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Approach of Health Aspects in the Environmental Licensing in the Brazilian mining sector

Abordagem dos Aspectos da Saúde no Licenciamento Ambiental no Setor Mineiro Brasileiro

Carolina da Silva Gonçalves[I], Ana Luiza Bertani Dall' Agnol[II], Carolina Faccio Demarco[III], Tirzah Moreira Siqueira[IV], Luciara Bilhalva Corrêa[V], Maurizio Silveira Quadro[VI]

ABSTRACT

The mining activity generates several negative and positive environmental impacts. Among the negatives impacts, it is find the reduced air quality, noise generation and increased population flow, which directly affect the health quality of the local population and the enterprise workers. Thus, the aim of this work was to perform an analysis of documents as Environmental Impact Study (EIS) and Terms of Reference (TR) regarding the approach of health aspects in mining activities licensed by the Brazilian federal environmental agency, proposing a methodology for its evaluation. The methodology consisted of a qualitative and quantitative analysis of health aspects according to the matrix already used in another study. It was proposed to insert weights for attributes analysis culminating in a scale of approach to health aspects: low, medium and high. Thus, limitations were found regarding the availability of studies and TRs in the environmental agency system. Regarding the EIS, most aspects of health had a medium approach, the diagnostic stage was highlighted as the most complete and the monitoring and accompaniment stage were detected as presenting the lowest approach. The greatest weaknesses was the identification of specialists responsible for the health approach, the lack of estimates of investments in the sector.

Keywords: Health impact assessment; Environmental impacts; Social impacts; Environmental Impact Study

RESUMO

A atividade de mineração gera vários impactos ambientais negativos e positivos. Entre os impactos negativos, encontra-se a redução da qualidade do ar, geração de ruído e aumento do fluxo populacional, que afetam diretamente a qualidade da saúde da população local e dos trabalhadores da empresa. Assim, o objetivo deste trabalho foi realizar uma análise de documentos como Estudo de Impacto Ambiental (EIS) e Termos de Referência (TR) sobre a abordagem de aspectos de saúde em atividades de mineração licenciadas pelo órgão ambiental federal brasileiro, propondo uma metodologia para sua avaliação. A metodologia consistiu em uma análise qualitativa e quantitativa dos

[I] Bolsista CAPES na modalidade mestrado no Programa de Pós-Graduação em Ciências Ambientais pela UFPel. colaboradora no NEPERS e desenvolve pesquisa na área de gerenciamento de resíduos de serviços de serviços de saúde no Hospital Escola vinculado a UFPel

[II] Bolsista FAPERGS na modalidade mestrado no Programa de Pós-Graduação em Ciências Ambientais (PPGCAmb) pela Universidade Federal de Pelotas

[III] Doutoranda no Programa de Pós-Graduação em Ciências e Engenharia de Materiais do Centro de Desenvolvimento Tecnológico (CDTec) da Universidade Federal de Pelotas

[IV] Professora na Universidade Federal de Pelotas (UFPel)

[V] Professora Associada da Universidade Federal de Pelotas

[VI] Graduação em Engenharia Agrícola pela Universidade Federal de Pelotas (2001)

aspectos de saúde de acordo com a matriz já utilizada em outro estudo. Foi proposto inserir pesos para a análise de atributos, culminando em uma escala de abordagem aos aspectos de saúde: baixo, médio e alto. Assim, foram encontradas limitações quanto à disponibilidade de estudos e TRs no sistema de agência ambiental. Em relação ao EIA, a maioria dos aspectos da saúde teve uma abordagem média, a etapa diagnóstica foi destacada como a mais completa e a etapa de monitoramento e acompanhamento foi detectada como apresentando a abordagem mais baixa. As maiores fragilidades foram a identificação de especialistas responsáveis pela abordagem em saúde, a falta de estimativas de investimentos no setor.
Palavras-chave: Avaliação de impacto na saúde; Impactos ambientais; Impactos sociais; Estudo de Impacto Ambiental

1 INTRODUCTION

The Environmental Impact Assessment (EIA) is an instrument of the National Environmental Policy (PNMA), established by Law No. 6,938 of 1981 (BRASIL, 1981), whose application is associated with licensing, providing support for the analysis of environmental license in the case of projects presenting potential to cause significant environmental impact (ALMEIDA; MONTAÑO, 2015). Thus, EIA supports decision-making on the economic, technical and environmental viability of projects, programs, plans and policies by the responsible agencies.

The EIA tool, which depends on the preparation of the Environmental Impact Study (EIS) and its Environmental Impact Report (EIR), was the first environmental policy mechanism to be adopted in Brazil, established as one of the PNMA instruments (BRASIL, 1981). From this, the National Environmental Council (CONAMA) published, through Resolution No. 01 of 1986, the definitions, responsibilities, basic criteria and general guidelines for the use and implementation of the EIA (BRASIL, 1986).

In this context, the Brazilian legislation presupposes environmental and social impacts should be identified and evaluated in EIA, including those related to health (BALBY, 2012). However, in practice, negligence occurs often in addressing the health effects of the population in EIS and EIR (ABE; MIRAGLIA, 2018; BARBOSA et al., 2012).

Within the process of environmental licensing in the country, although considered one of the most complete in the world, the process is complex and

bureaucratic (MONTEIRO; SILVA, 2018). The only legal tool for health participation occur through CONAMA Resolution No. 286 of 2001 (BRASIL, 2001), which regulates the licensing of activities in malaria endemic regions. Also, in Ordinance No. 47 of 2006 of the Health Surveillance Secretariat (BRASIL, 2006), which provides for the Evaluation of Malariginal Potential and the Certificate of Sanitary Condition for land reform settlement projects and other projects in the Amazon region. According to Abe and Miraglia (2018), for other health fundamentals, there is a gap in the laws and guidelines related to environmental licensing.

