CHILDREN'S HEALTH CHALLENGES CAUSED BY ENVIRONMENTAL DEGRADATION AND CLIMATE CHANGE AND MAIN PROPOSED SOLUTION APPROACHES[1]

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The article summarizes and analyzes both official and independent current experimental data on the state of the environment in the Republic of Armenia in order to identify the most disadvantaged areas and the possible impact of degraded ecosystems on the health of the population, especially children. The obtained results show that the most risk-relevant zones are mining areas contaminated with heavy metals, which exert rather negative impact on human health, in particular, children's health. Some recommendations for improving the situation are presented.

Keywords: environment in Republic of Armenia, climate change, children health, disasters, mining, heavy metals in soil, water, food.

INTRODUCTION

Currently, numerous and comprehensive extensive studies resulted in the following conclusion made by the International Scientific Society in conjunction with the World Health Organization: the health of the population generally depends on the following factors:

1. *Ecology* (up to 20%);
2. *Socio-economic factors* (up to 50%);
3. *Genetics* (up to 20%);
4. *State of healthcare services* (up to 10%) [1-3].

Meanwhile, it is also obvious that these relationships are typical for "standard" situations, hence, if any of the factors is severely deteriorated, the impact/weight of this factor significantly increases. Accordingly, it is quite natural that, if the contribution of relevant environmental factors is estimated to be 20% in industrially advanced countries, the impact of those factors on population health is estimated to reach 42% in developing countries. [1-3]. By the same logic, it is evident that in some cases the lack/deficiency of healthcare services, poverty, hereditary traits, frequent natural and technological disasters, etc. may become crucial.

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Consequently, in recent decades, a special importance has been given to the characterization of the impact of climate change, increasing disaster risks, environmental pollution, degradation of ecosystems, etc. on human health. Measures

have been taken aimed to studying, preventing and reducing the consequences of the above phenomena. Special attention is paid to adaptation to these factors, to this end, research studies are being conducted on children, as highly important and at the same time the most vulnerable group of population.

It is difficult to overestimate the importance of such research for the Republic of Armenia (RA), as a mountainous country with a complex relief, characterized by its numerous and comprehensive ecological issues associated with current extreme climatic phenomena and with the increase of various disaster risks (Fig. 1).

Fig. 1. Republic of Armenia map: Yerevan city and 11 Marzes (The term "marz" means region) [4].

1. ANALYSIS OF MANIFESTATIONS OF CLIMATE CHANGE AND DISASTER RISK IN RA

The results of numerous studies show that considerable increase in air temperature level has been observed in Armenia during last 80 years. Moreover, according to the Third National Communication [5] on Climate Change of RA, in 1935-1996, the average annual temperature increased by 0,4°C, in 1935-2007 – by 0,85°C, and in 1935-2012 - by already 1,03°C.

Likewise, a significant increase was observed in the last decades, in RA, as well as in the whole world, regarding the number of dangerous meteorological phenomena (DMPH), economy damage, as well as the number of victims. The DMPHs (hail, frost, strong wind, heavy precipitations, floods, drought, heat waves) may foster the occurrence/magnification of the following disasters: landslides (Fig. 2), avalanches, mudflows (Fig. 3), forest fires, rock falls, spread of infectious diseases, etc. in RA [5-9].

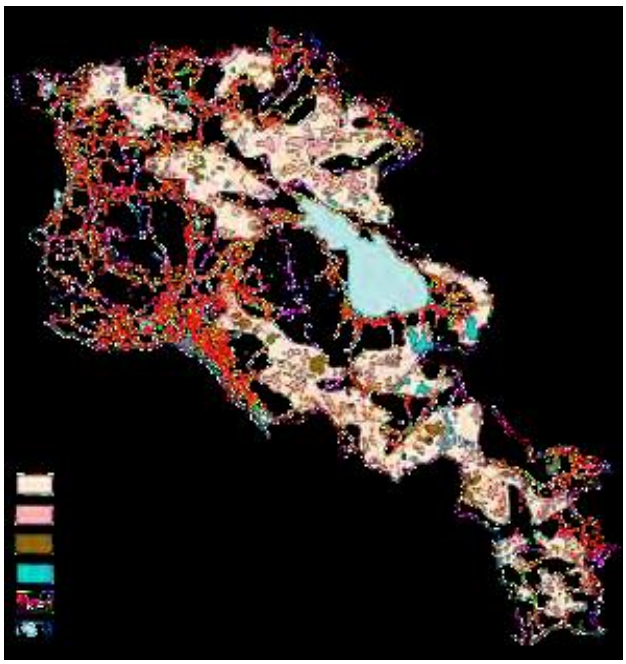

Fig. 2. Spatial location of Armenian settlements and infrastructures with regard to landslide hazard zone [5].

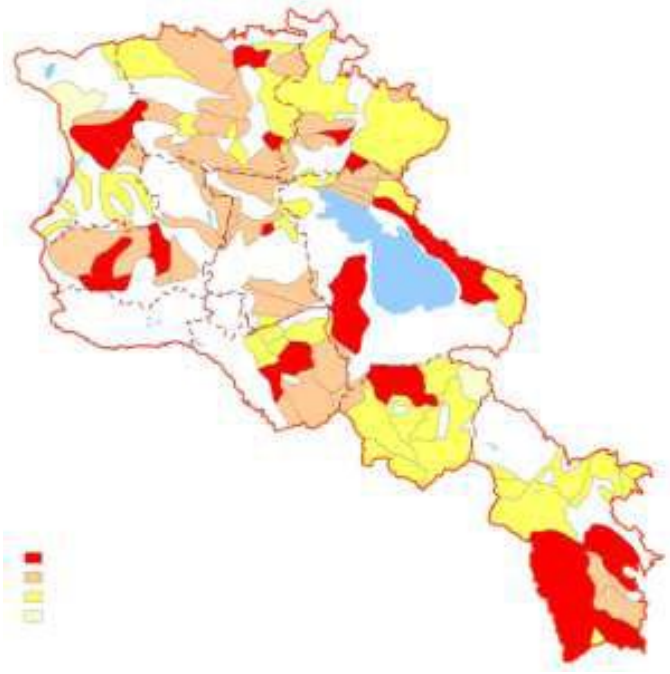

Fig. 3. Mudflow zones of Armenia according to recurrence of the phenomenon [5].

According to the results of the climate change vulnerability index, the vulnerability of the territory of the Republic of Armenia is rather high (the comparison has been made taking into account the region of Eastern Europe, Caucasus, Central Asia (Fig. 4).

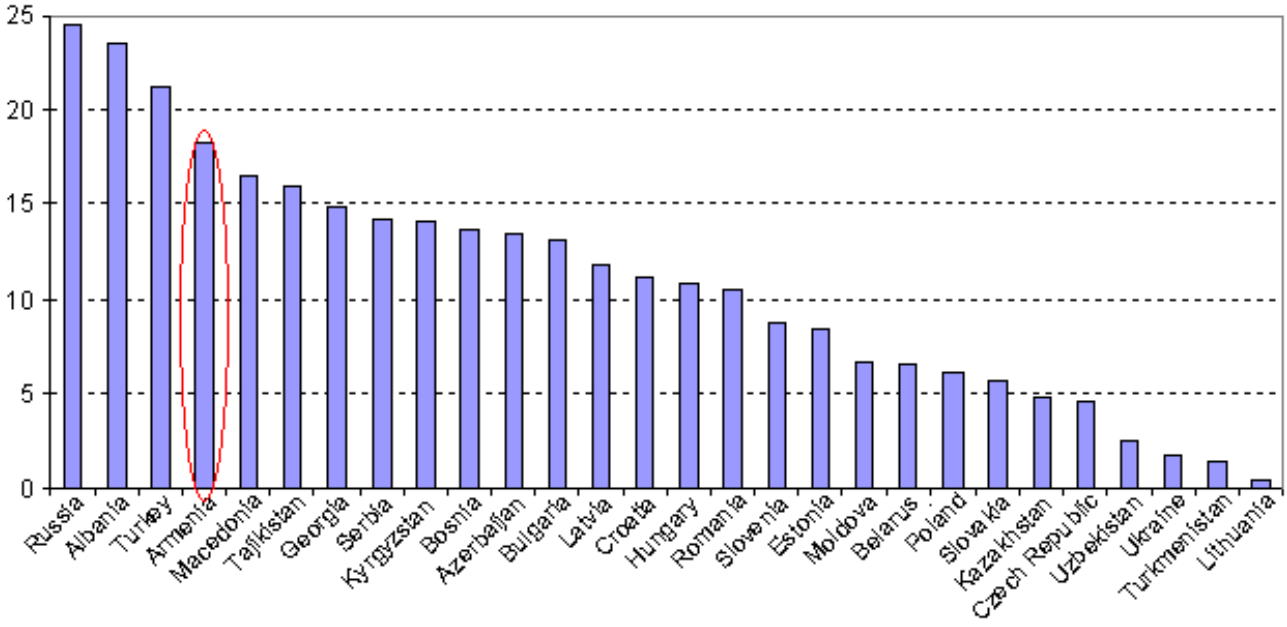

Fig. 4. Climate change vulnerability index ECA for in the region of Eastern Europe, Caucasus, Central Asia [10].

