

Sentiment Analysis of Public Opinions on Climate Change Across Three Indian Cities

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Abstract:

Climate change poses major threats to cities worldwide. Public opinions and behaviors shape the success of climate action, hence analyzing perspectives across urban regions is vital. This study conducts sentiment analysis of 25 recent news articles related to climate change from leading publications in three Indian cities – Mumbai, Hyderabad and Chennai. TextBlob is used to compare polarity and subjectivity scores between cities. Further, a transformers library zero-shot classifier examines emotions like anger and fear; outlooks like optimism; and climate discussions around impacts, causes and adaptation. Additionally, a Kruskal-Wallis nonparametric statistical test was conducted which indicated no significant differences between the three cities at the current sample size (H-statistic = 0.085 ; $p = 0.958$), revealing prevailing variability appears more related to chance similarities in aggregate climate opinions across three cities.

Keywords: zero-shot classification, climate change, sentiment analysis, non-parametric test

Introduction

As climate change intensifies its grip on India, urban centers like Mumbai are facing escalating threats from extreme weather, water scarcity, and other environmental disruptions. These cities, with their concentrated populations, infrastructure, and economic assets, are on the frontlines of the climate crisis.

Their residents' public perceptions and behaviors can significantly shape India's nationwide climate resilience and action. Understanding how climate change awareness and opinions vary between major city populations offers vital insights for policymakers and communication experts. This knowledge allows them to develop localized engagement strategies and mitigation and adaptation responses tailored to the prevailing public sentiments in each municipality. This is especially crucial for India, a vulnerable developing country at the forefront of climate change. A research shows that progress on defining and responding to climate dangers requires recognizing both 'external' expert-based risk assessments and 'internal' socially-constructed perceptions of risk, since danger must be experienced or perceived to be considered real (Dessai et al., 2004).

This study delves into public perspectives expressed in media reports across three major Indian cities:

- Mumbai: A coastal metropolis facing rising sea levels and extreme weather events.

- Hyderabad: A rapidly growing city in a semi-arid zone grappling with water scarcity and heatwaves.
- Chennai: A coastal city vulnerable to cyclones and floods.

By analyzing climate change news articles from each city, we can identify and classify the emotions, ideologies, and attitudes conveyed by the local media. This comparative sentiment analysis will allow us to assess if statistically significant differences exist between cities based on their aggregated public climate opinions. Climate change uncertainties are understood and experienced differently by various actors, from policy makers relying on techno-managerial solutions to local communities facing lived realities of interconnected socio-economic and climatic changes (*Mehta et al., 2019*).

Literature Review (Hypotheses inform)

Recognizing that public awareness, attitudes, and behaviors play a crucial role in shaping the success of climate change mitigation and adaptation strategies, researchers aim to understand opinions and response of people living in cities to the challenges posed by a changing climate.

This comparative literature review examines a total of 25 news articles related to climate change impacts and environmental issues from the three major Indian cities like Mumbai, Hyderabad and Chennai. The objective is to analyze the sentiments expressed across these cities to compare public perceptions regarding climate change threats in different regions.

As per the Ecological Threat Report summary published in 2022 (Institute for Economics and Peace, 2022), Indian cities Delhi, Mumbai, Chennai and Hyderabad are

among the 20 urban centers facing highest climate change vulnerability globally, with Delhi having the worst air pollution levels nationally though Mumbai and Chennai rank as the top two Indian cities facing overall ecological risks.

While Delhi is undoubtedly a city grappling with severe climate issues, our decision to exclude it from our study stems from the acknowledgment that it already occupies a prominent position in climate change discourse. Mumbai, Hyderabad, and Chennai, on the other hand, share comparable levels of vulnerability and exposure to climate-related concerns. By choosing these cities, we intended to shed light on opinions and sentiments from regions that are both critical and somewhat underrepresented in the current academic landscape. Our focus on these three cities allows for exploration of perspectives on climate change, contributing valuable insights.

Now coming to the technical part, according to the authors' studies (*CHIHAB et al., 2022*), the polarity of a sentiment is a quantified measure on the scale of values corresponding to a positive or negative assessment of emotional significance and subjectivity aimed at determining whether a text is subjective (opinion, emotions, evaluations, beliefs or speculations) or simply a fact. TextBlob's analysis of polarity and subjectivity in articles quantifies emotional tone, separates facts from opinions, and tracks trends over time, offering a powerful understanding of public sentiment.

