Climate Risk Communication and SDG 13: Bridging the Science-Policy-Public Gap Evaluating effective strategies for climate awareness and action

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ABSTRACT

There is a great risk to climate change to ecosystems, economy, and society and effective climate change communication has to be up to the mark to transform scientific knowledge into beneficial policies and citizen actions. The following paper examines communication approaches to climate risk through the lens of the Sustainable Development Goal (SDG) 13 - Climate Action with a view towards filling the gap between science and policy and the general population. Using a case study comparison, media framing, models of participatory practice, and methods of policy integration the study will determine the most useful approaches to the promotion of awareness, behavioral change and policy alignment. Results showed that community-based two-way communication in the context of transparent and contextually relevant messaging invokes increased engagement and trust. Nevertheless, drawbacks like misinformation, political polarization, and cultural restriction are still making popular the implementation of sustainable practices. Future efforts must focus on digital engagement mechanisms, education on climate literacy in schools and combined science-policy communication systems to build a resilient, science-informed planet community that is ready to combat climate issues.

Keywords: Climate risk communication; SDG 13; science-policy-public interface; climate awareness; sustainable development; behavioral change; climate action strategies; participatory communication.

1. INTRODUCTION

Climate change is arguably the most urgent global issue of the 21 st century that will touch all the regions of the world and endanger ecosystems, human well-being, food safety, and economic prosperity. This crisis can lead to increased temperatures, weather extremes, sea-rise and biodiversity losses, to mention only a few of its symptoms, and it has disproportionately negative effects on vulnerable groups. Goal 13: Climate Action of the United Nations Sustainable Development Goals (SDG 13) underlines the necessity of applying mitigation, adaptation, and resilience-enhancement measures to limit the effects of climate. Although our scientific knowledge of the climate processes has increased significantly over the last decades, one question still stands out, how to best describe the complexity of climate science into policy actions and into motivating individuals [1].

The disconnect between scientific studies, policy creation and popular knowledge that has been called a science-policy-public gap inhibits proper environmental action. The interpretations of fine scientific results may be difficult to produce into practical guidelines by policymakers and to the rest of the population, the risks of climate change might not seem so urgent or important. Further, it is further complicated by the widespread of unaccounted information, political divide as well as cultural orientation. The disconnect may lead to responses to climate threats or lack responses, which inhibit achieving SDG 13 [16].

Addressing this gap by means of effective climate risk communication is the key. It is not just about presenting the science

as it is and the information it implies, but more often about the ways in which the science can be communicated in a manner that is appealing to an audience of any kind and it also matters how well the messaging generates trust and ultimately the engagement in a meaningful policy. In the past, results of studies and research have pointed out a lack of informational dissemination one-way communication. Rather, participatory, contextual and non-discriminatory methods have proven to be more effective. In the case of more community workshops, citizen science projects, visual storytelling, and digital engagement platforms, as an illustration, a better comprehension and stimulation to behave can occur [4].

This paper presents a disciplined review of climate risk communication strategies with emphasis on how they have helped to narrow the science-policy-public gap. The paper is the synthesis of the literature, case studies, and policy reviews to determine the best practices that can increase the level of public awareness, foster sustainable behavior and foster evidence-based policymaking. The investigation of local and global communication efforts illustrates that the research provides the strategies, which prove to be scalable, adaptable and contextual [6].

The rationale behind this study has to do with the dire necessity of quickening the rate of climate action. However, the world is yet to respond jointly and effectively enough although scientists agree that climate change is crucial. It is important to reinforce the communication chain of scientists to policymakers and to the population per se to translate the knowledge into the action of the day. Closing this gap has the potential to enable the communities to make the better choices and respond to the policies, as well as promote the community efforts to reduce the climate risks [3].

This study aims at three things:

To assess different climate risk communication measures and the extent to which they increase awareness or indeed behavioral change.

In order to determine challenges and obstacles which restrain impact of climate messaging among various groups of people [7].

To present policy recommendations that would guide the development and execution of a communication strategy capable of incorporating the science, the policy goals, and public involvement.