According to generalized estimates, approximately 110 types of hazards from the world-known natural hazards list, are specific for Armenia (the most important ones referring to the RA natural disasters are presented in Table 1). It is explained by the fact that Armenia is a country with complex relief, steep mountain ranges, valleys and extremely fragmented territory. Natural disasters cause greatest damage to agriculture, moreover, 46% of the total land area of the country accounts for agricultural fund. During the last two decades, the droughts had reduced the production of grain by 35%, potato – 35%, vegetable crop – 16%. In 1998-2010, the total loss of agricultural gross domestic product accounted to 2,8 billion, and annual losses reached 250 million USD at an average [5, 9-18].

As far as natural disasters are concerned, more risky Marzes (Regions) are Aragatsotn, Lori, Gegharkunik, Syunik, and concerning technological disasters, more risky zones are Yerevan, Lori, Kotayk, and Syunik. Additionally, it is worth mentioning that according to the Third National Communication on RA Climate Change [5], high vulnerability for natural DMPHs is characteristic also to Armavir and Kotayk Marzes.

Table 1. Number of natural disasters registered in RA by types, 2009-2015 [4]

	2009	2010	2011	2012	2013	2014	2015
Strong wind, storm, hurricane, tornado, dust storm	55	45	29	38	48	114	95
Thunderstorm, lightening	2	3	4	9	4	3	9
Hail	58	32	53	41	33	44	24
Heavy rain	30	19	17	15	7	12	6
Landslide	9	19	12	6	6	7	3
Mudflow	19	13	10	4	2	-	-
Heavy snowfalls, gale, snowstorm	7	19	41	81	77	64	39
Glaze	-	-	-	-	-	96	76
Avalanche	-	-	-	1	-	-	-
Forest fire	2	21	5	26	4	17	15
Frostbite in vegetative stage	2	-	-	-	3	-	-
Overflowing of rivers and flood	37	29	39	4	8	7	10
Landfall	3	15	8	2	9	11	11
Rockfall	5	11	5	19	32	48	52
Earthquake	170	150	222	179	72	76	82
Groundwater rise	-	7	-	1	-	-	-
Total	**399**	**383**	**445**	**426**	**305**	**499**	**413**

2. ECOLOGICAL SITUATION ANALYSIS OF RA ENVIRONMENT (NATURAL AND ARTIFICIAL ECOSYSTEM DAMAGE HAZARDS)

Water resources

Annual volume of water resources in the Republic of Armenia equals to 8.5 billion m^3 (in per capita terms, it is a rather small value as compared to the most countries of the world), including about 7,1 billion m^3 of water balance, 3 billion m^3 of which are ground waters. Overall 9480 small and medium-sized rivers flow in the territory of the Republic, with the total length of 23000 km, all of which are the streams of the large rivers of South Caucasus - Aras (a river bordering with Turkey) and Kura.

As it follows from monitoring data [4, 19], the waters of the following rivers and one reservoir are characterized by the 5th class of pollution:

- Debed river *(downstream from Vanadzor city),*
- Akhuryan river *(downstream from Gyumri city),*
- Hrazdan river *(downstream from Hrazdan city and in the river mouth),*
- Voghji river *(downstream from Kapan city),*
- Aghstev river *(downstream from Dilijan city),*
- Yerevan Lake.

However, it should be noted that the studies are rather limited and may not describe the situation completely. This gap is filled by a series of target studies. For example, the research studies of almost all the rivers/streams of Syunik Marz [20] showed their contamination by toxic mining residues and heavy metals.

Land resources

The land fund of the Republic accounts for of 2 974 259 ha, of which only 0,15% is a land mostly suitable for agriculture. Almost 47% of land surface is occupied by oblique and steep slopes. The soil cover is extremely diverse with the following zones to be classified as semi-deserts (236 thousand ha), dry steppe (242 thousand ha), steppe (797 thousand ha), forest (712 thousand ha), mountain-meadow (629 thousand ha). The map below presents the most common 7 types of RA soils (Fig. 5) [12, 21, 22].

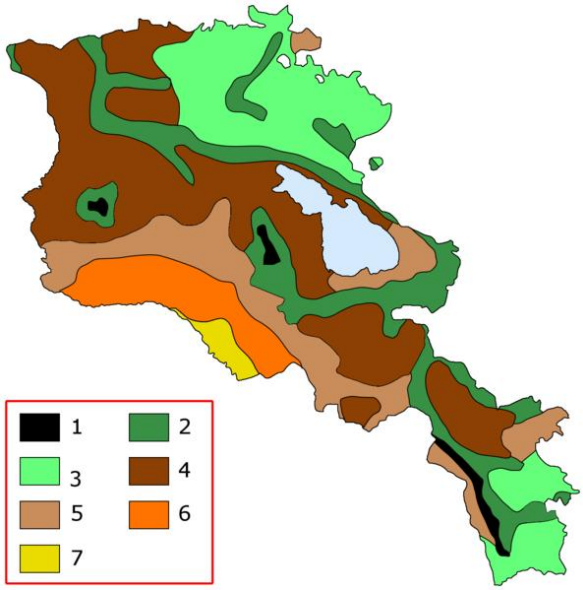

Fig. 5. The most common types of RA soils: high-mountain simple soil (1), mountain-meadow soil (2), mountain-forest soil (3), steppe soil (4), brown soil (5), drab soil (6), grey soil (7) [12, 21].

In total, about 45% of the Armenian soils are exposed to different levels of erosion, the reasons of which are overgrazing, landslides, deforestation, earthquakes and other factors. About 10% of the Ararat plain soils are subjected to secondary salinization. Because of irrational exploitation and climate change observed in recent years, about 86,5% of all the lands in the Republic are subjected to varying degrees of desertification. The lands disturbed in the result of metal and non-metal mineral extraction are located in more than 660 areas. The sources of soil contamination are the following: mining industry, processing industry, chemical industry, construction, transport, agriculture, municipal economy, etc. [12, 21, 22].

Wastes

Annually, an average of 47 mln tons of industrial wastes are being generated in the country, of which only 1,3% is involved in economic turnover, which proves the imperfection of waste management system.

An additional serious problem is the toxic wastes accumulated in a number of polygons. Mainly in a suburb of Yerevan, in a landslide zone is located a waste dump

which stores about 512 tonnes of toxic chemicals of 60 names (mainly obsolete pesticides), and in the suburb of Alaverdi-city, in the hillock near Lalvar river, there is a toxic waste dump containing arsenic compounds. Both dumps are not properly isolated from the environment and are very dangerous. Currently, measures are sought to neutralize those wastes and other accumulated toxic wastes (12 polygons/landfills are currently being investigated).

In average, 2500 thousand cubic meters of solid domestic wastes (SDW) are being generated in RA annually, which are mainly buried in polygons and only 0,3% is involved in economic turnover. Currently, SDW differentiating and reprocessing process is being initiated.

Radioactive wastes of Armenian Atomic Power Plant (with weak and average radioactivity) are buried in the temporary underground storage belonging to APP.

In the territory of the Republic**,** about 570 mines of metal and non-metal ***useful minerals*** have been discovered. Almost all metals used by people are available in the Earth's crust, most part of the revealed mines are polymetallic. Currently, the following metals are being extracted: iron, copper, molybdenum, lead, and zinc, with a small amount of rare and scattered metals. Mining wastes are stored in 21 tailing dumps, which are apparently a serious threat for the environment, and hence, for human health. At present time, measures are being taken to use tailing dumps as technological mines, which may have a significant useful ecological and environmental impact [4, 12, 21-23].

Ecological research studies and their results

A series of detailed research studies on the soil and water pollution with heavy metals has been carried out by various scientific-research institutions of RA.

The urgent necessity of the proper research was based on the following premises. According to the opinion of Center for Ecological-Noosphere Studies of NAS (NAS - National Academia of Sciences), RA, it became a common practice in RA that the mining industrial enterprises had been operating for many years without taking into account the ecological and environmental standards. The work had been performed mainly without the appropriate purification equipment, the free flow of mineral water was allowed to fall into surface waters and irrigation network, with the presence of abandoned, nonoperating tailing dumps and the exploitation of operating tailing dumps without meeting the standards, etc. All these violations surely could not but leave a negative impact on the state and quality of the environment.

