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Dominant Visual Frames in Climate Change News Stories: Implications for Formative Evaluation in Climate Change Campaigns

STACY REBICH-HESPANHA[1]
RONALD E. RICE
University of California, Santa Barbara, USA

We propose a rigorous basis for identifying and assessing visual frames as part of a pre-production phase of formative evaluation for climate change campaigns. We review research on images in climate change communication and examine the role of formative evaluation in communication campaigns in general and climate change campaigns in particular. From 350 images in 200 randomly selected climate change news articles from 1974–2009, manual content analysis generated over 100 highly reliable image themes, and cluster analysis generated 15 dominant visual frames. We discuss possible implications for use of those frames in climate change campaign messages. The dominant visual frames also provide bases for more structured and comprehensive formative evaluation research that could justify use or avoidance of certain visual frames in the pursuit of particular outcomes though communication with specific audiences.

Keywords: climate change news, images, visual framing, communication campaigns, formative evaluation

As awareness and concern about the current and future consequences of climate change increase in prevalence, more effort is being devoted to designing effective public communication campaigns about the issue. Images are central to mass media in general, but only recently has climate change communication research begun to identify and assess the presence, role, interpretation, and effects of images. This study examines how climate change *visual frames* can be identified, described, and analyzed as part of a formative-evaluation component of climate change campaign message design. The following sections review research on image framing in mass media, science and climate change communication, and the role of formative evaluation in communication campaigns in general and climate change

Stacy Rebich-Hespanha: hespanha@nceas.ucsb.edu
Ronald E. Rice: rrice@comm.ucsb.edu
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campaigns in particular. We then describe dominant climate change visual frames identified through previous research, suggest possible considerations in formative evaluation of each dominant frame, and outline a generalized strategy for formative evaluation of climate change images.

Visual Imagery in Climate Change Communication

Images in Mass Media and Science Communication

Images play a special role in the mediation of information. They expand cognitive capacity when processed in parallel with textual information (Clark & Paivio, 1991) and convey both literal (*denotative*) and symbolic (*connotative*) meaning (Barthes, 1977). They are perceived and processed more quickly than text (Lang, Potter, & Bolls, 1999), direct attention, and influence exposure to, and engagement with, information (Quinn, Stark, & Edmonds, 2007; Zillmann, Knobloch, & Yu, 2001). Exposure to visual imagery can promote cognitive elaboration and ethical reasoning (Coleman, 2006), and images play an important role in emotion, engagement, and persuasion (Joffe, 2008; Lazard & Atkinson, 2015). Contextually relevant imagery can enhance learning and memory of content (Bransford & Johnson, 1972;

David, 1998; Graber, 1990; Levie & Lentz, 1982; Newhagen & Reeves, 1992), but imagery can also distort memory, reduce understanding, and pose barriers to communication, especially when words and imagery contain contradictory messages (Garry, Strange, Bernstein, & Kinzett, 2007; Graber, 1990; Harp & Mayer, 1997; Mendelson & Darling-Wolf, 2009; Zillmann, Gibson, & Sargent, 1999). Visuals can influence audience responses by implying, rather than explicitly stating, relationships between elements of an image or between image and text. The apparent objectivity of some kinds of images, especially photographs and graphs, can also reinforce a link between the image and reality (Messaris & Abraham, 2001).

Images have been central to the development, representation, and communication of science and technology (Lefèvre, Renn, & Schoepflin, 2003; Pauwels, 2006). For example, Kemp (2003) described the transformative double-helix model of the structure of DNA as "the Mona Lisa of modern science" (p. 416) for its iconic, aesthetic presentation of nonarbitrary and complex information, and resulting wide use in scientific and popular media. Visual representations can be particularly important in scientific communication when the underlying scientific topic or essence has no physical form, when language is potentially misleading or insufficient to portray the topic, or when the phenomenon does not exist on a human scale.

Images of Climate Change: Image Framing

Mass media and images in them are an important source of public information about perceptions of climate change and environmental issues more generally (Ader, 1995; Corbett & Durfee, 2004; Meisner & Takahashi, 2013). However, creating or capturing images that effectively communicate about climate change—an abstract, complex, long-term, often distant phenomenon—is particularly challenging because of the invisibility of many key aspects (e.g., emissions, ocean processes, temperature and chemical changes) and the temporal and geographical disjunctures between causes and effects (Doyle, 2011).

The past decade has seen growth in analyses of visual framing of the environment and climate change (e.g., DiFrancesco & Young, 2011; Lester & Cottle, 2009; O'Neill, Boykoff, Niemeyer, & Day, 2013). When describing the historic lack of appropriate theories for studying news visuals, Coleman (2010) noted that "visual framing provides an important new direction for theory building and future research" (p. 233). Entman (1993) proposed *framing* as one particular way that media coverage can influence public attitudes. Framing is the "process by which the emphasis or construction of a message affects the interpretation of the receiver" (Shah, McLeod, Gotlieb, & Lee, 2009, p. 85). Framing can influence thoughts, attitudes, affect, and behavior, though most effects occur through complex interaction of audience characteristics, message features, and resonance with existing cognitions, as well as other situational and contextual factors. Messaris and Abraham (2001) argued that visual representations frame an issue by implicitly juxtaposing visual elements so as to suggest a particular interpretation of the relationships between the represented entities. Whether intentionally or not, images such as photographs, maps, charts, and drawings focus attention on particular aspects or components of an issue. A few prior climate change studies have observed a wide range of *visual themes* and frames in both news and climate action campaigns (DiFrancesco & Young, 2011; Doyle, 2007; Lester & Cottle, 2009; Manzo, 2010a, 2010b; O'Neill, 2013; Rebich-Hespanha et al., 2015; Smith & Joffe, 2009).