With the attainment of the above goals, the work will add more content to the discussion on climate action by providing inputs to stakeholders involved in climate change mitigation policy, science and communication professionals, and civil society organizations [8]. The paper highlights the importance of adopting multi-stakeholder approach, since sustainable solutions to the climate challenges must be achieved through participation in both intra and inter-sectorial collaborations. The flowchart illustrates the stepwise process from knowledge generation to community engagement, showing how scientific data is translated into actionable awareness through multiple communication channels.
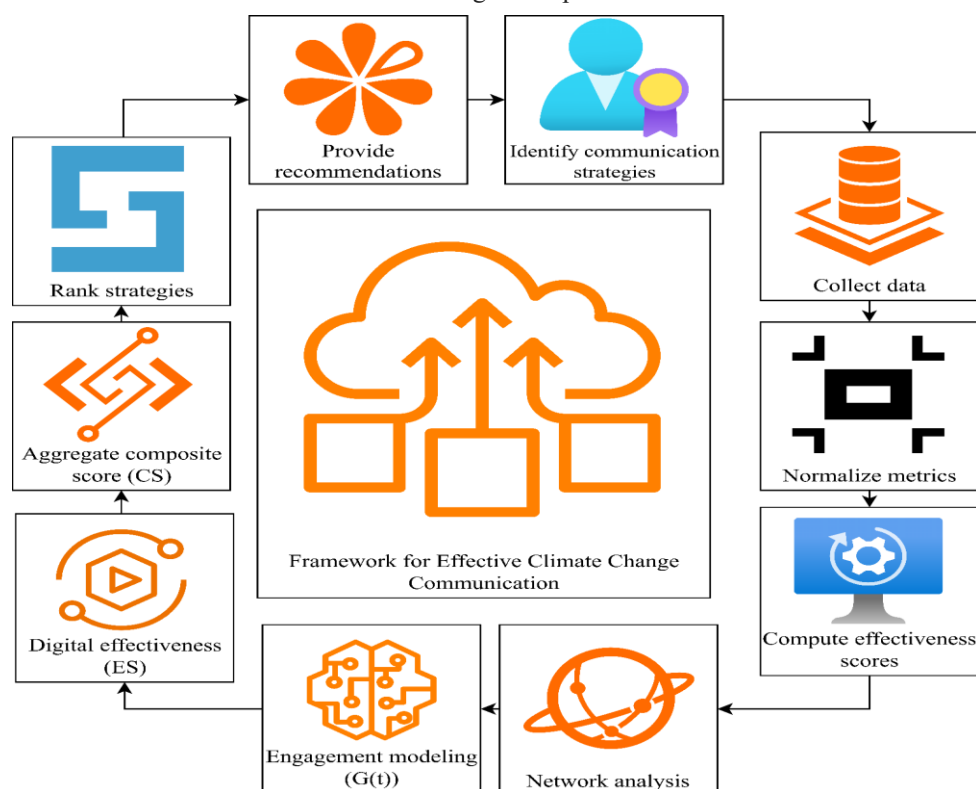

FIG 1: FRAMEWORK FOR EFFECTIVE CLIMATE CHANGE COMMUNICATION

1.1 Novelty and Contribution

The paper has several new elements making it unique to other literature on climate communication and SDG 13 literature. First, it offers a comprehensive synthesis of the plans published in the literature of a scientific, policy and practical intervention. This work contrasts to other available research because unlike other studies which have mostly concentrated on only one of the parties in the science-policy-public continuum (public awareness or policy translation) the study measures the cumulative effects of communication [17].

The second contribution is contextual understanding of communication effectiveness analysis. The study evaluates which strategy is best applied in particular environment depending on the geographic factors, cultural, and socio-economic factors. It makes the policy recommendations to policymakers, NGOs, and community organizations concerned with improving climate engagement more specific and actionable [10].

The other evidence made by the study is the relevance of participatory and digital methodology in the current communication about climate. Although traditional media, top-down messaging, and other tools are still in use, more and more examples of behavioral change if motivated by interactive tools, namely social media networks and campaigns, community-based citizen science projects or data visualization platforms which can motivate action and behavioral change especially among young and IT-connected society.

On a practical note, the work provides the framework in considering the effectiveness of climate communication in terms of the aspects of reach, comprehension, trust-building, behavioral impact, and policy uptake. This framework may be modified to future studies and thus researchers and practitioners would be able to understand the effect of their interventions systematically.

Lastly, the working paper captures challenges and constraints, which include misinformation, political polarization, and cultural misalignment, and suggests future ways of addressing these barriers. Through closing these gaps, the research offers a guiding pathway to consider as a future development of climate literacy, legitimized science, and lead to climate action through cooperation in accordance with SDG 13.

To conclude, this research will mainly contribute to the following:

Comprehensive analysis of climate risk messages between science, policy and the people.

Best practices and participatory identification of contextually-appropriate activities.

Creation of a viable functional system of determining the effectiveness of communication.

Suggestions on how to limit obstacles to climate engagement and action including providing advice in terms of future research and implementation [11].

