

Discourse Dynamics on X and Bluesky Amid Brazil's 2024 Environmental and Political-Digital Crises

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ABSTRACT

This study presents a comparative analysis of discourses on the 2024 environmental crisis in Brazil across the platforms X and Bluesky, amid a parallel political-digital crisis triggered by X's temporary suspension in the country. Over 170,000 posts collected between July and November 2024 were analyzed. Language models were employed for semantic filtering, topic modeling, and sentiment and toxicity analysis. Results indicate that Bluesky's discourse was more technical and institutional, dominated by governmental and progressive actors, whereas X fostered popular and highly polarized narratives, with ideological disputes over climate responsibility.

KEYWORDS

X, Twitter, Bluesky, Brazil, Climate, Data Science

1 INTRODUCTION

The increase in global temperature in recent decades has altered climate patterns and destabilized environmental equilibrium. As Earth's temperature rises, the occurrence of environmental disasters such as droughts, floods, biodiversity loss, ocean temperature shifts, and various risks to human health has intensified [15, 26].

In Brazil, the impacts of this crisis were particularly severe in 2024. A combination of climate variability, El Niño, and human activity triggered one of the country's most critical environmental emergencies, including the most intense drought since 1950 [19], an 80% increase in wildfires, primarily in the Amazon and Pantanal, compared to 2023 [12], and devastating floods in Rio Grande do Sul [25]. Between January and September, over 22 million hectares were affected by fires, a 150% increase over the same period in the previous year [22]. Simultaneously, five major river basins were declared in a state of water scarcity for the first time in history [1]. These events exposed Brazil's environmental vulnerability and intensified debates on government accountability and climate action.

Concurrently with this socio-environmental crisis, another highly impactful process marked 2024: a political-digital crisis triggered by

the reconfiguration of social media platforms, particularly following the acquisition of Twitter by Elon Musk and its rebranding into X [14]. Guided by a "free speech absolutism" approach, X relaxed content moderation policies, enabling a rise in extremist voices and disinformation [4]. On August 30, 2024, the Brazilian Supreme Federal Court (STF) ordered the blocking of X due to the company's failure to comply with legal requirements. The suspension was lifted on October 8, 2024, following compliance with judicial mandates and payment of fines totaling BRL 28.6 million [24].

With X offline, millions of Brazilians migrated to Bluesky [6], a decentralized social network that gained prominence as a refuge for public debate [2, 8, 9]. This migration included influencers, politicians, media outlets, and government accounts [10], reshaping the dynamics of online discourse. Studies suggest the new user base on Bluesky leaned politically left [21], while X's remaining active users were increasingly aligned with the political right [11].

Given this context, this article proposes a joint analysis of these two phenomena — the climate and environmental crisis and the political-digital crisis — through a comparative study of discourse on X and Bluesky during the period. The study addresses three research questions: [RQ1] What was the extent of Brazilian user migration to Bluesky during X's suspension? [RQ2] What is the sociopolitical profile of prominent actors on each platform? and [RQ3] How do discourses about the 2024 climate crisis differ between users of X and Bluesky?

To the best of our knowledge, this is the first study to explore this unique event in Brazil: the intersection of a climate and environmental crisis with a political-digital crisis.

2 METHODS

This study employed a quantitative methodological approach to analyze and compare discourses surrounding the 2024 climate and environmental crisis on the platforms X and Bluesky. The methodology was structured into three stages: Data Collection (Section 2.1); Preprocessing (Section 2.2); and Topic Modeling (Section 2.3).

2.1 Data Collection

To conduct this comparative analysis, data were collected from both platforms covering the period from July 1 to November 30, 2024, in order to encompass the pre-, during-, and post-block phases of the X platform during the climate and environmental crisis.

