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# Communicating Climate Change: Effective Strategies for Public Awareness and Action

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This study explores effective strategies for communicating climate change to raise public awareness and encourage meaningful action. Using a qualitative research approach through literature review and library research, the paper synthesizes findings from recent studies on climate communication. The analysis highlights the importance of tailored messaging that resonates with different audiences, including the use of emotional appeals and values-based framing. Results suggest that communication strategies combining scientific facts with relatable narratives are more effective in engaging the public and fostering behavioral change. Additionally, the study identifies the role of visual aids, storytelling, and social media in reaching wider audiences, particularly younger generations. However, challenges such as misinformation, skepticism, and political polarization continue to hinder public engagement with climate issues. The findings emphasize the need for trust-building efforts and the use of credible sources to combat misinformation. This study contributes to a deeper understanding of climate communication strategies and offers recommendations for policymakers, educators, and environmental organizations seeking to improve their outreach efforts. By utilizing a multi-faceted approach that integrates scientific information with emotional and values-driven messaging, climate communicators can better inspire individual and collective action to address the climate crisis.

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## 1. Introduction

Climate change represents one of the most significant global challenges of the 21st century, with wide-ranging impacts on ecosystems, economies, and human health. Despite the overwhelming scientific consensus on the causes and consequences of climate change (IPCC, 2021), public awareness and understanding remain inconsistent across different demographics and regions (Leiserowitz et al., 2018). Effective communication is essential to bridge this gap and foster action, as public perception and engagement are critical to the success of climate policies and initiatives (Moser, 2016). However, the complex and often abstract nature of climate science presents significant challenges for communicators attempting to convey its urgency and relevance to diverse audiences (Corner et al., 2018).

A research gap exists in understanding the most effective strategies for communicating climate change in a way that not only raises awareness but also leads to meaningful behavioral changes (Nisbet, 2009). While numerous studies have explored various communication techniques, few have comprehensively examined how different strategies, such as emotional appeals, visual storytelling, and values-based messaging, can be combined to improve engagement and motivate action (O'Neill & Nicholson-Cole, 2009). Furthermore, the role of digital platforms, including social media, in spreading both accurate information and misinformation, remains underexplored in the context of climate communication (Schäfer, 2017). This gap underscores the need for research that integrates these communication tools to develop more effective outreach strategies.

The urgency of this research is heightened by the accelerating impacts of climate change, such as more frequent extreme weather events, rising sea levels, and biodiversity loss, which demand immediate and coordinated global action (Gifford, 2011). Public support and understanding are vital for the successful implementation of climate mitigation and adaptation policies (Whitmarsh et al., 2013). However, public engagement is often undermined by misinformation, skepticism, and political polarization, which complicate efforts to communicate the risks and solutions associated with climate change (Hulme, 2009). Therefore,

it is critical to identify communication strategies that not only raise awareness but also build trust and encourage proactive responses.

Previous research has highlighted the importance of framing climate change in ways that resonate with people's values and everyday experiences. Studies by Corner et al. (2018) and Nisbet (2009) found that values-based messaging, which connects climate issues to personal concerns like health and economic security, can be more effective than fear-based approaches. Similarly, O'Neill and Nicholson-Cole (2009) emphasized the power of visual imagery and storytelling in making climate change more relatable and less abstract. However, these studies often focus on individual strategies in isolation, without fully exploring how they can be integrated into a comprehensive communication approach.

Leiserowitz et al. (2018) conducted a study on public perceptions of climate change in the United States. The research found that while awareness of climate change is increasing, a significant portion of the population remains disengaged or skeptical. The study highlighted the importance of messaging that connects climate change to everyday experiences and values. However, it focused primarily on the American public and did not explore the effectiveness of these strategies in different cultural contexts or on a global scale.

Moser (2016) examined the challenges and successes of climate change communication over the past decade. The findings suggested that fear-based messaging is often ineffective in driving long-term behavioral change. Instead, the study emphasized the need for positive, solutions-oriented communication strategies. However, Moser's research predominantly looked at messaging in general media, without a detailed examination of how social media or digital platforms can be leveraged for climate communication.

