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Visualizing climate change in the media: a systematic literature review, challenges, and future research

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Abstract

Climate change visualizations in the media play a crucial role in conveying information, raising awareness, and motivating action. This study combines systematic and scoping literature review (2005–2024) with content analysis to analyze current research on climate change visualizations of traditional and digital media. The findings show that most existing research concentrates on traditional media, with limited focus on social media and a predominance of studies focused on Western countries. Framing theory emerges as the predominant theoretical framework, especially in qualitative studies. By analyzing and comparing a large corpus of scientific studies, this study identifies predominant topics, methodologies trends, and research gaps, while also highlighting key challenges and implications for future research.

Keywords: climate change, visualizations, imagery, media, social media, systematic literature review, scoping review

Climate change is one of the most significant and immediate global challenges. Effective communication about this complex issue is crucial for mobilizing public awareness and action. Visual imagery (e.g., photographs, infographics, and videos) has emerged as an engaging and flexible tool to engage diverse audiences and to convey the urgency and impact of climate change. Visualizations are particularly beneficial in climate change communication by enhancing emotional engagement, accessibility, and inclusivity (O'Neill, 2017). Visuals evoke emotional experiences, enabling people, for example, to connect personally with depicted climate-related events (Iyer & Oldmeadow, 2006), which may eventually influence their perceptions, opinions, and behavioral intentions (Nicholson-Cole, 2005; Powell et al., 2015; Smith & Joffe, 2009; Wibeck et al., 2013). For policymakers and activists, climate change imagery is crucial for mobilizing collective action (Eskelinen & Lakkala, 2024; Manzo, 2010), driving policy change, identifying innovative solutions, amplifying messaging, and empowering individuals, communities, and decision-makers to address this urgent challenge (Shim, 2024; Wang et al., 2018). While many people encounter climate change messages in traditional media outlets (e.g., newspapers, television), the rise of online and social media has significantly reshaped how climate-related visuals are produced, disseminated, and engaged with (Schäffer, 2020a).

Understanding how scientific research examines the role of climate change imagery in communicating this phenomenon is vital, especially as the media landscape shifts from traditional channels to the digital platforms (Schäffer, 2020a). Despite the recognized importance of imagery in climate communication, existing reviews tend to focus on either traditional media (Schäfer & Schlichting, 2014) or individual digital platforms in isolation, often without systematic comparison across media types or methodologies (e.g., Schäfer, 2020a;

Wang et al., 2018). To our knowledge, there is currently no comprehensive review examining how climate change imagery is studied across traditional and digital media by using an integrated, systematic framework. This understanding is essential for identifying the key challenges and enhancing the use of climate imagery in efforts to address climate change more effectively.

To address these gaps, this study combines a systematic and scoping literature review of scientific research published between 2005 and 2024 on climate change imagery in the media by analyzing how scholars have engaged with this topic, we gain insights into methodological trends, theoretical approaches, and research gaps essential for advancing research on climate communication. By reviewing how visual climate imagery is studied across different media types, we identify dominant themes, methodological biases, and under-explored areas, laying the groundwork for future research to address these gaps effectively. We also propose pathways for future climate communication research, with a focus on understanding the use of visual imagery to address climate change more effectively.

Research on climate change imagery in the media

Despite the growing body of research on visual communication in climate change discourse, the concept of climate change visuals is often used implicitly rather than being explicitly defined (Bravo et al., 2025b; Yan & Schäffer, 2025). In this study, we use the term climate change visuals to refer to visual representations analyzed in prior research that portray or symbolically represent climate change and that communicate the causes, impacts, risks, public figures, responsibilities, solutions, or people's responses associated with

climate change across media contexts (Bravo et al., 2025a; Schuster et al., 2024).

Visualizing climate change posed a challenge to scientific community, particularly during the 1990s, as its causes and impacts were largely invisible, temporally dispersed, and accessible primarily through scientific prediction rather than direct observation (Doyle, 2009, 2007). Early climate change communication therefore relied mostly on abstract representations (e.g. graphs, model simulations, and projected future scenarios), which struggled to resonate within media environments (Doyle, 2009). Only toward the late 1990s did photographic evidence of visible impacts (e.g., melting glaciers and polar ice) marked a turning point in how climate change could be seen and communicated.

In the early 2000s, climate imagery remained largely confined to scientific and policy contexts, relying on visualizations such as the Intergovernmental Panel on Climate Change (IPCC) "Burning Embers" diagram and ice-related imagery to communicate climate risk (O'Neill, 2025). From the mid-2000s onward, climate change visuals increasingly shifted toward iconic and emotionally resonant symbols, including smokestacks, polar bears, and visually staged protest events, reflecting the growing mediatization and affective framing of climate discourse. During the 2010s, climate imagery became more contested and politicized, while scientific visualizations (e.g., "Climate Spiral" and "Climate Stripes") entered popular culture and prioritized accessibility and emotional impact (O'Neill, 2025). More recently, visual representations have increasingly focused on climate activism. Despite the diversity in climate change visuals in the media, there is still an underrepresentation of those communities, experiences, and perspectives from the Global South (Bravo et al., 2025b; O'Neill, 2025).

As climate change visuals increasingly moved beyond scientific and policy contexts into wider public circulation, media (e.g. both traditional and social) play a critical role in shaping perceptions, discourses, individual awareness and action on climate change. While traditional media (e.g., newspapers, television, radio, films, and documentaries) remain influential (Ben-David et al., 2024; Mosallaei & Feldman, 2024), the rise of social media platforms as a primary source of information has fundamentally changed how people consume and share information about climate change (Schäffer, 2020a). Social media also broaden climate change discussions, reaching more diverse audiences (Alejandro, 2010; Highfield & Leaver, 2016; Newman et al., 2016; Pearce et al., 2019). Importantly, they serve as important platforms for creating and disseminating climate change imagery through formats such as images, GIFs, and videos–particularly on YouTube, Twitter, and TikTok (Doerr & Langa, 2024; Kemp, 2024; McGarry & Treré, 2024). This shift has increased the use of visuals as communication tools in climate change communication, given their ease of cognitive processing (Hansen & Machin, 2008).

In climate science communication, an increasing number of studies explore how visuals can be used to effectively share and communicate new research findings. Some visualizations, such as Ed Hawkins' "climate spirals" and "warming stripes," have gained iconic status, becoming widely shared symbols of climate change communication. These graphics visually represent global temperature changes over time using circular progressions or sequences of colored bands. Another example is the "Hockey stick" graph, which shows the evolution of global warming over the last 800,000 years (O'Neill, 2017; Schneider et al., 2014). Their success highlights the power of data-driven visual storytelling in climate communication, showing how innovative formats can enhance public understanding and engagement with climate change data.