Zero-Shot classification is a machine learning model that requires no training data. It classifies objects to a different label that the classifier has not been trained on. The zero-shot model detects emotions first, and later they are used to assign positive, negative, and neutral sentiments. Such a method gradually decreases the dimensionality starting from the high-dimensional sentence transformer input (i.e.,

vectorized text) mapped into probability values of different emotions; probability values are further mapped into the sentiment labels (*Tesfagergish et al., 2022*).

Methodology

To analyze sentiments related to climate change, we gathered 25 Multi Language news articles from leading publications in the Indian cities of Mumbai, Chennai and Hyderabad over a 4 year period (2019-2023). Relevant metadata like article title, date, city, language published in and source publication were extracted along with full text content.

Date	Year	City	Language	Newspaper_Name	Topic	Article	Translated_Article	Polarity	Subjectivity
07/24/2019	2019	Mumbai	English	Mumbai Mirror	Farming and climate change	An economic survey noted that the average inco...	an economic survey noted that the average inco...	0.031939	0.383992
10/15/2019	2019	Mumbai	English	Mumbai Mirror	Children as champions of climate change	Talk of coincidences and Bijal Vachharajani's ...	talk of coincidences and bijal vachharajanis l...	0.018325	0.399436
10/31/2019	2019	Mumbai	English	Mumbai Mirror	Mumbai could go under water by 2050	International study gives new estimates on the...	international study gives new estimates on the...	0.068933	0.471552
06/05/2020	2020	Mumbai	English	Mumbai Mirror	Clean air is our right: On Environment Day, cl...	For over two months, the country has been unde...	for over two months the country has been unde...	0.166589	0.432949
11/25/2019	2019	Mumbai	English	NPR	Mangroves help fight the effects of climate ch...	Bare trees with slender branches line a half-b...	bare trees with slender branches line a halfbu...	0.052015	0.440720
09/03/2021	2021	Mumbai	English	Hindustan Times	Since 2019, Maharashtra spent ₹ 14K-crore as c...	The number is, however, a gross underestimat...	the number is however a gross underestimation ...	-0.042538	0.439538
09/29/2019	2019	Mumbai	English	Times of India	Mumbai: Five extremely heavy rain days in Mons...	MUMBAI: The city recorded as many as five "ext...	mumbai the city recorded as many as five extre...	0.020143	0.472907
03/21/2021	2021	Mumbai	English	Mumbai Mirror	Maharashtra: Warmer conditions, extreme weathe...	While farmers from Maharashtra continue to fac...	while farmers from maharashtra continue to fac...	0.048423	0.604955
05/05/2018	2018	Mumbai	Marathi	Maharashtra Times	हवामानबदल आणि तापमानवाढ	गेल्या अनेक वर्षांपासून आपण वाढते तापमान अनुभव...	for the past several years we have been experi...	0.048873	0.393284
05/01/2023	2023	Hyderabad	English	Deccan Cronicles	Experts blame climate change for intense rains...	HYDERABAD: The unseasonal downpours and hailst...	hyderabad the unseasonal downpours and hailsto...	0.058763	0.471358
10/19/2021	2021	Hyderabad	English	The news Minute	Climate change is here, and increasing microbu...	Written by :Rajeswari Parasa\nPublished on : \.	written by rajeswari parasa published on 19 oc...	0.086796	0.441270
08/11/2021	2021	Hyderabad	English	Times of India	EPTRI to release mandal-level projections for...	HYDERABAD: Telangana State Climate Change Cent...	hyderabad telangana state climate change centr...	0.041667	0.143627

Figure1: Dataset

The articles published in other languages like Marathi, Telugu and Tamil were translated to the English language using google translator. The text data was then preprocessed by converting all letters to lowercase, removing punctuation and any extraneous whitespaces. This formatted data was input for subsequent sentiment analysis.

We utilized TextBlob's pretrained sentiment analysis tool to obtain polarity and subjectivity scores for each article on a scale of -1 (most negative) to +1 (most positive). The distribution of sentiment scores was statistically compared across the three cities using box plots.

We used the “zero-shot-classification” pipeline classifier to look into two sentiment groups: negative, positive, and neutral; angry, fear, happy, sad. We also performed Sentiment analysis with labels like surprise; optimism, injustice and disgust; cause, impact, mitigation and adaptation to understand intent and aspects, in these articles. To understand the awareness levels and ideologies of citizens of the three cities we introduced additional labels including 'Informed,' 'Uninformed,' 'Misinformed' for awareness levels, and 'Liberal Views,' 'Conservative Views,' 'Moderate Views' for ideologies.

The emotion scores for the different sentiment categories were created for the articles in Hyderabad, Chennai, and Mumbai. The scores were then combined, and the Kruskal-Wallis H-test, a nonparametric statistical test, was used to see if there were any notable variations between the cities.

