

# PREVENTIVE MEASURES FOR WORK ACCIDENTS IN MINING ACTIVITIES

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## ABSTRACT

This article aims to demonstrate that corporate preventive measures that seek to avoid risks to the natural and work environment are capable of preventing environmental and occupational accidents in mines. In the work environment, the employee is who directly and immediately suffers all the physical and psychological consequences of working in an inappropriate place. In the case of mining, the risks are inherent to the activity, exposing the worker to greater chances of contracting diseases and suffering accidents. In this context, this research will investigate whether the application of environmental law principles in the labor market aiming at a healthy work environment is in line with the constitutional dictates of valuing work, free initiative and human dignity. In this way, the work uses the deductive method and bibliographic research, supported by theoretical models and labor and environmental normative fundamentals. The research shows that the

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application of environmental principles, especially prevention and precaution, is capable of enabling risk reduction, entailing benefits to all parties involved in the work relationship, by implementing sustainability in the work environment.

**Keywords:** mining; occupational accidents; occupational diseases; work environment.

## ***DAS MEDIDAS PREVENTIVAS DE ACIDENTES DO TRABALHO NA ATIVIDADE DE MINERAÇÃO***

### ***RESUMO***

*Este artigo tem por objetivo demonstrar que as medidas preventivas empresariais que buscam evitar riscos ao meio ambiente natural e do trabalho são capazes de prevenir acidentes ambientais e laborais em minas. No meio ambiente do trabalho, o empregado é aquele que sofre, direta e imediatamente, todas as consequências físicas e psíquicas do labor em um local inadequado. No caso da mineração, os riscos são inerentes à atividade, expondo o trabalhador a maiores chances de contrair doenças e sofrer acidentes. Nesse contexto, a pesquisa investiga se a aplicação dos princípios de Direito Ambiental na seara laboral, ao visar um meio ambiente do trabalho sadio, está em consonância com os ditames constitucionais de valorização do trabalho, livre iniciativa e dignidade da pessoa humana. Assim, o trabalho utiliza-se do método dedutivo e da pesquisa bibliográfica, com aporte em modelos teóricos e fundamentos normativos trabalhistas e ambientais. Conclui-se que a aplicação dos princípios ambientais, em especial o da prevenção e precaução, são capazes de proporcionar a redução dos riscos trazendo benefícios para todas as partes envolvidas na relação de trabalho, ao implementar a sustentabilidade no meio ambiente laboral.*

**Palavras-chave:** *acidentes do trabalho; doenças ocupacionais; meio ambiente do trabalho; mineração.*

## INTRODUCTION

Mining activity has played a core role in the socioeconomic and technical-scientific development of mankind. However, mining enterprises face the dual challenge of exploiting mineral resources and reducing their impact on the natural and working environment. This duality stems from the fact that the activity is based on the extraction of non-renewable natural resources, and that the entire work process is considered high-risk.

The fundamental constitutional rights, such as life and work, are experienced in the natural and work environments, respectively. Thus, these legal assets should be protected, guaranteeing their dignity in a conceptually broad way. This implies decent working conditions, and the preservation and protection of nature in a trans-generational way.

In this context, the analysis of the site where these activities are developed is an important means for the prevention of environmental and occupational accidents, especially if the work activities conform to the principles of Environmental Law such as prevention, precaution, and sustainable development. This interdisciplinary analysis unveiled the need for a careful convergence of Environmental and Labor Law institutes in search of the least possible degradation of the natural and working environments.

The importance of the topic is justified by the large number of work-related accidents and diseases contracted by workers in the mining industry in Brazil from the colonial era to the present day. The consequences of occupational accidents are often irreversible, and may even cause death or permanent illnesses to the work, reducing or suppressing their working capacity and their quality of life and life expectancy.

When applied by the entrepreneur, the observance of occupational health and safety norms, as well as the technical norms for the prevention of accidents in dams, may mitigate the risks of occupational diseases or accidents in mineral extraction activities.

To reach the proposed objective, this work used the deductive method and bibliographic research, supported by theoretical models and labor and environmental normative fundamentals. We consulted the legislation, doctrinal works and case studies, considering specifically the Public Civil Action No. 0012023-97.2016.5.03.0069, concerning the disaster in the city of Mariana, as the theoretical framework.