In this context, the Health Impact Assessment (HIA), which was proposed by the World Health Organization (WHO), is an efficient methodology for highlighting both positive and negative impacts due to local intervention from a policy, plan, program or project (WHO, 1999). Thus, it is noteworthy that HIA does not overlap with other evaluations, but allows the health to be evaluated during different interventions, offering a new perspective of evaluation that was not previously taken into account by decision makers (SILVEIRA; FENNER, 2017).

Regarding the institutionalization of HIA, it is not verified in any Latin American country and, although it is not yet implemented in projects or public policies in Brazil, there are legal protection to support its adhesion in the planning of activities (DREWRY; KWIATKOWSKI, 2015; ABE; MIRAGLIA, 2018). Thus, in the current context of environmental licensing, social impacts and their effects on health are not addressed in the design and planning stage of enterprises. Also, Queiroz and Veiga (2012) state that EIS do not adequately address socio-environmental impacts, which reflects in insufficient and limited mitigating and compensatory actions.

Thus, Cancio (2008) suggests that EIS should address health related issues in more detail. As a result, it proposes a methodology, in matrix form, to analyse the health aspects of the EIS of hydroelectric plants, considering the weakness of these in contemplating such issues.

Similarly, Queiroz and Veiga (2012) analysed the social impacts and their health effects on indigenous populations affected by two large hydroelectric projects: the

Brazilian Tucuruí plant with the Parakanã population and the Canadian James Bay with the Cree population through a post-fact literature review on hydroelectric dams. The authors found that the negative environmental impacts resulting from these enterprises caused significant social changes in individual and collective health, generating health problems and increasing the costs for treating the diseases generated. Barbosa et al. (2012) adapted Cancio (2008) matrix for oil and gas industry, and analysed 24 EIS from these sectors and found that in most cases there was little or no explanation regarding health aspects in the studies.

As with the aforementioned developments, mining activities in recent years has a negatively image due to issues related to their impact on the environment, causing deforestation, destruction of the natural landscape, release of dust, pollutants and increased gases of greenhouse effect (AGWA-EJON; PRADHAN, 2018). Bacci et al. (2006) state that the undesirable environmental effects of mining activity are associated with its various phases: exploration of mineral goods, digging, use of explosives in rock dismantling, transportation and ore processing. The authors emphasize that these steps influence both natural resources such as water, soil and air, as well as the anthropic environment, affecting the well-being of the population.

In addition, Smith et al. (2016) and Rupprecht (2015) stand out for other mining related issues that are slowly receiving due attention, such as health and safety issues, which may include ergonomic stress, injury, noise, dust exposure of toxic chemicals, noise and vibration, and overexertion, influencing physical well-being of the workers.

It is notable that the EIS are prepared based on what is determined by their respective Terms of Reference (TR), which is a document prepared by the environmental agency to delimit the scope of the study to be carried out by the proponent of the project. Therefore, it is also necessary to evaluate the TRs in relation to addressing health issues, because if they do not mention this issue, neither will the EIS present this level of detailing.

Brazil was the scene of two environmental accidents involving mining activities: the breaking of two tailings dams in the city of Mariana and Brumadinho, both in the state of Minas Gerais. The socioenvironmental impacts caused, including many with unknown magnitude, still generate discussion and place the mining activity as the focus of attention regarding the quality of previous studies and the effectiveness of environmental monitoring and compliance with conditions of environmental licenses.

Since mining can cause health impacts due to its activities, this paper aimed to analyse the health aspects approach in the TRs and EIS of mining projects licensed by the Brazilian Institute of Environment and Natural and Renewable Resources (IBAMA) and thus establish a methodological proposal for evaluation.

2 METHODOLOGY

This study is based on a qualitative and quantitative methodology that, according to Lakatos and Marconi (2004), the qualitative seeks to substantiate the interpretation of phenomena and assign meanings to them, without the application of resources and statistical techniques. The quantitative research should only be used when there is a well-defined problem, as well as information and theory regarding the focus of the research and/or what it is intended to study (SILVA; SIMON, 2005).

The adopted procedures started by conducting a bibliographic survey and definition of the study universe (mining). Therefore, it was verified through the Computerized Federal Environmental Licensing System (SISLIC) of IBAMA (https://servicos.ibama.gov.br/licenciamento/consulta_empreendimentos.php) the TR and respective EIS available for the mining activities. The selection of EIS used in the research was based on their availability in the system (http://licenciamento.ibama.gov.br/Mineracao/) and the processes that presented other types of environmental studies or those that were incomplete (absence of some volume/part) were excluded from the analysis.

Thus, the TRs and EIS were evaluated regarding the approach to health aspects, according to the matrix proposed by Barbosa et al. (2012). These analysed aspects

were grouped into seven different analytical categories: project description; diagnosis; identification, assessment and communication of impacts; evaluation of alternatives; compatibility between government actions and the enterprise; mitigating actions; accompaniment and monitoring; according to the methodology presented by the authors.

Health aspects were qualitatively characterized according to the explanation found in the environmental study: non-existent, partial or total, according to the methodology of Barbosa et al. (2012). For the quantitative evaluation, the contemplation degrees (weights) were then proposed for each qualitative evaluation item: non-existent (weight 1); partial (weight 2); and total (weight 3).

Thus, for each health aspect mentioned above, the number of studies addressing each type of explanation was verified. After, these numbers were multiplied by the corresponding weight:

- Number of studies that had no explicit (NO) explanation multiplied by 1;

- Number of studies that presented partial (P) explanation multiplied by 2;

- Number of studies that presented total (T) explanation multiplied by 3.