Corner et al. (2018) explored the role of values-based communication in engaging different audience segments on climate change. Their findings showed that framing climate issues in terms of personal health, economic benefits, or national security can be more effective than environmental or ecological frames. This study, while comprehensive in its approach to audience segmentation, did not delve deeply into the role of visual or emotional storytelling in enhancing these messages.

O'Neill et al. (2020) analyzed the impact of visual communication in climate change messaging, finding that imagery plays a critical role in shaping public perceptions. The research demonstrated that images depicting local impacts and human experiences resonated more with audiences compared to abstract, global-scale visuals. However, the study did not extensively explore how these visuals can be integrated with narrative techniques to build a more cohesive communication strategy.

Schäfer and Schlichting (2020) focused on climate change communication in the digital age, particularly the role of social media in spreading climate-related information. Their research found that while social media platforms offer significant potential for outreach, they also contribute to the spread of misinformation. The study suggested that communicators must prioritize credibility and trust-building to counteract misinformation, but it did not fully address how to tailor messages for different digital platforms or audiences.

Although these studies provide important insights into various aspects of climate change communication, several gaps remain. Leiserowitz et al. (2018) and Corner et al. (2018) focus heavily on values-based messaging but do not explore how these messages can be integrated with digital and visual storytelling techniques for a more impactful approach. Additionally, while Moser (2016) and Schäfer and Schlichting (2020) offer valuable findings on the general media and social media's role in climate communication, they do not address how communicators can balance scientific accuracy with emotional engagement across these platforms.

The novelty of this study lies in its comprehensive approach to synthesizing a range of communication strategies—including emotional appeals, values-based messaging, visual storytelling, and the use of digital media. Unlike previous research that treats these strategies as separate entities, this study seeks to integrate them into a unified framework that climate communicators can use to reach diverse audiences. Furthermore, this research will address the challenge of misinformation by exploring how credible sources can be incorporated into emotionally resonant messages to build trust and encourage action across various digital platforms.

The purpose of this research is to identify and evaluate the most effective strategies for communicating climate change to the public,

with a focus on fostering awareness and encouraging action. By reviewing existing literature and analyzing successful case studies, this study aims to provide practical recommendations for climate communicators, policymakers, and educators. The findings are expected to contribute to the broader field of climate communication by offering new insights into how diverse messaging techniques can be integrated to achieve greater public engagement and action on climate issues.

## 2. Research Method

This study employs a qualitative research approach, specifically utilizing a literature review method to explore effective strategies for communicating climate change and fostering public awareness and action. The literature review method is appropriate for synthesizing existing knowledge, identifying trends, and highlighting gaps in research related to climate change communication (Creswell, 2014). This qualitative approach enables a comprehensive analysis of diverse sources, providing insights into how different communication strategies have been applied and their effectiveness in engaging the public on climate issues.

The data sources for this research include peer-reviewed journal articles, books, reports from governmental and non-governmental organizations, and relevant publications on climate change communication from academic databases such as Scopus, Web of Science, and Google Scholar. To ensure the relevance and timeliness of the data, the study focuses on literature published within the last five years, although seminal works in the field may also be included for foundational context. Keywords such as “climate change communication,” “public awareness,” “behavioral change,” “visual storytelling,” and “social media” were used to identify appropriate studies.

For data collection, relevant studies were selected using a systematic search strategy. The inclusion criteria for the literature review included studies that specifically address strategies for communicating climate change to the public, focusing on variables such as emotional appeals, values-based messaging, and digital media engagement. Studies that solely focus on scientific communication without addressing public engagement were excluded. Articles were critically evaluated and categorized based on their research focus and contributions to understanding climate change communication.

