural communities. The city, from the economic and geographical point of view, has a favorable position. The favorability, at first, is due to the largest portion of international relations and cooperation of Armenia and other countries performed through the territory of Georgia, traditionally and historically, whereas Alaverdi lies on that path.

Physico-geographical characteristics. Alaverdi is located in the sub-region of the Small Caucasian mountain gorge, at an altitude of 750-1400m, on slopes, occupying the Valley of Debed River and Sanahin lowland. The height of Debed Valley is almost 350m, with Gugarats Mountains on the left and Virahayots highlands on the right (see Picture 1).

Picture 1: Alaverdi general view



Source: Google Earth program, 2009.

The area is rich with copper-sulfur volcanic rock, gypsum and stone reserves.

The highland zoning reflects the city area, by stretching from arid to forested areas. Forest soils are usual, as well as carbonated and black soils.

Alaverdi landscape (basically in Debed Valley) consists of sloped ridges, except for Sanahin lowland. The left bank slopes descent to the river abruptly, whereas the right bank slopes gradually.

Alaverdi copper mine has been systematically studied since 1929. By its origin it is a hydrothermal mine of small depths and average temperatures.

The mine area consists of volcanic tuff-basalts, conglomerates, high thickness sandstone layers. The main water body of the area is the Debed River, which heads from an absolute height of 870m, from the cross-section of Pambak and Dzoraget Rivers and flows into Khrami River in the territory of Georgia. River Debed flows through the mountain gorges of Somkheti and Gugarats. Till Ayrum the river flows through the deep valley (300-500m), then by lowland.

The remaining, more low water rivers of the area are mainly the tributaries to Debed, and area characterized by high speed flows and abrupt deviations of the river bed.

The Valley of Debed River has a form of a narrow and deep valley, which relatively expands in the area of Alaverdi. Tributary Lalvar passes through Alaverdi.

The regime of the river is characterized by spring and fall high waters (120-130 days). The increases in the level of water start in spring, from April, reach their maximum in May and continue till the first half of June. The river is fed from ground waters, melting and rains.

Debed River basin includes the steep ridges of the gorge, the plateaus of Akori and Sanahin, as well as the lowlands of Lalvar mountain chain. The absolute heights of the river basin are at 720 – 920m, whereas at the tops the altitudes are 960m – 1080m.

The Chatindagh slopes on the right bank of the river are covered by broad-leaved forests and the forests on the left bank are not dense, spreading only towards the North-Western ridges of Lalvar highlands.

Climate. Alaverdi is a hot climate, with mild winters of regular snow. In average the winter starts in the second 10-day period of December and ends in the beginning of March. The winter weather is unstable. Frosts, as well as sunny warm days are often.

The spring is long-lasting, with regular humidity. The spring late frosts end in the second half of April.

The summer is hot and humid. The relative humidity is rarely below 60%. The cloudy days comprise the largest percent.

Fall is mild, with a more humid second half. The first early frosts start in the end of October-beginning of November.

The period without frosts is 200-230 days.

The highest temperature was recorded in July by +30, +35°C, and the lowest in January and February by - 17, -18C°. The average annual precipitation (at 721m of altitude) is 551mm.

Current physico-geological processes. The area studied is characterized with various physico-geological processes. The most interesting of which are the erosion, denudation, gravity and mudflows.

Having sufficient energy, the River Debed and its tributaries contribute to depth erosion, with regional characteristic depth profiles (up to 200m and deeper) reflected by erosion. By sawing the rock layers, they partially create sediments of shifted and removed splinters.

The denudation processes, developed on the slopes in the valleys of Debed and its tributaries are quite powerful. The mountain ridges covered by significantly cracked and broken rocks, as well as the hydrothermal and methasomatic areas are subject to powerful denudation¹.

Due to the erosional-denudational processes, the area has gained a fractured landscape, with abruptly descending and steep ridges, gorges and deep V-form valleys.

The colluvium-landslide² processes are more developed on the gorge slopes and lowlands by Sanahin. Mainly two areas are separated here: Sanahin monastery and the new village, differentiated by rocky tops. Besides the active landslides, those ridges are completely located on sliding sands and belong to respective zones.

The mudflow processes are widely spread in the area studied. During the flood rains, large quantities of sludge and upper soil layers are washed into the river. Control dams with a number of runoff culverts through them currently protect more active mudflow gorges.

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1 Denudation is an exposure of rock by the erosion of the layers above.

2 Colluvium is a mixture of rock fragments from the bases of cliffs.

CHAPTER 2. SOCIO – ECONOMIC AND POLITICAL CONTEXT (PRESSURES)

1. *Historical assessment of urbanization*

Alaverdi is an area with rich history, which is reflected in a number of historical-cultural monuments located within the territory. The copper mines of the area have always been in the center of attention of many foreign companies. In the 19th century already, the French constructed a small factory there, which was later reconstructed by the Greeks.

The Tbilisi-Alexandropol railroad, which passes by the left bank gorge of Debed River, has been constructed in 1899. After that, the final processing facilities for copper were constructed in Debed valley, where Alaverdi Copper Molybdenum Plant is currently located.

The village located in the gorge of Debed River, was named “Manes”.

In 1912 that village, as well as the upper residence thereof (by Alaverdi and the factory “Piritis”), had a permanent population of 3235 people, except the workers of the plant. In the years of the World War I, the number of residents had decreased to 2711 (in 1915).

The mining activity and industrial development in Alaverdi started in 1960s, when very large investments were made by the Soviets for the purposes of reconstruction and operationalization of the plant.

The final main design of Alaverdi City was made in “HayPetNakhagits” scientific engineering institute, in 1989, according to which the number of people living in the city before the earthquake was 26,9 thousand, including 0,7 thousand in Akner village, located within the administrative territory.

The residential portion of the territory of the city was 355 thousand m², including 284,4 thousand m² of State owned and 70,6 thousand m² of private houses.

The average level of residential (apartment) deposit is 12,9 thousand people.

During the earthquake 17,6 thousand m² of residential areas were destroyed, of which 8,6 of state owned and 9,0 private.

120 thousand m² needed urgent rehabilitation.

According to the main design, the population for 2011 year was planned to be 37,0 thousand.

In the period of 1989-1991 it was planned to construct another 56 thousand m² of residential space, 37,0 thousand of which in the state owned sector and 18,0 thousand in the private. The average residential apartments occupied were planned to increase to 14,0 thousand people.

In the second phase, 1991-1996, it was planned to construct 84,0 thousand square meters of space, 69,0 thousand of which in the State owned and 15,0

thousand in the private sectors. The average residential living space was planned to increase by 18,0 thousand people. The industrial facilities were rehabilitated based on the preliminarily existing bases.

The primary residential construction was planned for implementation in Sanahin lowland, with planned 84,0 thousand m², by decreasing the 56,0 thousand m² of residential area in the lowland and 81 thousand m² in Akori lowland.

In parallel with the residential construction, it was planned to construct public areas of socio-economic significance.

2. Description of economic activities

Till the 90s Alaverdi was developing as a center of mining industry.

The earthquake and the transit to a new socio-economic reality had its impacts on the industries of Alaverdi. The copper plant, the apparel plant, the beer factory and the diary production stopped. The production of construction material decreased dramatically.

After the closure of the mining plant in 1988-1989 years, the territory thereof was used by various industrial facilities, with regularly changing profiles and capacities. Various areas of the community had tailoring industries, textile productions, factories producing cheese, bread and beer, the power station and a number of various companies. The public facilities and food stocks were all around the city area; however their main part was located in the East of Alaverdi, on the right bank of River Debed.

The mining plant, reopened in 1997, today comprises the largest portion of the GDP for the Alaverdi Community and the whole Marz of Lori. The copper processing branch of the mining facility employs 75% of the total number of labor force of the city, occupies 10% of construction industry, 10% of food industry and 5% of light industry.

The table below shows the plant production dynamics for the last twelve years.

Volume of copper produced, tonnes	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
	285,98	2789,3	535	6840,42	4955,2	4669,9	6258,7	9475,7	9882,49	8817,55	6954,05	6480,46

Source: Data provided by ACP company, 2009.

The establishment of small and medium enterprises in the city shall serve as a serious basis for increase in employment rates. Currently, there are 540 businesses registered in the whole Tumanyan region, 262 of which are active. These are mainly small trading or service providing enterprises. The largest business entities of Alaverdi are also the bakery, the production of beer and beverages, the

LLC “Arthur-Taron” (production of construction tiles), LLC “Titanyan Brothers” (asphalt, construction material), LLC “Levon Kirakosyan” (bread and pastry), as well as 3-5 stone processing manufactures.

The light industries of the city also had good traditions. Because of the socio-economic difficulties, the textile manufacture, the textile factory, the factories of condensers, lamps, and beer and non-alcohol beverages closed. The remaining production sites are maintained for any plans and perspective.

The rural communities of Sanahin and Akner that are within the administrative territory of the city have developed agriculture (700 economies). The land area of the community is 5299,4 ha, 120 ha of which is fertile. The community has 1962 hectares of state reserved land. About 10% of the population does crop farming. The community has:

1. Fertile lands 120,0 ha
2. Horticultures 136,7 ha
3. Pastures 671,0 ha

Horticultural companies act in the vicinity of the city.

The rural families mainly cultivate vegetables and fruits, which only partially satisfies the current needs of the city. During the last years, the farmers also deal with production of wheat and plants used for cattle feeding, which also does not satisfy the needs of the city. The horticultures use their areas or cultivating apricots, apples, figs, etc.

The difficulties with the trading of agricultural products disturb the agricultural development process. The main difficulties are the low prices, irrigation related issues, underdeveloped capacities of agencies responsible for the agricultural development or the absence of such agencies in general (agro-services, crediting, insurance), etc.

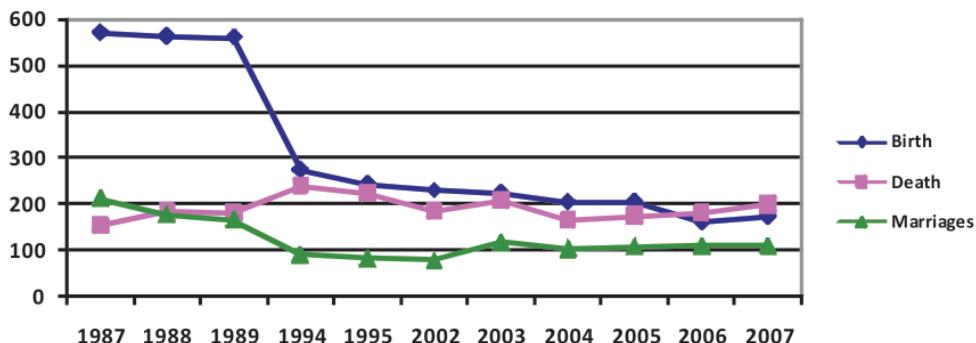
3. Demography

The current population of the city is 16641 people. It must be mentioned that before the 1988 earthquake the population of the city was 26900 people. The population growth rates were so high that, if maintained, the expected population of the city by 2011 was anticipated at 37000 people (calculated by demographic capacity method, with the requirement of ecological balance), for that purpose, the residential fund of the city was to be increased. In reality, though, the post-soviet years of economic crisis, as well as the closure of the most significant industrial entities of the area had their negative impact on the demography. The results of population census, held in 2001, showed that during the 15 post-soviet years the number of people in Alaverdi had decreased by 10000 people or by 40%. This was mainly because of the migration of unemployed population from the city to Yerevan or abroad.

Presently, the demographic condition is hard to evaluate, as the migration

trends change abruptly. Based on the aforementioned and the “Main Plan of Repopulation”, the perspective number of population is anticipated to grow to 24 thousand people. Such a quantity depends on the level and the possibilities of socio-economic development of the marz and city.

Diagram 2.1. Dynamics of Alaverdi population motion, number of cases



Source: Alaverdi municipality, 2009

The current age/sex structure of the population is as follows:

1.	Men	7821
2.	Women	8820
3.	Children (0-6 years)	798
4.	Schoolchildren (7-17 years)	1917
5.	18-60 years	10816
6.	Over 60 years	3110
7.	Pensioners	3938
8.	Including women	2382
9.	One-parent orphans	258
10.	Two-parent orphans	12
11.	Disabled from birth	57
12.	Refugees	5

There are 6100 families in the community.

About 2525 residents of the community are in job search, of which 1419 women. 1868 residents are registered with employment agencies as unemployed.

The age/sex analysis shows that 1217 of the unemployed population are women. According to age analysis of the population, 267 are 16 – 30 years old, of which 155 are women; 1537 people are 30-50 years old, of which 1013 are women. According to analysis performed, there are 49 engineers-technicians, 27

of which are women. There are 1364 factory workers, 763 of which are women.

In the past, the 70% of the capable population worked at the mining plant and the textile industry. The ACP Company, established and working in the premises of the mining plant employed only a quarter of the previous quantity of workers. Currently, after the job places cut due to the financial crisis, the number of employers at ACP plant is about 400 people.

4. Public service provision facilities: water supply, waste removal, energy and transport

4.1 Transport infrastructure

External transport. The M-6 interstate highway of Vanadzor-Alaverdi-Georgia passes through Alaverdi. The H-35 national significance highway of Sanahin-Odzun-Arevatsag starts from Alaverdi. As the city is located in a complex topographical area, within the gorge of Debed River, the highways and roads network is not well developed. A number of local significance roads, leading to the rural communities round Alaverdi start from the city.

The railroad Tbilisi-Vanadzor-Gyumri-Yerevan, constructed yet in the 19th century, passes through the Basin of Debed River. There can be no changes expected in this railroad transportation, as it was constructed 110 years before and needs complete reconstruction. That is the only railroad that links Armenia with the rest of the word.

The closest airport is located in Stepanavan, at a distance of approximately 70 km. The one in Gyumri is 116 km far.

Internal transport Alaverdi community consists of a group of communities: Sanahin kayaran, Alaverdi, Lenrudnik (Madan), Katsotsk, Sanahin and Akner. These communities are far from each other, both in space and altitude. Hence, the main street of the city, that stretches along the Debed River, and coincides with the M-6 interstate highway (Vanadzor-Alaverdi-Georgian border), has a length of 9,5 km. By altitude, the differences among the residential areas can reach 250 m. It is natural that the service of residential areas spread in such a way requires a lot of effort. In this regard, Akner is in the worst condition, as it is located on the right bank of the river, at a lowland of 250 m height and a distance of 12,8 km to the closest residence of Katsotsk, whereas in a straight line that distance comprises only 1 km. The same situation is with Madan.

If Sarahart, Sanahin and Akner communities are located in lowlands and there is no internal transport issue for them, then the rest are located on slopes with some having no roads to approach.

Only the central part of the city and the M-6 highway have active transport moving, for the rest of the roads the intensiveness reaches 20-25 vehicles per hour.

The highest activity is in the center of the city – 252 vehicles/per hour. However, the load of the street in that part of the city does not exceed 0,2. Currently, the length of all streets of the city is 27,2 km. In perspective, that indicator can reach 40 km.

There is a cable-way working in Alaverdi, which joins the left low bank of Debed River to the upper bank, to Sarahart, shortening the way by 5.2 km. The city has a bus route and a micro-bus route transportation means, which link the center to Sarahart and Sanahin.

4.2 Water supply and wastewater collection

The drinking and industrial water supply in Alaverdi is performed through totally 22 captations in the area of Lori Berd, the total capacity of which is 180-220 l/sec.

The consumers of water in the city are the population, small and medium food, beverage and other industries, including the mining company (ACP CJSC, production of alcohol free drinks, bread, cheese, textile), as well as the big and small cattle farms.

The water supply system consists of Lori Berd captations, Lori-Berd-Alaverdi water main, daily supply reservoirs, and the incomplete water distribution network.

- The totally 22 captations with a capacity of 180-220 l/sec. are located by Lori Berd village, from where the water flows by gravity to an accumulation pit by village Karmir Aghegi and then continues to Alaverdi. The length of the water main to the point it reaches Alaverdi is 23 km.
- The water main passes by Tsater, Karmir Aghegi, Odzun villages and through village Akori.
- The extraction of water is made by a liquid chlorine station, constructed by village Karmir Aghegi.
- The Lori-Berd-Alaverdi water main supplies water to:
 - “Sarahart” daily supply reservoirs, with capacities of $W=2x400m^3$, $W=2x500m^3$, constructed in 1986.
 - The DSRs of the district called Jravazan (water basin), with capacities of $W= 2x 400m^3$ and $W=1x 300m^3$, constructed in 1986. There are daily supply reservoirs in Sanahin, Piruzyan Akner and Lenhanqer communities with capacities of $2x150m^3$, $1x300m^3$, $1x400m^3$ and $1x300m^3$, respectively, which are not fed from the water main. The consumers in the communities of Lenhanqer and Akner use the local water sources, located within the territories of the communities.