Previous research has shown that iconic climate change visuals extend beyond strictly scientific depictions. Early imagery in climate change communication often focused on fear-based representations (Lopes & Azevedo, 2023), often highlighting the profound consequences of climate change. These include depictions of wildlife, particularly polar bears and other animals (Doyle, 2007; Leon & Erviti, 2013; O'Neill & Nicholson-Cole, 2009; Smith & Joffe, 2009), melting ice and glaciers (Doyle, 2007; Leon & Erviti, 2013; Manzo, 2010; Smith & Joffe, 2009; Smith & Leiserowitz, 2012), and extreme weather events including hurricanes, tornadoes, extreme heat, floods, droughts (Ahchong & Dodds, 2012; Grittmann, 2014; Metag et al., 2016; Nerlich & Jaspal, 2014; O'Neill et al., 2023; Rebich-Hespanha et al., 2014; Smith & Joffe, 2009). Images featuring people, particularly politicians, also draw attention (Metag et al., 2016; Smith & Joffe, 2009), as do representations of the Earth itself (Mooseder et al., 2023). More recent studies emphasize the importance of solution-oriented visuals to promote greater audience engagement (Lopes & Azevedo, 2023).

Visual content shared through traditional and social media platforms has the capacity transcend linguistic and geographic barriers (Metag et al., 2016; O'Neill, 2013), enable it to connect with diverse and even global audiences (Ben-David et al., 2024). These visuals often allow to simplify complex topics into a more understandable ideas, by facilitating rapid comprehension, fostering public awareness, and promoting collective action (Mooseder et al., 2023; Pearce et al., 2019; Schäfer, 2020a). In particular, real-time crisis imagery (e.g., footage of wildfires, floods, and climate protests) has become a powerful tool for shaping public discourse (McGarry & Treré, 2024). The immediacy and emotional intensity of these visuals amplify their people response, promoting the widespread online discussions and calls for action (Doerr & Langa, 2024). In these cases, shared visuals help to construct shared narratives, which resonate across different societies, encouraging at the same time a more unified interpretation of the message.

Given the communicative power of visuals, a wide array of actors (e.g., including politicians, sceptics, deniers, activists, and NGOs) use climate change imagery for diverse purposes (McGarry & Treré, 2024; Qian et al., 2024; Wozniak, 2020). First, visuals can enhance the communication process, fostering greater engagement, often surpassing text in persuasive power (Messaris & Abraham, 2001). Second, images effectively convey ideological messages (Brantner et al., 2011). These messages serve a dual purpose: they enable individuals and stakeholders to adopt specific stances on pertinent issues while encouraging and mobilizing collective action, from raising awareness and concern to driving protest participation (Chapman et al., 2016; Metag et al., 2016; O'Neill & Nicholson-Cole, 2009; O'Neill et al., 2013).

Challenges of researching climate change imagery in media

Climate change communication has evolved significantly over the past two decades, with visual representations playing

an increasingly central role in shaping public understanding and engagement (O'Neill, 2017). While early research focused on the portrayal of climate change in traditional media, the rise of social media platforms has introduced new avenues for climate discourse, allowing for a more diverse and dynamic use of imagery (Schäffer, 2020a). This shift necessitates an understanding of how the academic study of climate change visuals has evolved, particularly in response to changing media landscapes and research priorities. Our first research question is thus: *RQ1: How has the academic study of climate change visuals evolved over time?*

Research on climate change imagery has largely been shaped by an interdisciplinary approach, incorporating insights from communication studies, environmental science, political science, and psychology (Christensen & Nilsson, 2017). However, the field remains fragmented, with a dominance of qualitative studies using content and framing analysis (Schäfer, 2020b). While these methods provide in-depth insights, they also present limitations in terms of generalizability and cross-platform analysis. A more systematic examination of the types of studies conducted can help identify methodological gaps and opportunities for more integrative approaches. *RQ2: What types of studies (empirical, theoretical, methodological) dominate research on climate change visualization?*

Framing theory has emerged as an important theoretical approach in climate change visualization research, particularly in studies analyzing how media define and communicate climate issues (Guenther et al., 2023). Other theoretical perspectives, such as risk perception and emotional response theories, have been used to examine how visuals shape audience reactions (Smith & Joffe, 2009). However, there is a growing need for a more diverse and integrated theoretical framework that accounts for the complexities of digital media landscapes and evolving communication strategies. As a first step, we ask: *RQ3: What theoretical frameworks have been used to analyze climate change visuals?*

While the methodological approaches to climate visualization research have varied, we often see cross-sectional studies (e.g., Gan et al., 2024; Mcgarry & Treré, 2024; O'Neill et al., 2023; Qian et al., 2024) which limit the ability to track long-term trends in climate visualization. Furthermore, there is a broad variety of climate change visuals that can be studied, ranging from scientific graphics, to memes, GIFs, and interactive infographics. But we still do not know what role the different visual types have played in academic research. There seems to furthermore be a strong reliance on qualitative methods such as content analysis and discourse analysis (Lopes & Azevedo, 2023). While these approaches provide rich insights, they often lack scalability. Latest developments in computational methods, such as automated image classification and machine learning-based sentiment analysis, present an opportunity for methodological innovation, but we still do not know to what extent they have been incorporated by research in climate change visuals. We thus ask: RQ4: *What are the predominant study designs, data sources, and methods used in climate change visualization research?*

Empirical research on climate change visuals has traditionally focused on news media (e.g., Duan et al., 2017; O'Neill et al., 2013, 2015; Rebich-Hespanha et al., 2014; Schäfer, 2020a; Smith & Joffe, 2009; Wessler et al., 2016). However, the rapid expansion of social media platforms has introduced new modes of visual storytelling, but the study of climate imagery from these platforms seems to remain limited (Bai et al., 2024; Ben-David et al., 2024; León et al., 2022; Mooseder et al., 2023; Qian et al., 2024; Schneider et at., 2023). Studies comparing climate visuals across different media types also remain scarce, limiting our understanding of how different media environments shape climate narratives. We still lack a systematic overview of what kind of media types have been studied and thus ask: *RQ5: What media types are most commonly analyzed in climate change visualization research?*

While numerous studies have focused on climate change visuals from Western countries, often in the United States, the United Kingdom, and Australia (Lester & Cottle, 2009; Zhang & Jocuns, 2023), the field still lacks a systematic overview detailing which countries have been studied. As a result, our understanding of the geographic scope remains fragmented. Although several works hint at a Western-centric bias (Agin, 2021; Schäfer & Schlichting, 2014), there is no comprehensive mapping of the research landscape across diverse regions. This gap makes it difficult to ascertain how climate visuals are represented in under-explored contexts, particularly in the Global South, where the impacts of climate change are often most severe. This leads to the question: *RQ6: What are the geographic trends in climate change visualization research?*

By addressing these questions, we are able to gain a more comprehensive understanding of how climate change visuals have been studied across different theoretical frameworks, methodologies, and media types. Together, these inquiries reveal trends in the field while also highlighting areas that remain under-explored. The dominance of certain methodological approaches, the focus on specific media and geographic contexts, and the theoretical lenses applied all shape the knowledge produced about climate change visuals. However, despite the growing body of research, it remains unclear what key limitations persist and where critical gaps in the literature remain. To identify these shortcomings and outline directions for future research, we ask: *RQ7: What are the limitations and gaps in existing research on climate change visuals?*

Data and methods

The study combines and integrates elements from both systematic and scoping literature reviews to analyze relevant research output published between 2005 and 2024 about the representation of climate change imagery in media (e.g., traditional and social media). Systematic literature reviews synthesize and analyze data from multiple studies to answer a specific research question (Xiao & Watson, 2019), while scoping reviews explore the scope, diversity, and nature of research field. Combining these approaches not only ensures a rigorous synthesis of existing research, but also identifies research gaps, assesses the breadth of the literature, and highlights areas for future investigation (Templier & Paré, 2015). This method provides a more holistic understanding of the research landscape while maintaining both depth and breadth in analysis. To this end, we first developed a search strategy to derive a sample of relevant scientific publications that were then analyzed using quantitative content analysis. Both steps are outlined in detail in the following.