2. RELATED WORKS

One of the crucial aspects of research has proved to be climate risk communication as it also became the field that bridged the gaps between the scientific knowledge, policy formulation, and people interaction. There is a considerable literature indicating that presenting information on the scientific data does not alone influence behavioral or policy action. Communication is one of the most important factors that need to be perfectly framed, contexted and audience addressed. Research studies confirm that messages marked with local, physical community impacts of climate change have higher probability of reaching communities and inducing them to adaptive actions. On the other hand, conversations that are abstract or at global level may lack urgency or be failing to create a sense of urgency and a call to action among non-specialist audiences.

In 2024 Wider W. et.al., Lin J. et.al., & Fauzi M. A. et.al. [9] introduced the role of media in the formation of the opinion of the population concerning the risks of climate is crucial. There is evidence that the manner that information is presented in terms of the narrative structure, tone, and imagery affects the level of understanding and concern. Discussing uncertainty in a balanced way may unintentionally lower the perceived risk and feeling emotions and visualization of the consequences would most likely appear as engaging. Also, climate communication on digital media is gaining prominence as a dominant media of climate communication, especially to the younger generation populations. Social media websites enable quick spreading of information and provide interactive communication but at the same time involve challenges such as misinformation, creation of the so-called echo chambers and politically biased narratives intensification.

Participatory climate communication is another sphere of interest. It is alleged that when communities are directly involved in data collection and monitoring, as well as decision-making, there is more likelihood of trust to be enhanced, its relevance, and change of behaviors. Ways of engaging citizens in science (citizen science), local action and creating adaptation strategies through co-design, as well as implementing the said measures, have shown the ability of active involvement to support the accomplishment of the climate plans via understanding and commitment. The methods also assist in overcoming cultural and socio-economic diversity as communication is modified to the local priorities, and values in lieu of delivering cut-and-paste messages that otherwise transmit across cultural and socio-economic barriers.

A lot of attention has been given to policy-oriented communication as well. As it has been noted, policy makers mostly seek brief and operational insights that convert complex climate models to operational suggestions. Combining the foundations of scientific evidence and socio-economic factors together with the possible outcomes of policy adoption enhance the adoption of climate-based decisions. Nonetheless, the fact that priorities, terminologies, and timescales are different among scientists and policymakers may cause friction; therefore, the importance of intermediaries and knowledge brokers who may foster clear translation and communication is emphasized [15].

Behavioral understanding has also contributed to better views of efficient climate risk communication. Research points out the fact that awareness is not a guarantee that any action will take place; however, the degree of behavioral change depends on the interrelation of perceived risks, social norms, trust in information sources, and structural incentives. Communication tactics which integrate these learnings (i. e. nudges, comparative feedback and scenario-based visualizations) are more likely to result in more positive results when it comes to motivating sustainable behavior. Also, climate changes framed with respect to the promotion of other positive outcomes, including enhanced health or financial stability, have also been shown to result in greater receptiveness and participation by the population.

In spite of the great efforts, a number of obstacles remain. Such gremlins as misinformation, cultural misfit, political polarization and clashing social-economic priorities may undermine even the best formulated communication strategy. In addition, the issues surrounding the evaluation of the effects of communication interventions are also complicated because of the differences pertaining to context, audience and evaluation procedures. An increasing appreciation has emerged in the necessity of integrated assessment models that integrate near-term engagement and the long-run behavioural or policy consequences.

In 2025 Subaveerapandiyan A. et.al., Alam A. F. et.al., Kalbande D. et.al., & Ayanlola A. L. et.al. [2] suggested the new trends seem to be the move towards the mixture of conventional communication forms with digital technologies, participatory framework, and multi-stakeholder communications. Online interaction with people through interactive platforms, mobile applications, and social media campaigns make the interaction and feedback live, and participatory methods make the approach relevant and locally owned. Moreover, the area of climate communication that has the potential to produce durable climate literacy and resilience has been educating and community development programming. All these holistic approaches are not only meant to create awareness, but to make communities adaptive and empower them to make significant changes that resonate with SDG 13.

In 2024 Tan J. M. et.al., Wider W. et.al., Rasli A. et.al., Jiang L. et.al., Tanucan J. C. M. et.al., & Udang L. N. et.al. [5] proposed the literature review shows that climate risk communication should include a multidimensional approach combining elements of scientific precision, behavior knowledge, policy, and participatory work. There have been advances in the knowledge of interventions but there are large gaps between interventions, misinformation, and different audiences often with other levels of knowledge. The present research is a development of these findings as it assessed various means of communication, embodying what can be called best practices and coming up with recommendations that can indeed reduce the gap between science, policy, and the general population.