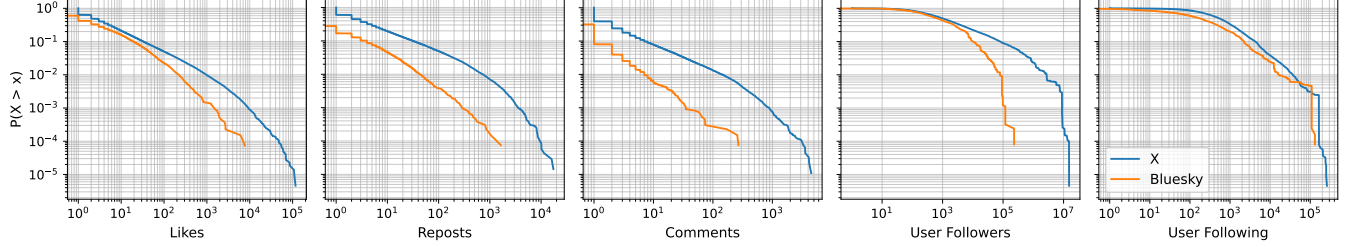


Figure 1: CCDFs of engagement metrics for posts (likes, reposts, comments) and users (followers, following), showing the power-law behavior typical of social media.

Data from Bluesky were collected via the official public API,¹ first by retrieving posts and subsequently by obtaining metadata from the associated user profiles. Data from X, in turn, were obtained using the Pysa² tool, developed by Labic/Ufes. This approach was necessary because X no longer offers a public API since its acquisition by Elon Musk. Instead, the team conducts high-volume daily data collections through web scraping techniques and third-party tools, monitoring relevant topics including environmental and climate issues.

A total of 98 keywords³ were used to retrieve posts related to the topic. The list of keywords was manually constructed by the researchers based on a series of preliminary and iterative data collection rounds, aiming to capture the full scope of discussions on the environmental and climate crises. Many of these keywords included word stems to account for variations such as plurals and verb conjugations, thereby maximizing the coverage of relevant topics. After data collection, only posts written in Portuguese were retained, and duplicate entries were removed to ensure the uniqueness and linguistic relevance of the dataset.

2.2 Preprocessing

Following the initial data collection, in order to eliminate noise caused by ambiguous yet contextually important terms and to refine the relevance of messages to the central theme, the Mistral 7B [16] Large Language Model (LLM) was employed. For each message, a zero-shot prompt⁴ was applied to assess its relevance. This process was designed to ensure that the dataset was strictly focused on discussions concerning environmental and climate crises.

2.3 Topic Modeling

To identify the main themes of discussion on each social media platform, we employed BERTopic model [13]. This topic modeling technique leverages sentence embeddings to generate semantic representations of text. The resulting embeddings were then clustered using the KMeans algorithm [18], enabling the identification of groups of semantically similar messages that represent the predominant discussion topics on each platform, thereby providing a granular view of the discourse.

¹<https://public.api.bsky.app/>

²<https://pysa.labic.net/>

³The complete list of the 98 search keywords is available in the project's GitHub repository: <https://github.com/dsl-ufes/2024climatecrisis/>.

⁴The exact prompt used for zero-shot filtering was: "Is the following message directly related to discussions on environmental and climate crises? Respond with only Yes or No: <TEXT>"

To complement the topic analysis, the 50 most frequently mentioned entities were also extracted from each platform. In this context, "entities" refer to terms with distinct and identifiable meaning. The NLTK library [5] was used to detect named entities of the types person (PER), organization (ORG), and location (LOC).

To assess the tone of the discourse, all data were analyzed for sentiment and toxicity. Sentiment polarity was computed using the LeIA lexicon [3], while toxicity levels were obtained through the Perspective API [17]. Each post received continuous sentiment and toxicity scores between 0 and 1, enabling a quantitative comparison of emotional and adversarial language across platforms.

3 RESULTS

This section presents the results obtained, including general data metrics, an analysis of discussion topics on each platform, and an assessment of the toxicity observed in the discourse.