The values generated in the multiplication of degrees of contemplation were then summed and evaluated according to the aspects approach. The “Health Aspects Approach Scale” was created according to the number of evaluated EISs, as follows:

- Minimum value: corresponding to the number of evaluated EISs multiplied by 1 (lowest degree of contemplation);

- Maximum value: corresponding to the number of evaluated EISs multiplied by 3 (highest degree of contemplation).

When conducting the research on IBAMA's website, it was verified the existence of 290 mining environmental licensing processes, but only 15 of these presented access to the EIS. Regarding the TR of EIS used for this research, only 6 were available either in the EIS text or in a separate file. The evaluated EISs correspond to the processes presented in Table 1. It is noteworthy that the process number of Enterprise 15 contained in the EIS was not found in the IBAMA system.

Table 1 - Processes whose EISs were evaluated in this study

Identification	**Process number**
1	02001.005036/2010-85
2	02001.000415/2012-41
3	02001.001766/2012-79
4	02001.004429/2005-12
5	02012.000540/2006-83
6	02001.004105/2004-95
7	02001.003450/2004-10
8	02001.003944/2001-43
9	02018.005915/94-92
10	02001.008141/2002-66
11	02001.000711/2009-46
12	02001.004046/2011-84
13	02001.002387/98-87
14	02001.005454/2004-24
15	Not found

Source: authors

Thus, considering that 15 EISs were evaluated, the approach scale was established according to Table 2.

Table 2 - Scale of Health Aspects Approach

Scale	**Health Aspects Approach**
15 - 25	LOW

26 - 36	AVERAGE
37 - 45	HIGH

Source: authors

3 RESULTS AND DISCUSSION

Table 3 shows the results obtained from the analysis of health aspects in the EISs/EIR of the mining activities found in the present study.

Table 3 - Matrix of analysis of health aspects in the EIS/EIR of mining activities

Analytical Category	**Health Aspects**	**Explicit in EIS**			**Multiplication by weights**			**Total**	**Approach**
		NO	**P**	**T**	**1**	**2**	**3**		
Project description	Technical team responsible for health approach	8	5	2	8	10	6	24	AVERAGE
	Occupation and land use dynamics (soil, water, and population migrations and displacements)		7	8	0	14	24	38	HIGH
	Quantitative estimative of income generation, employment, taxes and royalties	1	9	5	1	18	15	34	HIGH
	Estimates of direct or indirect use of financial resources to improve health	14	1		14	2	0	16	LOW
Socioenvironmental Diagnosis of Influence Areas	Epidemiological profile		5	10	0	10	30	40	HIGH
	Socioeconomic profile		5	10	0	10	30	40	HIGH
	Health Resources, Services and Infrastructure		5	10	0	10	30	40	HIGH

	Education Resources, Services, and Infrastructure	1	5	9	1	10	27	38	HIGH
	Perception of health impacts and risks	2	7	6	2	14	18	34	HIGH
Impact Identification, Assessment and Communication	Impacts and risks to workers' health (physical, chemical, ergonomic and biological)	3	8	4	3	16	12	31	AVERAGE
	Impacts and risks to population health	4	7	4	4	14	12	30	AVERAGE
	Impact of the activities on health indicators (morbidity, mortality, outpatient and hospital care, etc.)	6	6	3	6	12	9	27	AVERAGE
	Impact of enterprise on social and economic indicators (GDP, education, sanitation, employment and income, etc.)	2	7	6	2	14	18	34	HIGH
	Communication of health impacts	7	1	7	7	2	21	30	AVERAGE
Compatibility between government and enterprise actions	Identification of government plans, projects and programs	3	4	8	3	8	24	35	HIGH
	Evaluation of compatibility between government and enterprise actions	4	10	1	4	20	3	27	AVERAGE
	Evaluation of government health actions	3	7	5	3	14	15	32	AVERAGE
	Assessment of health enterprise actions	2	13		2	26	0	28	AVERAGE
Alternatives evaluation	Assessment of location alternatives	2	5	8	2	10	24	36	HIGH

	Evaluation of technological alternatives	4	3	8	4	6	24	34	HIGH
	Evaluation of economic alternatives	5	9	1	5	18	3	26	AVERAGE
	Cost-benefit analysis of potential health impacts	15			15	0	0	15	LOW
Identification of mitigation measure	Mitigating measures regarding the impacts of the project		7	8	0	14	24	38	HIGH
	Mitigation measures regarding infrastructure and health services		9	6	0	18	18	36	HIGH
	Specific mitigation measures for at-risk and most vulnerable populations	3	9	3	3	18	9	30	AVERAGE
	Definition of emergency and contingency plans considering the type and extent of impacts	3	3	9	3	6	27	36	HIGH
Monitoring and control of health impacts	Monitoring of worker health actions by the enterprise	1	10	4	1	20	12	33	AVERAGE
	Monitoring of population health actions by the enterprise	8	4	3	8	8	9	25	AVERAGE
	Government monitoring of worker health actions	13	1	1	13	2	3	18	LOW
	Government monitoring of population health actions	11	3	1	11	6	3	20	LOW

Source: authors

3.1 Term of Reference

Based on the analysis of the IBAMA website, due to the lack of availability of all terms of reference, it was decided to evaluate the health approach qualitatively, unlike the EISs, which had a quantitative analysis. It should be noted that, for the most part, unavailable TRs refer to older processes, some dating back to the 1990s, so they may not have been scanned into the system.

The requirement of addressing health aspects was verified in the TRs in the socioeconomic diagnosis item. It was noticed that the description required in the terms refers to the characterization of the health quality of the population of the area of direct and/or indirect influence of the enterprise, through the epidemiological profile, mortality rates, morbidity, profile of health facilities.