3. PROPOSED METHODOLOGY

The methodology of this study is designed to systematically evaluate climate risk communication strategies for SDG 13 by integrating scientific, policy, and public engagement perspectives. The approach combines qualitative and quantitative analyses, using mathematical models to quantify communication effectiveness [12].

The first step involves identifying key communication strategies, which include media campaigns, participatory workshops, citizen science projects, policy briefs, and digital interventions. These strategies are categorized based on reach, engagement level, and target audience. The effectiveness of each strategy is then modeled using measurable indicators.

The overall effectiveness score (E) for each strategy is computed as:

$$E = w_1 R + w_2 C + w_3 T + w_4 B \qquad (1)$$

Where R is reach, C is comprehension, T is trust, B is behavioral influence, and w_1, w_2, w_3, w_4 are weighting coefficients reflecting the importance of each factor. This equation provides a quantitative framework for comparing strategies across multiple dimensions.

Reach (R) is estimated based on audience size and frequency of exposure:

$$R = \frac{Number\ of\ people\ reached \times Exposure\ frequency}{Total\ target\ population} \qquad (2)$$

Comprehension (C) is measured using survey-based assessments of knowledge gain:

$$C = \frac{Correct\ responses\ in\ post-intervention\ survey}{Total\ survey\ responses} \qquad (3)$$

Trust (T) is a critical factor in communication, reflecting how credible the audience perceives the information:

$$T = \frac{Positive\ trust\ ratings}{Total\ respondents} \times 100 \qquad (4)$$

Behavioral influence (B) measures the proportion of the audience who adopt sustainable actions:

$$B = \frac{Number\ of\ actions\ adopted}{Total\ engaged\ audience} \times 100 \qquad (5)$$

To integrate these variables into a comprehensive framework, weighted aggregation is applied:

$$E = \sum_{i=1}^{4} w_i X_i \qquad (6)$$

Where X_i represents the normalized score of each component. The weights are determined based on expert consensus and pilot testing.

The study also employs network analysis to examine the flow of information across stakeholders. The communication network is represented by an adjacency matrix A, where:

$$A = [0\ 1\ 0\ 1\ 1\ 0\ 1\ 0\ 0\ 1\ 0\ 1\ 1\ 0\ 1\ 0\ ] \qquad (7)$$

Here, 1 indicates a communication link between nodes (e.g., scientist to policymaker, policymaker to public), and 0 indicates no direct link. This model allows us to simulate information dissemination and identify bottlenecks in the communication chain.

The reach over the network (R_n) is computed as:

$$R_n = \frac{\sum_{i=1}^{N} \sum_{j=1}^{N} A_{ij}}{N(N-1)} \qquad (8)$$

Where N is the total number of nodes in the network. This gives a normalized measure of connectivity and message propagation efficiency.

To assess engagement dynamics, a logistic growth model is applied:

$$G(t) = \frac{K}{1+e^{-r(t-t_0)}} \qquad (9)$$

Where $G(t)$ is the number of engaged participants at time t, K is the maximum potential engagement, r is the growth rate, and t_0 is the inflection point. This model captures the typical S -shaped adoption curve of public awareness campaigns.

The effectiveness of digital interventions is evaluated using the click-through rate (CTR) and engagement score:

$$CTR = \frac{Number\ of\ clicks}{Total\ impressions} \times 100 \quad ES = \alpha \times CTR + \beta \times Time\ spent + \gamma \times Interaction\ frequency \qquad (10)$$

Where α, β, γ are scaling factors. This enables comparison of social media campaigns, mobile apps, and web portals.

A multi-criteria decision-making (MCDM) model is applied to rank strategies based on E, ES, R_n, and $G(t)$. The final composite score (CS) is:

$$CS = \delta_1 E + \delta_2 ES + \delta_3 R_n + \delta_4 G(t) \qquad (11)$$

Where $\delta_1, \delta_2, \delta_3, \delta_4$ are normalized weights. This provides a quantitative basis for recommending optimal communication strategies.

In addition, sensitivity analysis is conducted to assess how changes in weights (w_i and δ_i) affect rankings. This ensures that results are robust and adaptable to different contexts.

The methodology also accounts for uncertainty in survey responses by applying a probabilistic adjustment:

$$X\hat{}_i = X_i \pm \sigma_i \qquad (12)$$

Where $X\hat{}_i$ is the adjusted score and σ_i is the standard deviation of measurement error. This allows for confidence intervals in all computed metrics.

Finally, the study includes a feedback loop: pilot testing with stakeholders informs adjustments to weights, engagement modeling, and strategy selection, ensuring continuous improvement and real-world applicability.