Effects of Climate Change Images

Climate communication strategies that involve use of imagery are often predicated on the notion that well-designed or well-selected images or frames will represent complex information in a way that is easy for the intended audience to understand and digest, reinforce the objective truth value of the message they convey, or invoke emotions that reinforce the urgency of risks and threats (Peeples, 2013; Schneider, 2011; Smith & Joffe, 2009). Under such assumptions, however, communicators may use imagery to elicit fear or anxiety, despite evidence that nonthreatening visuals related to normal emotions and concerns promote more effective engagement with climate change issues (O'Neill & Nicholson-Cole, 2009); overlook the visual skills or background knowledge needed to interpret imagery in the intended way (Trumbo, 1999); or risk allowing the concreteness and objective truth associated with certain types of imagery to undermine nuanced communication about uncertainty and risk.

To date, relatively few empirical investigations of audience responses to climate change imagery have been reported. Prior to O'Neill and Nicholson-Cole's (2009) evaluation of responses to fear-inducing visuals, Nicholson-Cole's (2005) study of self-generated visual conceptions of climate change found that participants reported difficulty imagining the future and described generally pessimistic visual conceptions that were negative, distant, and abstract, reflecting little personal relevance. Similarly, Lorenzoni and colleagues (Lorenzoni, Leiserowitz, De Franca Doria, Poortinga, & Pidgeon, 2006) found that mental images underlying climate change risk perceptions in the United States and Great Britain tended to emphasize general and distant impacts, confuse environmental problems, and evoke negative affect.

An investigation of responses to newspaper climate change images in Australia, the United Kingdom, and the United States (O'Neill et al., 2013) found that the images tended to either increase viewers' perceptions of the issue's importance (salience) or promote viewers' sense that they could do something about the issue (self-efficacy), but rarely both. Leviston, Price, and Bishop (2014) found that although imagery of climate change impacts generally elicited negative emotional responses, only images of natural disasters, extremes, and climate pollution evoked both high arousal and negative affect; in contrast, responses to images depicting climate solutions and leadership were both positive and highly arousing. O'Neill and Hulme (2009) evaluated public engagement with images selected to illustrate six different climate change themes (called "icons"). Prior participants had identified three icons (polar bears, London, and a UK wetlands area) as engaging and three (Arctic ice sheet, ocean acidification, and thermohaline circulation) as prominent icons in climate experts' discourse. In general, participants found images associated with nonexpert icons to be more understandable and engaging than those associated with the expert icons.

In the context of climate change communication, certain images and frames—for example, the stranded polar bear, the calving glacier, the billowing smokestack, or the hockey-stick graph of the recent rise in global mean temperature—have become iconic representations of the issue and "are widely recognized and remembered, are understood to be representations of historically significant events, activate strong emotional identification or response, and are reproduced across a range of media, genres, or topics" (Hariman & Lucaites, 2007, p. 27). Although use of iconic imagery can facilitate communication by aligning a message with narratives and schema already familiar to the audience, this communicative

strategy also carries risks. Repetitive use of particular image motifs may normalize such visual representations so much that they are looked through and taken for granted (Schneider, 2011), or reify hegemonic narratives and frames, making it difficult for both communicators and audiences to imagine and contemplate alternative perspectives (Peeples, 2013). Dominant visual frames may confine or simplify communication about the issue by representing certain perspectives while ignoring others (Boykoff, 2011; Cozen, 2013; Hansen & Machin, 2013; Manzo, 2010a; Remillard, 2011). Furthermore, repetition of similar images promotes development of a collective consciousness by "reproducing ideology, communicating social knowledge, shaping collective memory, modeling citizenship, and providing figural resources for collective action" (Hariman & Lucaites, 2007, p. 9).

Although images used in public communication are known to play an important role in the development of public awareness, knowledge, and attitudes, the understanding of appropriate and effective use of visual imagery in climate change communication campaigns remains incomplete and sometimes contradictory. Successful climate change messaging therefore requires both interrogation of assumptions and evaluation of candidate images for use in particular contexts and with particular audiences. Thus we briefly note the nature of communication campaigns and their formative-evaluation component.

Communication Campaigns and Formative Evaluation

Public communication campaigns are broadly defined as purposive attempts to inform, persuade, or motivate behavior changes in a relatively well-defined, large audience, generally for noncommercial benefits to individuals or society at large and within a given time period, by means of organized communication activities involving mass media and often complemented by interpersonal support (see Rice & Atkin, 2012 for a comprehensive review of public communication campaign components).

As climate-change-related communication campaigns or interventions have risen in number and visibility, so have efforts to develop and describe strategies and evaluate their effectiveness. Such work has included reviews of climate change communication history, challenges, and key considerations (Moser, 2010) and of relationships between information dissemination, awareness, and behavioral change in the context of climate change (Nerlich, Koteyko, & Brown, 2010), as well as a proposed transdisciplinary framework for designing and evaluating ocean sustainability campaigns (Rice & Robinson, 2012). Specific climate change campaigns that have been the focus of academic study include Greenpeace's efforts emphasizing the visual documentation of impacts (Doyle, 2007), the visual components of various UK action campaigns (Manzo, 2010a), Oxfam's climate change campaign (Cugelman & Otero, 2010), and McKibben's Step It Up and the Sierra Club's Beyond Coal campaigns (Cox, 2010). Nisbet and Kotcher (2009) have also examined the role and effects of opinion leaders, using Al Gore's Climate Project and We Campaign as examples (see also Nisbet, 2014).