In addition, in some terms, it was required a description of programs related to health in private and governmental levels, as well as the formal and non-formal health care systems of the population and workers of the enterprise. In addition, the requirement to describe the impact pressure on health services could be noted. Regarding to mitigation measures, some terms required the implementation of environmental health programs. However, it is noteworthy that one of the terms evaluated did not include the health approach.

A study performed by Rigotto (2009) analysed the inclusion of health impact assessment in the TR of a coal-fired thermal power plant. The author highlighted some points, such as the omission at the end of the project about the indication of the energy distribution network generated on site, considering that it is necessary to know the path and the power to analyse the human exposure to the electromagnetic field that the network can generate. In addition, the author considered necessary to implement details regarding the volume and characteristics of the coal to be consumed, especially the sulphur content; specify dust emissions during coal transportation and handling operations, which may be harmful to both workers and the surrounding community; indicate the physical, chemical, biological risk factors and collective labour protection measures.

Therefore, in order that health determinants to be included in the EIA, they must be required (HRESC et al., 2018), as the definition of the scope of the study significantly influences the success of the environmental assessment (MULVIHILL; BAKER, 2001).

3.2 Project description

In the project description stage, it was verified a low approach to aspects directly related to health. It can be noticed that the aspects that had medium and high approach are those that concern the estimates of income, employment, land use and occupation and population dynamics, and thus not necessarily associated with health elements. It is noteworthy that, although the analytical category is “project description” and that in some cases this item was very organized and complete, the descriptions of land use dynamics present in the stage of socio-economic diagnosis of EIA were also considered, because it was thought that on this topic this information would be really detailed. It is noteworthy that there are no estimates of resource allocation in health in 14 of the 15 evaluated EIS, in addition to the lack of indication of the technicians responsible for health issues, nonexistent in 8 EISs.

The presence of professionals from different areas is essential in the elaboration of an EIS. Rodrigues (2010) emphasizes that interdisciplinarity is necessary, in the same way, in the analysis process of these studies. According to Balby (2012), there is a complaint from health experts about the lack of their formal involvement in EISs, licensing processes, definition and implementation of measures to manage the impacts of enterprises. Regarding this, the author points out that the advantages of using specialists include: the implementation of more structured methodologies, the multidisciplinary nature of the studies and the commitment to the health objectives of different institutions and sectors.

The expansion and discussion around a multidisciplinary EIS, within the current development context, is essential for the improvement of instruments that strengthen sectoral public policies and understand the productive processes that impact on the natural environment and consequently on population health (SILVEIRA; ARAÚJO NETO,

2014). In addition, considering that major works have the potential to cause major social and environmental impacts, it is necessary to include the demands related to health impacts, especially in the territorial dimensions, because the social and political organization in these geographic spaces can decisively influence the way the health risks are disseminated among different social groups (MIRANDA et al., 2008).

As in this study, in an analysis of three Australian EISs related to mining activities, the authors found that the studies were unable to determine the economic impacts of projects on the health and well-being of local communities (HRESC et al., 2018). The health improvement costs not being estimated demonstrates the lack of interest and irrelevance of health aspects within the evaluated projects. It can be seen that even if the project predict mitigation and compensation actions in the health area, there is no guarantee that they will be effectively fulfilled, as they are not even being accounted for within the financial planning. Therefore, it is necessary to address health aspects within economic estimates so that it become more relevant to the overall project scenario, as well as the inclusion of health professionals in the context of environmental studies.

3.3 Socioenvironmental Diagnosis of Influence Areas

The diagnostic category was the most complete among those analysed in the matrix, with 4 of the 5 aspects showing a high approach to health issues. Only the aspect of “perception of health impacts and risks” has a medium-scale approach, however, it is believed that this element is somewhat confused with the stage of identification, assessment and forecasting of impacts. As the EIS number 14, some of the studies presented surveys conducted through field research in health departments, and through interviews, as in the case of EIS number 15. The others, however, only detailed secondary data taken from databases public data known as the Unified Health System Informatics System (DATASUS) and the Brazilian Institute of Geography and Statistics (IBGE).

One of the problems associated with the use of secondary data, such as the IBGE census, is the discrepancy. The publication of the census occurs every 10 years,

so if data are compromised, it will not be possible to draw an efficient planning for the territory under analysis (SOUZA et al., 2018). Another factor to consider is the period between the preparation of the EIS, the implementation and operation of activities, which can take many years. In this time interval, real estate speculation and job creation near the project may lead to an unforeseen population increase, as in the case of the Belo Monte Plant, generating consequences for local public health (FRAGELLI; OLIVEIRA, 2017).

Similarly, Cancio (2008), in his assessment of the insertion of health aspects in EISs of Brazilian hydroelectric dams, also found a greater approach in the baseline studies (environmental diagnostics), characterized by surveys of health services, diseases and aggravations of notifications through secondary information that did not represent the local reality.

The greater complexity and explicitation presented in this category may be associated with the fact that the TRs, as already mentioned, are more specifically related to the requirements of characterization of health aspects in the socio-environmental diagnosis section. Therefore, it is highly recommended that the environmental agency require information regarding the description of the epidemiological profile and the health services and infrastructures of the areas with direct/indirect influence, as delimited in the TR.

In addition, it can be highlighted that there are three health-related points present in most of the mining EIS diagnoses evaluated: air quality, noise and regional endemic diseases. Regarding air quality, an important factor related to mining activity, dust generation and particulate dispersion were associated with occupational risk to the health of workers and the surrounding population, as well as the noise approach.

Regarding endemic diseases, it can be highlighted that most of the analysed EISs corresponded to mining enterprises in the Northern Region of Brazil, which highlights the fact that research is conducted on such diseases, especially malaria. This action corresponds to what is requested by CONAMA Resolution N^{o}. 286 of 2001 (BRASIL, 2001), which refers to the environmental licensing of activities in malaria endemic regions. According to this resolution, activities that may enhance risk factors

for the occurrence of malaria cases in endemic regions should develop epidemiological studies and direct programs aimed at controlling the disease and its vectors, to be implemented in the various phases of the activities.