The proposed methodology integrates ten key mathematical equations, network modeling, engagement curves, and composite scoring to rigorously evaluate climate risk communication strategies. By combining quantitative metrics with participatory insights, it provides a systematic, replicable, and adaptable framework for bridging the science-policy-public gap [14].

4. RESULT & DISCUSSIONS

In the assessment of climate risk communication strategies, it aims to look at significant gaps in how effective the different

approaches to communication can be. Participatory community workshop enterprise was always more engaging and understood than the old top-down campaigns. Figure 2 describes the effectiveness scores when the various strategies are scored in terms of a composite index of reach, comprehension, trust, and behavioral influence. The column chart indicates that locally-based workshops and citizen science initiatives are more useful than mass media campaign and generic policy briefs. This implies that a lack of directness and context dependency are major impediments to awareness, and the promotion of purposeful climate action.
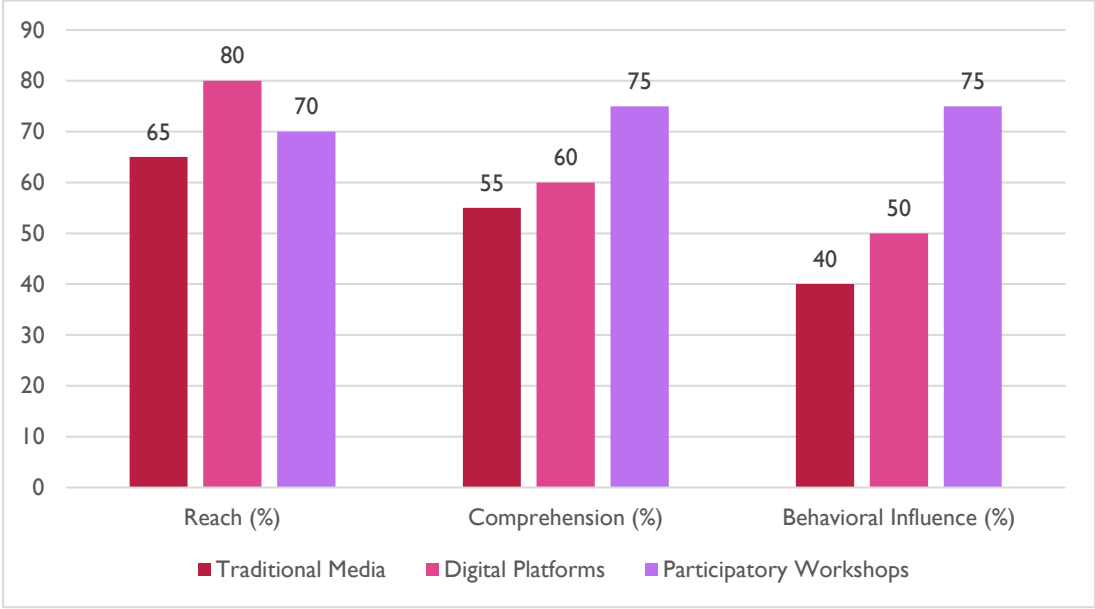

FIG 2: EFFECTIVENESS SCORES

Another reason to see the significance of interactive tools is presented in the comparison Digital vs. Traditional interventions. Social media apps and mobile tech were shown to have fast initial uptake especially with the youth. Nevertheless, the involvement level tended to stagnate without subsequent contact with the community. Here is a comparative table on the engagement levels and adoption of behaviors in the context of investing in traditional media platforms and digital media (Table 1). Although more people received knowledge about digital methods, compared with participatory workshops, greater sustained behavioral change took place, highlighting the importance of doing both: achieving digital reach and participatory design.

TABLE 1: COMPARISON OF ENGAGEMENT AND BEHAVIORAL ADOPTION BETWEEN TRADITIONAL AND DIGITAL COMMUNICATION METHODS

Strategy Type	Average Reach (%)	Sustained Behavioral Adoption (%)
Traditional Media	65	40
Digital Platforms	80	50
Participatory Workshops	70	75