A pumping station was constructed in the past to provide for the supply to Akner community, which is not working now.

In order to provide water by Lenhanqer district main, there is a need to construct a pumping station; the daily supply reservoirs of “Sanahin” and “Pirazyan” are out of order.

There is a total capacity of $W=4600\text{m}^3$ in the daily supply reservoirs, out of which only 3300m^3 is used, the remaining 1300m^3 capacity in the daily supply reservoirs do not work because of large quantity of losses.

The supply network consists of brass and steel pipes ($d=50-250\text{mm}$), the total length of which is 50km.

The construction of the aforementioned supply and distribution networks of Alaverdi started mainly from the 1960s and partially continued up to 1990, after which very little repairs were done, only when the need thereof occurred during the operation.

The quantity supplied to the tap of the consumer is about 40 l/sec., the remaining quantity of water entering the city comprises the losses and unaccounted quantities.

The existing supply system is in a technically insufficient condition and needs reconstruction.

Taking into account the geodesy of the territory occupied by Alaverdi, that changes between 700-1180m, as well as the existing daily supply reservoirs in the city, located at 800,11m, it will become clear that the daily supply reservoirs will not be able to satisfy the needs for the whole city, by providing the necessary pressure, proper and safe supply to all the consumers.

That was the main reason that a number of houses in certain streets are fed from the main directly. The distribution and the plumbing are in a bad condition, with losses accounting to 75-80%. 75% of the whole network needs rehabilitation.

Thus, because of the mentioned weaknesses, the consumers have water only for several (average 6) hours in a daytime; in some better conditions (supplied directly from the main) the water supply can even reach 24 hours.

Wastewater collection (sewage). Only 45% of Alaverdi has sewage. Villages Akner, Lenhanqer, Sanahin do not have sewage. The private residential areas, which comprise 30% of the total residential fond of the area have septic pits or discharge the wastewaters directly into Debed River.

The wastewater collectors of Sarahart and Engels, as well as the city's main collector, made of ferroconcrete and steel, work partially. The wastewaters do not reach the treatment plant; they are discharged into Debed, on the way.

The existing wastewater collection network and the collectors were constructed in the period of 1959-1980. The total length of the network and the collector is about 50km (without the internal district plumbing and pipelines). A lot of sections of the network are blocked and do not operate currently.

In 1979 a full power microbiological wastewater treatment plant of total

capacity 16,3 thousand m³/day was constructed and handed into operation for the purpose of treatment of the city wastewaters, which has stopped working from 1991.

The main Sarahart district collector and the collectors flowing to the treatment plant are obsolete and non-operational, as well as the sand filter to the wastewater treatment plant, the primary and secondary absorption pools, air decantation pipes, partition walls inside the structure, the contact basin and the building of the chlorination system. All the equipment has been removed from the building.

Currently, the wastewaters are discharged directly into the River Debed, without any preliminary treatment, hence resulting in worse sanitary conditions.

According to the existing data, the quantity of the discharged water and the runoff comprises 3,5 thousand m³/day.

The sewage and the collectors need significant investments to be brought to satisfactory conditions, by restoration of the old and non-operational mains and expansion of the physical network.

4.3 Power supply

The current power supply sources to Alaverdi are the 110/35/6 kW “Alaverdi 1”, “Alaverdi 2” and the 35/6 kW “Akner”, “Haghpat” and “Sarahart” power stations with capacities of 2 x 40 MW, 2 x 63,5 MW and 1 x 2,5 MW, respectively.

The connection of Alaverdi 2 power station to the energy system is performed through a 220 kW two-port “Kirovakan 2 – Alaverdi 2” and a 110 kW two-port “Alaverdi 2 – Bagratashen” lines.

Currently the average monthly energy consumption of Alaverdi is 7640 thousand kW of electricity, 6800 thousand kW of which are consumed by the general population.

4.4 Waste management

In order to provide for the normal everyday activity of the population, proper sanitary control is necessary. The community has serious problems in the field of waste management. Starting from 2006, the municipality undertook some urgent actions slightly improved the situation with garbage collection and removal. In the last three years, the community received support from the USAID and the Government of Greece, which was used to purchase and install more than hundred large garbage bins in the community, to obtain the necessary equipment and vehicles, to install a new, more effective system of collection of fees for the removal of waste. With the received support, it became possible to install small street garbage bins in the streets, public buildings, institutions and parks. In addition, the municipality currently owns two new garbage collection trucks.

Even though some work has been done to improve and equip the infrastructure;

however, there are many issues still remaining unsolved that is related to solid waste treatment and removal system. First, special attention must be paid to the waste disposal sites, where the non-neutralized wastes from the previous mining industry of Alaverdi are still buried. The Arsenic disposal site, located on a high altitude, on a hill by Lalvar River is full and is currently in a non-satisfactory condition. Oxidized materials cover the upper layer, which is a potential source of hazardous leaks. The whole area is within an active seismic zone, which creates an additional risk for uncontrolled spread of pollution. To avoid potential disasters and minimize the hazards, the high pressure airtight of waste disposal site should be recovered.

Secondly, the city lacks of an industrial and domestic landfill. The city's landfill is not controlled; it is located at a distance of 9 km from the community (within the administrative territory of Haghpat community), and the garbage collection vehicles hardly enter that area. Moreover, it is located on a hill, which makes all the works more complicated. The landfill is located at a distance of several meters from Debed River, which creates another environmental issue, related to the pollution of the river with solid wastes. It is a common practice that the drivers of garbage collection trucks prefer to through the garbage directly into the river, especially in winter, when most of the roads are covered by snow.

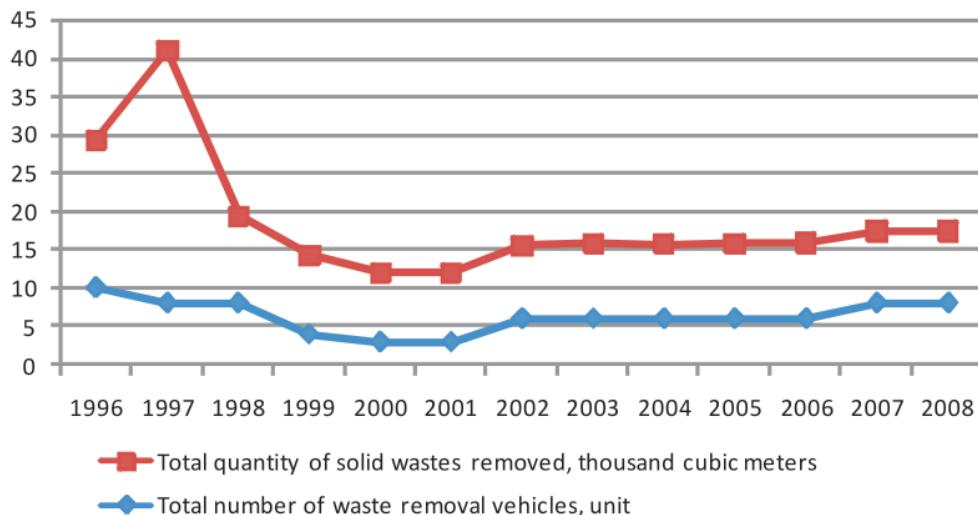
Thus, there is an urgent need now to allot an appropriate land area for landfill and construct it according to the requirements specified by legislation. In order to construct a new landfill, currently 4,6 hectares of land in the northern part of the administrative territory of the city is foreseen. The municipality with the support of the Ministry of Nature Protection conducted an investigation of the site, prepared all the necessary documentation required by legislation and submitted to the Government for approval.

According to the municipality calculations, the average cost for the construction of the landfill is about 250 million AMD (all the calculation documents will be ready in the end of 2009).

The current quantities of solid domestic waste amount to 120kg/per capita per year, whereas the sanitary cleaning of the streets accumulates 5kg of solid wastes per capita per year. In perspective, the solid domestic waste will amount to 14,4 thousand cubic meters (2880t) of waste annually, and the street garbage will amount to 120t per year. It might be mentioned that the SDW has the following statistical structure now:

- plastic and polymers: 8%,
- paper and wood: 4%,
- other wastes: 88%.

Taking into account the current volume of wastes and the trends of its increase in the future, it is necessary to plan the construction of a small capacity waste processing plant, with its respective landfill.

Diagram 2.2. Quantity dynamics of solid domestic wastes, 1996-2008

Source: Master Plan of Alaverdi, 2007; Data from MNP, 2009

The big difference in the figures for waste quantity for 1996-2000 years shown in the diagram 2.2 is explained by the fact that before 2001-year official census of the population it was proposed that the population of Alaverdi, based on the 1988-year data is about 26000 people. However, the 2001-year census data shown that the population decreased to 16600 people. As the waste quantity calculation based on the number of population, there is some statistical error among 1996-2001 and 2001-2008 years data.

Industrial wastes These are mainly formed in the area of the copper processing plant. On the 1st of January 2005 the slag residual in the area comprised 6406,94 tonnes. About 36265,0 tonnes have been accumulated within a year period. This type of wastes is highly demanded in various construction processes. The plant mainly sells the accumulated slag. In 2005, 29062,35 tonnes were sold. In the end of the year, the residual in the stock slag has comprised 13609,59 tonnes.

However, in the past, the trading of slag was not a usual process and the wastes were disposed in the improperly organized accumulation sites on the way to Jiliza. With years, the quantity of waste increased, slowly reaching the residential district of Madan.

Table 2.1. Dynamics of industrial wastes

								(tonnes)
	Received from other organizations	Formed within a year period	Provided to other organizations	Deused and eliminated by the company	Used by the company	Transferred to disposal sites	Quantity of the wastes in the end of the year	
2000	-	-	-	-	-	-	1124,0	
2001	-	11099,031	7019,15	-	-	-	5203,881	
2002	-	10495	14601,24	-	-	-	1097,641	
2003	-	14240	15240,35	-	-	-	97,291	
2004	-	29880	23570,35	-	-	-	6406,941	
2005	-	36265	29062,35	-	-	-	13609,59	
2006	-	34000	47342,39	-	-	-	267,201	
2007	-	38200	36333,32	-	-	-	2133,881	
2008	-	31720,0	31093,74	-	53,1	-	2707,041	

Source: ACP company, 2009.

Other wastes. Wastes are generated also at health facilities. The following types of wastes are generated from the hospital of Alaverdi:

- a) human anatomic wastes (joints, organs, parts of the body),
- b) plastic packs and spares,
- c) organic pollutants.

About 70kg of hospital waste is generated within a year period, which is accumulated and destroyed at the special stock of the maternity house. The wastes of organic origin (used cotton pads, antiseptic gauze), plastic containers, injectors and various rubbish (about 4,2t in total per year) is released into the environment, because of lack of a disposal site. The total quantity of garbage from the medical facility amounts to 12kg/day.

4.5 Sanitary condition

The Alaverdi branch of Lori Marz (regional) Center of the State Hygiene and Anti-Epidemiological Inspection of the RA Ministry of Health performs the control over the sanitary condition of the city. According to the information provided by the agency, the biggest problem of the city is the improvement of the sanitary condition of food trading entities. Only some of the retail stores, from the 100 registered with the Tax Office, which more or less corresponds to the norms of hygiene. Though about 70 retail stores are fined every year, their conditions do not improve.

According to the norms, the retail stores, among other requirements must also have an entrance space, a stock, and a lavatory with a washing bowl. However about 80 retails in Alaverdi do not have the mentioned necessities, they do not

even have a lavatory and a washing bowl³. Since 2006, there is one properly repaired market place, which has a lavatory and satisfactory sanitary conditions. However, the prices of the products in that market are a little higher than the prices in the smaller retails around it; hence, the population prefers shopping in those retails.

5. Social services (*health, education, culture and leisure*)

5.1 Health

The Alaverdi health protection system has been consisted of two outpatient medical treatment facilities, a hospital, a maternity hospital and an ambulance unit, which are unified into one medical center, after institutional restructuring. Besides the medical center, there are dentistry, a sanitary-epidemiological station and 3 drug stores working in the community. The lack of modern medical equipment in the treatment center is a serious problem for performing in normal medical environment. The residents of the community pass full medical treatment and analysis in Vanadzor or Yerevan, mainly, which are sometimes not affordable for the socially vulnerable population.

The health system is financed through the State Budget. The number of physicians is 110; with 227 patients per a physician.

The municipality for solution of health related issues, in particular, earmarks 30% of the environmental fees paid to the community budget by providing tours to health facilities for detected afflicted persons, and by providing with food rich with vitamins to patients with tuberculosis and kindergarten visiting children. Taking into account the distance of the residential area from the hospital or a treatment facility, there was a medical support unit constructed by Akner community.

5.2 Education

The educational system of the community includes the primary pre-school, general secondary, vocational and higher educational systems. There are nine secondary and one primary schools in the city, with 1917 students and 220 tutors.

The number of the students in the last several years has significantly decreased, because of emigration. Hence, the number of students per a tutor is 11-12. There are six kindergartens in the city, which have 2-day nurseries and 12 children's groups. There are 420 children visiting kindergartens that have 78 employees, 38 of which are pedagogues. There is also a private college gymnasium working in

³ Larisa Paremusyan, "The stores are fined, but the situation is not improved", electronic newspaper (168 hours), 19.01.2007, www.168.am/am/articles/8894

the city.

In general, the educational system of the city includes:

- The “Tumanyan” branch of Yerevan “Northern University”, which is an accredited higher educational facility, the state college and the craft-school act within the territory of the community. There are 285 students studying in the branch.
- “Alaverdi state college” State non-commercial organization“, which has 27 employees, 13 of which are pedagogists. The college has 97 students. Secondary professional and vocational education is provided in the college.
- Alaverdi Crafts School State Non-Commercial Organization works since August 1, 2006. There are 225 students in the school, studying 10 different professions; 59 employees, 35 of which are pedagogues.

5.3 Culture

The following cultural centers work in Alaverdi: Museum of Mikoyan Brothers and three vocational schools: music, art and artwork.

The musical school of the city, after R. Melikyan, was established in 1962. The school has about 100 students and 25 employees, 18 of which are musician pedagogues.

The art school of Sarahart was established in 1981. It has 14 employees and 70 students.

The Alaverdi School of arts was founded in 1978; it has 8 employees and 50 students.

There are 2 libraries in the city, with a total number of 143338 books. There are 11 employees in the library.

Alaverdi city theatre is famous for the whole Armenia. It was founded in 1932. Alaverdi ensemble of folk music is well known in and outside Armenia, which was established in 1945 and regularly gives concerts in present times.

In 1987, the branch of the RA National Art Gallery was opened in Alaverdi. The Gallery contains illustrations of several well-known artists.

There are three sport schools in Alaverdi, the youth sports center, the school of boxing and the oriental school of combat. The chess school, established in 2006, still works in Alaverdi.

5.4 Recreation possibilities

The city has one park, 7 open-air playgrounds, 2 swimming pools and a forested area adjacent to the city.

The park and the playgrounds need complete rehabilitation and reconstruction. The foreyards also need rehabilitation, landscaping and gardening.

The municipality aims at creating more small playgrounds for children, in case if additional funding is available.

6. Description of the local self-government system

The local self-government in the community is performed in accordance with the requirements of the RA law “On Local Self-Government”, through elected local executive bodies: the mayor and the Council of Elders that consists of 11 representatives. The municipality has 45 employees. The administrative management of the municipality consists of the mayor, his/her deputy, the advisor and the head of staff. The municipality includes departments on finance and on collection, as well as the professional staff (12 civil servants) and the technical service employees.

The Government approved the list of municipality-managed assets as follows:

- kinder gardens - 6,
- specialized schools - 3,
- art houses - 3
- libraries - 2,
- heating, water supply, sewage infrastructure and streets,
- leisure park - 1,
- open air playgrounds - 7,
- administrative buildings - 2,
- transportation means - 1,
- museum – 1,
- Sports school – 2.