In this sense, the first topic will demonstrate the general concept of environment, then specifying aspects of the mining environment

and occupational diseases arising from the activity. The second topic will review the main rules of health and safety at work in the Brazilian mining industry. The third topic will investigate the application of the core principles of work environment in mining. Finally, tragic events involving mining dams and the consequences for workers' health and safety will also be investigated.

## **1 THE WORK ENVIRONMENT IN MINES – OCCUPATIONAL DISEASES AND WORK-RELATED ACCIDENTS**

The Constitution of the Federative Republic of Brazil (CRFB) innovated the Brazilian Law by providing for the protection of the environment in its art. 225. Based on a systemic analysis, this rule integrates the category of collective and transgenerational fundamental rights. Therefore, it is up to the State, the community and individuals and corporations defend the environment and preserve it for present and future generations, in honor of the principle of intergenerational solidarity. The Brazilian constitutional system was one of the first to expressly address environmental protection, influenced by a sociocultural trend to provide laws on this issue at a global level (COSTA, 2021).

In this context, the environment reached special legal relevance, whose constitutional norms started to be binding upon public and private entities, in addition to becoming material reserves in relation to the Derived Constituent Power. Pursuant to art. 60, paragraph 4, of the Brazilian Constitution, environmental protection and preservation appear as essential rights to a healthy quality of life. For Costa (2009), the environment would be the gathering of natural and artificial components shared between all human and non-human beings, indispensable for the harmonious, empathetic and balanced development of the species.

The environment is not limited to natural and artificial elements. The legal concept contained in art. 3 of Federal Law no. 6.938, dated August 31, 1981, approaches social, cultural and economic aspects, as well as physical, chemical and biological aspects (BRAZIL, 1981). It is a unitary concept made of several principles, objectives and guidelines that make up the National Environmental Policy aimed not at establishing divisions or semiautonomous concepts, under penalty of compromising the effectiveness of essentially holistic environmental protection (FIORILLO, 2019).

In this context, according to the jurisprudence of the Federal Supreme

Court (STF), it is observed that the classification of the environment is broad and includes natural environment, artificial environment, cultural environment, and work environment (BRAZIL, 2006).

With regard to the work environment, it is understood that it is the place where the individual develops their work activities, voluntarily or paid, in which socioeconomic activities are made possible in the public and private sectors. According to Fiorillo (2019, p. 66, free translation), “[...] this place must have healthy and safe conditions, that is, it does not present agents that compromise the physical-psychoic health of those who work there”. The concept also encompasses “[...] the workplace, work instruments, the way tasks are performed, and the way in which the worker is treated by the employer or service taker and by co-workers” (MELO, 2010, p. 31).

The importance of protecting the work environment lies in the fact that it is there where the worker spends a large part of their day and, consequently, considerable time of their life. Thus, the right to a healthy work environment “[...] is inserted in the general environment (art. 200, VII of the Federal Constitution), so that it is impossible to achieve quality of life without having quality of work, nor can it be achieved balanced and sustainable environment, ignoring the work environment” (OLIVEIRA, 1996, p. 74, free translation).

However, mining work is unhealthy and dangerous by nature. Mining activity exposes workers to physical, chemical and biological agents and, with regard to ergonomic requirements, this work causes harm in the performance of tasks and exposure to risks. All these aspects may compromise the worker’s health and safety. In addition, when workers are extracting ore they face, during work, poor lighting, low quality of air permeated by suspended particles, humidity in the galleries, and dangerous use of explosives. It should also be added that workers in this activity carry heavy loads and make repetitive efforts, which unequivocally contributes to weakening their health, and compromising their quality and span of life (GONÇALVES, 2020).

The Labor Public Prosecutor’s Office (MPT), in an inspection carried out in 2015 and in partnership with the Ministry of Labor and Employment, in the interior of Paraíba, observed the vulnerability of workers who worked in clandestine quarries. In these activities, worker protection proved to be insufficient or non-existent, as:

[...] workers do not have any employment relationship, leading to a situation of instability in relation to health and safety, especially considering that the activity carried out in the quarries is of high risk. [...] [...] The activities not on this list, however, are clandestine activities, making inspection difficult. “The most serious irregularity is precisely the mining without authorization by the DNPM”, [...]. In the quarries of Currallinho workers on the site are exposed to constant insalubrity, wind, sun, rain. The only “protection” is a canvas tent that provides some shade. Workers work without using personal protective equipment, without shoes, without a hat, without sunscreen. and with handcrafted tools wearing only their clothes: shorts or pants and, sometimes, a shirt. There is also no proper support for resting or storing food. The site destined for the most basic needs, such as eating, drinking water and storing personal belongings, does not offer any safe and hygienic structure, since the place that serves as facilities for the workers is a wattle-and-daub (hammering house). There is no bathroom (LOPES, 2016, free translation).

