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Non-Brazilian environmental perception on the Amazon rainforest: an approach using text mining from social media

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ABSTRACT

Background: The Amazon rainforest plays an essential role in sheltering global biodiversity and providing essential ecosystem services. However, the region has been threatened by increased rates of deforestation and degradation, which is often reported as the failure of the Brazilian conservation policy that could affect the image of agriculture Brazilian products abroad. In this sense, here we aimed to evaluate the foreign environmental perception of the region using data from social medias, to assess which are the main terms related to the region, how their importance varies over time and whether this perception tends to be more negative or positive. For this, we used data from posts made on Twitter® involving the term "Amazon rainforest" over 18 weeks using a data mining process. From these posts, we extracted the text, which went through steps of cleaning and organization, as well as crossing with additional databases (such as the sentiment dictionary). From the final data set, we first evaluated which are the main terms present in these posts and how their importance varied in the evaluated period. Next, we assess whether the terms cited are mainly negative or positive and how this sentiment varied over the monitoring period.

Results: We found that the main terms are related to the environmental context such as "carbon", "deforestation" and "fire" and that there is a relationship between their importance and the occurrence of fires in the region, which is positive with a temporal lag. In addition, we also found that the posts are, on average, composed of 68.47% of negative terms and that this sentiment predominates throughout the entire time series, being higher during the fire peaks in the region.

Conclusion: Our results indicate that the environmental perception of the region presented in the posts in Twitter® is mainly negative, due to the degradation and fires observed over the last few years. We also discuss limitations of the approach and establish perspectives for future work.

Keywords: Tropical rainforest; social media; web-scrapping; sentiment analysis.

HIGHLIGHTS

Environmental perception on Amazon rainforest in social media are mainly negative.
Themes related to environmental issues are the most commonly cited in social media conversations.
There is a temporal match between the frequency of posts and fire occurrence in region.
Social media can be used as a tool for environmental perception evaluation.

INTRODUCTION

The Amazon rainforest is one of the most ecologically important places on the planet, due to its ecosystem services and its enormous biodiversity. This region is home to more than 15,000 tree species (25% of the global total), in addition to playing an essential role in the hydrological and biogeochemical dynamics of the South American continent, especially about its role as a stock and sink of carbon emitted by human sources (Pan; et al., 2013; Cardoso et al., 2017; Barlow et al., 2018). However, since the acceleration of its occupation in the second half of the 20th century, the region has undergone an advanced process of reduction of vegetation cover, which, according to MapBiomas, was 84.7 million ha between 1985 and 2021 (MAPBIOMAS – Souza et al., 2020). This reduction is associated with the occupation of areas and expansion of agricultural activities in the region, which is often carried out in an unplanned manner and with significant damage to ecosystems and their biodiversity.

In addition to its importance as a refuge of tropical forests, the Amazon region and adjacent states are associated with a large volume of economic activities mainly related to the export of agricultural and livestock products. The state of Mato Grosso, for example, is the largest Brazilian producer of soybeans, corn, cotton and cattle, which together with other crops make about 17.6% of the gross primary value of the country's agricultural production in 2021, according to data from the Development Observatory of the Secretary of State for Economic Development (SEDEC, 2022). Other states in the region also have a large volume of agricultural production, with important shares in the country's agricultural economics. (SEDEC, 2022).

Within the context of exporting agricultural products produced in the region, the concern of non-Brazilian consumer markets regarding the origin of products from the Amazon region has grown increasingly (Rajão et al., 2020). Thus, an average consumer in Europe, Asia or North America, for example, seeks guarantees that the production of that product is not associated with practices that are incompatible with the environmental conservation of the Amazon ecosystems. As a market response to this demand, there are measures such as the attribution of production certification seals, creation of chains of custody to trace production stages and the development of so-called ESG approaches (Environmental, Social and Governance) for organizations (Canavari; Coderoni, 2019; Lim et al., 2022). As an example of success, we should highlight the Amazon Soy Moratorium, a voluntary agreement of traders in the soy chain that aims to eliminate deforestation caused by soy cultivation in the Amazon (Heilmayr; et al., 2020; Amaral et al., 2021). As a result, the consumer market itself has led agricultural producers to adhere to certain practices that allow their products to enter certain markets that are more demanding, but that are willing to pay more for not contributing to environmental destruction of the Amazon rainforest (Canavari; Coderoni, 2019; Rajão; et al. 2020; Lim et al., 2022).