Public communication campaigns may apply three kinds of evaluation: *formative evaluation*, that is, collecting information about audiences and pretests of draft messages, *process* or *program evaluation* to judge how well a campaign's components were actually implemented, and *summative evaluation* to

assess effects and effectiveness. This study focuses on formative evaluation, which is crucial to achieving campaign message effectiveness (Dillard, Weber, & Renata, 2007). As Atkin and Freimuth (2012) wrote,

> Formative research can help identify what types of content and style will attract audience attention, facilitate comprehension, elicit emotional reactions and elaborations, impart knowledge gain and skills acquisition, influence the formation or change of affective orientations such as beliefs and attitudes, and affect pertinent behavioral performance. (p. 55)

A comprehensive formative evaluation process involves research both before and during a campaign to engage and analyze community resources and stakeholders, explore meanings and contexts of relevant goal behaviors, identify audience characteristics and media preferences, develop and test candidate messages, and help anticipate potential barriers to campaign effectiveness. Such formative evaluation may use a wide range of methodologies, such as focus group interviews, in-depth personal interviews, surveys, theater testing, day-after recall, media gatekeeper review, readability testing, eye- and attention-tracking, physiological responses, or combinations thereof.

Evaluation of public service announcement (PSA) videos offers a substantial basis for climate communication-campaign design (Atkin & Freimuth, 2012). Bator and Cialdini (2000) provided an excellent overview of application of persuasion theory and message design to environmental PSAs. Like many other communication campaign reviews, their summary emphasizes the importance of conducting formative evaluation to understand the audience and message design. This involves identifying the at-risk audience; relevant, susceptible, and feasible attitudes and behavior changes; message and source characteristics; and the salience and interpretation of the issue. Their detailed discussion of message pretesting, though mostly related to text, is largely generalizable to images, as are established approaches for using online tools and metrics to evaluate PSA reach and effectiveness (e.g., Tian, Brimmer, Lin, Tumpey, & Reeves, 2009).

Dominant Climate Change Visual Frames in U.S. Print News

Current understanding of the role of imagery in climate change communication has not arrived at normative guidelines or effectiveness measures for specific combinations of imagery and text. However, our previous work and that of others allows (1) identification of frequent types of climate change images and visual frames appearing in climate change news stories, and (2) consideration of advantages or disadvantages of using these visual frames to engage and motivate audiences. We integrate these insights to outline a process for testing candidate visual imagery during the formative evaluation phase of climate change communication campaigns.

We previously reported on a content analysis of 350 images and accompanying captions and headlines that appeared with 200 U.S. newspaper and magazine stories on climate change randomly selected from a set of 5,637 articles from 1969 through 2009 (Rebich-Hespanha et al., 2015; Rebich-Hespanha & Hespanha, 2014). In this earlier work, we first identified and reliably coded 118 visual themes appearing in the images, and then performed a cluster analysis of co-occurrences of the 103

nongeographic coded visual themes (Rebich-Hespanha et al., 2014) across the 350 images. Qualitative interpretation of the resulting clusters of themes[2] distinguished 42 overall visual frames. Figure 1 shows the frequency of appearance of the 15 dominant visual frames. The *government, politics, and negotiation* frame, observed in 34% of all of the coded images, appeared most frequently. *Climate science, research, and scientists* and *monitoring and quantifying* frames were also very salient, each appearing in 21% of the coded images. Other frequently observed frames included (in order of decreasing frequency) *temperature record*; *"regular" (sometimes vulnerable) people*; *food and agriculture*; *alternative energy and energy prices*; *industry impact on the environment*; *future climate, vulnerable landscapes, and adaptation*; *citizen leaders*; *wilderness and nature recreation*; *storms*; *impacts on polar animals and landscapes*; *view of globe from space*; and *energy efficiency*. The following sections provide additional information about each of these visual frames and discuss how awareness and understanding of these common elements of visual representations of climate change can be a key component of formative evaluation of climate communication campaigns.

Government, Politics, and Negotiation

The government, politics, and negotiation visual frame reinforces the perspective that governments and political processes are central to definition of and societal response to climate change. This frame is often represented by a photo of a political figure, typically a simple headshot or an "action" photo of the given person examining an efficient or alternative energy technology, participating in international negotiations, or discussing legislation (e.g., Figure 2). Communicators may exercise caution in using politically framed imagery, as such images are likely to provoke strong emotional responses, message avoidance, and disengagement among specific audiences (O'Neill et al., 2013), especially along partisan lines (very salient for climate change issues; see Leiserowitz, 2006). This frame also reinforces the notion that addressing climate change requires or relies on government action, and may contradict other message elements that promote alternatives to government (in)action or urge assumption of community or personal responsibility.

[2] The clustering approach identified two themes as related when they frequently co-occurred in the same images. Each image could be associated with more than one theme, and each theme could appear in one or more images. Agglomerative clustering began with each theme as its own cluster and then sequentially identified the most related themes (based on patterns of co-occurrence in the image set), uniting them to form larger clusters. Grouping of themes proceeded until all themes were part of a single large cluster within an overall hierarchical "tree" structure. This hierarchical tree was then segmented into clusters by thresholding the maximum distance between members of the same cluster.