In the abovementioned mining cities and in rural communities located in the deteriorated zone, such an alarming situation caused justified complaints within the local population, NGOs (NGO - Non Governmental Organization) and local self-governing bodies. Therefore, upon the request of Municipalities of Kapan and Kajaran cities and with the support of OSCE Office in Yerevan, in 2005-2011 the Center for Ecological-Noosphere Studies of NAS, RA conducted comprehensive studies in Kapan, Kajaran cities and in adjacent rural communities, and pilot studies in Alaverdi city and Akhtala town and adjacent rural communities. These studies were aimed at revealing the ecological and geochemical situation of the mentioned areas, identifying ecological risks, separating and assessing primary risks.

Geoecological principles and geochemical methods constituted the basis of the studies, whereas all the data had the distinct spatial-time correlation. Complex methods were used throughout the work, i.e. geochemical mapping, sampling, transportation and primary processing of water, soil, plants, agricultural products, biological substrates in accordance with the international and local standards.

Years of the studies resulted in conclusion that there were serious ecological risks and risks for the health of the population in the industrial mining area, which were especially connected with the penetration of heavy metals into air-water-soil-agriproduct, coupled with the including first class toxic elements into different levels of food chain [24-29].

In particular, it was found out that:

1. Mixtures of untreated effluents from mine railways, tailing dumps fall into surface water and irrigation network causing contamination of irrigation water by heavy metals. Various contents of Mo, Cu, Pb, As, Zn, Cd, Hg and other elements have been registered in the water of the Voghji river (Syunik marz) and Debed river (Lori marz) including their streams. The contamination with heavy metals was especially problematic in little streams of the mentioned rivers, where the contents of the registered heavy metals exceeded the MPC (maximum permissible concentration) values established for waters in RA.
2. High contents of heavy metals exceeding the MPCs were registered in agricultural farmlands and adjacent plots which had been irrigated with waters contaminated by heavy metals for years. An overriding concern causes the situation with the elements of first class toxicity: Hg, As, Cd, Pb.
3. The analysis of agriproducts of plant origin cultivated in contaminated soils revealed the contents of heavy metals exceeding the MPCs. Besides, it was found that the presence of Hg, an element having bioaccumulation characteristics of the first class toxicity, provided the descending series of Bioaccumulation Factor almost for every agriproduct of plant origin. This fact proves that even slight concentrations of Hg in irrigation water and soil, cause its accumulation in agriproducts. Such pattern was revealed in agriproducts of plant origin examined in the territory of the cities of Kajaran, Kapan (Syunik marz), Alaverdi (Lori marz) cities, as well as in Syunik, Neghots, and Karkop villages (the same marzes). Especially high level of contamination was registered in spicy greens, berries, beans and potatoes.
4. The territories of three nonfunctioning tailing dumps of Kajaran city are involved in agricultural turnover. These territories are used as vegetable crop cultivating plots and pastures. Both mineral elements of economic importance (Mo, Cu) and first class toxic elements (Hg, As, Cd) have also been discovered in the spoil, cultivated agriproducts, fodder grass of the territories of these tailing dumps. In most cases the registered concentrations exceeded the MPCs, in some cases by dozens of times. The heavy metals mentioned above have been found in the milk of cows grazing there.

The above mentioned examination studies have been carried out during 2004-2013 [24-28]. The examinations carried out in 2014-2015 considering vegetables cultivated in the surroundings of Kapan and Kajaran cities revealed not only high concentrations of Mo, Cu, but also noticable amounts of Pb, Ni, Cr substances exceeding the MPCs [29].

In 2013, the Center for Health Services Research and Development (CHSR) of Public Health Department of the American University of Armenia (AUA) together with "Pure Earth" (previously Blacksmith Institute) has conducted a detailed assessment of environmental risk in 11 communities of Lori and Syunik Marzes through making observations and taking soil samples in the selected communities for the purpose of discovering heavy metals. Taking into account the previously made rapid risk assessment data and the number of the population exposed to pollution, the following communities have been selected: Alaverdi, Akhtala, Amanis, Mets Ayrum, Tchotchkan, Agarak, Artsvanik, Kajaran, Kapan, Lernadzor, and Syunik Communities. The quantity of soil samples taken in each community was defined taking into account the number of the population exposed to the impact of potential pollution sources. The communities were divided into 3 groups: 1) Small villages (number of soil samples – 90-116), 2) Medium villages/small towns (number of soil samples – 166-202), and 3) Big cities (number of soil samples – 279-289) [30, 31].

In all 11 communities the soil samples were taken from yards, gardens, playgrounds of schools and kindergartens. In Akhtala town, soil samples were taken also from the Church yard of Akhtala and from soil which covered surface of adjacent Nazik tailing dump. In all the communities, besides test samples, also baseline samples were taken from 10 and 20 cm of soil depth. Table 2 presents the list of the examined communities in the order of the pollution level found there.

Table 2. List of examined communities classified in the order of found level of pollution (in Lori and Syunik marzes) [30]

Big cities Population: 8436-45711	Medium villages/small towns Population: 2138-4800	Small villages Population: 620-1023
Alaverdi	Akhtala	Armanis
Kapan	Tchotchkan	Lernadzor
Kajaran	Agarak	Artsvanik
Mets Ayrum	-	-
Syunik village	-	-

High concentrations of heavy metals have been discovered in almost all of the examined samples. Among the big cities, the most polluted community was found to be Alaverdi city. Among medium villages/small towns, the most polluted soil was in Akhtala town (Fig. 6), and among small villages – in Armanis. The following heavy metals exceeding the permitted levels were discovered in the soil samples of all three the most polluted communities: Pb, As, Cr, Cd. The main sources of pollution could be not only the smelter chimneys, but also slags (the so called "slag" looks like a kind of black sand and is generated in the result of copper melting activity in the city), which can be overspread in residential building yards, areas adjacent to yards, roads, schoolyards and cause a great concern. It's worth methioning that the obtained data are in line with the results of complex examinations of GEO-Alaverdi report published in 2009 and with other AUA CHSR investigation results, which proved the

pollution of land areas of the city with heavy metals and other toxic substances (Cu, Hg, As, Mo, Ni, Cd, Cr, Fe, etc.) [30, 31, 33, 36].

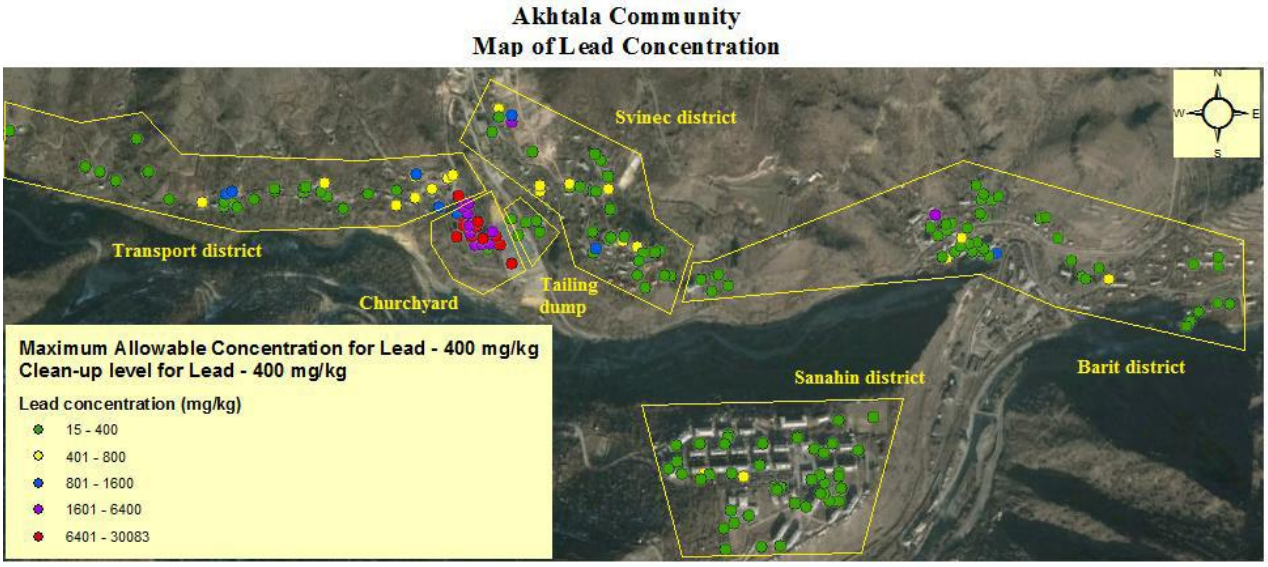

Fig. 6. Pollution in Akhtala town (Lori marz) [33].

In Akhtala town, a serious concern causes the level of pollution of Holy Mother of God Church yard (Fig. 7). Here, the measured quantities of all heavy metals exceeded the permitted concentrations significantly, particularly, the concentration of lead showed up to 75-fold excess of the maximum permissible concentration. This fact supports the possibility of a leakage from Kajaran and Kapan tailing dumps into aqueous and land resources, resulting in accumulation of heavy metals in the cultivated agriproducts and cow milk, which again confirms the above mentioned results of the RA NAS Center of Ecological Noosphere studies. A similar situation is recorded regarding the leakages of Akhtala tailing dump, resulting in both the water and the soil severe contamination of the environment with heavy metals (Pb, Zn, Cd) [36, 55, 57].

