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Environmental Data Storytelling for Strengthening Public Climate Engagement

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Abstract

Public communication of climate change increasingly takes place in an information environment saturated with scientific reports, dashboards, interactive maps, satellite imagery, news graphics, social-media posts, and numerical indicators. The availability of climate data, however, does not automatically produce public understanding, sustained attention, or willingness to participate in climate action. Environmental data storytelling offers a communication approach in which verified evidence is organized through narrative sequencing, accessible visual representation, human context, and actionable interpretation. This study develops and evaluates a conceptual Data-to-Engagement Storytelling Framework for examining how alternative presentations of identical climate information may influence public comprehension, perceived relevance, trust, engagement, and intention to undertake climate-responsive action. Because no original participant dataset was available, the investigation is explicitly structured as a simulation-based methodological study rather than a completed human-subject experiment.

A reproducible synthetic dataset representing 800 hypothetical respondents was generated across four communication conditions: a raw-data dashboard, a static infographic, a narrative data story, and a localized narrative data story. Five communication outcomes were represented on seven-point response scales. Simulated comparisons indicated a progressive increase in engagement as presentation moved from technically organized data toward contextualized and localized storytelling. Mean engagement increased from 3.66 in the raw-data condition to 5.95 in the localized narrative condition, while simulated action intention increased from 3.56 to 5.58. The largest simulated between-condition effects occurred for engagement and perceived relevance. The findings are illustrative rather than empirical, but they demonstrate a testable research design and support a broader argument emerging from climate-communication scholarship: public-facing climate information should preserve scientific accuracy while reducing unnecessary cognitive burden, connecting evidence with meaningful contexts, and showing feasible responses. The proposed framework can guide future field experiments, environmental journalism, climate-service design, public-sector communication, and digital sustainability campaigns.

Keywords: environmental data storytelling; climate communication; public engagement; data visualization; environmental journalism; narrative communication; climate literacy; public participation; sustainability communication

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1. Introduction

Climate change is simultaneously a scientific, social, economic, political, and communicative problem. Scientific institutions now produce increasingly detailed observations and projections concerning atmospheric warming, changing precipitation patterns, sea-level rise, extreme weather, ecosystem disruption, and associated social risks. Yet greater availability of environmental information does not necessarily ensure that members of the public understand its meaning, perceive it as relevant to their lives, or feel capable of responding constructively. Moser's foundational analysis of climate communication emphasized that effective communication involves much more than transferring additional scientific information; it requires attention to audiences, communication processes, meanings, barriers, and intended responses.

The difficulty is particularly visible in environmental data communication. Climate information frequently reaches public audiences through temperature anomalies, probability ranges, emissions scenarios, risk maps, time-series graphs, model ensembles, and multivariable dashboards. These formats are indispensable for scientific analysis, but they can create substantial interpretive demands when transferred directly to non-specialist audiences. Harold and colleagues demonstrated that cognitive and psychological principles are directly relevant to climate-data visualization, while later work by Gerst, Kenney, and Feygina and by Terrado, Calvo, and Christel emphasized user-centered design, appropriate visual encoding, cognitive-load reduction, and audience needs in the development of climate visualizations.

Environmental data storytelling addresses this communication gap by combining data with explanatory narrative. It does not replace evidence with anecdote. Rather, it organizes evidence into an interpretable sequence: what is happening, how the evidence demonstrates the change, why the pattern matters, who or what may be affected, what uncertainty remains, and what forms of response are possible. This approach is consistent with broader science-communication research. Dahlstrom has shown that narrative formats can offer distinctive advantages when scientific information is communicated to nonexpert audiences, although narrative persuasion must be used responsibly because stories can also influence interpretation beyond the evidentiary content itself.

The visual dimension is equally important. Contemporary science communication increasingly employs humanized and story-driven visual formats, sequential digital narratives, and forms of "scrollytelling" that guide audiences through complex evidence rather than displaying all information simultaneously. Recent work on visual narratives identifies their potential to support understanding, retention, confidence, and behavioral intentions.

Environmental data storytelling therefore sits at the intersection of climate science, journalism, information visualization, narrative communication, environmental psychology, and public engagement. Its central proposition is straightforward: accurate climate evidence may become more publicly meaningful when numerical information is transformed into a coherent, transparent, visually accessible, socially relevant, and action-oriented story without compromising scientific uncertainty.