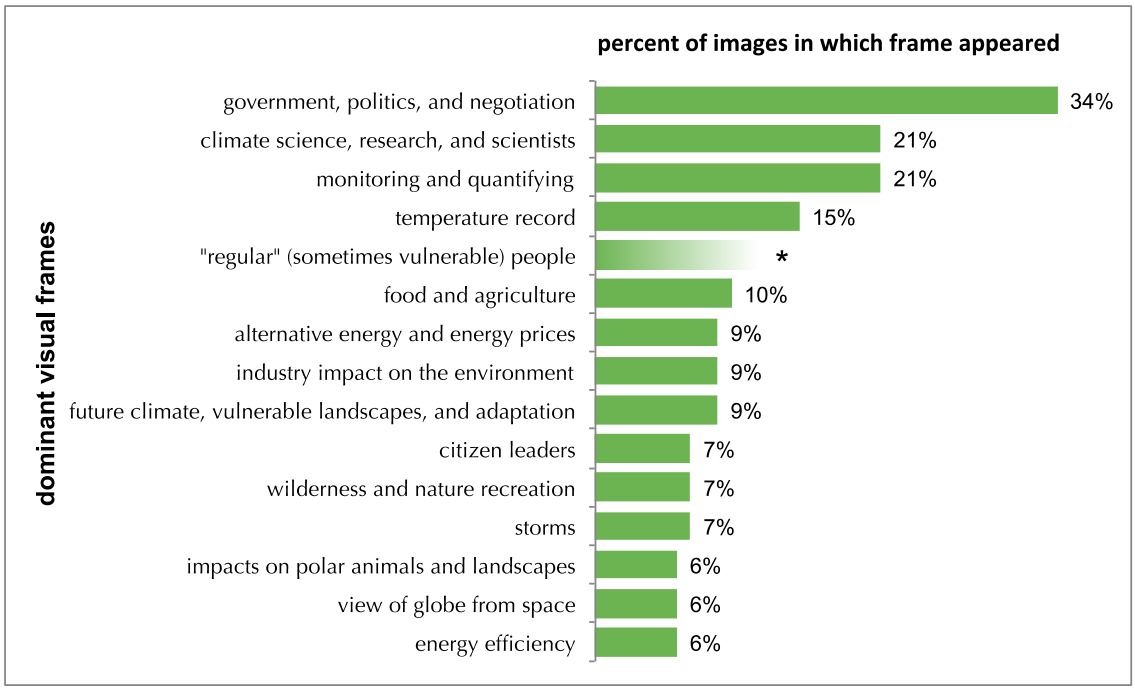

Figure 1. Frequency of appearance of the 15 dominant visual frames.

*Insufficient operationalization of the "regular" people theme prevented a precise estimate of the prevalence of this theme, but it is at most 13%. The ambiguity in coding was related to the salience of the presence of the regular person or people.

Climate Science, Research, and Scientists

Another frequently observed frame positions climate science and scientists as important *agents of definition* (Carvalho, 2007) for the climate change issue. Images containing this visual frame often include photos of scientists and their research equipment, as well as diagrams illustrating, for example, how the greenhouse effect (or another aspect of the climate system) works (e.g., Figure 3). Such images support the idea that science and scientists are central to definition of the issue. However, because scientists are usually associated with documenting or projecting the causes and impacts of climate change, viewers may have difficulty understanding or engaging with this type of imagery (O'Neill & Hulme, 2009) and may be

discouraged from thinking about potential mitigation or adaptation actions. Further, conservatives' trust in science declined sharply in the past 30 years while moderates' and liberals' trust remained stable (Gauchat, 2012), so such portrayals may have different implications depending on audience partisanship and ideology.

IMAGE SOURCE: The Washington Post, March 22, 2007 CREDIT: Susan Biddle

Headline: Gore Challenges Congress on Climate; Committees Implored to Combat Warming With Unprecedented Controls

Caption: Sen. Barbara Boxer, right, praised Al Gore for leadership on global warming during his appearance before the Environment and Public Works Committee, while Sen. James M. Inhofe, left, called climate change "a hoax."

Figure 2. Image containing the "government, politics and negotiation" frame.