3.1 Dataset Characterization

A total of 227,375 posts were collected from X and 13,256 from Bluesky, all within the same data collection period. After applying the zero-shot filtering to reduce noise in the textual analyses, the final dataset consisted of 162,564 posts from X and 10,739 from Bluesky, corresponding to retention rates of approximately 71% and 81%, respectively. This final dataset comprised 78,225 unique users on X, with an average of 1.92 posts per user, while Bluesky featured 6,522 unique users, with an average of 4.49 posts per user, indicating a higher frequency of individual activity on that platform in relation to climate crisis discussions.

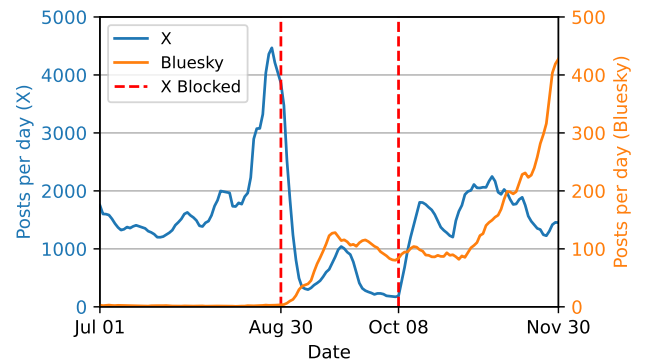


Figure 2: Publications per day (7-day moving average)

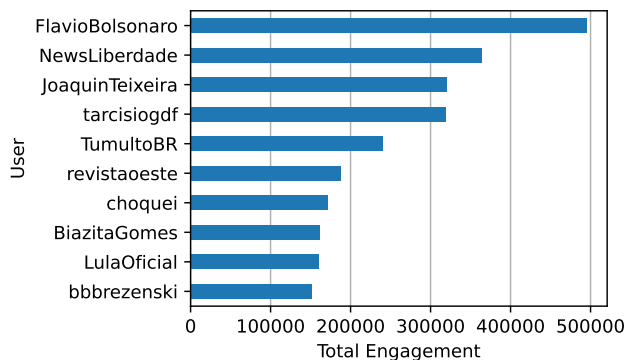


Figure 3: Top Users by Engagement on X.

Detailed distributions of user activity and engagement metrics across both platforms are provided in Figure 1, using Complementary Cumulative Distribution Functions (CCDFs) in log-log scale. This approach is preferred due to the typical power law distribution observed in social networks [20].

The CCDFs reveal structural similarities but also key differences between the platforms. Post metrics indicate the existence of viral content concentrating high levels of engagement. In contrast, Bluesky shows a steeper decline, suggesting more evenly distributed engagement levels. As for user metrics, follower distributions on X show a greater presence of highly followed, influential accounts.

The temporal dynamics of posting volume are illustrated in Figure 2. As expected, the blocking of X led to a notable increase in activity on Bluesky. This migration effect was also reflected in engagement metrics: during the suspension period, Bluesky recorded an 800% increase in likes, 413% in reposts, and 314% in comments. In contrast, engagement on X remained relatively stable, fluctuating between 3% and 5%, despite a sharp drop in posting volume.

This stability in engagement, even with reduced posting volume, suggests a degree of cohesion among users active in X discussions. Influential accounts such as *Flávio Bolsonaro* and outlets like *NewsLiberdade* and *Revista Oeste* were particularly prominent, reinforcing the presence of a politically right-aligned user base. Figure 3 shows the ten most engaged users on X, based on the sum of likes, reposts, and replies.

In contrast, Bluesky's most prominent users were characterized by a more institutional and progressive alignment. As shown in Figure 4, top accounts included official government profiles, political figures like Congresswoman *Erika Hilton* and President *Lula*, and progressive media outlets such as *Revista Fórum*. Notably, during X's suspension, several governmental figures and left-leaning political actors publicly promoted Bluesky as an alternative platform for debate [10], reinforcing its role as a politically distinct space.

3.2 Discussion Topics

The combination of topic modeling, sentiment, and toxicity assessment revealed clear differences in the nature of discourse between the two platforms. For each topic identified by BERTopic, we computed the average toxicity and sentiment scores to better understand the tone of the discussions.