The above mentioned results are in accordance with the conclusions of studies conducted in the Armenian National Agrarian University. Wild edible plants were examined in Lori marz, where conentrations of Fe, Zn, Cu, Mn, Ni, Pb heavy metals of technogenic origin exceeding the MPCs were discovered [37].

Fig. 7. Tailing dump in Akhtala community is located in close proximity to the church and not far from the school.

According to expert assessments [38], in Kajaran (Syunik marz), Alaverdi, Akhtala, Shamlugh (Lori marz), as well as in other cities, where thousands of people live, all environmental objects are contaminated with lead, the concentration levels of which in the environment of big industrial cities (Yerevan, Gyumri /Shirak marz/, Vanadzor /Lori marz/, etc.) are manifold above the level of maximum permissible concentration of the appropriate metal, which presents a serious threat to the health of all groups of the population. Notwithstanding the drastic measures taken, the air, water, soil, food of industrial cities continue to be contaminated with lead in the quantities exceeding the permissible levels. The research studies carried out in a number of cities of the Republic, have shown that the content of lead in the atmospheric air of Yerevan city reaches the range of 1,5-45 mkg/m^3, in Alaverdi – 0,9-2,9 mkg/m^3, in Byureghavan – 0,5-1,1 mkg/m^3. Lead can be found also in the dust sittings on the walls of residential and public buildings, windowsills, and on the floor in medical institutions, kindergartens, schools and other objects of Yerevan, Gagarinavan, Hrazdan, Spitak, Gyumri, especially Byureghavan and Alaverdi [38].

The studies conducted in Yerevan State University have shown the high level of contamination with heavy metals in Gegharkunik Marz, in the surroundings of Sotk mine with MPC exceeding of: Cr – by 24 000, Ni – 25,4, Pb – 17,7, Cu – 11,1 and Zn – by 3,7 times [39].

Table 3 summarizes the above mentioned collected official data and expert evidence data. It may be concluded from the table that the most risk-relevant zones are Yerevan, Syunik and Lori, followed by Kotayk, Ararat, Aragatsotn and Gegharkunik. Obviously, the available statistical and expertise data are not comprehensive and complete, particularly, official data are very limited in terms of the number of studied indices, and the expert examinations are limited to selected target areas. Consequently, a number of areas which had not shown the worst negative phenomena indices may be omitted in studies. It is clear that natural phenomena data can't be directly connected to the territorial distribution by marzes, but there is a kind of correlation. For example, the contamination of Lori Marz Alaverdi-Akhtala-Shamlugh section and Debed river with heavy metals appears to influence on the environment of Tavush Marz and the health of its population; the same can be said also about the impact of the contamination of Syunik Marz on the territory of Vayots Dzor. But in Tavush and in Vayots Dzor no relevant research for ecological characterization of the environment has been carried out. It is noteworthy that "Ecological situation is not subjected to administrative boundaries, which complicates the identification of cause-effect relationships" [40].

Therefore, even though the obtained results may be described as somewhat approximate, however, it can be stated that this brief description is quite corresponding to the reality.

Table 3. Assessment of environmental situation in RA Marzes and Yerevan city

Risk factors	Yerevan	Aragatsotn	Ararat	Armavir	Gegharkunik	Lori	Kotayk	Shirak	Syunik	Vayots Dzor	Tavush
Heat waves	**V**	-	**V**	-	-	-	-		**V**	-	-
Natural disasters	**V**	-	-	**V**	V	**V**	**V**	V	**V**	**V**	-
Technological disasters	**V**	-	-	-	-	**V**	**V**	-	**V**	-	-
Desertification risks	V	V	V	V						V	
Biodiversity loss	-	-	-	-	**V**	**V**	-	-	**V**	-	**V**
Air basin pollution (emissions)	V	-	-	-	-	**V**	V	-	-	-	V
Water resources pollution - rivers, irrigation water - fresh water	**V** V	V V	-	-	-	**V** V	**V**	**V**	**V**	-	**V**
Waste generation	**V**	-	-	-	**V**	**V**	-	-	**V**	-	-
Soil pollution by heavy metals	V	-	V	-	V	V	V	V	V	-	-
Soil pollution by pesticides and other toxic substances (PoPs)	V	V	V	-		-				-	-
Abandoned settlements	-	-	V	-	V	-	V	V	V	-	-
Disturbed settlements	-	V	-	V	-	-	-	-	-	-	-
Concentration of tailing dumps	-	-	-	-	-	V	-	-	V	-	-
TOTAL NEGATIVE POINTS	**10**	5	5	3	5	**9**	6	4	**9**	2	3

V – official data, **V-** expertise data

3. IMPACT OF CLIMATE CHANGE AND ECOSYSTEM DEGRADATION ON CHILDREN'S HEALTH

Analysis of official statistical data on child health

We examined in detail all the available statistical data on the morbidity of children in the country. Below the nosological data are presented referred to a limited number of diseases, especially focusing on neoplasms and congenital abnormalities as the most dangerous and intractable diseases, which are also mainly dependent on the presence of carcinogens and mutagens in the environment [41, 42].

It can be seen from these statistic data that there was a significant increase in the children's morbidity referring to cancer and congenital abnormalities during 1990-2014, whereas the total morbidity showed a decrease.

At Marz level, the situation among 0-14 year-old children is as follows:

– Tumor morbidity is higher in Yerevan, Kotayk, Tavush, Lori;
– Morbidity referred to congenital abnormalities was higher in 2012 and 2013 in Yerevan, Armavir, Lori, Syunik (the same situation was observed among 0-17 years old children), and in 2014 – in Yerevan, Armavir, Lori, Kotayk, Syunik.

– According to the data for "cancer as the most common cause of death", tumor rates are higher in Lori, Syunik, Yerevan, Shirak (unfortunately, age distribution data are not available here).

It is also important to note the morbidity in the following nosological class "Diseases of blood and hematopoietic organs: separate disorders by immune mechanisms invasion", which is also generally associated with environmental toxins. Here, the highest rates are in Lori, Aragatsotn and Vayots Dzor Marzes.

Quite similar situation is characteristic for the people who have applied to policlinics with various health complaints throughout 2006-2014, i.e. the most frequent visits were registered in Syunik, Yerevan, Lori, and Shirak. Similar situation is with the hospitalization rates. The highest rates are in Shirak, Lori, Syunik marzes and Yerevan. The highest number of children with disabilities with distribution by marzes is as follows: Lori, Ararat, Syunik, Shirak.

It is also worth mentioning that the described situation is in line with the values for the coefficient of Natural growth by marzes throughout 2000-2014. Thus, in 2014, the minimum numbers were: Lori – 2,67; Syunik – 1,71; Tavush – 1.27 (the average index in RA is 5,08) [41-43]. The above mentioned indices are summarized in Table 4 showing that the most unfavorable characteristics are again observed in Yerevan, and Lori and Syunik marzes.

Table 4. Morbidity data and demographic indices in RA

Characteristics of indices	Yerevan	Aragatsotn	Ararat	Armavir	Gegharkunik	Lori	Kotayk	Shirak	Syunik	Vayots Dzor	Tavush
Morbidity with neoplasms (0-14 years old) in 2013	**V**	-	-	-	-	**V**	**V**	-	-	-	**V**
Morbidity with neoplasms (0-14 years old) in 2015	**V**	-	-	-	-	**V**	**V**	-	-	-	-
Morbidity with congenital abnormalities in 2012-2013 (0-14 years old)	**V**	-	-	**V**	-	**V**	-	-	**V**	-	-
Morbidity with congenital abnormalities in 2014 (0-14 years old)	**V**	-	-	**V**	-	**V**	**V**	-	**V**	-	-
Cancer as the most common cause of death	**V**	-	-	-	-	**V**	-	**V**	**V**		-
Blood and blood forming organs diseases: separate disorders, with the invasion of immune mechanisms, 2013 (0-14 years old)	-	**V**	-	-	-	**V**	-	-	-	**V**	-
Blood and blood forming organs diseases: separate disorders, with the invasion of immune mechanisms, 2015 (0-14 years old)	-	**V**	**V**	**V**	-	**V**	-	-	**V**	**V**	**V**
Number of children with disabilities (per100 thousand)	-	-	**V**	-	-	**V**	-	**V**	**V**	-	-
General coefficient of natural growth	-	-	-	-	-	**V**	-	-	**V**	-	**V**
THE SUM OF NEGATIVE POINTS	**5**	**2**	**2**	**3**	**0**	**9**	**3**	**2**	**6**	**2**	**3**

Figure 8 displays a significant correlation between the sums of negative ecological points and negative health effect coefficients distributed by marzes. Evidently, the results seemed to be somewhat approximate since the calculations were made using summarized values, which, however, was the only possible way at the moment. Nevertheless, it may be stated that the results deserve careful consideration.