The present paper develops this proposition into a testable analytical framework.

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2. Background and Conceptual Context

2.1 From Climate Information to Climate Engagement

Traditional models of public science communication have sometimes assumed that insufficient action is primarily a consequence of insufficient knowledge. Contemporary climate-communication research provides a more complicated picture. Knowledge matters, but public interpretation also depends on values, trust, identities, media environments, emotional responses, communication frames, previous experience, and perceptions of efficacy.

Nisbet's work on framing argued that the presentation of climate change affects how audiences define and interpret the issue. Communication therefore cannot be evaluated solely by asking whether scientific facts are present. Researchers must also ask whether audiences can understand the information, recognize its relevance, assess its credibility, and identify realistic responses.

This distinction is important because attention is not equivalent to engagement. O'Neill and Nicholson-Cole found that dramatic climate imagery may capture attention and make climate change appear important while simultaneously producing feelings of helplessness or distance that inhibit constructive engagement. A communication strategy can therefore be visually striking without necessarily being behaviorally useful.

2.2 The Function of Data Visualization

Climate visualization converts abstract observations, estimates, scenarios, and trends into visible patterns. A well-designed graph can communicate a relationship more rapidly than several paragraphs of numerical description. Poor visualization, however, can increase confusion.

Terrado and colleagues describe visualizations as important entry points into climate-service information and argue that their effectiveness depends on information density, robustness, salience, purpose, user characteristics, interaction design, and appropriate representation. Similarly, Gerst and colleagues proposed diagnostic design principles to improve the usability of climate indicators.The communication problem is thus not "data versus story." A more productive distinction is between untranslated data and interpretable evidence.

2.3 Narrative Structure and Meaning

Narrative communication introduces temporal sequence, causality, human experience, conflict, consequence, and resolution. In environmental communication, narrative structure can connect an abstract indicator with an observable consequence.Dahlstrom argues that narrative formats can enhance communication with nonexperts because human cognition is highly responsive to story structures. Dillon and Craig subsequently extended the discussion through the concept of storylistening, emphasizing that stories can themselves constitute forms of narrative evidence contributing to public reasoning about climate change.A scientifically responsible climate-data story should therefore integrate rather than oppose quantitative and narrative evidence.

2.4 Localization and Audience Relevance

Audience heterogeneity further complicates climate communication. Leiserowitz, Roser-Renouf, Marlon, and Maibach demonstrate through the Six Americas framework that publics contain

distinguishable audience segments with different climate beliefs, concerns, and behavioral orientations. Strategic communication consequently requires audience identification rather than treating "the public" as a single homogeneous recipient.

Localization may increase salience by linking evidence with recognizable places, institutions, livelihoods, infrastructure, health conditions, or environmental changes. However, localization should not be treated as an automatic psychological intervention. Van Valkengoed, Steg, and Perlaviciute's systematic examination of psychological distance cautions that simply making climate change appear spatially or temporally closer does not reliably increase action.Accordingly, the framework proposed here treats localization as one component of meaningful communication rather than a universal solution.

3. Literature Review

3.1 Evolution of Climate-Communication Research

Moser's 2010 review established climate communication as a field requiring strategic consideration of audiences, messengers, channels, barriers, and purposes rather than mere information dissemination. Nisbet similarly showed that frames influence the social interpretation of climate information.

O'Neill and Nicholson-Cole added an important emotional dimension by demonstrating the limits of fear-oriented imagery. Visually dramatic portrayals may make climate threats memorable, but emotional intensity does not always translate into agency.

Spence, Poortinga, and Pidgeon examined psychological distance and provided influential evidence concerning how temporal, spatial, social, and hypothetical dimensions shape climate perceptions. McDonald, Chai, and Newell subsequently reviewed personal experience and psychological distance, highlighting the possible communicative significance of experiences perceived as immediate or locally relevant. More recent evidence has complicated simplistic assumptions about distance: van Valkengoed and colleagues found limited support for the proposition that reducing psychological distance consistently increases climate action.Together, these findings suggest that climate engagement cannot be produced by a single message property.

3.2 Storytelling in Science Communication

Dahlstrom's work provides a theoretical basis for incorporating narrative formats into public science communication. Narratives can make unfamiliar information easier to process because they organize events into cognitively familiar structures.

