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QUICK ECONOMIC GAINS OR LONG-TERM SUSTAINABILITY? NEGATIVE ENVIRONMENTAL AND HEALTH EFFECTS OF METAL MINING IN ARMENIA

CASE STUDY OF THE LORI REGION

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ABSTRACT

Objectives. Armenia demonstrates disastrous environmental and human health outcomes in mining-reliant regions with high indicators of environmental pollution, loss if biodiversity, and degraded human health caused by mining and processing activities. The study investigates the negative environmental and health impacts of such activities in Lori, Armenia to understand the neglected aspects, which, if addressed appropriately, may engender opportunities for conviviality of all parties involved.

Methods. A qualitative method case study applied a combined approach with drivers-pressures-state-impacts-responses (DPSIR) framework and Ecological Public Health (EPH) model. Semi-structured interviews with 12 individuals and two focus group discussions with seven individuals were conducted.

Main Findings. Armenia's imperfect regulatory frameworks create different layers of social and ecological inequities, lack of global responsibility, challenges to conviviality and sustainability. Compliance of mining legislation with international best practices is required for improvements. The assessment of negative environmental and health impacts of mining and processing activities should be complemented by tools allowing to see human health as a part of ecosystems health which can be seriously harmed by environmental pollution caused by mining and processing activities.

Key Words: mining and processing activities, environment, health, regulatory framework, DPSIR, EPH, Armenia, Lori

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Anush Poghosyan

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LIST OF ABBREVIATIONS

ACP	Armenian Copper Programme
AMEC	Akhtala Mountain Enrichment Combine
ENSC	Ecological Noosphere Studies Centre of the RA Academy of Science
ARMSTAT	Statistical Committee of the Republic of Armenia
AUA	American University of Armenia
AUA SPH	School of Public Health of the American University of Armenia
AUA CRM	Centre for Responsible Mining of the American University of Armenia
AWHHE	Armenian Women for Health and Healthy Environment
BHR	Business and Human Rights
BLL	Blood Lead Level
CENS	Centre for Ecological Noosphere Studies
CEPF	Critical Ecosystem Partnership Fund
CF	UN-Armenia Sustainable Cooperation Framework
CIA	Cumulative Impact Assessment
CJSC	Closed Joint-Stock Company
CSO	Civil society organisation
CSR	Corporate social responsibility
DPSIR	Drivers, Pressures, State, Impact, Response
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EIEC	“Environmental Impact Expertise Centre” State Non-Commercial Organization
EITI	Extractive Industries Transparency Initiative
EKF	Export Credit Agency
EPH	Ecological Public Health
Eurostat	European Statistical Office
GoA	Government of Armenia
HMC	“Hydrometeorological and Monitoring Centre” State Non-Commercial Organization
IARC	International Agency for Research on Cancer
ICRC	International Committee of the Red Cross
ILCS	Integrated Living Condition Survey of Households
INPMR	Inspectorate for Nature Protection and Mineral Resources

MEINR	Ministry of Energy Infrastructures and Natural Resources of the Republic of Armenia
MPA	Mining and processing activity
MPC	Mining and processing company
MoE	Ministry of Environment
MoH	Ministry of Health
MTED	Ministry of Trade and Economic Development
NAS	National Academy of Sciences of the Republic of Armenia
NCDC	National Centre of Diseases and Control
NIH	National Institute of Health
NGO	Non-governmental organisation
NRE	Nature resource exploitation
OECD	Organisation of Economic Development and Cooperation
PFA	Policy Forum Armenia
SES	Socio-ecological systems
SESA	Strategic environmental and social assessment
SDG	Sustainable development goals
RA	Republic of Armenia
TCL	Tobacco Control Laws
TSF	Tailing storage facility
UN	United Nations
UNCT	United Nations Country Team
WB	World Bank
WCED	World Commission on Environment and Development
WHO	World Health Organisation
ZCMC	Zangezur Copper Molybdenum Combine
Zoï	Zoï Environment Network

DEFINITIONS

DPSIR	The causal framework for describing the interactions between society and the environment adopted by the European Environment Agency: driving forces, pressures, state, impacts, responses (EEA, 2021)
Economic security	The ability of individuals, households, or communities to cover their essential needs sustainably and with dignity (ICRC, 2015)
Responsible mining	The mining which is based on the five key principles or pillars: holistic assessment, ethical relationships, community-based agreements, appropriate boundaries, and good governance (Bice, 2016).
Sustainable development	In the minerals sector sustainable development means mining investments that are financially profitable, technically appropriate, environmentally sound, and socially responsible (WB, 2014, p. 51).
Tailing	Tailings are the waste product of mineral processing operations for the purposes of mineral extraction. Tailings are often transported in slurry form and deposited in tailings storage facilities (TSFs), often referred to as tailings dams (WB, 2016, p. 84).
Water stress	Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of freshwater resources in terms of quantity and quality (EEA, 2021).

CHAPTER 1: INTRODUCTION

1.1.Motivation for Study

Mining and processing activities (MPAs) in Armenia have become one of the most debated topics within and beyond the country's borders recently due to raised awareness on their negative environmental and health impacts. Yet, MPAs are important for economic growth. Mining and quarrying sector had the biggest share in the total industrial production in Armenia making up 17,2% of the total in 2019 (ARMSTAT, 2020c). However, obsolete technology, irresponsible mining, permanent changes in the regulatory frameworks and structure of institutions have resulted in serious gaps and failures (WB, 2016) which reinforce the adverse impacts of MPAs on ecosystems and human health.

MPAs are regarded as being a source of environmental degradation in Armenia (WB, 2014). Open pit mining causes deforestation, and serious harm to biodiversity, as it covers a wide land surface (PFA, 2010). Apart from land uptake, loss of forest cover and biodiversity, mining and processing companies (MPCs) use large amounts of water for enrichment and processing operations (WB, 2014) which are likely to cause water stress in the future. Tailings of metal mines disposed in tailings storage facilities (TSFs) contain toxic chemicals such as cadmium, chromium, arsenic, lead etc. which may infiltrate into the environment and pollute the soil, water, and air. Ultimately, hazardous substances get into the food chain through irrigation water and wind (PFA, 2010; WB, 2014; Pipoyan et al., 2018; Belyaeva et al., 2019).

The environmental pollution caused by MPAs is likely to have impact on human health, as reflected in some concerning statements on health. Thus, Armenia, with a population of only three million and a small territory of 29 743 km² (ARMSTAT, 2020a), is the second country in the world with highest number of deaths caused by cancer[1]. According to the former chief oncologist of the Armenian Ministry of Health, the country recorded about 70% increase in oncological diseases and mortality rate in the past two decades as of April 2018 (Tert.am, 2018). Blood circulatory system diseases and malignant tumours made up three forth of the causes of death in the country in 2019 (ARMSTAT, 2020d) (see Annex 1). In Alaverdi, which is in the second biggest mining region of Armenia Lori, people were experiencing health problems, such as birth and developmental defects and chromosomal anomalies during the operation of the copper smelter by Armenian Copper Programme (ACP) (PFA, 2010). The region is the second by high cancer rates after the capital city, for which the local population

[1] Source: https://www.worldlifeexpectancy.com/

blames the environmental pollution in the result of MPAs (WB, 2016). Despite the fact that, MPAs cause environment pollution and high concentration of hazardous chemicals which are harmful for health and are found in the carcinogenicity classification of International Agency for Research on Cancer (IARC) (Mach et al., 2019), the direct link between MPAs and deteriorated health in Armenia is under-observed.

It is important to note that, since 2011 the United Nations (UN) has adopted Guiding Principles (UNGPs) on Business and Human Rights (BHR) with focus on "do no harm". Under the framework "Protect, Respect and Remedy" UNGPs steer the states in the direction that, it is the governments' responsibility to protect the rights of their citizens through enforcement of regulatory frameworks for businesses to respect human rights, it is the businesses' corporate responsibility to respect human rights, and it is the responsibility of both to provide "mechanisms" for accessible and effective "remediation of those negatively affected by business activities" (WB, 2014, p. 12).

Recalling the first definition of the sustainable development it is "the development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 2). Therefore, the governments' commitment in reaching Sustainable Development Goals (SDGs) is crucial. The most recent document, UN-Armenia Sustainable Cooperation Framework (CF) 2021-2025, which is to support Armenia in reaching its SDGs by 2030, outlines the need for sustainable mining, mitigation of negative environmental impacts and development of Armenia's mining sector strategy (GoA & UNCT, 2021).

The above-mentioned facts have been the motivation for this case study, which pursues the goal of looking at the reality in Lori and the negative health and environmental impacts of mining especially in the light of significant changes in the political arena of Armenia in 2018 referred to as "Velvet Revolution" due to the peaceful transfer of power to the opposition.

1.2. Problem, Purpose and Research Question

The ecosystem, as one of the determinants of health, is often neglected by decision makers, whereas understanding the impacts of such decisions on the environment and health is crucial in the context of sustainable coexistence of social and economic needs, nature, and human health (Yee et al., 2012). Furthermore, modern concept of public health puts individuals in the centre of the whole system of social determinants of health, where ecosystems are only one determinant, whereas humans are part of the ecosystem and create pressures, impacts and

responses leading to tensions (Bentley, 2014; Lang & Rayner, 2012). Thus, the policies, programs and research are often limited to addressing only one aspect of the problem without appropriate consideration of the consequences of those tensions on larger systems.

There is no shortage of research on the environmental degradation in the region, however, its impacts on human health are underplayed as there is a very limited number of studies. There are concerns and alarming statements regarding the negative health impacts of MPAs, particularly on decreased fertility and higher risks for cancer, however the studies on health are rather scarce (WB, 2016).

The purpose of this qualitative case analysis is to describe the problems of livelihoods, environmental degradation, and negative health impacts on the population in the result of MPAs in Lori and to interpret the response of various actors to the problem.

Combined drivers-pressures-state-impacts-responses (DPSIR) framework and Ecological Public Health (EPH) model are expected to give the research both disaggregated and holistic construct and identify issues which need urgent action. DPSIR will help understand the individual factors and determinants where the humans' role is central, whereas EPH will enable us to look at the whole system where humans are only a part of it.

While mining and other related activities in the Lori region of Armenia secure some livelihoods and keep the economy going, they violate the rights of people to live in healthy environment, and negatively impact their health. With this argument in mind the study will be guided by the following research question:

> *How can DPSIR and EPH be used to analyse the negative environmental and health impacts of MPAs in the Lori region of Armenia:*
>
> *(a) to identify downplayed matters related to environment and health and*
>
> *(b) to support the "conviviality" of economy, livelihood, environment, and health without compromising any of them?*

CHAPTER 2: BACKGROUND

2.1. Metal Mining in Armenia

Metal mining and industrial metal production in Armenia started in the 18th and early in the 19th centuries with the opening of Alaverdi copper mine in 1770s and Kapan copper mine in 1840s (WB, 2016). It expanded during the Soviet epoch in the early 1950s with the opening of the Zangezur Copper Molybdenum Combine (ZCMC) (MTED, 2005). During that period Armenia's economy was heavily relying on the mining industry due to the country's significant deposits of copper, gold, dimension stones, molybdenum, lead, silver and zinc (WB, 2016). The sector was paralysed after the collapse of the Soviet Union and independence of Armenia in 1991 (Akopyan et al., 2018). This was conditioned by incompliance with best international practices, difficulties connected with the obsolete technology and equipment, maintenance of production and entry to the world market (MTED, 2005; WB, 2016). However, due to the legislation changes in early 2000s, which were followed by privatisation of mining companies and liberalisation of the sector, it gradually recovered and started attracting foreign investments (Akopyan et al., 2018; MTED, 2005; WB, 2016).

For the last two decades mining and quarrying has been the country's largest productive industry of which mining of metal ores comprised 96,1% in 2019 (ARMSTAT, 2020c). In 2019 in two main mining regions of Armenia, Lori and Syunik, the industrial output of mining and quarrying made up 40,8% and 81,6% of the regional total respectively (ARMSTAT, 2020c).

Currently there are 400 operating mines in Armenia, of which 22 are metal (MEINR, 2021). There are 15 tailings dams[2] in the territory of the country, which occupy a total area of around 700 hectares (WB, 2014) equalling to 1308 football fields[3]. ZCMC's Artsvanik dam in Syunik is the largest dam making up almost 75% of the total volume of all TSFs in the country (WB, 2016). The Teghout dam in Lori is planned for large volumes and occupies 240 hectares (PFA, 2010; WB, 2016). Tailings, accumulated in the result of MPAs, contain significant volumes of polymetallic deposits which are not recycled currently (MEINR, 2021). Map 1 in Stuhlberger's (2012: 14) report shows MPAs in Armenia.

[2] This number is repetitive in several sources including the official website of the Ministry of Energy Infrastructures and Natural Resources (MEINR) and is often disputed. For example, according to Hetq online newspaper, there are 16 TSFs in the Registry of hazardous production facilities, however, Hetq claims that their real number is 25. Hence, there is no complete inventory of the TSFs in Armenia.
[3] Source: https://www.justintools.com/unit-conversion/area.php?k1=hectares&k2=football-fields

Map 1: Mining and processing activities in Armenia

The sector does not require much labour and mainly hires low-skilled labour force. In 2019 it employed only about 8300 people, which was only 0,8 % of the total number of the actively engaged in labour market – 1,08 million (ARMSTAT, 2020b; WB, 2014). The country's poverty rate remains high and was 26,4% in 2019 according to ARMSTAT (2020d)[4], i.e., the country has shown slow growth, as in most cases of resources-rich countries, where high natural resource exploitation correlates with slow growth (Sachs, 2001). From the poverty reduction perspective, there can be an opposite correlation, i.e., even if MPCs employ some of

[4] Poverty line defined at $5.50 a day per person for Armenia as a lower middle-income country, based on consumption aggregate which is calculated using the data from Integrated Living Condition Survey of Households (ILCS)

the local population, mining activities and their expansion are likely to have a negative impact on the environment, which may consequently increase inequalities (Grigoryan, 2013). Yet, local communities are put in the situation of a "forced non-choice" of a desperate population (Theriault, 2018, p. 5). They support MPAs as these are the main employers in Lori and Syunik, thus, as a sole job alternative people have not much bargaining power and are willing to take jobs at lower wages and in any environmental condition (WB, 2014).

Environmental pollution poses a huge risk for ecosystems and biodiversity. According to the Conservation International and Critical Ecosystem Partnership Fund (CEPF) the country's territory is one of the biodiversity hotspots globally (PFA, 2010) (see the map in Annex 2).

2.2. Regulatory Frameworks

Apart from primary risks, such as emissions of huge amounts of pollutants into the environment due to poor operation of mines, mineral sector in Armenia is associated with other risks. Even though laws are in place, none of them provide for adequate control and mitigation of negative environmental and health impacts (WB, 2014) (see the Regulatory and Institutional Frameworks in Annexes 3-6). For example, the Law on Environmental Impact Assessment (EIA) is elaborate and provides for assessment, prevention, and mitigation methods for potential negative environmental and health impacts, but there is a lack of some regulatory acts or guidelines for its implementation, such as methodologies for assessing the negative impact on human health or biodiversity (WB, 2016).

According to the WB mineral sector assessment (2016), non-compliance of MPCs with regulatory frameworks, due to the lack of by-laws, poor implementation, unclarities, or insufficient environmental fines, are among major concerns which are likely to generate most of the risks. It is one important factor fuelling "environmental crimes" (Stefes & Weingartner, 2015, p. 26). Exploited mines are left without adequate reclamation and rehabilitation, seismic risks, characteristic of this geographical area, are not considered when constructing TSFs (WB, 2016). Among those inspected annually for non-compliance with provisions of the mining contract, the WB assessment (2016) has identified high (70%), medium (25%), and low risk (5%) mines. Reoperation of the Teghout mine, the second biggest in Armenia, is one of the examples of failed due diligence of all parties involved. It was closed due to the risk of TSF collapse in 2018 but was reopened in 2019 despite several international expertise conclusions including the WB assessment (Vardanyan, 2019) (see the Risk Catalogue Annex 7).