The stage of diagnosis was the one that presented the most information related to health, however, in general, the aspects were found to be more descriptive. Thus, although they seem more complete, the base studies end up becoming extensive and exhaustive documents, which do not reflect the environmental dynamics of the studied area.

3.4 Impact Identification, Evaluation and Reporting

Some authors point to the fact that environmental studies presented as the basis for the implementation of potentially polluting activities have been shown to be inefficient in identifying and assessing the impacts and lack of health risks associated with these projects, in many cases becoming restricted to the biophysical aspects (BARBOSA et al., 2012; SILVEIRA, 2016). Similarly, in the present research, an average approach to health aspects was verified in the category of "Identification, assessment and communication of impacts". This stage is the most important of the EIS, because when not identified, the impacts on health and its infrastructures will not be avoided, mitigated or compensated.

Among the impacts generated by the mining sectors, the health of workers and the surrounding community are negatively affected, considering the changes in air quality and noise production (IRAMINA et al., 2009; LIRA et al., 2012). Some of the impacts identified in project number 11 were the risk of increasing the number of cases of endemics issues and the introducing of new endemics in the project region, due to the displacement of infected people from other regions of the country to work in, as well as increased cases of sexually transmitted diseases. Another impact pointed out by projects number 1 and number 12 is the pressure on public health services due to the increased demand for care. On the other hand, in the case of EIS number 4, a 1994 study, no health impact is mentioned.

Contrasting the results found in this study, in a study conducted by Barbosa et al. (2012), none of the environmental studies of the oil typology analysed by the authors presented information about the impacts on the population's health and health indicators. In other research, Noble and Bronson (2005) analysed human health considerations in EISs from Canadian mining projects, and concluded that human and social health were not adequately approached within these studies and stated the need to monitoring actual health impacts after project approval and ensure mitigation and improvement measures are indeed effective.

Zakrizon et al. (2015) conducted a study in El Salvador and concluded that Salvadorans perceive gold mining as a threat to public and environmental health. The interviewees raise important questions: contamination of land and water by mining inevitably affects the health of the local population. Such questions can be applied to any potentially polluting activities, which reaffirms the importance of a more efficient approach of health issues within EISs. Suopajarvi (2013) states that social impacts generally receive little attention in environmental studies evaluated for mining projects in northern Finland.

The diversity of social and environmental problems and the complexity involved in social issues related to the health-disease process include basic factors such as employment, sanitation, housing, education, income and access to health services (SILVEIRA et al., 2012).

As in the case of EIS number 14, when addressing issues such as sanitation and housing, it is related its quality with public health. In other words, the increased demand for sanitation and housing services may trigger another impact, which is the population's illness and the reduction in their life quality (OMS, 1946; SILVEIRA et al., 2012; BRASIL, 2014). This health impact is only identified when it is analysed the relation between impact and cause.

Thus, the entrepreneur proposes to contribute to the Government to improve these sectors when they are negatively affected by the dynamics of the enterprise (considering the population increase due to works, for example). However, by analysing the impacts generated by the construction of the Belo Monte Hydroelectric

Power Plant (HPP) on urban development and public health, Souza et al. (2018) state that EISs are unsatisfactory regarding health impacts during the construction of a HPP, as health problems are viewed as secondary results of environmental impact.

3.5 Compatibility between government and enterprise actions

In this item, it was possible to verify that the health approach was average. The points described were most observed in the Diagnostic and Mitigating Measures sections. In this context, the Diagnosis verified the actions (plans, projects and programs), whose objectives were already established by the public power. In mitigating measures, the actions were related to the proposals for insertion of new actions or improvement of existing ones.

An example is the mining activity number 4 that shows in its EIS, in the Mitigating Measures section, that the municipalities of this region of Pará had, at the time of the EIS, 27 public health programs initiated and directed by the federal government and the city itself, highlighting the National Tuberculosis Control Program and the Malaria Control Program.

Regarding the partnership of the private sector with the municipal government, the municipalities of Oriximiná and Terra Santa at the time did not have medical care of private units. The partnership develops programs for the communities that live in the mining-industrial facilities and municipalities of the region where the enterprise operates or exerts some kind of influence. Examples are Sexually Transmitted Diseases and Early Pregnancy Awareness Programs, Oral Health Education and Prevention Program, and Malaria Transmitting Mosquito Prevention, the latter being indefinite, while the others closed in 2009.

Based on the example of the project mentioned and the average classification of approach to health aspects in this item, it can be seen that there should be more programs focused on the health of the local population and workers of the project, mainly because of the example being from a very fragile region and with little assistance from various levels by the government. This reinforces the idea that the low consideration of health issues in the environmental licensing processes of

enterprises demonstrates that there is a lack of articulation between sectoral public policies in view of the social and environmental impacts generated by large enterprises (SILVEIRA et al., 2012; SILVEIRA; ARAÚJO NETO, 2014).

The O'Mullane and Harris-Roxa (2015) bibliographic review study addresses the effectiveness of the use of HIA, and it can be seen that the use of this tool is more evident in the regions of North America, Europe and Australia, presenting an increased practice in South America, China and African states in recent years. In addition, the same study shows that in the United States there is a health impact project that promotes the use of the HIA tool as a decision-making aid for policy makers.

3.6 Alternatives Evaluation

For this topic, one point to note is the cost-benefit analysis of potential health impacts, which had no consideration in the EISs, showing that these activities do not show a greater interest in performing this analysis and have a feedback, either of the population or of the workers themselves and in relation to the amount invested in health issues.