The diagram also shows that the response of health indicators to negative ecological indicators is most pronounced in 3 marzes, which suggests the presence of additional environmental stimulus. In the case of Lori marz, combination of 2 factors is obvious, i.e. mining/processing activities in the area and the effects of the former activity of Vanadzor chemical plant: environmental pollution and impact of toxic waste dump.

As for Tavush, we have mentioned in this report that the pollution of the territory of Lori tends to spread in the adjacent territory of Tavush, but it is not fully reflected on the environmental indicators because of the lack of relevant studies. It should also be taken into account that according to [44], the percentage of mining areas in Armavir and Kotayk marzes is the highest in the country, but they are of non-metallic character.

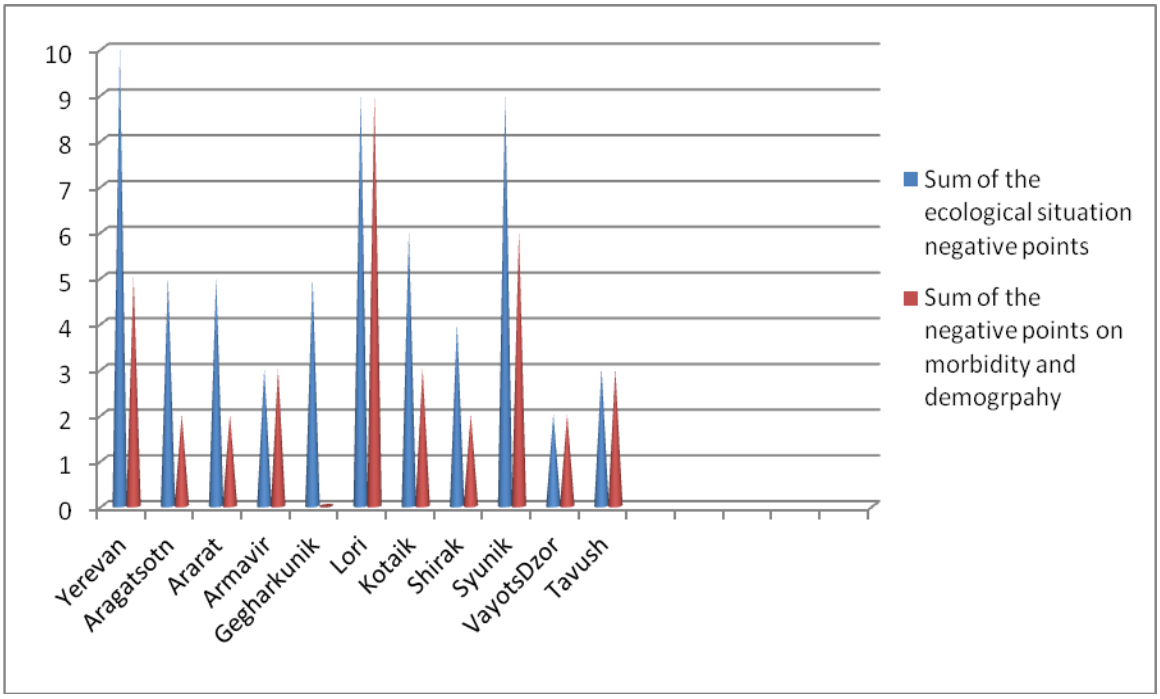

Fig. 8. The correlation of the sums of ecological and healthcare negative points distributed by marzes.

The results reflected in the diagram correspond in a certain way to the data of 2015 provided by the RA National Center of Oncology, which refer to the entire population, with no age restrictions. According to the data for morbidity rate with malignant neoplasms, the worst situation is in Lori, followed by Kotayk, Shirak and Syunik. According to the mortality rate, the worst situation is again in Lori followed by Kotayk and Syunik [45]. The data are summarized on Fig. 9.

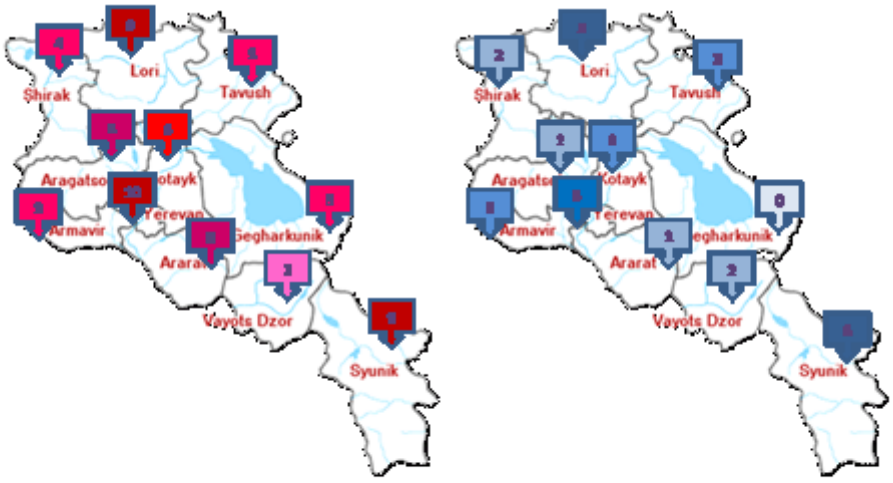

Fig. 9. Impact of the environment on the health of the population/children in RA.

The only region that does not fit the above mentioned correlation dependence is the Gegharkunik marz. This fact can be explained by the specific nature of the region, about 80% of the territory of which is occupied by the Lake Sevan.

We calculated the value of the correlation coefficient using the rank method (without taking into account the Gegharkunik marz). The following result for the correlation coefficient was obtained: r = 0,58, this value falls in the average dependence interval (0,3-0,6), closer to the upper limit. It would not be reasonable to expect a higher value of the correlation coefficient, for, as already emphasized, the processes under consideration can't so clearly correspond to the administrative division of the country's territory. Accordingly, the obtained result can be considered quite satisfactory.

In the publications of the RA Ministry of Health, the morbidity is presented with distribution for Marzes and Yerevan city. In our opinion, such a statistic approach is not complete, because it is not correct to compare the indices of Yerevan with the indices of Marzes. In particular, this type of comparison leads to the conclusion that the worst indices are specific to Yerevan city. We have tried to calculate separately the morbidity on cancer and congenital abnormalities for the large RA cities which seem to be more vulnerable in terms of the environment (data presented upon our request by the National Institute of Health named after Academician S. Avdalbekyan of the RA Ministry of Health have been used). The results are presented in Table 5, it can be seen that the highest rate of cancer morbidity is observed in the Vanadzor city (Lori marz), followed by Kapan (Syunik marz) and Yerevan. The highest rates of congenital abnormalities are characteristic to Kapan (Syunik marz), Alaverdi (Lori marz), and Yerevan cities [41-43].

Table 5. Indices of morbidity in a number of RA cities, data for 2013

Morbidity (0-14 years old) 2013	Yerevan	Alaverdi	Vanadzor	Gyumri	Kapan
Morbidity with malignant neoplasms	**31,9**	0	**61,3**	25,6	**38,5**
(RA average index: 32,0)	-	-	(Lori: 31,1)	(Shirak: 25,3)	(Syunik: 23,0)
Morbidity with congenital abnormalities	**1262,7**	**1332,9**	783,4	388,1	**2028,8**
(RA average index: 816,5)	-	(Lori:835,2)	(Lori: 835,2)	(Shirak:379,7)	(Syunik:749,0)

Impact of climate change on the health of the population/children

According to the data presented by the RA Ministry of Health [42], the climate change can be accompanied with the increase of the prevalence of eating disorders in the regions, where people are more dependent on the efficiency of agriculture, so that the foodborne disease characteristics will change. The burden of waterborne diseases will increase, especially in areas where water quality, sanitation, and personal hygiene levels are already of low quality level.

In summer, the number of accidents, injuries and poisoning of the population generally increases. Eventually, sustainable, long-lasting hot weather contributes to the increase of the rates of morbidity and mortality from cardiovascular diseases. The most vulnerable to hot weather are people of risk groups: young children, elderly people, outdoor workers. Shortage of safe water may lead to the increase in the number of intestinal infectious diseases, including outbreaks of waterborne diseases; and also may lead to drought and food provision issues. There were especially numerous foodborne outbreaks, largely due to an unprecedented prolonged hot weather in 2015. During 2015 year, 16 outbreaks of intestinal infectious diseases were registered in the Republic of Armenia, both food and waterborne (in 2014, only 3 outbreaks of intestinal infectious diseases were recorded in RA, only one of which had foodborne origin) [42].