Overall, Bluesky posts exhibited lower toxicity (-6.7%) and more

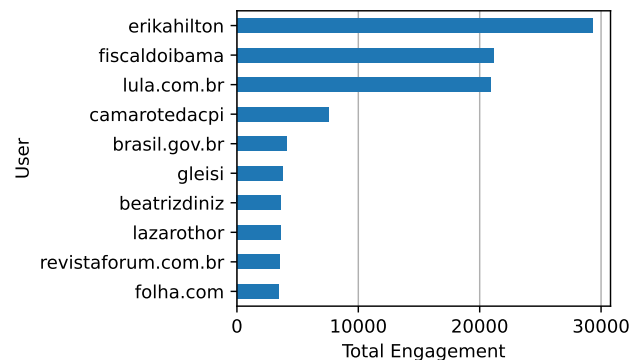


Figure 4: Top Users by Engagement on Bluesky.

positive sentiment (+16.2%) compared to those on X. These patterns, summarized in Tables 1 and 2, suggest that Bluesky provided a less adversarial environment for climate-related discussions.

In both networks, topics associated with extreme climate events and governmental responses displayed predominantly negative sentiment, reflecting public frustration and concern over the disasters. However, on X, discussions about environmental governance, such as the topic on Amazonian responsibility, exhibited higher levels of negativity and toxicity, indicating the presence of ideological conflicts and polarized narratives.

As an illustrative example from X, one of the most shared posts, published by *Gil Diniz*, a State Representative from São Paulo (8,644 reposts), stated: “*Brazil in flames, and the worst Environment Minister in history blames ‘climate change’ for her incompetence. Save the Amazon and SAVE BRAZIL! Where are you, Rouanet artists?*”. The post exemplifies the highly emotional and confrontational tone of X discussions, where environmental issues are weaponized in political attacks, directly targeting the Minister of Environment and even evoking the Rouanet Law [7], a cultural incentive policy often criticized by right-wing groups in Brazil [23].

In contrast, Bluesky's most popular post (published by Congresswoman *Erika Hilton*, with 3,580 reposts) adopted a more urgent yet technical tone: “*CLIMATE CRISIS: WE MUST ACT. Brazil has been suffering for weeks from criminal fires, intensified by severe drought and a heat wave. Moreover, smoke from the fires has completely destroyed air quality in our cities, including São Paulo*”. This suggests that discourse on Bluesky was more frequently framed in institutional or scientific terms, showing a relatively stable emotional tone even in the context of critical events.

The extraction and analysis of named entities reinforce these observed patterns. On Bluesky, discussions frequently referenced institutional actors and initiatives, such as *Amazon Fund*, *Ministry of the Environment*, *COP (Conference of the Parties)*, and *Chico Mendes Institute for Biodiversity Conservation (ICMBio)*. In contrast, X exhibited a greater presence of polarizing entities such as *Bolsonaro*, *STF*, and *Trump*, often accompanied by discursive noise. These findings suggest that Bluesky's discourse gravitated toward institutional and policy-oriented actors, whereas X was dominated by polarizing figures and became a battleground for ideologically charged debates. The full list of the 50 most cited entities on each network is available in the project's GitHub repository.

Table 1: Discussion Topics on Bluesky

Topic	Documents	Description	Toxicity	Sentiment
0	1060	Advances in combating deforestation and conservation efforts in Brazil's Biomes	-0.930	0.024
1	5	Recruitment for Sustainable Future Initiatives by FilhosDaEsperança	-0.983	0.358
2	929	Climate Crisis, Politics, and Environmental Concerns	-0.922	-0.168
3	793	Environmental Impact of Agriculture and Meat Production	-0.929	-0.153
4	40	Seminars/Workshops on Natural Disasters, Sustainability and Resource Management	-0.959	0.315
5	856	Weather conditions and electricity supply issues in SP (Sao Paulo)	-0.730	-0.110
6	7	Environmental Activism and Empowerment for Women and Children	-0.944	0.157
7	1156	Climate Conference COP29 in Baku, Azerbaijan	-0.981	0.009
8	886	Fogo na Amazônia e Cerrado: atualização sobre o combate às queimadas em setembro	-0.866	-0.181
9	853	Deforestation and Livestock Farming in Rondônia: Threat to Wildlife Species and Vegetation	-0.920	-0.081