To bring accountability and transparency to the mining sector and attract investments, Armenia, supported by WB (2016) and the Centre for Responsible Mining of the American University of Armenia (AUA CRM), joined Extractive Industries Transparency Initiative (EITI) in 2017 (EITI, 2018).

Efforts are underway by AUA CRM to support the improvement of Armenia's regulatory frameworks through drafting legislation that strengthens socio-economic benefits of mining while mitigating the environmental and health impacts, strengthening multistakeholder partnerships with an emphasis on the grassroot and community representation in policy making (Vivoda & Fulcher, 2017). WB and AUA CRM have recommended complementing EIA by tools such as cumulative impact assessment (CIA) and strategic environmental and social assessment (SESA) in line with best international practice. CIA assesses the impacts in interaction with other elements, and SESA is a sector-specific assessment of environmental and social impacts of mining (WB, 2016).

2.3. Mining in the Lori Region

The town of Alaverdi in Lori is known for the oldest and largest copper smelter of Armenia, which was closed after the collapse of the Soviet Union, reopened in 1997 and closed again in 2018 due to non-compliance with regulations on emissions (Akopyan et al., 2018; Bystrianský et al., 2018). It was a huge source of pollution as it was emitting sulphuric gases into the atmosphere. To improve the situation in 2011 a new and higher chimney stack was installed, due to which, however, hazardous emissions were spreading and covering a larger area (Akopyan et al., 2018). Another source of contamination was the smelter slag disposal in environment and its use by the municipality to de-ice the roads in winter (Akopyan et al., 2018; Nazaryan, 2009). Both in Alaverdi and Akhtala there are abandoned tailings (Saghatelyan & Sahakyan, 2010).

Akhtala is 15 km northeast of Alaverdi, located along the Shamlugh river, which flows into the Debed river. There are mines of copper and molybdenum which are processed in Akhtala Mountain Enrichment Combine (AMEC). The active and abandoned tailing dams, one of which is in the town, are the major sources of contamination in Akhtala (Bystrianský et al., 2018).

The Teghout copper mine in Lori was opened in 2014 (WB, 2016). Teghout is 20 km from Alaverdi, in the valley of the Shnogh river, which flows into the Debed river (Bystrianský et

al., 2018). After the Danish journalists' investigation in 2017 (Malling, 2017; Malling & Børjesen, 2017) and their claims that the project was unsafe due to a badly constructed tailings dam with upstream raise design (WB, 2016)[5], the mine was temporarily closed in 2018 as a result of the withdrawal of a $62 million credit guarantee by Denmark's Export Credit Agency (EKF) because the mining company Vallex failed to comply with environmental standards (Bystriansk ý et al., 2018; Lazarian & Hambardzumyan, 2017). The Vallex group invited American experts for further investigation, who confirmed the claim (Vardanyan, 2019). However, the operations restarted again in June of 2019 despite the existing risks.

2.4. Environmental Activism

After Armenia's independence public perception of environmental problems and participation in decision making developed gradually and in recent years civil society organisations have appeared to be quite active in reaching out wider public, grassroot communities, and decision makers (PFA, 2010; Stefes & Weingartner, 2015). The mining sector has been in focus of the environmental non-governmental organisations (NGOs) which led to some prominent results. The Save Teghut Civic Initiative launched in 2007 is one example, which involved a significant number of citizens in Armenia and abroad, and is probably one of the reasons the operation of mine was delayed until 2014 even though the mining permit was issued in 2007 (Stefes & Weingartner, 2015; WB, 2016). The recent biggest movement is connected with the biggest gold mining project in Amulsar which is currently on hold due to the grievance and protests of public, civil society organisations (CSO), and environmental activists (Taarup-Esbensen, 2019).

[5] In some jurisdictions, as, for example in Chile, where seismicity is at high level, the appliance of upstream raise construction of TSFs is prohibited by law (WB, 2016).

CHAPTER 3: LITERATURE REVIEW

3.1. Environmental and Health Impacts of MPAs in the Lori Region

The following studies of environmental and possible health impacts of MPAs in the Lori region have been identified in the result of the literature review.

In 2018 the Czech non-governmental organisation (NGO) Arnika with local NGOs, Armenian Women for Health and Healthy Environment (AWHHE) and "EcoLur" Informational NGO carried out sampling of soil, sediments, sand from children's playgrounds, and human hair from the vicinity of MPAs in Alaverdi, Akhtala, and Teghut (Bystrianský et al., 2018). According to the results, most samples contain high concentration of copper, often combined with molybdenum and zinc or, sometimes, with lead and arsenic. Of 14 hair sample results, only three have shown somewhat high or high concentrations of heavy metals, which the authors of the study relate to the consumption of local fish presumably caught in water sources polluted with heavy metals.

The same organisations conducted a study of sampled chicken eggs collected in 2018 in Alaverdi (Petrlík & Straková, 2018). The results identify contamination of eggs with dioxins which can be related to the copper smelter.

Arnika, in collaboration with the Centre for Community Mobilization and Support NGO (CCMS), and "EcoLur" collected 73 urine samples from Akhtala, and other communities in Lori and the neighbouring Tavush region, which is not affected by MPAs, for studying the presence of arsenic, cadmium, copper, nickel and lead and compare the results of both regions (Šuta et al., 2020). The results show that the concentration of arsenic is higher in the urine of the population, especially in children, in the communities of Akhtala compared to the non-mining region. Arsenic is considered carcinogenic which influences foetus and child development, nervous and blood circulatory systems (Šuta et al., 2020). The results of the study also show high concentrations of cadmium in the human urine which is another carcinogenic element damaging kidneys, nervous and hormonal systems. In comparison, concentrations of copper and lead are lower, but long-term exposure to these elements may cause liver and nervous problems.

Informational Analytical Centre for Risk Assessment of Food Chain of the Centre for Ecological Noosphere Studies (CENS) in the National Academy of Sciences (NAS) carried out

a study to investigate the transfer of potentially toxic elements from the soil to fruits and vegetables grown in Alaverdi (Pipoyan et al., 2018). Accordingly, concentration of hazardous elements in agricultural soil is likely to affect food safety by entering the food chain. The results show that nickel, lead, zinc, and cadmium in soil exceed the maximum allowable levels, and nickel, copper and mercury in fruits and vegetables exceed the health-based guidance values[6].

The results of another study by CENS, prove that during the processing of ore in Akhtala, tailings mix with surface waters polluting downstream lands and soil with substances including cadmium, classified as first category of hazard. These concentrations exceed maximum allowable concentrations by tens to hundreds of times (Belyaeva et al., 2019). Moreover, there is evidence that elements, such as lead, arsenic, cadmium, and mercury and their mixtures, which pose risks for human health, enter the food chain as they are contained in plants and animal products (IARC, 2006).

Results, similar to Belyaeva (2019), were shown by earlier studies with only one additional element, copper (Saghatelyan & Sahakyan, 2011). Figure 1 illustrates Saghatelyan and Sahakyan's (2011: 6) presentation of properties of metals as pollutants and their possible risks for human health.

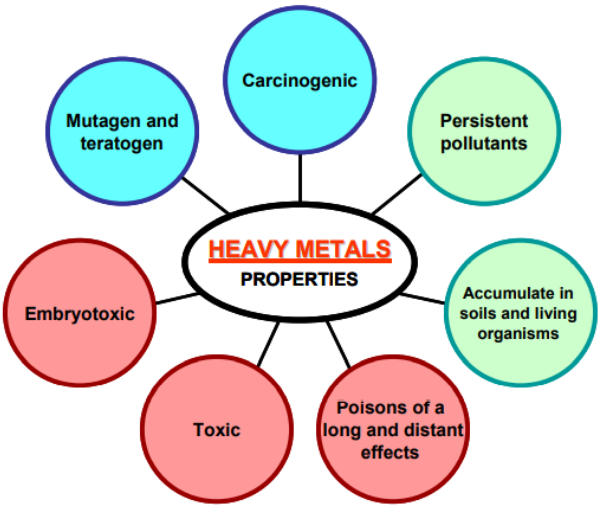


Figure 1: Properties of heavy metals

The School of Public Health of the American University of Armenia (AUA SPH) carried out a risk assessment of toxic waste sites in 2013 within a nation-wide Toxic Site Identification Program initiated by Pure Earth (Akopyan et al., 2014; Akopyan et al., 2018). The assessment

[6] The authors of the study have applied health-based guidance values defined by international organisations, such as US Institute of Medicine, Scientific Committee for Food, Expert Group on Vitamins and Minerals, European Food Safety Authority.

covered Alaverdi, Akhtala, Armanis, Metz Ayrum, Chochkan communities in Lori. The main findings point out at a number of significant environmental and human health impacts, including polluted soil surface water and groundwater (WB, 2014). The results of the sampling of soil revealed that in Alaverdi, 75.6% of samples surpassed 'Clean up Level[7] for arsenic and 24.0% for lead' (Akopyan et al., 2018, p. 97). In the mining town of Akhtala with an underground mine from the Soviet era, and an open pit mine in operation since 2001 (Stuhlberger et al., 2012), 3.2% of all soil samples exceeded Clean up Level for arsenic and 27.1% for lead (Akopyan et al., 2018, p. 1). By the results of this study pollution levels in Alaverdi and Akhtala were classified as moderate to strongly polluted[8].

AUA SPH carried out a study on blood lead levels (BLL) in children. The results show that children living near MPCs are exposed to lead (Grigoryan et al., 2016). According to the study and reviewed literature, lead is linked to health risks such as worsened neurobehavioral development, lower intelligence quotient, poor attention and memory, and other neurobehavioral and growth-related disorders. Thus, the study suggests an assessment of high BLL consequences (Grigoryan et al., 2016).

The abovementioned studies represent probability of negative impact of hazardous elements accumulated in the environment in the result of MPAs, however, there are quite a few studies on negative impact and health risks for communities affected by MPAs (Akopyan et al., 2014; Pipoyan et al., 2018). There are no periodical data and time series on adverse health effects of polluted environment on health, or local populations' health problems which might be a result of dietary exposure to hazardous elements (Pipoyan et al., 2018).

Despite evidence of contamination of the environment in Alaverdi and Akhtala by heavy metals, most of which are classified as human carcinogen by IARC, the Armenian health authorities have not taken any significant actions to assess the impact of the MPAs on public health (Grigoryan et al., 2016).

Studies and assessments of policy, environment, risk management pertaining to mining industry in Armenia have been carried out by the initiative of WB (2014, 2016), European

[7] Maximum Allowable Concentrations (MAC), Clean up Levels (CL) and Highest Background Level (HBL) at 10cm and 20 cm depth by National Environment Protection Council of Australia (1999) and Canadian Council of Ministers of the Environment (2001) were applied as reference levels for the assessment.

[8] The highest concentration of lead was found in the churchyard of Akhtala (Geometric Mean = 4841.1 mg/kg), and Alaverdi exceeding the total GM of lead by 16 and by 19 times, respectively. This may be explained by the centuries-old industrial activities in Alaverdi and the 10th century fortress of the Armenian Bagratid dynasty in Akhtala where they had a smelter to mint coins.

Union (EU) (Stefes & Weingartner, 2015), Political Forum Armenia (PFA, 2010), Zoï Environment Network (Stuhlberger et al., 2012) which identify gaps and set forth recommendations aimed at improvement of the industry that are referred to in different parts of this study.

The literature review, empirical data, and a response from the World Health Organisation (WHO) country office in Armenia allow one to assume that WHO has not initiated studies of such impacts in Armenia so far, apart from providing support to the development of a national methodology on the assessment of health impacts of MPAs to be carried out in the spring of 2021. This suggests that little attention has been paid to the study of negative health impacts of MPAs in WHO-initiated projects and support requested by the Armenian health authorities.

3.2. Available Data and Data-Driven Policy Making

The sources of information and data available for decision making are as follows. The primary data on environment are produced by the "Hydrometeorology and Monitoring Centre" SNCO (HMC) under the Ministry of Environment (MoE) which implements environmental monitoring of air, surface water, ground water, forest, waste, and soil (GoA, 2020). The primary data are provided to the RA Statistical Committee which produces the environmental statistics. The National Centre of Diseases and Control (NCDC) implements sanitary expertise and laboratory examination of environmental factors, and the National Institute of Health (NIH) produces health statistics (Andreasyan et al., 2020; NCDC, 2014). Apart from data provided by the research covered in section 3.1., investigations have been carried out by Armenian and Danish journalists. However, the efforts of the Armenian health authorities to conduct further in-depth research and develop policies to address the identified problems of public health remains unclear, especially given that the Armenian mining legislation does not allow calculations of broad effects of MPAs including their negative health effects and healthcare costs resulting from those effects (AUA CRM, 2016).

CHAPTER 4: THEORY

Given the intersectionality of the observed problem, the integrated DPSIR (drivers-pressures-state-impacts-responses) framework and EPH (Ecological Public Health) model have been employed to guide the body of knowledge of the research. While DPSIR framework is well-suited to look at the relationships between the causes and effects of environmental issues, as well as relationships between different factors (Smeets & Weterings, 1999), EPH draws on the ones relating to and impacting public health and social equity (Bentley, 2014).

Generally, DPSIR is known and liked for its simplicity, ability to integrate different factors under one umbrella and identify their causal relationships (Maxim et al., 2009). However, the framework has been widely criticised and, particularly, it is believed to be less sensitive to social injustices and inequalities (Maxim et al., 2009; Ness et al., 2010). While the categories or indicators study the matter in question at certain intervals, they fail to capture the important changes and trends within and beyond the relationships of the observed indicators (Carr et al., 2009). Nevertheless, the framework is scientifically relevant and has a high credibility among many researchers and international organisations such as European Environment Agency (EEA), European Statistical Office (Eurostat), UN agencies, to name a few, and has been used in combination with other theories for development of policy documents, for example, European Water Framework Directive (Borja et al., 2006; Gari et al., 2015; Yee et al., 2012). Some environmental scientists suggest that DPSIR is most efficient when combined with other theories (Gari et al., 2015).

Given that health is an important part of this research, the use of DPSIR in combination with other theories suited for public health has been reviewed. Thus, DPSIR has been combined with different models for public health assessment, which have been mainly focused on the individual level (Yee et al., 2012), whereas the interest of this research falls on the macro and policy level, and goes down to the community and individual levels to understand the under-observed problems and linkages which DPSIR might omit. Akin to that, public health has been studied using different socio-ecological models, but they downplayed the biological connections within ecosystems which are important for this research (Lang & Rayner, 2012).

Thus, inspired by Bentley (2014), Lang and Rayner (2012), the EPH model, which recognizes humans as part of the ecosystems, neither separate nor central to that (Bentley, 2014), has been favoured as most suitable public health model for this case study.

4.1. DPSIR Framework

As defined by the EEA, DPSIR is a causal framework for describing the interactions between society and the environment: driving forces, pressures, states, impacts, responses (Smeets & Weterings, 1999, p. 7). The DPSIR framework was developed by the Organisation of Economic Development and Cooperation (OECD) for the assessment of socio-ecological systems (SES) in 1993 and recommended to the EEA as an adaptive management instrument in 1995 (Carr et al., 2009; Gari et al., 2015). Since then, it has been widely used by the EEA as an integrated reporting approach (Kristensen, 2004). According to Maxim and colleagues:

> …social and economic developments (Driving Forces, D) exert Pressures (P) on the environment and, as a consequence, the State (S) of the environment changes. This leads to Impacts (I) on ecosystems, human health, and society, which may elicit a societal Response (R) that feeds back on Driving Forces, on State or on Impacts via various mitigation, adaptation or curative actions (2009, p. 2).