However, since 2019 there has been an increase in the occurrence of fires and deforestation in the region (Gibbens, 2019; Barlow et al., 2020). Only in 2020, Silva-Junior et al. (2020) recorded the deforestation of 11,088 km², which represents an increase of 47% and 9.5% compared to that observed in 2018 and 2019, respectively. In 2021, the deforestation rates in Amazon also increased, reaching an area of 12,200 km² of forests (INPE, 2022). This trend was widely reported, having triggered broad international pressure from countries on the Brazilian government, in search of guarantees of the measures for more effective protection of the forest (Barlow et al., 2020). In this case, attention to the origin of Brazilian products has intensified in marketing centers worldwide, even influencing the marketing of products from other regions of the country (Barlow et al., 2020; Rajão; et al., 2020). However, it is a challenge for the scientific community and government bodies to assess how consumers perceive such events, given the impact that this change in perception can influence the acceptance of products and the importance of developing forms of certification (Canavari; Coderoni, 2019).

Environmental perception is a mental process in which the individual interacts with the environment through perceptual stimuli captured by the five senses combined with the active contributions of the subject (Tuan, 1983). In other words, it is the way they perceive the environment with which they relate, considering ideological influences and socioeconomic factors such as gender, age, social class, and income (Trenouth et al., 2012). Thus, much of what we perceive has value for our biological survival, and for providing some satisfactions that are rooted in our culture (Tuan, 1983). In this way, the assessment of environmental perception can be useful to verify the relationship between the consumer public and the Amazon region, aiming at the products that originate from there (Ozdemir, 2010; Bennett, 2016). The most common ways to assess a group's environmental perception include disseminating questionnaires, conducting interviews and focus groups, among other ways (Ozdemir, 2010; Tsai et al., 2013; Silveira-Junior; et al., 2021).

In the current context of digitalization, social media emerge as an alternative for collecting environmental perception information, providing an open and accessible channel for individuals to share their observations, concerns and experiences related to the environment (Zhang; Skoric, 2018; Zafar et al, 2021). Platforms like Facebook, Twitter and Instagram allow people to document their perceptions about climate change, pollution, nature conservation and other environmental issues in real time, through posts, photos and videos (Robelia et al., 2011; Radi; Shokouhyar, 2021). Through them, it is possible to obtain a more comprehensive and decentralized data collection, allowing scientists, researchers, and policy makers to access a wealth of popular perceptions to complement formal studies (Zafar et al., 2021). However, it is essential to consider the quality and veracity of the information shared, as well as privacy and representativeness issues to avoid biases and distortions in the results. In this context, this work brings a new approach using information from posts related to the topic made on a social media using exclusively the English language. As a result, there is a fast, scalable form, with great geographical coverage and analytical capacity.

In this work we aim to evaluate the non-Brazilian environmental perception of the Amazon rainforest region, seeking to identify the main sentiment and temporal trends of variations in terms of importance. Thus, we explored: i) which are the main terms present in non-Brazilian posts on social media related to the Amazon region and how their importance varied over the time series evaluated; ii) whether the composition of terms in foreign posts about the region is more strongly associated with positive or negative sentiments. With this, the intention is to relate the perception of the region with the perception of the country, which can influence economic and image aspects, in addition to evaluating the permeability of social medias to internal events.

MATERIAL AND METHODS

Data collection

To assess the environmental perception of the region, we collected data from posts about the Amazon obtained on the social media Twitter ®, using the *twitterR* package version 1.1.9 (Gentry et al., 2016) in the software R v. 4.2.0 (R Core Team, 2022), which connects to the development API provided by the platform (https://developer.twitter.com/en) to obtain the information. However, before carrying out the collection, a project must be created on the platform after approval by the Twitter team, from which data access keys and a project identification code are provided. The project that originated this work is registered with APP ID 19715654. The posts ("tweets") were obtained using the *searchTwitter* function, which performs a search on Twitter based on a series of parameters defined within the function and according to its limitations. Among these parameters are the definition of the subject of interest, the posts language, the search time interval, the inclusion (or not) of retweets and the maximum number of tweets to return. The main limitations include the maximum limit of 18,000 tweets per search and the maximum time interval of 8 days prior to the execution of the function.

