



SOCIAL SCIENCES

Perceptions about massive environmental impacts: a Brazilian study case

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Abstract: The year 2019 brought three such impacts of high socio-environmental proportions in Brazil: the dam collapse in Brumadinho, oil spills on the coast, and fires in the Amazon. We investigated the Brazilian population's perceptions of the country's overall environmental situation, the degree to which Brazilians felt affected by these impacts considering personal and social factors, and the entities they held responsible for these disasters. Through Facebook's social media networks, we disseminated structured online surveys for Brazilian citizens above 18 years. Educational background explained how much the 775 respondents felt affected by the three evaluated events. Age was an explanatory factor for the degree to which the respondents felt affected by the dam collapse, and proximity to the disasters, while income levels were for the dam collapse and the fires in the Amazon. The government, criminal activity, and private companies were considered to be the main responsible for these three impacts. This perception reflects the series of changes in the country's environmental laws and protections that threaten biodiversity and the environment.

Key words: Brumadinho dam collapse, environmental impact, environmental perception, fires in Amazon, oil spill.

INTRODUCTION

The term “environmental impact” refers to any environmental changes arising from, or aggravated by, anthropogenic activities in the biotic, physical and socioeconomic environments (Sánchez 2020). In this view, environmental impacts come from actions such as mining (Yang et al. 2020), natural disasters (Amato et al. 2020), accidents (Hou 2012), and crime (Williams & Dupuy 2017). Furthermore, there are contextual differences in the definitions of environmental impact and its causes among experts and laypeople, mainly in factors that affect the economy (Truelove & Gillis 2018).

Perception studies evaluate how people organize, identify, and interpret data through their senses and previous experiences (Colley &

Craig 2019, Heidbreder et al. 2019, Shackleton et al. 2019). Environmental perception is multifactorial, based on each person's natural experience and beliefs that are derived from values and norms (Bennett et al. 2017), which may motivate pro-environmental attitudes (Cruz & Manata 2020) or, at least, a tendency to respond with some degree of positivity to a situation (Jones & Dunlap 1992). These attitudes and perceptions could be influenced by personal and social factors, like age, gender, socioeconomic status, and basic opinions on economics, politics, and technology (Aslanimehr et al. 2018, Dorsch 2014, Gifford & Nilsson 2014, Kilbourne et al. 2002, Xiao & McCright 2015). Specific events or issues can generate particular understandings and influence people to respond in specific

ways (Colley & Craig 2019, Heidbreder et al. 2019, Shackleton et al. 2019).

In Brazil, recent years have been marked by several events and changes in environmental laws and policies, threatening the country's natural resources (Abessa et al. 2019). The year 2019 was notable in terms of damaging events of significant socio-environmental proportions (Capelari et al. 2020), especially the Mina Córrego do Feijão dam collapse (hereafter dam collapse) (Silva Rotta et al. 2020), oil spills on the coast (Soares et al. 2020), and fires in the Amazon (Silveira et al. 2020). The following is a brief description of the three events.

On the 25th of January 2019, the "Córrego do Feijão" tailing dam collapsed in the city of Brumadinho (State of Minas Gerais), spilling about 12 million cubic meters of mud with ore (Thompson et al. 2020) in the administrative areas of the Vale S.A. mining company and surrounding communities (Porsani et al. 2019). It was one of the world's largest mining disasters and one of the most relevant Brazilian socio-environmental and work accidents (Polignano & Lemos 2020), which culminated in the deaths of 266 people, while 4 people remain missing (Vale 2022). Water accumulating on the dam's surface since its deactivation (2005) and seepage may have caused the dam to rupture (Silva Rotta et al. 2020). The consequent mud spill suppressed 70.65 ha of native Atlantic Forest (Thompson et al. 2020) as well as flowed into the Paraopeba River basin, after traveling 10 km, affecting 18 other counties (Silva et al. 2020). The contamination of this river compromised the water supply for the dependent regions of this basin (CPRM 2019) along with the surrounding area, impacting biota (Vergilio et al. 2020), flora, and tourism. The local community also was affected by unemployment or inability to work, food unavailability, and declines in mental and physical health (Polignano & Lemos 2020).