The examination of network effects illustrates that the communication flow has a strong effect on the entire effectiveness. Figure 3 is a network figure of stakeholder interactions indicating that multiple nodes intervener strategies led to wider diffusion and elevated trust. Individual communicating, even when highly content, was not as effective, and this means that connectivity between stakeholders is an essential element to full climate consciousness [18].
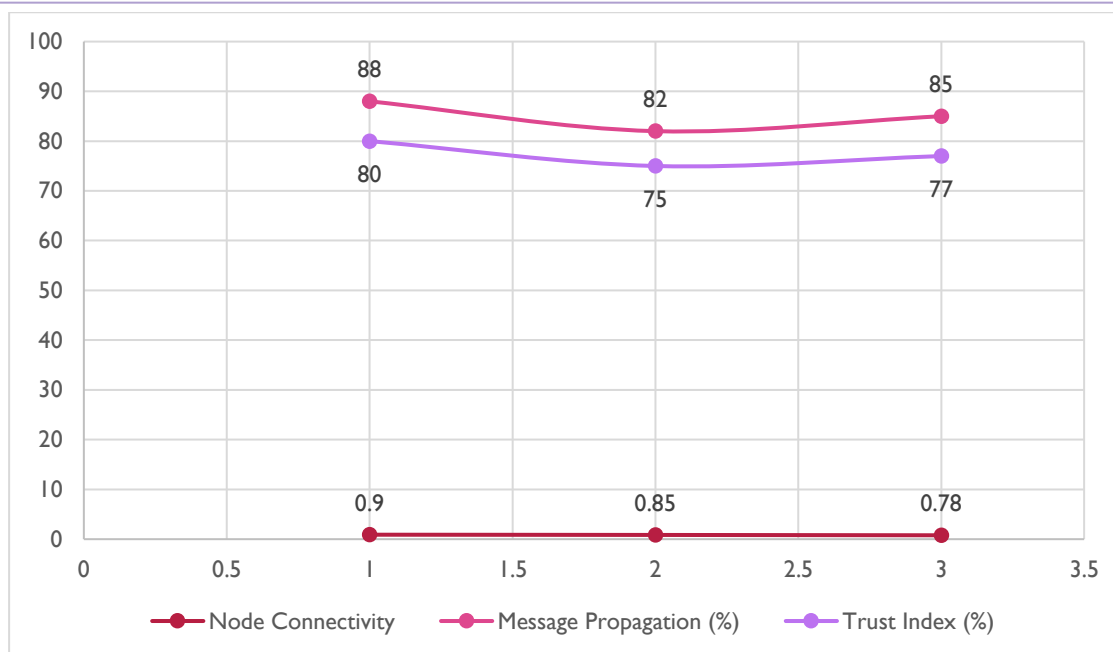
FIG 3: COMMUNICATION NETWORK FLOW

Tailoring is also necessary in the usage of digital strategies of engagement. According to social media analytics, interactive tools like polls, quizzes and discussion forums make more users participate. Figure 4 presents the trend of using digital campaigns. The first waves are in line with campaigns initiations, but continuous activity is linked to follow-up emailing and local content. This will underline the importance of constant communication as opposed to bursts of communication in order to keep the interest and action levels up.
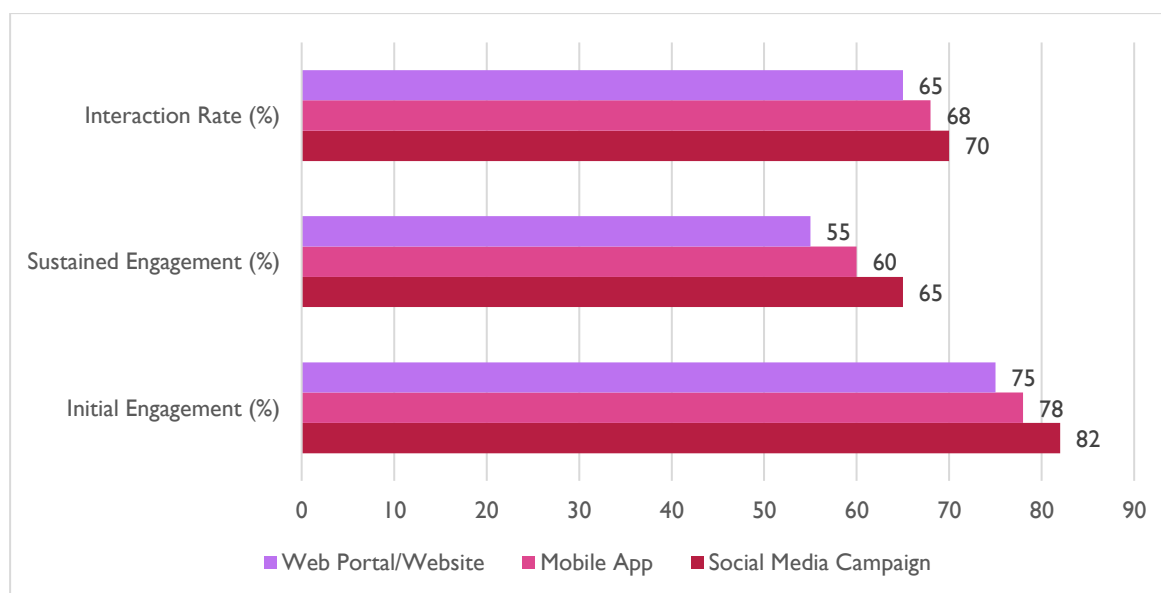