The data analysis method used is thematic analysis, which allows for the identification and synthesis of key themes across the selected literature (Braun & Clarke, 2006). This process involved coding the findings of the studies to extract recurring patterns related to effective communication strategies, such as the use of emotional narratives, values framing, and the impact of visual imagery. These themes were then grouped into broader categories that align with the research questions, such as understanding which communication techniques are most successful in fostering public action and how digital platforms contribute to spreading climate awareness. This method provides a structured way to interpret the data, allowing for the identification of gaps and opportunities for future research.

3. Result and Discussion

In this literature review, 10 key articles were selected from a larger pool of research to explore effective strategies for communicating climate change to enhance public awareness and inspire action. These articles were chosen based on their relevance to the study’s focus on emotional appeals, values-based messaging, visual storytelling, and digital media engagement. The following table provides a summary of these selected articles, highlighting their research focus and key findings, which contribute to the understanding of climate change communication strategies.

No.	Author(s), Year	Title	Research Focus	Key Findings
1	Leiserowitz et al. (2018)	Climate change in the American mind	Public perception of climate change in the US	Awareness is growing, but significant skepticism remains; values-based messaging can increase engagement.
2	Moser (2016)	Reflections on climate change communication research	Challenges in climate communication	Fear-based messages are ineffective for long-term change; solutions-oriented approaches are needed.
3	Corner et al. (2018)	Principles for effective communication and public engagement	Values-based climate communication	Framing climate change in terms of health and security increases engagement; fear-based messaging is limited.

4	O'Neill et al. (2020)	The role of visual imagery in climate change communication	Impact of visual imagery on climate awareness	Local, human-centered imagery resonates more with the public than global, abstract visuals.
5	Schäfer & Schlichting (2020)	Media representations of climate change	Role of media in spreading climate information	Social media plays a key role but also spreads misinformation; trust-building is essential.
6	Whitmarsh et al. (2019)	Engaging the public with climate change	Public engagement with climate change	Positive, action-oriented messages are more effective than doom-oriented messaging in engaging the public.
7	Futerra (2019)	The climate change communication handbook	Practical strategies for effective climate communication	Messages that highlight co-benefits (e.g., economic gains) are more effective than those focusing on risks.
8	Ballantyne et al. (2019)	Climate visuals: The power of pictures in climate change communication	Use of visuals in climate communication	Visuals depicting individual actions or relatable stories are more effective than images of disasters.
9	Hall et al. (2020)	Climate change communication on social media	Social media's role in climate change engagement	Social media increases engagement but also spreads false information, making source credibility critical.
10	Brulle et al. (2020)	The role of emotion in climate change communication	Emotional appeals in climate communication	Emotional engagement, particularly through hope and agency, can increase public support for climate action.

The selected articles from the literature review reveal several important insights into effective strategies for communicating climate change to foster public awareness and action. Leiserowitz et al. (2018) emphasized that while climate change awareness is increasing, skepticism and disengagement still persist in many segments of the population. This highlights the need for more tailored messaging that resonates with the values and everyday experiences of different audiences, rather than relying on generalized or global-scale messages. Climate communication that taps into personal relevance and local impacts has a greater chance of fostering engagement.

Similarly, the findings from Moser (2016) reinforce that fear-based messaging, often used to convey the urgency of the climate crisis, may not be effective in driving long-term behavior change. Instead, Moser advocates for positive, solutions-oriented communication strategies that offer hope and agency. These findings suggest that communicators should shift focus from emphasizing the catastrophic impacts of climate change to promoting achievable, tangible solutions that empower individuals and communities to act.

Corner et al. (2018) further expand on this by demonstrating the effectiveness of values-based messaging. Their research suggests that framing climate change in terms of health benefits, economic opportunities, or national security resonates more with the public than traditional environmental frames. This approach taps into personal concerns, making the issue of climate change more relatable and actionable. The use of values-based communication appears to be particularly successful in reaching individuals who may not typically engage with environmental messaging.

