

Understanding climate-related visual storytelling on TikTok

A cross-national multimodal analysis

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Abstract

This cross-cultural study investigates the prevalence and impact of climate-related campaigns on TikTok, with a specific focus on climate-related visual storytelling in Indonesia, Japan, Pakistan, the Philippines, Thailand, the United Kingdom, and the United States. Computational methods are employed in the study to analyse a dataset of 7,564 videos, providing insights into prominent visual characteristics and regional variations. The findings underline the significance of cultural and political contexts in shaping climate storytelling on TikTok. Furthermore, this research explores the potential of computational visual data analysis in studying climate communication, demonstrating the integration of computer vision and topic modelling to examine visual styles and communicative functions in TikTok's climate storytelling. The study enhances our understanding of climate communication on digital platforms and emphasizes the value of leveraging computational methods to gain meaningful cross-cultural insights into visual storytelling in the context of climate change.

Keywords: climate change; visual storytelling; TikTok; computer vision

1. Introduction

The proliferation of visually rich social media platforms has heralded the advent of the visual turn in digital communication, where imagery-based media texts, such as emojis, memes, and selfies, have gained increasing prominence as essential elements of communication. In recent years, the phenomenon of short videos has surfaced as the latest manifestation within our visually driven digital landscape, with the rapid rise of TikTok serving as a notable illustration. With more than one billion monthly active users worldwide (TikTok, 2021), TikTok is rapidly establishing itself as a crucial platform for fostering collective action (Hautea et al., 2021; Kaye et al., 2022), delivering news (Newman et al., 2023), and disseminating educational content (Cervi & Divon, 2023; Zeng, 2023). The growing socio-political significance of TikTok necessitates further academic research into the communications taking place on the platform.

To contribute to the emerging scholarship on TikTok, this study investigates visual storytelling relating to climate change on the platform. As informed by previous research, TikTok's unique technological affordances and user culture engender highly distinctive multimodal storytelling styles (Kaye et al., 2022;

Zulli & Zulli, 2020). To examine how such characteristics shape climate-related communication, this paper focuses on visual storytelling via a multimodal approach.

Climate-related content on TikTok has achieved significant prominence and influence internationally, partially due to the platform's official endorsement of climate initiatives (Kaye et al., 2022). However, prior investigations into climate-related content on TikTok have predominantly focused on English-speaking countries (Basch, 2022; Hautea et al., 2021; Zeng & Abidin, 2021). To gain a more comprehensive perspective beyond these regions, this study adopts a cross-cultural perspective and compares climate-related TikTok videos across seven countries: Indonesia, Japan, Pakistan, the Philippines, Thailand, the United Kingdom (UK), and the United States (US). These regions exhibit varying levels of vulnerability to the repercussions of climate change, as defined by the Climate Risk Index (Eckstein et al., 2020), as well as varying levels of responsibility for action under the Kyoto Protocol (UNFCCC, 1997).

To systematically compare the climate-related visual storytelling across the aforementioned seven regions, the study relies upon a multimodal computational analysis approach to examine 7,564 videos. This analysis involves BERT-model-based topic clustering and computer vision techniques. Methodologically, the analytical approach proposed in the study showcases how visual storytelling can be systematically operationalized and automatically evaluated in the realm of climate communication while contributing to the fast-growing field of computational short video analysis. Theoretically, the findings derived from the cross-country comparison contribute to advancing a contextualized understanding of climate communication.

2. Literature review

2.1 Visual storytelling about climate change

Visual storytelling has been practised throughout human history and plays an important role in preserving shared memories, generating knowledge, and constructing identities (McIver, 2016; Yılmaz & Cığerci, 2019). Visual storytelling, as a research subject, is an encompassing and broad concept that has become a fast-growing subgenre of visual studies (Pimenta & Poovaiah, 2010). In this study situated in media and communication studies, visual storytelling is defined as the practice of using visual elements to convey narratives, information, and knowledge. Visual elements refer to presented components that can be sensed with the human eye, which could include both visual narrative elements (e.g. characters, place) and visual cues (e.g. colour, effects, and captions) (Goodnow, 2020). As our definition of visual storytelling implies, visual elements have both aesthetic and communicative functions.

The usage of visual elements and their associated effects vary depending on the intended narrative. On topics related to environmental issues, prior research highlights the significance of visual elements in media storytelling. For example, O'Neill's (2013, 2020) pioneering work on the visual framing of climate change unveils people as a prominent element in the visual coverage of climate change in newspapers. Additionally, her cross-national analysis reveals specific landscapes and wildlife as iconic representations of climate imagery (ibid). Research also shows that visual elements function as effective communication devices for increasing public awareness and inspiring behavioural change regarding environmental issues (Doyle, 2007; Wang et al., 2018).

The choice of medium significantly influences the approach and impacts of visual storytelling. While research on the visual dimensions of climate communication has generated increased scholarly interest, most of these studies examine news media, with a focus on traditional print platforms and their online counterparts (Schäfer, 2020). Prior research shows that the news media's visual depictions of climate change exhibit certain commonalities across diverse cultural contexts. Notably, imagery of the impacts of climate change, such as the retreat of glaciers and the occurrence of natural catastrophes, along with the inclusion of prominent figures, is prevalent in climate change news across countries (O'Neill, 2020; O'Neill & Smith, 2014).

In recent years, the trend has been for climate communication to increasingly gravitate towards social media, where users actively create, share, and engage in discussions about climate change (Mooseder et al., 2023). As social media becomes increasingly central to discussions about climate change, it is important to understand the role of visual storytelling on these platforms. However, existing research on the visual aspects of climate-related communication on social media predominantly focuses on Twitter, with limited exploration of visually rich platforms (Pearce et al., 2019). Recent studies on climate-related visuals reveal that while memes, motivational quotes, and screenshots are prevalent on social media, the most engaging content typically features protests, people, and storytelling elements (León et al., 2022; Mooseder et al., 2023). In the literature, visual content is often found to be a key tool used by climate activist groups on social media to garner support and organize collective action (Askanius & Uldam, 2011; Molder et al., 2022).

The use of visuals can differ widely across social media platforms (Wang et al., 2018). On video streaming platforms, visual elements related to climate change often prioritize humour and emotional resonance, with scientifically reliable depictions taking a secondary role to more relatable content (Allgaier, 2019; Hautea et al., 2021). In the section below, we will discuss the particularity of TikTok for communication about climate change.