The service of the residential areas of the city (rehabilitation of roofs, cleaning of chimney pipes, repair of water pipes, etc.) is performed by first, second and third residential service units (RSU) of the municipality.

In general, the residential fund is characterized as follows:

number of employees:	38
apartments:	214,7 thousand m ²
privatized residential areas:	197,0 thousand m ²
multi-apartment buildings:	183,
including: high-rise buildings:	22
emergency blocks:	3
Total number of apartments:	5568
Number of privatized apartments	5120

Besides the abovementioned, the municipality operates its “Alaverdi improvement” LLC for the general improvement of the city. The general improvement includes:

Length of streets and street passes	41km, 27 streets
Area of streets, street passes and squares	320 thousand m ²
Number of bridges	18
Area of public parks and gardens	102ha
Length of illuminated streets	16km
Number of light bulbs	125
Number of storm sewers	10, length = 5846m
Boulevards and leisure zones	3
Monuments	6
Dams	8986 line meters

7. Summary of local socio-economic factors

The economic sector of Alaverdi is very weak, despite the fact that the region has a number of significant factors that could contribute to its economic development: favorable environment (mild climate, forests, etc.), human resources (specialists, who are experienced in mining, agricultural and other production) and natural resources. Besides, the market demand for the growing in these area agricultural products is high.

The mechanisms necessary for the reprocessing of raw materials and manufacture of final products, as well as the necessary markets are lacking; low level of production in the sectors of cattle breeding and land cultivation is registered. The reasons for that are the low awareness on modern technologies, as well as the lack of well-organized farming systems and bank crediting mechanisms.

Taking into account the weakly developed economy of Alaverdi, all the efforts must be focused on the establishment of production of agricultural and dairy products, as well as development of tourism. This will allow not only to decrease the level of unemployment in the communities (female population partially), but also serve as a firm basis for the sustainable development

Taking into account the rich forested areas around Alaverdi and the existence of a large number of historical monuments, tourism has been identified as one of the priority sectors of development for the region. That objective can be performed through improvement of community infrastructure and development of services, which require additional training and capacity building.

The demographic indicators of Alaverdi are also concerning. Within a period of 20 years the number of the population has decreased by 40%. Most of the young families and the labor force have left the city because of the socio-economic conditions. Besides, the seasonal migration in the region, mainly to the Russian Federation, for job search has become traditional.

More vulnerable areas of the health sector are the provision of medical services and the obsolete conditions of the medical facilities, as well as the low level of awareness on healthy life-style, i.e. balanced food, family planning and proper sexual education. The level of awareness on the regulations about medical services stated in the acting legislation is also low.

The studies have shown that despite the fact that the educational facilities have been rehabilitated to a certain extent for the last years, however, they still do not provide comfortable and safe environment for children. A number of rehabilitated educational facilities do not have heating, and most of them do not even have water supply.

Besides all this, there is a lack of out-class studies, as well as professional training and leisure opportunities in the schools, which results in high quantities of migration in youth.

The quality of education in the schools is noticeably low, as there is no professor for each of the subjects taught, there are no training opportunities for the tutors, and there is a need for study materials (literature), laboratory consumables and computers.

Though the population does not give importance to the gender issues, however, the job opportunities for women are strictly limited with a need for professional training. The majority of women worked in the two local factories, in the Soviet period. After the collapse of the Soviet Union, when those factories closed, these women became unemployed, though having very technical experience and narrow specialization. They were not able to find any job afterwards.

The copper mining and the explorations in the territory are of a serious threat for the environment of the region. Because of pollution from the copper processing plant, 15-20 times exceedances of the maximum permissible concentrations of sulfur dioxide in the ambient air are often registered in the city, which is a serious hazard for the human health. The city does not have a landfill, and the solid wastes are discharged directly into Debed River. The urban wastewater treatment plant does not work since 1991, thus the domestic wastewaters are discharged directly into Debed River. In the result of energy and industrial crisis of 1991-1996, the forested areas around and the gardens inside the city were destroyed significantly. The low level of public awareness on environmental issues and the incomplete realization of the real threats from those actions were present as well.

CHAPTER 3: STATE OF THE ENVIRONMENT

1. Description of the conditions of the ambient air in Alaverdi

The landscape of Alaverdi, especially the gorge of Debed River, and the location of Yerevan-Alaverdi-Tbilisi overloaded highway create unfavorable conditions for the ambient air in the city concerning the accumulation of emissions.

The two air monitoring stations of the city are used for controlling four main pollutants: dust, sulfur dioxide, carbon oxide, nitrogen dioxide compounds. In 2005 the following situation have been recorded: the average annual concentration of dust has exceeded the maximum allowable concentration (MAC)⁴ 1,3 times; the sulfur dioxide - 10,4 times. In 49% of the samples taken, the MAC for the sulfur dioxide has been exceeded 2,4 times; for the nitrogen dioxide 7% of samples exceeded MAC by 1,3 times.

Compared to the previous year, no significant improvement has been registered in regard to the average annual concentration of the monitored substances.

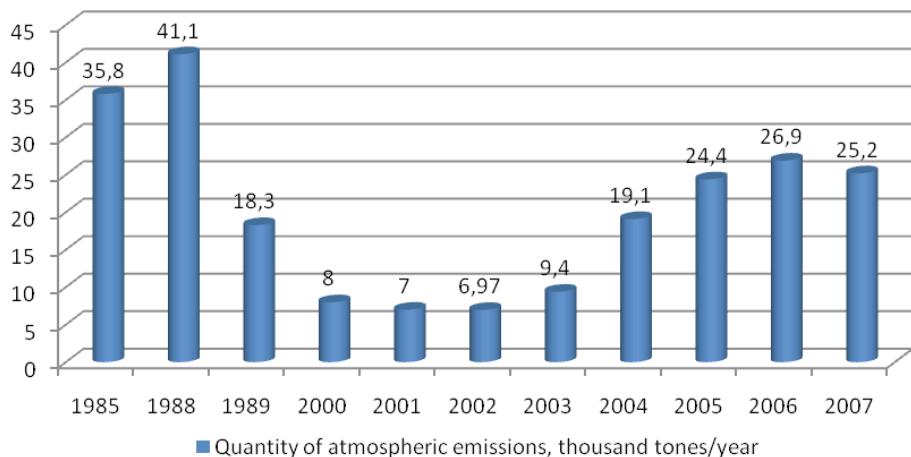
Table 3.1. Results of the monitoring, 2008

Monitored substances, number of monitoring posts (in brackets)	The observed maximum concentrations (mg/m ³) and the numbers on the observation stations (in brackets)	Number of exceedances of the MACs		Average annual concentration (mg/m ³)	MAC (mg/m ³)	
		>1 MAC	>5 MAC		Maximum	Average daily
Dust (1)	-	-	-	0,2	0,5	0,15
Sulfur dioxide (2)	1,19 (2)	874	-	0,52	0,50	0,05
Carbon oxide (2)	5 (1;2)	-	-	2	5	3
Nitrogen dioxide (2)	0,11 (1;2)	124	-	0,04	0,085	0,04

Source: "Information on ambient air situation in settlements for 2008 year", EIMC, Yerevan, 2009, p.5.

Emissions from a permanent source. In the end of 80s, the maximum annual quantity of emissions to the ambient air in Alaverdi was over 41 thousand tones, or the 26% of the emissions from the all stationary sources in the city.

4 The Maximum Allowable Concentration limits for air and water polluting substances are defined by legislation in Armenia.

Diagram 3.1 Dynamics of total annual atmospheric emissions in Alaverdi

Source: Statistical Yearbooks for appropriate years, National Statistical Service of Armenia, Yerevan

In 2007 there were 13 stationary pollution sources, two of which had defined permissible records of pollution quantity; and the total number of emissions from the static pollution sources was 25,2 thousand tones that were completely released into the atmosphere.

Table 3.2 Atmospheric specific emissions by some cities of the Republic, 2007

	Quantity of hazardous substances emitted into atmosphere from stationary sources of emission, t	Atmospheric specific emissions		
		per capita, kg	per square km, kg	per organization, t
Yerevan	2989,9	2,7	13171,4	6,7
Ararat	1776,3	85,8	296050,0	222,0
Alaverdi	25176,2	1573,5	2098016,7	2517,6
Hrazdan	1680,9	31,8	84045,0	98,9
Vanadzor	53,4	0,5	1977,8	1,3
Gyumri	36,8	0,2	736,0	1,0

Source: Environment and natural resources in RA for 2007, National Statistical Service of Armenia, Yerevan, 2008, p.47

99,4% of the emissions into the atmosphere are of sulfur anhydride (25021,4 tones); carbon oxide comprised 0,1% (27,4 tones). The total quantity of the heavy metals in the ambient air was 38,6 tones. The amount of dust released into the

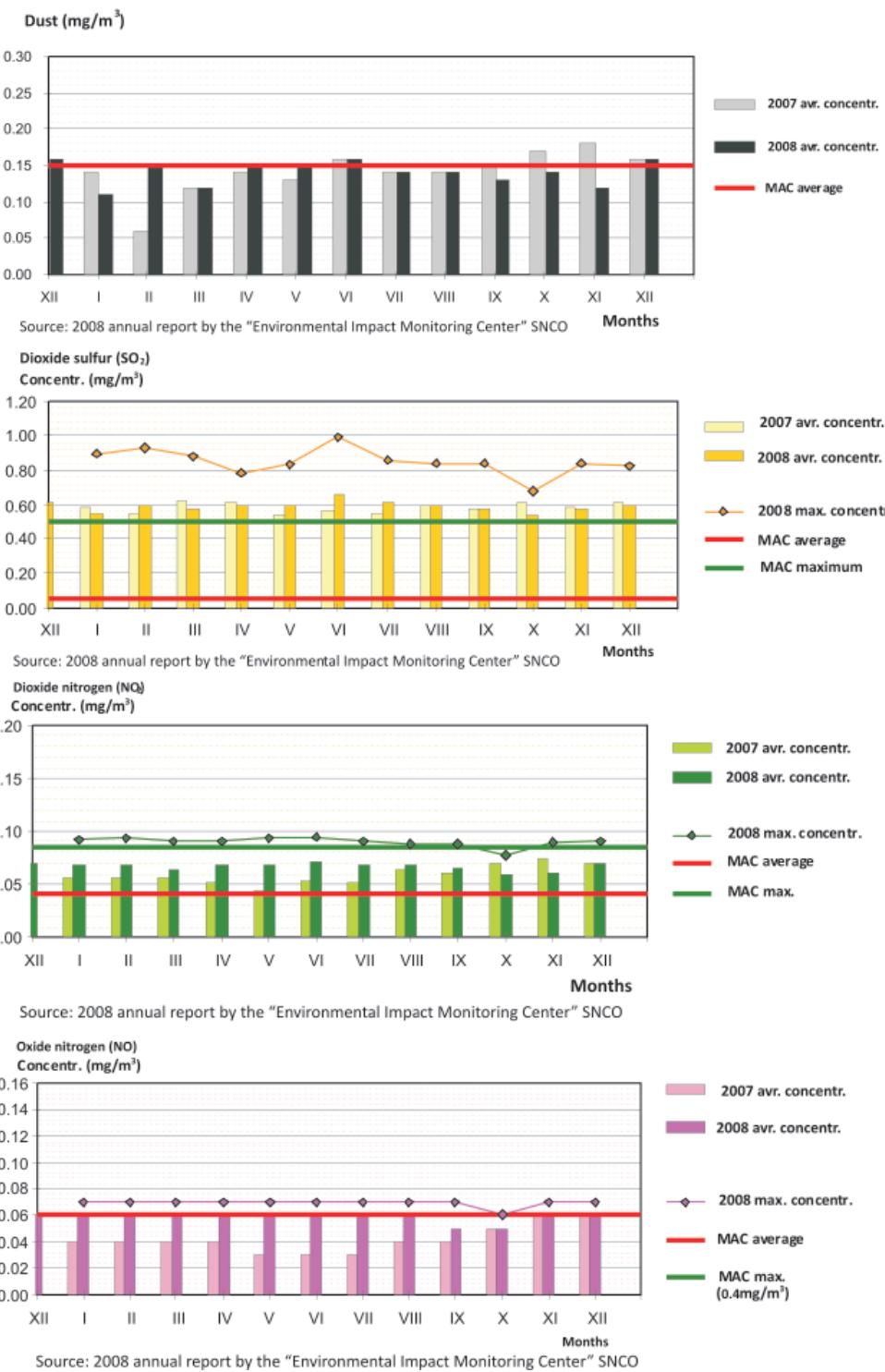
atmosphere was 196,8 tonnes, 4% of which (7t) was the organic dust.

It should be mentioned that there is no pollution prevention systems enacted hence all the substances released from the pollution sources appear in the environment.

The Alaverdi air monitoring laboratory of the Environmental Impact Monitoring Center holds permanent monitoring of air pollution. Only in 2008 the 2 monitoring posts in the city had taken 6286 samples, to decide on dust, sulfur dioxide, nitrogen dioxide and nitrogen oxide.

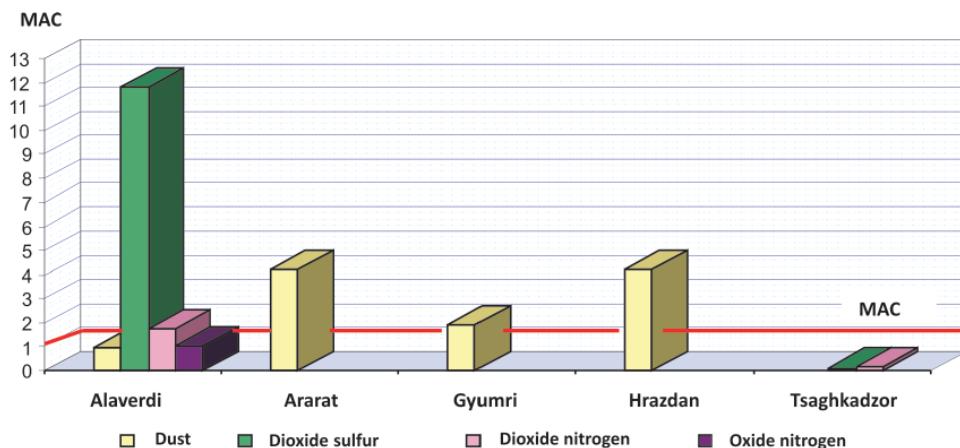
The average annual concentration of sulfur dioxide was observed at high levels, exceeding the maximum allowable concentration (MAC) norms 11,8 times, and 1,7 times for nitrogen. The observed maximal concentration of sulfur dioxide in the 75% of the samples taken has exceeded the MAC 2,0 times. Compared to the previous year, no significant changes in the concentrations of the observed substances have been recorded.

Diagram 3.2 2007-2008 results from the air pollution monitoring in Alaverdi



It is obvious from diagram 3.3 that Alaverdi occupies a special place in terms of air pollution in the Republic, as there is no such exceedance of MACs in other cities.

Diagram 3.3 Comparison to the air pollution levels in several other cities of the Republic, 2008



Source: 2008 annual report by the "Environmental Impact Monitoring Center" SNCO , Yerevan, 2009

One of the most significant air polluting sources in the city is the Armenia Copper Program CJSC, which produces copper and receives the first level of environmental hazard.

The raw material for the metallurgical plant is the copper ore mostly received from the Zangezur copper and molybdenum factory and "Baze Metalls" CJSC. The ore received by railroad is melt in a gas furnace to get the matte and slag. The granulated slag is washed into the sedimentation basin, from where the most part (70-80%) of the water runoff flows back to the production cycle by recycling system and the remaining small part flows to Debed River.

After adding the melted quartz, cold supplements, copper casts (if any) and with insufflations of compressed air to the converter, it is produced a pure copper.

In order to evaluate the spread of sulfur dioxide, as the biggest pollutant of atmospheric air in Alaverdi, in the lower surface layers (up to 250m) a "3D mathematical model" developed by Armenian State Hydrometeorological Agency was used as an alternative method. By the way, it was observed in conditions of weak winds (dead calm or no wind) and by the priority directions, according to the wind rose, defined for the given area by ArmStateHydromet.