These workers work under an intense risk of suffering serious accidents, and being affected by various diseases. Many factors put them in a vulnerable situation, such as landslides, use of powerful explosives, electric shocks, accidents with dams, unhealthy places due to humidity, dust, bacteria, viruses, fungi, and physical-chemical elements.

It is, therefore, an activity classified as a level-4 risk that, according to the Ministry of Labor is the most harmful level. In other words, one of the most dangerous work processes. In this scenario, mining workers deal with physical risks that may cause hearing impairment, spinal disorders, sunburn, ionizing radiation, among others. There are also chemical risks with hydrargyrisms, explosions, silicosis. In addition to all these, there are biological risks that may affect them with diseases such as malaria and tuberculosis. In this light of health vulnerability, psychosocial illnesses related to mental health are also developed (CAVALCANTI et al., 2022).

Therefore, the lack of risk management and non-observance of rules boost the occurrence of occupational environmental accidents. According to Candia et al. (2009, p. 520), unsafe management includes “[...] inadequate mine designs, geological-structural uncertainties, inadequate maintenance of equipment conditions, inadequate supervision, or a combination of these factors”. It is also found that this management fraught with errors and disregard for safety is responsible for 90% of work-related accidents in such environments (CANDIA et al., 2009, free translation).

The reduction or, whenever possible, the elimination of impacts caused by the mining activity on workers’ health is the entrepreneur’s duty. The employee participates in the production processes, and their work is

the instrument to provide a dignified existence for themselves and their families. Furthermore, the principles of economic order, and appreciation of work and human dignity provided for in the Constitution should be related in a harmonious way.

The norms aimed at the evaluation, reduction or elimination of risks of accidents and diseases at work are viewed in the light of the State's regulatory and supervisory perspectives, especially in the context of the socioeconomic activity of mining.

## **2 EVOLUTION OF THE MAIN RULES ON HEALTH AND SAFETY AT WORK IN MINING IN BRAZIL**

Brazil, since the colonial era, had mineral extraction as one of its main activities. The Portuguese Crown cared little about regulating the activity, since its interest in the colonies was limited to the profit arising from them. Therefore, the first record of the discovery of gold in Brazil was formalized on the tombstone of Brás Cubas, founder of the city of Santos, where it is recorded “[...] he discovered gold and metals in the year 1560 [...] he died in the year 1592. [...] the discovery is probably in the Serra de Jaguará, located on the northern outskirts of São Paulo (AZEVEDO MARQUES, 1952 apud RENGER, 2006, p. 94, free translation).

The Brazilian colonial era was marked by a real mining looting in the mountains, valleys, bottoms and riverbanks of the country. In this approach, despite the fact that mineral exploration started being carried out by individuals elected by the Crown, all the gold, silver or any other metal extracted would be the domain of the colonizing country and, in the case of Brazil, Portugal. Thus, according to Antonino (2021, p. 196), “[...] the result of all gold washing was mandated to be taken to the imperial foundry, and its circulation within the province was prohibited”.

In the historical document “How the gold is removed from the mines they call Paranaguá”, from 1662, he demonstrates that there was no possibility of existing rules to protect workers who, at the time, would be the Brazilian Native people. This document informs that mines were worked with indigenous labor, and not with African slaves. They worked 12 to 15 days, between coming and going, and took supplies for their stay in the mines. He also reports that in the 1580s the first foundry house was created, which remained active until the end of the 17th century (RENGER, 2006).

The Regalian system existing by them determined that discoverers of

mineral deposits would be rewarded with the “mineral date”. This instrument guaranteed them the private ownership of the soil and subsoil (SER-RA; ESTEVES, 2012). During that period and that of the dominion system, in which mineral assets belonged to the State, there was no law to protect workers, including Native people, professional miners and convicts, as stated by Renger (2006, p. 97, free translation):

Four years after the Portuguese Restoration, D. João IV appointed, in 1644, a new administrator of the mines in Brazil, tasking Salvador Corrêa de Sá e Benevides with the investigation of the said mines [of São Paulo and São Vicente]. In addition to Native people, it authorizes the use of convicts to work in the mines, and also determines that there must be professional miners in the mines: two in each of gold, silver and iron, and one in each of gold of betas (veins), pearls, of saltpeter and emeralds, as well as an assayer.

