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Review Article

Multidisciplinary perspective: A review of the importance of communication in managing climate change challenges

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ABSTRACT

Climate change is a global issue that affects the entire world, associated with greenhouse gas emissions and resulting in long-term changes in climate conditions. Scientists conduct numerous research studies focused on climate change and mitigating its effects, making it a central topic of discussion. Overall approaches are typically centered around sustainability and reducing greenhouse gas emissions through green and innovative technologies. However, these approaches and scientific expressions can appear complex and abstract to the public, governments, and civil society organizations. In this regard, the role of communication is significant in creating long-term awareness among the public and generating action-oriented solution proposals. The use of effective language and storytelling techniques, localization, visualization, and effective use of media can help contextualize climate change issues, raise awareness, and build consciousness. The role of communication is undeniable in breaking down barriers between scientists and the public, ensuring that solutions to climate change problems are sustainable and effective, and facilitating the development of appropriate policies by governments and civil society organizations. It is essential to prioritize and conduct advanced research and develop innovative strategies for coordinated efforts between scientists and communication experts in addressing climate change and developing effective solutions. The scope of this review is to examine the role of communication in addressing climate change. This article provides an overview of climate change, its impacts, and solutions, explores the relationship between climate change and communication, and highlights the explanation of communication strategies and intergenerational connectivity to increase awareness of climate change.

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INTRODUCTION

Atmosphere, biosphere, seas and oceans, glaciers and terrestrial regions constitute the climate system, and solar radiation, ocean currents, precipitation patterns, surface characteristics, and human factors form and alter this climate system [1]. Climate change is triggered by existing greenhouse gas emissions, primarily carbon dioxide (CO_2), and increases the temperature of the Earth's atmosphere, serving as the main cause of global warming [2, 3]. Besides greenhouse gases generated by natural processes like respiration, fermentation, and volcanic activity, these gases also stem from diverse industrial operations, inadequate waste management, deforestation, and notably, the combustion of fossil fuels, responsible for approximately 65% of greenhouse gas emissions [4, 5].

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A climate crisis is the negative effects of incremental and cumulative disasters caused by climate change, from the environment and health to social life and psychology [6]. Numerous factors influence the atmospheric CO_2 concentration, which reached 421 ppm in 2022 in the context of climate change. Current estimates suggest that if we do not control the atmospheric CO_2 concentration, global warming could increase by 3–5 °C by 2100. This situation leads to a climate crisis [7, 8]. For example, researchers determined that 2023 was the hottest year in human history, observing heat waves in various regions and a general increase in deaths due to these heat waves [9]. Furthermore, experts predict that children under the age of 5 will bear nearly 90% of the disease burden due to climate change, a situation that will impact the rest of the population and future generations, leading to both mental and physical harm to society [10]. Accordingly, an increase in steric sea level of 0.34±0.16 mm/year was observed in the Pacific Ocean between 2005 and 2019, and an average increase of 3.3 mm/year in global sea level was observed between 1993 and 2018 [11]. Changes in water cycles cause changes in salinity as well as warming of the oceans, which, according to climate model predictions, causes changes in the biological functions of the ocean [12]. Outside of the oceans, when looking at tree dimensions in the forestry sector as well, it has been observed that over the last 50 years, the diameter/volume growth of tree species in Central and Northern Europe has varied from -1% to +99%, while in Southern Europe, it has decreased from -12% to -49% [13].

In recent years, climate change and the climate crisis have been affecting not only environmental and natural sciences, but also geography, sociology, psychology and political science [14]. In this context, global warming and climate change have emerged as the most pressing threat facing the world today, necessitating concerted action through integrated efforts from both the natural and social sciences. Tackling these anthropogenic sources of greenhouse gas emissions is essential to mitigating the consequences of climate change. In recent years, the notion of achieving net-zero emissions has gained prominence. However, it is crucial to underline that the success of this concept relies on ensuring the maintenance of social, economic, political, and environmental integrity [15, 16].

In today's world, the concept of sustainability is not only relevant to the natural sciences but also attracts the attention of social sciences, humanities, and arts fields to create positive global social and environmental change and achieve integrated sustainability [17]. In recent years, understanding public perception and behavior towards climate change, observing how it is understood by the public, mass media, strategic communication, and how communication influences public perception and behavior towards climate change has drawn the attention of researchers [18]. Climate change communication is a complex system that encompasses not only the content and form of this communication, but also scientists, communication professionals, political and social environments. The complexities to effective climate change communication are many, diverse and often interconnected [19]. Explaining and communicating the climate crisis and its consequences correctly, adopting sustainable practices, switching to renewable energy sources, and raising public awareness are key steps towards reducing the carbon footprint and mitigating the effects of global warming [3, 20].

