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Analysis of Impacts Generated by Oil Spill on the Beaches of Cabo de Santo Agostinho, Brazil

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***Abstract*—** *Considered raw material for a wide variety of products, today oil is removed from nature on a large scale. From time to time there are problems with the oil spill in the ocean. The reasons range from oil tanker accidents, hull breaches and oil rig explosions. The environmental impacts of the oil spill are widespread. The stain spreads through the sea, killing thousands of fish, birds, and corals. The losses caused by the oil spill in the Northeast Region of Brazil are incalculable and have not yet been well dimensioned by the government. The health of the population close to the northeastern coast, must be carefully analyzed before an assessment of risks based on a food and trophic chain. This work aimed to present an analysis of environmental impacts based on the Leopold matrix regarding the oil spill that hit the municipality of Cabo, Pernambuco, Brazil. The subsidies used to analyze the situation in the area were collected through information obtained in the press, in addition to technical field visits with photographic records. In general, the Leopold matrix helped in the analysis of the analyzed aspects and impacts: the fauna and flora suffered impacts that will take years or decades to be recovered in case the cleaning and conservation is carried out partially. Among the solutions for the crude oil that reached the beaches, after receiving adequate treatment, they can be used as fuel and / or alternative raw material in the cement kilns of the industries.*

I. INTRODUCTION

Petroleum, which from the Latin petra (rock) and oleum (oil) mean “rock oil”, is a term currently used as a common term for crude mineral oils and natural gas, from which various oily and gaseous products are obtained. Petroleum is the product of thermochemical transformations of organic matter over millions of years [1].

Historically, the increase in world demand for oil has been the result of the nations' own economic growth, where energy represents an indispensable input for the production of consumer goods, where its derivatives are the raw material for the manufacture of numerous consumer goods and in this way, they have an increasingly present and relevant role in people's lives [2]. However, to be used in the various areas of the industry, oil must go through a refining process, transforming it into products used in the most diverse applications such as: fuels, lubricants, plastics, fertilizers, medicines, paints, fabrics etc. Petroleum enterprises are established and developed at the expense of consumption of natural resources, production of liquid, solid and aerial waste, impacts on species diversity, use of water and soil [3]. Thus, they deeply affect the original characteristics of ecosystems, which, in turn, lead to changes in society / nature interrelations, especially in environmental health [4]. The losses caused by the oil spill in the Northeast Region of Brazil are incalculable and have not yet been well dimensioned by the government. The health of the

population close to the northeastern coast, must be carefully analyzed before an assessment of risks based on a food and trophic chain.

To analyze possible dimensions of the impacts caused, instruments of the Environmental Impact Assessment (EIA) can be used considering that it is a systematic process to identify, predict, evaluate and mitigate the relevant biophysical, social or other effects of projects or activities. According to [5], environmental impact is defined as any change in the physical, chemical, and biological properties of the environment caused by any form of matter or energy resulting from human activities that directly or indirectly.

II. METHODOLOGY

- Place of Study

The municipality of Cabo de Santo Agostinho extends over 446.6 km² and had 185123 inhabitants in the last census. The demographic density is 414.5 inhabitants per km² in the territory of the municipality. Neighboring the municipalities of Jaboatão dos Guararapes, Ipojuca and Moreno, Cabo de Santo Agostinho is located 20 km south-west of Jaboatão dos Guararapes, located 6 meters above sea level, and Cabo de Santo Agostinho has the following geographical coordinates: Latitude: 8 ° 17 '15' 'South, Longitude: 35 ° 2' 7 " West (Fig. 1). The highest concentration of spilled oil reached the beaches of the city of Cabo de Santo Agostinho with its greatest concentration, this being the municipality chosen for the study.