With the Constitution of 1891, the accession system was instituted, in which land ownership comprised the air space and the subsoil. In other words, the mines and mineral resources belonged to the land owners, except for limitations established by law. In this system, some occupational health rules in mining were provided for in the “Calógeras Law”, published in the Official Gazette (DOU) of January 7, 1915, by Presidential Decree nº 2.933, of January 6, 1915 (BRAZIL, 1915).

In its chapter IV, the aforementioned law creates the “mining police”, a government agency responsible for overseeing research and mining. This mining police could also act on complaints from stakeholders, for example, the mine workers themselves. Duties included, among others, the possibility of interdiction of mines if working conditions compromised the safety of workers, in addition to the requirement that mining companies should pre-establish plans in order to guarantee their safety. The law also provided for the obligation to report the occurrence of accidents that affected the life and health of employees in the mining sectors to local authorities and the competent administrative “departments” (BRAZIL, 1915).

In 1922, the “Simão Lopes Law” was enacted by Presidential Decree n. 15.211, of December 28, 1921. This law ruled the Presidential Decree n. 4.265, of January 15, 1921 (BRAZIL, 1921).

The Simão Lopes Law maintained the “mining police” to inspect the working environment in the mines, in title III, arts. 108 and following, and maintained the rules established in the previous laws with regard to worker safety.

With the enactment of the 1934 Mining Code, the concession system

was instituted. The system provided that mineral assets would belong to the State. In this way, it granted its exploitation and use to private individuals (SERRA; ESTEVES, 2012). In that regulatory framework, and according to Art. 68 I, the government would have the power to inspect research and mining works, among other objectives, such as the protection of workers.

After the six-year interstice, there was the enactment of Decree nº 1985, dated January 29, 1940, known as the 1940 Mining Code, considered a benchmark for subsequent mining regulations. On that occasion, Brazil began a period of strong investment in the mining sector, creating the *Companhia Siderúrgica Nacional* (CSN) in 1941, and the *Companhia Vale do Rio Doce* in 1942 (BITTENCOURT, 2014).

As for occupational health and safety, the Code assigned duties to the *Departamento Nacional de Produção Mineral* (DNPM) created by Decree n. 23.979, of March 8, 1934. In this matter, the Decree established technical rules for the protection of the soil and safety of constructions, the safety of the health and life of mining workers, and the interdiction of companies that put the health of workers at risk, until the required mitigating measures were taken.

In 1967, the Mining Code was enacted, changed by the Constitutional Amendment of 1969. The 1969 Amendment established some changes to the system, and radicalized the State's regulatory presence. This Code “[...] launches a long-term phase in the Brazilian mineral production. The socioeconomic paradigm linked mineral production to basic industries, especially steel, and sought to advance the country's industrialization” (BITTENCOURT, 2014, free translation).

In this context, there were also beneficial changes to the work environment, since it promoted contributions to increase the safety of workers. Among these changes, it provided for specs concerning lighting, ventilation, transportation, in the case of underground mining, and the observance of safety and salubrity of the dwellings existing on the site (BRAZIL, 1967).

The Consolidation of Labor Laws (CLT), Decree nº 5.452, of 1943, has a specific chapter devoted to mine workers. Articles 293 to 301 rule work in underground mines. These articles are related to workday control, worker displacement between the mine entrance and the workplace (and vice versa), and should be computed in the workday for the purpose of salary payment, adequate food and special breaks during the workday.

With regard to the Regulatory Norms (NR), there is NR 21 that

regulates Open Pit Mine Work, applicable to ground mines. There is also NR 22, which provides for worker health and safety, both in underground mining and in open pit mining.

At the international level, Brazil is a signatory to Convention # 176 of the International Labour Organization (ILO), which provides for mine safety. Conventions # 138 and # 182 – also from the ILO – rule forms of child labor, and establish the protection of minors. It is also important to mention, at the international sphere, the ILO Convention # 155, which establishes rules on the safety and health of workers, and the work environment.

In the next item, the application of Environmental Law principles to the work environment in mining activities will be reviewed as drivers to the suppression of gaps and interpretation of the laws, seeking safety at work and environmental preservation.