Literature search and sampling strategy

To identify relevant scientific publications such as journal articles, conference paper, and book chapters, we used the

Scopus and Web of Science databases, two of the largest and most widely used abstract and citation databases for peer-reviewed literature,[1] scientific journals, books, and conference proceedings (Zhu & Liu, 2020).

The temporal scope of this review covers publications from 2005 to 2024. This time frame was selected based on both conceptual considerations related to the evolution of climate change visualization and methodological constraints arising from the systematic literature search. From a conceptual perspective, the early 2000s mark a period in which climate change visuals became a central object of mediated representation, coinciding with the increased prominence of scientific visualizations produced by organizations such as the IPCC and the expansion of digital media platforms that facilitated the widespread circulation of climate imagery (O'Neill, 2017, 2025; O'Neill & Smith, 2014). At the same time, the selection of this time frame was empirically informed by the results of the literature search itself. Initial exploratory searches revealed that peer-reviewed research explicitly addressing visual representations of climate change in media began to appear with greater consistency from 2005 onward.

Since this study is interested in research on the role of visuals in communicating climate change in traditional and digital media, we focus on journals from the fields of social sciences and computer science, searching for English-language publications published between 2005 and 2024 that included keywords related to visuals, climate change, and media in the article's title, keywords, or abstract. Specifically, we used combination of Boolean operators, which are highly effective for achieving precise search results within databases, and keywords: (visual* OR image* AND ("climate change" OR "climate crisis" OR "climate emergency" OR "global warming" AND ("media" OR "news"))).

The search returned a total of 845 publications (see Figure 1, Step 1). Next, we removed duplicates, that is, publications identified by both databases (Scopus and Web of Science) with the same title, year of publication, list of authors and abstract ($N = 776$). We furthermore manually limited the sample (Figure 1, Step 2) by verifying that the studies have a focus on visual communication, meaning that their empirical analysis or theoretical argumentation focuses on visual elements to communicate the phenomenon of climate change, where visual elements are defined as images, videos, and hybrids of these formats combined with text. Next, we also ensure that the studies focus on traditional or digital media. The result of this manual assessment identified 118 relevant publications (Step 3). The manual selection was carried out by two coders. We assessed their intercoder reliability using a random subset of approximately 10% of publications ($N = 83$) and found a robust agreement between them (Krippendorff's alpha = 0.9).

Finally, after an initial scan of the titles and abstracts of each article, we noticed that frequently cited studies that match our search criteria were not returned by our search in the two databases. To achieve a greater scope of the studies (Schäfer & Schlichting, 2014), we added four more relevant articles (Step 4), leading to a final sample of 124 journal publications that form the basis of our analysis (a comprehensive list can be found in the Supplementary Material).

Content analysis of the journal articles

Content analysis serves as a systematic approach to identifying and synthesizing patterns in climate imagery research, making it particularly effective for mapping theoretical, methodological, and geographical trends over time (Metag, 2016). For its implementation, we first developed a codebook (see Supplementary Material) with categories along two dimensions: variables capturing descriptive and analytical aspects of the publications analyzed. The first dimension, primarily quantitative, addressed the evolution of climate change visualization research. Coders coded formal attributes such as article title, year of publication, keywords, author count, authors' affiliations by country, and journal.

Content-related categories capture details about the publications' conceptual design. We first code the literature type (e.g., empirical, theoretical, methodological, or mixed studies), and the different theoretical frameworks used to analyze climate change visuals (e.g., framing, risk perception, visual narratives, grounded theory, among others). Then, we classified the publications based on multiples topics such as those involving the communication of climate change through visual representations, emotional responses, framing strategies, social media utilization, the impact of visualizations on public understanding, the role of art, educational applications, and the addressing of visual misinformation. We also captured the study design (case study; longitudinal study; cross-sectional study; multi-sectional study), study approach (e.g., qualitative, quantitative, or mixed), and the type of methodology (see Supplementary Material for further details).

Additionally, we classify the publications according to the media type (e.g., traditional media, social media, other, or mixed), and the type of visual data used in the literature (e.g., images, videos, images and videos, or images and text). Finally, regarding the geographical trends in climate change visualization research, we captured the study's geographical scope (the countries studied and whether it is a single vs. multi-country study).[2]

