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# Disasters of Dam Breakage: A Brief Analysis on Risk and Laws from International, National And Regional Perspectives

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***Abstract***
***Introduction:*** *Human beings are directly linked to nature and the environment that surrounds them. Different ways of dealing with the planet's various biomes have emerged, and throughout history, human beings have come to have greater control over nature and have created methods to adapt to it. Dams have a variety of functions and are of great socioeconomic importance. However, dams also pose a potential risk to the population living near them, as well as to the people who work there; in addition to risks to the environment and limnological resources. Laws have historically been presented as a means of ensuring the safety of dams; however, these laws vary internationally.*
***Objectives:*** *This paper has as its general objective a brief contextualisation of the laws on disasters with dams. As specific objectives, analysis of risk of dam breakage in Brazil and the comparation of laws about dams and disasters from an international, national and regional perspective.*
***Methodology:*** *Data collection was performed through database searches using the Boolean operators Dam /+/ Disasters, Disasters /+/ Law, Dam disasters, on the SciELO and Google Scholar platforms, in an open period, requesting results in English, Portuguese and Russian as well as research on legislation from several countries, with emphasis on Brazil. After the results obtained, the content obtained was analysed, and through this a screening was carried out to select the articles and laws of greatest interest to the research.*
***Conclusion:*** *It is possible to observe the differences between legislation from different countries perspective on the risk and disasters related to the dams. Such differences should be largely studied, with the objective of improving national and local laws, and further, the security of the population who does live nearby the dams, as well as the people who work in the dams itself. Not only a good legislation on this theme is important to the security of people, but also for the efficiency and efficacy of the dams for the people and for the State. Considering the size of the territorial impact of big and average dams over a population and that can often inflict damage to neighbouring nations, analysing the laws of different countries on this topic could lead to a better structures international law on the topic, noticing that the security of dams can often become not only of national interest, but also, international.*

***Keywords:*** *Disasters; Dams; Dam Breakage; Law; Risk management.*

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## I. Introduction

Human beings are directly linked to nature and the environment that surrounds them. Different ways of dealing with the planet's various biomes have emerged, and throughout history, human beings have come to have greater control over nature and have created methods to adapt to it. Since ancient times, there has been concern about risks and disasters. In ancient civilisations, for example, the Persians created the first aqueducts, which provided water supplies to regions where there was no availability, becoming an effective method for dealing with drought in the region. Other peoples used theological methods, carrying out human and animal sacrifices in order to prevent a disaster or as a response to a disaster, in order to mitigate it.

According to Covello & Mumpower (1985, p. 111), historical records indicate that throughout history, governments have been responsible for some of the development and financing of elaborate flood control systems, including dams, levees, and canals, which have been observed since Ancient Egypt. In addition to attempts to prevent or control disasters of this type, government authorities have also responded by providing relief after disasters have occurred[1].

In the contemporary era, there has been the creation of laws to provide relief to victims of disasters. In 1803, for example, the United States Congress passed an act to assist victims of a fire that occurred in Portsmouth, New Hampshire; and in the years that followed, Congress passed on an ad hoc basis more than 100 separate acts granting relief after specific disasters had occurred.[1] In most cases, these acts authorized the purchase and distribution of medical supplies and provisions in response to various disasters such as floods, earthquakes, and fires[2].

Currently, the Pan American Health Organization describes the concept of mass disasters as sudden and disastrous events resulting from natural phaenomena or human action. There is great public commotion after such disasters, and for various reasons, rapid response to the demands of families and society is not always possible[3].

This paper has as its general objective a brief contextualisation of the laws on disasters with dams. As specific objectives, analysis of risk of dam breakage in Brazil and the comparation of laws about dams and disasters from an international, national and regional perspective.

## II. Methodology

Data collection was performed through database searches using the Boolean operators Dam /+/ Disasters, Disasters /+/ Law, Dam disasters, on the SciELO and Google Scholar platforms, in an open period, requesting results in English, Portuguese and Russian as well as research on legislation from several countries, with emphasis on Brazil. After the results obtained, the content obtained was analysed, and through this a screening was carried out to select the articles and laws of greatest interest to the research.