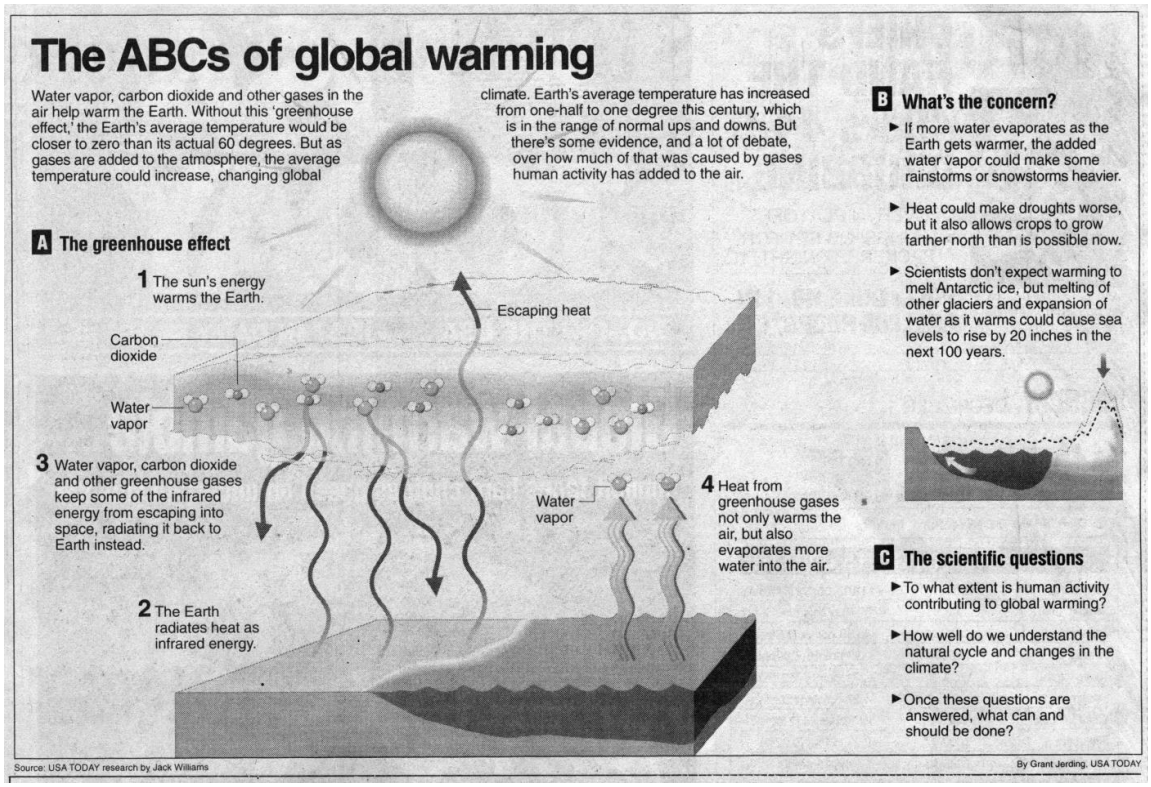

IMAGE SOURCE: USA Today, December 1, 1997 CREDIT: Grant Jerding

Headline: Global warming gamble: Summit faces hard choices based on uncertain science Politics and economics further complicate issue

Figure 3. Image containing the "climate science, research, and scientists" frame.

Monitoring and Quantifying

The monitoring and quantifying frame reinforces the perspective that society's understanding of problems associated with climate change and of the feasibility and benefits of possible solutions is grounded in empirical evidence. Much of the imagery associated with this frame takes the form of charts, graphs, and maps with a thematic focus on emission levels, energy generation and fuel use, and carbon markets and trading schemes (e.g., Figures 4–6). Because such images typically contain graphical representations of data, they can be used to imbue the message with a sense of objectivity or authority, and portray otherwise invisible changes over time or relationships among multiple factors. However, such graphical representations may fail to engage (and may even alienate) viewers who lack the motivation or requisite skills to accurately interpret graphical data representations (Trumbo, 1999). Such graphics also, with some exceptions, tend to focus on past occurrences, thereby possibly discouraging the audience from thinking about alternative futures.