Content analysis was carried out by two coders, after several coder training sessions, we assessed the intercoder reliability for both the formal and content categories using a sample of 13 publications (approximately 10% of the total sample size). Krippendorff's alpha values ranged between 0.75 and 1.0, indicating a high level of agreement. This threshold is generally considered acceptable for reliable content analysis (Krippendorff, 2013; see Appendix A for details).
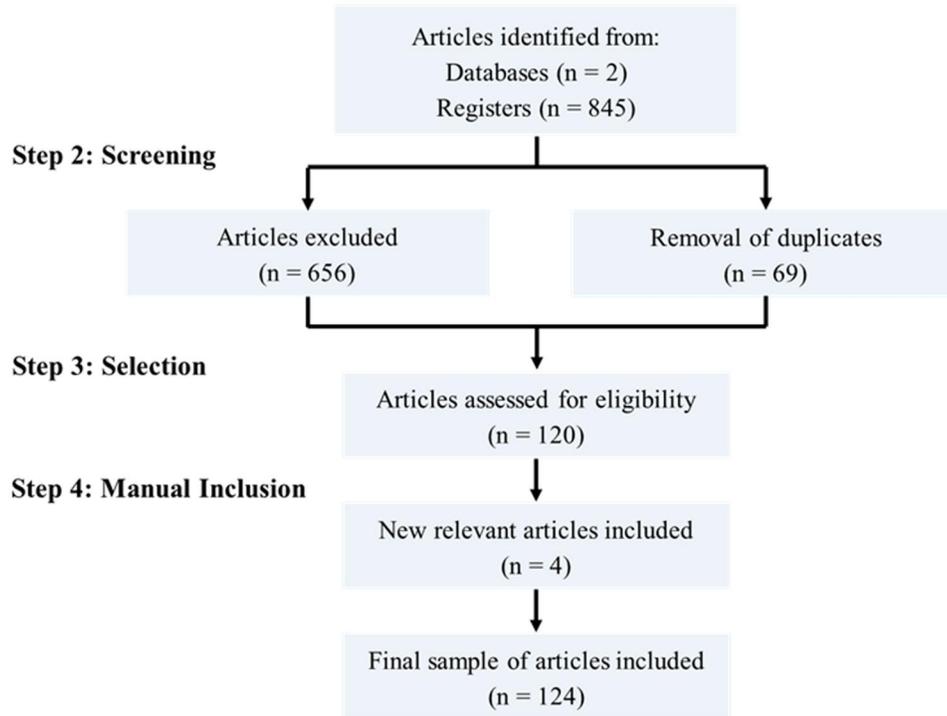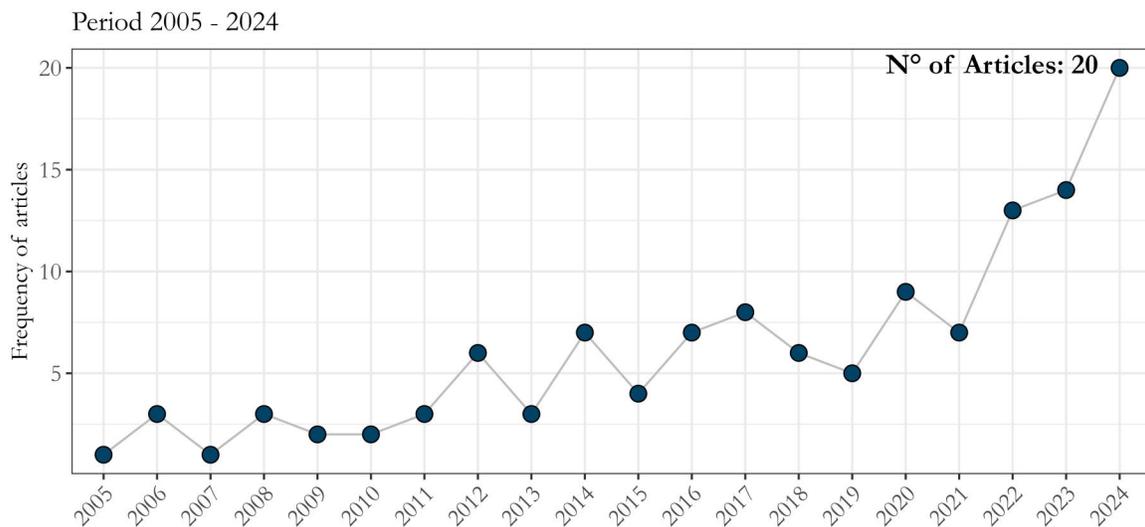
The last step of the content analysis involved an analytical review, where the coders discerned salient aspects within each article, encompassing central arguments or research questions, dominant concepts or theories, perceived gaps within the existing literature, study time frame, data characteristics (e.g., sample size), principal findings, limitations, and recommendations for future research (see Supplementary Material for a more comprehensive overview of this analytical review of the publications coded).

Results

The study of climate change visuals across time

This study is interested in exploring and mapping the research landscape on climate change visuals that play a crucial role in climate change communication. Looking first at the

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[1] While this approach excludes non-indexed journals, focusing on peer-reviewed literature ensures a reliable standard of quality, rigor, and credibility in academic research (Kelly et al., 2024).

[2] Studies without specified geolocation were categorized as "no information."

Step 1: Identification

Articles identified from:
Databases (n = 2)
Registers (n = 845)

Step 2: Screening

Articles excluded
(n = 656)

Removal of duplicates
(n = 69)

Step 3: Selection

Articles assessed for eligibility
(n = 120)

Step 4: Manual Inclusion

New relevant articles included
(n = 4)

Final sample of articles included
(n = 124)

Figure 1 Selection process of the literature.

Period 2005 - 2024

N° of Articles: 20

Figure 2 Distribution of publications across sample.

frequency of publications across time (RQ1), our results show that out of the 124 publications published between 2005 to 2024, more than half ($N = 63$, 51%) have been published over the last five years (see Figure 2) and that there has been a sharp rise as of 2022, reflecting a growing academic interest in the subject. Notably, social media studies reached their highest number of publications to date in 2024 ($N = 20$), representing a 42.9% increase from 2023 and underscoring the growing importance of digital platforms in shaping visual discourse on climate change.

Early efforts were predominantly single-author studies ($N = 38$, 30.6%). However, from 2013 onward, the field became more collaborative ($N = 86$, 69.4%), indicating an interdisciplinary approach merging insights from communication studies, environmental science, political science, and media studies (Table B1 in Appendix B for further details). This involves collaboration not only from different disciplines but also different academic institutions, with the United States ($N = 92$, 27.6%), the United Kingdom ($N = 61$, 18.3%), and Germany ($N = 45$, 13.5%), emerging as

dominant contributors to the research landscape (see Table B2 in Appendix B). Here, we see a clear dominance of Western countries ($N = 170$, 78.0%), the exceptions being Singapore ($N = 2$), Tasmania ($N = 1$), and Vietnam ($N = 3$).

Theoretical vs. empirical orientations in research on climate change visualization

Looking at the different types of studies (RQ2) that have been published in the field (see Table 1), our findings show that empirical studies dominate the field ($N = 143$, 73.3%), in contrast to theoretical ($N = 7$, 3.6%) and methodological studies ($N = 16$, 8.2%). An additional 15% of studies are mixed type which means that they combine at least two of the approaches ($N = 29$, 14.9%).

When we take a closer look at the theoretical approaches employed by past research (RQ3), we find that most studies used framing theory ($N = 59$, 25.7%) to analyze climate change visualizations. Studying climate change visualizations from a framing perspective allows researchers to examine how media visually define and communicate climate change and how people may understand and internalize the issue. Other popular theoretical frameworks include people's risk perceptions ($N = 32$, 13.9%), followed by theories related to visual narratives theories ($N = 31$, 13.5%), and emotional responses ($N = 15$, 6.5%). From 2020 onward, theoretical approaches in the field have expanded by incorporating perspectives from cognitive science, political communication, and digital media studies, highlighting the interdisciplinary nature of the study of climate change visualization (see Table B3 in Appendix B for further details). This theoretical diversification also reflects a maturing of the research field and suggests a shift toward more theoretical complexity.

In terms research topics, the study of climate change imagery has evolved significantly, shifting from an initial focus on the prevalence of visual representations to more complex explorations into audience engagement, social media dynamics, and activist-driven visuals. Early research (2005–2010) primarily examined the prevalence of climate change imagery in traditional media and how iconic visuals (e.g., polar bears and melting ice) shaped public perceptions (Leiserowitz, 2006; Liu et al., 2008; Nicholson-Cole, 2005). These studies laid the groundwork for understanding how visual representations influence people's emotional engagement and risk perceptions by analyzing how climate visuals functioned as symbolic representations of the broader climate crisis.