The second event considered in this study were the vast episodes of fires that occurred in the Brazilian Amazon, from July to December 2019. Brazil's National Institute of Space Research Agency (INPE in Portuguese) recorded 78 570 distinct fires in this ecosystem (INPE 2021): almost a three-fold increase compared to the values observed in the previous year (Barlow et al. 2020). These outbreaks of fires were not significantly influenced by meteorological conditions (Kelley et al. 2021, Silveira et al. 2020). The main causes have been attributed to accumulative deforestation (Barlow et al. 2020, INPE 2021) and the country's political instability (Escobar 2019a, Soares et al. 2020) which stimulated landowners and farmers to set fires to clear land (Silveira et al. 2020). The fires caused large ecosystem damage and released greenhouse gases to the atmosphere (Lovejoy & Nobre 2019), further contributing to climate change. The gas and the particulate matter emission from fires also affected the air quality (Lovejoy & Nobre 2019, Marlier et al. 2020), causing respiratory ailments for human beings (Marlier et al. 2020). Other impacts of fires are disruptions to social processes and functioning, psychosocial consequences, reduced tourism, and loss of landscape's aesthetic value (Paveglio et al. 2015). Moreover, the 2019 fires increased the instability and vulnerability of local communities of the Amazon, including indigenous and riverside communities (ISA 2020).

The third event observed in this study were the crude oil spills first observed on the Brazilian coast (mainly in the Northeast) in August 2019. The peak incident occurred until December 2019 (Soares et al. 2020), but large slicks were reported in June 2020 and July 2021, during the COVID-19 pandemic, and also October 2022 (Bahia state) (Sousa 2022). This disaster was considered the worst environmental disaster that occurred in Brazilian and the most

extensive in tropical oceans (Soares et al. 2022), as about 5379 tons of oil residue (Oliveira et al. 2022), a toxic and carcinogenic substance (Pena et al. 2020) was found along more than 3000 km of beaches, and 11 Brazilian states (IBAMA 2020). The local communities suffered impacts on their health due to direct contact and indirectly from contaminated fish, inability to fish, or its devaluation. (de Oliveira Estevo et al. 2021). Additionally, the communities also were impacted by a reduction in tourism and local economic activity (e.g., food, accommodation, leisure, shops, and general services; Câmara et al. 2021), and unemployment (Ribeiro et al. 2021). The COVID-19 pandemic aggravated the oil spill's damage, contributing to a synergic effect on the economy, public health, and ecology (Magalhães et al. 2021). The causes and the culprits of the oil spill are still uncertain, but the Federal Police holds a Greek-flagged ship for this disaster (Porto 2021). Although the environmental and social dimension of this event, more than three years later, is still missing information about the origin of the oil and adequate attention to the socio-environmental damage and investment in research and public policies to analyze and mitigate impacts (Soares et al. 2022). The consequences of these three events of 2019 can take years to reverse. Their medium and long-term effects are not known, as we consider human perception and awareness are temporally and spatially dynamic with the environment itself (Mónus 2020, Truelove & Gillis 2018).

Here, we investigated human perception of the country's overall environmental situation and the above-described socio-environmental events. We used interviews to evaluate (i) people's perception of the environmental situation in the last five years, (ii) the degree to which they felt affected by the three major disastrous ecological events of 2019 including socioeconomic characteristics such as age

range, gender, income, education level, and proximity to the impacted areas, and (iii) who they held responsible for these events (Figure 1).

Objectives i and ii will provide a social diagnosis as understanding people's perceptions of high-impact ecological events in the same country can emerge with insights regarding the interaction of society and the environment. This opens up an opportunity to contribute to identifying ways to reduce the future impacts of environmental changes on society. Objective iii relates to the context-dependent social construct of whom society interprets as responsible for threats to ecological integrity. Such understandings are imperative in megadiverse countries that are constantly threatened by human activities (Jones & Dunlap 1992).

MATERIALS AND METHODS

Data collection

We used structured online surveys (Supplementary Text 1) to investigate the perception concerning these three events and the Brazilian environmental situation in the last five years. We disseminated our surveys using Facebook's social media networks (SMNs), a useful research tool for Social Sciences (Kosinski et al. 2015) (see in Appendix A). We implemented a paid advertising campaign to target Brazilian citizens (from all states) above 18 years (the legal age in Brazil) between the 12th of May to the 9th of September of 2020. All advertisements shared on Facebook were also shared on Instagram with the same ad configurations. The online form was left available until we had enough respondents to reach a 95% confidence interval (Taherdoost 2017), corresponding to 938 people, considering a Brazilian population of 209 500 000 (IBGE 2021). This survey follows the standards of the Human Ethics Committee of the Federal University