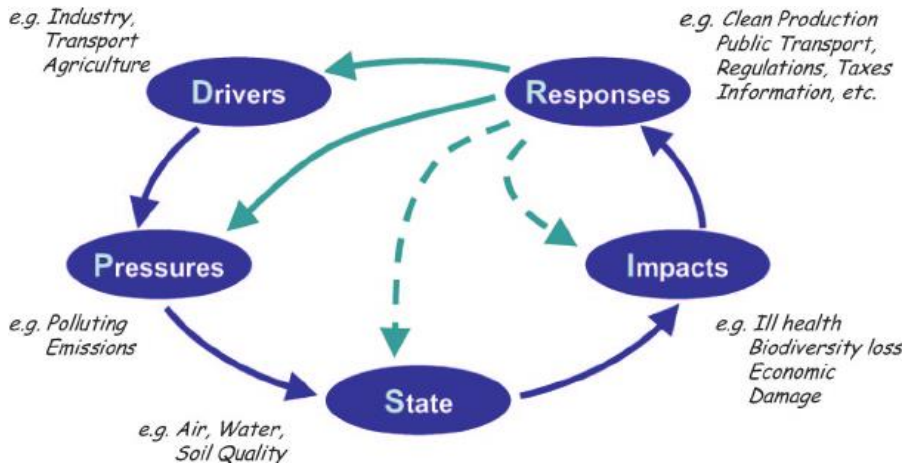


Figure 2: EEA illustration of DPSIR Framework (1997)[9]

In this study, DPSIR gives a holistic overview of and linkages between economic, social, environmental and health factors associated with MPAs in Lori. The factors identified within this research have been categorised into five groups. The structure provided by DPSIR enables one to adopt indicators as basis for feedback on decisions and policies on environment (Kristensen, 2004). It helps analyse the response by the society and policy makers to the 'economic 'impacts' on the functioning of ecosystems, their life-supporting abilities, and

[9] Source: https://www.eea.europa.eu/publications/92-9167-059-6-sum/page002.html

ultimately on human health and on the economic and social performance of society' (Kristensen, 2004, p. 3). This gives an overview of the gaps and inefficiencies in the whole cycle.

The definitions of the five categories of the DPSIR framework have been altered to some degree by different researchers (Yee et al., 2012). The table below gives an integrated summary definition for each component inspired by Kristensen (2004), Yee et al. (2012) and Maxim et al. (2009). It is made so to guide the given study while maintaining the simplicity of DPSIR.

DPSIR categories	Definitions	Key concepts
D – Drivers	Social, cultural, & economic forces that are based on human needs & lead to economic & human activities; the factors that motivate human activities	Population; Government; Economy; Policy; Development; Investment; Livelihoods; Economic security; Employment; Jobs; Income; Benefit; No alternative Natural resource exploitation; Mining industry; Responsible mining; Metal mining; Copper smelter; Raw material; Complete production cycle; Ore processing; Production technology; Concentrate; High-value end-product; Low-value raw material
P - Pressures	Result of drivers, i.e., creation of environmental pressures, human behaviour & activities that alter the state of environment & humans.	Mining & processing activities (MPAs); Mining & processing companies (MPCs) Excessive exploitation of natural resources; Excessive use of water for processing Direct emissions to air, water, & soil; Indirect emissions to air, water, & soil; Excessive emissions; Leakage of tailings Tailings; Tailing storage facilities (TSFs); Tailings dam; Monitoring; Control; Uninformed decision; Norms;

		Smoke; Accidental or intentional discharges & disposals
S-State	Altered 'state' of environment because of the pressures, i.e., the quantity of physical, chemical, & biological components in air, water, soil & biodiversity which affect the quality of air, water, soil & biodiversity. Human exposure to the changes in the quality of air, water, soil & biodiversity	Excessive concentration of pollutants; Fifth-class water pollution Lead; Cadmium; Uranium; Arsenic; Pollutant; Acidic rain; Sulphuric gases; Sulphur; Dioxide; Molybdenum; Copper; Carcinogenicity
I-Impacts	Changes in environment then impact human well-being through changes in ecosystem structure; 'Impacts' on ecosystems, human health & functions, eventually leading to 'Responses'	Negative impact; Affected communities, Degraded environment; Degraded human health; No alternatives. Diseases; Cardiovascular diseases; Cancer; Respiratory disease; Liver; Diarrhoea; Insufficient data; Insufficient evidence; Statistics; Depopulation
R-Responses	A response by society or policy makers is the result of an undesired impact; it means modification of human activities, State of the environment through restoration or remediation, or attempt to quantify costs or compensate for Impacts of environmental degradation to humans	Public grievance; Activism; Civil society; Civil society organisation; Public discussions; Awareness raising. Policies, Programs; State support; Regulatory frameworks Social programs; Corporate social responsibility; Medical check-ups; Restoration; Reclamation

Table 1: Integrated summary definitions of DPSIR categories and key concepts of the research

4.2. Ecological Public Health Model

EPH is a public health model focused on links between environmental pollution and its impact on humans and nature (Lang & Rayner, 2012). The advantages of the model are macro-environmental focus, knowledge building in addition to evidence-base, intersectionality, and

its acceptance of complexity of connections, which, simultaneously, lead to the criticism of the model as a long-term approach requiring system changes and actions by all involved or impacted parties (Lang & Rayner, 2012).

The adoption of this model is motivated by findings based on literature review, observations on health, worrying statistics on high rates of cancer in Lori (Andreasyan et al., 2020) and the inaction of decision makers in this respect. Moreover, according to some data, artifacts, and observations, the pressures created by MPAs are not regarded potentially harmful for public health in Armenia. Hence, health has been one of the main focuses during the qualitative data collection. EPH has been embedded into the theory as a more sensitive approach to observing interrelations as a happy co-existence or *conviviality* between different entities of an environment, *equities* and *sustainability* considerations in distribution of goods and *global responsibility* for the taken actions or inactions (Bentley, 2014). Due to its integrative and multidisciplinary nature EPH allows framing the complexity of the matter in question which is "often used as an excuse for inaction" (Rayner, 2009, p. 590). The model also allows to have a closer look at the relationships of public health and ecology to understand why the Armenian health authorities do not relate health to ecology. Moreover, in pursuit of economic gains public health becomes secondary to political and economic agendas. Public health policies are often narrowed to the idea of healthcare and individual choices, behaviour, and lifestyle, thus giving a weak linkage between evidence, policy and practice as well as political will to create a better accord between humans and their living environment (Lang & Rayner, 2012). As Lang and Rayner (2012) further elaborate, EPH allows to take actions for addressing the problems which deteriorate the balance between human health and ecosystems health.

While the health policy in Armenia is concerned by the physical environment and impact of individual choices and behaviour, the lack of political will to accept and research the environment from the public health perspective leads to underinformed decisions and actions which often downplay ecological factors, such as degraded ecosystems, and their impact on public health. Health promotion campaigns in Armenia, such as anti-smoking campaigns and law enforcement on bans to smoke in public areas, are predominantly related to individual choices (TCL, 2021), whereas the relation between degraded health and MPAs seem to be neglected (Poghosyan, 2019).

The new public health movements criticize health promotion campaigns which are highly unlikely to make sustainable changes (Baum, 2008; Baum & Fisher, 2014) or they may even

exacerbate inequities in public health and social life (Keleher et al., 2007). A significant example of inequity is the exclusion of people from the participation in decision making and shaping of democratic society (Lang and Rayner, 2012). Lang and Rayner introduce EPH principles in material, biological, cultural, and social dimensions. Bentley sees EPH as conviviality, equity, sustainability, and global responsibility. The two approaches have differences but the core idea of both is the successful co-existence of ecosystems and social relationships. This model is well suited in answering the research question in terms of the purpose to *identify downplayed health and environmental matters, and opportunities for conviviality of economy, livelihood, environment, and health without compromising any of them.* The table below illustrates a synthesis of EPH principles inspired by Bentley (2014) and Rayner and Lang (2012).

Conviviality	Health depends on 'successful co-existence of the natural world and social relationships' (Lang & Rayner, 2012, p. 5), i.e., the relations of the 'entities of an environment to each other and their surroundings' (Bentley, 2014, p. 531).
Equity	Equity which also relates to sustainability concern is about how equitably social and environmental goods are distributed.
Sustainability	Resilience is 'the key to sustainability in complex adaptive systems' (Bentley, 2014, p. 532), and provision of long-term security for future generations and sustainable development.
Global responsibility	Global responsibility synthesises the other three principles. State is the coordinator of multiple actors; protection of eco-systems is the responsibility of all through social dimension institutions created between people and expressed in terms of laws, social arrangements, conventions.

Table 2: Principles of Ecological Public Health model

CHAPTER 5: METHODOLOGY

5.1. Research Design

This research has been conducted using qualitative exploratory methods for analysis. The analysis of the primary qualitative data collected from semi-structured interviews and focus group discussions (FGDs) has been the backbone of this study. In parallel with that, data from secondary sources, such as surveys and research have been used to triangulate, test, and verify the primary qualitative data and empirical findings through looking at causalities between the studied activities and phenomena, such as mining, environmental pollution, and the most common diseases in the Lori region.

The research design has shaped a better understanding of the connections between available data on environment and health in official national and international sources and empirical data collected within this research, as well as helped investigate the conflict of *economic security and economic gains* vs *degraded nature and health* in the observed geographic location.

During the first phase of the research qualitative data were collected. The field work provided a complex and detailed overview of the matter in question, understanding of the context and different settings, which enabled the researcher to hear answers from various actors, and voices which might be silenced by vested interests. The qualitative research shaped into a "dynamic and emergent" design as defined by Creswell (2018, pp. 86 & 92) to reflect multiple perspectives, refine questions to reflect an increased understanding of the problem. The initial design of the work was adjusted after the researcher's entry into the field and start of the data collection. The interviewed individuals represented different institutions, organisations, and groups. Thus, in addition to core questions for all the informants, *idiosyncratic approach* (Gomm et al., 2000) was adopted to maintain relevance of the questions for each group and to receive more insightful information. In addition to the interviews, survey data, the researcher's observations, enquiries, documents, reports, artifacts, and social media posts have supported the conduction of the research.

5.2. Research Method and Data

The sample included 19 respondents in total representing MPCs, CSOs, environmental activists, academia, consultants, and government. Two FGDs were conducted with community members and statisticians. The diverse composition of the sample relates to the complexity of

the matter in question and the multidisciplinary nature of the adopted theoretical approach with combined DPSIR framework and EPH model.

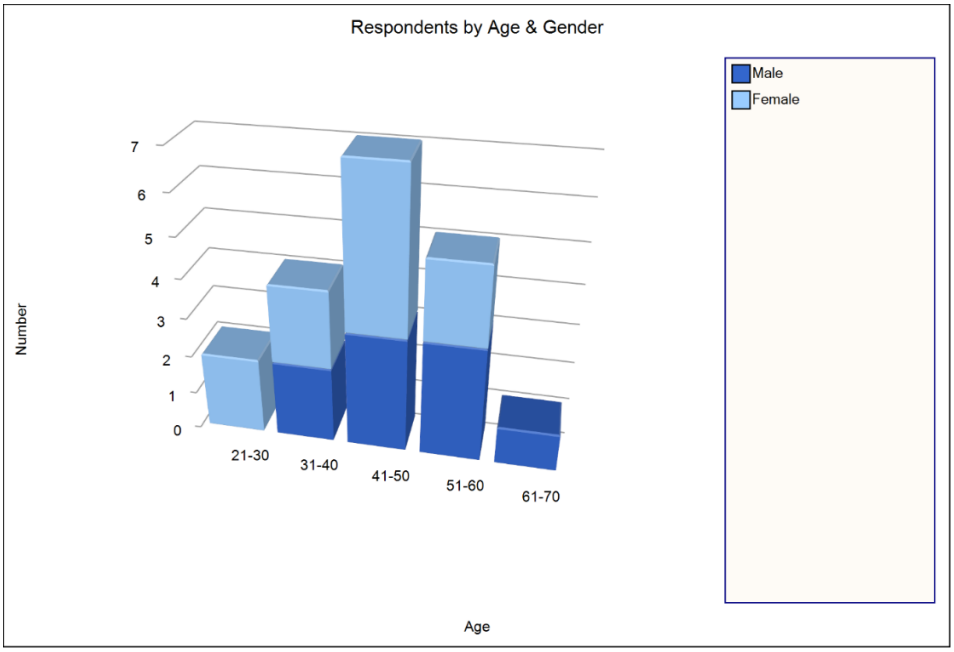
Listening to all the parties involved starting from the communities to policy makers, was aimed to shape a better overview of the tensions related to the matter in question, understanding of the policies adopted by the new government of Armenia, and its priorities in the aftermath of the recent 44-day war in the fall of 2020 between Armenia and Azerbaijan over the disputed territory of Nagorno Karabakh.

5.3. Research Sample Overview

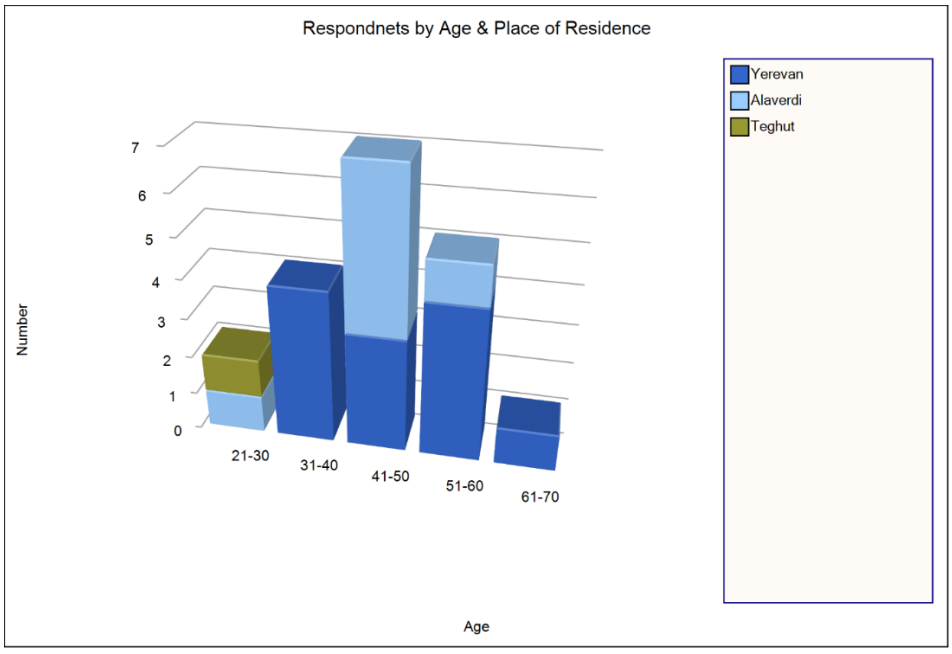
The table and the graphs below represent all the respondents including focus group participants by gender, age groups, place of residence and areas of work.