This review provides a concise overview of the impacts of the climate crisis, highlights strategies for reducing greenhouse gas emissions, and emphasizes the significance of communication to increase understanding and awareness of climate change and global warming. The purpose of this article is to investigate how communication could contribute to addressing climate change, as well as to review the studies conducted in this field. The review discusses climate change, the climate crisis, and strategies to combat it, delves into the role of communication in addressing this challenge, thoroughly examines relevant communication strategies and studies in this field and explains intergenerational connectivity in climate change. This study is valuable in providing readers with a multidisciplinary perspective on the natural and social sciences in addressing climate change, as well as in recognizing the role and importance of proper communication and understanding of climate change.

Climate Change

With the increase in greenhouse gas emissions and the consequent rise in global atmospheric temperatures, observable effects of climate change on the earth's ecosystem include shifts in seasons, changes in the frequency and intensity of weather events, increased frequency of hot days, decreased frequency of cold days and nights, desertification, melting of polar glaciers, and rising sea levels, forest fires and acid rains [21–23]. Along with these effects, seasonal changes have an impact on industries like tourism [24], building and transport [7, 25], food, and energy [26, 27], as well as habitat loss, changes in the timing of species migration, increased extinction rates [28], threats to agriculture and food security [27], and the increased occurrence of natural disasters [29, 30]. The escalating disasters, shifts in agriculture and water resources, along with the increasing migration due to these changes, have brought about the emergence of the climate crisis [6]. Sectors affected by climate change and how they are/will be affected by climate crisis are summarized in Figure 1.

This crisis necessitates urgent action, as it has particularly adverse effects on the well-being of children worldwide. This crisis has a particularly negative impact on the well-being of children worldwide, and is generating negative public sentiments. The eco-anxiety and climate change-related concerns, especially among Generation Z, is an important issue as it triggers new directions in environmental thinking and awareness. Raising awareness among all sectors of society to prioritize action on this issue is crucial for the future of the world and generations to come [31, 32]. Also, increasing temperatures and extreme weather conditions threaten food security, leading to deteriorating food quali-