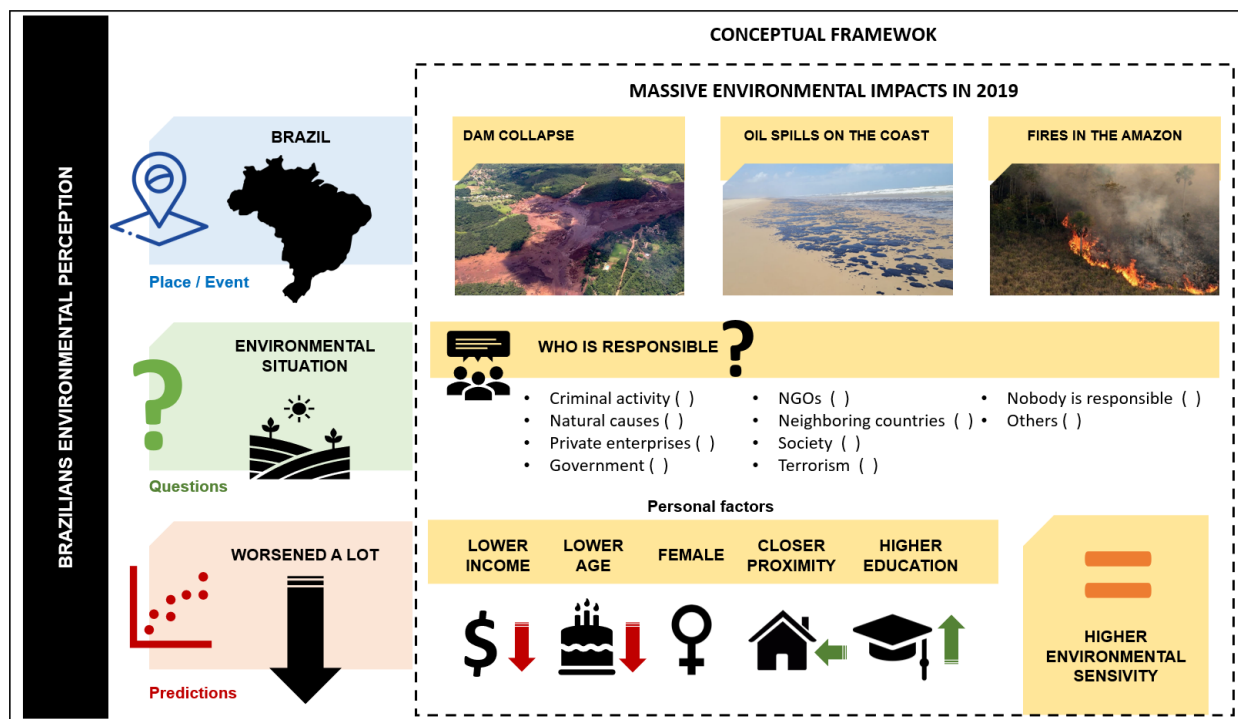


Figure 1. Conceptual framework for the surveys and interviews assessing perceptions held by Brazilians of their country’s overall environmental situation and the three massive environmental impacts in 2019 (the dam collapse, oil spills on the coast and fires in the Amazon).

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Data analysis

Of the 938 forms answered, we obtained the proximity to impact variables by estimating the Euclidian distance from the centroid of each respondent’s resident state to the centroid of the affected state. For the dam collapse, we considered the centroid of the state of Minas Gerais, and for the other two events, we took the shortest distance between the respondents’ state of residence and all affected states. We estimated the Brazilian centroids of states using the Political Boundaries of Brazilian States vector map (INDE 2018), which we converted to South America Albers Equal Area Conic projection in QGIS (QGIS Development Team 2019) to maintain accurate area measurements. Thus, we computed the centroid distances using

the “spDists” function from the “sp” R package (Pebesma & Biband 2005). Furthermore, for each state, we measured the average number of aspects of respondents’ lives that were affected by the three events. We represented this spatial distribution with maps elaborated using QGIS (QGIS Development Team 2019).

We performed all statistical analyses with 775 of the 938 forms answered, as we did not consider duplicates, non-binary sex (only 1.4% of respondents), incomplete forms, and outliers (Supplementary Material - Figure S1). We used the Likert scale to measure the perception of the Brazil’s environmental situation in the last five years (Table I). We used generalized linear models to investigate how much the people felt affected by these impacts considering characteristics of respondents. We quantified the number of aspects of respondents’ lives that were affected and analyzed them concerning

Table I. Variables used in the analyses to measure the Brazilian people’s perception of the country’s environmental situation in the last five years considering the dam collapse, oil spills on the coast, and the fires in the Amazon – Environmental impacts of 2019.

Response variable	Explanatory variables					Descriptive variables	
Affected areas of life	Income (BRL)	Age range	Sex	Education level	Proximity to the impact (Km)	Responsible for the disasters	Brazilian environmental situation*
None	No income (unemployed)	18 to 22	Male	Basic education	Distances to the affected areas	Criminal activity	Worsened
Health	Up to R\$ 1 045 00	23 to 30	Female	Elementary School		Government	Worsened considerably
Housing	R\$ 1 045 00 to R\$ 3 135 00	31 to 40		High school		Natural Causes	Remained stable
Food	R\$ 3 135 00 to R\$ 6 270 00	41 to 50		University education		Neighboring countries	Improved
Economy	R\$ 6 270 00 to R\$ 9 405 00	51 to 60		Specialization		NGO’s	Improved considerably
Employment and income	R\$ 9 405 00 to R\$ 12 540 00	61 to 80		Master’s degree		Private companies	
Psychological/ Emotional	12 540 00 to R\$ 15 675 00	81 to 90		Doctorate degree		Society	
Death of relatives or friends	Above R\$ 15 675 00	91 to 100				Terrorism	
Material goods		above 100				Without culprits	
Transport							
Communication							
Recreation							
Others							

respondents’ socioeconomic characteristics such as age range, sex, income, education level, and proximity to the impacted areas (Table I).