Table 2: Discussion Topics on X

Topic	Documents	Description	Toxicity	Sentiment
0	9891	Weather conditions in São Paulo (rain, strong, cold front)	-0.760	-0.136
1	7144	Disputes over Indigenous Rights and Amazonian Territory (Marco Temporal, PEC48)	-0.961	0.000
2	10877	Governing Responsibility for Amazon Rainforest Fires under Lula and Bolsonaro Administrations	-0.800	-0.308
3	12878	Deforestation and Conservation Efforts in Brazil's Amazonia and Cerrado Biomes	-0.938	-0.085
4	16014	Disaster response and reelection in Rio Grande do Sul	-0.853	-0.153
5	12312	Discussion on Climate Crisis and Polarized Responses	-0.881	-0.262
6	7120	Air and Noise Pollution Impact on Mental Health in Cities	-0.720	-0.125
7	6890	Weather alert for intense rains and strong winds across several states in Brazil	-0.963	0.084
8	9840	Government Policies Regarding Environmental Protection and Conservation Efforts	-0.845	-0.281
9	14147	Forest fires warnings and combating efforts in various regions of Brazil	-0.869	-0.186

4 FINAL REMARKS

This study explored the intersection of two major crises in Brazil in 2024: a socio-environmental crisis marked by wildfires, droughts, and floods, and a political-digital crisis caused by the suspension of X (formerly Twitter) and the subsequent migration of users to Bluesky. By analyzing over 170,000 posts across both platforms, we identified how these events shaped online discourse and revealed distinct sociopolitical dynamics within each network.

Regarding RQ1, our findings indicate a significant migration of users to Bluesky during the blocking of X. While Bluesky's overall post volume remained smaller than X's, it experienced an 800% surge in likes, a 413% increase in reposts, and a 314% rise in comments during the suspension period. This engagement spike indicates that Bluesky temporarily emerged as a central platform for the discussions, amplifying the voices of newly migrated users.

For RQ2, the sociopolitical profiles of top users differed starkly. On Bluesky, leading accounts included governmental institutions (e.g. Brazilian Government), left-leaning politicians (e.g. President Lula and Congresswoman Erika Hilton), and progressive media outlets. On X, influential accounts were predominantly conservative figures and media actors, such as Flavio Bolsonaro and Revista Oeste, reinforcing the platform's increasingly polarized landscape.

These findings align with [21], who observed political clustering in Bluesky's user base. However, our results suggest that during Brazil's X suspension, the platform became not only politically clustered but also highly institutionalized, dominated by government accounts and progressive media outlets. This indicates that platform migration dynamics under crisis conditions may produce unique discursive configurations.

Regarding RQ3, discourse analysis revealed contrasting patterns. Bluesky discussions were characterized by a technical and institutional tone, often referencing policy initiatives and scientific events like COP. Conversely, X users adopted a more popular and experiential style, with high levels of polarization, emotional expression, and ideological conflict, particularly on topics such as Amazonian deforestation and climate governance.

These findings highlight how platform architectures and political contexts shape public debates during critical moments. By demonstrating how network effects and sociopolitical alignments influence environmental discourse, this study contributes to understanding the role of decentralized platforms in fostering pluralistic or fragmented public spheres.

Limitations and Future Work

This study has some limitations. The use of topic modeling and sentiment analysis based on embeddings may overlook discursive nuances such as irony and ambiguity. Additionally, the analysis did not consider multimodal content, which limits the understanding of broader communication strategies. Future work should explore longitudinal analyses and incorporate more advanced supervised models, able to capture dynamic narratives, as well as compare user interactions across the two platforms.

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