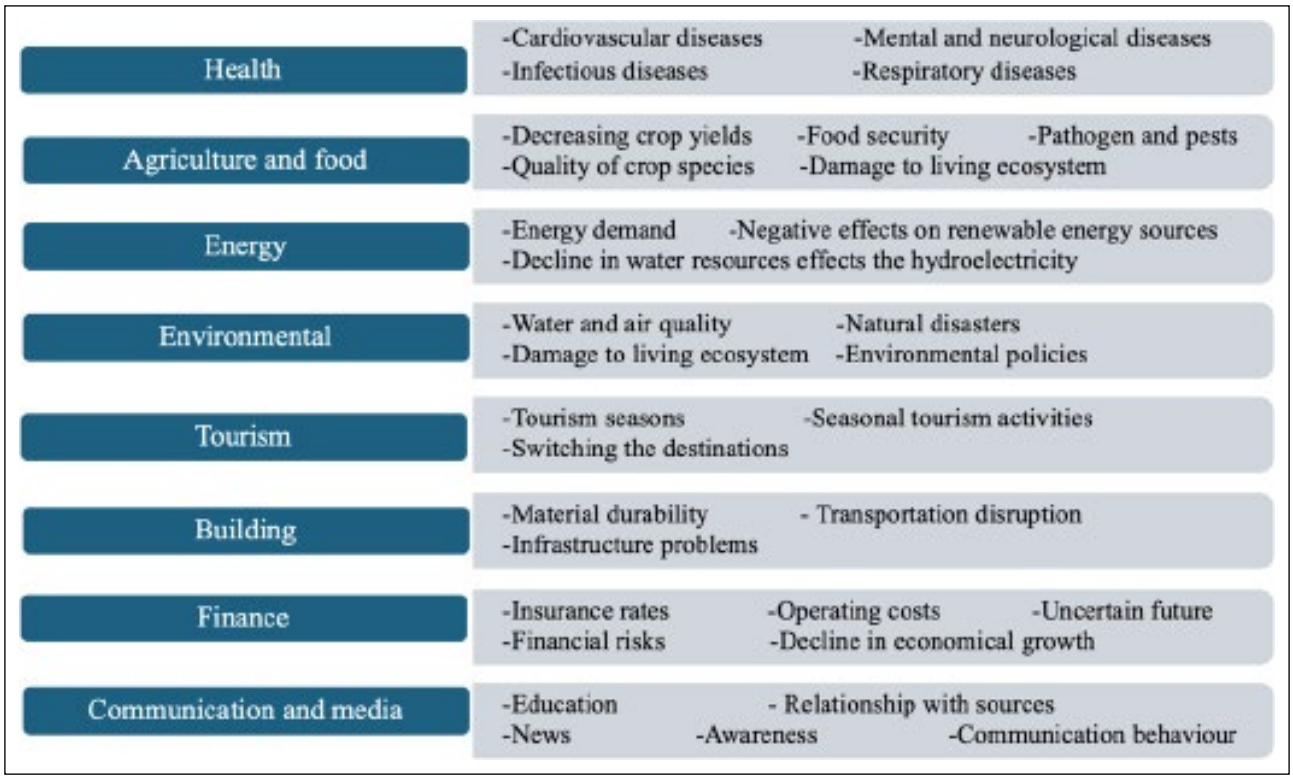

Figure 1. Sectors affected by climate crisis.

ty, difficulties in finding food for people, and consequently, higher food prices in the agriculture and food sector [33]. On the other hand, since climate change directly affects the ecosystem, it results in adverse effects such as harm to marine life [34], reduction in soil retention due to plant destruction by pathogens [35] and an increase in plant pathogens such as wheat crown rot (Fusarium spp.) due to drought [36], decrease in bee populations [37], and reduction in habitats for many plant and animal species. Furthermore, studies have shown that extreme weather events have negative effects on human physical and mental health, education, and employment [38]. Changes in animal migration routes have led to an increased potential for the emergence of new vector-borne (such as West Nile virus [13]), waterborne diseases (such as diarrhoeal disease [39]) and foodborne diseases (diarrhoeal and invasive infections [40]) [41], and an increase in the frequency and severity of allergies has been observed [42].

Adressing the Challenge of Climate Change

The impacts of climate change are deepening, transforming into a global crisis. In the collective effort to combat this crisis, the roles of governments, civil society organizations, and various entities are significant [43]. After the acknowledgment of the reality of climate crisis at the first climate conference held in Geneva in 1979, the establishment of the Intergovernmental Panel on Climate Change in 1988, the acceptance of the United Nations Framework Convention on Climate Change in 1992 and its entry into force in 1994, the adoption of the Kyoto Protocol in 1997 and its entry into force in 2005, the acceptance of the Paris Agreement in 2015 and its entry into force in 2016, and the signing of the Kigali Amendment in 2016, numerous actions have been undertaken by the international community to combat climate crisis [2]. The United Nations Framework Convention on Climate Change encourages international cooperation to reduce greenhouse gas emissions and adapt to climate change in order to prevent dangerous levels of global warming [44], while the Kyoto Protocol aims for industrialized countries to reduce their greenhouse gas emissions to specific levels [45], the Paris Agreement aims to limit global warming to below 2 °C and preferably to 1.5 °C [46], and the Kigali Amendment aims to reduce the production and use of hydrofluorocarbon greenhouse gases [47].

Many countries have recently made sustainable development a key component of their national policies, strategies, and economic growth plans. Australia and Canada, for example, are leading countries in terms of environmental sustainability because they use fewer natural resources and capital for economic growth [48]. China, on the other hand, is establishing policies to support the green transformation of the maritime economy [49] and reduce energy expenditure [50] through environmental regulations and effective mechanisms. In the UK, the Climate Change Act, which came into force in 2008, was revised in 2019, aiming to reduce greenhouse gas emissions to net zero [51]. Moreover, 193 countries gathered under the framework of the United Nations are obliged to realize the "Sustainable Development Goals" such as climate action, life below water and on land, affordable and clean energy, and responsible consumption and production by 2030. When we look at these goals in terms of climate change, it can be said that they are viewed

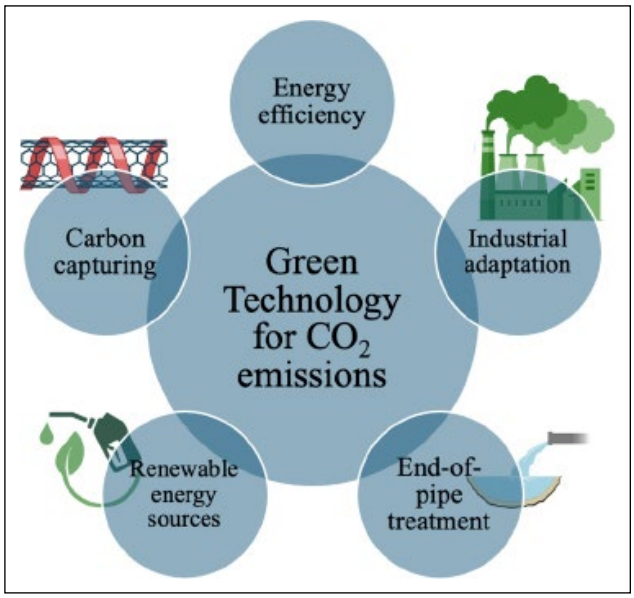

Figure 2. Green technology for CO_2 emissions.