We ran separate full models for each impact and fitted them under Poisson distribution errors. We obtained the Minimal Adequate Models (MAMs) by removing non-significant predictor variables ($p > 0.05$) from the full models (Crawley 2013). We used the p and Z-values of MAMs to make our inferences. We used the “hpn” function from “hpn” R package (Moral et al. 2017) to verify the models’ assumptions (e.g., homogeneity and normality, Zuur et al. 2010). For it, we plotted the residuals versus fitted values,

performing a diagnostic analysis based on half-normal plots with a simulated envelope (Figure S2). To assess the independent contribution and relative importance of each predictor’s variables of our full models, we performed a hierarchical partitioning analysis (Murray & Conner 2009). We used a parameter of significance as an evaluation based on R^2 goodness of fit, which allowed us to interpret the independent effects of each predictor as the proportion of the explained variance. For the hierarchical partitioning analysis, we also used the Z-value with values >2 to correspond to the predictor’s

variable importance using a randomization test with 100 interactions (Nally 2002).

We investigated the respondents' perceptions of those responsible for the assessed impacts exploring the predetermined choices on the survey (Table I). We analyzed the answers through the "wordcloud" function from the "wordcloud" R package (Fellows 2018), which performs an analysis aggregating similar alternatives, and representing them graphically according to their frequency. All statistical procedures were performed with the software R v.4.0.1 (R Core Team 2020).

RESULTS

The 116 sampling days resulted in 775 analyzed forms, 497 of which were answered by women (64.04%) and 279 by men (35.95%). Brazilians from almost all states participated in the survey, with the exception of the state of Roraima. The state with greatest participation was São Paulo. The respondents' age ranges varied from 18-22 to 81-90, with 31-40 being the most representative (n=213; 27.44%) and 81-90 the least (n=4; 0.51%). A total of 220 (28.35%) respondents had incomes between one and three times the national minimum wage, and 18 respondents (2.31%) were in the highest sampled income bracket. Finally, the predominant education level was university education (Table SI).

Most of the respondents (65%) reported that the environmental situation in the last five years had worsened considerably, while 26.2% of them perceived that it had worsened, 5.2% reported that it remained stable, 2.6% that it had improved, and none answered that the situation had improved considerably. Thus, in total, 91% of respondents perceived a worsening in the environmental status in Brazil (Table SI).

The analyzed environmental impacts affected at least one aspect of life for 391 (50.45%)

of the respondents for the dam collapse, 461 (59.48%) for the oil spills on the coast, and 528 (68.12%) for the fires in the Amazon. The average number of respondents' affected aspects of life was 1.19 for the dam collapse, 1.43 for the oil spills on the coast, and 1.60 for the fires in the Amazon. The states where, on average, the respondents felt more affected varied for each impact (Figure 2).

The explanatory variables which composed the MAMs varied for each impact (Table II). Education level was the only explanatory variable in common for all three impact models (Table II, Figure 3). Gender was the only variable that did not explain any variation for all events. On average, from our research respondents, people with higher levels of education were affected in more life areas than those with low levels of education (Figure 3a-c). Income explained how much the respondents felt impacted by the dam collapse (Figure 3a) and Amazon impacts (Figure 3c), but not by the oil spills (Figure 3b). For these first two events, our data shows that people with higher incomes were more affected by the impacts. However, for the oil spill on the coast, income presented a low influence in how the respondents felt impacted. The age range was related to the respondents' perception only in the dam collapse, in which younger people were the most affected (Figure 3a). Proximity to the impact was relevant concerning the dam collapse (Figure 3a) and Amazon impacts (Figure 3c), in which respondents living near the regions where these events occurred felt more affected than people living further. Overall, level of education was the most important descriptor for the oil spills on the coast and fires in the Amazon, accounting for about 50% of the explanation of the full model. The dam collapse was better predicted by the proximity to the disasters, followed by level of education, age, and income (Figure 3a).