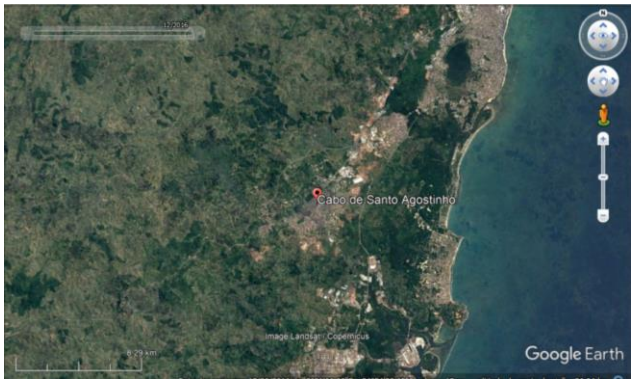

Fig. 1: Cabo de Santo Agostinho. Source: Google Earth.

- Data Collection and Analysis

The study started with a bibliographic review and pertinent legislation on the theme, which supported the development of the study. The subsidies used to analyze the situation in the area were collected through information obtained in the press, in addition to technical field visits with photographic records.

For a more detailed analysis and visual representation of the data obtained, the Microsoft Office Excel program was used to create the graphs and tabulation of the data. Due to the complexity involved in the diagnosis of environmental impacts, it was necessary to have a holistic view in the analysis of the data, applying the Leopold Matrix, to identify and analyze the negative impacts generated and their consequences for the environment. The matrix was used to guide the assessment of the state of the environment and what can be done to mitigate or avoid current and future problems. The environmental impact classification was defined through the relationship between degree of importance versus severity, providing the final category. The environmental factors evaluated refer to soil, water and living beings. An adaptation was made regarding the score of the degree of importance, being considered points ranging from 1 to 5, where the number 1 corresponds to the condition of less importance and the number 5 corresponds to the maximum values of these attributes, etc.

III. RESULTS AND DISCUSSION

- In Loco Research and Partial Analysis

In the tragedy that occurred in the municipality, it is known that countless resources are affected, but without an impact analysis carefully analyzed. In turn, it was noted that fishermen, the local population, consumers of fish and shellfish, and volunteers in the removal of waste are the main affected by the oil spill in the region, being considered a high magnitude impact (Figure 2). It should also be noted that those responsible for removing these residues, manually and without adequate guidance or protection, may be suffering an even greater risk or impact. If fishermen used to live in journeys of up to ninety hours a week involved in the extraction and processing of seafood and fish, today, even without personal protective equipment, or access to periodic examinations, they have an increased vulnerability with the oil spill. Occupational and environmental hazards that were enhanced by the government's negligence and exclusion of these subjects from decision-making processes.

Considering that living conditions, morbidity and mortality profile of individuals, vulnerability of social groups and environmental degradation result from interrelationships between production, environment and health, guiding the way of production and consumption, these are references for the design of effective interventions to guarantee life and health of the population and the environment [6,7,8] Studies show an increase in vulnerabilities, conflicts and environmental injustices due

to tragedies such as the oil spill, bringing environmental hazards, as well as to the health of workers and people introduced in the territories and negative impact on traditional populations of the countryside and waters [9,10,11]. The Health Impact Assessment (HIA) has been recommended and recommended by the World Health Organization (WHO) and its branch, the Pan American Health Organization (PAHO), which published a guidance manual for its preparation. According to this manual, "health impact assessment is a systematic analysis of possible impacts on public health of policies and programs, in order to optimize health interests" [12].

Fig. 2: Fishermen, local population, consumers of fish and seafood, and volunteers in the removal of waste. Source: Authors (2020).

In response to the identification of crude oil / petroleum on the coast of Pernambuco and the possibility of damage to health, [13] monitored the cases notified by municipalities on the coast of Pernambuco. The cases were reported on the exogenous intoxication form, following the routine of the Notifiable Diseases Information System (Sinan); and immediately informed to the Center for Strategic Information on Health Surveillance (CIEVS). Until 12/1/2019, 154 suspected cases of oil poisoning in Pernambuco were reported. Another 21 cases reported by the municipalities are being analyzed by the Municipal and State Health Departments, since the notification forms do not have information, such as signs and symptoms, and are in the process of being qualified by the municipalities. Cases of patients residing in another state (N = 03) were also not included in this report. Of this survey, about 36 intoxicated people live in the city of Cabo de Santo Agostinho, place of study.