from the perspectives of reducing carbon emissions, reducing energy consumption, and protecting biodiversity [50, 52]. In this context, controlling or reducing greenhouse gas emissions, especially CO_2, and monitoring the emission of greenhouse gases into the atmosphere have become the main focus of all countries [3]. While there are numerous research topics and climate crisis action plans within the realm of positive sciences aimed at reducing carbon emissions, accurately understanding and communicating the climate crisis is also crucial for the implementation and success of these action plans.

Among the efforts to reduce carbon emissions today, carbon capture, utilization, storage, and achieving net-zero carbon emissions have become prominent topics [8]. Reducing the use of fossil fuels and chemicals, which are identified as major contributors to carbon dioxide emissions, and prioritizing the adoption of green and sustainable technologies are among the crucial issues as illustrated in Figure 2.

The necessity to reduce the use of fossil fuels, due to their limited availability and significant environmental damage, is critical for both reducing greenhouse gas emissions and shaping energy security and climate change. Renewable energy sources such as solar, wind, hydroelectric, geothermal, wave, and biomass emerge as sustainable alternative energy sources. The existence of technical and economic challenges in renewable energy sources, leading to their limited adoption, represents the biggest obstacle. However, technological advancements such as the development of renewable energy harvesting devices, fuel cells, and effective carbon capture methods help overcome these limitations. Furthermore, there is a need for new regulations and policies to promote the use of renewable energy sources. Therefore, comprehensive and multidisciplinary efforts in this field have become imperative [53, 54].

For instance, research efforts have gained momentum in recent years on exploring the potential of end-of-pipe treatments [23] such as electrochemical, thermal, biochemical, chemo-enzymatic, and photocatalytic methods for capturing carbon from the atmosphere [55, 56], as well as developing porous materials as CO_2 adsorbents [57], advancing liquid absorption CO_2 techniques [58], alongside the utilization of renewable energy sources. Also many microorganisms such as plants and algae can naturally absorb CO_2 through photosynthesis, converting inorganic carbon in the atmosphere into organic carbon in biomass, thus contributing to the production of high-value-added products [59, 60]. The fundamental objective of every approach is to guarantee a sustainable future and bequeath a clean world as a heritage for future generations.

The Relationship Between Communication and Climate Change

As atmospheric temperatures continue to rise, it becomes evident that the ecosystem is being affected, new diseases and viruses are emerging, and extreme weather events are becoming more frequent. In light of these developments, the need to address climate change, governments taking urgent action plans, and the necessity of societal transformation have become prominent issues that require effective communication. Although, increase in greenhouse gas emissions are not attributed to a single factor, but rather depends on various factors such as fossil fuels [61], buildings [62], transportation [63] and damage to forest ecosystem. [64] Therefore, complex models are used to understand climate change, as it involves multiple interacting elements. Consequently, predicting both its potential impacts and effectively communicating them to governments and society can be challenging [35, 65]. In this context, climate change communication has emerged as a major field of research and is becoming increasingly important in adopting and implementing a sustainable approach to combat climate change by reducing greenhouse gas emissions and the impacts of climate change [18].

Communication plays a critical role in accurately conveying climate change and its effects, using language-appropriate communication in transmission, and ensuring proper understanding by society. The term language-appropriate communication as defined here can be summarized as accepting, nonjudgmental, empathic, providing personal support, feeling adequacy and turning technical scientific concepts into understandable discussions [66, 67]. The language used in communication appears both as a barrier and a facilitator in understanding global warming and climate change. Before creating awareness in the public for societal transformation regarding the significance of climate change, it is crucial for communication tools conveying them to understand the objectives of climate change correctly and to be influenced correctly by communication tools, which is associated with the power of language used. At this point, scientists have a significant role to play because using informal language will not evoke the expected impact on the public. In this context, collective efforts and statements from scientists, official meetings and organizations, and climate change conferences will be more

effective in creating awareness among both governments and the public than individual statements [68]. Scientists should emphasize that climate change does not have a single solution and is influenced by many factors, using realistic data and engaging language. It is crucial for scientists to communicate the environmental and human consequences of climate change clearly and effectively, while also using frameworks and metaphors that effectively communicate with a wide range of expertise and stakeholders, maintaining a positive and inspiring communication approach [69]. Hence, it is important to have synchronized endeavors between scientists, journalists and social scientists [70].