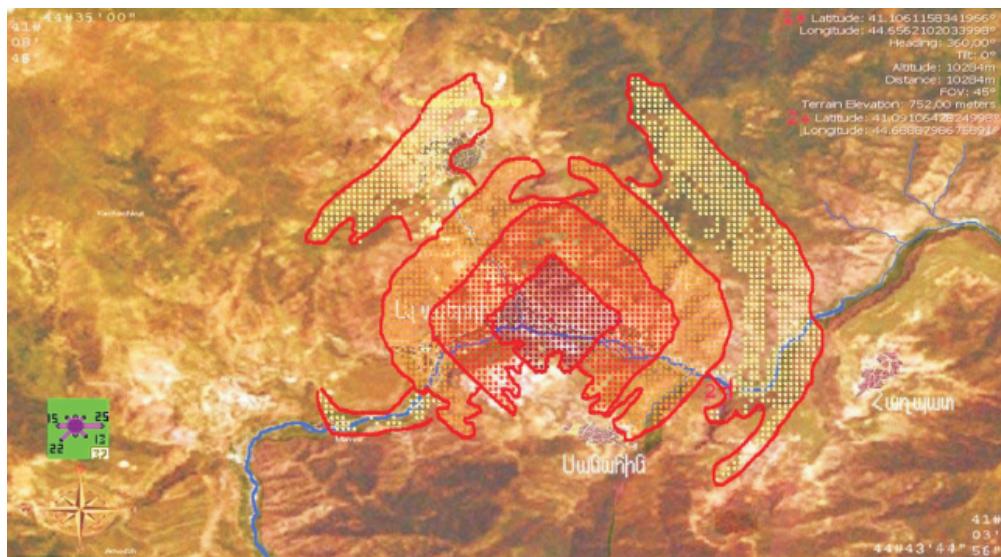
The following empirical values were received by MAC exceeding and wind rose calculations for sulfur dioxide emission zones and the borders thereof:

Table 3.3. Average circumference of spread for sulfur dioxide, m (emission capacity – 434,42 gr/sec. or 15597,6 t/year)

MAC exceedances	The calculated densities within the borders of the zones, mg/c.b. m	Lack of winds /dead calm/	Priority directions of wind, V=5m/sec.			
			East	South-East	South-West	West
1 st zone: At a distance of 90m from the source – 80,6, at a distance of 180m – 30,5, at the border – 1,2 times	0,6	386	454	363	386	499
2 nd zone – up to 0,44 times	0,22	613	840	704	749	885
3 rd zone – up to 0,3 times	0,15	885	1226	931	1067	1294
4 th zone – up to 0,2 times	0,1	1175	1859	1680	1703	1930

The average calculation of ambient air pollution spread in the territory of Alaverdi and the vicinities thereof is clearly presented below, where the 4 pollution zones are shown, as reflected by Table 3.3.

Diagram 3.4: The average calculation of ambient air pollution spread in the territory of Alaverdi and the vicinities thereof⁵



⁵ RA ArmStateHydromet Service, 2006.

Though the diagram proves that Alaverdi is completely within the zone of pollution by the ACP factory, most of the pollution load falls on the territories of communities Evoyan, Engels, Katsotsq and Sarahart. The exceedances of the maximum allowable concentrations in these districts are as follows: in Evoyan and Engels communities (on the right bank of Debed River), and in case of western winds – 4,44 times, in Katsotsq community (on the left bank of Debed River) – 1,35 times, in the North-West of Sarahart community, in case of eastern winds - 1.1 times.

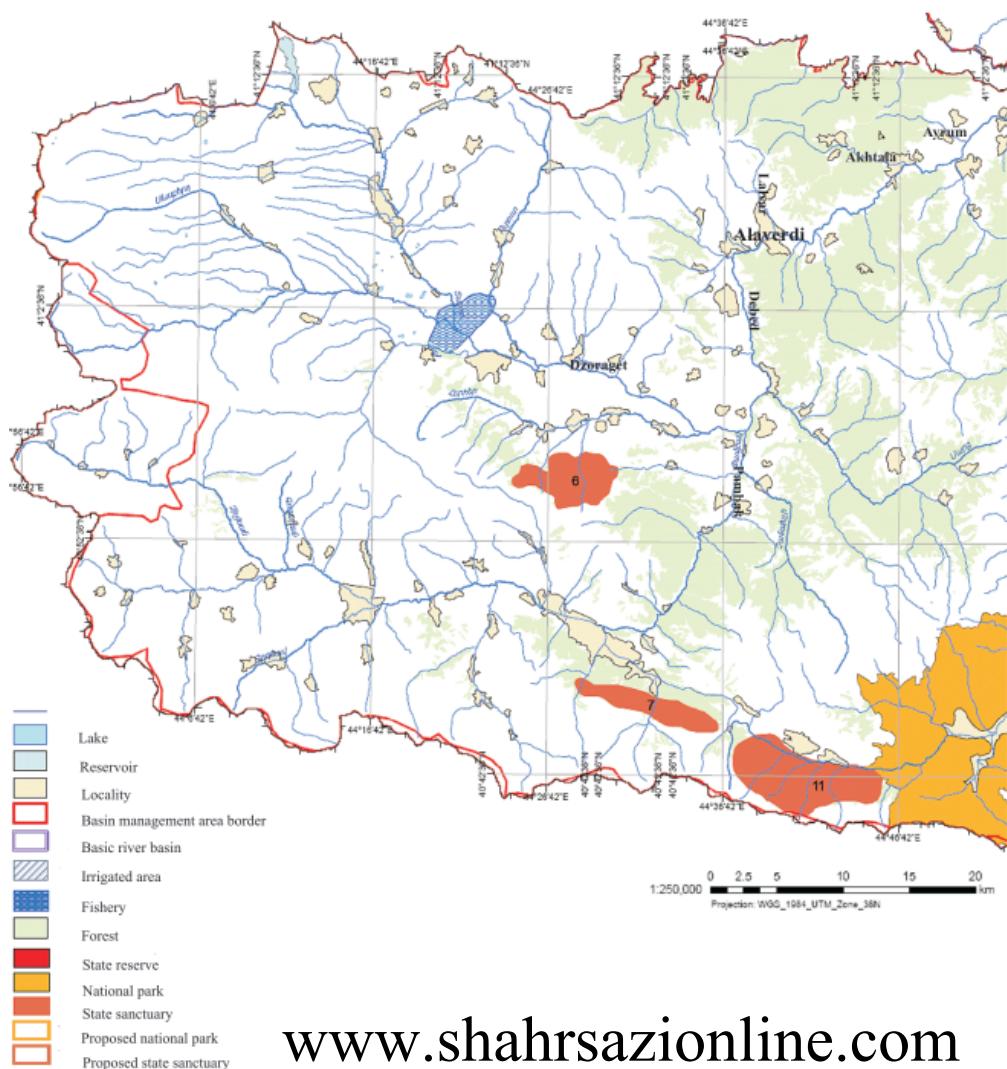
2. Characteristics of the water resources of Alaverdi

The main water resource of the city is the Debed River. It heads from an altitude of 870m, from the point of cross-section of rivers Pambak and Dzoraget, it then flows into Khrami River, in the territory of Georgia. River Debed separates the mountain ridges of Somkheti and Gugarats. Until the point of Ayrum, the river flows through a deep gorge (300-500m), then passes by a lowlands.

The remaining, more low water rivers of the area are mainly the tributaries to Debed, and area characterized by high speed flows and abrupt deviations of the river bed.

The Valley of Debed River has a form of a narrow and deep valley, which relatively expands in the area of Alaverdi. Tributary Lalvar passes through Alaverdi.

Diagram 3.5 Debed River Basin Area



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The regime of the river is characterized by Spring and Fall high waters (120-130 days). The increases in the level of water start in Spring, from April, reach their maximum in May and continue till the first half of June. The river is fed from ground waters, melting and rains.

Debed River basin includes the steep ridges of the gorge, the plateaus of Akori and Sanahin, as well as the lowlands of Lalvar mountain chain. The absolute heights of the river basin are at 720 – 920m, whereas at the tops the altitudes are 960m – 1080m.

The Chatindagh slopes on the right bank of the river are covered by broad-

leaved forests and the forests on the left bank are not dense, spreading only towards the North-Western ridges of Lalvar highlands.

The pollution of the river within the area of the city is mainly because of the discharges of domestic wastewaters into the river, as well as by direct release of solid waste and industrial wastes into the river, and indirect spreading of air pollution. Besides, the inflow of pollution through the Lalvar tributary is also significant. The water in Lalvar would seem clean from the first sight, however, flowing through iron and copper mines and passing closely by ACP factory those waters accumulate significant concentrations of copper, molybdenum and vanadium therein, which directly flow into Debed. That is clearly visible in the point of confluence of Lalvar and Debed rivers, where the colors of the water and the stones in it differs.

It might be mentioned also that Debed is a high-speed and a high-assimilatory capacity river; and the pollution from Alaverdi wastewaters has insignificant impact on the waters thereof. The other cities of the Marz (the administrative territorial unit) and the industries thereof have the largest portion of Debed pollution, because of which the monitoring efforts performed by EIMC in 2008 have recorded quite distressing indicators. Moreover, the 14 gaging stations in the watershed of Debed River are located in a way that the indication of impact from Alaverdi wastewaters solely is not possible in the total pollution load. The Martsiget gaging station is upstream Alaverdi, whereas the two gaging stations upstream and downstream Akhtala and Ayrum. The samples taken in the confluence section of Akhtala and Debed Rivers also reflect the pollution from Akhtala mining plant and city Akhtala, because of which the Akhtala tributary is heavily polluted.

However, the samples taken in 2008 from Pambak, Debed, Dzoraget, Tashir, Martsiget and Akhtala rivers showed exceedances in MACs of ammonium and nitrate ions, BOD_5 , aluminium, vanadium, chrome, manganese, copper, zinc, as well as by the mouth of Akhtala River, in sulphate ion, iron and cadmium.

The samples, taken in 2008 from the mouth of Akhtala, have shown significantly high concentrations of zinc; and the average annual concentration has exceeded the MAC norm 261,9 times.

The samples taken from the watershed of River Debed, were heavily polluted by aluminium; with the average annual concentrations exceeding the defined MACs 10,1-14,5 times (and by 47,9 times in the mouth of River Akhtala).

In areas close to the mouth of Akhtala River high concentrations of manganese have been observed; by exceeding the defined norms 58,9 times.

The area of the mouth of Akhtala River also has high concentrations of copper, by exceeding the permissible norms 30,8 times.

The average annual concentrations of vanadium in the waters of Debed River have exceeded the maximum permissible concentration 2,0-6,0 times, for chrome

- 4,0-9,0 times, for manganese - 1,6-4,8 times, for copper 2,0-9,0 times (as well as 14,0 times in Debed River upstream and downstream Ayrum).

The average annual concentration of nitrite ion in Debed River have exceeded the MPCs 1,5-3,7 times.

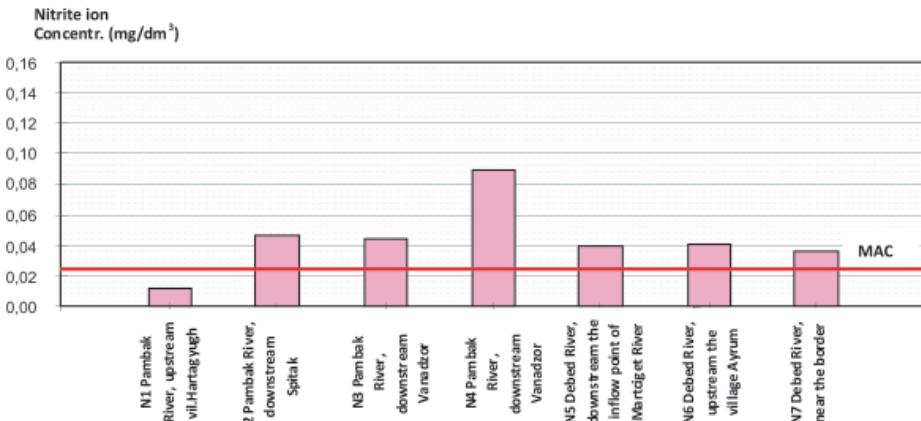
The MPC for zinc have also been exceeded in the Debed River, downstream and upstream Ayrum, 2,3-2,5 times.

The average annual concentration of sulphate ion in the mouth of Akhtala River has exceeded the permissible norm 6,3 times, for iron - 4,4 times, and for cadmium - 4,0 times.

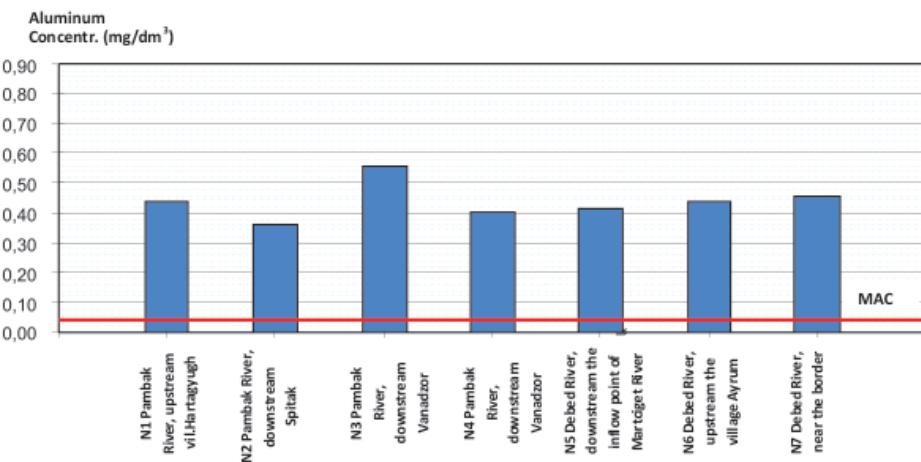
The concentrations for the remaining elements were observed in the limits of normal.

The changes in the average annual monthly concentrations of the elements that have regularly exceeded the maximum permissible norms in the samples taken from Debed River in 2008 are shown in the chart below:

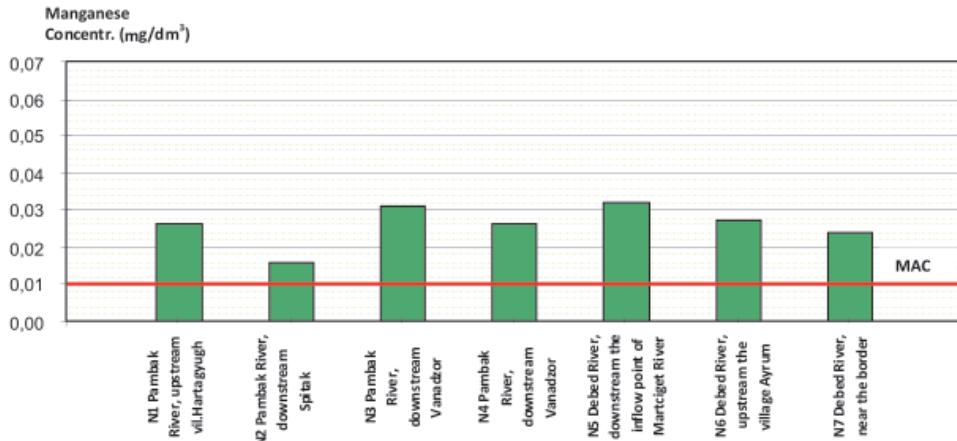
Diagram 3.6. The pollution of Rivers Pambak and Debed, 2008



Source: 2008 annual report by the "Environmental Impact Monitoring Center" SNCO , Yerevan, 2009

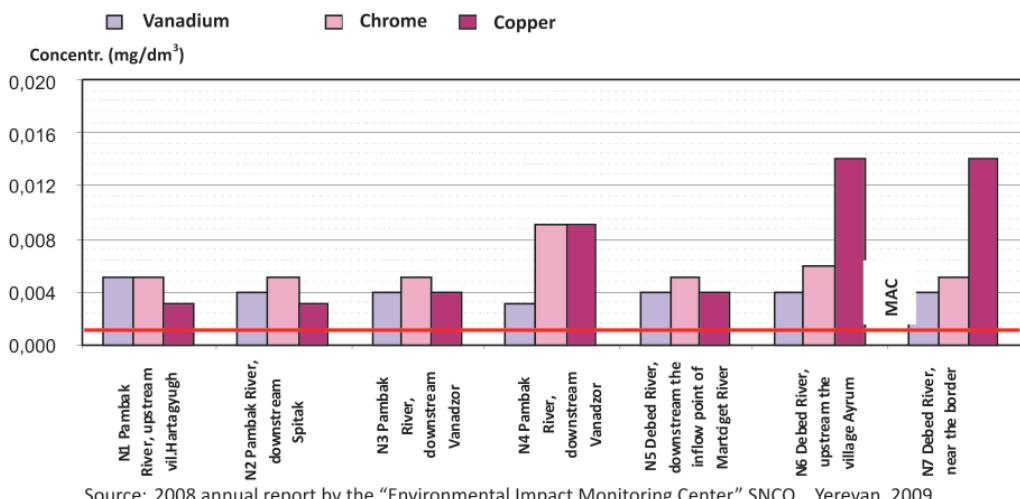


Source: 2008 annual report by the "Environmental Impact Monitoring Center" SNCO , Yerevan, 2009



Source: 2008 annual report by the "Environmental Impact Monitoring Center" SNCO , Yerevan, 2009

Diagram 3.6 (cont.)