Contemporary narrative research has expanded beyond conventional storytelling. Dillon and Craig argue that narrative evidence can contribute to public reasoning rather than functioning only as persuasive decoration. This perspective is relevant to environmental data storytelling because it encourages communication systems in which quantitative trends and community experience illuminate one another.

3.3 Climate Data Visualization

Harold, Lorenzoni, Shipley, and Coventry translated cognitive and psychological research into recommendations for climate visualization and highlighted the need to understand how audiences interpret graphical information. Gerst and colleagues later emphasized diagnostic design principles,

while Terrado and colleagues integrated perspectives from climate services, user experience, data visualization, graphic design, and psychology.

Tsang's research on animated climate-data visualization further demonstrates that design choices can influence perceptions not only of information but also of communicative motive and media bias. The implication is significant: visual sophistication is not automatically persuasive. Design elements may alter judgments about the communicator as well as the evidence.

4. Research Gap

Existing research provides strong but fragmented knowledge concerning climate framing, narrative communication, audience segmentation, visual design, psychological distance, environmental imagery, and digital engagement.

Three gaps are especially evident.

First, research frequently examines narrative communication and climate-data visualization as separate domains. The communication effectiveness of deliberately integrating data accuracy, visual explanation, narrative sequencing, localization, and response efficacy requires additional structured testing.

Second, many public climate-information interfaces remain designed around the availability of data rather than the informational needs of specific audiences. Terrado and colleagues explicitly emphasize the importance of user-centered climate visualization. A theoretically grounded model is therefore needed to explain how technical climate data can move through stages of translation toward public engagement.

Third, communication outcomes should not be reduced to a single measure. A message may improve comprehension without improving trust, or increase emotional engagement without increasing behavioral intention. A multidimensional evaluation framework is necessary.

5. Novelty and Proposed Contribution

This paper proposes the Data-to-Engagement Storytelling Framework (DESF).

The framework conceptualizes public climate engagement as a communication pathway involving five linked stages:

Climate Evidence → Audience Translation → Narrative Visualization → Contextual Relevance and Efficacy → Public Engagement

Its principal contribution is the integration of five design dimensions within one evaluative structure:

Scientific fidelity, referring to accuracy, source transparency, uncertainty, and preservation of the original evidence.

Cognitive accessibility, referring to simplification of interpretation without distortion.Narrative coherence, referring to an intelligible relationship among evidence, causes, consequences, actors, and responses.

Contextual relevance, referring to the connection between the information and meaningful social, geographic, economic, or environmental contexts.Response efficacy, referring to whether the communication shows credible individual, community, institutional, or policy responses rather than presenting threat alone.

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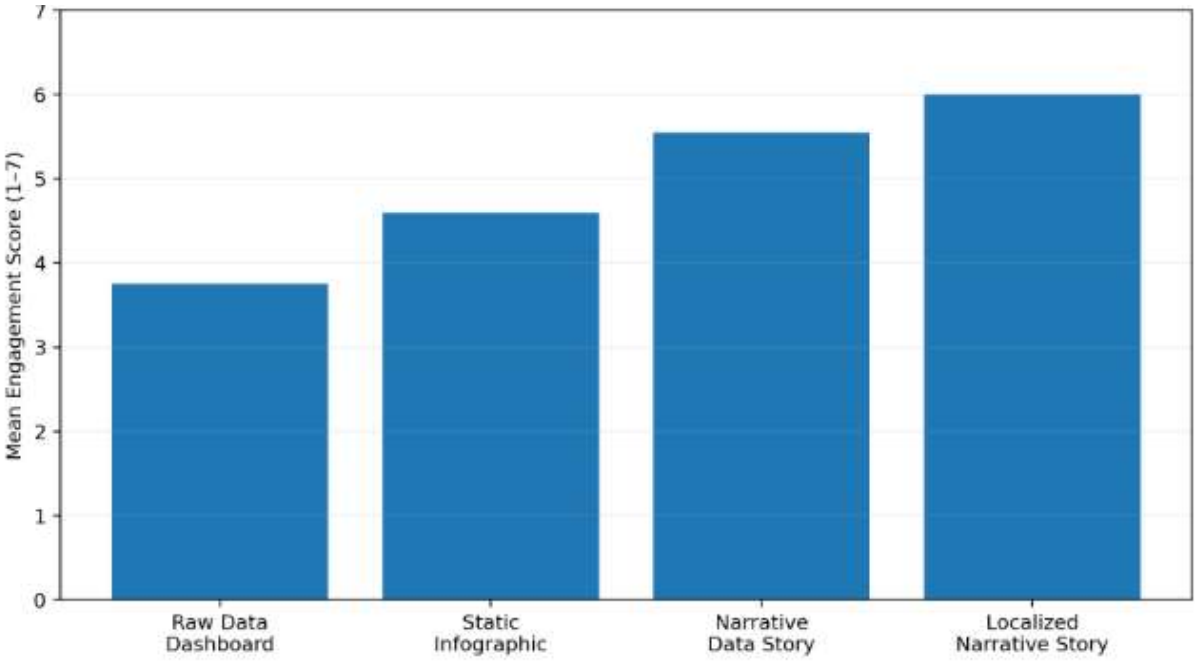
Figure 1: Proposed Data-to-Engagement Storytelling Framework