	A : Gender	B : Place of Residence	C : Area of Work
1	Male	Yerevan	Academia
2	Female	Teghut	Mining Company
3	Female	Yerevan	Government
4	Female	Yerevan	Government
5	Female	Alaverdi	Community
6	Male	Yerevan	Government
7	Male	Yerevan	Civil Society Organisation
8	Male	Yerevan	Investigative Journalism
9	Male	Alaverdi	Mining Company
10	Female	Yerevan	Government
11	Female	Alaverdi	Community
12	Male	Yerevan	Civil Society Organisation
13	Female	Yerevan	Government
14	Female	Yerevan	Investigative Journalism
15	Female	Yerevan	Government
16	Male	Alaverdi	Civil Society Organisation
17	Female	Alaverdi	Community
18	Male	Alaverdi	Mining Company
19	Male	Yerevan	Academia

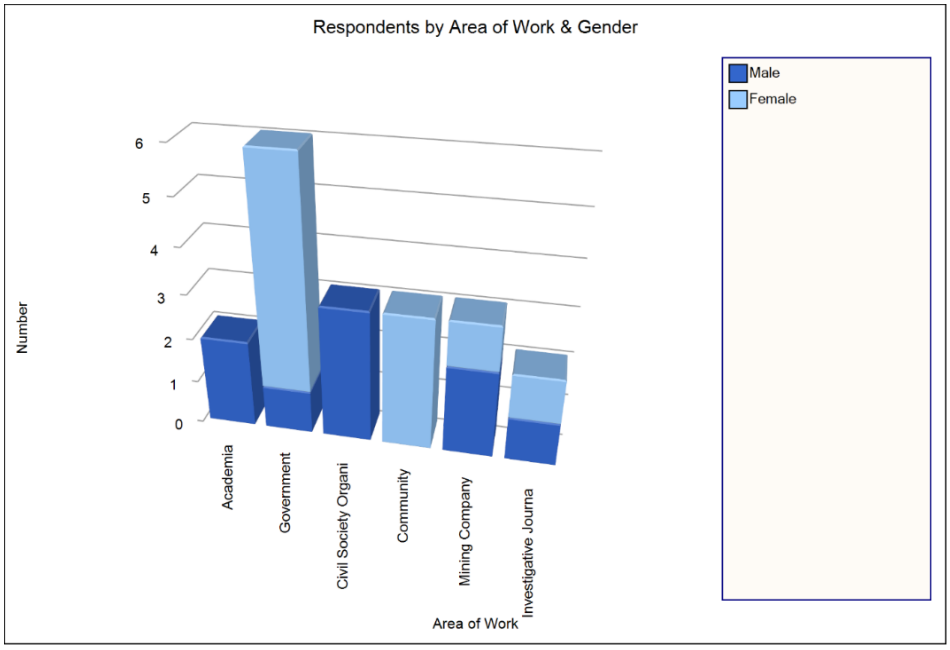
Table 3: Research sample by gender, place of residence and areas of work



Graph 1: Research sample by age and gender



Graph 2: Research sample by age and place of residence



Graph 3: Research sample by area of work and gender

5.4. Interviewing Respondents

The initial contact and the first interviews were made with four key informants, afterwards the sampling was made by the principle of chain-referral and snowball sampling (Saldaña, 2016). Bearing in mind that the data collected from a sample of 19 informants can be subjective and hinder proposing a generalizable theory, the main findings are checked against other surveys and investigations along with analysis to support the research findings.

Claiming that the research question derives from the element of negative impact of mining on health and environment, and its role for economy and livelihoods, the questions were asked thereafter to guide the interviews upwards and downwards to identify factors associated to DPSIR categories and produce meaning from the information and data received from the interviews and other relevant sources (Yee et al., 2012). While the guiding questions were initially classified in five main themes, the interviews followed an inductive approach by applying a particular question on the respondents' observations and opinion on the linkage between the MPAs and the health issues, especially high cancer rates in the Lori region.

The same approach was applied towards the FGDs. The FDG with the community members was conducted via a Zoom meeting due to Covid-19 restrictions. FDG participants were in the same room in Alaverdi which enabled them to interact with each other. This gave additional valuable insights to the interviewer.

An impromptu group discussion with statisticians took place in physical meeting at their office in Yerevan. The group of statisticians working with relevant topic showed openness to have a discussion together. The discussion was conducted based on the guiding questions after the procedure of scripted introduction and acquisition of the participants' consent. It was more a think-aloud process which provided interesting background information on health and environment statistics and political decision making (Tashakkori & Teddlie, 1998).

All the interviews and FGDs were conducted in Armenian.

5.5. Data Processing

The employed framework and model have guided the coding of qualitative data using a generic holistic approach (Saldaña, 2016). Eclectic coding combing attribute, holistic, process, in vivo, emotion, evaluation and pattern coding were applied to data (Saldaña, 2016).

The primary coding was done according to DPSIR framework with a holistic approach scheme, i.e., *theory-theme-categories-codes*, while keeping in mind the four areas either driving MPAs or being impacted by MPAs: *economy, livelihoods, environment, and health*. This part was revisited several times to finetune category classifications according to DPSIR before passing to the actual analysis against DPSIR and discussion of findings against EPH model. This helped identify that all the codes and categories are attributive to more than one EPH principle, *conviviality-equity-sustainability-global responsibility*, or in some cases, relate to all the four principles. The figures below illustrate the initial mapping of data coding according to the adopted framework and model with the use of NVivo 12 plus software. The mapping of final coding is introduced in the analysis and discussion parts of the next Chapter.

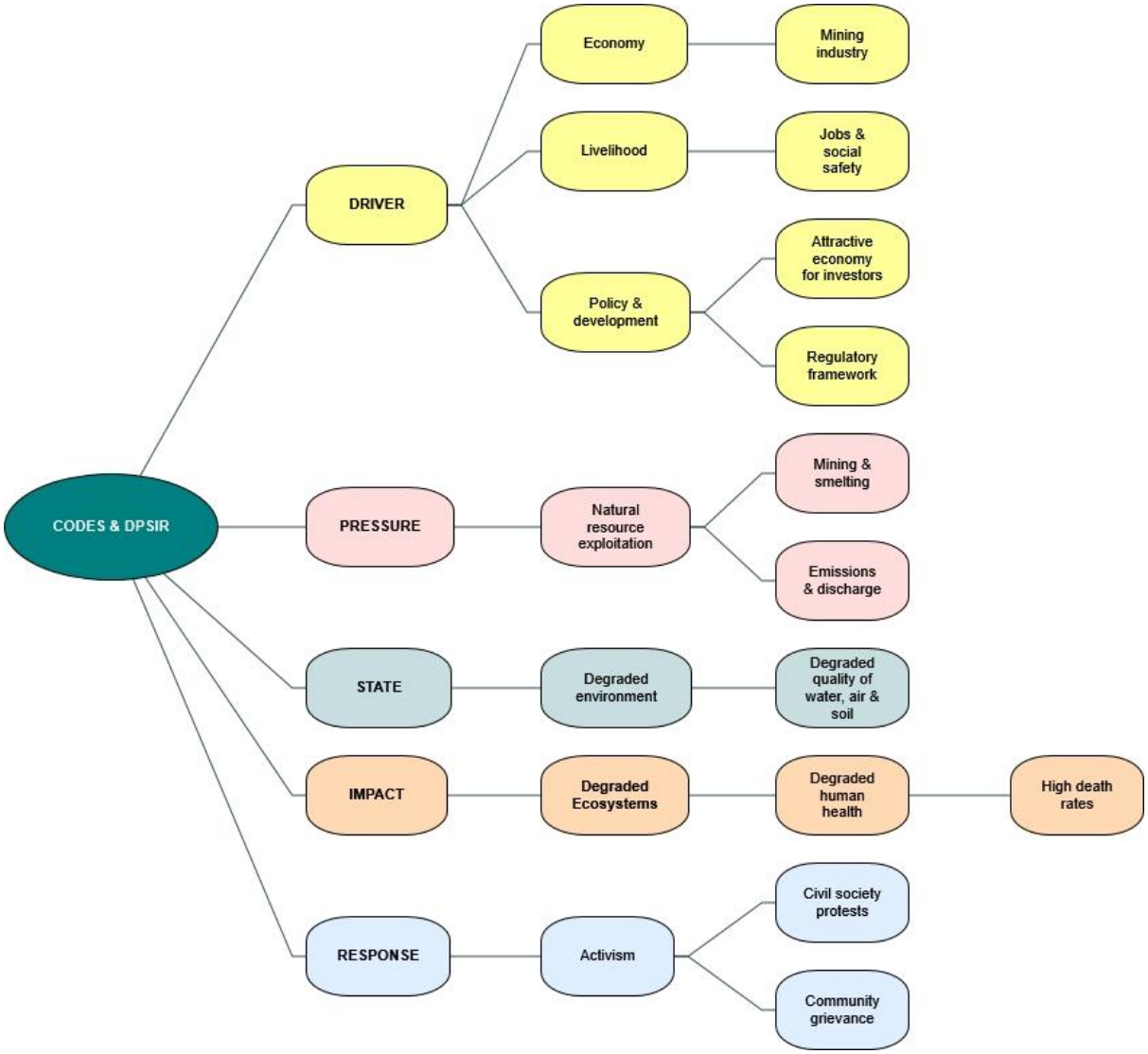


Figure 3: Primary coding by DPSIR

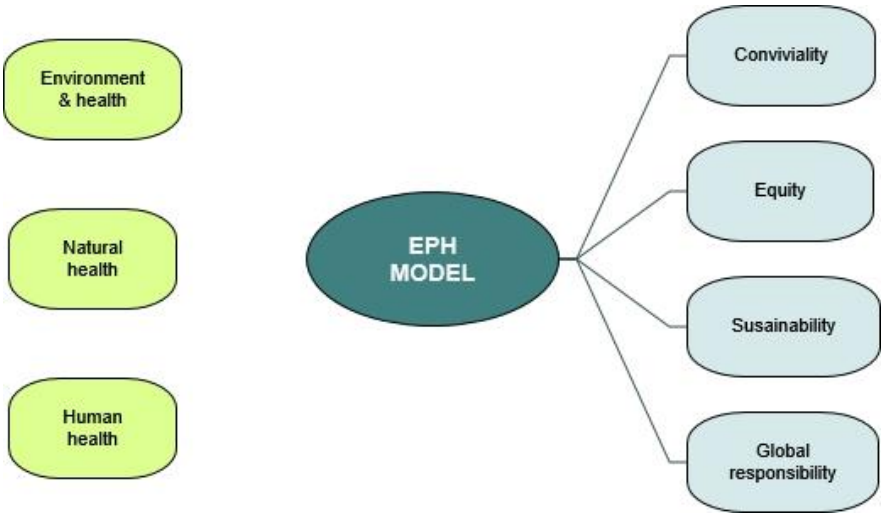


Figure 4: Primary EPH mapping

5.4. Limitations

Acknowledgment of some limitations during this research can be useful for future considerations and improvements.

Even though the researcher managed to travel to Armenia for the field semester and data collection, Covid-19 and related restrictions made it impossible to travel to the observed communities and have meetings on the ground. Nevertheless, four face-to-face individual interviews and one FGD in Yerevan were carried out making up 35,7 % of the total. The gap was filled by the literature review, written communications, social media posts and news in addition to the in-depth interviews with open-ended questions.

The post-war apathy and overall environment of mistrust made it quite difficult to interact with people. Further, the research was not conducted in collaboration with one single local organisation and, therefore, the researcher did not have a 'one window' support in terms of contacting people, which, on the other hand, is regarded as the researcher's advantage of not being constrained by any organisation's agenda and priorities. Some time was, therefore, spent prior to the field work to contact potential interviewees or initial informants for referrals.

Then, the method of chain-referral and snowball sampling was somewhat limiting in terms of control over the method and possible bias of nominating respondents the interview participants knew.

Finally, the interviews in Armenian made the processing of transcripts at a later stage rather time-consuming as they were translated into English, and quality-checked so as not to miss out any important data.

5.5. Ethical Considerations

Ethical considerations and main principles such as *informed consent, voluntary participation, purpose of the study, protection of personal data, reciprocity, small rewards for the time* spent on interviews have been a major part of different phases of the study.

Both by email and at the beginning of the interviews the informants were familiarized with the purpose of the interview, the principles of their guaranteed anonymity and confidentiality, the voluntary basis of their participation, their freedom to refrain from answering any question or

abort the interview should they feel uncomfortable or have any other reason to do so. Before starting the query, they were asked for their consent for being interviewed and recorded.

The interviewer's commitment to personal data protection and protection of the respondents from harm and any risk was made explicit. The principle of reciprocity was secured by answering the respondents' questions and agreeing to provide the copies of the report to them. At face-to-face interviews, the respondents were rewarded in the form of sweets for their time commitment.

Ethical issues might have arisen or may arise in different phases of the research especially given that the respondents represent communities, civil society, commercial companies, and the government. This means that they might represent opposing opinions deviating from the mainstream or their employers' viewpoint, or sensitive data not to be disclosed. Thus, the researcher's obligation has been being mindful of opportunities which might put the respondents at unnecessary risks of job loss or other unforeseen inconveniences in the phases of analysis and publishing the study. That is why, while coding and analysing the interviews, multiple perspectives, contrary findings, and composite stories have been reported so the individuals cannot be identified (Creswell & Poth, 2018).

The use of any previously published material is referenced appropriately with the respect of proprietary and copy right considerations.

CHAPTER 6: ANALYSIS OF FINDINGS

Before presentation of findings and proceeding with analytical part of this work it is worth introducing how the chapter is structured and how it responds to the research question. The case study is complex due to the intersectional nature of the chosen area, and the adopted theoretical approach is to support the analysis and discussion of findings.

This chapter presents an overview of analysis of MPAs in Lori with the research question in mind which asks *how DPSIR and EPH can be used to analyse the negative environmental and health impacts of MPAs in Lori, to identify downplayed matters and opportunities for conviviality of economy, livelihoods, environment, and health*. The analysis and discussion of findings are integrated into a two-phase sequential theoretical approach which adopts the DPSIR framework as the first phase and EPH model as the second phase of the work. The DPSIR will first help describe the identified factors by each category and their relationship to each other, particularly from the perspective of *mining as a driver for economic growth and source of livelihood* vs *mining as a pressure on environment and negative effect on health*. The findings per each DPSIR category will be discussed against EPH principles in the next chapter to enhance the understanding of underlying structures which induce economic, environmental, social and health inequities. Such approach is supported by the literature review and evidence which identify ecosystems and health as the most marginalized spheres in the whole cycle of MPAs in Armenia.

6.1. DPSIR Analysis

During the analysis of data and findings the coding was refined and reorganised to produce meaningful groups of codes in coherence with the DPSIR categories to present multilevel causality interactions including *policy, societal and individual levels*. The figures below offer an overview of the identified DPSIR categories and the final coding derived by the same logic.