The relationship between communication and climate change extends beyond language use to encompass its impact on governments, raising awareness in society, and scientific communication. Moreover, it extends to crisis management and emergency planning prompted by climate change. Crisis management in the face of climate change can be delineated into three stages: pre-crisis, crisis, and post-crisis, given the lengthy and complex nature of the process [71]. Public awareness initiatives, identification of potential emergencies, formulation of climate change policies, and enhanced communication among scientists, governments, the public, and civil society organizations all contribute to crisis preparedness. Additionally, organizing training initiatives, workshops, and outreach events to inform and empower individuals for action in their daily lives is essential [72]. Clear communication of the crisis by relevant institutions and organizations during a crisis, coupled with the prompt and effective transmission of solutions, serves to minimize its impact. The importance of an organization's communication with its external environment becomes particularly evident during times of crisis [73, 74]. Similar importance of accurate information flow, public awareness, and collective action in crisis management has been demonstrated during the COVID-19 pandemic [75].

After the first climate conference held in Geneva in 1979, climate change communication began to appear in various communication channels such as newspapers, televisions and journals [2, 76]. Due to the trust instilled by the news media and journals in the public, climate journalism has been important tools in conveying the impacts of climate change. While trust in these media outlets persists in many countries, changes in the media ecosystem, as well as economic and working conditions, have led to challenges for reporters and journalists, and their numbers are decreasing, paving the way for this change [70, 76]. In recent years, with advancements in technology, the more frequent use of visual depictions, various campaigns and the sdesire to reach more target audiences have been conducted using social media platforms such as forums, Instagram, X, and Facebook, as well as online channels, to raise awareness about climate change [77, 78]. Alongside these social media tools, climate information websites on systemic climate risks are playing an increasingly important role in climate change communication [79]. The main difference between news channels and social media lies in the fact that news sources focus on climate policy action and the consequences of climate change, while social media addresses social justice issues surrounding climate change [80]. Mavrodieva et al. [81] reported in their study that social media has an impact on changing public perceptions and can influence the public's political decision-making process. However, it is important to note that the causal relationship between the messages in social media posts and news articles and the public's awareness and intention to participate in climate strike discussions should be examined. This is because while social media can have a positive impact on promoting awareness, social debate on climate change, and raising communication between scientists, the use of bots and unrealistic sharing may also lead to backlash, making it an issue that academics need to research and focus on [76].

Another approach is related to the protest images that are circulated on social media and attract a lot of attention. While such images may have a positive effect on conscious people, they may trigger skepticism, an 'us versus them' approach, and discrimination in others [77]. In contrast, games serve as an additional means of communication for promoting social change. By engaging individuals in various interactive experiences, games can effectively enhance empathy, alleviate skepticism towards scientific knowledge, improve problem-solving abilities, particularly in scientific domains, through the cultivation of critical thinking skills, and encourage environmental protection [82, 83]. The Future Delta game, created to focus on sustainability and climate change, stands as one of the prime examples in this domain. Players assume the role of a leader of a community residing in a delta region, making decisions and developing strategies to tackle the climate crisis. Throughout the game, players are provided with visualizations of climate change effects such as rising sea levels and erosion, along with information on topics like renewable energy, thereby raising awareness among players about these issues [84]. Future Delta and others like it (e.g. Fate of the World and Anno 2070 [85]) allow children to have fun visualizing the climate crisis, learning about environmental sustainability and climate change, and developing environmental awareness and behavioral change.

One of the communication methods in combating climate change can be demonstrated through education and educational programs, and the necessity of initiating sustainability, environmental, and climate change education, especially in early childhood years, is inevitable. The importance of early climate change education, the integration of sustainability education into formal education, and preparing students for climate change were emphasized at the UNESCO Education for Sustainable Development vision [86], The Early Years Learning Framework for Australia [87], and the 28th annual United Nations (UN) Conference of the Parties (COP 28) held in Dubai in December 2023. [88] The growing recognition and regulations surrounding climate change in relation to children may be attributed to the understanding that the education and teachings received during childhood significantly influence their

long-term behavior and attitudes towards the environment. [89] Additionally, children are viewed as potential leaders of change in the future [90]. The importance of integrating communication strategies such as immersion in nature, providing sensory and emotional education, localization, and visualization into education programs for children and youth has been proven in studies [91–93]. Furthermore, the significance of conducting these education programs in an integrated manner with families and communities has also been demonstrated [94].