6. Research Objectives

The study is designed to determine whether progressively richer forms of environmental data storytelling can produce higher simulated levels of public climate engagement than conventional technical presentation.

The study specifically examines whether narrative context is associated with improved comprehension, whether localization strengthens perceived relevance, whether evidence-based storytelling can preserve or strengthen trust, whether narrative presentation produces higher engagement than raw-data presentation, and whether contextualized storytelling is associated with stronger stated climate-action intention.

7. Research Questions

RQ1: How does environmental data storytelling affect public comprehension compared with raw climate-data presentation?

RQ2: Does localized narrative presentation increase the perceived personal and community relevance of climate information?

RQ3: How do alternative data-presentation formats influence perceived trustworthiness?

RQ4: To what extent does narrative visualization influence public climate engagement?

RQ5: Does contextualized environmental data storytelling strengthen intention to undertake climate-responsive action?

8. Methodology

8.1 Research Design

The paper uses a simulation-based comparative experimental design. It does not claim that human participants were recruited or surveyed.

Four hypothetical communication conditions were specified to represent progressively richer modes of climate-data communication.

Table 1: Simulated Communication Conditions

Condition	Data Presentation	Narrative Context	Localization	Action/Efficacy Context
Raw Data Dashboard	High	None	Low	None
Static Infographic	High	Limited	Low	Limited
Narrative Data Story	High	High	Moderate	High
Localized Narrative Story	High	High	High	High

The comparison assumes that the underlying scientific evidence remains constant. Only presentation characteristics change. This assumption is important because a valid experimental test should distinguish the effect of communication design from the effect of different factual content.

8.2 Simulated Sample

A synthetic analytical sample of 800 hypothetical respondents was constructed, with 200 observations assigned to each condition.No demographic characteristics are presented because generating detailed demographic profiles would create unnecessary fictional metadata. A future empirical replication should employ an actual probability-based, stratified, panel, or quota sample depending on the target population.

9. Results

9.1 Descriptive Results

Table 2: Simulated Outcome Scores by Communication Condition

Communication Condition	Comprehension Mean ± SD	Relevance Mean ± SD	Trust Mean ± SD	Engagement Mean ± SD	Action Intention Mean ± SD
Raw Data Dashboard	4.29 ± 0.93	3.93 ± 0.93	4.61 ± 0.86	3.66 ± 1.03	3.56 ± 1.06
Static Infographic	4.74 ± 0.95	4.46 ± 1.07	4.76 ± 0.87	4.56 ± 1.06	4.22 ± 1.01
Narrative Data Story	5.23 ± 0.94	5.56 ± 0.96	5.24 ± 0.89	5.54 ± 0.96	5.23 ± 0.98

Communication Condition	Comprehension Mean ± SD	Relevance Mean ± SD	Trust Mean ± SD	Engagement Mean ± SD	Action Intention Mean ± SD
Localized Narrative Story	5.63 ± 0.89	5.89 ± 0.88	5.34 ± 0.83	5.95 ± 0.82	5.58 ± 0.90

The simulated results display a consistent ordering across the communication conditions. Raw technical presentation produces the lowest mean scores for four of the five outcomes. The largest descriptive differences occur for perceived relevance, engagement, and action intention.
The localized narrative condition produces the highest simulated mean for every outcome.