Outcomes

According to Figure 1, Mumbai has a median polarity score, whereas Hyderabad and Chennai have the lowest median polarity scores. This implies that Mumbai has a more split public attitude on climate change than Hyderabad or Chennai. The three cities with the highest median subjectivity scores are Mumbai (0.50), Hyderabad (0.55), and

Chennai (0.60). This implies that, in contrast to Hyderabad and Mumbai, where it is more fact-based, media coverage of climate change in Chennai is more opinion-based.

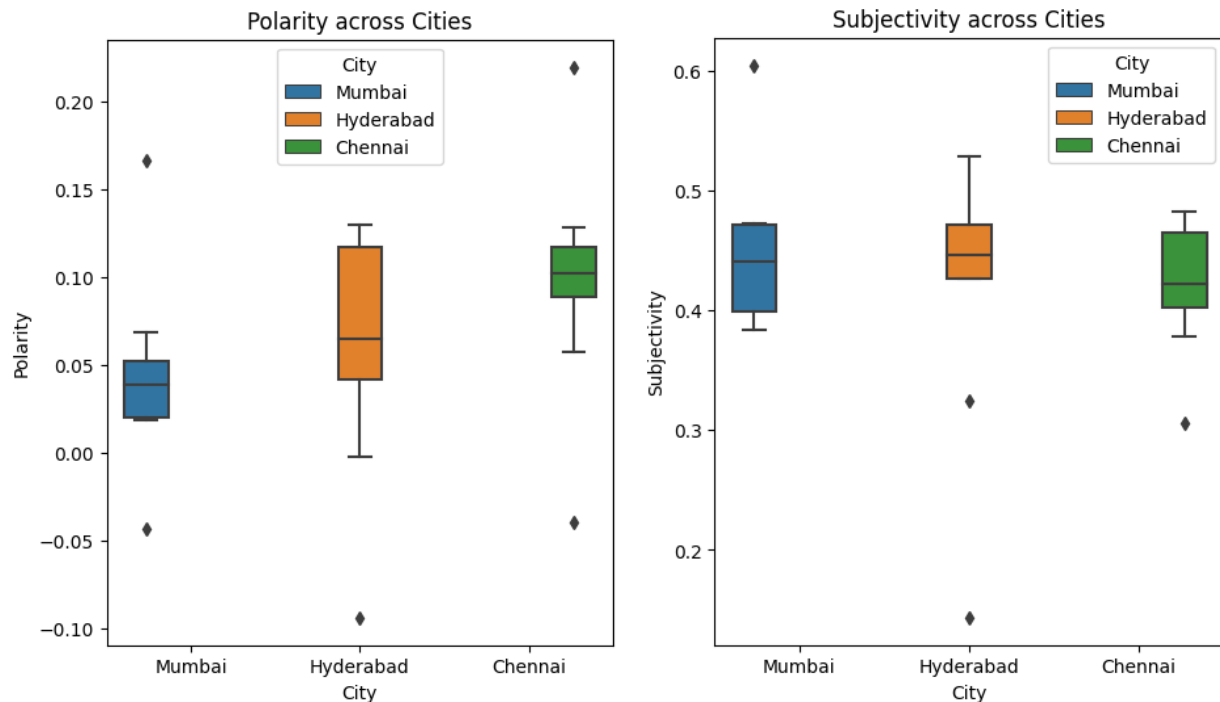


Figure 2: *Subjectivity and Polarity across Three Cities*

Diving into specific sentiment categories, the initial labels indicated an overall positive approach from all three cities, with Chennai being the most positive, followed by Mumbai and then Hyderabad. Hyderabad displayed a higher level of negative sentiments compared to the other two cities.

Further analysis of emotions with labels like anger, fear, happiness, sadness and surprise revealed that anger was the dominant emotion across all cities, with a close score. Fear followed, succeeded by happiness, sadness and surprise. Mumbai consistently led in all three emotions, with Hyderabad and Chennai closely trailing.

Obviously, 'surprise' was the least expressed emotion as climate change is not any more new to India.

When looking at the intent expressed in the articles, we analyzed whether the overall tone was optimistic, conveyed a sense of disgust, or highlighted a perception of injustice. The results unveiled that Chennai's articles tended to be slightly more optimistic in nature compared to Mumbai and Hyderabad. In other words, Chennai showcased a greater sense of hope in addressing climate change-related issues. On the other hand, when it came to perceptions of injustice, Hyderabad took the lead, indicating that articles from this city often expressed a stronger sense of unfairness in the context of climate change. Chennai displayed a somewhat lower emphasis on perceptions of injustice but scored highest to show disgust.