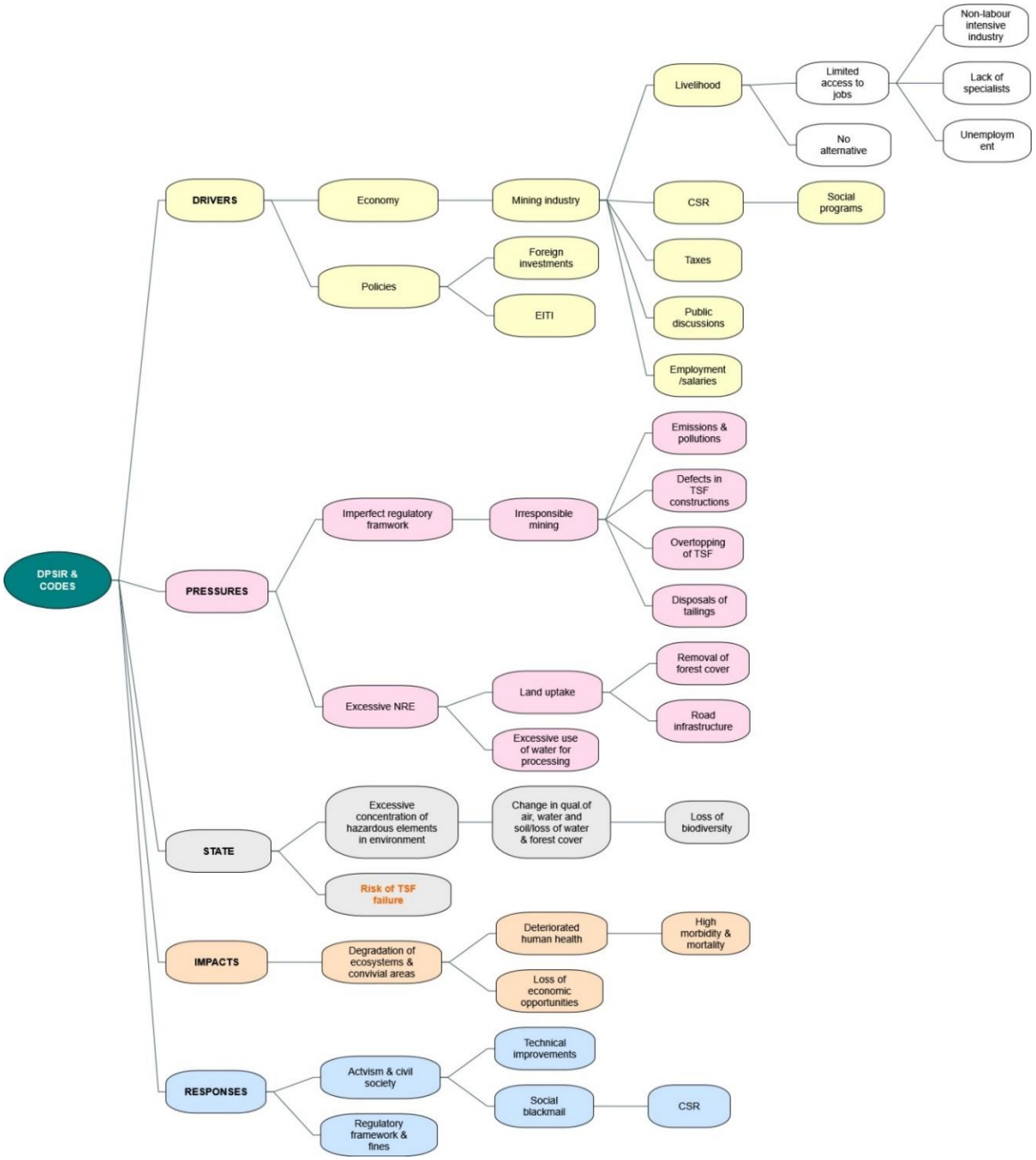


Figure 5: Final coding tree

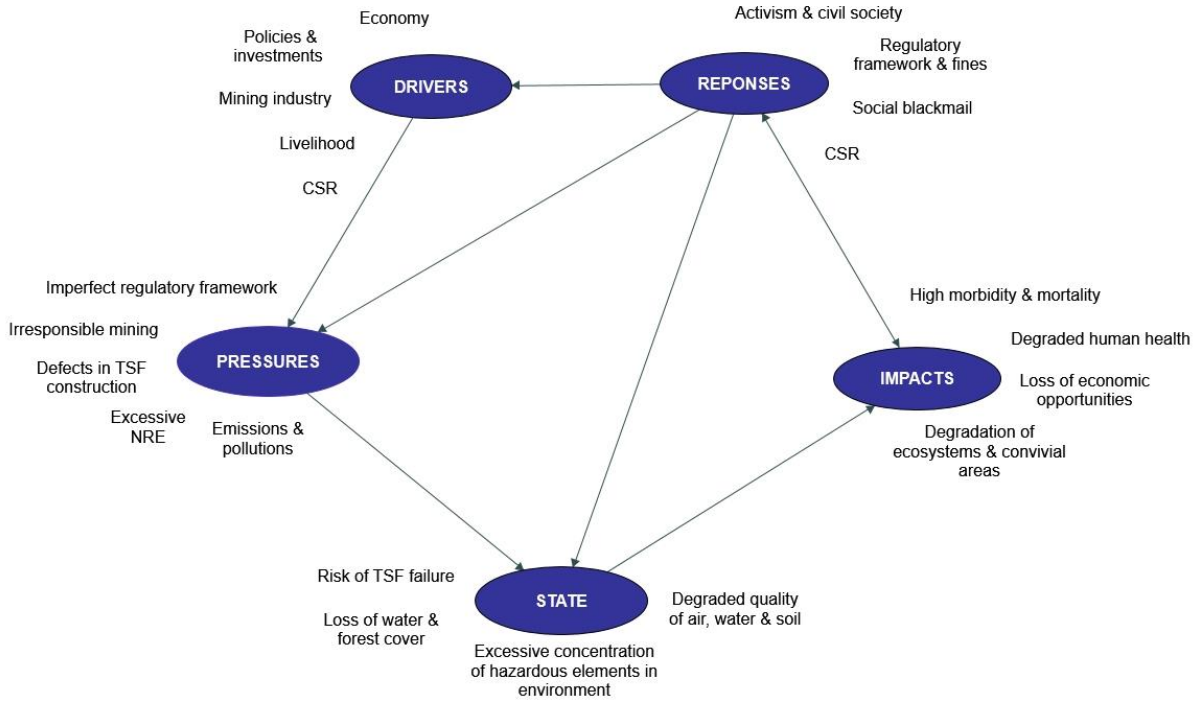


Figure 6: Overview of identified DPSIR categories

6.1.1. Drivers

Economy, mining industry, policies, and investments, EITI, employment (policy level) livelihoods, salaries, access to jobs (individual), corporate social responsibility (CSR) (societal)

According to the collected data, all the interviewed participants see mining industry as an important economic sector without which Armenia's economy cannot exist. MPAs create huge environmental pressures, but the socio-economic aspect should not be neglected either (Interview 11). However, mining is not a labour-intensive branch of economy and employs not more than 10 000 people (Interview 8).

In Lori, the three biggest MPAs, Teghout CJSC of the Vallex group, Akhtala Mountain Enrichment Combine (AMEC) and Alaverdi Copper Smelter belonging to the Armenian Copper Programme company (ACP) within the same Vallex Group, have been identified as economic drivers.

Teghout CJSC operates an open pit mine to extract copper and molybdenum ore which the company further processes by flotation method with the use of reagents (Interview 2). The mine was closed in 2018 due to the risks of tailings dam failure, financial problems and

bankruptcy and was reopened by the new owner in 2019 after TSF reinforcement activities (FGD 1, Interview 10).

Policies are either drivers or responses to certain impacts and activist movements. As drivers, *investment policies* on natural resource exploitation (NRE) seem to be one main option to spur economic growth in Armenia, which however endanger the scarce resources and living areas of the small country (Interview 8). Whereas there are other options to develop the industry, such as smart metallurgy with modern technologies and minimum or zero-waste production (Interviews 6 & 11). Introduction of new technologies, such as instalment of filters in the copper smelter and capturing the sulphuric gases in emissions might create opportunities to have a new marketable product (Interviews 2, 6 & 11). Copper is sold in ore without any calculation how much it would have cost as a final high-value product (Interview 8).

> *The ore is 50-60% of the export, but the taxes the companies pay, make up 5-6% of the taxes paid to Armenia. The operation of mines is based on poor research, calculation, management, risks assessment etc.*
>
> (Interview 8)

The WB-supported initiative *EITI* is regarded as a part of policies to improve transparency, responsibility, and sustainability of extractive industries. 50% of the respondents knew about it. Some of the CSOs and journalists were sceptical about the initiative in terms of the margins allowing some confidentiality, and avoidance to disclose information (Interviews 5, 8 & 10). Moreover, digitization of the geological data and making it available online, is seen as an attempt to make Armenia a country of low-value raw material which "*is just another way to implement colonial policies"* (Interview 8).

Public discussions as a part of mining projects approval are regarded as drivers which according to one respondent:

> *…are just a figment, only to provide the formality. EIA conducted by the companies are figment too. We strongly recommend the communities to avoid participating in those discussions and legitimising the process.*
>
> (Interview 8)

Public discussions are more often *Responses* since they are recommenced in the result of civil society and community activism for protection of nature and health.

All the observed companies have or had *CSR* programmes which appear both in the drivers and pressures. They are a part of the MPCs' policies and as such they appear at the very beginning during the public discussions or during MPAs.

Livelihoods, employment, salaries, and *access to jobs* are amongst commonly emerging concepts in this research.

The towns of Alaverdi and Akhtala were created based on the development of MPAs, thus they primarily hired people from the local population (Interview 10). ACP was *employing* about 600-650 people[10] (Interviews 6 & 11), but its activities were suspended in 2018 for the same reason as the activities of Teghout CJSC, i.e., loan and huge debts. ACP was declared bankrupt in 2020 (Simonyan, 2020). According to some informants, ACP was closed because of the raw material scarcity, as the owner had previously announced on several occasions (Interviews 6, 8, 10). Teghout CJSC had also promised that at least 60% of its employees should be from the two neighbouring Teghout and Shnogh villages (EcoLur, 2019). After the reopening of Teghout CJSC in 2019, the new owner hired approximately 60 unemployed from the closed ACP (Interviews 6 & 11). Currently it employs 1013 people in total (Paremuzyan, 2020). AMEC employs about 700 people (Interview 10).

Further issues identified by empirical data go down to the community level where the residents of the affected communities and the majority of the former ACP workers have *no access or equal access to jobs* due to the closure of ACP, limited employment capacities of Teghout CJSC or lack of skills and specialisation in certain areas, such as open pit mining, automation, and instrumentation due to which some specific jobs are given to persons from abroad (Interviews 2 & 11). These facts led to protests by the neighbouring communities who blockaded the roads as a manifestation of their grievance (EcoLur, 2019).

50% of the respondents think the *salaries* as *livelihoods* are sufficient, the other 50% is unsatisfied especially if the person engaged in MPAs is the sole breadwinner of the family (Interviews 2, 6, 11 & FGD 1).

Almost all the respondents' opinions about the ACP were similar: the factory had caused disastrous air pollution and health problems. Yet, it was solving a huge socio-economic problem through providing jobs to the town's population (Interview 11). By contrast, most of

[10] The number was checked against different sources and information received from the ARMSTAT, which did not provide any number explaining that such information contradicts statistical principle of confidentiality. Other sources used for checking this number have been media sources, for example, https://armeniasputnik.am/economy/20190705/19479850/inche-arajarkum-alaverdu-gorcarany-ashxatakicnerin.html etc. where the numbers provided varied from 600 to 650

the respondents are against its reoperation unless there are prospects of technological modernisation, construction of a new factory, and gradual transition from the old to *new technologies* (Interviews 6 & 11, FGD 1). Surprisingly, the Soviet-era technologies were more modern compared to the present technologies. This was explained by the factory's non-substantial productivity threshold and volumes hindering the application of the Soviet-era technology. "*We worked by the methods of the 1900s*" (Interview 6). Malling's (2019) photograph below depicts the technologies applied in ACP.

Image 1: Alaverdi copper smelter from inside

6.1.2. Pressures

The factors identified as pressures are *imperfect regulatory frameworks, irresponsible mining, defects in TSF construction, emissions, pollutions, excessive NRE, excessive use of process water, and land uptake (policy level).*

AMEC is endangering the lives of thousands by the enormous volumes of pollution (Interviews 8 & 10). *"There is no responsible mining in Armenia, none of mining activities is responsible"* (Interview 4).

ACP was a huge source of pollution. The emissions were so much that even the changes in the height of the chimney stack did not make a sizeable change, but instead enlarged the area of dispersion and reached more settlements than before (Interviews 6, 10 & 11).

> *The company had a permission to emit 5000-6000 tons per year but was emitting 30 000 annually. It is a crime.*
>
> (Interview 8)

The photograph provided by E-motion studio (2013) below illustrates the situation when ACP was still operating.

Image 2: Alaverdi copper smelter from outside

The main pressures by Teghout CJSC are land uptake for mining activities and construction of road infrastructure, removal of forests, tailings, and their accidental outflow from the TSF (Interview 12). Previously there have also been cases of intentional disposals of the tailings into the rivers to free up space in the TSF (Interviews 4 & 2, FGD 1). The photograph by EcoLur (2015) below shows the massive tree cutting at the beginning of the Teghout project.

Image 3: Removal of forest cover for mining in Teghout

There are a lot of uncontrollable risks which emerge during the mining activity and usually nature is damaged much more extensively than initially planned (Interview 12). The defects of the TSF construction, its poor management and physical instability of the wall create an

additional pressure on the environment. Now Teghout CJSC seems to be able to maintain the minimum level of the tailings accumulated in TSF and keep under control the outflows of the tailings into the Debed river (Interview 10). Even so, sooner or later the TSF will have a problem as it has a limited capacity, and the reinforcement works were conducted without ensuring transparency and civil society involvement (Interviews 8 & 10, FGD 2). From the resilience and sustainability perspective, it failed as a "*totally new, responsible and different*" from the old mines (Interview 8). The promises of 25-30 years of production do not seem to reflect the reality as the Teghout mine was stopped just after three years of operation in 2018 (Interview 8).

Imperfect regulatory frameworks are an emergent category in the interviews. For the approval of a mining project, the MoE does not implement a proper expertise of the EIA conducted by mining companies which often fail to implement proper EIAs (Interviews 4, 7 & 8). The MoE only ticks off the written sections in EIA because it lacks the methodological and expertise knowledge and proper tools (Interview 7). According to the RA Law on EIA, the impact on health shall be assessed. However, the opinion provided by the Ministry of Health (MoH) has no legal force as it is just an opinion. "*In fact, health assessment is not implemented…*" concludes the respondent (Interview 4). While the role of the Inspectorate for Nature Protection and Mineral Resources (INPMR) seems to be essential in assessing pressures and the MPC's compliance with regulations, the checklist, used for the guidance of the inspection, does not reflect all hazards implied by mining especially in terms of negative health effects (Interview 4).

6.1.3. State

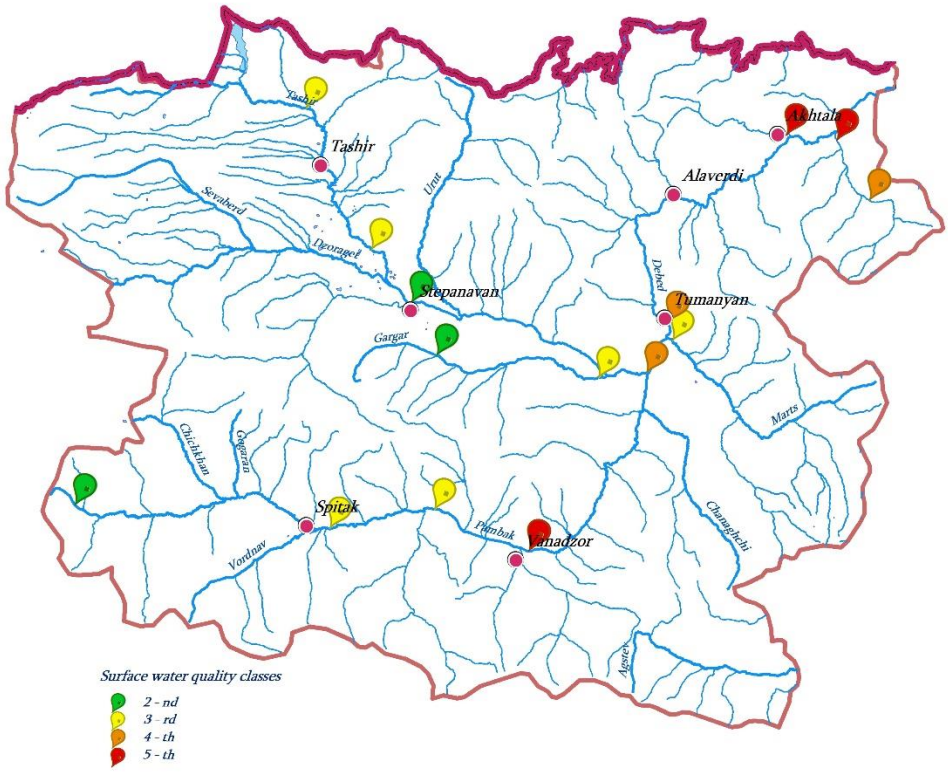
The state created by the MPAs are the *loss of big water quantities, loss of forest cover, the change of the quality of air, water, and soil (policy level)* due to the excessive concentrations of hazardous elements in environment and the *risk of Teghout TSF failure (policy level)* due to defects in construction and poor management.