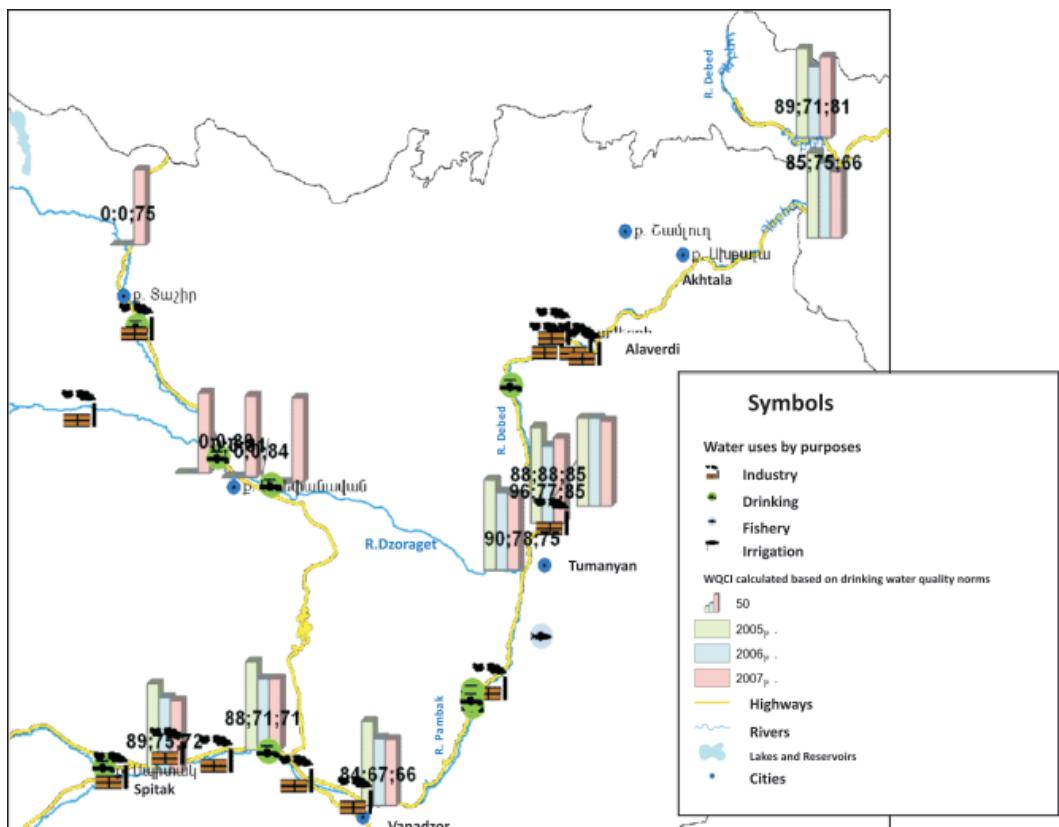


In order to have a more detailed picture on the existing pollution, an attempt was made to assess the full picture of possible changes in the quality of waters in Debed River, based on the data collected from the samples taken by EIMC from the gaging stations. Based on the data of 2005-2007, taken from each gaging station, the Canadian Index was calculated for 31 elements, based on a defined methodology. The index values are within a range of 1-100, and the water quality is classified by five categories. The index values and the water quality classification by the Canadian Index are shown below:

Table 3.4. Water quality classification by Canadian Water Quality Index (CWQI)

Category	Quality	Color	CI value	Water quality description
I	Excellent		95-100	The water quality is well maintained, there is no threat to water quality, the total condition is close to the original
II	Good		80-94	The water quality is well maintained, there are only several slight deviations, the general condition is slightly different from the original.
III	Satisfactory		65-79	The water quality is maintained mainly, there are seldom threats to the quality of water, the general condition is sometimes below the preferable
IV	Poor		45-64	The water quality worsens regularly, the conditions have changed from the original
V	Very Poor		0-44	The water quality is permanently negative, the conditions usually differ from the original

Diagram 3.6 CWQI calculation for Debed River, 2005-2007



As one can see from the calculations, the quality of water in Debed River for the last 3 years has worsened, by changing the general category from “good” to “satisfactory”. Thus, though in the analysis above it was detected the huge pollution of water resources from different sources, however the strong self-purification capacity of rivers allow to become clear after flowing several kilometers. That is why the pollution impact is stronger on the local scale than on regional.

3. Land resources

Alaverdi has poor land resources. The city is located in gorges and valleys formed by Debed canyon, Sanahin lowland and tributaries to Debed.

The canyon has mostly steep or gradual slopes. The plateaus of Odzun, Akori, Sanahin and Haghpat spread in a narrow line, which are clasts of late Plyocene. The depth of the canyon is 250-350m, with partial asymmetries.

The area of Alaverdi has various levels of erosion. Significant clefts and cracks have formed on the surface due to continuous winds.

The canyon differs from the zone of upper plateaus by its climate and vegetation. Rock rise immediately from the river bank and the railroad, fruit gardens stretch along the river banks. Brown forest soils are widespread in lands below 1700m and in dry sunny lands below 2400m, which are characterized by clay contents in the medium layers of the profile, by mechanical clay composition, high levels of humus (4-10%), average absorption capacity (30-44 mg/eqw.), significant carbon contents, sufficient hydrophysical properties /National program against desertification, Yerevan 2002/.

The mountainous mesophile forests develop in the forested gorges and canyons, on carbon brown and black soils. The annual quantity of precipitation reaches 800mm.

On the warmer and humid ridges and in the plateau the feather grass – fescue grass black soil savannas can be observed, the southern slopes of which are reach with mountainous dry plants.

The forests that grow on the South-Eastern ridges of Lalvar have been seriously damaged by erosion caused by sulphur gases from ACP plant. In calm weather sedimentation of hazardous compounds (sulfur compounds) takes place and the surrounding lands are subjected to erosion. It might be mentioned that since 1770 and up to day the operating copper processing plant pollutes the surrounding soils by heavy metals, which have penetrated below the humus layer.

The area of the copper processing plant is 3km in circumference, with high contents of heavy metals throughout the whole territory, the composition of which exceeds the maximum permissible norms 20-40 times (background pollution). The concentrations of copper and lead are even higher (exceeding the norms 32,3 and 16,0 times respectively). Besides all these, the soils are full of other chemical substances (Hg, As, Mo, Ni, Cd, Cr, etc.). These soils are refer to a medium category of hazard, the sanitary index is⁶ 0,85-0,98, the cumulative pollution index⁷ is 16-32.

Arsenic disposal site is of an additional load for the soils. The site is located on a hill by Lalvar River. The upper concrete layer of that disposal site is damaged and some substances transpire into the atmosphere (the upper layer thereof is of yellow-green color), some cattle have access to this place. There is no available funding for constructing a new disposal site, hence there is a necessity to rehabilitate the walls of the existing construction and make it corresponding to the requirements of seismic safety rules, by excluding the runoffs from the site to the water objects, or weathering from the site, or the entrance of people or animals therein.

⁶ Sanitary number is the relationship of the quantity of humus in the soil to the quantity of ammonium and nitrate nitrogen in the soil (mg/kg dry soil).

⁷ Cumulative pollution index is the sum of indexes of polluting chemical substances.

4. Flora

The ridges descending from the Gugarats highlands to the canyon (except for the southern slope) are covered mainly by lime, hornbeam and breadfruit tree forests. The trees grow in low soils, though at high descents. Bushes grow from the land-covered rocks, mainly rosehip, cornelian cherry, Christ's-thorn and average density grass cover. The forests spread from the bottom of the gorge to the heights of 1700-1800m. The dominant tree species of these forests are oak, beech, hornbeams, breadfruit, lime; the bush forests are rich with cornelian cherry, elder grove, hackberry, couch grass.

In the period of 1991-2000, because of energy and economic crisis, the forests of Alaverdi, as well as the forests of the whole Republic were used intensively. Because of lack of any coordination in this process the self-regulation and self-assimilatory capacities, as well as the ecological properties of the forests were disturbed in a territory of thousands of hectares. According to the data provided by several international observers, in the years of energy crisis about 700,000 – 1,000,000m³ of trees were cut in the forests of Armenia every year, 70% of which illegally. Because of lack of any inventory efforts in the forests, the aforementioned data are not approved officially.

62% of the forested areas of the RA are located in the South-East, in the Marzes of Lori and Tavush.

The State reserve of forests in the Marz of Lori is 101835ha, 80867ha of which are forested areas. The forest reserve comprises about 26% of the Marz area. 1463 hectares of forested land belong to Alaverdi, 262,15 of which are bushes. The forests of the region have special soil protective, water protective and climate regulative significance for the area, as well as high socio-economic and scientific value. These areas are rich with various plant species. The lower parts of the forests are rich with a Georgian type of oak, in mix with hornbeam and sibljak population. Because of the gas erosion, the trees of the forest are significantly damaged, with sooner periods of defoliation and low growth rates.

If 10-15 years ago, the population was used to cutting the forests and separate trees around the residential areas, because of the energy and economic crisis, now only beech trees are being intensively cut (about 100-150 years old trees only). The lower and upper borders of the forest are being pressed, and the flora species vanish. Gradually, the traditionally characteristic plants become extinct.

It is important to mention also that there are 23 vanishing species registered in the Red Book, present in these forests, the main reasons for the elimination of which are anthropogenic.

5. Protection of fauna

The energy crisis and the aggravation of the socio-economic conditions

resulted in massive destruction of forests and green areas around the cities and villages of the area, which, in its turn brought elimination of migrating and permanent animal species from the area, because of destruction of the natural habitats thereof.

Taking into account the steep and abrupt landscape of the area, various animal species can be observed in the territory (including both forest and savanna types).

There are 15 animal species in the area that registered in the Armenian and International Red Books: Vormela peregrina, Lutra lutra meridionalis, Felis silvestris caucasica Satunin, Pantera pardus tullianus Valenciennes, Gyps fulvus Hablizi Linneaus, Deyocopus mertius pinetorum Brehm, Corvus corax corax Linneaus, Sylvia misoria misoria Bechstein, Monticola saxatilis saxatilis, Monticola solitarius solitarius Linneaus, Luscinia svecica occidentalis, Remiz pendulinus menzbier Zarudny, Tichodroma muraria, Testudo graeca Linneaus, Elaphe hohenackeri Strauch.

6. Analysis of environmental impacts

The analysis of the condition of the ambient air in Alaverdi shows that the stationary source of air pollution – the copper processing plant, does not have air cleaning equipment, thus the whole volume of emissions are released directly into the open environment. The possible increase in the production of blister copper, or the maintenance of current production volumes, transit of own extraction of ore from company's Drnbon mines (and possibly in future from Teghut's mines), and production of pure copper will not only increase the amount of emissions significantly, but will contribute to formation of a number of other elements therein.

The city does not have a properly (corresponding to the defined requirements) constructed landfill; hence all the accumulated garbage in the city is directly released into the Debed River. As a result, the quality of water in the river has significantly been degraded. The residual of domestic rubbish, which rots and decays, is observed along the banks of the river.

The expansion of the gas supply network in the city, the lack of heating systems has their negative impact on the quality of the atmosphere. The installation of heating systems will bring the emissions to the minimum, and will noticeably reduce the use of alternative energy sources, especially wood, hence contributing to the preservation of the forests (even though the cuttings in the forests are mostly illegal).

The lack of a protective forest cover provides an opportunity for penetration of dust into the city. The active desertification of the city areas and the vicinity contributes thereto.

The bad road communication, with the anticipated increase in the quantity of (permanent and transit) vehicles, the use of low quality fuel, as well as the improper condition of the vehicles will bring to continuous increase in the quantity of polluting emissions into the atmosphere. The insufficient capacity to construct highways for transit vehicles, to avoid them entering the city, assumes development in the technical means for implementing control over the quantity of car emissions.

The physical-geographical location of the city allows very little circulation of airflows and contributes to the accumulation of hazardous emissions, which is well displayed at the figure on proliferation of pollution. Moreover, the relatively high level of humidity in the area, and the high contents of sulfur and other chemical compounds can bring formation of acid rains, thus the reduction of emissions becomes an essential issue.

The existing atmospheric and meteorological conditions can result in respiratory problems, allergies, epidemics (especially, droplet-diffused diseases).

CHAPTER 4. IMPACT OF THE STATE OF THE ENVIRONMENT

1. Impact on the ecosystems

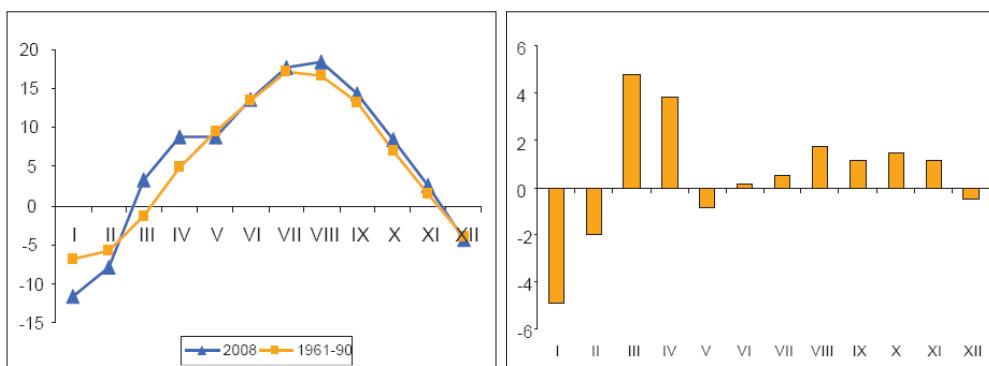
Deforestation, enormous volumes of atmospheric pollution, exceedances in the permissible levels of pollution of soil and water resources finally have their irreversible impact on the ecosystem. The nature always uses protective measures against the anthropogenic impacts. Especially, when the climate of the area has suffered serious changes in the last several years, and thus contributed to increase in the probabilities of hydro-meteorological hazardous phenomena.

Some of the mentioned phenomena in the area of Alaverdi are the mudflows, droughts, heats (torrid), intensive precipitation, frosts, strong winds and ice-rains. The analysis have shown that the frequency of strong winds (over 25m/sec) has increased in relation to the capacity by 18%; the flood rains (20mm or more within 12 hours) have reduced by 12%; the ice-rains (20mm and larger in diameter) have reduced by 17%; and the frequency of frosts (below 0°C during the vegetative season) and heats has not changed.

The data of 2004-2008 shows that the average annual temperature in Alaverdi has been recorded above the norm by 0.7°C⁸ in the period of 1961-1990. The anticipated increase in the average temperature is 1.5-2.0°C, and the precipitation will reduce by 10%. The assessments made by ArmStateHydromet, based on this data, show that in the result the evapotranspiration will increase by 40-80mm annually. Due to this, there will be 8-15% of deficiency of irrigation water in the region, if the current norms on watering are maintained. The soil humidity will decrease by 10-30%, with 25-50mm of increase in the deficiency level. The river flow will be reduced by 15-20%⁹.

Figure 4.1: Average monthly air temperature in 2008 and the deviation thereof from the 1961-1990 norms

a) average monthly air temperature, °C b) deviation from 1961-1990 norms, °C



Source: ArmStateHydromet Service, Yerevan, 2009.