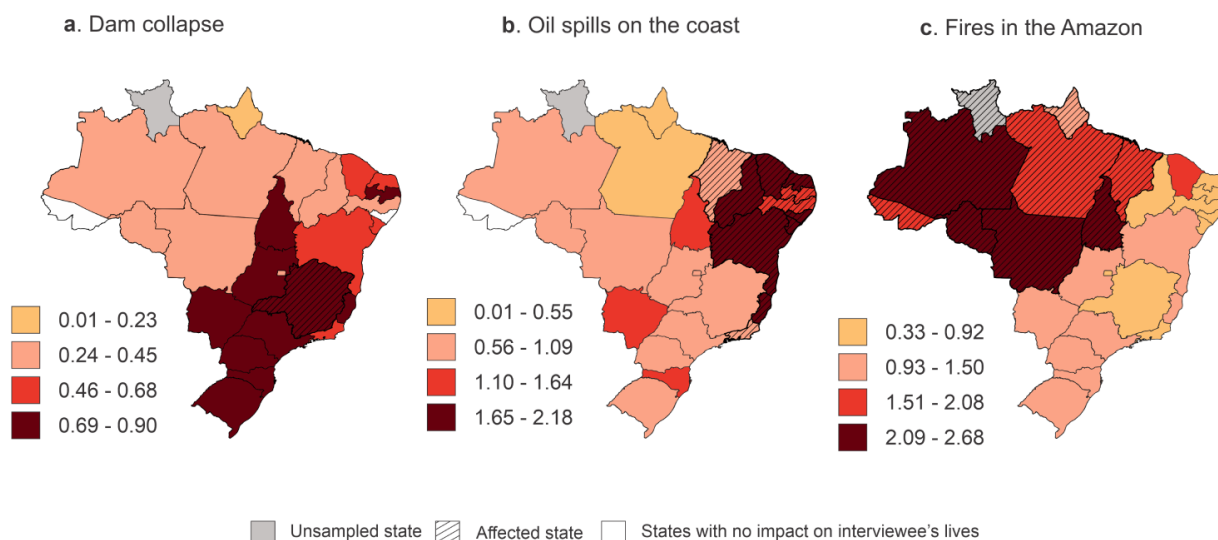


Figure 2. The average perception of negative impacts on aspects of life, by Brazilian states, caused by the dam collapse (a), oil spills on the coast (b), and fires in the Amazon (c).

Most respondents reported that private companies were the main actors responsible for the dam collapse and the oil spills on the coast (Figure 4). For the fires in the Amazon, the top ranked culprit was criminal activity (Figure 4c). The government and criminal activity were both placed in the top three positions of actors responsible for each of the three impacts (Figure 4a-c).

DISCUSSION

From our sampled population, limited to people that can read, use a computer, have internet access, and use social media platform, most perceived a worsened environmental status, which is congruent with the Brazilian political crisis (Escobar 2019b, Wade 2016) and a series of changes and events related to the environment, like actions and changes in environmental laws that endanger biodiversity protection (Abessa et al. 2019, Barbosa et al. 2021). The last decade’s reduction of investments in national environmental protection also has been remarkable (Barbosa et al. 2021). Similarly,

federal environmental agencies have been weakened by replacing specialists with military officials or by the appointment of officials without training in environmental protection (Vale et al. 2021). Moreover, the occurrence and knowledge of these three disastrous ecological events (Barbosa et al. 2021) within the last five years would contribute to a more negative perception of the environmental situation in Brazil.

We revealed how the three disastrous environmental events of 2019 have affected the livelihoods of our surveyed respondents. However, it is important to highlight that the concept of environmental perception depends on history, culture and many individual characteristics (Dietz et al. 1998, Jones & Dunlap 1992). These internal conditions, plus social and psychological aspects, can engender personal environmental concerns and pro-environmental behavior and attitudes (Bennett et al. 2017, Colley & Craig 2019, Corraliza & Berenguer 2000, Cruz & Manata 2020, Jones & Dunlap 1992). Our results show that the way each respondent felt affected by the environmental impacts on

Table II. Deviance table of the Minimum Adequate Models for how much the respondents felt affected by the three major environmental impacts of 2019 in relation to their age range, income, education level, and proximity to the impacted areas.

Environmental impacts	Explanatory variables	DF	Residual DF	Deviance	Residual Deviance	Pr(>Chi)
Brumadinho dam collapse	Null		774		707.24	
	Age range	1	773	4.646	702.59	0.031
	Income	1	772	13.753	688.84	<0.001
	Education level	1	771	25.706	663.13	<0.001
	Proximity of the impact	1	770	29.960	633.17	<0.001
Oil spills on the coast	Null		774		707.24	
	Income	1	773	5.861	701.38	0.015
	Education level	1	772	17.618	683.76	<0.001
Fires in the Amazon	Null		774		966.86	
	Income	1	773	16.629	950.23	<0.001
	Education level	1	772	18.786	931.44	<0.001
	Proximity of the impact	1	765	15.043	902.25	<0.001

their lives varies among the three evaluated events concerning their personal and social characteristics. This is not surprising since environmental damage perception is a context-dependent social construction (Bennett et al. 2017, Brody et al. 2004).