Between 2011 and 2015, research expanded to investigate the impact of media coverage on public perception, focusing on how the visual representations of climate change in the media influenced audience understanding, trust, and engagement (Höijer, 2010; Nielsen & Schmidt, 2011; O'Neill & Smith, 2014; O'Neill et al., 2015; Rebich-Hespanha et al., 2014). From 2016 to 2020, the emphasis shifted to how climate change is portrayed across diverse visual formats, including news coverage, documentaries, and online media (Chapman et al., 2016; Wessler et al., 2016). This shift represents a broader transformation in the study of climate change imagery, moving beyond traditional media representations to examine how diverse new visual strategies shape public understanding and engagement in an evolving media landscape. Some studies have also examined regional and ideological differences in visual representations across various media systems, revealing how climate imagery was shaped by political and cultural contexts (e.g., Chapman et al., 2016; Metag et al., 2016; Painter et al., 2016).

In the last period 2021–2024, the growing influence of digital and social media platforms led to a new focus on how social media platforms (e.g., Twitter, Instagram, and TikTok) influenced visual content and engagement dynamics in the climate change imagery (e.g., León et al., 2022; Mooseder et al., 2023). At the same time, attention to the role of different stakeholders, including activists and scientists, in shaping climate change discourse through interactive and participatory visuals to advocate for climate justice and community resilience increased (e.g., Doerr & Langa, 2024; Gan et al., 2024; Haastrup & Marshall, 2024; McGarry & Treré, 2024; Shim, 2024).

This shift in research topics reflects the broader transformation of climate communication, moving from an early reliance on static, fear-based imagery to a more nuanced,

Table 1 Overview of study type and topics across the sample.

Study type/topic	Empirical studies	Theoretical–conceptual studies	Methodological studies	Mixed studies	Total
Visual representations of framing climate change in the media	41 (28.7%)	2 (28.6%)	3 (18.8%)	9 (31%)	55 (28.2%)
Visual representations of climate change in the media	23 (16.1%)	2 (28.6%)	6 (37.5%)	5 (17.2%)	36 (18.5%)
The impact of climate change visualizations on public understanding	26 (18.2%)	2 (28.6%)	2 (12.5%)	3 (10.3%)	33 (16.9%)
The use of social media in climate change communication	22 (15.4%)	1 (14.3%)	0 (0%)	2 (6.9%)	25 (12.8%)
Emotional responses	10 (7%)	0 (0%)	3 (18.8%)	4 (13.8%)	17 (8.7%)
The use of visual communication in climate change education	9 (6.3%)	0 (0%)	0 (0%)	2 (6.9%)	11 (5.6%)
The role of art in climate change communication	4 (2.8%)	0 (0%)	2 (12.5%)	2 (6.9%)	8 (4.1%)
Misconceptions about climate change	5 (3.5%)	0 (0%)	0 (0%)	1 (3.4%)	6 (3.1%)
Other topics	3 (2.1%)	0 (0%)	0 (0%)	1 (3.4%)	4 (2.1%)
	143 (100%)	7 (100%)	16 (100%)	29 (100%)	195 (100%)

Note. Empirical studies involve studies that collect and analyze data through different methods to analyze the climate change imagery in the media landscape. Theoretical–conceptual studies explore concepts, theories, and frameworks applied to climate change imagery. Methodological studies focus on developing, assessing, or refining research methods for analyzing climate change imagery. Mixed studies combine empirical research with theoretical or methodological components to provide a more comprehensive understanding of climate change imagery.

platform-specific, and emotionally resonant visual discourse that aims to drive engagement and action.

Methodological approaches in climate change visualization research

After having established the topics and theoretical frameworks employed by past research, we now turn to their methodological approaches. Looking first at the study design type (RQ4), we find that case studies ($N = 49$, 39.5%), that can offer a comprehensive understanding of contextual, social, and psychological factors, are the most popular research design. This is followed by cross-sectional studies ($N = 34$, 27.4%), capturing momentary snapshots of visual discourses, revealing predominant patterns. Longitudinal studies that allow researchers to track changes and trends in the visualization of climate change in the media over time are less common ($N = 25$, 20.2%). Only very few studies ($N = 16$, 12.9%) use multi-sectional designs that can integrate data collection methods to provide a nuanced and comprehensive understanding of how different audiences interpret and respond to climate visuals (see Table B4 in Appendix B).

Our analysis reveals that researchers have used a broad range of methods to analyze climate change visuals (see Table 2). One of the key findings of our study is the predominant reliance on qualitative methods in climate change imagery research. Nearly half of the papers analyzed employ qualitative approaches ($N = 70$, 39.3%), with content analysis being the most popular one (19.6%). Also, 43.8% of the papers ($N = 78$) use mixed methods, that is, a combination of qualitative and quantitative approaches. Only 16.9% of the studies use a purely quantitative methodology with content analysis being again the most popular method. Computational

methods, specifically automated image classification, have thus far played only a marginal role ($N = 5$, 2.8%). Only a handful of studies have employed techniques such as convolutional neural networks for unsupervised image clustering (Bai et al., 2024; Ben-David et al., 2024; Mooseder et al., 2023; Qian et al., 2024; Schneider et at., 2023).

Similarly, the types of visual data analyzed also vary considerably, including images, videos, and other formats such as text and audio (see Table 3). Perhaps not surprisingly, while most of the studies used images ($N = 108$, 59.7%) as their central unit of analysis, while videos receive comparatively less attention ($N = 20$, 11.0%). Studies on video formats examine films, documentaries, television programs, and videos from social media platforms.

Additionally, text data is a key feature in multimodal visual analyses ($N = 59$, 47.6%), where a considerable number of multimodal studies that analyze visual (e.g., images) and textual elements simultaneously ($N = 52$, 41.9%), in contrast to studies analyzing visual contents with other types of formats as videos and audio ($N = 8$, 6.4%). Such studies illuminate the intricate interplay between visual and textual components, demonstrating how important these components are combined for shaping audience perceptions and responses (Hopke & Hestres, 2018; León et al., 2022; Lück et al., 2018; Seelig et al., 2022).

Media type: traditional vs. social media

Next, we move on to investigating where the visual contents analyzed have been published (RQ5). The media landscape involves a series of media through which a message is transmitted. In the case of climate change, the results show a diversity of media types analyzed, as indicated in Table 4.

Table 2 Overview of methodology types and methods.