## III. Risk Represented By Dams In Brazil

According to the Dam Safety Report prepared by the Brazilian National Agency of Water (ANA), most of the multi-purpose dams registered with the SNISB do not have sufficient information to assess their integration with the PNSB, nor their own safety conditions. Among the multi-purpose dams submitted to the PNSB, only 6.6% have a Dam Safety Plan (PSB), and 6.4% have an Emergency Action Plan (PAE) included, with 6.3% being subject to regular inspections by their developers. It was observed that such measures were implemented more by public supply service providers, compared to developers of multi-purpose dams. There is a need for greater implementation of the PNSB in multi-purpose dams, for risk and safety diagnosis of dams, and for the proposal of specific policies to support and strengthen inspectors and developers[4].

Based on analyses carried out on dams classified by the National System of Information and Security of Dams (SNISB), the 122 dams that raise the most concerns based on the risk they present were listed. The analysis was carried out between the agencies ANA, the National Electric Energy Agency (ANEEL) and the National Mining Agency (ANM), each with different evaluation criteria. Among the criteria used are the state of maintenance and the existing level of danger (ANA), dams with safety levels on alert (ANEEL), high risk category, high potential damage and orphan dams (which do not have a responsible developer). Among the 122 dams, 16 dams are located in the Legal Amazon. It is worth noting that the state of Pará has one of these dams that present the greatest risk in Brazil, a tailings dam, classified by the SNISB with the number 20405.[4] Dam 20405 is a mineral waste containment dam located in the municipality of Curionópolis, southeastern of Pará state, Brazil, a municipality with great notoriety for having contained the largest open-pit mining site in the world in the 1980's.

According to the Brazilian Institute of Geography and Statistic, Curionópolis has 17,764 inhabitants[5]. It is important to emphasise the need to map areas at risk of natural disasters, such as the area of dam 20405, as it allows the identification of populations in situations of vulnerability to disaster. In addition, this mapping facilitates the implementation of prevention and mitigation actions in the geography and local population itself, in a contextualised manner.

Regarding the mapping of areas that present risks, "the zoning of areas susceptible to geodynamic processes emerges as a planning instrument necessary for public policies of territorial management". The author also highlights the "relevance of prior knowledge of the natural and anthropogenic conditioning factors and of the occurrence data registered by the Civil Defense". Among the regions most indicated for zoning, those with populations living near dams stand out, due to their potential risk.[6]

## IV. Legislation on Dams, With Emphasis on Disasters: A Perspective from International to National and Regional.

When it is thought of laws in disasters, it is necessary to understand that each country must deal with disasters, sometimes different, sometimes equal to that which does show risk to other nations as well. Dams are present all around the world, with different function. Nations, especially those with great limnological resources will often use dams with the purpose of producing hydroelectrical energy to supply the country. Nations with great mineral resources, as it is in Brazil, can use dams to contain mineral tailings. Dam breakages occur all around the world, being of great concern, especially when such breakage can extend its contents to areas as large

as entire nations, often spreading even to neighbouring countries, as the example of the breakage of the Dam of Sardoba, in the region of Sirdaryo, Uzbekistan, which extended its impacts over the neighbouring country, Kazahkstan, or the breakage of the dam in the city of Mariana, in the state of Minas Gerais, Brazil, which had such a large area of extension in both, land, rivers and sea, that could match and even pass the total area of many nations. Observing that, it is possible to observe the differences between legislation from different countries perspective.

In the United States, in 2002, Public Law 107-310 was developed, which created the National Dam Safety Program Act, which aims and prioritises improving dam safety in the United States through federal and state dam safety agencies that share common issues and responsibilities for dam safety, including planning, design, construction, operation, emergency response planning, inspections, maintenance, regulation or licensing, technical or financial assistance, research, and data management[7].

In Russia, according to Chapter I of Federal Law No. 117-FZ of 1997, this law regulates relations arising in the course of carrying out activities to ensure safety in the design, construction, overhaul, operation, reconstruction, conservation and liquidation of hydraulic structures, establishing obligations of state authorities, owners of hydraulic structures and operating organisations to ensure the safety of hydraulic structures, among which dams are included. In Art. 7, the law stipulates that all hydraulic structures must be registered in the Russian Register of Hydraulic Structures. In Chapter II Art. 9, it is described that the owner or organisation responsible for the operation of a hydraulic structure must ensure compliance with mandatory safety requirements, as well as analysis of natural and technological impacts caused by the hydraulic structure or affecting it. It also provides for the creation of financial and material reserves for victims of possible disasters[8].