All the respondents agree that mining negatively impacts the environment. The state of air, soil, water, and forests is monitored by the HMC through the network of towns and cities, observation points, water management basins and forest cover (Interview 7). According to the qualitative data from the interviews there is excessive concentration of heavy and hazardous metals such as copper, molybdenum, arsenic, cadmium, chromium, nickel, lead, zinc, and sulphuric dioxide in the environment (Interviews 4, 6, 7, 8, 10 & 11). These elements are found

in different quantities in different areas, but arsenic is found everywhere (Interview 10). The explanation of the MoH representative is that such concentrations are typical of those areas as their studies have shown no difference between a mining-impacted area and an area not impacted by an MPA.

The change in the water quality is the most emerging topic in this section. The rivers change to the fifth class in the estuary compared to the primary first or second class in the source. The information on the quality and the classification of surface water is not accessible to the communities who are using that water to irrigate their gardens (Interview 4).

The HMC has carried out a hydrobiological monitoring recently which confirmed the level of pollution of these rivers (Interview 7). The following map provided by HMC shows the quality of surface water by observation points in Lori.



Map 2: Surface water quality in Lori in 2021 by observation points

There are normally some seasonal fluctuations in water of the rivers, but in Akhtala it is permanently the fifth class despite the seasonal precipitations and fluctuations in the volume of the river water (Interview 7). It is the most polluted area in Lori (FDG 1 & 2). There is only one active TSF there now, and it is operated with huge and serious violations (Interview 10). There is no circulating water system, the storage is stuffed, and the tailings constantly flow into

the Debed river (Interview 10). The gorges around Akhtala are full of tailings and any precipitation causes mixture of hazardous elements with the run-off into the Debed river (Interviews 7, 10 &12). "*Akhtala is a dead, desolate area"* says a participant of FGD. There are two more TSFs from the past which have not undergone any reclamation. Currently discussions are underway to reclaim Nahatak TSF (Interview 10).

The air in Alaverdi was so much polluted that people were keeping their doors and windows permanently closed. Acidic rains used to be typical of the town (FGD 1).

The pollution may remain for centuries, as in case of Tandzut area, which was exploited about 100 years ago. The same pertains to other areas with concentration of heavy metals if no measures are taken (Interview 8).

There is a risk of Teghout TSF failure (Interview 8, FGD 1). The photograph by EcoLur (Yenokyan, 2019) below illustrates the TSF.

Image 4: Teghout TSF

6.1.4. Impacts

The identified impacts are *degradation of ecosystems and convivial areas, loss of economic opportunities, degraded human health, high morbidity,* and *mortality.* Causalities between all of them involve *policy, societal* and *individual* levels.

Huge areas of forests and biodiversity are cut from the natural environment (Interview 12). Dumping of sulphuric waste in the forest has caused total disappearance of greenery on that spot (Interview 8). The condition of ecosystem degradation is uncontrollable as the industrial waste is poorly managed and the environmental payments are spent on social and

infrastructural programs (Interview 10). The HMC monitoring data on water in Lori point out at the total loss of biodiversity in certain points where the quality of water is of the 5th class which means no organism can live in that condition (Interview 7).

Even though ACP is not operated now, the impact it has left is still there and has not disappeared completely (Interview 8). The emission of the exhaust sulphuric gases was covering the whole town, people could not breathe (FGD 1). To the question, how differently they feel now when the factory has been closed for over two years, the focus group participants say univocally: "*We can breathe now"* (FGD 1).

The state regulatory framework lacks a sufficient level of enforcement and strictness to control and penalize violations by MPCs (Interviews 4 & 7). "*The fines are so small…they are just another type of tax"* (Interview 7).

Residents of Akhtala, Teghout and Shnogh have limited opportunities to earn their living by growing and selling agricultural products. According to a CSO representative, some have given up their lands to the company, and those who have access to lands still are unable to grow vegetables and fruit. The trees and plants dry up because of the polluted irrigation water and no one is interested to buy products from a polluted food chain (Interview 10). Even breeding cattle near the tailing dams becomes harmful (FGD 1, Interview 10). To consume their harvest, people take their agricultural products to the market of another non-mining region thus creating risks for the residents of that region (Interview 10). For the same reason people cannot start a micro business project to grow and export products as the banks and financial institutions consider them uncreditworthy. It turns out that for the jobs of 700 people, MPAs have a serious negative economic impact on the lives of several thousand people who have no connection with the mining industry (Interview 10).

The negative environmental impact of MPAs often spreads on to communities which are not related to that activity and are not in proximity to the MPCs (Interviews 8 & 10). In some cases, the impact has already gone beyond the limits of Lori reaching some settlements of neighbouring Tavush which are classified as impacted villages and receive compensations (Interview 10).

The active dam and two non-active and non-reclaimed dams in Akhtala, as well as the surrounding gorges and cloughs full of industrial waste containing hazardous elements pose serious environmental risks as they pollute the soil, water and sometimes air via spreading by wind (Interviews 10 & 12).

Degraded ecosystems result in degradation of human health. Lori is second highest in the republic by the cancer incidence (Interviews 4, 5, 8, 9 & 11; FGDs 1 & 2). The health representative refers to the biggest mining region in Armenia, Syuniq, which is the 7th by the incidence of cancer. This data indicate that environmental pollution induced by MPAs do not cause cancer in humans (Interview 3).

Our former Minister of Health of post-revolution period was relating the high cancer rate in Lori with stress, smoking…with everything except mining.

(Interview 10)

The same resistance to accept negative impacts of mining is also observed on the level of local clinics. It turns out that they *"blindly trust"* the reports produced by mining companies, they do not investigate the problem themselves, and they do not *"like"* and accept what others do (Interview 3, 5, 6, 10).

After my investigation results were ready, I was invited to present my project at a round table in Alaverdi. The invited local doctors angrily left the room after I presented my findings.

(Interview 9)

Another respondent assumes that the studies carried out so far *"have no scientific ground"*, and time series and thorough periodical sampling and laboratory investigation should be carried out to make conclusions, rather than insist on the presence of negative health effects by purely conducting single surveys.

The biggest factors damaging health in Lori region are alcohol consumption and smoking. Hence there are lung and liver problems.

(Interview 3)

The MoH has conducted some research even though they have been avoiding publicity and have chosen not to publish the results (Interviews 3 & 4). *"Why to spread panic?"* the health representative says.

The most common types of cancers mentioned by the respondents were breast, lung, and prostate cancers; other common health problems in the region highlighted were blood pressure, cardiovascular disease, gastrointestinal problems, diarrhoea, food poisoning, diseases of respiratory tract, liver diseases, bone diseases, childbirth anomalies, allergies, etc. (Interviews

8, 9, 10, 11 & FGD 1). Lori is the only region in Armenia that had negative natural growth indicators, - 0,4 and - 0.1 in 2018 and 2019, respectively (ARMSTAT, 2020e).

The causes of deaths are hard to establish, as their description is normally quite vague (Interviews 5 & 12).

> *Most of those patients [cancer] come to Yerevan and often die in Yerevan. Their medical history is not available in the local clinic as it is compiled in Yerevan.*
>
> (Interview 5)

It is hard to study health as the list of the diseases which are characteristic to a certain geographic area is not defined to make comparisons against data on those diseases (Interviews 5 & 12).

Among health problems mentioned, the general impression is that occupational health is limited to organizing regular health checks by the mining companies. But neither the mining company nor the MoH are interested to dig deeper into the problem and investigate the causes of morbidity (Interview 8). Moreover, "*...many employees hide that they are ill because they are afraid to lose their jobs*" (Interviews 5, 8 & 10). Additionally, they have no access to remedy, and high-quality health services (Interview 10).

The NCDC has developed a methodology on assessment of the impact of mining on health with the support of WHO and intends to launch the project this spring (Interview 3).

6.1.5. Responses

Activism, CSR, social blackmail (societal), regulatory frameworks and fines, technical improvements (policy level) are the primarily identified responses to the impacts.

The affected communities often protest about the uncontrolled pollution by the companies. The community in Akhtala protest and raise their voices against incidences of violations by the AMEC (Interview 10). *"Social blackmail"* is regarded as a response subcategory which the company adopts to respond to the community's protests aimed at negative environmental impacts of mining. Upon any pressure by the community or fine issued by the INPMR, the MPCs widely apply this technique by threatening to close the factory and jobs or not to pay environmental fees if they feel some pressure (Interviews 8 & 10).

> *There is not a smart, educated, and open way of communicating with the*

> *public. It is more a blackmail instead of having a policy. The coexistence of the economy, environment and health is possible only if there is a state will.*
>
> (Interview 10)

The companies pay environmental taxes to the budget, which are allocated to the affected communities as subventions (Interview 10). In this way, AMEC keeps the local municipality of Akhtala dependent which uses these subventions to implement infrastructural or social programs (Interviews 8 &10). When the community members want to express their disapproval of the company's violations and environmental pollution, the local government steps in as a reconciliation mediator (Interview 10).

Neither CSR nor subvention programs solve any environmental or health problems. Moreover, as a part of its CSR policy the AMEC renovates roads which, as a rule, serve the company. It was also noted that, the AMEC started to make these payments only after the revolution in 2018. Before, the company had implemented small and fragmented charities (Interview 10).

However, an important recent achievement by civil society in terms of the environment in Akhtala was the cancellation of the construction of a second tailing dam which made AMEC start considering a mechanism for processing dry tailings (Interview 10). The discussions are underway now.

As mentioned earlier, the legal frameworks can be seen both as a driver and a response. In this specific context they are considered a response as legal decisions for granting an official status of a mining-impacted community to some settlements have been made in the result of civil society and activist efforts (Interview 10). Due to that these communities are entitled to environmental compensations. Civil society efforts often result in CSR programs (Interview 10). Teghout CJSC organises medical examinations for its employees (Interview 2). ACP was covering the employees' medical expenses in case of accidents and injuries, but not the chronic diseases developed over years (Interview 6).

6.2. Emergent Categories Outside of DPSIR and Transition to EPH

Collaboration and data

Most of the respondents point out at the problem of staff turnover in all the state authorities. Before newly appointed people learn and understand the essence of the work, the staff is changed again. Things are quite *"unstable and any positive change in the condition of such turbulence is not possible"* (Interview 7). This implies challenges for productive

collaboration between all the stakeholders especially in this area which is multi- and cross-sectional. In addition to staff turnover, changing and restructuring ministries, merging, and demerging state agencies hinders carrying out projects. *"This is a waste of time, money and human capital"* (FGD 2).

Work between CSOs and other stakeholders, mostly with the government is another subtext which emerges throughout the whole cycle. The impression oftentimes is that they have good dialogue. Still there are activist group that consider collaboration useless. According to one group, the government does not have professional and expertise potential for the right decision making. "*What can we discuss with groups which disagree with us?"* a former minister had asked them once and the respondent thinks aloud: *"What do they discuss with those they always agree with?"* (Interview 8).

Data availability and lack of interest in the existing data was another category which is not an explicit part of the DPSIR but at the same time data availability and quality can affect the interactions within and between all the categories. *"They do not use statistics for policy making"* (FGD 2). The findings suggest that the government agencies do not seem to be interested in the data and results of research produced by other stakeholders.

CHAPTER 7: DISCUSSION

EPH model is used sequentially for further discussion of findings to provide a holistic overview of the problem and emphasise the need for researching individual structures as parts of a system, the success or failure of which depends on how those structures interact. The discussion addresses each DPSIR category against EPH principles. This, along with origin and relations of codes to each other and to each EPH principle, identifies the whole complexity of interactions, the need for due attention, and consideration of each component and its relations within the primary DPSIR and secondary EPH levels. This is illustrated in Figure 7 below.

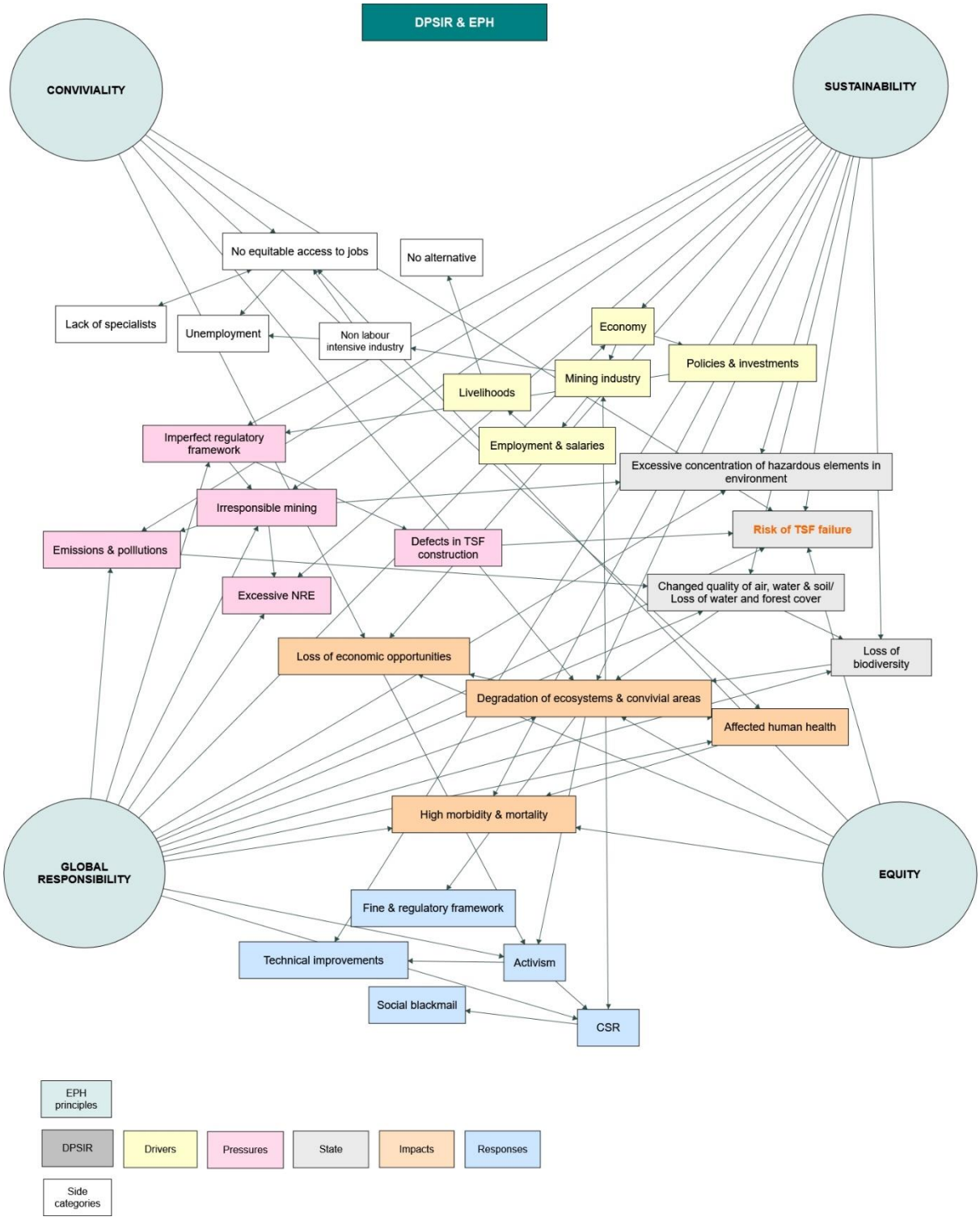


Figure 7: DPSIR categories against EPH principles

7.1. Drivers against EPH Principles

All the identified categories relate to each other and the EPH principles of *equity, conviviality, sustainability, and global responsibility*, to different extent.