2.2 TikTok for climate

In recent years, TikTok has emerged as a significant platform for youth engagement in climate change discourse. TikTok's collaborations with international Non-Governmental Organizations (NGOs) since 2019 have led to numerous global initiatives, including the #ForClimate campaign, which received hundreds of millions of views (Kaye et al., 2022). Such official endorsement has catalysed a diverse array of climate-related videos on the platform, ranging from humorous memes to serious lectures and from acting sketches to lip-syncs, fostering creative and engaging advocacy for climate action (Basch et al., 2022; Hautea et al., 2021; Zeng & Abidin, 2021).

However, climate activism on TikTok is motivated by diverse and even conflicting interests. As Hautea et al. (2021) put it, "climate-related expressions on TikTok take place in a complex social media ecosystem in which earnest activists compete with mocking satirists, playful attention-seekers, and bored time-killers for visibility and clout" (p. 2). Scholars have raised concerns about potentially misleading information and the under-representation of scientific evidence and credible sources in TikTok's climate-related content (Basch et al., 2022), echoing similar issues previously noted about climate-related videos on YouTube (Allgaier, 2019).

The communicative features and platform affordances of TikTok shape the storytelling about climate change. The platform offers a wide range of features to facilitate both sociality and creativity (Kaye et al., 2022; Zulli & Zulli, 2020). For instance, challenges, duets, and stitches, as well as reusable visual effects and soundtracks, enhance the "templatability" (Abidin 2021, p. 80) of TikTok videos, which allow others to easily react, imitate, and remix. Moreover, despite their compact size, TikTok videos incorporate a rich blend of textual, visual, and aural elements. The creation and editing process on TikTok often involves using special effects, filters, text stickers, and captions.

Previous content analyses of TikTok videos addressing climate change and science also indicate that the platform's affordances enable a wide range of engaging and multimodal communication by climate activists and scientists (Hautea et al., 2021; Zeng et al., 2021). TikTokers utilize features like green-screen and auto-captioning to incorporate text and audio elements on the screen, facilitating educational exchanges (Cervi & Divon, 2023; Kaye et al., 2022). This multimodality not only enables the delivery of impactful climate-related messages but also presents unique research opportunities, which will be elaborated upon in the following section.

2.3 Computational analysis of TikTok

Although TikTok scholarship is expanding rapidly, methodologies for researching short videos and related user practices remain in the early stages of development. As mentioned above, the centrality of

sound, visual vernacular, textual elements, and rich expression through choreography make TikTok videos powerful communication devices. However, doing a multimodal analysis of TikTok can be challenging. TikTok videos are multimodal but also highly intertextual, which makes it difficult to understand certain visual vernacular or to discern the creator's intent (Hautea et al., 2022). While acknowledging the importance of a qualitative in-depth reading and insights about the platform culture in studying TikTok videos, the rich modality of TikTok videos presents new opportunities for automated analysis using computational approaches (Lu & Pan, 2022; Jiang, Jin, & Deng, 2022).

Firstly, the bit-sized short videos make it computationally more affordable for researchers to conduct automated analyses, in comparison to long-format videos, such as YouTube videos. Moreover, like on other social media platforms, TikTok videos come with rich metadata that offer insights into the content's impacts (with engagement metrics), authorship (e.g. user profile information), and content characteristics (e.g. video captions and sound information). It is worth mentioning that the platform's recent launch of Research API can greatly improve the accessibility of structured platform data (TikTok, 2023).

Moreover, the rapid advancement of computer vision provides a comprehensive toolkit for retrieving and analysing visual data from large volumes of video data. Some of the most commonly used computer vision techniques include object detection, image classification, pattern recognition, and facial recognition, all of which are highly relevant in analysing multimodal content on TikTok. The multimodal computational analysis of TikTok content, though a niche field, is increasingly attracting the attention of media and communication scholars. Of the handful of publications about TikTok employing computational methods, several recent studies (e.g. Jiang et al., 2022; Lu & Pan, 2022; Lu & Shen, 2022) conduct feature extraction through computer vision. Surabhi et al. (2022) detect sentiment in TikTok videos through facial expression analysis. In other examples, scholars classify and identify potentially harmful content on TikTok by studying social networks and multimodal content features (Bonifazi et al., 2022; Qi et al., 2022). These pioneering examples demonstrate the potential and operationalization of multimodal computational studies on TikTok.

2.4 Research gap & research questions

There are several gaps in the related scholarship that this study aims to address. First, prior studies investigating communication about climate change on social media have predominantly utilized text-based analysis, overlooking the multimedia nature of digital communication (Pearce et al., 2019). The few studies that have examined climate-related visuals on social media have relied on manual approaches, such as discourse analysis and qualitative or quantitative content analysis, with relatively small sample sizes (e.g. Allgaier, 2019; Basch et al., 2022; Molder et al., 2022). Additionally, previous qualitative visual analyses of climate-related content have often employed purposive sampling, focusing on well-known individuals or groups, like Greenpeace and Greta Thunberg (e.g. Molder et al., 2022; Pramana et al., 2021), or prominent events, such as COP summits (e.g. Askanius & Uldam, 2011). The in-depth qualitative insights generated by these studies are valuable and could be enhanced by research employing novel computational research methods. As discussed above, advances in computational visual analysis, such as computer vision, allow researchers to experiment and develop new approaches to systematically analyse large volumes of visually rich climate-related content. Exploring the implementation of these methods to produce significant findings can greatly contribute to the advancement of visual storytelling scholarship, particularly in the context of climate change.

Furthermore, in the field of visual climate communication and climate communication more broadly, there is a notable under-representation of studies that include cross-cultural comparative perspectives. Although climate change is a global issue, the prevailing body of research on this subject concentrates on the Global North (Blicharska et al., 2017; Schäfer & Schlichting, 2014), while regions in underdeveloped areas with higher susceptibility to climate change often receive insufficient attention in the academic literature (Althor et al., 2016). The varying levels of vulnerability to climate change influence how the issue is communicated and covered in different regions. For instance, Schäfer and Painter (2020) argue that substantial disparities in climate-related news coverage exist between the Global North and South.