Still according to [13], the greatest predominance was cutaneous and respiratory, regarding the number of reported cases of exogenous intoxication according to the route of exposure. Considering the signs and symptoms reported by the patients, headache, nausea, dizziness, vomiting, skin irritation and shortness of breath were the most reported.

People living in areas affected by oil spills are also more susceptible to contamination with chemicals of widely proven toxicology [14], and may suffer from acute or chronic, carcinogenic, mutagenic, and systemic disorders.

When effectively referring to the impacts of the oil spill at sea, economic and social losses are associated directly and indirectly due to the reduction of fishing, tourist, and industrial activities dependent on the quality of marine water, bringing risks to public health, such as death by explosions. and fires, poisoning from eating contaminated food, or dermatological problems and irritations, caused by direct contact with the oil [15], as seen in Figure 3. Seafood and oysters require even more special attention. They filter water for food and therefore accumulate more oil residues than fish.

Fig. 3: Beaches affected by oil. Source: Authors (2020).

According to [16], fishing communities were no longer able to market seafood, oysters, mussels, and crabs. This conclusion came about through interviews and meetings held with fishermen, middlemen and fish market traders. Between the second half of October and the first week of November, the sale of these products plummeted between 80% and 100% in Pernambuco. The sale of open sea fish (mackerel, snapper, and dorado) was also affected, decreasing by at least 60%, as well as of cultivated species (salmon, shrimp), around 50% in relation to the market prices before the leak. Although the fishing sector has been affected, fishermen themselves have been hardest hit, as they fish for seafood, oysters, and mussels.

Negative impacts tend to be common in people who work, have a family, or have fun in areas affected by spilled oil (Figure 4). Some residents report depressed and

anxious feelings and suffering from post-traumatic stress. Others may experience levels of depression, mental illness, and stress mainly up to two years after the disaster. Depression and anxiety impacts can also be seen in residents of oil-free areas who are concerned about the environment, human health, and the safety of marine foods.

Fig. 4: Fish killed by oil and the fisherman's despair. Source: Raul Spinassé / Folhapress.

People who had their source of income in the oil industries and lost them tend to suffer more impacts than the others, and may experience more anxiety or depression, increasing alcohol consumption, in addition to possible suicidal thoughts. Not only adults can suffer impacts on mental health. Children of parents who lost their income are 1.5 times more likely to develop mental problems. However, these problems are not only due to the oil spill, but these families had faced problems before and were not supported by coping policies.

According to [17], in the oil spill in the gulf, people linked to fishing had higher stress levels than others with a source of income, with migration to work in the period when fishing was banned, however, in areas most heavily affected the oil was not released because of contamination. A year later, residents of municipalities with people linked to fishing were more stressed and concerned about the economy in the future than those related to tourism.

- The Use of the Leopold Matrix

To analyze possible dimensions of the impacts caused, instruments of the Environmental Impact Assessment (EIA) can be used considering that it is a systematic process to identify, predict, evaluate, and mitigate the relevant biophysical, social, or other effects of projects or activities. According to [5], environmental impact is defined as any change in the physical, chemical, and biological properties of the environment caused by any form of matter or energy resulting from human activities that directly or indirectly.

Having the Leopold matrix as one of the chosen tools, according to Figure 5, an analysis of the environmental impacts is observed. As you can see, in all, 18 elements and 6 actions were summarized. The matrix of the present study was composed of the crossing of 18 environmental components (columns) and 6 potentially impacting actions, resulting in a total of 108 squares.