As we expected, the level of education explained the number of affected aspects of life for all impacts. Knowledge and level of education both have been considered predictors of environmental concern (Gifford & Nilsson 2014, Jones & Dunlap 1992), and educated people tend to feel more greatly affected by the environment (Gifford & Nilsson 2014). Pro-environmental behaviors and attitudes depend directly on having adequate knowledge about environmental issues (Robelia & Murphy 2012). However, we understand that it is complex and controversial to determine a cause-and-effect relationship of education with the population's ability to perceive a greater number of risks. Socioeconomic characteristics alone cannot predict environmental perception, since

other factors such as history and culture aid in its determination (Bennett et al. 2017), but it is known that they can act as modifiers or amplifiers (Wachinger et al. 2013). People living in proximity to the dam collapse and living in the states directly impacted by the fires in the Amazon felt more affected than people who lived farther away. Previous studies have also found that proximity to impacted areas contributed to how many people became injured (Brody et al. 2004, Gifford & Nilsson 2014). However, proximity would not be a determinant factor without a personal experience of damage, as observed with people's perception of climate change and its possible consequences (Lujala et al. 2015). The age factor was relevant only for the dam collapse. Younger people, aged 18 and younger, tended to feel more damaged psychologically and emotionally than older people, despite the fact that the direct consequences of the disasters in their lives, such as material losses, were equal to both (Gifford & Nilsson 2014, Ngo 2001). Similarly, people with higher incomes felt

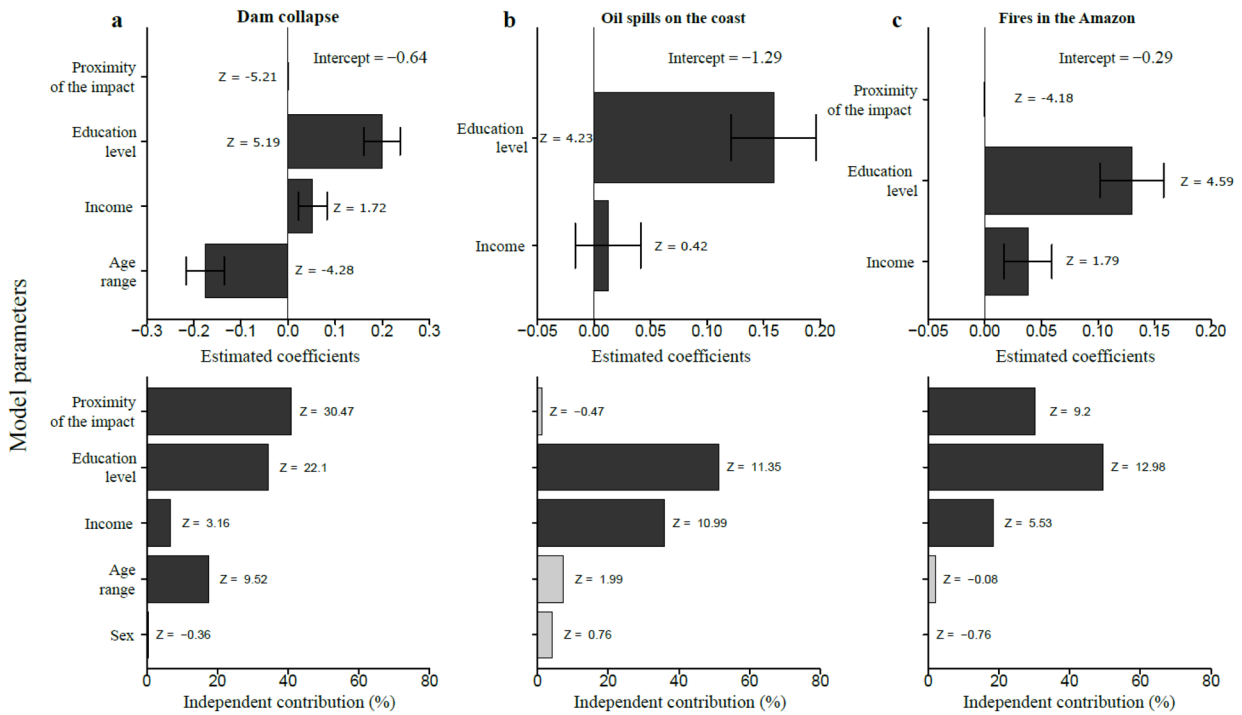


Figure 3. Perception of how much the respondents felt affected by the dam collapse (a), oil spills on the coast (b), and fires in the Amazon (c), concerning age range, income, education level, and proximity to the impacted areas. Dark gray bars represent significant effects ($Z > 2$) of the independent contribution of each explanatory variable (relative importance) on the perception of each disaster.

more affected for all events, but this factor had low importance for the oil spill impact. Franzen and Meyer (2010) observed a positive correlation between environmental concerns and gross domestic product (GDP) per capita, converging for most upper-middle class environmentalists. A potential explanation for that is an inversion of people’s values with increasing income, from materialist to post-materialist, and being focused on self-development and well-being (Gökşen et al. 2002). When income increases to such a point, basic material needs do not require great time and effort, and other aspects, such as education and environmental concern are prioritized (Gökşen et al. 2002). This can also be inferred at higher social scales, where rich people from developing countries tend to be more environmentally concerned than those from poorer ones (Fairbrother 2013).