Visual communication also plays a significant role in enhancing public understanding and engagement with climate change, as discussed by O'Neill et al. (2020). Their study found that imagery focusing on local and human-centered impacts resonates more with the public than abstract, global images. This highlights the power of visual storytelling in making climate change feel more immediate and real to audiences. By using visuals that depict relatable experiences or everyday scenarios, communicators can break down the abstract nature of climate science and bring it into a context that feels personally relevant.

In the digital age, the role of social media in climate change communication is undeniable. Schäfer and Schlichting (2020) found that while social media platforms have been instrumental in raising awareness and spreading climate-

related information, they have also become a breeding ground for misinformation. The study points to the need for building credibility and trust within these platforms by prioritizing credible sources and combating misinformation with facts and transparency. Social media offers a powerful tool for climate communicators, but it also requires careful navigation to ensure that accurate, science-based messages reach the public.

Lastly, Brulle et al. (2020) highlighted the importance of emotional appeals in climate communication. Their research suggests that emotional engagement, particularly through hope and a sense of agency, can significantly increase public support for climate action. Emotional storytelling, when combined with facts, has the potential to move people beyond awareness and into action. This finding underscores the importance of not only providing information but also connecting with the audience on an emotional level to inspire meaningful change.

Overall, the findings from these studies suggest that a multifaceted approach to climate change communication—one that combines values-based messaging, emotional storytelling, visual imagery, and the strategic use of digital platforms—offers the most effective means of raising public awareness and inspiring action. The synthesis of these strategies, as revealed through the literature review, provides a roadmap for communicators looking to make climate change more relatable, actionable, and engaging for diverse audiences.

The findings from the literature on climate change communication strategies highlight the growing complexity and necessity of reaching diverse audiences in the context of global environmental crises. Leiserowitz et al. (2018) demonstrated that while awareness of climate change is rising, skepticism and disengagement still present substantial challenges, particularly in regions or communities where climate change is perceived as a distant threat. This reflects the broader issue of psychological distance in climate communication, which has been discussed in theories such as Construal Level Theory (Liberman & Trope, 2008). The theory posits that the greater the perceived distance of an issue—whether spatial, temporal, or social—the less likely individuals are to engage with it. Communicators must, therefore, work to reduce this distance by framing climate change in ways that are immediately relevant to the audience's daily lives.

Building on this, Moser (2016) emphasizes the limitations of fear-based messaging, which often dominates environmental communication but fails to motivate sustained action. The theory of Fear Appeals (Witte & Allen, 2000) suggests that fear can prompt action only when individuals believe they can

effectively address the threat. Without this sense of agency, fear can lead to disengagement or denial. Moser's argument for solution-oriented communication aligns with this, as promoting actionable steps fosters hope and a sense of control, which are essential for maintaining long-term engagement with climate action.

Corner et al. (2018) reinforce the idea that values-based messaging, which frames climate change in terms of personal and societal benefits—such as health, economic growth, or national security—is more effective than traditional environmental frames. This aligns with Framing Theory (Goffman, 1974), which suggests that the way an issue is presented influences how it is perceived and understood. By linking climate change to issues that resonate more deeply with an audience's values, communicators can foster a stronger emotional connection and, consequently, a higher likelihood of action. In today's polarized political environment, this approach is particularly useful in reaching audiences who may not typically engage with environmental messaging, such as conservatives or economically-driven stakeholders.

The impact of visual storytelling, as discussed by O'Neill et al. (2020), is also crucial. Visuals that depict local and human-centered impacts make climate change feel more immediate and relatable. This approach is especially important in the age of social media, where attention spans are short, and impactful visuals can convey complex messages quickly. The Dual Coding Theory (Paivio, 1986) supports this by asserting that information is better retained when both verbal and visual elements are combined. By using compelling imagery that focuses on relatable human experiences, climate communicators can make abstract issues like rising temperatures or sea-level rise more tangible and emotionally engaging.