8 Data taken from ArmStateHydromet

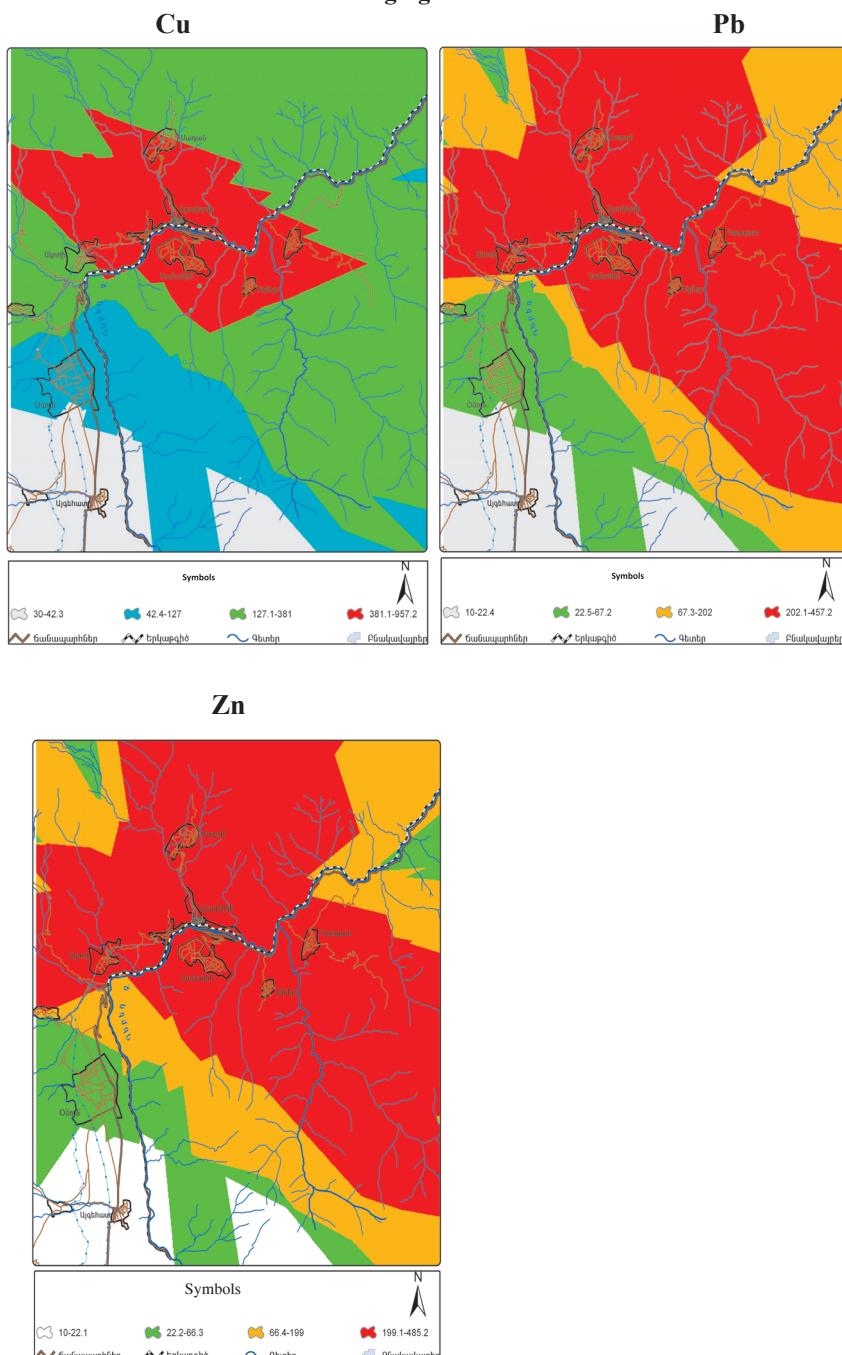
9 "Environment and Natural Resources of Armenia, in 2004", RA NSS, 2004

The threats to biodiversity in the northern part of Armenia are related to the anthropogenic activity. The main endangering processes are the changes in the natural habitat or losses thereof, depleting uses of natural resources, pollution, climate change, hard social conditions of the population, social polarization, poverty, lack of stable alternative sources of income, demographic changes in the population, as a result of which decrease in the number of plant species and population thereof, depletion of ecosystems, loss of groups of fauna and flora species occur. Because of non-planned, random and mass destruction of forests, the natural reproduction processes have been terminated in the forests.

You can find more detailed and complete data on the current conditions of ecosystems of Alaverdi in the Z. Vardanyan 2008 scientific research report on “Bio-ecological assessment of the main flora ecosystems in the northern Armenia”.¹⁰ According to this report, the main impact on the environment comes from the activity of the copper processing plant, managed by ACP company. Moreover, accumulations of mobile and other types of heavy metals (Cu, Pb, Zn) in the soil and the plants, in the result of discharges from the ACP, have brought to several times exceedances of indicators in the territory of the plant and around it. The composition of heavy metals and the proliferation thereof depend on the distance from the source of pollution, the main directions of winds, the landscape of the area and vegetation. The following pollution zones are defined by levels of pollution: maximally polluted (1-1,5km), excessive pollution (2-3km), heavy pollution (3-3,5km and 4-5km), medium pollution (6-10km), weak pollution (11-15km, 16-20km), minimal pollution (21-24km, 25-30km).

¹⁰ Zaruhi Vardanyan: “Bio-ecological assessment of the main vegetative ecosystems of the Northern Armenia”, C.00.05 – briefing of DPhil thesis on “Phytology”, Yerevan, 2009.

**Figure 4.2: Gross total composition of Cu, Pb, Zn in the soils of Alaverdi and its vicinities,
mg/kg scale: 1:80 000**



Source: Zaruhi Vardanyan: “Bio-ecological assessment of the main vegetative ecosystems of the Northern Armenia”, C.00.05 –DPhil thesis on “Phytology”, Yerevan, 2009.

It should be mentioned that the forest cover results in less spread of technogenic wastes, which is also related to the phyto-filtering capacity of the forest. The impact of the split landscape and the forest on the proliferation of the heavy metals is especially noticeable in eastern, southeastern, western, northeastern and southwestern directions, where the annual regularity of winds is low.

Figure 4.3: Proliferation of pollution through ground winds

a) in case of north-eastern winds

b) in case of south-western winds



Source: ArmStateHydromet Service of Armenia, Yerevan, 2006

According to Dr. Z. Vardanyan, the spread of technogenic wastes is possible only through airflows, which pass into the gorge. The inside and outside movement of the ground winds is possible in two directions through the gorge: north-eastern and south-western.

The mentioned is approved by the fact that there is a “technogenic desert” formed at a distance of 4,5km from the plant, in the north-eastern direction. There are no stem plants in the polluted areas, rarely multi-year breadfruit trees happen, the main vegetation is low grass.

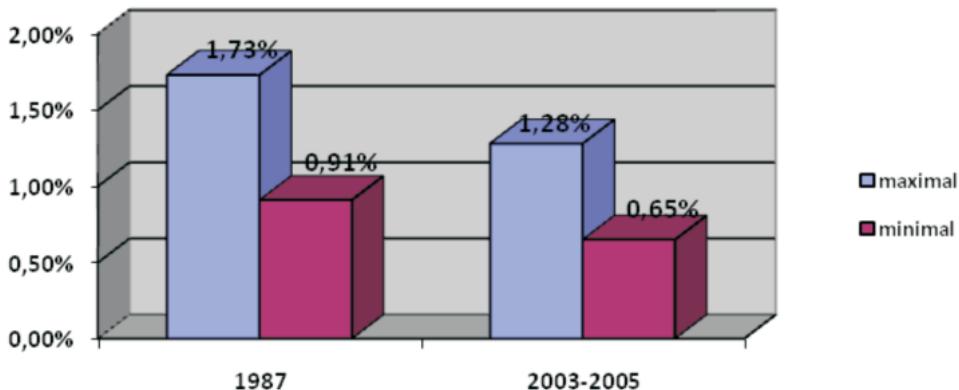
The studies of the absorption capacity of the chemical elements in tree-type bushes showed that in the pollution from the ACP copper processing accumulates in significant quantities in the leaves. Plants located at a distance of 1-3km from the technogenic pollution sources were also subjected to anatomic-structural deformations. Such deformations include small leaves, wrinkles, wrenched leaves, shortening of junctions, changes in the shape of the flower, etc. All the plants studied for background pollution mostly accumulated zinc, copper (in the second place), and then lead. By the way, the composition of copper at a distance of 1–1.5km from the source of pollution, exceeded the background level 22-27,6 times, zinc: 7-9,9 times, and lead: 26,4-39 times¹¹.

Besides the heavy metals, the sulfur gases also have significant impact on trees and bushes. The impact of sulfur gas is observed by changes in the color of the leaves in a number of plants, turning it into dark yellow or dark red. The

11 At the same place, p. 34:

central parts of the leaves, as well as the edges, dry up and look damaged, the leaves become wrinkled.

Diagram 4.4: Maximal and minimal quantities of sulfur in the plants growing in the ACP area in 1987 and in 2003-2005¹²



Although the indicators shown in diagram 4.4 are relatively lower from those of the Soviet period (1987), however, they clearly prove the significant pollution levels in the technogenic zones.

2. Impacts on the quality of life and human health

One of the most important factors that reflect the quality of life is system of social values, which is based on the security and reduction of risks. The safety of human life depends on personal, economic, sustainability and health factors. The security of life is probably one of the primary considerations, as it supposes the relative protection of the population from diseases and epidemics.

The human health factor includes both the physical and mental health. The most important precondition for economic progress is the public health.

In that regard, the analysis of 2004-2008 data from Alaverdi health center gives a quite concerning picture on the condition of health of the urban population.¹³

12 At the same place, p. 35:

13 Doctor Ruzanna Mirzoyan, Coordinator of Alaverdi Aarhus Center.

Table 4.1: Diseases registered in Alaverdi in the period of 2004-2008

#	Type of disease	2004	2008
1	Tumors	70	110
2	Respiratory organs	31	86
3	Nervous diseases	211	446
4	Blood circulation	1127	1398
	<i>including:</i>		
	blood pressure	286	707
	stenocardia	44	94
	disturbances of cerebral blood circulation	76	140
	vascular diseases of limbs	37	76
	other	684	381
5	Dermatological	132	515
6	Infections	21	80

It is worth mentioning, that in 2008 Government increased the subsidies for the some medical services provided in Alaverdi, which contributed to some increase in the number of patients. However, the actual number of patients studied in Alaverdi Health Center in 2004-2008 has increased drastically by 1.5 times. The trends in increase of the number of cases are related to infectious diseases, tumors, respiratory disturbances. The number of nervous diseases has increased significantly, almost twice. It might be mentioned that there is increase in the cases of diseases related to blood circulation. Table 4.1 shows the 2004-2008 statistics of the Alaverdi Health Center.

The impact of the environment on the population of Alaverdi is quite better observed in the analysis performed by the Supervisor of the Republican Oncological Statistical Group of the National Center of Oncology, Doctor P. Poghosyan.¹⁴

The analysis has been performed for the cities of Alaverdi and Gavar. The latter is similar to Alaverdi by its population and territory; however, the difference is that Gavar has never been an industrial center. The population in this city has mainly been busy with agriculture, cattle breeding and organization of leisure on the shores of Lake Sevan. There have been no large industrial facilities in Gavar. In ecological sense the atmosphere in Gavar, the water and soil resources are relatively cleaner, but it lacks forested areas.

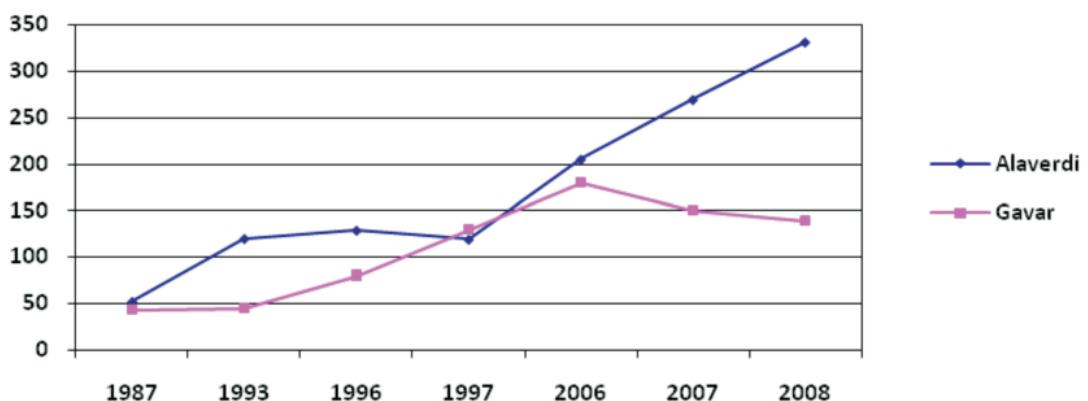
Lung, stomach and throat cancer diseases have been observed in these two cities in 1987, 1993, 1996, 1997, 2006-2008. The selection of the year is conditioned by the period of activity and standstill of the ACP plant (the standstill period was 1989-1996). At the same time, the data has been calculated for cases per 100000 people. The data is presented in Table 4.2, below.

14 The analysis has been made by the request and initiative of the author in 2009.

Table 4.2: Relative comparison of malignant tumor morbidity levels in the RA cities of Gavar and Alaverdi by years and by cases per 100000 people

Name of the disease	Years of observation													
	1987		1993		1996		1997		2006		2007			
	Alaverdi	Gavar	Alaverdi	Gavar	Alaverdi	Gavar	Alaverdi	Gavar	Alaverdi	Gavar	Alaverdi	Gavar		
Lung Cr	7,4	2,8	20	17,5	20,6	21,7	36,2	29,5	23,8	38,3	35,9	15,4	120,5	7,7
Stomach Cr	3,7	0	12	14,5	10,3	0	15,5	7,4	0	7,6	59,9	15,4	24	0
Throat Cr	0	0	12	0	0	7,2	0	0	0	0	6	0	0	0
<i>All types together</i>	<i>52</i>	<i>42,8</i>	<i>120</i>	<i>43,7</i>	<i>128,8</i>	<i>79,7</i>	<i>119,1</i>	<i>129,1</i>	<i>250</i>	<i>180</i>	<i>269,4</i>	<i>150</i>	<i>331,3</i>	<i>139,5</i>

According to MD P. Poghosyan, the most probable type of cancer that originates because of sulfur dioxide pollution is the lung cancer, as the concentrations of lead, zinc, copper, molybdenum, arsenic, iron, manganese, nickel, vanadium, chrome, cadmium and fluoride in the soil and water resources (the environment) of the area contribute to the origination of such diseases. These elements penetrate into the human body by food, water and air and serve as the agents of diseases. The stomach and the throat are more resistible organs, thus the cases of cancer thereof are rare.

Diagram 4.4: Dynamics of cancer cases in Alaverdi and Gavar cities

The diagram 4.4 shows that the tendency of sickness with cancer diseases in Alaverdi increases drastically. It could be added to the above mentioned only that

the patients with cancer in Armenia usually live shorter lives, because of lack of effective treatment infrastructures, properly qualified medical staff and necessary medicines.

The level of pollution in the area is one of the factors contributing to the bad quality of life. The increase in the level of welfare in the population and the poverty reduction remain the most urgent and the highest priority issues for the Government of the Republic of Armenia, so defined by “Sustainable Development Program”, approved by RA Government decision 1207-N, dated 30th of October 2008, and by the Medium-Term Expenditure Program.

Table 4.3: Poverty trends in the RA Marzes in the periods of 1998/99, 2005-2007, %

Marz/Region	1998/1999	2005		2006		2007	
	Poverty level	Poverty level	of which very poor	Poverty level	of which very poor	Poverty level	of which very poor
Yerevan	58,4	23,9	3,6	21,0	3,5	20,0	3,2
Aragatsotn	60,5	32,3	3,1	27,5	2,6	22,2	3,0
Ararat	52,3	30,9	7,4	27,0	5,5	25,5	3,5
Armavir	41,7	31,6	3,8	30,8	3,4	30,7	3,8
Gegharqunik	49,9	36,8	2,9	29,8	2,6	29,6	2,5
Lori	62,6	28,8	5,8	27,0	5,5	26,8	3,6
Kotayq	61,7	34,5	8,7	32,0	8,1	30,0	6,1
Shirak	75,8	42,5	4,3	37,3	3,7	32,1	6,0
Syunik	53,1	28,9	2,3	25,3	2,1	24,0	3,7
Vayots Dzor	34,7	19,2	1,8	11,4	1,3	13,7	2,3
Tavush	29,3	25,8	3,8	23,5	3,3	21,6	3,3
Average per country	56,1	29,8	4,6	26,5	4,1	25,0	3,8

Source: “Social-economic development program of the Lori marz of the Republic of Armenia for 2009-2012”, final draft, Vanadzor 2009

The total program of policy measures within the Sustainable Development Program includes the priority actions throughout the whole Republic, which are basically related to the enforcement of sustainable economic growth, equal regional development, improvements in public management, including: fight against corruption, and to the development of human resources. Almost all of the mentioned factors are present in the RA Lori Marz, because of which the poverty issues in the Marz are tenser.