### **3 THE APPLICATION OF ENVIRONMENTAL LAW PRINCIPLES TO THE WORK ENVIRONMENT IN MINING**

The principles are considered the foundations of Law, allowing the harmonization between values and interests, through weight and consideration when competing (MACHADO, 2022, free translation). For Barroso (2001), principles have certain functions, namely: to condense values, give unity to the system, and condition the interpreter's activity, since it guides them using the method of analysis of the major principle applied to the theme, descending from the generic to the more specific, until reaching the concrete rule to be applied.

Labor Law and Environmental Law are governed by specific protective principles, since they deal with rights related to life that the Constitution considers to be fundamental. Principles of Environmental Law are applied to the work environment in order to provide dignity to the life of the worker.

For Milaré (2015), the principle of sustainable development ensues from the concern about exploring the planet's ecosystem, making human beings aware of the importance of protecting the environment in which they grow. This fact brought about small changes of technical and behavioral nature. The aforementioned principle determines that economic activities should be developed in harmony with the environment.

Thus, in the work environment, the principle of sustainable development stems from the need to unfold economic and productive activity in

harmony with sustainability, which corresponds to the healthiness of work environments (MARANHÃO, 2017). In mining, this principle is found, for example, in the environmental impact assessment and is a risk management tool and “[...] is intended to verify a series of elements related to the area in which the mine is installed, in order to avoid changes in health, safety, well-being and maintenance of environmental resources” (REZENDE; NETO, 2019, p. 296, free translation).

For Melo (2010), the investment of the entrepreneur’s capital should not only be in equipment, technology and working capital, but also in the people who work there, the so-called human capital, because the unhappy and sick human being would not be able to keep up with the production processes.

According to the ‘polluter pays’ principle, the entrepreneur must bear the costs of environmental degradation in the development of their economic activity. Therefore, they must recover, indemnify or compensate for such impacts.

For the work environment, the aforementioned principle is provided as a fundamental right of the worker in art. 7 of the Brazilian Constitution. The constitutional article guarantees the receipt of a premium for painful, unhealthy or dangerous activities (BRAZIL, 1988). Therefore, unhealthy activities are those that put health at risk, through habitual exposure to a harmful agent, and also to dangerous activities.

The above-mentioned activities are those in which the worker is exposed to a dangerous agent capable of harming their physical/psychological integrity, or even leading to death. As for the arduous activities “[...] are those strenuous, capable of causing extreme tiredness, and that generate impacts on the human organism” (MELO, 2010, p. 63, free translation).

In this light, the risks of landslides and strenuous journeys that cause physical and emotional problems should also be considered. A drastic case is the “[...] mineral dust that can cause numerous diseases such as pneumoconiosis, silicosis, tuberculosis, cancers, chronic bronchitis, and chronic limitations of air weight” (LUCON, 2002, p. 24, free translation).

The principle of environmental prevention, in turn, is based on the adoption of precautionary measures to prevent damage that has not yet occurred, but that would be certain or at least predictable. Thus, all possible means should be used in advance, seeking to prevent environmental damage.

In Labor Law, the principle of prevention is inserted in the principle of

risk reduction of art. 7, XXII, Brazilian Constitution, considering that the quality of life is intrinsic to a safe working environment (BRAZIL, 1988).

Health is a fundamental right of the worker and the employer's duty to provide it. For that, it should reduce the physical, chemical, biological and psychological risks existing in the work environment. For Thomé and Mendes (2016), the principle of prevention aims at avoiding the substantiation of risks to the environment and human beings, since they may be directly and indirectly affected by environmental damage and occupational risks arising from their activities.

Regarding disasters with tailings dams, as well as other accidents in the mining work environment, the adoption of these techniques is possible, considering the level of human knowledge about the activity. In the aforementioned work, Toledo, Ribeiro and Thomé, after analyzing several problems with dams, explain that one cannot claim ignorance of the cause for the failure of structures, since knowledge of soil mechanics is manifest today, as well as the specific behavior of numerous materials used in construction. Thus, in all "[...] disasters there was prior notorious and available technical knowledge to prevent the failure" (TOLEDO; RIBEIRO; THOMÉ, 2016, p. 41, free translation).