In this work, the search was for posts made in English in the eight days prior to each execution of the code that contains the term "Amazon rainforest", which is the most common way to refer to the Amazon Rainforest in English. In addition to scientific questioning, the choice to limit the language to English was motivated by the higher quality of existing word and sentiment dictionaries compared to other languages (such as portugueses). The search also included retweets, considering that the replication of the same content

counts as an indication of its importance and is associated with environmental perception. Due to the temporal limitation, the collection was carried out over 18 weeks, always defining the maximum number of return tweets. The high number of weeks was adopted so that the data sample contained a time interval that included the transition of climatic seasons observed in the region. The intervals for each collection week are shown in Table 1. The data object generated by executing the code each week has 16 columns, some of which are null or do not provide relevant information for this work. Thus, a selection of main columns was made, as well as other identifier columns were added that could facilitate the work with the data. Data from all weeks were combined into a single dataset of 63,773 rows, which correspond to different tweets.

Data processing

The processing of the collected data began with the removal of duplicate tweets, which resulted in a dataset of 53,736 lines, each of which corresponds to a post made on the social media. Next, the data cleaning stage began, in which a series of standardization and removal steps were carried out: i) removal of hashtags; ii) removal of words with @ (mentions); iii) removal of "https://" and "http://"; iv) removal of graphic characters such as emotions; v) scoring removal; vi) removal of control characters; vii) removal of numbers; viii) replacement of "_" by space; ix) removal of excessive and unnecessary spaces; and x) Removal of line breaks.

Next, we did the "tokenization" step, which consists of breaking the text of the tweets into isolated words that will occupy the lines. Thus, the same tweet that previously occupied a line is partitioned into several lines related to each of its words. This activity was performed using the "*unnest_tokens*" function of the *tidytext* package v. 0.3.3. As a result, the dataset now has a total of 966,325 rows. However, part of these lines consists of words that have no valuable meaning for this work, such as prepositions, conjunctions and articles, among other sets of words that are commonly called "Stop words". These words are present in all languages at a high frequency and do not have a specific meaning, which may impair the analysis. To deal with this, we removed these words from the dataset using the stop words dictionary "Lektek" (http://www.lextek.com/manuals/onix/stopwords1.html) present in the *tidytext* package. In addition to these words, the words that are part of the search term ("amazon" and "rainforest") were removed, considering their expected importance, and the term "rt", which is present in retweets. After removing these words, the dataset was reduced to 384,287 rows.

Table 1: Start and end date of the collection interval for each week of data collection carried out in the year 2021.

Week	Start	Final	Week	Start	Final	Week	Start	Final
1	31/05	07/06	7	12/07	19/07	13	23/08	30/08
2	07/06	14/06	8	19/07	26/07	14	30/08	06/09
3	14/06	21/06	9	26/07	02/08	15	06/09	13/09
4	21/06	28/06	10	02/08	09/08	16	13/09	20/09
5	28/06	05/07	11	09/08	16/08	17	20/09	27/09
6	05/07	12/07	12	16/08	23/08	18	27/09	04/10

Finally, we performed an additional cross-referencing of the words obtained with a dictionary of sentiments of words ("bing") through the function *get_sentiments* of the *tidytext* package, to obtain for each one of them the identification of the sentiment tendency of its meaning. This identification seeks to indicate whether the word tends to be associated more with positive or negative sentiments. However, it is important to point out that not all words are present in the sentiment dictionary, therefore, this column is not completely filled in the dataset. In the case of these data, the sample filled in with sentiment information has 43,774 lines, thus representing a filling of just over 11%. Here it is important to highlight that sentiment dictionaries often fail to identify terms and expressions because they are unable to analyze their context, thus being a more likely approximation of sentiment.

Data analysis

With the data from posts already processed and treated, the first data analysis and exploration activities were carried out to identify the main terms present in foreign posts in Twitter ® related to the Amazon region and how their importance varied over the evaluated time series. For this, we analyzed the 20 most cited words in tweets throughout the monitoring period, quantifying their frequency within the total set of citations of identified words. Within this group, we also evaluated how this number of citations varied for the 5 most important words over the time series. The definition of the number of selected words was made considering the large number of words available and the difficulty of presenting results for all of them. In the dataset as a whole, we also raised descriptive measures of the importance of words and their variation over the monitored period.