As these studied environmental impacts were huge, their repercussions reached a broad and worldwide audience (The Washington Post 2019). However, some geographical scale particularities have to be highlighted to provide insights into Brazilian perceptions for each of the three disastrous events. The dam collapse happened in a limited area, having an immense effect on local people’s lives and the regional ecosystem (Polignano & Lemos 2020, Thompson et al. 2020). On the other hand, the oil spill has a broader scale, affecting those who live in the coastal areas as well as Brazilians that come from non-coastal areas for recreation and tourism purposes (Soares et al. 2020). In contrast, although the fires in the Amazon have occurred on a biome scale, it has not affected only local people but also populations from other regions, as the smoke extended to southeastern states (Lovejoy & Nobre 2019). However, this impact

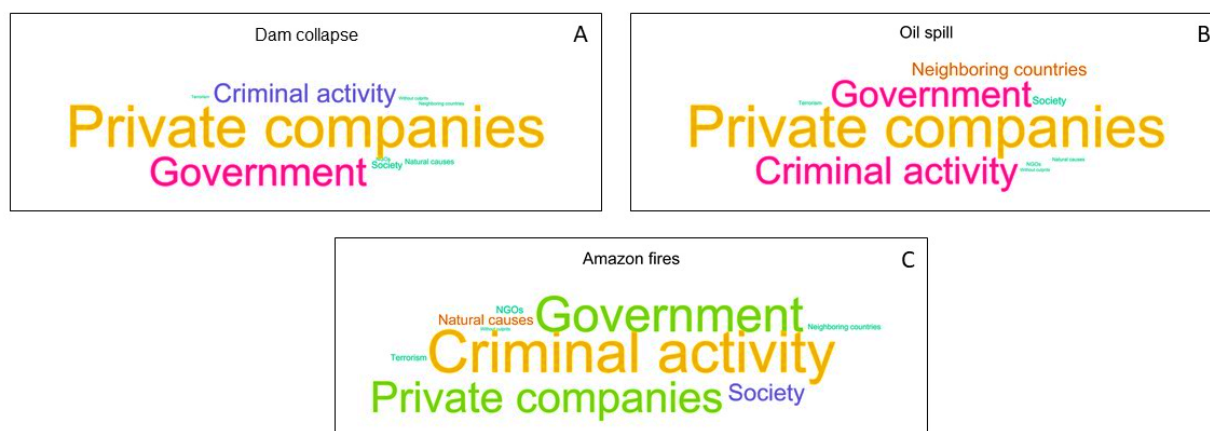


Figure 4. Word clouds representing the frequency of respondents' choices about who they hold responsible for the dam collapse (a), oil spills on the coast (b), and fires in the Amazon (c) – Environmental impacts of 2019.

additionally raised international concerns (The BBC News 2020, The Guardian 2020). The three events occurred in the same country; therefore, we could expect a national identity to shape a perception pattern of how people felt affected. However, as it is a country of continental dimensions, this scale-dependent context only emerged on the regional scale (dam collapse).

Of the set of culprits presented as the main responsible for the three environmental impacts, most of the respondents blamed private companies, the government, and criminal activity, although these groups ranked different positions for each impact. Private companies ranked first for the dam collapse and the oil spill events, which would be expected considering its scope, impacts, and market control. Ten companies in the world hold more than 50% of global productions of nickel, iron, and copper, and the same number of companies hold 72% of the world's oil reserves (Folke et al. 2019). These industries damage the environment with habitat destruction, air and land contamination, loss of biodiversity, and others (Folke et al. 2019). In the case of the dam collapse, the mining waste that destroyed the Córrego do Feijão district and damaged a long extension of the Paraopeba River came from a private company, Vale S.A.

Furthermore, Brazil had already experienced other huge dam failures in the recent past, such as the Fundão mine located in the municipality of Mariana, which was owned by the Samarco Company, controlled by Vale S.A. (Cionek et al. 2019, Garcia et al. 2017). The private monopoly of the world's oil reserves seems to be related to private companies ranking as the main culprit for the oil spill on the Brazilian coast (Folke et al. 2019). However, at the moment of this writing, the culprits that are legally responsible for this environmental disaster have not yet been identified (Barbosa et al. 2021).