Communication Strategies for Raising Awareness About Climate Change

Climate change communication strategies are crucial for raising awareness of the climate crisis, mobilizing action to mitigate its effects, encouraging participation, and ensuring long-term impact. Therefore, scientists in various fields continue to work on accurately explaining, conveying, and understanding global warming and climate change. For instance, scientists have performed an experiment on the environmental risks of climate change with CLIMEX [95], an experiment on insect distribution in response to climate change based on modeling [96] and bioclimatic distribution modeling, drawing on fields such as environment, nature, and geography [14]. Scientists also draw on fields such as psychology [97] and sociology [98] to examine the impact of the climate crisis on people and societies, perceptions, and attitudes.

One of the requirements for using a multidisciplinary approach in climate change communication strategies is that it is a crisis that concerns every segment of society, from children to the elderly. Since attitudes and behaviors towards climate change, such as energy consumption, vary depending on age, individuals need to share information about sustainability and climate change with each other and learn to address issues in a discussion environment [99]. Youth and adults have the potential to create global resonance with their awareness and impact in the field of climate change. Examples such as the United Nations hosting the 'Youth Climate Summit' in 2019 [100], where young climate advocates aged 18-30 discussed ways to fulfill the Paris Agreement commitments, the Climate Smart Agriculture Youth Network in Africa educating young farmers and agricultural experts on combating climate change [101], Greta Thunberg initiating the 'school strike for climate' in front of the Swedish parliament in 2018 [102], and the school strikes and Fridays for Future movement worldwide since 2018 are prominent illustrations [103]. These examples demonstrate that adults play roles in policy-making and leadership positions, while young people engage in education, awareness-raising, activism, and innovative solutions in the fight against climate change. The elderly may face certain mental and physical health issues related to climate change, leading them to contemplate the struggles of younger generations and consider adopting certain climate crisis action plans aligned with specific political views, shaping their roles in this challenge [104]. A study conducted in the United States in 2018 [105], revealed that while the elderly population tends to be more sensitive to global challenges, the opposite is observed when it comes to issues such as climate change, renewable energy, and environmental policies. This may stem from the lack of inclusion of the elderly in climate change policies, their limited access to information about climate change, and the absence of a sense of responsibility in the fight against it.

At the core of these communication strategies lies the transmission of accurate scientific knowledge and data because the primary goal should be to build trust in the public. Subsequently, different strategies are proposed for how climate change will be presented and what impression will be created among the public, accelerating the process of adapting to climate change, and developing action-oriented plans. Fundamentally, climate change communication strategies involve using various digital and traditional sources to create mass awareness, strengthening the public's empathy, localizing and storytelling to enable individuals to relate climate change to their own lives, using various visualization techniques to provide more concrete and understandable information, and emphasizing hope and opportunity in communication and transmission. While implementing these communication strategies, coordination among scientists, civil society organizations, and governments is necessary.

Localization

Climate change is considered an urgent international crisis affecting the entire world; however, due to its impacts on specific communities and environments, it is also regarded as a national and local issue [84]. In the initial awareness campaigns regarding climate change, communication techniques such as emphasizing psychologically distant and continuously unseen effects like glacier melting and omitting details in explaining the effects of climate change have failed to resonate with society. When individuals do not personally witness the tangible effects of climate change, they may not perceive themselves as being threatened, thus they may not change their behavior [106]. Studies indicate that despite living in regions with higher exposure to the effects of climate change, individuals do not change their behavior without experiencing personal damage [107]. For example, Sloggy et al. [30]. reported that in order to increase the proportion of individuals supporting policies to reduce greenhouse gas emissions by one percent, more than one hurricane would have to hit the region where those individuals live. Therefore, it is crucial that communication strategies emphasize the immediate and tangible impacts of climate change that individuals can relate to their daily lives before they experience the disaster. By making the impacts of climate change more relevant and personal, assessing them from the audience's perspective, with end-users as the audience, people are more likely to take action to reduce their impact [108]. For instance, stating “Acid rain harms crops” may not prompt behavioral change, whereas stating "Following acid rain in Izmir as a consequence of climate change, cases of nutrient imbalance and aluminum poisoning were observed in individuals consuming affected crops" could evoke behavioral change. This behavioral change can

be ascribed to the adoption of appropriate, concrete, and localized language in communication. Similarly, Waters et al. [106] observed that climate crisis messages centered in Great Britain were more effective than general climate crisis messages without specific place/region names and increased the public's inclination towards behaviors to reduce energy consumption. Hence, when discussing climate change, it is imperative to emphasize the observable and immediate effects of climate change that will shape individuals' actions and to take into account the cultural and socio-economic background of the intended audience [109].