Based on the sentiment data obtained in the data processing step, we subsequently evaluated whether the composition of terms in foreign posts on the region is more strongly associated with positive or negative sentiments, in addition to analyzing the temporal variation of these proportions. For this, we first quantify the representation of terms of each sentiment (positive/negative) in each tweet, thus obtaining a % of positives and % of negatives in each one of them. We then use this data to quantify the average composition of tweets in general and assess whether there is a significant difference between the representativeness of each sentiment in the posts. To assess this difference, we performed an analysis using linear models in which the percentage of each sentiment was used as the response variable and sentiment (positive/negative) as an explanatory variable. The distribution of gaussian residuals was used, considering that the data showed normality of residues and homogeneity of variance, in addition to adopting a significance level of 0.05. Furthermore, for these sentiment composition data, we also obtained descriptive measures of each category. The average of each sentiment over the evaluation period was also obtained, thus allowing the analysis of temporal trends. The complete flow of data collection, processing and analysis can be seen summarized in Figure 1.

RESULTS

Main topics and their temporal importance variation

The occurrence of posts changed throughout the evaluated time series, oscillating between moments of greater and lesser occurrence. The highest values were observed in July 2021, when the three highest daily values of 5372 posts on 07/15, 2720 posts on 07/16 and 1006 posts on 07/17 were
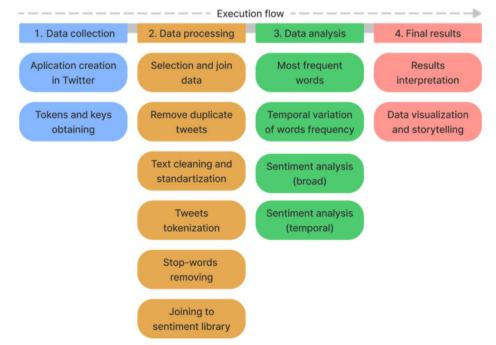

Figure 1: Execution flow of activities performed in this work, from data collection to results.

observed on consecutive days (Figure 2). On the other hand, the lowest daily values were 98 posts on 06/14, 132 posts on 09/25 and 151 posts on 07/05. Considering the entire evaluation period, the top 20 words in frequency in posts involving the term "Amazon Rainforest" were, in the sequence (Figure 3): carbon, fire, people, indigenous, deforestation, brazil, brazilian, emitting, absorbs, climate, forest, world, Bolsonaro, dying, destruction, absorb, ice, dioxide, president and protect. Thus, the main words are associated with issues related to climate change (carbon, dioxide, climate), conservation (protect) or forest destruction (fire, deforestation, dying, destruction, etc.).

Considering the 5 most frequent words throughout the evaluation period ("Carbon", "deforestation", "fire", "indigenous" and "people"), we observed the existence of higher frequency peaks concentrated between June and July (Figure 4). The words "people" and "indigenous" had their frequency peaks in late June and early July, while "carbon" and the other words had their peaks in the middle of July. In particular, the highest peaks of the word "carbon" were observed in this period, especially on the 15th and 16th of July, with 1781 and 1062 citations of the word, respectively.
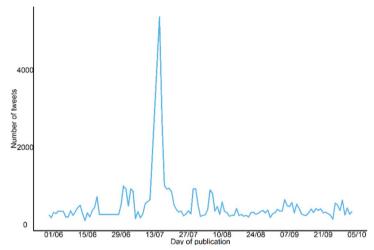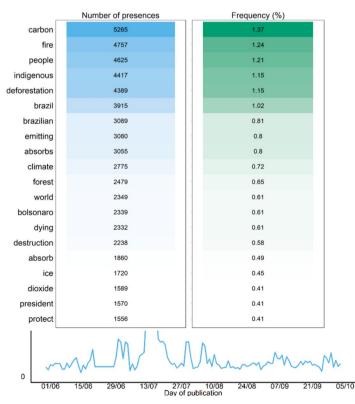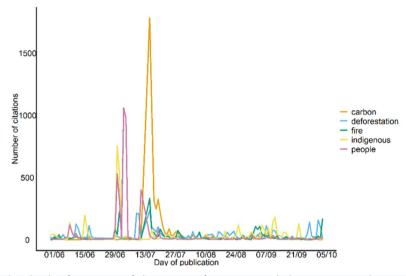

Figure 2: Daily number of posts on Twitter ® containing the term "Amazon Rainforest".