The effective risk elimination and the principle of worker protection would be possible with the adoption of preventive technical measures to eliminate accidents and risks in the work environment. As an example, one can mention the monitoring of operational conditions that may affect the stability of structures, safety and emergency plans, in case of accidents. If risks are not completely suppressed after having adopted all these precautionary techniques to eliminate the risks, individual protection equipment (PPE) should be provided to workers. Melo (2010, p. 66) lists these instruments:

As important instruments for the defense and protection of the work environment, the following can be mentioned: a) International Program for the Improvement of Conditions and the Work Environment – PIACT; b) Prior Environmental Impact Study – EPIA; c) Collective negotiation; d) Internal Accident Prevention Commissions – CIPAs; e) Embargo and Interdiction; f) Environmental Strike; g) Environmental Risk Prevention Program – PPRA; h) PCMSO Occupational Health Medical Control Program; i) Specialized Services in Safety Engineering and Occupational Medicine – SESMT; j) Personal Protective Equipment – PPEs; k) X – Social Security Professional Profile; l) Civil Inquiry; m) Term of Conduct Adjustment – TCA; n) Public Hearing; o) Recommendations; p) Environmental Public Civil Action; q) Popular Action; r) Collective Writ of Mandamus; s) Writ of Injunction; f) Collective Bargaining.

Still regarding the implementation of measures to prevent accidents at work, the principle of environmental education is relevant. This principle has great value because the implementation of educational measures regarding environmental degradation helps raising awareness among employers. Therefore, it is a fundamental instrument in the development of its activity, in addition to offering decent working conditions.

On the other hand, in relation to workers, when they are conscious they use the natural environment, and respect the limits imposed by the competent environmental agency. However, with regard to labor protection, they become attentive to safety standards, worrying about using personal protective equipment (PPE).

In mining, due to the nature of the activity, there are several risks to the safety and health of the worker, such as: landslides, accidents with explosives, chemical, physical, mechanical, biological and ergonomic risks, in addition to work-related musculoskeletal disorders. It also includes hearing problems, cancer, pneumoconiosis, asphyxia, tuberculosis, occupational asthma, dermatitises, among others, as reported by Candia et al. (2009, p. 520, free translation

Unsafe conditions and unsafe acts are the main causes of accidents. Unsafe conditions appear when mine design considerations are insufficient, when geological conditions are not recognized in advance, when there is a deficiency in equipment maintenance, among others. Unsafe acts appear mainly due to inappropriate behavior, some of them associated with lack of information (Battacherjee, 1991). Although in recent years there have been significant reductions in the rate of injuries and fatal accidents in mining, the number of accidents and their degree of severity are still high when comparing mining with other industrial activities. In this context, most governments consider the prevention of health and safety of workers, through proper management, as strategic actions.

In this circumstance, it is not enough for the mining entrepreneur to comply with the formal duty of payment of wages, as they are required to offer all the necessary training instruments to clarify or reduce the risks of diseases and accidents at work. Currently, one of the main environmental problems in mining activities stem from poor mining planning, and in this circumstance violates the Mining Code (VIANA; BURSZTYN, 2010).

Costa (2009) clarifies that the mining activity is essential for the Brazilian economy, since it accounts for a considerable portion of the Gross Domestic Product (GDP). Still in the social context, the enterprise creates numerous jobs. Therefore, it benefits many families, showing its social,

economic and environmental importance for a developing country.

In this context, there is a need for effective licensing and inspection procedures, in compliance with the principle of prevention and precaution, to ensure a healthy work environment, and the environmental preservation.

Despite all the normative and principled framework, accidents in mines are frequent, and have occurred throughout history in several parts of the world. This fact echoes not only among direct and indirect workers of the mining company, but also on the environment and society that surround the activity. Considering mining a risky activity, the next topic will address the entrepreneur's civil liability regarding work accidents related to this activity.

#### **4 MINING DAMS DISASTERS AND THE CONSEQUENCES FOR THE LIVES OF WORKERS**

In a comparative analysis between the working conditions in the mines in the 19th century, narrated in the novel *Germinal* published in 1885 by the French writer Émile Zola, and the accident in the Soma mine, in Turkey, in 2014, Thomé (2015) describes the insufficient evolution over a century in relation to the social rights and working conditions of miners, as it seeks to reduce the costs of worker safety:

AlpGürkan, owner of the Soma Holding, the company responsible for exploring the Soma mine, informed a Turkish newspaper in 2012 that he had achieved the “feat” of reducing production costs to 24 (twenty-four) dollars a ton, against 130 (one hundred and thirty) dollars before the privatization of the mine. The quest to reduce production costs of mines may be identified as the main responsible for the reduction of investments in instruments and procedures for safety at work [...] If in the 19th century, in Zola's France, mining companies reduced workers' wages to demeaning values alleging financial difficulties, in the 21st century, in Turkey, social and environmental guarantees are left aside under the argument of the need to reduce the production costs of coal mines, and in favor of the implementation of a developmental policy. At the international level, it should be noted that Turkey has not signed the Convention of the International Labour Organization (ILO) on Mine Health and Safety (THOMÉ, 2015, p. 18, free translation).