Methodology/method	Qualitative, *n* (percent)	Quantitative, *n* (percent)	Mixed, *n* (percent)	Total, *n* (percent)
Manual content analysis	35 (50)	8 (26.7)	30 (38.5)	73 (41)
Survey	3 (4.3)	9 (30)	6 (7.7)	18 (10.1)
Automated content analysis	0 (0)	5 (16.7)	11 (14.1)	16 (9)
Critical discourse analysis	7 (10)	0 (0)	8 (10.3)	15 (8.4)
Interview	6 (8.6)	0 (0)	6 (7.7)	12 (6.7)
Automated image classification	0 (0)	2 (6.7)	3 (3.8)	5 (2.8)
Systematize literature review	4 (5.7)	0 (0)	0 (0)	4 (2.2)
Focus group	1 (1.4)	0 (0)	3 (3.8)	4 (2.2)
Network analysis	0 (0)	1 (3.3)	2 (2.6)	3 (1.7)
Experimental design	0 (0)	3 (10)	0 (0)	3 (1.7)
Ethnography	2 (2.9)	0 (0)	1 (1.3)	3 (1.7)
Q-sort	2 (2.9)	0 (0)	0 (0)	2 (1.1)
Hierarchical cluster analysis	0 (0)	0 (0)	2 (2.6)	2 (1.1)
Conceptual review	1 (1.4)	0 (0)	1 (1.3)	2 (1.1)
Workshops	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Visual iconography	0 (0)	0 (0)	1 (1.3)	1 (0.6)
Visual discourse analysis	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Semiotic analysis	0 (0)	0 (0)	1 (1.3)	1 (0.6)
Semiology	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Other	0 (0)	0 (0)	1 (1.3)	1 (0.6)
NLP from audios	0 (0)	1 (3.3)	0 (0)	1 (0.6)
Multimodal discourse analysis	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Interpretative analysis	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Hauntological approach	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Grounded theory	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Field theory	0 (0)	0 (0)	1 (1.3)	1 (0.6)
Eye-tracking analysis	0 (0)	1 (3.3)	0 (0)	1 (0.6)
Cluster analysis	0 (0)	0 (0)	1 (1.3)	1 (0.6)
Case study	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Audio-visual rhetoric	1 (1.4)	0 (0)	0 (0)	1 (0.6)
Total	70 (100)	30 (100)	78 (100)	178 (100)

Over the last two decades, most research has focused on traditional media ($N = 82$, 59.4%) rather than social media ($N = 38$, 27.5%). Traditional media includes source like news media (printed or digital), magazines, and broadcast media (e.g., television programs, radio, films or documentaries). Additionally, media such as websites of scientific or public institutions, NGOs, Internet search engines, or photo-centric platform such as Getty, Flickr, and Google Images were categorized as "Other" ($N = 18$, 13.0%). When looking at the development over time (Figure 3), we see however a growing number of publications focusing on social media. Among these, most of the studies have focused on Twitter ($N = 19$, 28.4%) and Instagram ($N = 16$, 23.9%), followed by YouTube ($N = 9$, 13.4%), and Facebook ($N = 6$, 9.0%). Research on platforms such as Reddit and TikTok remains limited, with only one publication in our sample (for more details, see Table B5 in Appendix B).

Table 3 Overview of data type and modality.

Modality of the data	N	Percent
Unimodal	65	52.4
Images	53	42.7
Videos	12	9.7
Multimodal	59	47.6
Images and text	51	41.1
Images and videos	5	4.0
Images, videos, and audio	1	0.8
Images, videos, text	1	0.8
Videos and text	1	0.8
Total	124	100

Table 4 Overview of media type across the sample.

Media type	N	Percent
Traditional media	82	59.4
Social media	38	27.5
Other	18	13.0
Total	138	100.0

In line with findings by past research (Schäfer, 2020a; Wang et al., 2018), studies combining traditional and social media are nearly absent, comprising only 4.92% ($N = 6$). Additionally, most studies analyze climate change imagery using a single media type ($N = 72$, 59.0%), whereas only 10.7% examine multiple media types ($N = 13$), such as traditional and social media sources (see Table B6 in Appendix B).

Country scope

Turning to the geographical scope of extant research (RQ6), we find strong bias toward English-speaking countries and the Global North, with the United States ($N = 38$, 17.4%), the United Kingdom ($N = 30$, 13.8%), and Germany ($N = 21$, 9.6%) being studied most extensively (see Table 5 and Table B7 in Appendix B for further details). Beyond this dominance, several other countries such as Australia ($N = 11$, 5.0%), India ($N = 10$, 4.6%), and South Africa ($N = 9$, 4.1%) also are also represented, though to a lesser extent. In total, 48 countries appear in our dataset, underscoring the diverse but uneven global scope of previous studies. Furthermore, although nations from multiple continents are covered, this is largely due to Ben-David et al. (2024) and Eide (2012)'s work, which examine 21 and 15 countries, respectively.

These findings suggest the narrow focus on existing research on climate, by the dominance of Global North perspectives. This imbalance has important implications climate change communication strategies and studies, as it risks overlooking culturally specific visual narratives, and regionally distinct climate impacts, particularly in the Global South, where communities are often most vulnerable (O'Neill & Smith, 2014). This dominance of Global North contexts may also skew visual communication strategies toward audiences and media systems that do not reflect the diversity of global experiences. In particular, for climate advocacy, these results suggest a call for more inclusive research agendas and media practices that amplify underrepresented voices and adapt visual strategies to portray localized social, political, and environmental realities (León et al., 2022).
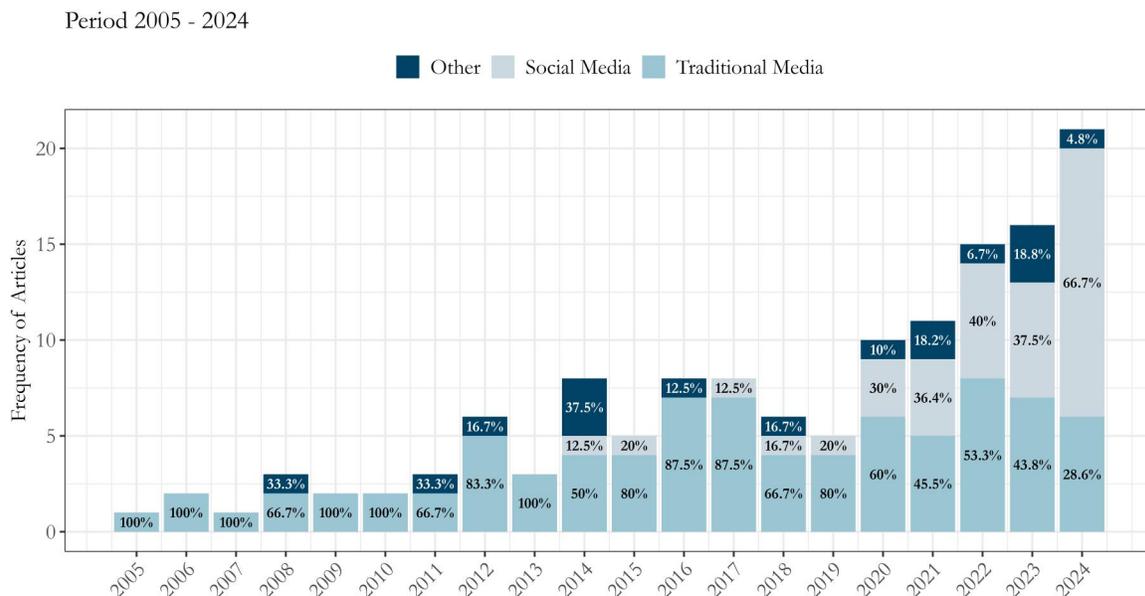
Period 2005 - 2024

Figure 3 Distribution of media type by year.