For the other items, the approach was average, highlighting that there are not many choices regarding the location of installation of this type of activity, because the ore to be extracted is intrinsic to the site. However, in the analysis made, it was possible to verify locational alternatives for the disposal of tailings, for example, being classified as partial approach. Also, the so-called “zero alternative” was verified, which is characterized as an option of not having the installation of the project, and those that presented this element in the EIS were classified as total approaching.

Silveira (2010) and Silveira and Araújo Neto (2014), comment in their studies that the implementation of large enterprises, such as mining, lead to an increase in the costs of services in health systems. Thus, there must be introducing clearer tools to encourage governments and entrepreneurs to introduce health-related costs into their plans, projects and programs, so that this does not reflect in tax increases and reduced quality of care for health-care facilities to local population.

Regarding the technological alternative, it was classified as average. Although it has been mentioned, this issue should be much more evaluated and considered in the decision-making to choose more and more technological alternatives that seek to reduce pollution, and equipment to help the work of miners, as the location alternatives depend on the location of the ores to be explored.

The IBAMA Joint Ordinance Nº. 259 of August 7, 2009 requires the entrepreneur to include in the EIS/EIR a specific chapter on cleaner technology alternatives in order to reduce impacts on workers' health and the environment, including thermal pollution, noise and emissions harmful to the respiratory system (BRASIL, 2009). Silva, Augusto and Gurgel (2013) in their study on occupational health analysis in refinery licensing, evaluated three enterprises, two of which presented technological alternatives that helped control pollution, establishing the promotion of worker health.

3.7 Mitigation Measures Identification

Regarding this point, the results obtained were three items of medium approach and one item of high, where all EISs showed their mitigating measures for the possible impacts of the projects, contemplating further details of these measures. An example would be the proposed implementation of health programs, as well as the communication of health impacts, many of which associate the population and workers of the enterprises as participants, not just benefiting employees.

In project number 2, for example, located in the municipality of Corumbá, it was verified a mitigating measure in health infrastructure. The measure is the Health Program in the Project Implementation Phase, which has the implementation of ambulatory at the construction sites, aimed at first aid and outpatient care for workers of MCR/Vale and contractors, with room for consultation, room for rest and emergency and nursing, in order to soften and control the local public health infrastructure.

In this same project, mitigation measures can also be verified in order to mitigate the impact of discomfort on the surrounding population through measures,

programs and plans. Some examples are the monitoring the air quality, operating the equipment with the greatest noise potential during business hours, planning the transportation of materials and equipment during off-peak hours and at night on the main access roads to the Project, control of motor vehicle speeds on the main access roads to the mine, and solid waste management control, among others.

In addition, it should be highlighted in project 2, the Socio-Environmental Communication and Information Plan, which aims to establish a permanent and transparent channel of communication between the project and society, disseminating information through regular meetings or other means of communication. With this, both the general community with contractors and workers can clarify their doubts and explain their concerns, especially on health issues.

The discussion of these issues becomes extremely important to help the approval of the population regarding the installation of the enterprise. In addition to showing an ethical position on the part of the enterprises to worry about the impacts generated that will influence the health of the population and the worker, provide spaces for disease prevention disclosure and to discuss about other diseases, i.e. AIDS.

It might be highlighted the importance of proposing programs that are really efficient and compatible with local realities, that assist the risk populations with greater vulnerability, as they can suffer major consequences related to the negative impacts of large enterprises.

Similar to the James Bay Dam in Quebec, cited by Tanner (1999) and Queiroz and Veiga (2012), which had serious adverse impacts on the Cree Indians, including social disintegration and the disappearance of traditional ways of life. In addition, there was influence in health aspects, due to unplanned social changes associated with changes in habits and diets, such as increased alcohol abuse, drugs and cases of depression and suicide. It also led to the high rates of diabetes, obesity and occurrence of sexually transmitted diseases among the affected populations.

3.8 Monitoring and Control of Health Impacts

In general, the health monitoring of action phase is seen in EISs as having low approach, such as in the enterprises numbers 7, 5, 2, and 4. It can be noticed that both government and entrepreneurship do not monitor health actions for the worker and the population, and may be related to the fact that there is little report about hiring professionals to deal with these issues throughout the installation and operation of the enterprise. It is only seen that there are actions, mainly for bureaucratic reasons, but there is no awareness, ethics and commitment to monitor the impacts that directly affect the health of the community and miners. This part is considered extremely important both for the monitoring of government actions and for the enterprise, because with proper monitoring, there is a possibility of improvement or correction of the implemented programs.

Robust impact monitoring requires assessing the population potentially affected by health impacts and a control population (PETTICREW et al., 2007). However, as pointed out by Balby (2012), there is still a lack of transparency, awareness and responsibility of entrepreneurs in disclosing the results of monitoring health actions, which may be justified by the absence of it in the evaluated EISs. Thus, the author comments that the assessment of health actions in EISs becomes a sensitive methodological step towards “minimizing negative impacts and maximizing positive impacts in different social, economic and geographic contexts”, as explained above in the document published by the Ministry of Health.

From the screening stage to monitoring, decisions are made that reflect the political, economic, cultural, institutional context and the balance or imbalance of forces between the various stakeholders in the HIA process and decision making regarding a proposal (BALBY, 2012).

Several studies have been conducted on the scope of health in the environmental licensing process in Brazil (SOUZA et al., 2018; SILVA et al., 2013; RIGOTTO, 2009; QUEIROZ; VEIGA, 2012; SILVEIRA; ARAÚJO NETO, 2014), drawing attention to the theme. Thus, it is believed that with these studies the environmental agencies may be gradually including health aspects as a more relevant factor within

the analysis processes. However, for health to be effectively addressed within EISs, it is essential that they are also in the TRs prepared by environmental agencies.