For Costa (2009), Brazil can be considered one of the richest countries in natural environmental resources, in addition to being the Latin American country reputed as one of the world's powers in mineral substances, especially in relation to iron ore.

Considering the state of Minas Gerais, mining and the use of waste

dams are inherent to its history and culture. Therefore, it comprises the social, economic, political and legal context, from its settlement to the present day (OLIVEIRA; COSTA, 2020).

In this context, it appears that in Brazil the *Agência Nacional de Águas* (ANA) has registered about 17,259 dams, including mining tailings dams and others, for example, hydroelectric dams. Of these, the State of Minas Gerais lists about 731 mining tailings dams certified by the *Fundação Estadual de Meio Ambiente* (FEAM) (COSTA; SAMPAIO, 2017).

However, the State faces problems with the poor inspection of dams. That is what happened in the Municipality of Brumadinho at the Córrego do Feijão Mine, Dam B1, in 2019, and in the Municipality of Mariana, Dam of Fundão, in 2015. These tragedies claimed countless lives in addition to causing unprecedented environmental devastation (COSTA; SIQUEIRA, 2019).

In 2015, the disaster at the Fundão dam owned by mining company Samarco, in Bento Rodrigues, located 35 kilometers from the seat of the Municipality of Mariana in Minas Gerais, led to one of the greatest tragedies of mining in Brazil. The event was a disaster with serious environmental and social consequences. According to data from the World Information Service on Energy (Wise),

[...] over the last 50 years, there have been at least 37 very serious mining dam disasters. The Samarco disaster is, among all, the largest in terms of the amount of material released into the environment, and the territorial extent of the damage (FREITAS, 2016, p. 25, free translation).

The disaster at the Córrego do Feijão mine, in the Municipality of Brumadinho, which took place on January 25, 2019, also had labor-environmental consequences. It is estimated that “[...] approximately 13 million m<sup>3</sup> of mud with mining tailings were released, causing major environmental impacts, mainly on the Paraopeba River, and human damage in excess of 300 deaths” (FREITAS, 2019, p. 1, free translation).

It appears that the disaster could have been avoided if the preventive rules had been carefully observed, as well as those on health and safety at work. However, such norms were ignored in favor of the economic benefit of the mining activity, as Meira describes:

The Córrego de Feijão dam, located downstream the Paraopeba River, however, has not been in operation since 2015, due to the dry ore processing. In December 2018, after obtaining the environmental license, endorsed by the government of the State of Minas Gerais – in record time, by the way – Vale resumed the process of expanding

the activities of the Paraopeba complex, which included the Córrego do Feijão mine. It did so, however, in disagreement with basic standards of environmental prevention, costing the lives of countless workers, and imposing on present and future generations the very high costs of environmental degradation (MEIRA et al., 2019, p. 108, free translation).

Specifically in the case of disasters with tailings dams, the devastating potential is difficult to measure, both for workers and for the local population. The high number of dams existing in the world gives rise to a mobilization for entrepreneurs to adopt really effective preventive safety techniques. In this sense, Toledo, Ribeiro and Thomé state that “[...] around the world there would be approximately more than 3,500 tailings dams. In this scenario, since the 1970s, two to five failures of ore tailings dams have occurred annually” (TOLEDO; RIBEIRO; THOMÉ, 2016, p. 41).

The lack of investment in the prevention of work accidents and the predatory exploitation of the environment generated injuries to direct and indirect workers (outsourced), who worked at the disaster site, that not to mention environmental problems. Regarding the surrounding residents, there were those who lived by fishing in the rivers, sand farmers, farmers, among others who used the river that was polluted by the mud (MEIRA et al., 2019).

Specifically in the state of Minas Gerais, Siqueira and Costa (2018) report that the most influential mining municipalities, despite the degree of importance of the activity, do not achieve a socioeconomic development proportional to the gains obtained in the private sphere of the mining activity. In addition, they suffer from environmental degradation, which is often unrecoverable, given that the enterprises privilege profit over environmental preservation.