Visualization

Climate visualization is an effective tool for understanding and concretizing the complex models and abstract effects of climate change. The use of visual coding techniques such as color, shape, and location is crucial for making climate change-related data understandable to governments and the public [110]. Alongside visualizing data, integrating various communication methods such as linguistic text, sound, and music will further strengthen this strategy [111]. Comprehensive reviews in the literature have shown that visualizing the effects of climate change through climate visualization tools is more effective and efficient for both the public and governments, enhancing communication between scientists and stakeholders [112].

The communication strategy utilized to raise awareness about climate change is recommended to be integrated with localization, as it has been observed over time that the use of iconic figures such as polar bears, glaciers, and penguins in climate change iconography leads to the perception of climate change crisis as both temporally and spatially distant and of low risk among the Public [84, 113]. For instance, Richards et al. [109] facilitated the examination of the street-level impacts of rising waters while providing sea level rise data using an interactive sea level rise viewer, a map-based visualization tool. This aimed to raise awareness among the public by employing both visualization and localization strategies. Through various studies utilizing interactive sea level rise viewers, communication with society about social and ecological risks through localization and visualization of climate change impacts, transitioning society to a different level of understanding and communication regarding climate change, and evaluating approaches for identifying future risks and creating emergency plans are being assessed [114, 115]. Similarly, Glaas et al. [113] have demonstrated that the visualization of risk maps and the presentation of adaptation measures for local regions using the web-based VisAdapt™ visualization tool effectively emphasize the impacts of climate change and accelerate the adaptation process by influencing individual behaviors through visualizing weather risks. Besides, artistic knowledge visualizations such as news photographs, art visuals, and cartoons can also be utilized as tools for visualizing climate change alongside data, maps, and visualization techniques. However, compared to other visualization tools, the impact of this method is less significant due to artists' freedom in data focus and artistic style choices, but it can still be effective in enhancing public understanding and clarity about climate change when integrated with other methods [116]. This is because it allows the community to perceive climate change from a different perspective beyond scientific explanations in art pieces; however, the excessive emphasis on climate change in artworks may appear distant and abstract to observers, leading them to encounter exaggerated and negative expressions directly [117].

Storytelling

Providing accurate and reliable information about climate change through education, conferences, and seminars, while effective, is not sufficient to induce behavioral change in people [118]. In this regard, storytelling comes into play to enhance the society's empathy, raise awareness about climate change, and expedite the process of climate change adaptation, which differs from more quantitative, measurable, and generalizable data formats [119]. This strategy, by combining science and effective communication strategies, can be an effective method to break down the barriers between science and the public. Studies have shown that storytelling can assist in reaching politicians and individuals from the public and making science communication more effective. The underlying reason is that real-life stories and case studies about climate change can create an emotional connection in the public, engage our imagination, and develop sensitivity towards targeted behaviors aimed at reducing the effects of climate change [19, 120]. Additionally, storytelling aims to increase people's access to data, enhance data reading and comprehension, and reduce readers' attention deficits [121]. In an experimental study [122], the effects of a personal radio story narrating the impact of climate change on beloved places of a North Carolina athlete were investigated on moderate and conservative individuals. As a result, it was found that storytelling had positive effects on global warming beliefs and risk perceptions, indicating the usefulness of structuring climate change communications designed to motivate different audiences in the form of stories. Additionally, these effects were mediated by emotional responses such as concern and compassion [122, 123].

Since the main sources in climate change storytelling are articles, surveys, models, and various data analyses, the inevitable need for collaboration between scientists and the art of storytelling arises. This is because conveying the story accurately and effectively is as important as communicating science, selecting which information to convey, and managing uncertainty. However, making climate change data, graphics, models, and scientific language understandable to the public can prevent misinformation in both the media and institutions. In this context, leveraging folklore can be seen as a sensible approach [19, 121]. Particularly, the use of folkloric elements, creating a plot, employing motifs, and better defining actors and settings can trigger empathy and the instinct to take action among the public [119]. Using narrative style and content for climate change storytelling involves defining the target audience, conveying the prob-

lem, its causes, and context specifically and timely, adopting an action perspective, utilizing folkloric features, selecting characters with whom the reader can relate, preferring positive and inspirational communication language, ensuring that risks and human factors are relevant to the topic, and including policy solutions. Instead of providing instructions, climate storytelling should assist individuals in uncovering ways to take action [17, 124].