Countries in the Global North tend to cover more climate politics and science, while the climate-related coverage in Global South countries tends to focus on challenges and societal implications (Grundmann & Scott, 2014; Hase et al., 2021; Schmidt et al., 2013; Vu et al., 2019). Such disparities and complexities need to be better incorporated into research on visual storytelling about climate change, which is dominated by English-speaking countries (O'Neill, 2020; Wozniak et al., 2015) or platforms that are popular within English-speaking countries (Pearce et al., 2019; Wang et al., 2018).

To address these gaps, this study employs a multimodal design to investigate the visual and textual communication about climate change on TikTok using computer vision algorithms and topic modelling. We use data from seven countries representing both the Global North and South, characterized by varying levels of responsibility for and vulnerability to climate change (Eckstein et al., 2020; UNFCCC, 1997). In this study focused specifically on the visual aspect of TikTok videos, we address the following research questions:

RQ1. What are the key characteristics of climate-related visual storytelling on TikTok?

The study operationalizes this concept by examining two dimensions: visual style, which refers to the aesthetic characteristics determined by primary visual elements, and communicative functions, which pertain to the explicit purpose or goal of the conveyed messages. In line with this operationalization, RQ1 encompasses two sub-research questions:

RQ1a. What are the key characteristics of the visual styles in these videos?

RQ1b. What are the key characteristics of the communicative functions in these videos?

The study's second objective involves comparing cross-cultural differences in climate-related visual storytelling on TikTok by addressing the following question:

RQ2. How does the climate-related visual storytelling on TikTok differ across countries?

3. Methods

3.1 Data collection

The data collection was based on a list of hashtags¹, curated through a combination of deductive and inductive approaches. Deductively, we consulted prior research, including content analyses and experimental studies examining the prevalence or consequences of climate change labels (e.g. climate change, climate crisis), to create a list of terms used frequently to characterize the issue (Grundmann & Scott, 2014; Jaskulsky & Besel, 2013; Schäfer & Schlichting, 2014; Song et al., 2021). Based on these studies, we identified several hashtags, including “climate change”, “global warming”, “climate crisis”, “climate emergency”, and “global heating”. Since the majority of extant research has been conducted in a news media context, and there may be a more diverse discussion about climate change on social media (Segeberg & Bennett, 2011), we relied on a snowball approach to gather social media hashtags inductively. We began with hashtags obtained from the literature as search terms and gathered co-occurring climate-related hashtags under the top search results returned by TikTok. We excluded hashtags that appeared in fewer than 1,000 posts. Furthermore, we added six non-English hashtags to obtain extra Japanese, Thai, and Indonesian content to ensure at least 200 videos per sampled country². Subsequently, we manually read through all hashtags and excluded those that were either too general (e.g. #environment, #climate) or did not directly reflect climate change (e.g. #deforestation, #plasticfree). To validate the selection of hashtags, two coders manually annotated the relevance³ of 800 randomly sampled videos (50 videos per hashtag). After excluding videos that could not be accessed or annotated, 81.30% of the videos

¹ #climatechange, #globalwarming, #greenhouseeffect, #climateaction, #climatechangeawareness, #climatecrisis, #climateemergency, #climatejustice, #climateactivism, #climatechangeisreal, #氣候變動, #温暖化, #地球温暖化, #ภาวะโลกร้อน, #perubahaniklim, #pemanasanglobal

² Information about the country is included as part of the metadata accompanying each video.

³ Two coders coded the videos manually as 0 (not relevant to climate change), 1 (relevant to climate change), 2 (video is not accessible or video is in a foreign language and cannot be understood by watching and translating its description and caption texts) ($\alpha = .76$).

($n = 690$) were found to be relevant to climate change⁴. Therefore, using any of the selected hashtags appearing at least once in the video description as a criterion, we could conclude that the majority of videos in the dataset were related to climate change.

The data collection took place in April 2023. Using Python 3.10 programming language and the Python libraries Beautiful Soup (Richardson, 2007) and Selenium (version 4.16.0), we followed the procedure outlined in Figure 1 to collect video metadata and extract video URLs. From each TikTok hashtag webpage, we extracted all featured video URLs after parsing the HTML content. To account for videos that may include multiple climate change-related hashtags and appear on multiple hashtag pages, we identified and removed duplicate entries. This process resulted in a total of 10,068 unique video links. Next, we visited individual video pages and scraped metadata related to the study, including essential information, such as video ID, publication timestamp, and engagement metrics (e.g. likes, shares, comments, and views). Additionally, the metadata included details regarding the creator's user ID and country. After filtering out videos originating from outside the seven targeted countries, we were left with 7,564 entries. These videos were then downloaded for further analysis. The publication dates of the collected videos ranged from 16 September 2018, to 4 April 2023. Table 1 provides an overview of the videos included in the dataset.

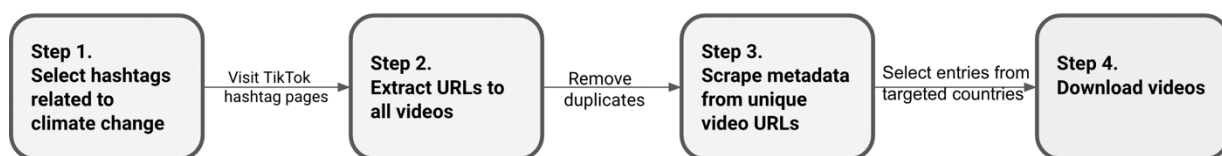


Figure 1. Data collection steps

Table 1. Overview of videos from each country⁵

Country	Video count ⁶	Duration (mean)	Like (mean)	Share (mean)	Comment (mean)	Play (mean)
US	3,097	42	84,998	2,536	1,183	726,426
ID	1,575	43	7,976	249	176	72,041
UK	937	43	75,675	1,971	1,180	591,522
JP	883	58	4,450	45	52	73,161
TH	548	66	8,225	183	75	114,989
PH	294	59	73,583	2,840	1,067	428,705
PK	194 ⁷	39	39,555	1,039	371	523,726

3.2 Data Analysis

As defined in Section 2, visual storytelling is the practice of using visual elements to convey narratives, information, and knowledge. We have noted that the visual elements used in storytelling have both aesthetic and communicative functions. In line with this, the study analytically operationalizes the concept of visual storytelling by examining two dimensions: visual style, which refers to the aesthetic characteristics determined by primary visual elements, and communicative functions, which pertain to the explicit purpose or goal of the conveyed messages.

⁴ This result aligns with the benchmark used in search term validation studies (Mahl et al., 2022).