	Number of presences	Frequency (%)
carbon	5265	1.37
fire	4757	1.24
people	4625	1.21
indigenous	4417	1.15
deforestation	4389	1.15
brazil	3915	1.02
brazilian	3089	0.81
emitting	3080	0.8
absorbs	3055	0.8
climate	2775	0.72
forest	2479	0.65
world	2349	0.61
bolsonaro	2339	0.61
dying	2332	0.61
destruction	2238	0.58
absorb	1860	0.49
ice	1720	0.45
dioxide	1589	0.41
president	1570	0.41
protect	1556	0.41

Figure 3: Heatmap showing the number of presences and the proportional frequency of the 20 most frequent words in posts on Twitter ® containing the term "Amazon Rainforest" over the entire period evaluated.

Figure 4: Daily variation in the frequency of the 5 most frequent words in posts on Twitter ® containing the term "Amazon Rainforest" over the entire evaluated period.

General patterns of sentiment composition of tweets

According to the sentiment analysis of the tweets containing the term "Amazon rainforest", we found that, throughout the evaluated period, the posts had an average of 68.47% of terms with negative connotations, against 31.53% of terms considered positive (Figure 5). The minimum and maximum observed were 0% and 100% for some posts, that is, they are posts in which all terms are negative or positive, according to the sentiment dictionary used. The analysis using generalized linear models indicated that such means are significantly different at the 0.05 significance level (R^2 of the model was 15.06 %). Thus, in general, posts involving the term "Amazon rainforest" were more negative than positive. Considering the evaluated period, the average daily proportion of terms for each sentiment in the posts was more negative than positive throughout the entire time series, with peaks of negative terms especially in the month of July (Figure 6). The lowest negative daily average value observed was 44.5 on September 15th, while the highest was 76.13 on July 23rd. On these same days, the highest positive value was 55.5% and the lowest was 23.86%. Thus, in addition to the posts being composed of more negative terms in general, this pattern was also observed throughout the time series.

DISCUSSION

Environmental issues are the main theme of posts on Amazon rainforest
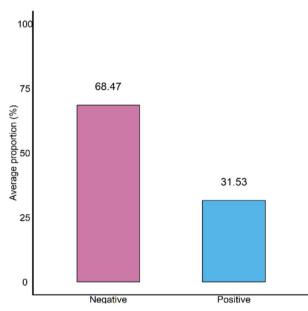
Our results indicate that the posts content involving the term "Amazon rainforest" is mainly associated with environmental issues, such as the terms "carbon" and "emitting" that are associated with the emission of CO_2 into the atmosphere and its contribution to global warming and climate change; and "fire", which refers to the fires that occur in the region and which are also responsible for emitting a large amount of carbon dioxide into the atmosphere and for significant impacts on Amazonian ecosystems. In addition, some words are directly related to these impacts, such as "dying", "deforestation" and "destruction". There are also terms related to forest protection ("protect") and indigenous peoples ("peoples" and "indigenous") who inhabit the forests of the region and who are affected by the process of forest destruction (Conceição et al., 2021) and also from public policies recently introduced by an ultraconservative presidential administration that caters to economic and political lobbies that aim to weaken environmental protection (Le Tourneau, 2019). Taken together, the result found points to a pattern of concern about the status of environmental conservation in posts involving the Amazon region and indigenous peoples, addressing topics of global relevance today such as climate change and deforestation (Barlow et al., 2020; Lim et al. al., 2022), and the importance of indigenous peoples for the conservation of the Amazon rainforest (Walker et al., 2014; Fernandez-Lhamazares et al., 2021).