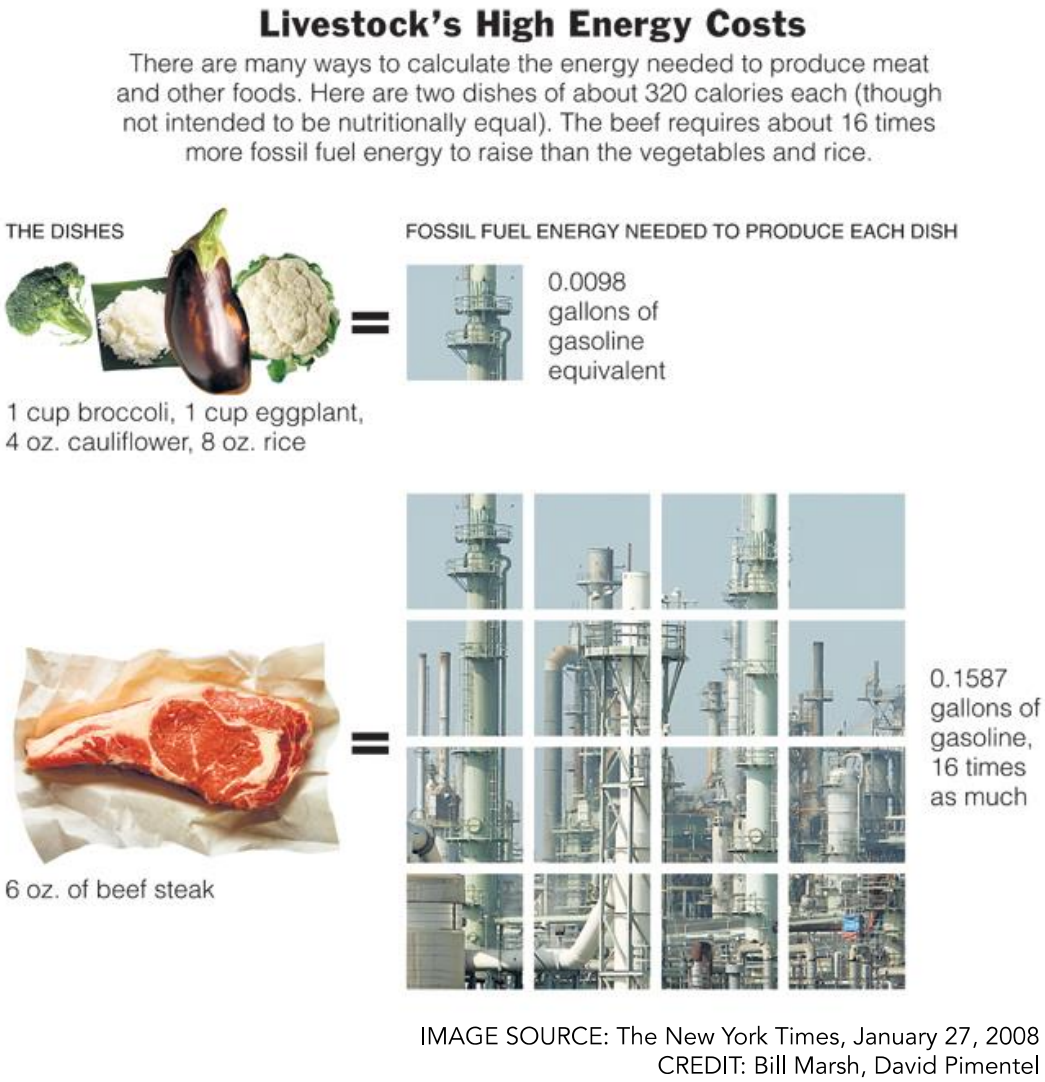

Figure 4. Image containing the "monitoring and quantifying" and "food and agriculture" frames.

Temperature Record

The temperature record frame emphasizes a diagnostic role for global temperature phenomena in identifying changes to the climate system. This frame is typically observed in two distinct types of imagery: graphs, charts, and maps comparing past, present, and projected future temperatures (e.g., see Figures 5 and 6); and photographs that represent unseasonably warm temperatures in particular locations at particular moments in time. Like the monitoring and quantifying frame, graphical depictions of historic temperature trends can be used to emphasize the objectivity of claims about a changing climate, but they can also cause certain audiences to disengage. The hockey-stick graph, which arguably has become an icon of the controversy over global warming's existence, may also reinforce the "divide between the makers and viewers of climate-change graphics" (Walsh, 2015, p. 366) and prime attitudes and cognitions that make certain audiences less willing to engage with new perspectives on the issue. And although photographs showing locations experiencing unseasonable warmth can be used to bring home the reality that climate change is happening, the same imagery may work to distance viewers (Doyle, 2007; O'Neill, 2013) who perceive the location as far away.

Regular (Sometimes Vulnerable) People

Another frame presents a particular view of the relevance and roles of regular people—that is, people who are not in positions of influence—in the experience of and public deliberation about climate change. Within the frame, three distinct roles emerge: Regular people can experience or be vulnerable to the impacts of climate change (e.g., Figures 6 and 12) or policy decisions related to climate change; they can serve as audience or context for others, such as political, business, or civic leaders; and they can participate in protests, demonstrations, or other climate-related events. Regular people in these roles do not appear to be agents of definition (Carvalho, 2007) on the issue of climate change; rather, they depend on the actions and decisions of those who are empowered to define problems and possible solutions. This frame may usefully evoke emotional responses through identification with the plight of those represented in the imagery, but such framing may also diminish a sense of self-efficacy and ability to take action to address the issue (O'Neill & Nicholson-Cole, 2009).