Moving on to discussions about the reasons behind climate change and actions to be taken, labels such as cause, mitigation, impact, and adaptation were considered. Results indicated that all cities addressed causes, impacts, and mitigation, with variations in emphasis. Notably, Chennai stood out as the only city that extensively discussed adaptation strategies.

In Figure 2 four graphs suggest that public opinions about climate change in Chennai are more positive, optimistic, and solution-focused than media coverage in Mumbai and Hyderabad. This may reflect the different levels of climate risk and vulnerability in these cities.

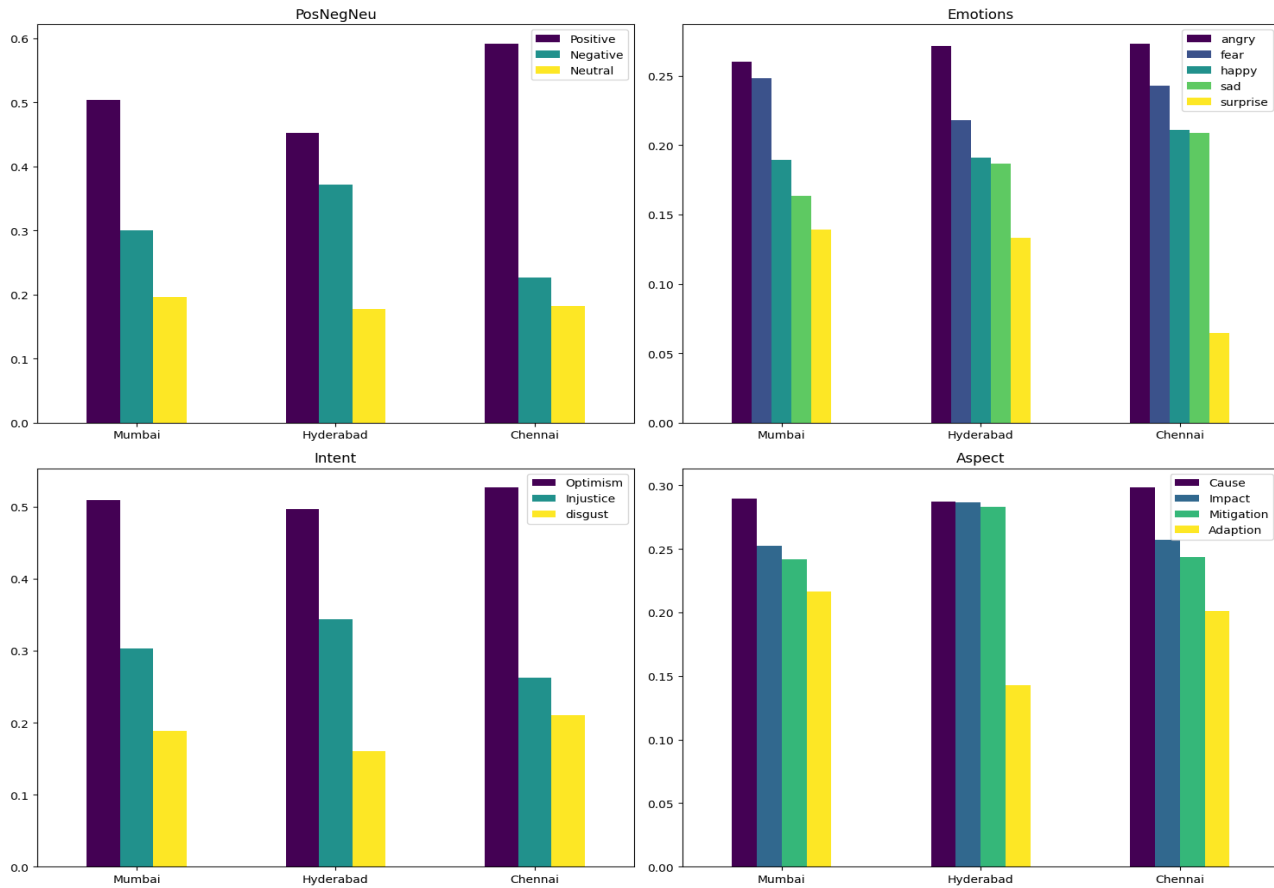


Figure 2: *Sentiments across Three Cities*

Figure 3 is a graph of the expression of ideology and awareness in the article sentiment across cities. Results showed some variation in ideological leanings, with Mumbai showing a slight tendency towards more liberal ideologies, Hyderabad expressing a mix of moderate and conservative ideologies, and Chennai falling in between. In terms of climate change awareness, Mumbai edged out the other cities, potentially indicating greater engagement with and consciousness of climate issues. However, awareness levels were moderately high across all three cities.