In summary, a total of 6 environmental impacts related to the oil spill were obtained. It is observed that the highest degree of severity of negative impact is associated with the oil spill followed by humans as transforming agents. Regarding the aspect of modifications or alterations in the environment, it is suggested that the flora has suffered greater impacts, considering the corals belonging to this modality in this study. According to [18] a coral reef is a rocky, rigid structure that resists the mechanical action of waves and marine currents and is built by marine organisms (animals and plants) with limestone skeletons. As for the necessary operation, such as cleaning and post-spill conservation, it is essential to rescue the impacted landscape, which will bring positive impacts from an economic, cultural, and environmental point of view (Figure 5).

			Elementos da natureza																	
			Características Físico-Químicas						Condições Biológicas				Fatores Culturais						Relações Ecológicas	
			Terra		Água			Atmosfera	Flora		Fauna		Interesses		Cultura					
			Propriedades Físicas	Propriedades Químicas	Qualidade da água superficial	Temperatura	Qualidade das águas profundas	Gases	Gases Tóxicos	Mangues	Corais	Pássaros	Animais Marinhos	Patrão da Paisagem	Turismo	Saúde e Meio Ambiente	Trabalho	Geração Futura	Cadeia alimentar	Troca Gasosa
Ações	Modificações	Flora	-4	-4	-5	-5	-5	-4	-4	-4	-5	-2	-3	-5	-5	-5	-5	-2	-4	-5
		Fauna	-4	-4	-5	-3	-2	-2	-2	-4	-4	-2	-5	-5	-5	-1	-5	-2	-5	-5
	Agentes Transformadores	Clima	-5	-5	-4	-5	-2	-5	-5	-4	-4	-3	-3	-4	-5	-3	-2	0	-2	-5
		Petróleo	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5
		Ser Humano	-5	-5	-5	-3	-5	-1	-5	-4	-4	-4	-4	-5	-5	-5	-1	-3	-5	-5
	Operação Necessária	Limpeza e Conservação	2	2	2	2	3	3	5	1	1	4	1	5	5	-2	5	3	3	1

Fig. 5: Leopold matrix for polluted beaches in Cape Town. Source: Authors (2020).

In general, the Leopold matrix comes to prove aspects and impacts analyzed in loco: the fauna and flora suffered impacts that will take years or decades to be recovered in case the cleaning and conservation is partially carried out. Among the solutions for the crude oil that reached the beaches, after receiving adequate treatment, they can be used as fuel and / or alternative raw material in the cement kilns of the industries. If the use is made possible, this material will be destroyed, avoiding new environmental impacts caused by an eventual incorrect disposal. The use of solid residues contaminated with oil in the production of cement occurs through the technology of coprocessing,

used to replace fossil fuels - such as petroleum coke and mineral coal - in the generation of thermal energy for the manufacture of cement.

In the Leopold matrix, seen in Figure 5, the cleaning and conservation associated with the reuse of the oil will bring numerous environmental benefits, as well as generating income and employment for the local population (even temporarily) If they use the environmental protection equipment properly.

IV. CONCLUSION

Negative impacts tend to be common in people who work or have some activity related to the area affected by the spilled oil, the most likely being depressive feelings, anxiety and post-traumatic stress.

The levels of depression, mental illness, and stress mainly up to two years after the disaster can be seen in the local population, especially those who are concerned with the environment, human health and the safety of marine foods.

The adopted methodology enabled the identification and evaluation of local environmental aspects and impacts, pointing out as the most significant the spill / leakage of oil / chemical in the sea, characterized as to the severity of the direct and indirect consequences that may cause to the environment.

Among the suggestions for reducing these environmental impacts, it is suggested: reuse of oil sludge, proposing to minimize the hazardous waste and the consumption of natural resources, in addition to guiding the population on possible emergency plans in the event of a new occurrence.

The applied matrix objectively ordered the main environmental impacts that were caused by the oil spill on the beaches of Cape Town in Santo Agostinho, Pernambuco, Brazil. It is a tool that guides the most impactful activities, allowing managers a broad view of the aspects and impacts generated.

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