The results of the investigation “Vulnerable population in the Marzes”,

performed in the framework of Marz development program, in 2005, showed that the level of social vulnerability of the population in Lori Marz (35,5) is lower by 1,1% from the total level of social vulnerability in the Republic.

Table 4.4: Representation of vulnerable groups in the Marzes of RA (2005)

	Representation of vulnerable groups in Lori Marz, % from the total population of the Marz								
	Disabled, including children	Orphans	Lonely elders	Unemployed	Elders	Large families	Refugees	Allowances	Vulnerability index
Lori Marz	5,1	3,9	9,6	19,1	11,6	9,0	5,8	29,4	35,5
Yerevan	4,4	2,1	9,8	25,0	12,9	4,9	4,6	9,2	31,7
Total in the RA	4,2	3,2	10,1	24,2	12,2	12,3	7,2	17,3	36,6

Source: "Social-economic development program of the Lori marz of the Republic of Armenia for 2009-2012", final draft, Vanadzor 2009

Even though the vulnerability index in Lori is lower than the total for the Republic, however Lori comes second after Shirak by the number of allowances, the reason for which is the location of the latter in the disaster (earthquake) zone.

Even though there are improvements in some indicators, the comparison of the data from the Marz to the average data from the Republic shows the general negative demographic condition of the Marz: in terms of continuous decrease in the number of the population, overall aging in the population groups, lower labor capacities and payment rates.

In Tumanyan region, the population of which comprises 16,1% from the whole population of the Marz, and which includes four urban (Alaverdi, Tumanyan, Akhtala and Shamlukh) and 27 rural communities, the work of the mining and metallurgical facilities has the most significant impacts on the levels of poverty and social vulnerability. For the last 4-5 years (till the world financial crisis of 2009), the slight reduction of the poverty levels in the Tumanyan community occurred because of opening of 700 vacancies in the Alaverdi ACP and Akhtala metallurgical facilities. The four urban communities of the area were formed mainly around these large industries, thus the existence thereof depends on the proper activity of those industries.

Table 4.5: Demographic changes in the 5-year period, in Lori Marz, and in average for the Republic

#		2004	2005	2006	2007	2008
1	<i>Population of Lori (thousand people)</i>	283,9	283,4	282,7	282,0	281,8
2	Family allowances	27950	25349	24920	24453	22818
3	Relative comparison of the family allowance receivers to the total number of the population	0,098	0,089	0,088	0,087	0,081
4	Welfare (thousand people)	56,5	55,1	54,3	53,4	53,0
5	Relative comparison of the welfare receivers to the total number of the population	0,199	0,194	0,192	0,189	0,188
1	Natural growth (per thousand people)	2,30	1,90	1,40	0,80	1,56
4	Growth rates compared to the previous year (%)		82,6	73,7	57,1	195,0
5	Average monthly salary rate	35662	42818	47974	60640	71182
1	<i>RA population total (thousand people)</i>	3215,8	3219,2	3222,9	3230,1	3238,4
2	Family allowances	171002	146726	139670	136917	129414
3	Relative comparison of the family allowance receivers to the total number of the population	0,053	0,046	0,043	0,042	0,040
4	Welfare (thousand people)	540,3	533,2	527,5	522,7	523,8
5	Relative comparison of the welfare receivers to the total number of the population	0,168	0,166	0,164	0,162	0,162
1	Natural growth (per thousand people)	3,7	3,5	3,2	4,1	4,3
4	Growth rates compared to the previous year (%)		94,6	91,4	128,1	104,9
5	Average monthly salary rate	43430	52062	64166	77776	91539
1	Growth rate compared to the previous year (%)		119,9	123,2	121,2	117,7

Source: "Social-economic development program of the Lori marz of the Republic of Armenia for 2009-2012", final draft, Vanadzor 2009.

More than half of the rural communities of the region have almost 500 residents and are located far from Alaverdi and the center of the Marz – Vanadzor. The main poverty factor in these rural communities is the under developed infrastructure and the distance from the urban areas. Another factor that contributes to the poverty levels of the area is the large number of villages with population less than 500 people, where the low availability of educational and health related services is low because of the same weakly developed infrastructures.

Besides the fact that the region is well-known for its industrial capacities, the agriculture has also been developed here: the 24% of the whole number of cattle and 25% of agricultural cultivated lands in the Marz are in Alaverdi. Due to the dislocation and spread of the rural communities of the region from the highland zones (Atan, Ahnidzor, Shamut) to zones of sub-tropical climate (Alaverdi, Neghots, Shnogh, Qarkop, Chochkan), all the directions of the agriculture develop equally, including the cattle breeding, horticultures, tobacco production and grapes. Due to this the percentage of use of agricultural lands in the area is quite high (85%).

For Tumanyan region, the factors contributing to the poverty are as follows:

- high dependence of the social activity of urban communities from the large industrial facilities (in case if the activity of the latter is terminated, the whole population of Alaverdi, Akhtala and Shamlukh will become unemployed),
- Unfavorable environmental condition,
- Under developed infrastructures in rural communities with population less than 500 people, especially the obsolete and destroyed conditions of the local roads.

3. Vulnerability to natural and technogenic disasters

The flood rains in Alaverdi are usual. Before such levels of precipitation, resulting in sludge runoff from the highlands, snow-melt had significant harms to the city by flooding certain sections thereof. Taking into account the continuously existing hazards from the flood rains, a number of storm sewers and water collection systems were constructed in the city in 1970:

1. Khudyakov street storm sewer - 1973, length – 925,0m, width 2,2m, depth 2,2m.
2. Jravazan street storm sewer - 1978, length - 975,5m, width -1,8m, depth - 1,6m.
3. Debed district storm sewer - 1970, length - 310,0m, width - 1,8m, depth - 1,6m.
4. Baghramyan district storm sewer - 1975, length - 345,0m, width - 2,4m, depth - 2,0–2,6m.

5. The district of Tparani Dzor, doesn't have any mudflow runoff collection system, there is an urgent need to construct a runoff canal.

In 2004 the Municipality, in cooperation with the NGOs of the sector, organized and implemented the cleaning of the runoff canals in the districts of Baghramyan and Engels; and in 2006, according to the RA law on “Earmarking and targeted use of environmental fees paid by the industries”, the State Budget has allocated financial means, in a form of a subsidy, to the Municipality of Alaverdi, to partially rehabilitate the runoff canals in the districts of Jravazan, Debed and Khudyakov, within the framework of “Commercial Public Works” project.

The runoff canals, even after their cleaning, get polluted by domestic rubbish, construction and other wastes very quickly, which is a result of low level of environmental education of the population, lack of a landfill and improper control. As a result, there is a regular necessity to clean the runoff canals, but there is no sufficient funding allocated for it. Hence, the risk of flooding is permanently present in the city. For example, just recently, on the 16-17th of June 2009, the flood rains and ice-rains in Alaverdi have blocked the runoff canals of the city, the mudflows dropped 4 trees and the roads were covered with sludge.

CHAPTER 5. POLICY INTERVENTIONS AND INSTRUMENTS

1. The authorities of environmental management in the local self-government

The policy and the legislation of the environmental (nature protection) sector of Armenia were mainly formed and improved for the last 15 years. According to Article 10 of the RA Constitution, the State shall provide for the protection and restoration of the environment, as well as the reasonable use of natural resources. Armenia actively participates in the processes on international cooperation, has signed and ratified a number of international and European conventions, with the protocols emanating thereof.

In the framework of those international agreements and conventions, Armenia aims at reduction and elimination of negative impacts on the human health and the environment, eliminate the extended levels of air pollution, alleviate the negative consequences of global climate change, protect biodiversity, provide for the necessary volumes of renewable natural resources and enforce conditions contributing to natural balance, ensure reasonable and efficient use of non-renewable natural resources.

The issues of protection and management of the environment and the natural resources of the Republic of Armenia, exist in a certain extent also in Lori Marz. Those are: effective management of forests, collection of domestic wastes and management of hazardous industrial wastes, efficient management, use of water resources, prevention of soil degradation, reduction of anthropogenic factors contributing to desertification, restoration and efficient use of meadows.

During the last several years, in the process of improving the legislative framework, significant volume of work has been done for the solution of the mentioned issues: e.g. a number of strategically important legal acts and programs have been adopted. Some of them are: the Forest Code (2005) and the RA National Program of Forests (2005), the RA Law “On National Water Policy and Principles” (2005), the RA Law “On Wastes” (2004), the RA Law on “Protected Areas” (2006), the RA Law “On Environmental Control” (2005), the RA Law “On Substances Depleting the Ozone Layer” (2006), the RA Law “On the National Water Program” (2006), the RA Law “On Hunting and Maintenance of Hunting Economies” (2007), etc.

The environmental legislation has envisaged a certain framework of actions for the Marz Administration. According to Point 1.20 of the RA Presidential Decree NH-728, dated 6th of May 1997, “On Public Management in the Marzes of the Republic of Armenia”, the Marzpet (Governor or Community Leader) shall implement the following actions in the sectors of nature protection and environmental management:

- participate in the development of State programs on nature protection and environmental management, and provides for the implementation of those programs in the territory of the Marz and in the framework of his authorities,
- control the implementation of the environmental legislation in the territory of the Marz and informs the respective agencies on the cases of violations thereof,
- support the protection and use of preserves, wildlife areas and protected areas, as well as the implementation of measures against poaching, illegal fishing and deforestation,
- cooperate with environmental NGOs and citizens.

The local self-government bodies also have authorities of environmental protection. The RA Law “On Local Self-Government” adopted in 1996 and terminated in 2002, as well as the other water related legal acts adopted by the RA in 2001, did not include provisions that would grant the respective communities with necessary authorities, liabilities or responsibilities. However, this situation was improved afterwards. According to Article 32 of the new law on LSG, the community leader obtains the authority to manage the environmental cadastre of the community, in accordance with the law or with a Government decision pertaining thereto. According to Article 45 of the same law, the following obligatory and state assigned additional authorities shall be practiced in the sectors of environmental management and nature protection, concerning lands, forests and waters owned by the community:

- control in the sector of nature protection, organization of measures related to subsoils, forests, water and air resources, as well as use and protection of flora and fauna;
- protection of lands from erosion, floods, swamping, pollution by chemical, radioactive or industrial wastes,

The environmental sector of Lori also has an institutional structure. The following agencies of the Marz administration have environment related authorities:

- Department of Agriculture and Nature Protection of the RA Lori Marz Administration;
- Lori Branch of the State Environmental Inspectorate of the RA Ministry of Nature Protection;
- Forest economies of the Marz, which act within the structure of the RA Ministry of Agriculture;
- Environmental NGOs, Vanadzor and Alaverdi Aarhus Centers.

Are the existing capacities sufficient for the solution of the mentioned environmental issues? Compared to the other Marzes, the number of civil servants in the Department of Agriculture and Nature Protection of the Lori Marzpetaran is the biggest. However, only two members of the personnel from that department really deal with environmental issues. At the same time, the Marz has several serious environmental challenges, one of which is the development of a regional environmental program for Rivers Debed and Khrami, as well as the protection of forests, programs on production of copper in Alaverdi and Akhtala and Vanadzor chemical plant. It is natural that the two civil servants will be able to effectively solve the mentioned issues.

It will be necessary also to have the remaining five members of the staff, who are in charge of soil protection, pass training sessions. The Marz of Lori experiences also financial problems. There have been two funds established in the Marz for the solution of the mentioned issues (one of which is for the elimination of emergency consequences). These funds have been successfully established and active for the last five years. Actions are being taken for enhancing the funding sources and involvement of new stakeholders. The TACIS program has supported the Marz of Lori in establishment of proper Marz-Community, Community-Community and Community-Civil Society relations, the clear progress of which has been reported. Nevertheless, the relations between the mentioned instances are weak.

In reality, the cooperation between the Marzes has resulted in solution of several important issues. The water resources of Lori, Shirak and Tavush marzes are interconnected, thus the cooperation among the Marzpetarans is essential for effective solution of water related issues. The Marzes of Lori and Tavush use the same river – Debed. The water sources mainly originate in Lori Marz and flow towards the Marz of Tavush. The Water Resources Management Agency is in charge of managing the water resources. However, the neighboring Marzes do not find coordinated solutions to the water management issues at stake.

The forests located in the regions of Noyemberyan, Ijevan and Tumanyan of the Marzes of Lori and Tavush, are essentially considered as one large forest, which is divided by administrative borders only. For that reason, it would be more comfortable to have the Marzpetarans of Lori, Tavush and Kotayk (located in the South) cooperate in the solution of issues related to the forests.

The Marz of Lori is not special for its environmental and institutional issues; the other Marzes experience the same difficulties.

2. Agencies with authorities of environmental management in Alaverdi

The system of environmental management of Alaverdi includes the following sub-sectors: water quality and wastewater management, air quality and air

pollution control, waste management (industrial solid wastes and hazardous wastes). By the help of an EIA the environmental control is implemented towards the new industrial (or acting industrial projects). The purpose of the integrated program is to harmonize the standards and coordinate the processes of licensing, monitoring and legal compliance.

The tables 5.1-5.5 describe the legal authorities of various organizations in the given sector and in the framework of the EIA program. There is a difference between the main regulatory role (expressed as ●) and the secondary regulatory role (expressed as ○). The main regulatory role generally includes the following authorities: definition of norms, issuance of permits (licenses), compliance monitoring and application of sanctions in cases of non-compliance. The secondary regulator authorities perform all the remaining, e.g. provision of opinions, conclusions, definition of additional requirements, etc.

Exhibit 5.1 Air Quality and Pollution Control						
	SHAEI	SEI	MNP	EE	EIMC	MA
Standards						
Ambient	●	○	●		○	
Emissions		●	●			
Control		●	●			
Noise	●		○	○		
Licensing						
Operation	○		●	●		○
Emit air pollutants	○		●			○
Monitoring						
Ambient air quality	○				●	○
Stack emissions		●				○
Indoor air quality	●					○
Enforcement	●	●				○

Key: ● - Lead responsibility; ○ - Support responsibility

SHAEI – State Hygiene and Anti-Epidemiology Inspectorate under the Ministry of Health; SEI – State Environmental Inspectorate; MNP – Ministry of Nature Protection (include functions of structural subdivisions only); EE – “Environmental Expertise” state non-commercial organization; EIMC – “Environmental Impact Monitoring Center” SNCO; MA – Municipality of Alaverdi.

	SHAEI	SEI	MNP	WRMA, BMOs	EE	EIMC	HGMC	MA
Standards								
Groundwater			●	○				
Surface water			●	○				
Drinking	●		○	○	○			
Control		●	○	○				
Licensing				●	○		○	○
Water use permits		○						
Monitoring								
Groundwater quality				○				
Surface water quality		○		○				
Drinking water	●			○		●		○
Enforcement	●	●		○				○

SHAEI – State Hygiene and Anti-Epidemiology Inspectorate under the Ministry of Health; SEI – State Environmental Inspectorate; MNP – Ministry of Nature Protection (include functions of structural subdivisions only); WRMA, BMOs – Water Resources Management Agency with its Basin Management Organizations; EE – “Environmental Expertise” state non-commercial organization; EIMC – “Environmental Impact Monitoring Center” SNCO; HGMC – “Hydro-Geological Monitoring Center” SNCO; MA – Municipality of Alaverdi. Marz – Marzpetaran, Territorial administration unit, Governor’s office; Gov. – Government of Armenia within established Interdepartmental Commission.