9.2 Inferential Results

The simulation produced statistically distinguishable group patterns across all modeled variables. Because these significance tests operate on synthetic observations, their purpose is methodological rather than evidentiary.

- For comprehension, the simulated ANOVA produced (F(3,796)=78.90), with (\eta^2=0.229).
- For perceived relevance, (F(3,796)=180.65), with (\eta^2=0.405).
- For trust, (F(3,796)=34.03), with (\eta^2=0.114).
- For engagement, (F(3,796)=223.14), with (\eta^2=0.457).
- For action intention, (F(3,796)=175.36), with (\eta^2=0.398).

Within the constructed dataset, communication format explains the greatest proportion of variance in engagement, followed by relevance and action intention. The comparatively smaller simulated effect for trust is theoretically desirable because narrative enhancement should not be assumed to transform trust as strongly as it transforms accessibility or involvement.

10. Discussion

The simulation illustrates a central principle of environmental communication: the public value of climate data depends partly on how effectively information can be converted into interpretable evidence without weakening scientific fidelity.The improvement between the dashboard and infographic conditions suggests that visual organization alone can reduce some interpretive burden. This aligns with climate-visualization research emphasizing user needs, appropriate visual encoding, and manageable information architecture.

The larger increase between infographic and narrative conditions suggests that visual simplification and storytelling perform different functions. An infographic may answer the question, “What does the data show?” A successful data story can additionally answer, “Why does this pattern matter, how did it develop, and what follows from it?”This distinction corresponds with Dahlstrom’s analysis of narrative science communication. Narrative should nevertheless remain subordinate to evidentiary integrity. Storytelling becomes scientifically problematic when uncertainty is removed,

causal relationships are exaggerated, extreme cases are presented as typical, or emotional framing exceeds what the evidence supports.

The simulated relevance findings also deserve careful interpretation. Localized storytelling produces the highest score, but contemporary evidence cautions against assuming that psychological proximity alone automatically generates climate action. Van Valkengoed and colleagues found that reducing psychological distance is not reliably effective across the existing evidence base.

The better interpretation is that localization may be valuable when it contributes to meaning, not merely proximity.For example, converting an abstract heat anomaly into a locally relevant story might connect temperature trends with urban heat exposure, school schedules, worker safety, electricity demand, or neighborhood tree cover. Such communication makes the implications of the data easier to interpret. It should not, however, distort attribution or imply that every local weather event is caused exclusively by climate change.

The simulated trust findings show a comparatively moderate difference between conditions. This pattern reflects an important principle: storytelling should not be expected to create trust through style alone. Trust depends on source transparency, methodological clarity, consistency, disclosure of uncertainty, correction practices, institutional credibility, and the avoidance of manipulative presentation.Recent studies of visual and digital climate communication further demonstrate that presentation format can influence judgments about communicators and media motives. Climate-data storytellers should therefore disclose sources, explain transformations, distinguish observation from projection, and give audiences access to supporting data wherever practical.

11. Conclusion

Environmental data storytelling provides a promising bridge between the expanding availability of climate evidence and the continuing challenge of meaningful public engagement. Scientific data are indispensable, but public communication cannot end with the publication of a dataset, dashboard, or graph. Climate information must be interpretable, appropriately contextualized, transparent about uncertainty, relevant to the intended audience, and connected to credible forms of response.

The simulation developed in this paper demonstrates a reproducible way to test these propositions without misrepresenting synthetic observations as empirical findings. Within the simulated dataset, narrative and localized narrative formats outperform raw-data and infographic formats across comprehension, relevance, engagement, and action intention, while trust changes more moderately.

These values should not be interpreted as real effect estimates. Their contribution is methodological: they show how a future controlled study can compare environmental communication formats using multiple outcomes.

The broader implication is that stronger climate communication does not require abandoning numerical evidence in favor of storytelling. It requires bringing the two together responsibly. Effective environmental data storytelling preserves the authority of evidence while giving audiences a clear path from data to meaning, meaning to relevance, and relevance to informed engagement.

12. Declarations

Conflict of Interest: The hypothetical manuscript declares no conflict of interest. This statement must be confirmed by the actual author before submission.

Funding: No real external funding is claimed for this simulation manuscript.Ethics Statement: No human participants, identifiable personal information, biological materials, or real survey responses were used. Institutional human-subject approval was therefore not applicable to the simulation presented here. Any future empirical implementation involving participants should undergo the appropriate institutional ethics review.