In addition to the physical injuries and health of the worker, there are also social consequences of dam failures. In the case of the Fundão dam failure, the disaster provoked threats of mass layoffs. That was so because the destruction of the enterprise’s structures made it impossible for all workers to resume activities. Thus, the Labor Public Prosecutor’s Office, in the records of Public Civil Action nº 0012023-97.2016.5.03.0069, intervened in the matter to reduce social losses, as follows:

After negotiation between the parties based on the agreement proposals previously made with the Labor Public Prosecutor’s Office, and with a favorable opinion from the representatives of the professional categories, who expressed a desire for the indemnity to cover a greater number of workers, including active employees, the following composition was reached, in addition to the collective bargain for staff

reduction and the collective bargain of PLR 2015:

[...]

SAMARCO will maintain the jobs of the 1800 remaining employees who were not covered by the staff reduction program, refraining from promoting collective layoffs until 03/31/2017, being understood as collective layoffs those superior to 1% of the current active staff a month. This parameter does not bind or represent the company's understanding for future decisions or situations (BRASIL, 2016).

Some enterprises, due to their specific characteristics, are estimated as having a high risk of accidents for the worker. Such activities are considered to be those “[...] in which there are more or less predictable probabilities of danger; involves all human activity that exposes someone to danger, even if carried out normally” (BRANDÃO, 2010, p. 87). The risk of the enterprise is a burden to be borne only by the employer, pursuant to art. 2 of the CLT, and the employer is the one who must take all necessary measures so that no accident or damage to the worker occurs.

As in the environmental sphere, in which civil liability for damages is of an objective nature, with regard to damages caused to workers, strict liability in occupational accidents also applies. This is the understanding of the First Workshop on Material and Procedural Labor Law, held in Brasília, in 2007, by the *Associação Nacional dos Juizes do Trabalho* (ANAMATRA), and by the Superior Labor Court (TST):

37. Objective civil liability in the work-related accident. Risky activity. Art. 927, Sole Paragraph, of the Civil Code in occupational accidents is applicable. Art. 7, XXVIII, of the Brazilian Constitution, does not constitute an obstacle to the application of this legal provision, since its heading it guarantees the inclusion of other rights aimed at improving the social condition of workers (ANAMATRA, 2007).

Therefore, objective civil liability is applicable in cases of work accidents in risky activities, as seen in Oliveira (2011, p. 113): “[...] because it does not ask whether or not there was benefit to the person responsible; reparation of the damage is owed by the mere creation of the risk”. From this perspective, Labor Law, in connection with Environmental Law, offers instruments that can guide the organization and performance of labor activity in the many mining sectors, in order to make it sustainable from the socioeconomic and environmental perspectives.

## CONCLUSION

The lack of safety in the working environment in mines, and the consequent environmental degradation has existed since the colonial times. At

that time, the force of the worker was used cruelly. Today, despite the existence of companies equipped with advanced technologies, the disregard for work safety still persists. Despite all the legislative and administrative-regulatory evolution, considering national and international standards, the occurrence of accidents and deaths during the exercise of work perpetuates over time.

The application of Environmental Law principles, and the use of the instruments provided for in the legislation concerning the working environment in mines, is of great value in helping to prevent accidents. In this light, the entrepreneur is able to use management and inspection measures to significantly reduce these accidents, avoiding injuries or accidents that may have irreversible consequences.

The Brumadinho and Mariana disasters caused environmental, social and humanitarian losses. In addition to the lives taken, the Municipalities suffered economic losses, the environment was devastated, and countless people lost their homes and jobs.

The employer also suffered consequences from the disasters with the imposition of legal and administrative liabilities. For a preventive system, the employer should go beyond providing safety equipment, also supervising its effective use, and carrying out training with employees for its proper use. However, mining companies, in particular, should hire specialized professionals to assess safety and possible accident risks, in addition to maintaining specialized professionals for consistent on-site assessments.

As for the employee, they should receive guidance and instructions on the use of personal protective equipment, in addition to safety training in the event of a threat or occurrence of harmful events at the workplace. A culture of risk awareness and adequate protection should be built in the work environment.

Awareness about the application of environmental principles should come from private agents, unions of workers and employers, and public agents and agencies. All these agents and institutions should, according to their responsibilities, inspect, apply penalties, and carry out social and labor awareness-raising programs. It is a change of scenery in the development of the enterprise, in which the elements necessary for the humanization of work spaces, the protection of nature and entrepreneurship may coexist in a harmonious and sustainable way for present and future generations.

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