⁵ Country codes are used in figures and tables in the paper. US: the United States, ID: Indonesia; UK: the United Kingdoms; JP: Japan, TH: Thailand, PH: the Philippines, PK: Pakistan.

⁶ The total number here is smaller than the total number of videos collected, 7,564, because a few videos could not be downloaded for video processing but remained in the dataset for other metadata-based analyses.

⁷ Although at least 200 videos were collected for each country, some videos could not be downloaded for visual processing.

3.2.1 Visual style

Visual style is fundamentally anchored in its employment of visual elements. To systematically identify visual elements within climate-related content on TikTok, we adopted an inductive approach in this study. Building upon prior research into visual elements in climate communication (O'Neill, 2013, 2020; Pearce & De Gaetano, 2021) and the pedagogical utility of TikTok videos (Cervi & Divon, 2023; Kaye et al., 2022; Zeng et al., 2021), our analytical framework focuses on three principal visual elements: human figures, natural settings, and textual representations.

To extract the aforementioned three elements from TikTok videos, we utilized Google Vision API, a cloud-based service offering pre-trained models for visual analysis. We extracted five frames from each video⁸, which served as input for the computer vision analysis. Frame extraction was done using the Python package OpenCV (Version 4.7.0) (Bradski, 2000). Three algorithms from Vision API were employed: object detection, face recognition, and text extraction (Figure 2). The object detection algorithm provides labels with probability scores, indicating objects that are identifiable by the machine. For this study, object labels with a probability score below 0.9 were excluded from the analysis. The face detection algorithm detects the presence of faces in each frame and assigns emotion scores, while the text extraction algorithm identifies and extracts all text appearing in each frame, facilitating subsequent topic modelling.

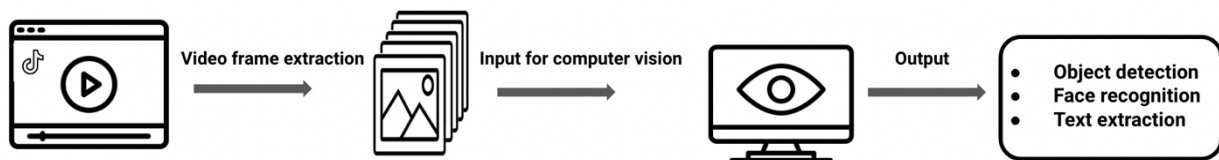


Figure 2. Main steps for computer vision analysis

With the output obtained from Google Vision API, the videos were classified into four distinct visual styles: person-dominated, nature-dominated, text-dominated, and mixed. Person-dominated videos are characterized by the prominence of a face, as determined by the face's frequency of appearance (detected in at least three out of five frames) and its significance (where face-related labels account for more than half the extracted object labels). Nature-dominated videos are identified when nature-related objects constitute more than half the list of object labels associated with each video. The operationalization of these two visual styles is contingent upon the performance of Vision API. We validated the automatically assigned visual labels using a sample of 200 videos, each of which was also manually labelled by a trained coder. Both visual frames achieved a high F1 score exceeding 0.85. Further details of the validation results can be found in Appendix A of this report.

Text-dominated videos are those that do not fall under the person-dominated or nature-dominated categories. Instead, they are characterized by the presence of over 1,320 characters detected from the video frames. To ensure comparable text lengths, all detected in-video texts were translated into English. The threshold of 1,320 characters represents the 75th percentile of the value distribution. Lastly, the mixed category encompasses videos that do not fit into any of the aforementioned categories.

3.2.2 Communicative function

To contextualize the visual elements associated with climate change, we used insights from topic modelling to assign communicative functions to each video. Topic modelling was carried out using BERTopic (Grootendorst, 2022), with two types of text data: video descriptions collected as part of the video metadata and the texts detected by Google Vision from each frame. BERTopic was chosen for this study due to its proven performance and compatibility with social media data. BERTopic represents a

⁸ By calculating the video's total duration and dividing it into five equal segments, we determined the specific time points at which each frame should be extracted.

state-of-the-art technique for extracting topics from texts using transformer-based language models, and it has been found to yield better results compared to conventional topic modelling techniques, like latent Dirichlet allocation (LDA) and non-negative matrix factorization (NMF), in many contexts, including social media (Abuzayed & Al-Khalifa, 2021; Egger & Yu, 2022; Grootendorst, 2022). In addition, the language model BERTweet (Nguyen et al., 2020) is used to generate document embedding as it is trained with tweets and is, therefore, competent at understanding short social media texts.

To prepare the data for topic modelling, all texts were first translated into English using Google translation, an approach that has been demonstrated to produce reliable outcomes when used to translate climate change content (Reber, 2019). The translated English texts were then prepared following the suggestions from Nguyen et al. (2020) to improve the performance of BERTweet. We removed URLs and usernames, converted emojis to text, and retained stop words, because full contexts are important for transformer-based embedding models (Grootendorst, 2022). Considering the scale of our dataset and to get topics of a substantive size for subsequent analyses, we set the minimum topic size to 10, meaning that the generated topic must be present in at least 10 videos. For this study, half the videos ($n = 4,681$) were deemed outliers as they contained more niche topics (topics present in fewer than 10 videos) in the first topic model. To reduce the number of outliers, the outliers were clustered to adjacent topics with a cosine similarity higher than 0.2⁹. The final BERTopic model identified 89 topics across 5,099 videos, which were used for further interpretation and analysis.

The goal of topic modelling was to assign the communicative functions of videos. Based on a hierarchical clustering analysis (see Appendix B), we first grouped the initial 89 topics into bigger clusters and then compared them to content typologies identified in prior searches of climate change in media (Hase et al., 2021; Hautea et al., 2021; León et al., 2022; O'Neill, 2017). Eventually, seven categories related to different communicative functions were developed: (1) calling for action, (2) explaining the causes of climate change, (3) warning about the consequences of climate change, (4) offering solutions, (5) raising awareness of wider environmental issues, (6) commenting on climate-related politics, and (7) campaign hijacking. A more detailed explanation of these categories is presented in Section 4.2.