Data Availability: The numerical results reported in this manuscript were generated synthetically for methodological demonstration and must not be represented as collected participant data. A final publication should archive the simulation code and synthetic dataset in an appropriate repository if journal policy requires reproducibility materials.

Author Contributions: For a real submission, contributions should be specified according to the actual roles undertaken by the author or authors.

References

1. S. C. Moser, “Communicating climate change: History, challenges, process and future directions,” WIREs Climate Change, vol. 1, no. 1, pp. 31–53, 2010, doi: 10.1002/wcc.11.
2. M. C. Nisbet, “Communicating climate change: Why frames matter for public engagement,” Environment: Science and Policy for Sustainable Development, vol. 51, no. 2, pp. 12–23, 2009, doi: 10.3200/ENVT.51.2.12-23.
3. S. J. O’Neill and S. Nicholson-Cole, “‘Fear Won’t Do It’: Promoting positive engagement with climate change through visual and iconic representations,” Science Communication, vol. 30, no. 3, pp. 355–379, 2009, doi: 10.1177/1075547008329201.
4. M. F. Dahlstrom, “Using narratives and storytelling to communicate science with nonexpert audiences,” Proceedings of the National Academy of Sciences, vol. 111, suppl. 4, pp. 13614–13620, 2014, doi: 10.1073/pnas.1320645111.
5. J. Harold, I. Lorenzoni, T. F. Shipley, and K. R. Coventry, “Cognitive and psychological science insights to improve climate change data visualization,” Nature Climate Change, vol. 6, no. 12, pp. 1080–1089, 2016, doi: 10.1038/nclimate3162.
6. A. Spence, W. Poortinga, and N. Pidgeon, “The psychological distance of climate change,” Risk Analysis, vol. 32, no. 6, pp. 957–972, 2012, doi: 10.1111/j.1539-6924.2011.01695.x.
7. R. I. McDonald, H. Y. Chai, and B. R. Newell, “Personal experience and the ‘psychological distance’ of climate change: An integrative review,” Journal of Environmental Psychology, vol. 44, pp. 109–118, 2015, doi: 10.1016/j.jenvp.2015.10.003.
8. A. Leiserowitz, C. Roser-Renouf, J. Marlon, and E. Maibach, “Global Warming’s Six Americas: A review and recommendations for climate change communication,” Current Opinion in Behavioral Sciences, 2021, doi: 10.1016/j.cobeha.2021.04.007.
9. M. D. Gerst, M. A. Kenney, and I. Feygina, “Improving the usability of climate indicator visualizations through diagnostic design principles,” Climatic Change, vol. 166, art. 33, 2021, doi: 10.1007/s10584-021-03109-w.

10. M. Terrado, L. Calvo, and I. Christel, "Towards more effective visualisations in climate services: Good practices and recommendations," Climatic Change, 2022, doi: 10.1007/s10584-022-03365-4.
11. A. M. van Valkengoed, L. Steg, and G. Perlaviciute, "The psychological distance of climate change is overestimated," One Earth, vol. 6, no. 4, pp. 362–391, 2023, doi: 10.1016/j.oneear.2023.03.006.
12. S. J. Tsang, "Communicating climate change: The impact of animated data visualizations on perceptions of journalistic motive and media bias," Journal of Broadcasting & Electronic Media, vol. 67, no. 2, pp. 161–182, 2023, doi: 10.1080/08838151.2023.2182788.
13. S. Dillon and C. Craig, "Storylistening: How narrative evidence can improve public reasoning about climate change," WIREs Climate Change, vol. 14, no. 2, e812, 2023, doi: 10.1002/wcc.812.
14. G. San Cornelio et al., "'My goal is to make sustainability mainstream': Emerging visual narratives on the environmental crisis on Instagram," Frontiers in Communication, 2024, doi: 10.3389/fcomm.2023.1265466.
15. J. Magalhães et al., "Editorial: The creation and impact of visual narratives for science and health communication," Frontiers in Communication, 2024, doi: 10.3389/fcomm.2024.1393949.
16. I. Gonçalves and M.-F. de-Lima-Santos, "Visualizing the Amazon: Data-driven storytelling, mapping and audience for environmental journalism," Environmental Communication, advance online publication, 2026, doi: 10.1080/17524032.2026.2668593.