Social media's role in climate communication, as explored by Schäfer and Schlichting (2020), presents both opportunities and challenges. While platforms like Twitter, Instagram, and Facebook have made it easier to spread climate information, they have also contributed to the rise of misinformation and skepticism. The Elaboration Likelihood Model (Petty & Cacioppo, 1986) is relevant here, suggesting that when individuals are not motivated to process information deeply, they rely on peripheral cues—such as the credibility of the source or the emotional appeal of the message. This makes trust-building on social media critical, as audiences are more likely to accept information from credible, trustworthy sources. Communicators must work to establish trust and counter misinformation by using transparent and science-based messaging while also tapping into emotional narratives to capture attention.

The role of emotion in climate communication, as highlighted by Brulle et al. (2020), cannot be overstated. Emotional appeals, particularly those that evoke hope and agency, are essential for moving people from awareness to action. According to Affective Intelligence Theory (Marcus, Neuman, & MacKuen, 2000), emotions like hope and enthusiasm are key to encouraging proactive behavior. When individuals feel empowered to make a difference, they are more likely to support and engage in climate action. Communicators should thus focus on framing climate solutions in ways that instill a sense of optimism and individual agency, rather than overwhelming audiences with the scale of the problem.

In the context of current climate change discourse, these findings are highly relevant. The rise of youth-led movements like Fridays for Future, spearheaded by activists such as Greta Thunberg, demonstrates the power of combining emotional storytelling, social media engagement, and values-based messaging. These movements have successfully shifted the narrative from a distant global crisis to an urgent, personal issue that affects the future of younger generations. The emotional appeal of youth activism has galvanized global attention and mobilized mass participation in climate strikes and protests, showing the effectiveness of emotionally charged, visually powerful, and values-driven messaging in inspiring public action.

However, the challenge of combating climate misinformation remains significant, as noted by Schäfer and Schlichting (2020). In the digital age, where information spreads rapidly, climate communicators must be strategic in using both scientific accuracy and emotional engagement to ensure that accurate, motivating information reaches the public. The need for a balanced approach—one that informs, engages emotionally, and promotes actionable solutions—is critical in overcoming the current barriers to public engagement with climate change.

In conclusion, the findings from this literature review suggest that a multifaceted approach is needed to effectively communicate climate change and inspire public action. By integrating values-based messaging, emotional appeals, visual storytelling, and credible social media engagement, climate communicators can better connect with diverse audiences. These strategies not only make climate change more relatable and urgent but also foster a sense of agency and optimism that is essential for driving meaningful action. Moving forward, communicators should continue to refine their approaches, ensuring that they address both the informational and emotional needs of the public in order to build sustained momentum for climate action.

## 4. Conclusion

The literature review highlights the complex and multifaceted nature of climate change communication, demonstrating that effective strategies must go beyond simply conveying scientific facts. The findings emphasize the importance of integrating emotional appeals, values-based messaging, and visual storytelling to engage diverse audiences. Climate change is often perceived as a distant, abstract problem, but by framing it in terms of personal relevance—such as health, economic stability, or national security—communicators can bridge this psychological distance and make the issue more immediate and actionable. Moreover, social media has become a powerful tool for spreading climate information, though it also presents challenges related to misinformation.

The role of emotions, particularly hope and agency, emerged as critical in moving individuals from awareness to action. The use of fear-based messages has shown limited effectiveness, with research suggesting that positive, solutions-oriented communication is more successful in sustaining public engagement. Visual storytelling also plays a key role in climate communication, helping to make abstract concepts more tangible and relatable. Images that focus on local impacts and human experiences resonate more deeply with audiences and can inspire a stronger connection to the issue.

For future research, it is recommended that studies focus on the long-term effectiveness of integrated communication strategies across different cultural and demographic contexts. More research is needed on how digital platforms can be optimized to combat misinformation while promoting credible, science-based climate communication. Additionally, exploring the intersection of emotional engagement and behavior change, particularly how hope and a sense of agency can be cultivated in various audience segments, will be vital in shaping the next generation of climate communication strategies. These insights will help inform more effective approaches to fostering widespread public action on climate change.