Considering the perspective of temporal variation, the peaks observed in the number of citations of the most frequent terms between June and July 2021 are directly associated with the beginning of the dry season in the region, in which the number of fires increases substantially. According to data from the Queimadas Program of the National Institute for Space Research (INPE, 2020) the number of fire outbreaks identified by the MODIS sensor of the AQUA satellite increased from 1166 in May to 2305 outbreaks in June, 4977 in July, 28060 outbreaks in August, and 16742 outbreaks in September. Thus, the period of highest citations of terms marks the beginning of the period of substantial increase in fires in the region, which is compatible with the increase in international attention given to these events, which have a serious environmental impact on the conservation of the region's ecosystems. However,

attention is drawn to the fact that the increase in the number of citations in response to the increase in fire outbreaks has not continued. This pattern may be associated with the replacement of the topic by another topic highlighted in the public debate, which is common on social medias (Li et al., 2019), and may cause the decreasing of the number of posts on the topic. Thus, this result draws attention to the non-direct relationship between real events and the perception of the public on the networks, considering the interaction with several factors such as posts of news in credible vehicles and campaigns with objectives contrary to conservation (Bennett, 2016; Canavari; Coderoni, 2019; Barlow et al. al., 2020).
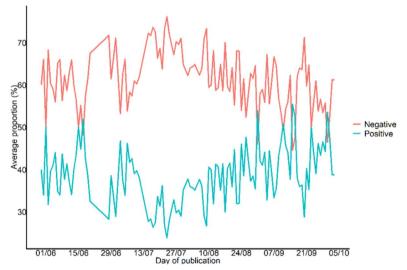

Figure 5: Average proportion of terms for each sentiment in social media posts containing the term "Amazon Rainforest" over the entire evaluated period.

In this way, the environmental perception here is related to all the information about the destruction of the Amazon and consequences for society, stored by individuals in individual cognitive processes, more strongly influenced by the culture of the groups to which they belong (Tuan, 1983). Well, hardly any participant in Twitter ® had direct contact with the burning Amazonian rainforests to perceive, through the senses, how negative their destruction is. Robelia et al. (2011) demonstrated that participation in a community of like-minded users on the social media Facebook encouraged participants to learn more about climate change and pursue mitigation through personal and public engagement. Thus, it is possible to understand the important role of social medias for non-formal and informal educational processes, by sensitizing individuals who are still unaware of the socio-environmental impacts caused to the Amazon rainforest, indigenous peoples, and the planet's climate. The use of social media is also observed in formal education around the world (Tsai et al., 2013), in which students are already more easily involved in education and communication processes through social medias compared to conventional sources of literature for learning (Tiryakioglu; Erzurum, 2011; Buzov, 2014).

The posts' content of are mostly negative

Our result found on the prevalence of negative sentiment in foreign posts points to a scenario of predominantly negative foreign environmental perception about the Amazon region. This perception is even enhanced in periods of greater occurrence of fires, in which issues related to the theme are more publicized in the international media (Barlow et al., 2020). The region's ecosystems are recognized as important in the provision of essential ecosystem services globally, to arouse the concern of audiences from various parts of the planet (Canavari; Coderoni, 2019; Gibbens, 2019; Rajão et al., 2020; Conceição et al., 2021).

Figure 6: Average daily proportion of terms for each feeling (%) in social media posts containing the term "Amazon Rainforest" over the entire evaluated period.

Considering the importance given to the environmental issue by consumers, such a negative perception can influence the purchase of Brazilian products by foreign consumers, who will associate the product's image with the destruction of the forest and the failure to meet important environmental goals (Gong et al., 2019; Radi; Shokouhyar, 2021). This greater demand for environmental guarantees has been a trend in consumer markets, which have sought guarantees that the product consumed has no aspect of its production associated with environmental or social impacts (García-Herrero et al., 2019; Gong et al., 2019). The search for environmental and social certification, as well as the growing demand from consumers for the implementation of ESG principles by companies are the main indications that the consumption profile has changed (Canavari; Coderoni, 2019; Gong et al., 2019; Lim et al., 2022). The inconsequential consumption profile was replaced by a public with greater environmental awareness and concern about the origin of the products they consume, especially in markets with greater purchasing power, such as the European, North American and Asian markets (Gong et al., 2019). In this context, in September 2022 the European Parliament validated a project proposal from the European Commission that prohibits the entry of commodities associated with deforestation into the European market (European Commission, 2021).