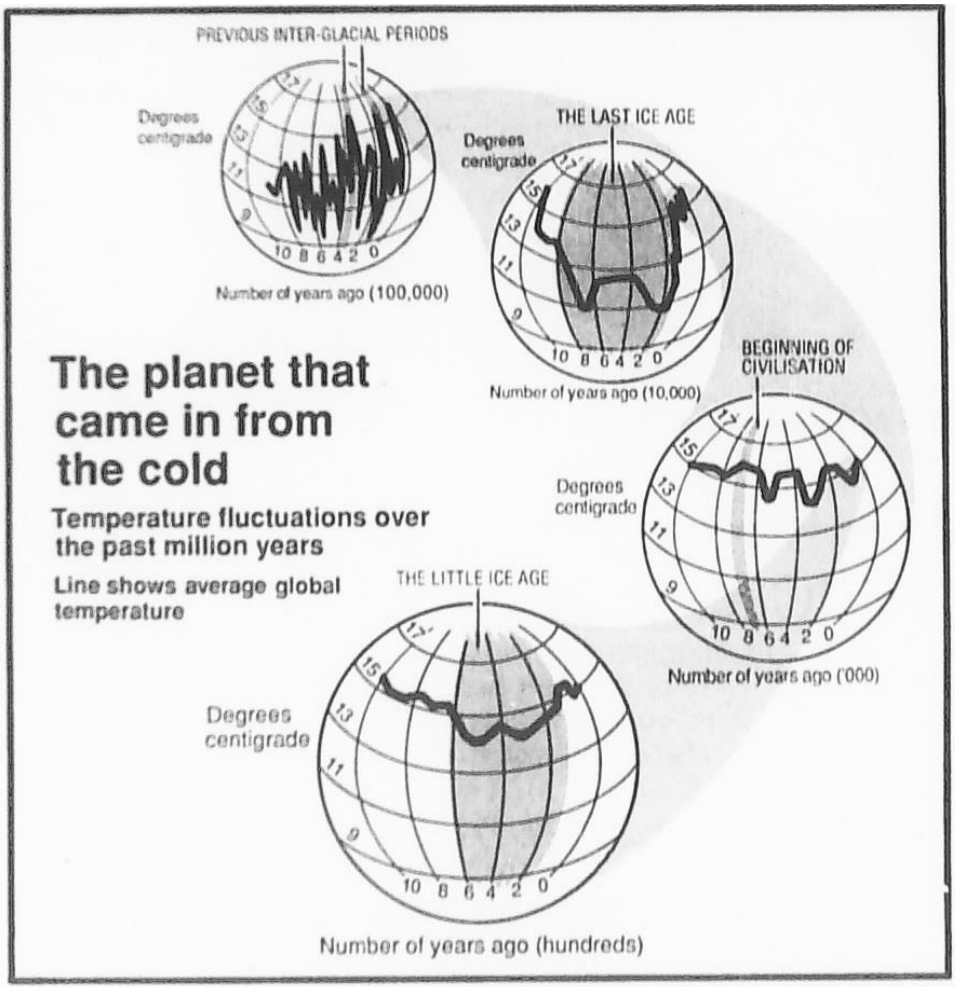

IMAGE SOURCE: The Economist, May 18, 1987

Headline: The very air

Figure 5. Image containing the "temperature record," "monitoring and quantifying," and "view of globe from space" frames.

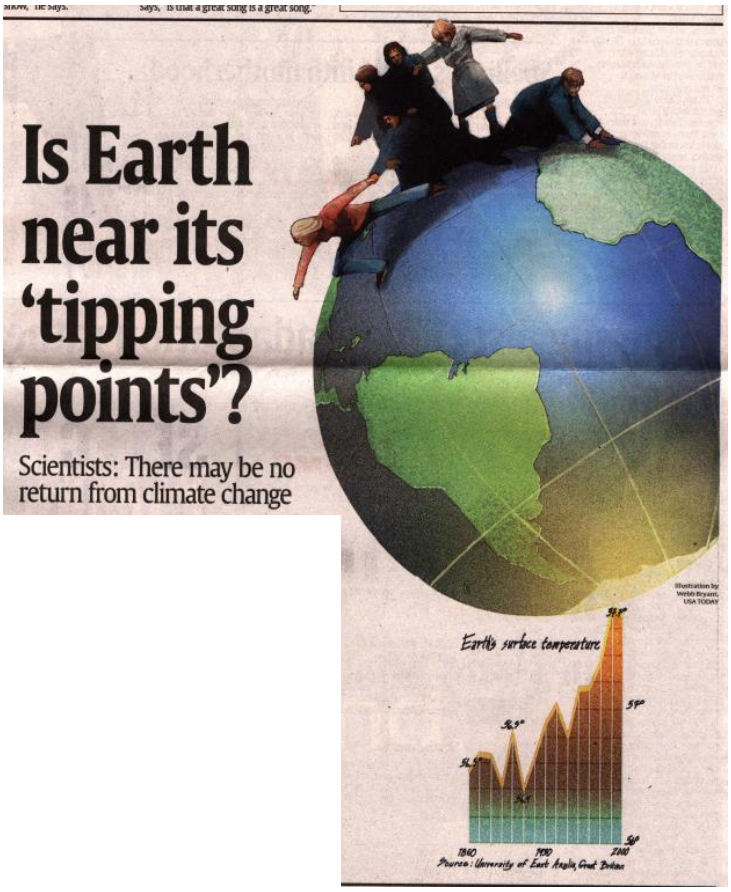

IMAGE SOURCE: USA Today, April 4, 2007
CREDIT: Webb Bryant

Figure 6. Image containing the "regular (sometimes vulnerable) people," "temperature record," "monitoring and quantifying," and "view of globe from space" frames.

Food and Agriculture

The food and agriculture frame emphasizes connections between climate systems, food production, and consumption, focusing on the food-related habits, businesses, and preferences that affect human impact on the environment and the vulnerability of food systems. Imagery associated with this frame typically illustrates greenhouse gas emissions associated with production of different foods (e.g., Figure 4), contrasts the environmental impacts of factory farming and meat production more generally with the impacts of other farming methods and foods, and highlights the economic and cultural systems in which food production and consumption are embedded. Charts, graphs, and diagrams are often used to

represent the degree of impact or illustrate the connectedness of the food and climate systems, but some viewers may not readily understand these relatively complex visualizations (O'Neill & Hulme, 2009; Trumbo, 1999). Though photographic images of factory farms (e.g., Figure 7) may draw attention and arouse emotions in some audiences, they may also decrease interest and openness to new ideas among audiences who have strong economic and cultural ties to agricultural production and consumption or feel they are being manipulated emotionally. Images associated with traditional and sustainable food production methods may evoke nostalgia or a desire for stronger connectedness to natural systems for some while striking others as romanticized and unrealistic. Because images containing the food and agriculture frame most often focus on the production side of the food system, they may constrain thinking about the problem by keeping audiences from considering other components of commercial food systems, such as transportation, processing, marketing and advertising, and convenience- and luxury-driven consumption habits (Hansen & Machin, 2013).