From the above mentioned analysis we can conclude the following:

- Climate change may mostly affect the agriculture, to this end, the most vulnerable RA territories are Ararat Valley and other agricultural areas. The situation is exacerbated by desertification process, which has already been developing in Aragatsotn, Armavir, Ararat, Vayots Dzor marzes. The other problem is water level decline as a result of overuse of Ararat Artesian Basin. Thus, food safety issue becomes a matter of concern.
- Along with the climate change, nutritional disorders will increase in the territories where people mainly depend on the efficiency of agriculture, which can lead to changing foodborne disease characteristics. The burden of waterborne diseases will increase, especially in the regions where water quality,

sanitation, and personal hygiene levels are already of low quality. Lack of safe water may lead to the growth of intestinal infectious diseases, including outbreaks of waterborne diseases. The year of 2015 was characterized by outbreaks of particularly foodborne diseases, which was largely due to unprecedented prolonged hot weather.

- Heat waves occurred most frequently in Yerevan, Meghri, Ararat cities. A significantly negative impact on the health of the population was revealed in Yerevan. Children, as a more vulnerable group, are a subject of special examination and protection.
- Taking in consideration international experience, we examined the rates of morbidity in regard to cholera, malaria, plague, tularaemia, Crimean-Congo haemorrhagic fever, tick encephalitis and meningoencephalitis, and Siberian anthrax. The results have shown that only cases of Siberian anthrax and leishmaniosis occurred in Armenia, the remained possible risks were not implemented, but the problem should be kept in the focus of attention.
- Considering the impact of degraded ecosystems on the health of the population, especially children, the most risk-relevant areas are Yerevan, Lori and Syunik. In addition, the ecological issues in Yerevan are multivariable, whereas the top-priority issue in Lori and Syunk Marzes is the heavy metal pollution of soil, water, food-chain caused by mining industry.

Although, the last statement has given rise to considerable controversies from some specialists of Ministry of Health.

Below we have tried to present the differences in approaches and views.

It should be emphasized that each marz has its unique characteristic features to be considered risky; in particular, the following marzes should be noted:

- Shirak Marz is of special interest since there it is characterized by the high level of poverty.
- Aragatsotn and Ararat, as can be seen from the studies of "Armenian Women For Health And Healthy Environment" NGO, caused concern in terms of pollution by toxic chemicals (mainly pesticides).
- In Gegharkunik and Ararat, quite negative factors can cause gold mining/manufacturing processes.
- However, the presence of protected nature areas in some marzes can have a positive effect both on the ecosystems in the marz and on the health of the population living there [29, 30, 34, 35, 46-49].
- Yerevan seems to face almost all known kinds of hazards (Nubarashen dump with toxic materials, which spreads persistent organic pollutants, city landfills, drainage system imperfection, the mines operating not only in a suburban area but even in the center of the city, which are lavishly "supplying" emissions of dust to the air basin of the city, deforestation, etc.). The situation is getting worse due to the anti-ecological urbanization which took place during the years of independence. In particular, the intensive construction of high-rise buildings in the city centre has played a significantly negative role, most often harmful to green areas, which became an obstacle for self-purification of air basin, construction/closure of Getar mudflow channel and removal of the respective

catchment protective structures. In the context of the discussed topic, special attention should be given to the construction of high-rise buildings in the immediate vicinity of a number of schools to the detriment of green areas and sports-ground areas, which can also enhance the seismic hazard in these schools. Additionally, the concentration of such construction materials may contribute to higher radioactive background [75-82].

As we have already noted, the research studies conducted only at Marz level, and particularly comparing data for Yerevan city with marzes data is not unsufficient and incorrect. This is evidenced particularly from the data of Table 5.

In our opinion, along with the statistics carried out at Marz level, the research aimed at determining main environmental indices for at least big cities of the country would greatly assist in receiving a more complete and comprehensive picture in that important endeavour.

As it was already mentioned above, the studies carried out by RA NAS Center of Ecological Noosphere Studies have shown that emissions from Zangezur Copper Molybdenum Combine resulted in significant pollution of the atmospheric air of neighbouring settlements with solid particles (dust), carbon, nitrogen and sulfur oxides. The waters of the affected area are found to contain metals belonging to different classes of danger: arsenic and mercury (I class), copper, molybdenum, zinc, manganese and nickel (II class), sometimes substantialy exceeding the MPCs. These data are confirmed also by the the results of the investigations carried out by Armenian State Economic University (ASEU) [44]. Significant concentrations of molybdenum, copper, lead, nickel, arsenic, mercury, zinc and cobalt can be found iIn the soils, sand and dust of the Zangezur Combine and of the neighbouring settlements, including playground areas. Soil contamination with heavy metals leads to contamination of food of plant and animal origin produced in the region: relatively high contents of mercury and arsenic were discovered in the samples of cultivated plants and dairy products. According to the researchers, environmental pollution with heavy metals is fraught with the risk of serious diseases among the population. Apart from breathing dust by people and metal penetration into water, these metals are characterized by ability of transfer via food chains and accumulating in human organism (mercury, cadmium and arsenic in concentrations exceeding the MPC values were recorded in the hair of the children living in the two villages adjacent to the Combine: Kajaran city and an adjacent village) [24-29].

The above conclusions were confirmed by a series of expert examinations [30-38]. Namely, according to the examinations carried out by “Kanaker-Zeytun” MC CJSC Hygiene and Professional Diseases Scientific Research Institute” in Yerevan, Byureghavan, Alaverdi and other cities, hazardous lead concentrations were discovered in the blood of children (10-20 mkg/dl and above 20 mkg/dl) [38]. Similar examinations were carried out by the Public Health School of American University in Armenia, which confirmed the mentioned results. For example, the percentage of children living in big cities and having impermissible lead contents in their blood was found to be as follows: in Akhtala - 84,6%, in Alaverdi - 75,4%, and in Yerevan - 57,4% of children examined [33]. The researchers express deep concern about the situation in Alaverdi city, which stands out from the others when compared the

indices of Alaverdi and Artik cities, i.e. studies of women have demonstrated the most unsatisfactory data for their reproductive health [34]. The authors also linked the unfavourable health indices registered in Alaverdi with the environment pollution with heavy metals, especially lead, and also with sulphur dioxide.

In the report titled "Analysis of the socio-economic situation of the Republic of Armenia and Lori Marz" prepared within the framework of the UNDP/UNEP project "Economic valuation of ecosystem services" implemented in Armenia, in 2013, the following statements were made:

"By the volume of specific atmospheric emissions as a result of mining industry Lori marz is the first from all Marzes surpassing even Syunik Marz. It is noteworthy that the index of Lori Marz on per capita ratio is higher than the national average index approximately for 4 times, and for one square km approximately for 2.5 times.

Notwithstanding the reforms, child health and mortality is still a serious issue in Lori Marz. Worrisome is the fact that, the specific weight of the death cases from perinatal diseases and developmental defects in the structure of child mortality is gradually increasing" [50].

According to another study [51], the "high rates of almost all diseases of Syunik Marz are mainly due to the penetration of emissions of the most powerful man-made mining industrial enterprises of the Marz (heavy metals, dust, chemicals, etc.) into the human organism through food chains or through respiratory system".

According to [44], "When talking about mining industry, the limitations and peculiarities of the RA geographical territory should be taken into account. Stressing the importance of this provision, it should be noted that today there are 11 metal mines in Syunik and another 28 are waiting for exploitation. As a result of exploitation of the operating mines there are already 12 big and small tailing dumps in Syunik. For a small country like Armenia the mining with such volumes is impermissible".

It is important to note also the results of joint studies of the specialists of RA National Academy of Science's Institute of Geological Sciences and RA MoH National Institute of Health, which revealed that the territories of Yerevan city and Lori marz are geoecologically unfavourable for health and by 1,5 times exceed the general morbidity indices of the Republic [49].

It is logical that the assessment of dietary risks of the population has led to serious concerns about the health of the population, especially children [29, 52]. In this context, there is also alarming situation with the registered cases of anemia of children, which also requires comprehensive studies [35].

It is worth mentioning that the negative impact of mining industry on the environment and on the health of the population was the main focus of attention in the society and was also examined and admitted by the Commission established in accordance with the Decision № 1147-A dated 09.12.2013 of RA Prime Minister (amendments of the Decision № 899-A dated 05.10.2015 of RA Prime Minister) within the framework of preparing the Report on the Concept on the Strategy of the Realization of the UN "Rio+20" Summit Recommendations in the Republic of

Armenia in the context of the World program "Transforming our World. 2030 Agenda for Sustainable Development" [53].

Noteworthy that the above mentioned strategic program of UNICEF for 2016-2017 emphasizes the need of improving social protection systems for children, women in most risky zones, polluted industrial zones, mining areas, tailing dumps, landfills, landslides, etc. [54].

However, as we have mentioned, according to the data provided by the specialists of the RA Ministry of Health within the framework of this investigation, the viewpoint on the primary negative impact of mining on the health of the population, particularly children, is not enough substantiated.

It is truly noted that "the environmental factors monitoring system is still imperfect, ambient air fixed monitoring points are practically missing in affected communities related with the activity of mining and metallurgical industry" [42].