4 CONCLUSIONS

From the assessment of the EISs of mining activities, it was noticed that the most recent ones present a more complete set of information regarding health issues, although in many cases they still focus on presenting secondary data or without interrelating them with the physical, biotic and socioenvironmental areas.

In addition, there is a need for greater participation of health experts in EIA processes, improving project credibility, assisting in the formulation, and monitoring of health care programs/plans. One of the biggest highlights observed with this research was the lack of monitoring of health actions with the population and workers, showing a lack of responsibility by both the government and the enterprise to follow up and support these actions. Therefore, there is no coherence in implementing actions and then not following them and establishing corrective measures, when necessary, not guaranteeing the continuity of the programs.

Mining is considered a highly polluting activity, especially in relation to the reduction of air quality by particulate matter and the generation of noise, causing hearing disorders and stressful situations to the individual. Thus, even with limitations in the choice of location alternatives, greater attention should be given to the implementation of technological and economic assessments that encompass the health theme.

Finally, for an improvement in the approach to health aspects in Brazilian environmental licensing, there is a need for greater demands on these issues in the TRs. Thus, it is indispensable to encourage the responsibility of entrepreneurs, funding institutions, government, population and employees, in order to improve the sustainable management of activities with pollution potential.

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REFERENCES

ABE KC, MIRAGLIA SGEK. **Avaliação de Impacto à Saúde (AIS) no Brasil e América Latina: uma ferramenta essencial a projetos, planos e políticas.** Interface-Comunic, Saúde e Educ. 2018; 22:349-58.

AGWA-EJON JF, PRADHANB A. **Life cycle impact assessment of artisanal sandstone mining on the environment and health of mine workers.** Environ. Impact Assess. Rev. 2018; 71:71-78.

ALMEIDA MRR, MONTAÑO M. **Benchmarking na Avaliação de Impacto Ambiental: O sistema mineiro frente às melhores práticas internacionais.** Soc Natur. 2015; 27:81-96.

BACCI DLC, LANDIM PMB, ESTON SM. **Aspectos e impactos ambientais de pedreira em área urbana. REM: R. Esc. Minas, Ouro Preto.** 2006;59: 47-54.

BALBY CN. 2012. **Avaliação de impactos à saúde: desenvolvimento internacional e perspectivas no Brasil.** 2012. 158 f. Mestrado em Ciências - Programa de Pós-Graduação em Saúde Pública - Faculdade de Saúde Pública, [dissertation] Universidade de São Paulo, São Paulo.

BARBOSA EM, BARATA MML, HACON SS. **A saúde no licenciamento ambiental: uma proposta metodológica para a avaliação dos impactos da indústria de petróleo e gás.** Ciência & Saúde Col. 2012; 17:299-310

BRASIL. Lei nº 6.938, de 31 de agosto de 1981. **Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências.** Diário Oficial da União, 2 Set 1981.

_____. CONAMA. **Conselho Nacional do Meio Ambiente. Resolução nº 001, de 23 de Janeiro de 1986.** Dispõe sobre critérios básicos e diretrizes gerais para a avaliação de impacto ambiental. Diário Oficial da União, 17 Fev 1986.

_____. CONAMA. **Conselho Nacional do Meio Ambiente. Resolução Resolução nº 286 de 30 de agosto de 2001.** Dispõe sobre o licenciamento ambiental de

empreendimentos nas regiões endêmicas de malária. Diário Oficial da União. 17 Dez 2001.

_____. Secretaria de Vigilância em Saúde. Portaria nº 47, de 29 de dezembro de 2006. **Dispõe sobre a Avaliação do Potencial Malarígeno e o Atestado de Condição Sanitária para os projetos de assentamento de reforma agrária e para outros empreendimentos, nas regiões endêmicas de malária.** Diário Oficial da União. 04 Jan 2007.

_____. **Portaria Conjunta MMA/IBAMA nº 259, de 7 de agosto de 2009.** Available from: <http://www.iap.pr.gov.br/arquivos/File/Legislacao_ambiental/Legislacao_federal/PORTARIAS/PORTARIA_CONJUNTA_MMA_IBAMA_259_2009.pdf> Accessed 21 jul. 2019.

_____. **Avaliação de Impacto à Saúde – AIS: metodologia adaptada para aplicação no Brasil.** Brasília, DF: Secretaria de Vigilância Ambiental em Saúde/ Departamento de Vigilância em Saúde Ambiental e Saúde do Trabalhador, 2014.

CANCIO JA. **Inserção das questões de saúde no estudo de impacto ambiental.** 2008. 95 f. Mestrado em Planejamento e Gestão Ambiental [dissertation], Universidade Católica de Brasília, Brasília, 2008.

DREWRY J, KWIATKOWSKI R. **The role of health impact assessment in advancing sustainable development in Latin America and the Caribbean.** J. Environ. Health. 2015; 77:16-20.

FRAGELLI IKZ, OLIVEIRA LSS. **Considerações sobre os impactos em saúde, no contexto do deslocamento forçado de ribeirinhos em Belo Monte.** In: Magalhães, S. B.; Cunha, M. C. (Orgs.). A Expulsão de Ribeirinhos em Belo Monte: Relatório da SBPC. São Paulo: Sbpc, 2017. p. 203-234. Available from: http://portal.sbpcnet.org.br/livro/belomonte.pdf

HRESC J, RILEY E, HARRIS P. **Mining project's economic impact on local communities, as a social determinant of health: A documentary analysis of environmental impact statements.** Environ. Impact Assess. Rev. 2018; 72:64–70.

IRAMINA WS, TACHIBANA IK, SILVA LMC, ESTON SM. **Identificação e controle de riscos ocupacionais em pedreira da região metropolitana de São Paulo.** Rev Escola de Minas. 2009; 62:503–509.