Mining industry is an important branch of economy, which creates jobs and employment opportunities. Nonetheless, it underpins environmental and social inequities. Indeed, despite

its promises during the public discussions, the Teghout company has partially failed its promise to provide communities with jobs. This reinforces the opinion that public discussions are only meant to legitimise the new mining projects. In fact, the communities are often not even informed properly of possible impacts of the mining (Interview 4).

No other alternative, no access to jobs was a repetitive subtext and is regarded from the perspective of "how equitably the social and environmental goods are distributed" (Bentley, 2013, p. 532). While mining implies economic growth, people of the neighbouring communities get poorer. Mining industry is *not labour-intensive* thus it hires less people than expected (Interview 2). Even though Teghout CJSC employed about 60 unemployed from ACP, the social inequity and tension became even more severe in the neighbouring Teghout and Shnogh communities which are under direct adverse impact of the environmental pressures created by Teghout mine.

The sector employs approximately 1713 people in Lori which made only 3,6 % of the region's economically active population in 2019 (ARMSTAT, 2020b).

Land uptake by mining industries results in *no alternative* for livelihoods for those community members who were not successful in getting jobs in the factory. While the factories and mines in the region are either bankrupt or in the process of liquidation, the community members, especially the residents of Alaverdi – a town established around the copper smelter, have nowhere to work (Interviews 11 & 6). The labour situation is drastically worsening, and people are concerned about their living more than environment and health. *"A hungry person cannot be healthy"* (Interview 11).

In case of mass dismissals, the employer shall notify the SEA (State Employment Agency) which shall inform the unemployed of the state employment programs they might benefit from[11]. However, it is unclear what has been done so far. According to a respondent, the employment office has done nothing (Interview 11). The unemployment benefits have been cut off since 2014; and the researcher did not receive any response from the employment office if any unemployed from ACP got registered and involved in state employment programs.

Finally, the lack of certain specialists in the mining sector, especially open pit mining, automation, and instrumentation, points out at the lack of interest on behalf of the state, commercial organisations, and the society to invest more in the education and professional

[11] Source: A response to a written enquiry to SEA

training in mining-reliant Armenia. Thus, certain jobs are given to foreign specialists as the country lacks them (Interviews 2 & 11).

7.2. Pressures against EPH Principles

While the observed MPAs are regarded as drivers and sources of economic development and livelihood, they create huge pressures on the environment and communities by excessive NRE and application of physical and chemical processes.

Excessive exploitation of metal mines (*NRE*) contradicts the principles of *sustainability* and *global responsibility* and involves all the parties, the state, commercial organisations, and the society. First, it is the responsibility of the state to coordinate the multiple actors, enforce legislation to regulate, monitor and control the work of the existing MPAs. Even so, the recent instable situation in the country is most likely to make the state adopt more tolerant investment policies to attract international investors, as some respondents think (Interviews 8 & 10). Inefficient policies and legislation create a regulatory environment inducive for violations and non-compliance with the adopted framework. *"When they come to mine in Armenia, they know that they can violate the laws"* (Interview 7).

"No other alternative" is a multi-layered and emergent topic in different categories, and relates to *sustainability and equity principles* of EPH. Here it is discussed as an indirect pressure on the environment through communities' decisions which have no alternative to make a conscious choice in favour of their clean environment and health. Hence, there are no other economic alternatives, and the community members chose to agree to the mining project with hope to get jobs which underpins *social inequities* as not all the residents get jobs.

Excessive emissions and pollution relate to the *sustainability and global responsibility* principles in which the role of the state is focal as a coordinator and controller of the processes. Lack of methodological and expertise base hinders the implementation of appropriate, informed expertise of the initial EIA of a mining project and monitoring and control in later phases. Imperfect regulatory frameworks are friendly to foreign investments and allow the companies to overexploit the natural resources. Apart from compromising sustainability principle, this also discourages domestic investors to start businesses.

The defects in construction of Teghout TSF point out at *global responsibility* principle.

7.3. State against EPH Principles

The identified state categories, *excessive concentration of heavy metals and dioxides in environment, degraded quality of air, soil, and water,* relate to *sustainability, equity, global responsibility, and conviviality principles*. The highlighted problems suggest that the state, commercial organisations, and the society may need to review their perspective on the state and resilience thinking to support the sustainable conviviality of the nature and humans for creation of "a better fit" between them (Lang & Rayner, 2012, p. 1). The human and ecosystems health are not regarded as a policy priority, public health focus on individual behaviours and tackling problems in isolation hinders sustained improvements in the environment and public health which according to Bentley (2013) will at worst increase inequities in social and health aspects.

The notable example of the risk of the TSF failure in Teghout reflects serious deficiency of *sustainability and global responsibility*. According to the present general manager, previously during the TSF exploitation, the defined maximum levels of the tailings' storage was not maintained which might have caused more troubles with the TSF (Paremuzyan, 2020). According to the WB assessment "the TSF design is inadequate, both in environmental and physical stability terms" (2016, p.129). However, despite all the concerns, it still operates ignoring the most important factor – human lives and the seismicity feature of this geographic area, which may pose a serious threat to human lives in case of an earthquake. The TSF problem has been investigated multiple times and described as extremely dangerous. The legal and technical causes of the risk of tailing dam failure have been assessed by an EU-Twinning project and the conclusion is that the technical safety expertise of the tailing dam breaches the RA laws[12]. The results of the last assessment recommended by the Armenian government and carried out by "GeoTechMin" from September 2019 are unknown (Interview 10).

The environment and human lives seem to be secondary to interests in gaining profit and the global responsibility is often underplayed across countries, social institutions, arrangements, and agreements.

7.4. Impacts against EPH Principles

MPAs in Lori have resulted in serious ecosystems and human health degradation. As Lang and Rayner say, "economic development distorted the relationship of humans to the

[12] https://www.ecolur.org/hy/news/mining/--/10482/

planet, despite it being known that human health ultimately depends on the health of ecosystems" (2012, p.1). The respondents seem to be fully aware of this and highlight the importance of the industry's compliance with environmental standards recalling that the country should not and cannot abandon mining overall.

Environmental pollution creates multisided negative impacts on the ecosystems and human health which relate to *all the EPH principles* and result in ecological and social *inequities*. As areas of socio-ecological production, these towns and villages are left without means of subsistence, i.e., jobs, land and even an opportunity to borrow loans to start a small business. Even though mining creates economic activity in a global sense, it brings huge economic damage to communities or individuals who are deprived of the equity to benefit from the mining activities in the form of employment or any other way. But the fate of those who are currently employed is unknown too because, even if not any other force major like unpredicted liquidations and bankruptcy, the natural resources will exhaust one day. The long-term contamination threatens the environment with reduced or totally destructed productivity and *sustainability*. "*No one has an answer to this question what will happen to the communities then"* (Interview 8).

As suggested by Bentley, *conviviality* does not only pertain to living together peacefully but it entails equitable distribution of convivial areas which seems to be distorted in the mining-impacted areas of Lori (2013).

The negative human health effects of the polluted and degraded ecosystems make the conviviality even more challenging especially when there is no political will to accept it. While the researchers and investigative journalists claim that there might be causality between the mining-induced pollution and the morbidity and mortality indicators in mining-intensive areas, the MoH seems to avoid such discussions and sometimes denies any causalities, explaining the official data and statistics produced by the NIH by other factors (Andreasyan et al., 2020). Unquestionably, a single survey is unlikely to answer all the questions, but it is still unclear why the MoH underplays the research conducted by different stakeholders. The most recent research by Arnika and local organisations suggests that there are excessive concentrations of arsenic, cadmium, copper, lead, nickel, zinc, etc. in Lori, of which cadmium and arsenic are considered human carcinogens according to the IARC (Arnika, 2020). High concentrations of copper may cause liver and neurological damage. Children are considered the most vulnerable to lead exposure which is known by its neurotoxicity. Nickel may cause food allergies. The

table below shows the carcinogenicity groups of these hazardous substances classified by IARC (Mach et al., 2019, p. 3).

Group 1	Carcinogenic to humans	arsenic and inorganic arsenic compounds
Group 2A	Probably carcinogenic to humans	inorganic compounds of lead
Group 2B	Possibly carcinogenic to humans	lead
Group 3	Not classifiable regarding its carcinogenicity to humans	organic compounds of lead
Group 4	Probably not carcinogenic to humans	

Figure 8: Carcinogenicity of the pollutants found in Lori according to IARC

As discussed from the public health perspective by Lang and Rayner (2012), the global changes and transitions in conditions and their outcomes seem to be overlooked by the health authorities and policies, and the public health discussions seem to be more focused on evidence and questioning the evidence rather than its further and systematic research. Hence, the negative health effects of pollution are not properly reflected in the policies, and therefore neither are they addressed in Armenia.

Another worrying fact intersecting with *equity* are the frequently emerging categories of *no choice, no alternative*. People either must work and expose themselves to health risks, or remain unemployed which, if long-term, may result in negative health impacts such as unhealthy lifestyle, excessive consumption of tobacco products and alcohol, depression and other mental health problems, and no financial means for healthcare (Bjorklund et al., 2015).

The communities have a responsibility to familiarise themselves with the available information, or to require explanations, for example, on the classifications of the quality of the surface water and their meanings. Water classifications were only touched upon by decision makers during the interviews, but the community appears to be lacking sufficient level of knowledge which may result in inaction or lack of conscious choices.

7.5. Responses against EPH Principles

This category is related to all the EPH principles. The insufficient level of *global responsibility* impacts *sustainability* and resilience which underpins *unequitable* distribution of healthy environments and may potentially make the *conviviality* challenging. Moreover, the gap analysis of the Armenian mining legislation points out that the elements of the environment are considered separately, rather than as interacting components of a whole system (AUA CRM, 2016).

To start with, the companies utilize environmental protection fees, which are nature protection taxes, to 'delegate' the problem to the municipalities who are expected to silence the residents' voices against pollution. Some of these fees are directly allocated to the local municipalities, and some are 'returned' to the municipalities through the state budget and subventions which are very low and are only used for socio-infrastructural programs (AUA CRM, 2016). The environmental fines defined by the regulatory framework for non-compliance with nature protection provisions are low and do not result in serious changes in irresponsible mining (WB, 2016).

The response to the health data and alleged connection between mining and health in Lori on high cancer incidence, mortality rates and depopulation have attracted the attention of NGOs, civil society, investigative journalists, and academia, who have carried out research and published results. The health authorities have implemented research too. But they do not publish the results and they deny accepting other results as evidence base. Hence, there seems to be a lack of political will to acknowledge health impacts of mining which results in inaction to enforce laws to protect the ecology and nation (Bentley, 2014; Lang & Rayner, 2012).

In terms of livelihoods and limited opportunities of employment in the mining sector, which also diminishes other economic opportunities, the response of the civil society is recurrent in the form of protests and road blockades, which however does not receive a due response on behalf of the MPCs and the state thus reinforcing the underlying social *inequities*. The MPCs seem to use CSR programmes as a social blackmail and implement those mainly to silence the communities' voice of grievance against their violations. This underlines the imperfection of the regulatory frameworks and lack of capacity of the state to balance the relationships between the community's rights and needs, and commercial interests. CSR is only used to create a false impression of social *equity* and *convivial* environment. And yet, the recent success of activists in Akhtala which made AMEC cancel the construction of a new tailings dam, inspires one hope that in future the voices will be heard and tackled in a due manner.

CHAPTER 8: CONCLUSION

7.1. Summary of Analysis and Discussion

A general observation is that the negative impacts of mining in Lori are under-observed with the health effects more underreported than the environmental effects.

Absence of new technologies in mining industry, export of low-value raw material rather than high-value finished industrial products hinder the optimisation of Armenia's mining industry (Stuhlberger et al., 2012).

Armenia's imperfect regulatory frameworks create different layers of social and ecological inequities, lack of global responsibility, challenges to conviviality and sustainability. They lack sufficient by-laws, guidelines, methodologies, institutional capacity, and theoretical knowledge base for implementation of the legislation, and assessment, prevention, and mitigation of potential negative environmental and health impacts (WB, 2016). This often leads to excessive and irresponsible NRE, environmental pollution, ecosystems degradation and ill health. Additionally, there is a lack of political will to focus efforts on the assessment of the environmental, social and health impacts of MPAs (Stefes & Weingartner, 2015).

The state's role as the main responsible actor is crucial but seems to be inefficient due to the gaps in regulatory frameworks and mining policies, as well as total absence of state ownership in metal mining industry which would imply stronger monitoring and control measures (Bauer, 2018; WB, 2016). As opposed to that, the country's mining legislation seems to be reinforcing the role and power of the MPCs due to which the communities may appear unprotected, insufficiently informed of their rights, and deprived of economic alternatives for their livelihoods. Furthermore, the environment does not appear encouraging for local businesses due to the environmental impacts created by MPAs.

Cooperation and dialogue with communities, and their participation in decision making on mining often seem to be in place only to provide the formality and ensure the veil of legitimacy for the decisions made behind the closed doors. It resembles '*tokensim'*, a typology of participation which according to Arnstein includes consultation, informing and placation, i.e., "means of legitimating the already-made decisions" (Cornwall, 2008, p. 270). There is a secrecy culture in mining industry in Armenia which is a big obstacle for public participation (Vivoda & Fulcher, 2017).

Finally, the imperfect expertise of EIA (Pressure) followed by granting exploitation

permissions to MPCs (Pressure), the imperfect control measures without any sanctioning power (Response), the imperfect inspection (Response) and the lack of methodological base (Pressure) result in the deficiency of global responsibility on behalf of the state and investors.

To sum up, the analysis suggests that the drivers, which only represent interest in economic growth, do not comply with equity and global responsibility principles as the benefits from NRE are not distributed equitably. Pressures, state, and impacts point out at issues related to the global responsibility during the whole cycle of metal mining in Armenia and threaten health, sustainability and resilience of ecosystems and wellbeing of the present and future generations. Responses, potentially influenced by vested interests of the commercial organization to get super profit, and of the governments – to provide quick economic gains, while having little power to regulate the relations between commerce and society, are only masked with virtue of global responsibility.

7.2. Theory and Research Question Revisited

The purpose and guiding research question of this study has been to analyse the negative environmental and health impacts of mining in the Lori region in Armenia using DPSIR framework and EPH model, to identify neglected areas and search for opportunities for happy coexistence of all parties involved. Applying DPSIR identified interacting factors on a micro level across the whole cycle of MPAs in a logical and orderly manner. Combining it with EPH brought in a macro-perspective with a more holistic overview of the matter in question. Looking at negative environmental and health impacts of MPAs from the perspective of their relation to EPH principles underlines the complexity of relations and the importance of considering different aspects when developing mining policy, projects, and tools to analyse impacts of mining projects. The applied framework helps identify factors, such as data and collaboration, which are outside of the DPSIR framework but are as important as any other factor described within the theoretical construct.

The major findings of this study are consistent with the results of other studies on the negative environmental and health impacts of MPAs in Lori, some of them pointing out at the most neglected area – public health. The reality is that there cannot be a happy co-existence or conviviality of commerce, state, and society, when one of them is the least advantaged and has no choice. “A hungry person cannot be healthy” is a powerful message by one of the respondents of this research. Unquestionably, ill-health cannot provide livelihoods either.

Unhealthy society and nation cannot be labour productive – a path, that is far beyond development and SDGs.

7.3. Critical Reflections for Future Studies

Recalling the limitations of generalizability of findings due to the small sample size of this study, a representative quantitative and qualitative survey of the negative environmental and health impacts of MPAs, as well as improvement of administrative and up-to-date data on health will provide generalizability and statistical power to findings as an important base for decision making.