Positive and Inspirational Communication

Since emotions are intertwined with cognitive and motivational processes, the process of perceiving information, making decisions, and changing behavior is influenced by emotions. Similarly, behavior change targeted at climate change can also be guided by emotions [125]. It has been observed that even inadvertently triggering emotional states unrelated to climate change can affect policies aimed at reducing the effects of climate change [126]. The importance of positive emotions is particularly noticeable in the process of decision-making, behavior change, and the generation of action-oriented solutions related to climate change [127]. These positive emotions can also be fostered by creating hopeful messages about climate change, which enhances persuasive impact on society and encourages people to participate in climate change actions. Badullovich et al. [128] demonstrated through their experiment that certain emotions, particularly hope, serve as a fundamental tool between attitudes towards climate change policies and advocacy. Additionally, the positive emotions experienced by society as it begins to take action on climate change can promote participation in climate change actions [127]. Behavior change in climate change is not only important for adults but also for children, and it is crucial to consider that this education should begin in childhood, as it can influence behavior patterns both at this age and in later years. Baker et al. [129] have emphasized the importance of children's climate change education being inspirational, accepting of emotions, and proactive.

Nevertheless, the media language regarding climate change often emphasizes dramatic events and creates a sense of hopelessness. This can undermine interest in the issue of climate change and distance people from its problems and solutions [130]. However, some research suggests that emotions such as pride, fear, and guilt sometimes trigger climate change action, although the connections between emotions and outcomes are complex [131]. In some cases, negative emotions have been found to trigger a correct perception of climate change risks and prompt action, while in other cases, the feeling of fear may have the opposite effect. Similarly, the feeling of hope has been found to trigger action in some cases but may reduce the perception of risk in others [132, 133]. In this regard, it is important to strike a balance between generating both positive and negative emotions, avoiding the suppression of any emotion, and focusing on hopeful solutions to overcome problems while also acknowledging the importance of avoiding unrealistic or overly optimistic perspectives. Additionally, integrating neurophysiological approaches to understand how emotional climate messages influence human emotion and decision-making processes presents a new research avenue [125].

CONCLUSION

Climate change is the long-term alteration of climate conditions on Earth, primarily associated with the increase in greenhouse gases in the atmosphere, which are mostly human-induced. Due to the acceleration and intensification of the adverse effects caused by climate change in various sectors such as health, agriculture, environment, and tourism, the entire world is facing the threat of a climate crisis. Despite the intensive efforts of scientists, including carbon capture, industrial adaptation, and the use of renewable energy sources, in the fight against climate change, the importance of a multidisciplinary approach is inevitable. In the field of social sciences, the role of communication and different communication strategies is crucial because accurately conveying climate change, which involves complex and scientific language, to diverse communities and governments can be challenging. At this point, the public should both correctly understand climate change and the climate crisis, communities should be empowered, and long-term behavioral changes towards combating climate change and attitudes towards the environment should be instilled in the public. For this, communication strategies such as localization, visualization, storytelling, and the collective use of positive and inspirational language are highly valuable. Communication strategies in climate change have the following objectives: to inform society accurately, to raise awareness about climate change, and to make behavioral change towards sustainability goals permanent in society. This would be possible through the realization and development of various strategy studies for all segments of society, including cultures, languages, genders, and age groups.

In the future, the importance of multidisciplinary studies on climate change will continue to grow. Accessing reliable and accurate information from scientists, along with the importance of reducing the effects of climate change and directing strategies correctly, will make it increasingly critical to communicate and convey these to governments, civil society organizations, and the public. As messages about climate change can reach broader audiences through technological advancements and the prevalence of social media, there will be a greater need to access more information and current news. Establishing correct communication strategies can lead to action-oriented results regarding climate change and foster social and environmental awareness. This situation will require collaboration between the media, scientists, and communication experts to develop effective communication strategies. In the future, climate change communication will not only be limited to information dissemination but will also focus on creating powerful narratives that connect people emotionally to climate change and encourage them to take action, utilizing integrated and balanced communication strategies.

AUTHORSHIP CONTRIBUTIONS

Authors equally contributed to this work.

DATA AVAILABILITY STATEMENT

The author confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

USE OF AI FOR WRITING ASSISTANCE

Not declared.

ETHICS

There are no ethical issues with the publication of this manuscript.

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