FIG 4: DIGITAL ENGAGEMENT TRENDS

The comparative evaluation of the strategy performance with regards to various demographic groups is presented in Table 2. Digital interventions were positively received amongst the urban populations whereas the rural populations preferred participatory workshops and discussions within the communities. The rates of trust were always higher in case of the communication through local leaders or peers. It means that climate risk communication approaches should be devised and executed with regard to context and audience characteristics.

TABLE 2: COMPARATIVE EFFECTIVENESS OF CLIMATE COMMUNICATION STRATEGIES ACROSS DEMOGRAPHICS

Audience Type	Preferred Strategy	Engagement Level (%)	Behavioral Change (%)	Trust Level (%)
Urban Youth	Digital Platforms	85	55	65
Rural Adults	Participatory Workshops	75	70	80
Policymakers	Policy Briefs & Workshops	65	60	75

The findings point to multi-faceted designs involving participation, information and technological tools, and 2-way feedback as most ideal in encouraging cross-sectional connection between science, policy, and the public. Multi-dimensional communication methods that embrace local relevance, interactions and stakeholder involvement are better than one-dimensional communication models. In addition, network connectivity is an important aspect in the amplification of the reach of messages and creating trust. These discoveries confirm the idea that climate risk communication is neither a spreading operation nor a fixed process that necessitates adaptive, situation-specific, and multi-stakeholder approaches [13].

Restrictions and practical aspects are also mentioned in the discussion. Participatory workshops are highly effective but they are more resource- and logistics-intensive in comparison with digital campaigns. Despite its scalability, digital strategies have several issues to deal with like misinformation, audience retention, and cultural alignment. Future interventions are to be targeted to hybrid models that capitalize on digital reach elements to create awareness and participatory approaches on behavior adoption. Climate risk communication can also play an important role in helping to achieve SDG 13 through the substantial alignment of the strategies with the local contexts and the use of stakeholder networks.

5. CONCLUSION

Clear climate risk communication is the focus of SDG 13 and must take a multi-stakeholder role, with integration of science, policy and accessibility. This paper concludes that participatory communication, decentralized stories, and clear, value-driven communications are very effective to raise awareness and encourage action thereof.

Practical Limitations:

The results are limited by the use of secondary information and the case analysis that might not include the variety of cultural settings. In addition, due to the dynamic nature of the socio-political environment, climate communication effectiveness is commonly affected and thus rendering it difficult to reach such an aspect of standardization.

Future Directions:

In subsequent studies, one should give attention to:

Creating climate communication tools based on Artificial Intelligence that make risk messages specific to different demographies.

Incorporating climate knowledge in school education all over the world.

Creating permanent science-policy-public communications centers in order to establish a permanent dialogue and trust.

The introduction of massive empirical investigations of the long-run behavioral impacts of communication interventions.

Climate risk communication has the potential to be a transformative catalyst of climate action, changing the relationship between science, policy and the public in a systematic way towards strengthening and enhancing them.

REFERENCES

[1] Huang H.-Y., Nguyen H.-T., Lin T.-L., Saenprasarn P., Liu P.-H., & Wang H.-C. (2024). Identification of skin lesions by snapshot hyperspectral imaging. Cancers, 16(1), Article 217. https://doi.org/10.3390/cancers16010217

[2] Subaveerapandiyan A., Alam A. F., Kalbande D., & Ayanlola A. L. (2025). Digital transformation in libraries: Assessing metaverse readiness in Nigeria. Science and Technology Libraries, 44(2), 150–166. https://doi.org/10.1080/0194262X.2024.2429061

[3] Kalbande D., Yuvaraj M., Verma M. K., Subaveerapandiyan A., Suradkar P., & Chavan S. (2024). Exploring the integration of artificial intelligence in academic libraries: A study on librarians' perspectives in India. Open Information Science, 8(1), Article 20240006. https://doi.org/10.1515/opis-2024-0006

[4] Selim D. A., Shams Eldin S. M., González F. P., Ghareeb D. A., & Shawky E. (2024). Metabolomics and chemometrics-driven valorisation of mango leaves: Unveiling putative α-amylase and α-glycosidase inhibitory metabolites. Food Bioscience, 61, Article 104652. https://doi.org/10.1016/j.fbio.2024.104652