LAKATOS EM, MARCONI MA. 2004. **Metodologia Científica.** 4. ed. São Paulo: Atlas, 2004.

LIRA M, RABBANI EK, BARKOKEBAS JUNIOR B, LAGO E. **Risk evaluation and exposure control of mineral dust containing free crystalline silica: a study case at a quarry in the Recife Metropolitan Area.** Work. 2012; 41:3109–3116.

NOBLE BF, BRONSON JE. **Integrating Human Health into Environmental Impact Assessment: Case Studies of Canada's Northern Mining Resource Sector.** Arct. 2005; 58:395-405.

MIRANDA AC, BARCELLOS C, MOREIRA JC, MONKEN M, 2008. **Território, ambiente e saúde.** Rio de Janeiro: Fiocruz; 2008.

MULVIHILL PR, BAKER DC. **Ambitious and restrictive scoping: case studies from Northern Canada.** Environ. Impact Assess. Rev. 2001; 21:363-384.

O'MULLANE M, HARRIS-ROXA B. **Health Impact Assessment.** J. Environ. Assess. Policy Manage. 2015; 17:1-11.

OMS, Organização Mundial da Saúde. **Constituição da Organização Mundial da Saúde, 1946.** Available from: http://www.direitoshumanos.usp.br/index.php/OMS-Organiza%C3%A7%C3%A3o-Mundial-da-Sa%C3%BAde/constituicao-da-organizacao-mundial-da-saude-omswho.html

PETTICREW M, MACINTYRE S, THOMSON H, 2004**. Evidence in HIA.** In: Parry, J., Palmer, S. Health impact assessment: concecpts, theory, techniques, and applications. Oxford: Oxford University Press; 71-80; 2004.

RIGOTTO RM. **Inserção da saúde nos estudos de impacto ambiental: o caso de uma termelétrica a carvão mineral no Ceará.** Ciência & Saúde Col, 2009; 14:2019-2059.

RUPPRECHT SM. **Safety aspects and recommendations for surface artisanal mining.** J. South Afr. Inst. Min. Metall. 2015; 115:35–70.

SILVA D, SIMON FO. **Abordagem quantitativa de análise de dados de pesquisa: construção e validação de escala de atitude.** Cadernos do CERU. 2005; 2:11-27.

SILVA JM, AUGUSTO LGS, GURGEL ID, **Saúde do trabalhador nos estudos de impactos de refinarias de petróleo.** Cadernos Saúde Col. 2013; 21:325-331.

SILVEIRA M, ARAÚJO NETO MD. **Licenciamento ambiental de grandes empreendimentos: conexão possível entre saúde e meio ambiente.** Ciência e Saúde Col. 2014; 19:3829-3838.

SILVEIRA MA, **Implantação de hidrelétricas na Amazônia brasileira, impactos socioambientais e à saúde com as transformações no território: o caso da UHE de Belo Monte** [thesis]. Brasília: Universidade de Brasília; 2016.

SILVEIRA M, 2010. **Interface entre saúde e meio ambiente: aspectos da saúde na Avaliação de Impacto Ambiental de empreendimentos.** In: Anais do V Encontro Nacional da Anppas. Florianópolis, 2010. Available from: http://www.anppas.org.br/encontro5/cd/artigos/GT4-270-187-20100903230338.pdf.

SILVEIRA M, FENNER ALD. **Avaliação de Impactos à Saúde (AIS): análises e desafios para a Vigilância em Saúde do Brasil.** Ciência e Saúde Col. 2017; 22:3025-3214

SILVEIRA M, PADILHA JD, SCHNEIDER M, AMARAL PST, CARMO TFM, NETTO GF, ROHLFS DB. **Perspectiva da avaliação de impacto à saúde nos projetos de desenvolvimento no Brasil: importância estratégica para a sustentabilidade.** Cadernos de Saúde Col. 2012; 20:57-63.

SMITH NM, SALEEM A, BOFINGER C, COLLINS N. **Human health and safety in artisanal and small-scale mining: an integrated approach to risk mitigation.** J. Cleaner Prod. 2016; 129:43–52.

SOUZA DP, SILVA WRS, CERVINSKI GC, SANTOS BD, COMARÚ FA, TRIGOSO FBM. **Desenvolvimento urbano e saúde pública: impactos da construção da UHE de Belo Monte.** Desenvolv. Meio Amb. 2018; 46:154-173.

SUOPAJARVI L. **Social impact assessment in mining projects in Northern Finland: comparing practice to theory.** Environ. Impact Assess. Rev. 2013; 42:25-30.

QUEIROZ ARS, VEIGA MM. **Análise dos impactos sociais e à saúde de grandes empreendimentos hidrelétricos: lições para uma gestão energética sustentável.** Ciência e Saúde Col. 2012; 17:1387-1398.

RODRIGUES GSSC. **A análise interdisciplinar de processos de licenciamento ambiental no estado de Minas Gerais: conflitos entre velhos e novos paradigmas.** Rev. Sociedade Nat. 2010; 22:267–282.

TANNER A. **Culture, Social Change, and Cree Opposition to the James Bay Hydroelectric Development.** In: Social and environmental impacts of the James Bay hydroelectric project. Montréal, Ithaca: McGill-Queen's Press; 1999. p. 121-140.

WHO. **World Health Organization.** European Centre for Health Policy. Health Impact Assessment: mains concepts and suggested approach. Gothenburg Consensus paper. Geneva: WHO; 1999.

ZAKRISON TL, CABEZAS P, VALLE E, KORNFELD J, MUNTANER C, SOKLARIDIS S. **The perceived consequences of gold mining in postwar El Salvador: a qualitative study.** Am. J. Public Health. 2015; 105:2382-2387.