We admit the view that both the environmental indices and the data on health indices are not complete and can't provide making conclusions, but it is difficult for us to ignore the significant negative impact of mining on the environment, and consequently on the health of the population, particularly children. It is noteworthy that the lack of statistical data, which had also hindered our analysis, was also highlighted in other studies [55].

It should be noted also that it is difficult to imagine that Marz sectors of nearly homogenous population can significantly differ in genotype and other above mentioned factors. Of course, poverty rates differ in different marzes, and this was taken into consideration in the case of Shirak Marz.

We consider it necessary to add the following.

- The negative impact of heavy metals on human health has been proved by long-lasting international practice (Table 6) [56-61].
- Subsequent discussions of the results obtained by the Ministry of Health convinced the Ministry's specialists in the fairness of these conclusions to a certain extent.
- In 2017, the Ministry of Territorial Administration and Development of RA presented a Draft of regional development programs (for marzes) [62]. In this document only Lori region showed a negative indicator with a high mortality, which completely coincides with our conclusions.

Table 6. Negative impact of high (toxic) concentrations of Arsenicum and some heavy metals on human health [56-61]

Element	*Negative impact*
Pb	Saturnizm (lead poisoning). Anemia, kidney, brain and peripheral nervous system lesions, hearing loss, growth retardation, bone tissue destruction, attacks, rheumatism, reduction of reaction of immune system, impairment of the functions of cardiovascular system, gastrointestinal tract, decrease in fertility. Penetrates through the placenta, as well as accumulates in breast milk.
Zn	Anemia. Increases the toxic impact of other heavy metals.
Cu	Intoxication, anemia, hepatitis, organic changes in tissues, bone tissue abrasion.

Ni	Dermatitis, eczemas, respiratory diseases, asthmatic bronchitis, bronchial asthma, asthenoneurotic disturbances, disturbance of protein, DNA and RNA synthesis, disturbance of the functions of cardiovascular system. Ni compounds belong to the first group of carcinogens, mouth cavity, throat, lung, bronchus, kidney, colon and rectum cancer, sarcoma.
Co	Toxic myocarditis.
Fe	Siderosis and pneumosclerosis, in case of systematic breathing of air containing metal dust.
Mn	Neurotoxic effects (fatigue, sleepiness, decreased reaction rate, decreased work capacity, dizziness, depressive, depressed emotional state), dynamic lesion of the central nervous system, pneumonia, disturbance of calcification, processes of internal structure of bones, toxicosis of pregnant women, development of dementia in embryos.
Cr	Dermatitis, eczemas, allergic reactions, upper respiratory tract lesions, asthmatic bronchitis, bronchial asthma, diffuse pneumosclerosis, asthenoneurotic disturbances, disorders of gastric function (gastritis, ulcer disease), liver (hepatitis), pancreatic function disorder. Cr (VI) and Cr (III) compounds – are carcinogenous, lung cancer and bronchial cancer.
As	Arsenosis (arsenic poisoning), blockade of enzymatic systems, accumulation of acid metabolite in tissues (total acidosis), tissue respiration disorder, peripheral neuritis, disturbance of the functions of cardiac system, haemolysis, anemia, thrombosis, bone marrow atrophy, degenerative and necrotic processes in tissues, disturbance of the functions of stomach and liver. Carcinogenous: lung cancer, and skin cancer. Mutagenic and teratogenic effect, without causing gene mutation causes chromosomal anomalies.
V	Local inflammatory processes in the mucous membrane of the eye, skin, upper respiratory tract, in case of acute exposure to toxic doses, accumulation of mucus in the bronchi and alveoli. Asthma, eczemas, anemias, leucopenia, growth retardation, diarrhea.
Sr	Locomotor system pathologies (osteoporosis, etc.).
Hg	Disorder of the functions of endocrine and central nervous systems, decreased vision, damage of respiratory organs, disorder in the course of pregnancy in women.
Mo	Weight loss, kidney and joints lesion, swellings, increase in arterial blood pressure.
Cd	Kidney, lung and bone system lesions, anemia, carcinogenic.

4. ACTIVITIES AND PROPOSALS AIMED AT IMPROVING THE SITUATION

According to the data of the RA Ministry of Emergency Situations Rescue Service and other authors,

- 100% of the territory of the Republic is prone to earthquakes,
- 4,1% – to landslides (approximately 15% of the population lives in landslide risk zones),
- 30% – to mudflows and floodings,
- 0,5% – to collapses and rock falls,
- 12% – to frosts,
- 15% – to droughts,
- 17% – to hails,
- More than 80% of the RA territory is prone to the impact of erosion, salinization or alkalization, excessive humidity, overwatering hazards [17, 63, 64].

A significant part of these phenomena is also closely connected with climatic changes that aggravate disaster risks and consequences. Therefore it is difficult to overestimate the various activities aimed at:

- Climate change prevention/mitigation,

- Adaptation to climate change,
- Reduction of disaster risks and negative consequences.

Climate change prevention/mitigation and adaptation activities carried out in the RA follows from the United Nations Framework Convention on Climate Change (UNFCCC) and the corresponding protocols and is included also in various sectoral sub-programs.

The Republic of Armenia signed the United Nations Framework Convention on Climate Change in 1992 and ratified it in 1993. In December 2002, the Republic of Armenia has ratified the Kyoto Protocol to UNFCCC. According to a Decree of the Government of the Republic of Armenia No. 974-N adopted on July 13, 2006, on "Implementation of Projects in the Framework of Clean Development Mechanism (CDM) under the Kyoto Protocol", the RA Ministry of Nature Protection was declared as designated national authority for Clean Development Mechanism (CDM) under Kyoto Protocol. The procedure for submission and approval of CDM projects was approved, according to which projects should be in line with the sustainable development strategy and criteria of the country. As of 2014, within the framework of CDM, 6 projects have been approved in Armenia by the International Executive Board.

The Government of Armenia adopted the following decisions for the implementation of the Convention: "On Approval of the Procedures of the Forecasting, Warning and Response on Dangerous Hydrometeorological Phenomena Related to Atmosphere Excessive Pollution, Climate Change and Ozone Layer Condition" (Decree No. 1186-N October 16, 2008), "On Approval of the Action Plan of the Republic of Armenia Obligations Emanated from a Number of RA Environmental Conventions" (Decree No. 1594-N dated 10.11.2011). These decisions also define the measures and responsible parties for the implementation of Armenian obligations under the Convention on Climate change.

On October 2, 2012, the RA Prime Minister adopted Decree No. 955-A on "Approval of the Composition and Functions of the Interagency Coordinating Council for the Implementation of the Requirements and Provisions of the Framework Convention on Climate Change". The Council was established to ensure the implementation of the provisions of the FCCC, in general, the implementation of the measures set forth in the above mentioned Decree No. 1594-N and for the efficient participation of the Republic of Armenia in the developments under the Convention. Currently, the National Action Plan for RA climate change mitigation, with a relevant road map is at the stage of discussion [5]. RA also joined the Paris Agreement on Climate Change [65].

The country has developed and implements "National Strategy on Disaster Risk Reduction of the Republic of Armenia and the Action Plan for the Implementation of the National Strategy on Disaster Risk Reduction" (Decree No. 281-N, 07.03.2012) approved by the RA Government in 2012 [66]. Below are presented the introductory points of this strategic plan, which reflect the fundamental principles of the program fairly accurately.

«1. One of the most important factors for sustainable development of the Republic of Armenia is the establishment and development of efficient system for disaster risk reduction that involves all sectors of the economy and wide layers of the society.

2. The disaster risk reduction system is a framework of processes and functions aimed at strengthening capacities for disaster resilience. It is aimed at prevention or mitigation of hazards, reduction of their negative implications, as well as contribution to the sustainable development of the society.

3. The process of disaster risk reduction cannot be the monopoly of one institution. It requires comprehensive approach, including mobilization of resources of all structures of the country, as well as utilization of political, technical, scientific and participatory components.

4. The disaster risk reduction system is an important factor for the country's development, which involves all sectors of the country and all layers of the society. It implies joint actions of the Government, other state agencies, communities and community based structures, the civil society, scientific institutions, the private sector and the mass media" [66].

It is noteworthy that major activities are taking place at local community level both aimed at climate change prevention/mitigation and adaptation, and disaster risk reduction [63, 66].

The principles and approaches of these projects are in line with positive international experience, particularly with the activity carried out in the appropriate field by the Czech Republic, which is presented as an exemplary experience in the international arena [67, 68] and it is certainly welcome.

However, when adopting correctly internationally recognized positive experience as a guideline, it is also necessary to take into account local climatic and socio-economic conditions. For example, small hydropower plants are considered to be a positive example of renewable carbonless energy for RA and in the last decade, preferential conditions were created for the construction and use of these energy plants. But, in fact, the practice of the construction and use of small hydropower plants has caused serious environmental and social problems in the country. As a result, degradation of a number of rivers and coastal water ecosystems had started, which was exacerbated by climate change. Besides, a shortage of the amount of irrigation water occurred, causing additional damage to agriculture, and therefore to regional/local communities [69-72].