A major challenge of the topic modelling approach lies in ensuring the validity or accuracy of the identified topics (Arceneaux, Albishri, & Kioussis, 2022; Brookes & McEnery, 2019; Maier et al., 2018). A common validation method for topic modelling results involves manually inspecting the topics' quality, which we did in this study during topic modelling and the process of identifying communicative functions. We adopted a widely utilized manual evaluation approach suggested by Chang et al. (2009) to ensure the interpretability and coherence of the communicative function categories. A list of the top 10 terms for each category was created, and a random term from another category with a high probability score was inserted into the list. Two students with no prior knowledge of the categories were asked to identify the false intruder. The manual review determined that all seven categories (100%) were cohesive.

4. Findings

4.1 Visual style

Person-dominated: Videos dominated by people form the largest group, accounting for more than a third of all videos in the dataset (35.2%). Such videos typically showcase an individual, often a TikToker, in a close-up shot in front of the camera, singing, dancing, acting, or addressing the audience directly. As illustrated in Figure 3, alongside their own presence, TikTokers frequently employ various effects, like green-screen backgrounds or text stickers, to enhance their video's visual complexity.

⁹ We identified 0.2 as the inflection point of this dataset. Cosine similarity values below 0.2 greatly reduced the number of outliers but also introduced a lot of noise into the results; therefore, we choose 0.2 to maintain a balance of outliers and noise.

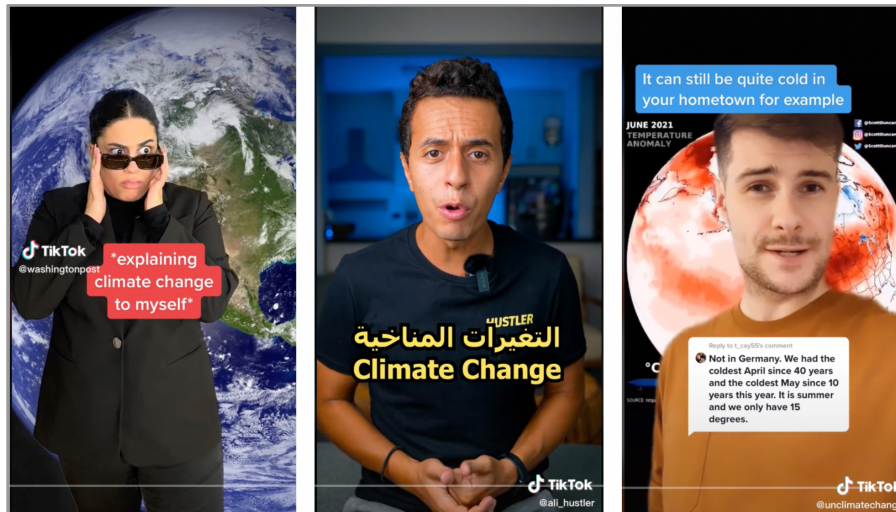


Figure 3. Examples of the people-dominated visual style¹⁰

Nature-dominated: Around 20% of the analysed videos showcase a significant proportion of nature-centric visuals, including landscapes, wildlife, and vegetation. Figure 4 illustrates how, in the context of communication about climate change, videos from this nature-dominated category often depict species most impacted by environmental degradation and scenes from polar regions. A general depiction of the beauty of Mother Nature is another commonly occurring way of using nature as a subject in the videos.

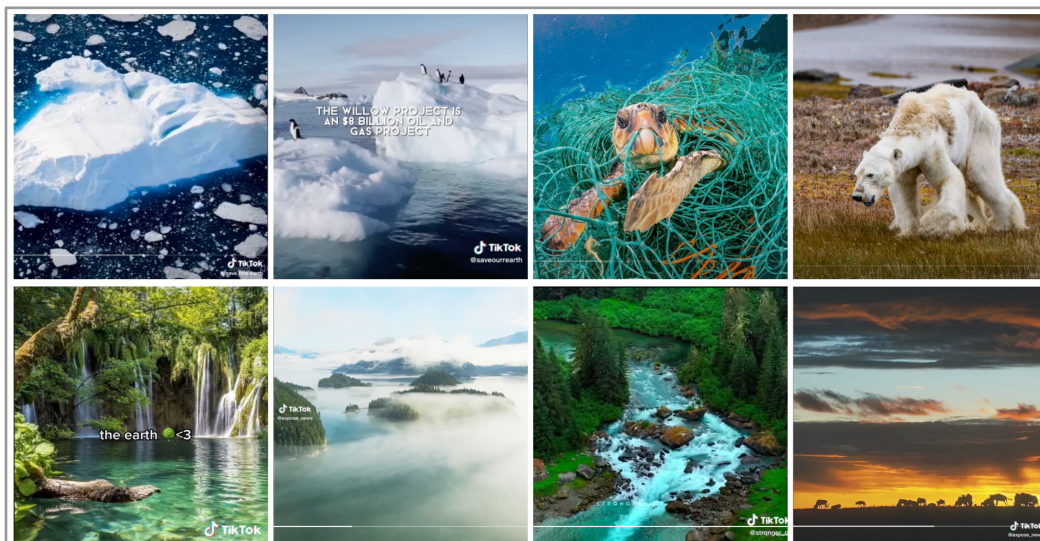


Figure 4. Examples of the nature-dominated visual style

Text-dominated: The text-dominated category represents only 12.9% of the dataset. Although the platform is primarily visual-centric, text content can be seamlessly incorporated into videos through various means. For instance, content creators can utilize the green screen function to directly display screenshots of news articles as the video background. Additionally, features such as text stickers and subtitles enable users to enhance their visual presentations with textual elements. Examples presented in Figure 5 illustrate that this visual style is typically associated with educational infographics or personal text-based narration by content creators.

¹⁰ For privacy concerns, examples showing people’s faces are from verified accounts of either professional content creators or public institutions.