Table 5 Overview of country scope across the sample.

Country list	N	Percent
United States	38	17.4
United Kingdom	30	13.8
Germany	21	9.6
Australia	11	5.0
India	10	4.6
South Africa	9	4.1
Brazil	8	3.7
The Netherlands	8	3.7
Canada	7	3.2
China	5	2.3
France	5	2.3
Spain	4	1.8
Sweden	4	1.8
Bangladesh	3	1.4
Chile	3	1.4
Ireland	3	1.4
Russia	3	1.4
Turkey	3	1.4
Argentina	2	0.9
Belgium	2	0.9
Denmark	2	0.9
Finland	2	0.9
Indonesia	2	0.9
Israel	2	0.9
Italy	2	0.9
Mexico	2	0.9
Norway	2	0.9
Poland	2	0.9
Qatar	2	0.9
Singapore	2	0.9
Switzerland	2	0.9
Other	17	0.8
Total	**218**	**100**

Note. "Other" includes countries studied only a single time by past research.

Limitations, gaps, and future directions
Methodological challenges

Having presented the results of our systematic and scoping literature review, we summarize the main findings by focusing on the limitations and gaps in existing research to identify potential for future research (RQ7). First, looking at the methods used by past research, the field has thus far been dominated by qualitative approaches, with content and framing analysis being used most frequently. While these methods allow us to gain in depth insights, they have limited generalizability. This leaves much potential not only for approaches from computational social science (e.g., image classification or image sentiment analysis) that allow visual elements to be analyzed at a larger scale, but also for mixed methods research. The combination computational and qualitative methods, for example, allows researchers to draw broader conclusions combined with nuanced perspectives, ensuring a more complete interpretation of visual climate change communication. Mixed approach will enable researchers to have a more holistic understanding of climate change imagery, expanding the analysis range of previous research.

Although a handful of recent studies have begun leveraging computational techniques (Bai et al., 2024; Ben-David et al., 2024; Mooseder et al., 2023; Qian et al., 2024; Schneider et al., 2023), the field has yet to fully embrace the potential of large-scale visual data analysis. Adopting these methods requires careful attention to bias, especially given that models like Contrastive Language-Image Pre-training are primarily trained on English-language datasets (Radford et al., 2024). This can skew interpretations of visuals from non-English-speaking regions, reinforcing Western-centric narratives and underrepresenting localized climate impacts.

Despite these challenges, computational approaches offer promising avenues for expanding and refining climate imagery research. By automating large-scale data collection and classification, scholars can more readily detect patterns that might otherwise be overlooked in qualitative analyses. To ensure accuracy and cultural sensitivity, these models must be adapted to each specific case study, accompanied by strong validation measures that can detect and mitigate inherent biases. Incorporating qualitative methods remains equally critical, as it preserves the narrative and contextual depth necessary for interpreting how climate visuals resonate in different cultural and media environments. By combining computational scale with qualitative nuance, researchers can build a more comprehensive and equitable understanding of climate change imagery, ultimately enhancing the field's impact on communication strategies and public engagement.

Diversity on the use of media types

Similarly, the type of media analyzed by past research remains limited. In the domain of traditional media, a prevalent pattern emerges where a significant portion of studies primarily focuses on a limited number of news media from a single country, especially those with a national reach. Similarly, the few studies that analyze social media data focus on a single platform, such as Twitter, Instagram, and YouTube. A more inclusive and diverse analysis such as comparing climate change imagery across multiple social media platforms, contrasting mainstream and alternative news outlets, or examining different regional publications, could provide a more nuanced understanding of the diversity and dynamics of climate change portrayal in media. This could consequently foster a more comprehensive and holistic interpretation of how the visual representation of climate change unfolds across the media landscape.

Data access and generalizability

In climate change visualization research, data access and generalizability remain evident limitations that challenge the field's ability to provide comprehensive, scalable, and representative insights. A major challenge lies in the accessibility of visual data across diverse social media platforms and news media data, which restricts the ability to analyze climate communication dynamics across a broader media type. The recent restriction of API access policies, such as Twitter/X's limitations on free API usage, has made it increasingly difficult to collect large-scale datasets of climate visuals (McGarry & Treré, 2024), affecting studies that rely on real-time analyses of the evolution and engagement of the climate discourse.

Beyond data accessibility, the frequent use of small sample sizes in numerous studies can pose challenges to the broader applicability of findings, as they may not fully capture the diversity of perspectives within larger populations, even though small or strategically selected samples can also offer in-depth insights. Many studies analyze a limited set of images due to constraints in data collection, storage, and manual annotation, making it challenging to extrapolate findings to broader audiences or across diverse media types. This limitation is

particularly problematic in comparative research that aims to explore regional variations, ideological differences, or platform-specific engagement trends. Also, researchers must consider platform-specific biases in dataset availability. For instance, some platforms amplify climate narratives while suppressing others, shaping the visibility of specific visual frames in ways that are not always transparent. Addressing these limitations requires greater cooperation between researchers and platforms to facilitate the collection of more extensive and representative datasets, enhancing research outcomes' robustness and external validity.

Geographical scope

A recurring aspect in the literature relates to the geographical scope of past empirical studies. Between 2005 and 2024, the existing literature has primarily focused on the visual representation of climate change in Western countries, with a strong focus on the United States and the United Kingdom, and other high-income nations, while regions such as the Global South remain largely overlooked. This creates an incomplete picture of how climate is portrayed, particularly in regions most vulnerable to climate change, such as Africa, South Asia, and island nations. This is particularly the case for Oceania, which is one of the most exposed areas to the impacts of climate change, with a significant proportion of island territories facing increased vulnerability to sea level rise and associated climatic adversities (Parsons, 2022).

Some studies highlight the need for more inclusive and intersectional climate imagery that represents marginalized communities, indigenous knowledge, and climate justice movements (Doerr 2024; Hayes & O'Neill, 2021; Herrmann, 2017). Despite this, studies on the role of indigenous and local knowledge systems in climate change imagery remain scarce, limiting a comprehensive understanding of diverse climate narratives beyond Western-centric framings. Notably, climate justice movements and grassroots activism in the Global South have increasingly utilized participatory visual storytelling to amplify underrepresented voices (Herrmann, 2017; San Cornelio et al., 2024).

Conclusions

In a world grappling with the consequences of climate change, effective communication is key in driving awareness and action. Visualizations are powerful tools for conveying complex scientific data and mobilizing public opinion. Our combination of scoping a systematic literature review provided a comprehensive overview of research on climate change visualizations in the media.