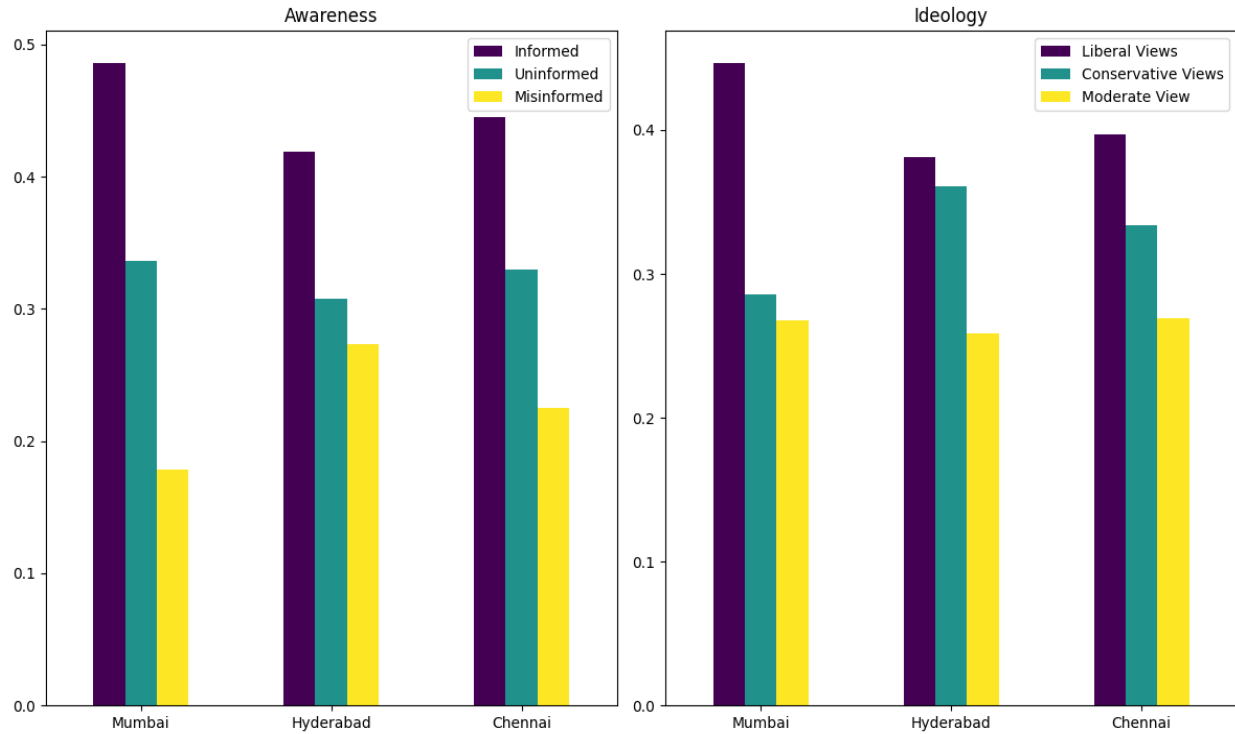


Figure 3: *Awareness and Ideology across Three Cities*

At the end of the project we performed a non parametric test called Kruskal-Wallis H test that revealed no significant differences between the groups (p-value = 0.9979).

Conclusion:

Based on the graphs we can conclude that Chennai had the most optimistic approach to addressing climate-related issues. Hyderabad, on the other hand, displayed more negative emotions, such as grief and rage. Mumbai was the city with the most fear about the consequences in the future. Everywhere there was anger, there was a sense of dissatisfaction with the authority.

Mumbai inhabitants appeared to be the most knowledgeable and concerned about climate change beliefs. However, Chennai stood out for giving special attention to anticipating and adjusting to the effects of climate change.

In conclusion, while this exploratory sentiment analysis revealed noticeable variation between Mumbai, Chennai and Hyderabad in dominant emotions expressed and climate change awareness, the nonparametric Kruskal-Wallis Test determined these differences were not statistically significant at the current sample size. With a high p-value of 0.958, observed variability appears to be chance relative to similarities in overall climate opinions between urban populations.

This suggests that the observed variations in polarity, subjectivity, ideology, and awareness between the three cities likely occurred by chance. While Mumbai displayed some trends of more positive, opinion-based, and ideologically charged climate change articles, these differences were not statistically significant. Further research with larger sample sizes or focusing on specific aspects might be necessary to identify potential nuanced differences in climate change perceptions across the cities.

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