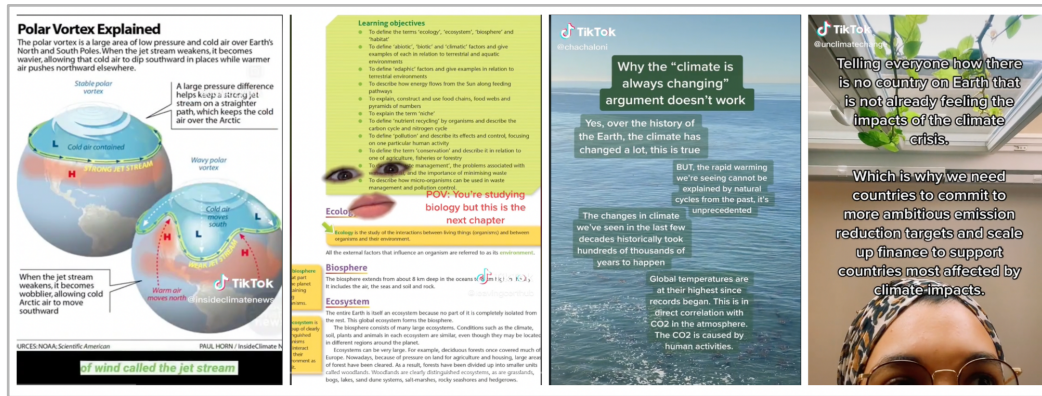


Figure 5. Examples of the text-dominated visual style

Mixed: Videos classified as “Mixed” account for a substantial portion of the dataset, comprising approximately a third of the total (32.2%). This category is characterized by a balanced distribution of diverse visual elements, often incorporating elements from different genres. Notably, news or TV programme clips are frequently observed within this category, showcasing its versatility in capturing different forms of content.

4.2 Communicative function

With insights from the topic modelling, we could identify seven groups of climate-related communicative functions from the data: calling for action (32.1%), explaining the causes of climate change (4.8%), warning about the consequences of climate change (17.1%), offering solutions (5.8%), raising awareness of wider environmental issues (16.7%), commenting on climate-related politics (12.6%), and campaign hijacking (10.8%).

Around a third of the videos in the dataset demonstrate the function of “calling for action”. A significant proportion of videos within this category mobilize support for climate activism, focusing on protesting against specific sectors, such as the oil industry, or specific projects. A notable recurring example is the Willow Project, which involves drilling for oil on Alaska’s North Slope. Other videos in this category primarily urge viewers to take measures to mitigate climate change. The category “explaining the causes of climate change” comprises 4.8% of the videos, which predominantly adopt an educational approach to discuss the various factors contributing to global warming. Greenhouse gas emissions and their impacts on the environment and temperature are frequently addressed topics within this category. The category “warning about the consequences of climate change” accounts for 17.1% of all videos, the focus of which primarily revolves around the consequences of climate change, such as rising temperatures and the occurrence of natural disasters, like floods and droughts. Another 5.8% of the videos are categorized as “offering solutions”. These primarily emphasize practical measures that individuals and institutions can adopt to combat climate change, rather than solely advocating for action. Examples include promoting the use of solar energy over fossil fuels, reducing the reliance on automobiles, transitioning to electric vehicles, and adopting more sustainable farming practices. The category “raising awareness of wider environmental issues” comprises 16.7% of the videos. These address climate change alongside broader environmental concerns, such as plastic pollution in the oceans and the waste generated by fast fashion brands. In addition, 12.6% of the videos fall into the “climate-related politics” category and delve into the political aspects of climate change. Some of these videos encourage viewers to support politicians who prioritize climate change, advocate for the passage of new climate-related laws, or promote the views of specific politicians through TikTok content created by their followers. Lastly, the category “campaign hijacking” represents 10.8% of the videos, including those that are unrelated to climate or environmental issues but utilize climate-related hashtags to gain greater visibility.

Combining insights from the communicative functions and visual style analysis yields a deeper understanding of the context in which different visual elements are incorporated. As shown in Figure 6,

identifying the most “preferred” visual style associated with communicative functions reveals certain patterns. For instance, regarding videos communicating the severe impacts of climate change, natural elements are most commonly featured. Examples include melting icebergs, starved polar bears, and forests on fire. When mobilizing for protests and actions and commenting on politics, the videos primarily rely on personal storytelling, with individuals at the forefront of the videos.



Figure 6. Heatmap of observations by visual style and communicative functions

4.3 Country differences

Visual style & country: Videos from the seven countries exhibit significant disparities in the use of visual styles ($\chi^2(18, N = 7,564) = 741.7, p < .001$). Figures 7 and 8 illustrate the distribution of visual styles in each country as well as the disparities in their actual play counts. In this instance, taking into account both the number of videos and play counts provides a more comprehensive picture of the prevalence and visibility of different visual styles. As the results show, videos featuring a mixture of visual elements (“Mixed” visual style) are prevalent in all regions, except for the US and Pakistan, where person-dominated video styles account for about half the content (US: 54.2%; Pakistan: 47.9%). In most countries, mixed and person-dominated visual styles garner high viewership, with Indonesia being a notable exception; here, person-dominated videos attract considerably fewer views compared to other styles. Videos showcasing nature are most prevalent in Thailand. A notable observation is the large viewership of text-dominated content in Japan, Indonesia, and Thailand. In these three countries, videos featuring prominent textual visual elements surpass other videos in terms of average viewership. Figure 8 presents logged counts of each visual style across the seven countries.