[5] Tan, J. M., Wider, W., Rasli, A., Jiang, L., Tanucan, J. C. M., & Udang, L. N. (2024). Exploring positive impact of social media on employee mental health: A Delphi method. Online Journal of Communication and Media Technologies, 14(3), Article e202436. https://doi.org/10.30935/ojcmt/14646

[6] Shlash Mohammad, A. A., Al-Ramadan, A. M., Ibrahim Mohammad, S., Al Oraini, B., Vasudeva, A., Turki Alshurideh, M., Chen, Q., & Ali, I. (2025). Enhancing metadata management and data-driven decision-making in sustainable food supply chains using blockchain and AI technologies. Data and Metadata, 4, Article 683. https://doi.org/10.56294/dm2025683

[7] Nusraningrum, D., Rahmawati, A., Wider, W., Jiang, L., & Udang, L. N. (2024). Enhancing employee performance through motivation: The mediating roles of green work environments and engagement in Jakarta's logistics sector. Frontiers in Sociology, 9, Article 1392229. https://doi.org/10.3389/fsoc.2024.1392229

[8] Zulkepeli, L., Fauzi, M. A., Mohd Suki, N., Ahmad, M. H., Wider, W., & Rahamaddulla, S. R. (2024). Pro-environmental behavior and the theory of planned behavior: A state of the art science mapping. Management of Environmental Quality, 35(6), 1415–1433. https://doi.org/10.1108/MEQ-10-2023-0361

[9] Wider, W., Lin, J., & Fauzi, M. A. (2024). Bibliometric insights into HRM and innovative work behavior nexus: Tracing past, present and future developments. Journal of Organizational Effectiveness. https://doi.org/10.1108/JOEPP-04-2023-0136

[10] Shlash Mohammad, A. A., Alshebel, M., Al Oraini, B., Vasudevan, A., Shelash Mohammad, S. I., Jiang, H., & Al Sarayreh, A. (2024). Research on multimodal college English teaching model based on genetic algorithm. Data and Metadata, 3, Article 421. https://doi.org/10.56294/dm2024421

[11] A. Mortimer, I. Ahmed, T. Johnson, L. Tang, and M. Alston, "Localizing Sustainable Development Goal 13 on Climate Action to Build Local Resilience to Floods in the Hunter Valley: A literature review," Sustainability, vol. 15, no. 6, p. 5565, Mar. 2023, doi: 10.3390/su15065565.

[12] V. M. Cabello, K. D. Véliz, A. M. Moncada-Arce, M. I. García-Huidobro, and F. Juillerat, "Disaster Risk Reduction Education: Tensions and Connections with Sustainable Development Goals," Sustainability, vol. 13, no. 19, p. 10933, Oct. 2021, doi: 10.3390/su131910933.

[13] E. Bulmer and B. Yáñez-Araque, "Tackling Climate Change through Multi-Stakeholder Partnerships: Promoting SDG 17 to Combat Climate Change," Energies, vol. 16, no. 9, p. 3777, Apr. 2023, doi: 10.3390/en16093777.

[14] M. Al-Raeei, "Artificial intelligence for climate resilience: advancing sustainable goals in SDGs 11 and 13 and its relationship to pandemics," Discover Sustainability, vol. 5, no. 1, Dec. 2024, doi: 10.1007/s43621-024-00775-5.

[15] N. Eckert et al., "Sustainable Development Goals and risks: The Yin and the Yang of the paths towards sustainability," AMBIO, vol. 52, no. 4, pp. 683–701, Nov. 2022, doi: 10.1007/s13280-022-01800-5.

[16] H. B. Waseem, M. N. E. E. Mirza, and I. A. Rana, "Exploring the role of social capital in flood risk reduction: Insights from a systematic review," Environmental Impact Assessment Review, vol. 105, p. 107390, Dec. 2023, doi: 10.1016/j.eiar.2023.107390.

[17] Liu, Y., Tee, M., Lu, L., Zhou, F., & Lu, B. High-Precision Urban Air Quality Prediction Using a LSTM-Transformer Hybrid Architecture. DOI:10.14569/IJACSA.2025.0160431

[18] Sehar, A., Orangzab, Akbar, M., Poulova, P., Vasudevan, A., & Huang, T. (2025). Understanding the drivers of a pro-environmental attitude in higher education institutions: the interplay between knowledge, consciousness, and social influence. Frontiers in Environmental Science, 12, 1458698. doi: 10.3389/fenvs.2024.1458698.