In Brazil, Law No. 12,334/10 defines dams in Chapter I, Art. 2, § I, as: "structure built inside or outside a permanent or temporary watercourse, in a thalweg or in an exhausted pit with a dike, for the purpose of containing or accumulating liquid substances or mixtures of liquids and solids" including the dam and associated structures. This law established the National Dam Safety Policy (PNSB) in Brazil. According to Chapter II, Art. 3, § I, the objectives of this law include "ensuring compliance with dam safety standards in order to promote prevention and reduce the possibility of accidents or disasters and their consequences" and in § VIII "defining emergency procedures and encouraging joint action by developers, inspectors and civil defence and protection agencies in the event of an incident, accident or disaster". In the context of risk management and monitoring, the instrument of the National Dam Safety Policy stands out in its chapter IV, Art. 6, § III, which establishes the National Dam Safety Information System (SNISB), described in section III, Art. 13, as an integrated information system on dams (under construction, active or inactive) in Brazilian territory, with information on risks, accidents and disasters related to dams. SNISB is a system widely used by the National Water and Sanitation Agency for safety and risk analysis[9].

It is important to highlight within the Brazilian national laws, that the law 12.608/12, later replaced by the law 14.750/23 does exist to assure the prevention, preparation, mitigation, immediate answer to the disaster and recovering after the disaster. It is important to highlight that what is said by the Brazilian law on what concerns the prevention of disasters. In the law 14.750/23 article 1º paragraph VIII states that "planning, land use planning and investment actions aimed at reducing the vulnerability of ecosystems and populations and at preventing the occurrence of accidents or disasters or minimizing their intensity, through the identification, mapping and monitoring of risks and the training of society in civil protection and defense activities, among others established"; article 1º paragraph IX describes preparation as "actions aimed at preparing agencies, the community and the private sector, including, among other actions, training, monitoring and implementation of warning systems and the infrastructure necessary to ensure an adequate response to accidents or disasters and to minimise damage and losses resulting from them"; paragraph X "civil protection and defence: set of prevention, preparation, response and recovery actions aimed at avoiding or reducing the risks of accidents or disasters, minimising their socioeconomic and environmental impacts and restoring social normality, including the generation of knowledge about accidents or disasters"; paragraph XI "recovery: set of definitive actions taken after the occurrence of an accident or disaster, aimed at restoring ecosystems, reestablishing the destroyed landscape and the living conditions of the affected community, boosting local socioeconomic development, recovering degraded areas and preventing the reproduction of conditions of vulnerability (...)"; paragraph XII "disaster response: immediate actions with the objective of assisting the affected population and reestablishing the safety conditions of the affected areas, including search and rescue actions for victims, first aid, pre-hospital, hospital, medical and emergency surgical care, without prejudice to attention to the chronic and acute problems of the population, provision of food and shelter (...)"[10]. Among other disasters, these procedures are also related to dam breakage.

In the state of Pará, Brazil, state law no. 7408, according to its Art. 1º, "establishes guidelines for verifying the safety of dams and industrial toxic waste deposits". This law shows a strong focus by the state government on the relationship between the environment and dams. In Art. 2º, several studies and analyses are required regarding the environment where a dam will be built, as well as in Art. 7º, the need to "present to the water resource and environmental management agencies a technical study that proves the safety of the works

carried out" based on Art. 2º.[11] However, this law does not provide for emergency actions related to the population that may live in the vicinity of these dams.

## V. Conclusion

It is possible to observe the differences between legislation from different countries perspective on the risk and disasters related to the dams. Such differences should be largely studied, with the objective of improving national and local laws, and further, the security of the population who does live nearby the dams, as well as the people who work in the dams itself. Not only a good legislation on this theme is important to the security of people, but also for the efficiency and efficacy of the dams for the environment and the State itself. Considering the size of the territorial impact of big and average dams over a population and that can often inflict damage to neighbouring nations, analysing the laws of different countries on this topic could lead to increasing the laws even lead to the creation of an international law on the topic, observing that the security of dams can often become not only of national interest, but also, international.

Therefore, it can be analysed that, regarding the legislation presented, from an international perspective, there is greater development regarding laws that regulate dams and increase their safety. In Brazilian national government stand out programs such as the Brazilian National Dam Safety System (SNISB), which, in addition to registering dams, classifies them, ideal for identifying risks and subsequent preparedness actions to avoid and minimise disasters.

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