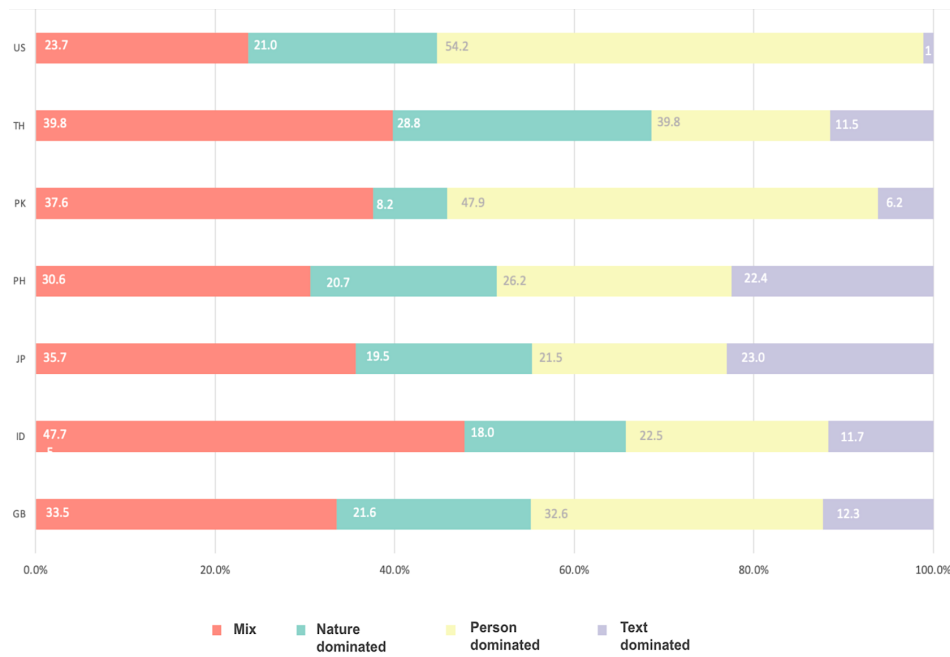


Figure 7. Visual style distribution across the seven countries

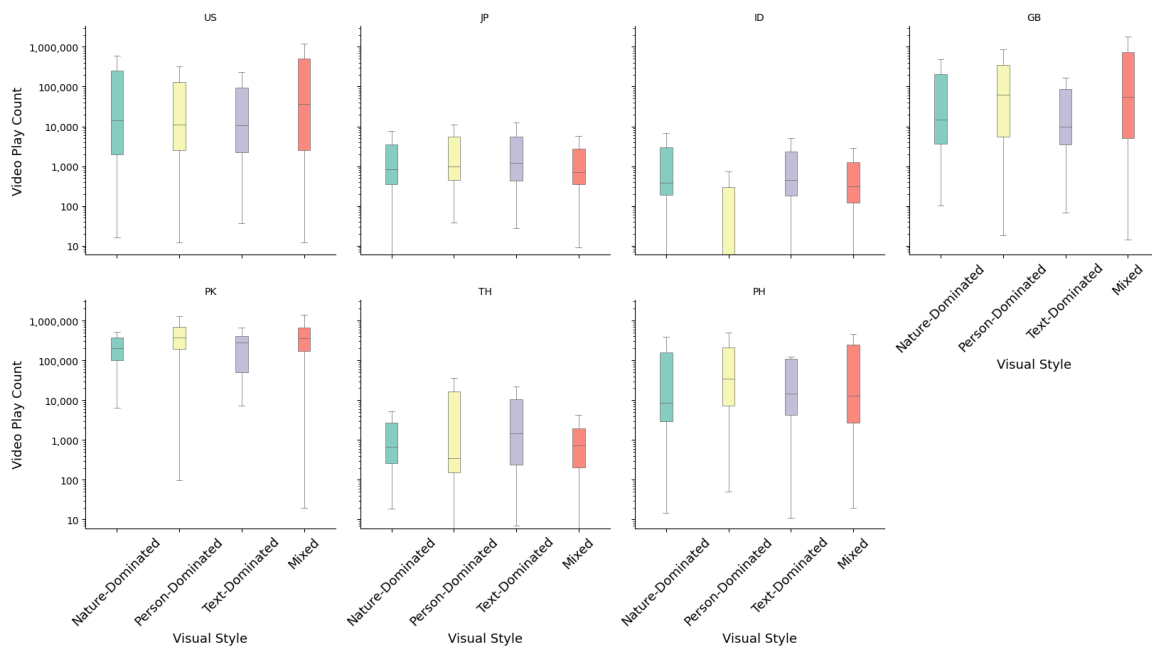


Figure 8. Play distribution by country and visual style (log scale)

Communicative function & country: Videos from different countries exhibit significantly different patterns in the use of communicative functions ($\chi^2(36, n = 5,099) = 1,919.8, p < .001$). As shown in Table 2, when examining individual countries, videos calling for action appear most frequently in the UK, the US, and the Philippines, where they account for 27.5%, 24.2%, and 25.4% of all available videos, respectively. In the UK and the US, these videos frequently rally viewers to take a stand against projects, like the Willow project, and major oil companies. In the Philippines, the focus is primarily on emphasizing the gravity and urgency of climate change to motivate action. Notably, Thailand and Indonesia exhibit a strong emphasis on the impacts of climate change, with a significant proportion of videos (16.3% and

14.8%, respectively) warning about the consequences. Indonesia also stands out with the notable presence of videos addressing climate-related politics, particularly those supporting Arsjad Rasjid, Chairman of the Indonesian Chamber of Commerce and Industry and President Director of Indika Energy. These videos convey that Arsjad Rasjid and Indonesia are prepared to take a leading role in the global fight against climate change. Lastly, Pakistan has the highest percentage (58.6%) of videos classified as “campaign hijacking”, where climate-related hashtags are intentionally used in unrelated videos to enhance their visibility on TikTok.

Table 2. Distribution of communicative functions in each country

	UK	ID	JP	PH	PK	TH	US
<i>Calling for actions & protest</i>	27.5%	3.2%	13.6%	25.4%	2.1%	7.5%	24.2%
<i>Explaining causes</i>	1.8%	4.5%	4.3%	1.4%	0.5%	1.1%	2.5%
<i>Warning consequences</i>	8.1%	14.8%	8.8%	1.4%	4.2%	16.3%	9.0%
<i>Offering solutions</i>	1.5%	4.9%	3.1%	2.8%	0.0%	14.8%	1.9%
<i>Wider environmental issues</i>	13.4%	4.8%	6.2%	21.6%	17.3%	9.9%	9.4%
<i>Campaign hijacking</i>	1.3%	7.9%	8.6%	3.9%	58.6%	6.6%	3.2%
<i>Commenting on politics</i>	1.5%	25.5%	8.1%	1.1%	0.0%	0.2%	4.4%

5. Discussion

5.1 Personalization of climate messages

The personalization of climate messages is a significant characteristic of climate storytelling on TikTok, as observed in this study. This personalization occurs at two levels: the central role of individuals as primary storytellers and the use of personalized narratives. Our findings indicate the prevalence of videos where TikTokers take centre stage in climate-related storytelling on the platform, evident in both their frequency and engagement levels. While previous research has noted the prominence of people in news images related to climate communication, with a focus on politicians, scientists, and celebrities (Niederer, 2019; O’Neill, 2013), the role played by individuals in TikTok videos is distinctive. Grassroots content creators, rather than public figures, predominantly serve as the people objects in climate-related imagery. This is even evident in videos from the accounts of official institutions, as exemplified by @UNclimate and @WorldEconomicForum, where young and relatable individuals are employed to deliver engaging and playful messages (see Figure 3).

In terms of narrative content, findings from the study indicate that a large proportion of TikTokers employ videos to advocate for climate action. This observation largely epitomizes a form of personalized climate activism that particularly resonates with youth on the platform. As previously mentioned, TikTok’s user base predominantly consists of younger individuals, who will inevitably confront the repercussions of climate-related issues throughout their lives. Consequently, prior research argues that climate action emerges as a matter of great personal significance to these youthful content creators on TikTok (Zeng & Abidin, 2021).