It is important to enhance that there is a prevailing trend of algorithms amplifying negative content and sentiments on social media, which can introduce a bias in evaluating environmental perceptions (Li et al., 2019; Zafar et al., 2021). As these algorithms prioritize engagement and often sensational or emotionally charged posts, discussions around environmental issues that evoke anger or fear might gain disproportionate prominence. Consequently, the collective perception of the environment could become skewed towards negative aspects, overshadowing nuanced and positive discussions (Li et al., 2019; Zafar et al., 2021). Striking a balance between highlighting concerns and promoting constructive discourse is essential to ensure that the evaluation of environmental perceptions through social media remains accurate and representative. In addition, not all words are included in the sentiment dictionary, and there may be discussions about the sentiments attributed to words, which tend to represent a general trend. Improvements in the quality of dictionaries and analysis tools are needed to bring more confidence to the analyses.

Limitations and perspectives of the work

The results presented here bring several relevant points to the debate on the occurrence and assessment of environmental perception in the technological era. First, our work shows the possibility of advancing environmental perception assessment techniques to the social media scenario, which is where much of the political and social debate takes place today. In this sense, the use of the content of posts made in these networks can be an interesting alternative to the traditional methods of applying structured and semi-structured interviews and questionnaires, especially in situations with broad objectives in geographic and temporal scale. As benefits in relation to traditional methods, the methodology used here allows for quick and cheap collection, in addition to allowing the continuous collection of perceptions on the topic (Li et al., 2019; Radi and Shokouhvar, 2021; Silveira-Junior; et al., 2021).

On the other hand, the approach using social media has some points of attention and limitations. The first refers to the difficulty in obtaining a representative sample of society through them. Not all social strata and age groups use social media and are active in publications, so the sample obtained in analyzes such as those carried out here runs the risk of being biased by the presence of certain social groups and the most active voices (Zafar et al. al., 2021). In addition, the algorithm's own logic of giving preference to the engagement of negative content can also bias the results, directing them to negative contexts or those with greater impact (Radi; Shokouhvar, 2021; Zafar et al., 2021). Thus, it is necessary to add other layers of analysis to this approach, incorporating additional stratifications and seeking better information bases (such as sentiment dictionaries) and tools that consider a greater number of sources of variation. It is worth mentioning that the use of other classic methods is necessary in situations of more specific objectives or groups, such as in evaluating the perception of technical groups or consumption niches. However, we understand that the combination of the characteristics of the different approaches may be the best option, as it increases the methodologies already consolidated with aspects of technological innovation that are part of today's society (Li et al., 2019; Radi and Shokouhvar, 2021).

In addition, our results reinforce a phenemenon already observed in other works of increasing society's concern with the environmental theme, in which the public goes to social media to express their opinions, share relevant information, and discuss sensitive points on the subject (Ozdemir, 2010; Bennett, 2016; García-Herrero et al., 2019; Gong et al., 2019). In moments of greater concern, such as the peaks of fires observed in the period evaluated, such discussions become even more frequent, which shows a sensitivity of the networks to the events in occurrence (García-Herrero et al., 2019; Li et al., 2019). All this digital movement around the environmental theme is carried out with the main objective of making more people aware of the situation, who can jointly pressure environmental agencies and public agents to act in relation to the scenarios and events that are taking place (Bennett, 2016; Gong et al., 2019). We believe that the debate on social media about the negative impacts caused to the Amazon rainforest has contributed to formal, non-formal and informal communication campaign in a comprehensive way, as it allows easy access to updated information. Ultimately, a greater discussion on the subject on social medias due to greater environmental awareness can help in the formulation of public policies and initiatives that can contribute to the environmental conservation of ecologically relevant areas such as the Amazon.

CONCLUSION

The non-Brazilian environmental perception on the Amazon rainforest observed in social media is mainly negative and related to themes related to events such as fires, deforestation and climate changes. There is a partial match between the frequency of posts related to the region and their fire regime, likely due to the social appeal of the region on a global scale. Such trends demonstrate an increase in society's environmental concern, which is increasingly aware of related issues, especially within the context of climate changes. Social media can be used as potential tool for environmental perception evaluation, however combined with additional sources of data and other tools that can compensate for its limitations.

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Project Idea: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

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Database: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

Processing: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

Analysis: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

Writing: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

Review: CRS, WJSJ, RFM, ACSCJ, MALF, RMS

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