## 5. References

- Ballantyne, A., Wibeck, V., & Neset, T. S. (2019). Climate visuals: The power of pictures in climate change communication. *Environmental Communication*, 13(2), 233-248.

- <https://doi.org/10.1080/17524032.2018.1544168>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Brulle, R. J., Carmichael, J., & Jenkins, J. C. (2020). The role of emotion in climate change communication. *Climatic Change*, 158(3), 393-409. <https://doi.org/10.1007/s10584-019-02430-9>
- Corner, A., Shaw, C., & Clarke, J. (2018). Principles for effective communication and public engagement on climate change: A Handbook for IPCC authors. Climate Outreach.
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). SAGE Publications.
- Futerra. (2019). *The climate change communication handbook*. Futerra Sustainability Communications.
- Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist*, 66(4), 290-302. <https://doi.org/10.1037/a0023566>
- Goffman, E. (1974). *Frame analysis: An essay on the organization of experience*. Harvard University Press.
- Hall, S., Merrick, C., & Wood, R. (2020). Climate change communication on social media: Challenges and opportunities. *Journal of Environmental Communication*, 14(5), 123-142. <https://doi.org/10.1080/17524032.2020.1745752>
- Hulme, M. (2009). *Why we disagree about climate change: Understanding controversy, inaction, and opportunity*. Cambridge University Press.
- Intergovernmental Panel on Climate Change (IPCC). (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press. <https://doi.org/10.1017/9781009157896>
- Leiserowitz, A., Maibach, E., Roser-Renouf, C., & Rosenthal, S. (2018). *Climate change in the American mind: March 2018*. Yale Program on Climate Change Communication. <https://climatecommunication.yale.edu/publications/climate-change-in-the-american-mind-march-2018>
- Liberman, N., & Trope, Y. (2008). The psychology of transcending the here and now. *Science*, 322(5905), 1201-1205.

- Moser, S. C. (2016). Reflections on climate change communication research and practice in the second decade of the 21st century: What more is there to say? *WIREs Climate Change*, 7(3), 345-369. <https://doi.org/10.1002/wcc.403>
- Nisbet, M. C. (2009). Communicating climate change: Why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development*, 51(2), 12-23. <https://doi.org/10.3200/ENVT.51.2.12-23>
- O'Neill, S., & Nicholson-Cole, S. (2009). "Fear Won't Do It": Promoting positive engagement with climate change through visual and iconic representations. *Science Communication*, 30(3), 355-379. <https://doi.org/10.1177/1075547008329201>
- O'Neill, S., Boykoff, M., Niemeyer, S., & Day, S. (2020). The role of visual imagery in climate change communication. *Oxford Research Encyclopedia of Climate Science*. <https://doi.org/10.1093/acrefore/9780190228620.013.493>
- Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford University Press.
- Petty, R. E., & Cacioppo, J. T. (1986). *Communication and persuasion: Central and peripheral routes to attitude change*. Springer-Verlag.
- Schäfer, M. S. (2017). Climate change communication in the digital age: Theoretical perspectives and open questions. *Oxford Research Encyclopedia of Climate Science*. <https://doi.org/10.1093/acrefore/9780190228620.013.493>
- Schäfer, M. S., & Schlichting, I. (2020). Media representations of climate change: A meta-analysis of the research field. *Environmental Communication*, 14(1), 1-17. <https://doi.org/10.1080/17524032.2019.944474>
- Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2013). Public engagement with climate change: What do we know and where do we go from here? *International Journal of Media & Cultural Politics*, 9(1), 7-25. [https://doi.org/10.1386/macp.9.1.7\\_1](https://doi.org/10.1386/macp.9.1.7_1)
- Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2019). Engaging the public with climate change: Behaviour change and communication. *Environmental Research Letters*, 14(12), 123-134. <https://doi.org/10.1088/1748-9326/ab402d>