By analyzing a broad array of scientific studies, we have unveiled the multifaceted nature of this field. Our findings underscore the importance content analysis as a methodological pillar, enabling researchers to examine textual and visual components effectively. However, the theoretical and methodological diversity also presents new challenges. The field should now synthesize multiple theoretical approaches to avoid fragmentation and ensure methodological coherence. Researchers need to bridge traditional qualitative methods with computational tools to analyze climate visuals at scale, assess engagement across platforms, and measure the long-term effects of climate imagery on behaviors and engagement. The growing emphasis on climate justice, political ideology, and intersectionality underscores the urgency of studying

how different communities interpret and respond to climate visuals, ensuring more inclusive and equitable communication strategies.

However, certain methodological limitations must be considered in the interpretation of our findings. Since our sample focuses on English-language publications, this may introduce language bias by excluding relevant studies in other languages. Despite this limitation, we chose to focus on English-language publications given the prominence of English in academic discourse (Guenther & Joubert, 2017). We also excluded studies from disciplines other than social and computer science (e.g., remote sensing and environmental sciences) which are inherently linked to the climate change as broader topic and often involve the analysis of visual data. However, they fall outside our study focus on media. By limiting our inquiry to these specific fields, we ensure a consistent interdisciplinary framework aligned with our research scope. Another limitation lies in our reliance on Scopus and Web of Science for data collection. Although these databases focus on peer-reviewed content and methodological rigor, ensuring a reliable standard of quality, rigor, and credibility in academic research (Kelly et al., 2024), they may omit relevant studies published in less widely indexed journals or in grey literature. Thus, future reviews could expand on this limitation by incorporating additional repositories or open-access sources to capture a more diverse and inclusive research.

As climate change remains a pressing global concern, this systematic literature review strengthens existing knowledge and provides insights for future research. We hope that it will serve as a valuable resource for researchers, policymakers, and stakeholders seeking to improve the impact of climate change visualization in the media landscape.

Supplementary material

Supplementary material is available at *Annals of the International Communication Association* online.

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Appendix A: Intercoder Reliability

- Selection process of the literature: Krippendorff's alpha
  = 0.9.
- Descriptive review:

Table A1

Variable	Question	Krippendorff's alpha
Literature type	Q1	1
Theoretical, conceptual framework provided	Q2	1
Topic type	Q3	0.75
Country scope	Q4	1
Modality of the data	Q5	1
Media type	Q6	1
Design type	Q7	1
Analytical approach	Q8	1
Methodology	Q9	1
Country affiliation (authors)	Q10	1

Appendix B: Additional Results

Table B1 Distribution of collaborative vs. single work contributions across the sample.

Type of collaboration	N	Percent
Collaborative work	86	69.4
Single work	38	30.6
Total	124	100.0

Table B2 List country affiliation across the sample.

Country	N	Percent
United States	92	27.6
United Kingdom	61	18.3
Germany	45	13.5
Canada	21	6.3
Australia	16	4.8
Spain	15	4.5
Netherlands	11	3.3
Switzerland	10	3.0
Denmark	8	2.4
Sweden	7	2.1
Belgium	6	1.8
China	6	1.8
Finland	3	0.9
Israel	3	0.9
Norway	3	0.9
Portugal	3	0.9
Turkey	3	0.9
Vietnam	3	0.9
Bangladesh	2	0.6
Brazil	2	0.6
Czech Republic	2	0.6
France	2	0.6
Hungary	2	0.6
Ireland	2	0.6
Singapore	2	0.6
Austria	1	0.3
Tasmania	1	0.3
Thailand	1	0.3
Total	333	100

Table B3 Distribution of climate change imagery topic across time.

Topics	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Total
Emotional responses										2											2
Framing climate change		1		1			1	1		2		1	3		3	2	2		1		18
Misconceptions about climate change																1					1
Multiple topics				1			1			1	1	2	1	4		4	2	4	6	16	42
Other topics								1	1			1									3
The impact of climate change visualizations on public understanding	1	1							1	1		1							1		6
The role of art in climate change communication								1							1			2	1		5
The use of social media in climate change communication													1				2		2	4	9
The use of visual communication in climate change education																		1	1		2
Visual representations of climate change in the media		1	1	1	2	2	1	3	1	1	3	3	3	2	1	1	2	6	2		36
Total	1	3	1	3	2	2	3	6	3	7	4	7	8	6	5	8	8	13	14	20	124

Table B4 List country scope across the sample.

Country list	N	Percent
United States	38	17.4
United Kingdom	30	13.8
Germany	21	9.6
Australia	11	5.0
India	10	4.6
South Africa	9	4.1
Brazil	8	3.7
The Netherlands	8	3.7
Canada	7	3.2
China	5	2.3
France	5	2.3
Spain	4	1.8
Sweden	4	1.8
Bangladesh	3	1.4
Chile	3	1.4
Ireland	3	1.4
Russia	3	1.4
Turkey	3	1.4
Argentina	2	0.9
Belgium	2	0.9
Denmark	2	0.9
Finland	2	0.9
Indonesia	2	0.9
Israel	2	0.9
Italy	2	0.9
Mexico	2	0.9
Norway	2	0.9
Poland	2	0.9
Qatar	2	0.9
Singapore	2	0.9
Switzerland	2	0.9
Austria	1	0.5
Colombia	1	0.5
Egypt	1	0.5
Fiji	1	0.5
Hong Kong	1	0.5
Hungary	1	0.5
Japan	1	0.5
Kenya	1	0.5
Lebanon	1	0.5
New Zealand	1	0.5
Nigeria	1	0.5
Peru	1	0.5
Portugal	1	0.5
Thailand	1	0.5
United Arab Emirates	1	0.5
Vanuatu	1	0.5
Vietnam	1	0.5
Total	218	100

Table B5 Distribution of media type studies across the sample.

Media type	N	Percent
Unimodal	109	89.3
Traditional media	72	59.0
Social media	29	23.8
Other	8	6.6
Multimodal	13	10.7
Traditional media, social media	5	4.1
Traditional media, other	4	3.3
Social media, other	3	2.5
Traditional media, social media, other	1	0.8
Note: Studies excluded 2 (theoretical articles)	122	100.0

Table B6 Distribution of social media studies across the sample.

	N	%
Twitter	19	28.4
Instagram	16	23.9
YouTube	9	13.4
Facebook	6	9.0
Google Images	4	6.0
Reddit	2	3.0
Telegram	2	3.0
TikTok	2	3.0
Flicker	1	1.5
Flickr	1	1.5
Getty	1	1.5
Minecraft	1	1.5
Pinterest	1	1.5
Tumblr	1	1.5
Viber	1	1.5
Total	54	100

Table B7 Distribution research design of publications across the sample.

	N	Percent
Case study	49	39.5
Longitudinal study	34	27.4
Cross-sectional study	25	20.2
Multi-sectional study	16	12.94
Total	124	100