	SHAEI	SEI	MNP	EE	Marz	MA	Gov.
Standards							
Substances	○		●	○			
Controls	○		●	○			
Transportation	○		●	○			
TSD facilities*	○		●	○			
Licensing							
Handling/transport.	○		○	○	○		●
Treatment facilities	○		○	○	○		●
Disposal facilities	○		○	○	○		●
Monitoring							
Generation	○				○	○	
TSD facilities*	○	●			○	○	
Storage site	○	●			○	○	
Enforcement	●	●			●	○	

Key: ● - Lead responsibility; ○ - Support responsibility

* Treatment, storage and disposal

	MNP	SHAEI	SEI	Marz	MA
Standards					
GTR*	●	●			
Landfills	●	●			
Licensing					
Removal					●
Landfills	○	○		●	
Monitoring					
Cadastre	●			●	○
Landfills	●	●		○	○
Enforcement		●	●	●	○

Key: ● - Lead responsibility; ○ - Support responsibility

* GTR – Waste Generation, Treatment and Recycling

SHAEI – State Hygiene and Anti-Epidemiology Inspectorate under the Ministry of Health; SEI – State Environmental Inspectorate; MNP – Ministry of Nature Protection (include functions of structural subdivisions only); MA – Municipality of Alaverdi; Marz – Marzpetaran, Territorial administration unit, Governor's office.

	EE	MNP	SEI	MA
Standards				
Applicable projects	●	●		●
Licensing				
Review of EIA	●	○		●
Approval of EIA	○	●		●
Operation		●		○
Enforcement			●	○

Key: ● - Lead responsibility; ○ - Support responsibility

SEI – State Environmental Inspectorate; MNP – Ministry of Nature Protection (include functions of structural subdivisions only); EE – “Environmental Expertise” state non-commercial organization; MA – Municipality of Alaverdi.

3. Environmental programs and tools used by Alaverdi Municipality

In order to ensure effective actions, in the conditions of economic and socio-cultural developments and changes, the real potential of Alaverdi community is weakly demonstrated in the legal framework and state policies. At the same time, it is hard to over evaluate the important role and significance of the community and the local self-government bodies, within the framework of environmental issues. It is important to mention that Alaverdi community plays a double role from the point of environmental programs. About 30% of the population of Alaverdi is farmers, i.e. main and direct users of the natural resources, as well as those who contribute to the origin of anthropogenic impacts in the environment. Moreover, staying in direct dependence on the natural resources, the rural population immediately feels the environmental impact on their income and on public health.

Ignorance of the need for special authorities and capacities of the local self-government bodies, in the newly formed socio-economic and legal conditions, can become a factor contributing to the degradation of the environment. The present legislation has envisaged limited authorities and capacities for the Municipality of Alaverdi. Those authorities are mainly of declarative nature, as the city does not have the necessary financial means or sources of funding to implement the defined tasks. Besides, the municipality also does not have skilled and qualified human resources; hence, they do not have a complete picture on the nature of the environmental problems.

There is no organized system of training for the staff of the municipality, even though some work has been carried out in that direction, especially through involvement of international organizations, the social investment fund, NGOs and the Public School of Management. The training programs mostly include sessions for the management and financial staff of the municipality. The main subjects discussed at the training sessions are the community budget and the development of the three-year program.

The solution of environmental issues of Alaverdi in such conditions would require higher level of environmental education and awareness among the municipality officials, so that the latter is able to find solutions thereto, within the framework of their authorities.

It might also be mentioned that certain funding has been earmarked from the State Budget in form of subsidies to Alaverdi Community, since 2005, for the solution of health and environmental issues, in accordance with the RA Law “On Targeted Use of Environmental Fees”. The allocations made in the period of 2005-2007 were not significant, comprising 20-30 million AMD. Some of the programs implemented by that funding were: establishment of green playgrounds for children, provision of additional food to the vulnerable groups,

construction of a medical aid unit in Akner rural community, construction of a lavatory by Sanahin monastery, asphalt coverage, rehabilitation of waterways, etc. Starting from 2008 the amount of subsidies significantly increased. In 2008 the Government provided a sum of 68,226 million AMD, in 2009 - 103,564 million AMD; and for 2010 it is planning to provide 140.93 million AMD from the State Budget.

All the programs developed thereafter have not been based on the results of complex environmental impact assessment in the area of Alaverdi community. Though the programs funded contributed to the improvement of the situation in general, the programs recommended by the municipality of Alaverdi did not emanate from one complex strategic objective. In January 2009, the Alaverdi Council of Elders approved the four year (2009-2012) socio-economic development program, which plans the implementation of 27 large development projects within that 4-year period. Some projects were related to cleaning of Alaverdi streets, waste collection, purchase of necessary equipment for the service of communication lines, provision of additional food to the children in primary educational institutions by using the environmental fees, organization of tree planting activity in the community area, cleaning and rehabilitation of runoff canals in the districts of Debed and Jravazan, rehabilitation of water supply and wastewater collection network of the community, reconstruction of the landfill for the solid domestic wastes or construction of a new landfill. Though it is clear that it is hard to solve all the existing issues by the limited funding, it is known also that the implemented programs do not include solutions related to pollution of ambient air, wastewater treatment, prevention of soil pollution and other urgent environmental problems.

The community of Alaverdi has sufficient political will and readiness to start the implementation of the planned environmental programs. The current legislation already envisages (or does not prohibit) a number of coordination tasks. Thus, the staff of the municipality must have the necessary knowledge and play an active role in the process of decision-making related to the environmental protection:

The authorities of Alaverdi Municipality can include the following:

- ***Issuance of permits and further update***
– Organize public hearings for the programs to be implemented in Alaverdi, analyze and consider all the comments and recommendations received and present the program to the RA Ministry of Nature Protection. Any influence on the processes of issuing permits for the implementation of programs related to Alaverdi community will provide for more effective and objective decisions by the management.
- ***Monitoring of nature use companies with pollution permits*** – implementation of compliance monitoring, guidelines for the permit

holders on implementation of self-monitoring, maintain the statistics of data on environmental impact assessment, cooperate with authorized bodies to hold regular and emergency inspections at industrial facilities, inventory the results of the inspections, identify any single violation of permit conditions and inform the authorized bodies thereon, for preparation of the necessary notifications.

- ***Application of sanctions*** – review the reports of companies on the elimination of violations of the norms after the preparation of the notification by the controlling entity, decide whether the company has or has not performed actions aimed at elimination of the mentioned violations, and present the necessary information to the respective entities, process all the complaints related to the application of sanctions and refer them to the RA Ministry of Nature Protection, for further revocation of the permit for a period till the sanction is applied.

CHAPTER 6. FUTURE PERSPECTIVES

The impact on human health, economy, flora and fauna of Alaverdi increases daily. By nature and significance the pollution of Alaverdi impact the ecological system of the whole South-Caucasian region, first of all because of the transboundary Debed River passes through Alaverdi, secondly, because of the forests of Alaverdi stretch towards Georgia and Azerbaijan by comprising one general ecosystem.

Alaverdi has been facing two choices for a long time: economic development at the expense of destroying the environment and reduction in the quality of life, or establish the healthy environment, but remain in hard social-economic conditions. The contrasting of the two does not bring to any acceptable solution yet. It is clear, however, that the maintenance of the current environmental situation in the future can be destructive for the community.

For the purpose of perspective development of the city, the Program of “GEO-Alaverdi” in the period of April-May 2009 formed a group of technical experts, represented by main stakeholders and known in the region environmental and local government experts. This group had to discuss issues pertaining to the perspective development.

During the discussion held on May 1, 2009 the technical group developed the perspective development scenarios for Alaverdi. Taking into account the opinions and recommendations expressed by the working group, this chapter will discuss the inertia trend, the worst trend and the best trend scenarios for the perspective development of Alaverdi. These scenarios were developed with the assumption that the management of ACP does not yet find an alternative solution to the current technological process for treating the discharges from the plant and avoid harming the environment. It means that if the plant continues to act then the pollution levels are not reduced and the plant must be closed to avoid current damages caused to the environment.

1. The inertia trend

Description of the situation: Based on the results of analyses in the previous chapters, it could be stated that the community of Alaverdi currently represents a zone of ecological disaster. It was observed decrease in the population, multiple exceedances of pollution concentrations in the ambient air, pollution of soils with heavy metals, continuous aggravation of processes at a huge disposal of arsenic, pollution of vegetation by heavy metals, decrease of forested areas, lack of landfills, direct discharge of untreated wastewaters into Debed River, increase in morbidity levels for cancer and other diseases. All these terrible conditions have irreversible impact on the environment and the natural habitats.

It might be mentioned also that the biggest cause in having the current terrible environmental condition of Alaverdi belongs to the ACP copper processing plant. The pollution of ambient air mostly occurs from the activity of this plant. However, the same plant contributes to the economic development of the community by giving jobs to the residents and by indirectly contributing to establishment and development of satellite companies.

The programs implemented by the RA Government, the Marzpetaran of Lori and by the Municipality of Alaverdi have weak impact on the solution of the existing problems.

Consequences, in case of the inertia trend is maintained:

- a) taking into consideration the demographic data of 1989-2009, the number of the population in the coming 20 years will decrease by 40% and comprise 10000 people,
- b) the forested areas of Alaverdi will be reduced by 20% and the existing vegetation will be toxic,
- c) the climate of the area will change; the temperature will rise by $0,5^{\circ}\text{C}$, which will result in lower water quantities,
- d) the quality of agricultural products will fall, the agricultural areas will diminish, because of pollution of soils by heavy metals and erosion,
- e) the frequency of epidemics will increase,
- f) about half a million USD will be provided from the State Budget annually in a form of subsidy, for implementation of various programs, however those programs will not provide for significant improvements in the quality of life, as the pollution will continue with the environmental degradation.

2. The worst trend

Description of the situation: The worst scenario would be if the ACP, identified as the biggest polluter continues working and expands the volumes of production, and no practical measures are taken for eliminating the threats to the environment in the city.

This situation could bring to the unforeseen **consequences**. The population will be subjected to occurrence of genovariation. The present biodiversity will be lost. The climatic and geographical conditions of the city will change. The city will become a disaster zone, the rehabilitation of which will require significant funding and decades of time.

3. The best trend

Description of the situation: The stakeholders and experts discussion on the best trend scenario for Alaverdi came to the two possible alternatives that could bring to the best scenario of development.

Case 1: The ACP's management finds a technological solution to the air pollution issue and make investment to install new technology. In this case the plant continues work without causing damage to the environment and human health. In this case Alaverdi city will remain as developed industrial center with many satellite companies assisting ACP activities and with appropriate high employment rate.

Case 2: The ACP's management doesn't find a technological solution to the air pollution issue, which means that the plant should be closed

Only in that case the city will avoid this enormous load of pollution and start restoring the environmental conditions.

In that case, the optimistic scenario supposes the following:

- a) The remediation measures for the plant is clearly designed and planned by the Government,
- b) The Government program addresses the risk of worsening the social-economic situation and increase of unemployment by about 400 people. There is a provision in the Government program for creation of temporary job places and simultaneous retraining,
- c) The Government program consist provision on alternative possibilities of economic development.

Consequently, the area of the plant is conserved in a proper way. The Government invests in and contributes to the development of tourism in the city and possible local scale agriculture. Development of manufacture industries is enforced; investments are made in constructing a factory for processing of agricultural products. Incentives are created for the development of small and medium enterprises in the city. In this regard the best perspective is the activation of the railroad communication between Georgia and Armenia, which will contribute to the development of trade and tourism in the city.

The municipality approves the long-term health and environmental strategy, which is developed based on detailed studies and investigations, held by experts.

All the normative sanitary criteria are satisfied in the territory of the city, especially the establishment of a proper landfill and construction of a waste processing plant. A chemical, biological and physical waste treatment plant is constructed in accordance with the requirements of the modern technologies.

The water supply and wastewater collection network of the city has completely been rehabilitated; the losses are within the range of normal.

The medical facilities of the city are reconstructed, furnished and equipped with modern treatment means.

The arsenic burial in Madan has been properly conserved, and the upper layers of the soil thereof have been recultivated. The banks and the bed of Debed River are cleaned from solid domestic wastes. The general view and architecture of the

city have been improved.

The forested areas of the city are restored, overall landscape gardening of the public areas of the city is performed, recreation zones established. The Aarhus environmental center works actively and the NGOs regularly organize events aimed at improvement of ecological education and awareness of the public.

According to the draft program on socio-economic development of Lori Marz, the solution of priority issues in Alaverdi will require about 2 billion AMD.

Table 6.1: Funding necessary for the solution of priority issues in Alaverdi

Issues by priority	Amount necessary million AMD
1. Rehabilitation of roofs of multi-apartment buildings of the community	177,60
2. Rehabilitation of community roads	105,00
3. Reconstruction of the existing solid waste landfill or construction of a new one	170,00
4. Repair of the water supply and wastewater collection networks	1480,00
5. Cleaning and rehabilitation of the runoff canal in the Jravazan district of Alaverdi	15,00
6. Maintenance and improvement of the street lighting system of the community	8,00
7. Organization of tree planting activity in the community	8,00
8. Provision of gas supply to public general and cultural facilities	1,80
9. Construction of playgrounds in the community	7,02
10. Rehabilitation of the building of the art school after A. Papoyan	80,00
Total	1972,42

Table 6.1 shows that e.g. the construction of wastewater treatment plant (which will require about 2,5 million dollars of investment, by some calculations) is not a priority. The issue of reconstruction and recultivation of Madan burial is not included either.

According to some initial forecasting, the implementation of the BEST scenario will require an initial 20 million USD investment in Alaverdi community. This investment will have a boosting effect and will be reimbursed in the short-term.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

The economic and environmental issues of Alaverdi are closely interconnected. The justified analysis of these issues and the implementation of a uniform complex program of measures will result in improved coexistence of the economic and environmental realities of the Marz. Some of the most important preconditions are the construction of the wastewater treatment plant, construction of the landfill and re-equipment of the mining industry by modern technologies, which will reduce the levels of pollution in the city.

In order to improve and restore the disturbed environmental and ecological balances it will be necessary to focus the attention on the following measures, aimed at the development of the socio-economic conditions of the city:

- ❖ Urgently define the case of urban development under the best trend scenario. If there is no technological solution to normalize the pollution from ACP plant, then develop the exact and detailed program on remediation and alternative job places creation measures.
- ❖ Increase the level of awareness and participation of the municipality on environmental issues and possible solutions thereto, mainly through organization of training sessions.
- ❖ The public participation in environmental decision-making can serve as a perfect tool for the proper implementation of the environmental policy. Such participation can be organized according to the Aarhus convention, to which Armenia is a party. In this regard, it will be necessary to contribute to active participation of the stakeholder organizations in the solution of environmental issues of the city.
- ❖ The development of tourism and eco-tourism will contribute to the protection of the ecosystems in and around the city.
- ❖ Involve the educational facilities, public schools, the environmental NGOs and the Environmental Information Center of Alaverdi (Aarhus Center) in provision of environmental education.
- ❖ Implement measures aimed at prevention of erosion and landslides, improvement of ameliorative conditions and restoration of lands (recultivation).
- ❖ Establish control over the implementation of agricultural rules in cultivation areas, for preserving the soils from erosion, washing and mudflows; create soil protection layers of forest.
- ❖ It is necessary to enforce the installation of safe, wasteless and resource saving technologies. The municipality, in cooperation with the Marzpetaran and the Government, can request, for example, all the large industrial companies of the city to obtain ISO14001, which will reduce the levels of pollution.

- ❖ One of the urgent issues is the implementation of programs related to recultivation of abandoned mines and burials, which is aimed at preventing environmental pollution, restoration of the ecosystems and saving the health of the population.
- ❖ The industries and manufacturing plants must refrain from exceeding the defined concentration norms and implement all the required ecological measures.
- ❖ Installation of treatment and filtering stations at industrial facilities and planting of certain types of trees, depending on the impact area.
- ❖ Add and establish new plantings in the territory of the city, organize further maintenance of those areas.
- ❖ As the design of the treatment plant and its construction will require a lot of time and large investments, it will be necessary to implement certain measures to prevent the pollution of the water basin, especially by solid wastes.
- ❖ Because of inactivity of the biochemical and chemical treatment plants, the existence of closed water circulation cycles inside the industries becomes necessary, otherwise new local treatment plants must be constructed, or the existing ones rehabilitated.

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