The volume and structure of this work has limited the consideration and research of the occupational health in MPAs. But the hypothesis is that this area is under-researched by the health authorities as are the health impacts of metal mining in general due to the lack of political will to focus efforts on the issue, as well as the lack of institutional capacities, expertise, and relevant tools under the regulatory frameworks.

The methodology supported by WHO to be launched by NCDC in 2021, is not shared with stakeholders. Hence, it is still unclear if the methodology will allow investigating the effects of the legacy mining and concentrations of hazardous materials in soil, water, food chain, mined sites, or it will also allow conducting project-based assessment, possible effects of mining projects. Thus, it needs further research when put in practice.

Another aspect to study concurrently with political and socio-economic developments of the country is changes in Armenia's mining policy along with projects such as the ones implemented by AUA CRM which are aimed at legislation reforms, support to Armenia's EITI membership etc. The impact of these efforts should be assessed over time.

7.4. The Road Ahead

Armenia exports low-value raw material such as copper in ore and semi-processed concentrates with other compounds such as gold, silver, etc. Processing of these metals into a high-value industrial product would benefit the economy of the country much more, given that the rich copper reserves of the country allow introduction of relevant modern and responsible technologies. So, instead of encouraging opening of new mines, a smart way would be to improve and develop the existing MPAs to live up to high-value production.

The current regulatory framework and tools for its implementation require improvements while having a viable vision of the mineral sector policy. The human and ecological health and well-being need to be prioritised especially those of the directly impacted communities, their physical, economic, and social security, hence more comprehensive EIA complemented with CIA and SESA is needed (WB, 2016). The mining methods should be modernised and made responsible to produce minimum waste.

The powers of MoE, which are currently limited to monitoring the state of the environment, should be expanded over the whole cycle of control of MPAs.

Calculations should be made to avoid geotechnical risks in TSF construction which require adequate technical expertise, preparedness, and compliance with international standards (Vivoda & Fulcher, 2017).

Finally, appropriate planning and calculations should be made to avoid overexploitation of natural resources to the extent that they do not lose their reproduction capacity. The state's role as an entrepreneur and mining industry shareholder is an important discussion in this context.

It is not sufficient to limit public health by individual behaviour and a larger model, such as EPH, is required to address those issues which are underplayed by the mainstream public health proponents. Only considering humans as part of ecosystems has a potential to guide the country towards SDGs.

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ANNEXES

Annex 1 *Mortality rate by main cause of death in Armenia, 2018 and 2019*

Annex 2 *Biodiversity hotspots (Map 3)*

Annex 3 *RA Laws regulating MPAs*

Annex 4 *International Commitments*

Annex 5 *Institutions responsible for MPAs, nature protection & public health*

Annex 6 *Armenian state bodies reviewing and giving conclusion on the EIA & state bodies providing mining & environmental permits*

Annex 7 *Inspired by literature (Tubis et al., 2020; Turner et al., 2916; Tweeddale et al., 1997; WB, 2016) the catalogue below represents risks implied by MPAs.*

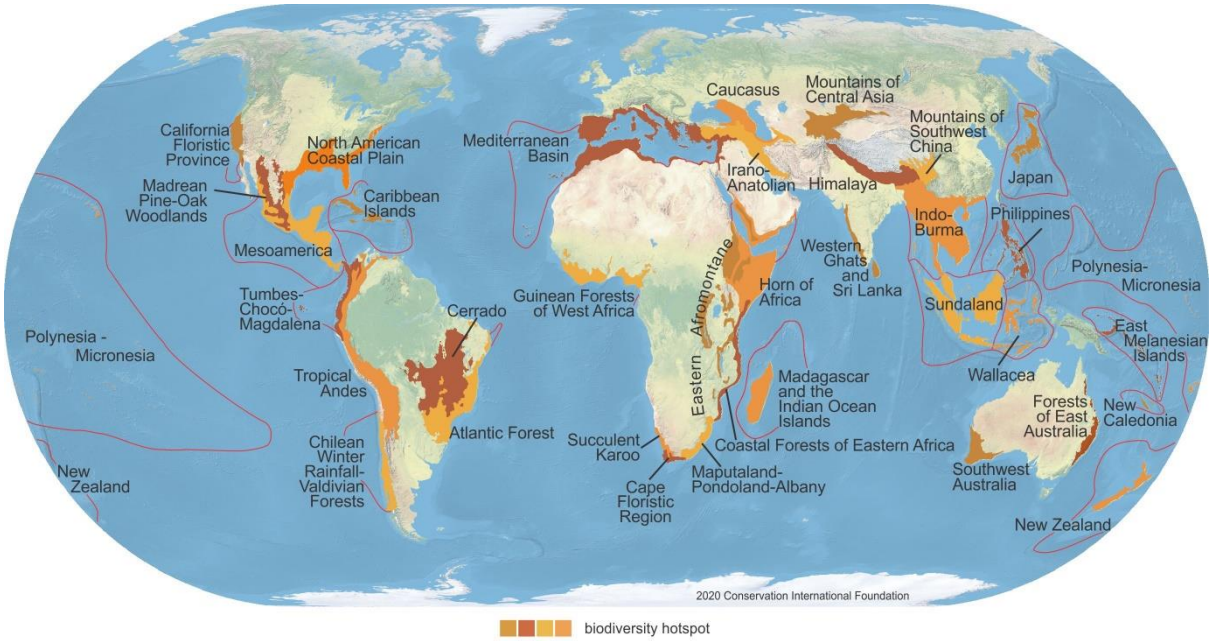
Annex 1: Mortality rate by main cause of death in Armenia, 2018 and 2019

Cause of death	Total number of deaths (person)				Mortality rate, per 100 000 residents			
	Male		Female		Male		Female	
	2018	2019	2018	2019	2018	2019	2018	2019
Total number of deaths	**13021**	**13384**	**12730**	**12802**	**926.8**	**956.4**	**813.9**	**819.0**
Of which, by causes:								
Blood circulatory system diseases	6764	6764	7445	7305	481.4	483.3	476.0	467.3
Malignant tumor	2831	2999	2368	2435	201.5	214.3	151.4	155.8
Endocrine system diseases	216	213	382	330	15.4	15.2	24.4	21.1
Exogenous reasons (accident, intoxication, injury etc.)	794	821	264	256	56.5	58.7	16.9	16.4
Respiratory system diseases	983	1007	995	1162	70.0	72.0	63.6	74.3
Digestive system diseases	640	690	577	544	45.6	49.3	36.9	34.8
Urogenital system diseases	174	169	172	143	12.4	12.1	11.0	9.1
Infectious and parasitic diseases	104	115	59	50	7.4	8.2	3.8	3.2
Other diseases	515	606	468	577	36.6	43.3	29.9	37.0

Source: *ARMSTAT*

Annex 2: Map of biodiversity hotspots[13]

Map 3: Biodiversity hotspots



Conservation International (conservation.org) defines 36 biodiversity hotspots — extraordinary places that harbor vast numbers of plant and animal species found nowhere else. All are heavily threatened by habitat loss and degradation, making their conservation crucial to protecting nature for the benefit of all life on Earth.

[13] Online source: https://zenodo.org/record/4311850#.YIF8EpAzY2y

Annex 3: RA Laws regulating MPAs

	NAME	DATE OF ADOPTION
1	RA Constitution	July 5, 1995
2	Mining Code	November 28, 2011
	Civil Code	1998
3	RA Law on Targeted Use of Environmental Charges Paid by Mining Companies	2001
4	RA Law on Environmental Impact Assessment and Expertise	August 9, 2014
5	RA Law on Administrative Infringements	June 12, 1985
6	RA Law on Nature Protection and Nature Utilization Payments	December 28, 1998
7	RA Law on Rates of Nature Protection Payments	December 20, 2006
8	RA Land Code	May 2, 2001
9	RA Forest Code	October 24, 2005
10	RA Law on Specially Protected Natural Areas	November 27, 2006
11	RA Law on Wastes	November 24, 2004
12	RA Law on Land Taxes	February 14, 1994
13	RA Law on Nature Protection Control	November 4, 2005
14	RA Law on Governmental Dues	December 2, 1997
15	RA Law on Lake Sevan	May 15, 2001
16	RA Law on Governmental Regulation on Technical Safety	October 24, 2005
17	RA Law on Fire Protection	April 18, 2001

Annex 4: International commitments

	NAME	DATE OF ENDORSEMENT/RATIFICATION
1	UN Guiding Principles on business and Human Rights	Adopted in 2011 by UN Council on HR, and since endorsed by governments and organisations
2	Aarhus Convention on Access to Information, Public Participation in Decision-Making, and Access to Justice in Environmental Matters	Signed on June 25, 1998; ratified it 2001
3	Convention on Environmental Impact Assessment in a Transboundary Context	Adopted: 25 Feb 1991 Ratified on 21 Feb 1997
4	Kiev Protocol on Strategic Environmental Assessment, UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)[14].	Signed: May 21, 2003 Ratified in 2011
5	UN Framework Convention on Climate Change,	Convention ratified:1993
6	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters	Adopted: 25 Jun 1998 Ratified: 1 Aug 2001
7	UN Convention on Biodiversity	Adopted: 5 June 1992 Ratified: 14 May 1993
8	UN Convention on Combating Desertification	Adopted: 14 Oct 1994 Ratified: 2 Jul 1997
9	Minamata Convention on Mercury	Adopted: 10 Oct 2013; Signed: 10 Oct 2013
10	Convention on Long-range Transboundary Air Pollution	Adopted: 30 Nov 1979; Armenia ratified on 21 Feb 1997
11	Stockholm Convention on Persistent Organic Pollutants	Adopted: 22 May 2001 Ratified: 26 Nov 2003
12	European Landscape Convention	Adopted: 2000 Signed: 2017

[14] www.unece.org/environmental-policy/conventions/environmental-assessment/

Annex 5: Institutions responsible for MPAs, nature protection & public health

	Name	Function	Status
1	Inspectorate for Nature Protection & Mineral Resources	Supervision &/or other functions prescribed by law; application of sanctions in the field of environmental protection, the use & reproduction of subsoil & mineral resources[15]; inspections of violations of environmental legislation caused by mining activities, inspections of mining permits & licenses for violations of regulatory provisions; checks for cases of surpassing the permitted extraction quantities, prevention of selective operation of mines (WB, 2014)	Body under the Government of the RA
2	Mining Agency	Issuance of mining permits & licenses, record keeping of permits issued in a registrar, management of implementation of government programs, consideration of mining project applications, & application for initial environmental assessment & examination(WB, 2014). feasibility assessment of the mineral deposits & revaluation of reserves of deposits during mining operation (check)	Ministry of Energy Infrastructures & Natural Resources of the Republic of Armenia (MEINR)
3	Republican geological fund	Management of Database of information on Geological Funds of Armenia since 30s of the last century; repository of exploration and mining company reports; data on minerals reserves; exploration and mining contracts; responsible for storing data and information, and providing access upon request (WB, 2016)	Ministry of Energy Infrastructures & Natural Resources of the Republic of Armenia (MEINR)
4	Department of Underground Resources & L& Protection Policy	develops legal acts, technical standards, & procedures related to mining; calculates damages caused as a result of mining activities; carries out studies on adverse impacts & monitoring of mining activities; issues conclusions on EIAs of mining projects; manages waste-disposal issues; & so forth.	Ministry of Environment (MoE)
5	"Environmental Impact Expertise Centre" SNCO (EIEC)	EIA review & expertise for development & investments projects; participation in policy making	Ministry of Environment (MoE)

[15] https://www.gov.am/en/bodies-under-government/42/

6	"Environmental project implementation unit" state agency, SA "EPIU" MoE RA	Protection of environment, i.e., subsoil, land, water, atmosphere, flora & fauna, & specially protected areas, & providing implementation of state programs in the areas of reasonable use & reproduction of the natural resources of the RA	Ministry of Environment (MoE)
7	Health & Labour Inspectorate, HLIB of the RA	Supervision & (or) other functions prescribed by law; implementation of sanctions in the spheres of healthcare, workers' health & safety; implementation of sampling & instrument measurements for expertise & laboratory investigations; Provision of information & guidance on safety & preservation of health to employers & employees	Body under the Government of the RA
8	National Centre of Diseases & Control, NCDC	Implementation of sanitary-hygienic expertise & laboratory investigation of environmental factors Implementation of socio-hygienic monitoring & biological examination of the impacts of environmental factors on population's health, result analysis & assessment (NCDC Charter, 2014)	Ministry of Health
9	"National Centre of Technical Security" SNCO (NCTS)	Responsible for the safety examination of mining permit applications, including the assessment of the technical and safety aspects of tailings dams.	Ministry of Emergency Situations

Annex 6: Armenian state bodies reviewing and giving conclusion on the EIA & state bodies providing mining & environmental permits

6.1. Armenian state bodies reviewing and giving conclusion on the EIA

	NAME
1	"Environmental Impact Expertise Centre" SNCO (EIEC), MoE
2	Ministry of Agriculture
3	Ministry of Emergency Situations
4	Forestry Service (HayAntar), MoE
5	Ministry of Health
6	Ministry of Culture
7	Ministry of Economy
	Ministry of Transport and Communication

6.2. Armenian state bodies providing mining & environmental permits

	NAME	**TYPE OF THE PERMIT/LICENSE**
1	Ministry of Energy Infrastructures & Natural Resources	a/License given based on application for geological exploration b/ License issued based on application for geological exploration for further exploitation. c/ Permit for exploitation of mines based on feasibility study for further exploitation of the mine after which the mining company submits initial environmental examination and environmental management plan (EMP) with an application for an EIA and State Environmental Expertise[16]
2	Ministry of Environment	Water abstraction & use permits

[16] According to the Mining Code, operational permits for a mining project should include permits for mine opening and operation (based on international best practices), an EMP, a mine closure plan, and a social program (WB, 2014, p. 19)

Annex 7: Environmental risks inspired by literature (Tubis et al., 2020; Turner et al., 2916; Tweeddale et al., 1997; WB, 2016) the catalogue below represents risks implied by MPAs.

Environmental risks: primary	
1	Risk of exposure to dust containing radioactive elements (uranium, thorium) & tailings containing toxic elements during open pit mining
2	Urgent security risks, unfenced pits
3	Reduced water quantity due to overexploitation of underground & surface water resources for processing activities
4	Waste disposal; excessive concentration of hazardous materials in waste, such as process chemicals;
	Contamination of surface and underground water, for drinking, irrigation, aquaculture, recreation
5	Pollution, acidification of soil, water & air from smelter gases
7	Risks of overtopping of tailings due to poor management of the TSF
8	High seismic, land instability & geotechnical risk; risks of TSF collapses due to inappropriate construction & poor management; risk of accidental spills or broad-scale contamination
11	Soil, water & air contamination & endangered flora & fauna
12	Polluted or abandoned mine sites
13	Poor or no recovery measures, such as rehabilitation, reclamation, after the cease of mining
Social & economic security risks: secondary	
14	Dependence on single industry & limitations for agriculture and tourism
15	Copper price fluctuations
16	Incorrect mineral resource calculation & lack of appropriate feasibility study
17	Shortage of skilled manpower
18	Political instability
19	Financial problems of owners & inability to pay back loans/bankruptcy
20	Liquidation & mass layoffs
21	Imperfect legislation
22	Strikes & community protests
23	Dependence on single industry & limitations for agriculture and tourism
	Profit underreporting, tax avoidance
Health risks: secondary	
24	Overexposure of humans to hazardous materials, such as arsenic, cadmium, chromium, cooper, lead, mercury, & molybdenum in the environment & food chain
25	Use of abandoned tailings as pastures, cultivated land and polluted rivers for irrigation; contaminated food chain
26	Hypothetical lowered fertility among women
27	Hypothetical increased risks of cancer
28	High blood lead levels in children
29	Occupational health & intoxication by process chemicals
30	Occupational health & injuries from accidents