For the Amazon fires, criminal activities ranked first as the possible culprits, followed by the government. This is not surprising considering events like "Fire Day", in which farmers were coordinated to set fires in agricultural and deforested areas during this day (Silveira et al. 2020). As a consequence, 20% of fire occurrences during 2019 happened in the two weeks that followed the Fire Day (Silveira et al. 2020). Nevertheless, citizens will also question the government's responsibility for environmental impacts since it is one of the government's duties to protect the country's biodiversity and natural resources (Brazil Law No. 6938/1981).

Despite the potential and reach of SMNs, voices of groups can be omitted, and values such as loyalty, authority and social bonds can be maximized in this environment, representing some sampling biases on these platforms (Hargittai 2020). However, these biases do not invalidate Facebook as a research tool for demographic and psychometric aspects (Kalimeri et al. 2020). Another limitation for sampling is that only 21,7% of Brazilians have access to the Internet and social media networks (IBGE 2021). Since it is not possible to eliminate this type of bias, we limited the advertisement campaign for a random sampling of the legal-aged population (age 18 and over in Brazil). Although the biases are reduced, they are still present. Every advertisement shared on Facebook was also shared on Instagram with the same ad configurations.

There is also a “distance bias” associated with the determination of a central point to assess the effects of the distance between the respondent and the events in the results. Some of these events, such as the oil spill on the Brazilian coast and the Amazon fires, happened in widespread areas, and Brazil is a continental sized country, with states that are large in geography. To minimize this bias, we calculated centroid areas based on the respondent’s home state and the local of the environmental impact. These detailed procedures are presented in the Methods section. Despite addressing this bias, however, our results show a spatial distribution of perception from the perspective that respondents living closer to the impacted area are possibly more concerned with its environmental quality (Brody et al. 2004).

In regards to the entities which respondents held responsible for these disastrous events, we provided on the online form with predetermined choices (Supporting text S1) as well as a blank space for other possibilities. However, few

respondents used this opportunity, and the low number of responses do not allow for further analysis.

The people’s perception of a country’s environmental situation are linked to the history of actions and positions that the country took in facing events that changed ecosystems and impacted biodiversity (Cionek et al. 2019, Colley & Craig 2019). The determination of environmental liability is linked to a lengthy judicial process. When the process determines culprits, the fines imposed do not recover the damage caused and do not reflect the real cost for lost biodiversity (Garcia et al. 2017, Ziliotto 2020). Moreover, those responsible for the impacts try to judicially exempt themselves from socio-environmental responsibility (Barbosa et al. 2021) or neglect to pay the imposed fines, as in the case of the dam collapse (Cionek et al. 2019, Garcia et al. 2017). Additionally, the fines cannot compensate for the huge environmental damage (Ziliotto 2020). This legal instability related to environmental issues is likely to foster the population’s mistrust in the government’s duty of biodiversity protection.

Finally, considering the weakening of Brazilian environmental protection and the currently poor environmental governance, new disasters are likely to happen (Barbosa et al. 2021, Cionek et al. 2019, Ferrante & Fearnside 2019, Garcia et al. 2017). It will not take long to occur, as in 2022 when some oil spills were again found on the Brazilian coast (Sousa 2022), the Amazon caught fire again in 2020 (NASA Earth Observatory 2020), and the Pantanal biome suffered one of its greatest fire episodes (Garcia et al. 2021). Although these disasters have consequence for the rest of the world, the biodiverse environment of Brazil and its people are the most affected entities of these disastrous events. As part of this nation’s history, these events are shaping social perceptions and

the decision-making processes in relation to the environment.

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SUPPLEMENTARY MATERIAL

Figures S1-S2.

Table S1.

Text S1.

Appendix A - Supporting text about the use of Facebook's social media networks (SMNs) in scientific research

The Facebook's social media networks SMNs hold a prominent platform, with at least 2.8 billion users, 130 million of which reside in Brazil (Statista 2021), encompassing 75.4% of the 2021 projected population for this country (IBGE 2021). Its coverage, automatic data collection, and customization tools for creating and sharing surveys make this platform a pertinent tool for science (Matz 2015). Facebook has been used for these purposes in scientific research in several areas, such as psychology and well-being (Faelens et al. 2021), ecology (Werenkraut et al. 2020), education (Lopes et al. 2017), conservation science (Christos et al. 2020), health (Obamiro et al. 2020) and social sciences (Matz 2015). The authors are aware of SMNs sampling biases, as some groups' voices can be omitted (Hargittai 2020). However, the implementation of advertisements is an advantage, allowing to sample populations that cannot be easily analyzed in other ways (Schneider & Harknett 2019); thus, the biases do not invalidate SMNs as a research tool for demographic and psychometric purposes (Kalimeri et al. 2020).

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