5.2 Dual role of the political aesthetics of Mother Nature

The dual role of nature-related elements in climate storytelling on TikTok is noteworthy within the context of this study. Referring to the concept of political aesthetics, as expounded by Yusoff (2010), we employ the term to encapsulate the twofold function played by nature in configuring the aesthetic and artistic aspects of climate storytelling. In contrast to TikToker-centric videos discussed earlier, in these particular videos, nature itself assumes the storyteller role. Our findings demonstrate that such visual representation is closely associated with discussions surrounding climate impacts, leading to the

prevalence of varied and often distressing imagery. This aligns with evidence from prior studies examining other media that suggest that dramatic depictions of natural disasters and endangered animals serve as powerful devices to capture public attention and elicit strong emotional responses regarding climate change (O'Neill & Nicholson-Cole, 2009; Pearce & De Gaetano, 2021).

While prior research on the representation of nature in climate communication has emphasized its role in inducing fear through shocking and distressing imagery in news media (O'Neill & Nicholson-Cole, 2009), we also observe depictions focusing on the beauty of Mother Nature. Such videos present natural beauty from a first-person perspective, inviting viewers to share the creators' visual harmony with nature and "produce a particular affective vibe" (Hautea et al., 2021, p.7). The affective aesthetics of nature project natural beauty in a highly idealistic manner, featuring lush landscapes, blooming flowers, flowing water, and serene wildlife. By incorporating these elements into their videos, content creators seek to elicit feelings of awe and tranquillity and foster a sense of connection and responsibility towards nature. Even without explicit links to climate change, such aesthetically appealing visual depictions of Mother Nature serve to evoke emotions and convey highly affective messages that serve as reminders of humanity's intrinsic connection to the natural world.

5.3 Culturally sensitive climate visuals in storytelling

The findings from this study shed light on the varied approaches to climate storytelling on TikTok across the seven countries examined. Significant disparities were observed in the use of visual styles and communicative functions across these countries. For instance, climate content from the US predominantly features videos with individuals, often the TikTokers themselves, as the focal point. In contrast, climate videos from Thailand emphasize nature more than any other country. Although TikTok content primarily focuses on imagery, textual elements continue to play a crucial role as visual cues in climate videos, particularly in the Philippines and Japan. These disparities underscore the importance of considering local preferences in visual climate-related communication. While videos produced within Anglophone countries (specifically the UK and the US in this instance) are highly visible and influential on the platform, the visual grammar and style used in these contexts should not be indiscriminately applied to other cultural settings. Factors such as the local context, relationship with climate, and user culture are crucial and should be taken into account for effective communication with users on the platform.

Domestic politics also shape regional climate storytelling on TikTok. For example, in the US and the UK, TikTok has become a prominent platform for expressing dissent and critique of government policies perceived as detrimental to addressing climate change. In the US, videos often focus on the Willow Project, a controversial oil drilling initiative in Alaska, with content creators voicing concerns about its potential environmental impact and its contradiction to climate change mitigation efforts. Similarly, in the UK, TikTok users frequently highlight the government's decision to offer new North Sea oil and gas licences, criticizing it for running contrary to their climate change commitments. These political issues gain significant attention and spark discussions on TikTok, driving a higher proportion of protest-related content and shaping the narrative around regional climate concerns on the platform.

6. Conclusion

In conclusion, this study, focusing on seven countries, has provided valuable insights into climate storytelling on TikTok. As an exploratory study, the aim was to demonstrate the potential of computational visual data analysis for climate communication research. By combining findings from computer vision with topic modelling, the study sheds light on the characteristics of visual storytelling on TikTok by examining visual styles and communicative functions. The cross-national comparison reveals both similarities and disparities in visual storytelling across the seven countries. To comprehensively interpret these patterns, it is crucial to consider the specific cultural norms, values, and socio-political dynamics that influence the production and reception of climate change-related content on TikTok within each region. As the study has shown, computational methods can help to investigate interplays between these contextual factors and the visual and communicative functions of the videos. Findings from the

research could also help in providing a more nuanced understanding of how climate change narratives can be better conveyed in varied cultural and political contexts.

The study has several limitations that should be acknowledged. First, by focusing solely on the textual and visual aspects of TikTok videos, the study neglects the potential impact of audio elements in shaping the narrative and engagement with the content. Future research should expand the modality of TikTok analysis by incorporating audio processing to gain a comprehensive understanding of the important role played by sound in storytelling on the platform. Second, the study predominantly employs a data-driven approach to categorize visual styles. Future research could benefit from incorporating a more nuanced approach that more closely integrates qualitative methods to gain a deeper understanding of the visual styles and their implications. Third, the exclusion of niche topics means that only half the dataset is utilized for identifying communicative functions, potentially leading to a loss of nuanced insights. Lastly, the utilization of proprietary methods, such as Google Vision API, warrants critical reflection. These tools often operate as enigmatic black-box systems where access to their underlying algorithms and data is withheld, thereby raising pertinent concerns about transparency and interpretability. Their adoption can also be financially burdensome, curtailing access for researchers with limited resources. These concerns underscore the need for a more comprehensive discussion of the implications and limitations associated with the use of such proprietary tools in research, and as shown in the study, the validation process remains important.

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Appendix A

The validation focuses on two visual styles: nature-dominated and person-dominated. The operationalization of text-dominated visual style, labelled through an arbitrary 75% quantile threshold, presents challenges for human labelling; mixed frames are classified as videos that do not fit into the other three categories. As the main purpose of the validation is to gain insights into the efficacy of our visual style categorization scheme and the performance of the object detection algorithm, the text-dominated and mixed frames are not the focus of the validation. Worth mentioning, 200 videos were randomly selected for the validation task, but 22 of them are no longer accessible. For this reason, the table below shows a total of 178 videos.

Table 3. Validation report of the categorization of visual styles

Class	Precision	Recall	F1-Score	Support
Nature Dominant	0.87	0.83	0.85	47
Person Dominant	0.95	0.83	0.89	70
Text Dominant	0.52	0.79	0.63	19
Mixed	0.67	0.69	0.68	42
Accuracy			0.79	178
Macro Average	0.75	0.78	0.76	178
Weighted Average	0.82	0.79	0.8	178

Appendix B: Hierarchical clustering plot of topics