What main obstacles are to be overcome and what measures are to be taken to improve the situation in the country

1. We have already mentioned the imperfection of both ecological and health statistics. In particular, the following is stated in the report submitted by the RA Ministry of Health:

- "To assess the impact of environmental factors on children's health and to identify the risks, it is necessary to have a comprehensive monitoring system for the assessment of the impacts of environmental factors. This issue has been approved at the session of the Government as of August 14, 2008, and by point 33 of protocol decree the "Second national environmental protection action

plan" was approved, which was intended to improve the environmental monitoring, including waste, soil monitoring and to enhance air monitoring system. However, the environmental monitoring system is still imperfect.

- Ambient air fixed monitoring points are practically missing in affected communities related with the activity of mining and metallurgical industry. Samplings from Kapan, Kajaran, Akhtala, Syunik village and other affected communities are made by passive samplers; the research is carried out only by the indices of nitrogen dioxide and sulfur dioxide.
- In order to assess the impact on health, including children, and the risks, it is mandatorily necessary to include the suspended particles: $PM_{2.5}$, PM_{10} in the monitored indices of ambient air. Although safety rules have been established for these indices in the annex approved by the Decision No. 160-N of the RA Government, as of 02.02.06 "On the approval of norms for maximum permissible concentrations (MPC) of air polluting substances in settlements", but their monitoring is not still being implemented.
- The system of risk assessment related to ambient air pollution is imperfect. The degree of air pollution in developed countries is estimated by "Air Pollution Index" or "Air Quality Index", which is calculated based on the levels of main air pollutants (NO_2, SO_2, PM2.5, PM10, CO) and is regularly posted to the relevant site as information necessary to the population. (We note that in 2017 the Ministry of Nature Protection slightly expanded the list of air pollutants to be monitored [19]).
- Monitoring of soil pollution is not carried out in the Republic, that's why it is impossible to distinguish between baseline and technological pollution of the soil. In terms of safety for health, RA standards are established for soil quality. There are no international standards for soil quality and safety. Each country has its own approach on this issue. There is no methodology in line with international approaches for environmental and health risks associated with soil pollution.
- The quality and safety of raw food products are directly related to environmental pollution, which is not regarded as a sector subject to monitoring in RA. Thus, in RA there are no safety rules for irrigation water, in the result of which agricultural lands may be irrigated by waters of any quality and pollution level. As a result, both waters contaminated as a result of in industrial activity, as well as industrial waste water, including tailings effluent waters are being used for irrigation purposes. At the same time cattle-breeding activities are sometimes carried out in the pastures contaminated by mining industry or other types of industry. However, contamination of meat, milk and dairy products with heavy metals, chemicals is not subject to monitoring, and so on" [73].

According to [42]:

- "There is no study that will include a risk assessment of the entire RA territory.
- Regular data updating is not fully operational".

Thus, it is evident that the above issues are of vital importance and must be solved.

2. We suggest to replenish the morbidity data by indices referring to cities and stop to compare the indices of Yerevan city with the indices of marzes.

It is also desirable to study the RA territory in the context of the discussed issues by joint efforts, since the available experimental data refer only to a limited number of settlements and their surroundings and are not enough to form a complete environmental picture of the entire territory of the country.

3. The cooperation between sectors for solving the problems is now poor enough (this drawback was also highlighted in the conclusions of the analysis of RA public healthcare services made by the American University of Armenia [74]). It is necessary to strengthen interagency coordination and cooperation between the RA Ministry of Nature Protection and Ministries of Health, Urban Development, Economy and other ministries, in order to demonstrate a more complex approach while solving problems and considering the environmental components comprehensively. It is particularly important both in sectoral projects and in strategic programs for the development of the country, to take into consideration not only economic priorities, but also the two other components of sustainable development: social and ecological ones.

The above mentioned suggestions mostly refer to mining industry, development of renewing energy, design and implementation of urban development programs.

4. With the support of various international organizations a number of pilot programs/projects have been implemented in the country aimed at climate change mitigation and adaptation, as well as prevention of ecosystem degradation, development of green economy, but, unfortunately, the acquired positive experience is mostly being used in the limited parts of the country. Stating that the fulfilled works are completely in line with the directions of strategic framework of UNICEF [54], we believe that it is necessary to demonstrate a more careful approach to this positive experience and to make efforts to promote it throughout the country.

5. It is necessary to intensify the activities of the Sendai Action Plan for Disaster Risk Reduction [83] for the implementation of its localized version in RA.

6. It is necessary to bring to life many of these officially approved programs, as, unfortunately, there is a negative experience in the country, when conscientiously developed, comprehensive programs remain on paper, or are implemented partially.

7. It is essential to implement targeted monitoring of ecological safety and disaster risk resistance of school and pre-school facilities/homes and their surrounding, especially in climate change conditions (pollution by toxins, radiation background, noise, microclimate, sanitary-hygienic conditions, building density, green and evacuation buffer zones availability, etc.), to develop and implement measures to improve the situation.

It is also expedient to regularly examine children's toys, clothes and other items of use with respect to the content of toxic chemicals and heavy metals.

8. It is necessary to solve the following issues:

As a result of the urbanization carried out in Yerevan during the last twenty years, a number of kindergarten buildings were unfortunately destroyed (replaced by high-rise buildings with other aims of significance), that were exemplary and

specifically designed to be extremely comfortable for children and surrounded by children's playgrounds and green buffer zones. As a result, the following situation was created:

- The number of public kindergartens has been reduced, it is not enough for the city's children, long queues have formed for kindergarten admission.
- Kindergartens were organized in a number of ordinary apartments of residential buildings, so they are not adapted for this function. In addition, as a result of the created situation, the existing kindergartens are often overloaded with superdense admission capacity.
- There is a certain amount of relatively comfortable private, paid kindergartens, but they are accessible for the economically well-situated people, and poor families are not able to use this possibility.

It is necessary to examine the situation at governmental and municipal level and develop the ways of solving the issue.

9. It would be reasonable to focus particularly on the implementation of Education for Sustainable Development in the country. Although the UN "Rio+20" Summit decided that the activities taking place within the framework of "Education for Sustainable Development" Decade should be continued, and UNESCO has developed Global Action Plan and the Road Map [84, 85], in Armenia all the initiatives were carried out by individual educational institutions and non-governmental organizations, and, unfortunately, almost nothing is carried out at state level, neither within a decade nor in recent times. We can confirm, that, quite the contrary, in some universities corresponding specializations and class hours were reduced, etc.

It is necessary to reconsider this inadequate approach and make maximum efforts to train qualified professionals, as well as to create ecological culture within the society, engaging the media (unfortunately, the only environmental TV program "Ecologica" was closed, nowadays only one radio program "Ecosphere" is working). It is also important to activate healthy lifestyle propaganda using the mass media.

It should be noted also that UNICEF strategic plan pays an exclusive attention to environmental education both in schools and universities, as the most important means of multilateral awareness and creating ecological culture, as well as developing scientific grounds for clean technologies [54].

10. There is some discrepancy between the data, approaches and conclusions of the employees of the RA Ministry of Health and independent experts. Therefore, in order to receive a distinct comprehensive picture on the discussed issues, it is reasonable to carry out additional target research studies locally: especially in the above mentioned most risk-related marzes/cities.

11. The issues discussed in this work are of profound importance and require a comprehensive, systemic approach. Such an approach can provide the localization and implementation of sustainable development goals within the framework of the UN "Transforming our World: 2030 Agenda for Sustainable Development" Global Program [86].

The first step in that direction was made within the framework of drafting the Concept on the Strategy of the Realization of the UN "Rio+20" Summit

recommendations in the Republic of Armenia in the context of the World program "Transforming our World. 2030 Agenda for Sustainable Development". It is expedient to expand the achieved results and to start from the implementation of developed and widely discussed recommendations [53].

It should be noted that the 17 goals of the above mentioned sustainable development are closely linked to each other, demonstrate comprehensive, ecosystematic approach and as is emphasized in GEO-6, "These goals are integrated, indivisible and balance the three dimensions of sustainable development. One goal should not be achieved at the expense of another goal, making an integrated approach vital" [87].

Therefore, the comprehensive plan based on them should lead to a higher efficiency in all sectors, as well as in the most overarching challenge of creating favourable conditions for the health of the population, especially children.

Currently, the SDGs implementation process in the Republic of Armenia has been initiated and is actively developing: an interdepartmental commission has been set up under the government, many NGOs and the expert community (including the authors of this article) have been involved in these activities. The group of independent experts analysed all the strategic programs in the country in terms of compliance with SDGs and identified shortcomings (the most significant ones were found mainly in the sphere of ecology), which should be eliminated in the process of implementing programs to achieve these goals [88].

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