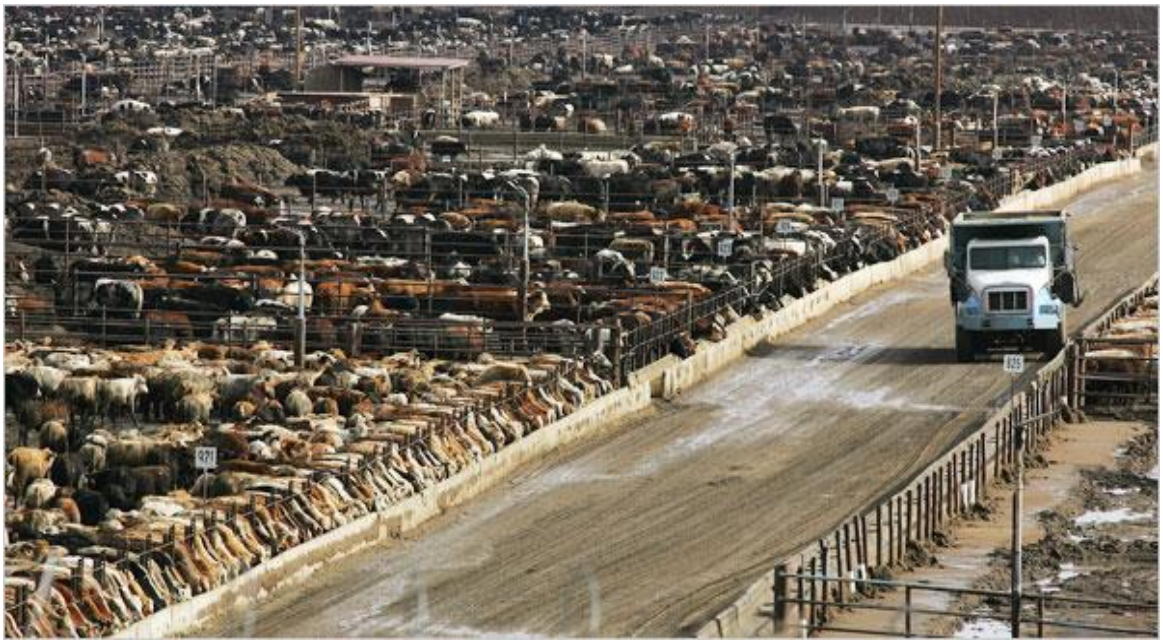

IMAGE SOURCE: The New York Times, January 27, 2008 CREDIT: Gary Kazanjian

Headline: Rethinking the Meat-Guzzler
Caption: HERE'S THE BEEF: This feed lot in California can accommodate up to 100,000 head of cattle.

Figure 7. Image containing the "food and agriculture," and "industry impact on the environment" frames.

IMAGE SOURCE: The Economist, May 30, 2009

Headline: A green revolution

Figure 8. Image containing the "alternative energy and energy prices" and "industry impact on the environment" frames.

Alternative Energy and Energy Prices

The frame that positions climate change as a (potentially) costly energy technology problem focuses primarily on alternatives to fossil fuel energy, and on the economic aspects of possible transitions to these alternative sources of energy. Energy prices are most often represented through charts or graphs, and alternative energy technologies through photographs. There is some evidence that this frame can generate positive affect and arousal in audiences (Leviston et al., 2014). However, the frequent intersection of representations of alternative energy technologies with the costs of these technologies privileges an economic perspective on these potential solutions, likely impeding audiences' consideration of other types of costs and benefits of both traditional and alternative energy sources. Photographs depicting wind energy technology often show white turbines dotting a picturesque landscape (e.g., Figure 8), while photographs of nuclear energy technology typically have a more industrial feel. Although

romanticized imagery of alternative energy technology may encourage certain audiences to develop positive feelings about alternative energy, repeated representation of energy issues as a technology problem may make it hard for audiences to think of innovative solutions to energy issues—for example, those involving changed consumption habits and reduced energy demand—or of the competing political and regional forces involved in any such change.

Industry Impact on the Environment

Another frame identifies industrial development as a key cause of damage to the climate system. Imagery containing this frame typically comprises photographs, illustrations, and other artistic representations of industrial landscapes. Billowing smokestacks are particularly salient visual elements (e.g., Figure 9) and are often appropriated as icons of industry-driven environmental destruction. The frequent repetition of this iconic representation may mean that this imagery has lost its power to engage certain audiences, who essentially see through this iconic visual frame (Schneider, 2011). Further, in combination with the alternative energy and energy prices frame (e.g., Figure 8), this frame supports the idea that technology is both cause of and solution to the climate change problem; however, this technical frame can also depersonalize and distance energy issues, thus preventing audiences from seeing sociocultural aspects of energy consumption problems and recognizing how their own behaviors create demand for such technologies.

IMAGE SOURCE: The New York Times, April 25, 2007 CREDIT: Joseph Sywenkyj

Headline: Russian Energy Giant to Bundle Carbon Credits With Gas Sales

Caption: MAKING POLLUTION PAY IN RUSSIA: Energy companies are moving into the carbon trading market in Russia, where industrial plants are so antiquated that even modest improvements can yield great reductions in carbon emissions. Gazprom, the energy giant, is packaging the credits with its fuel sales. Page C4.

Figure 9. Image containing the "industry impact on the environment" frame.

Future Climate, Vulnerable Landscapes, and Adaptation

Another frame casts climate change as a range of possible futures and potential paths toward those alternative futures., Artistic representations of imagined future landscapes are prevalent, and range from dystopianist to techno-optimistic in tone (see Figure 10). Imagery showing landscapes impacted by or vulnerable to sea level rise is particularly common. These visual representations often use artistic modes of expression to depict changes or expected changes by superimposing visual elements onto current landscapes. Images of geoengineering technologies that could present paths to some of these alternative futures also represent this frame. Though such imagery may help audiences envision difficult-to-imagine changes, the dystopian elements in some of these images may encourage a sense of defeatism in viewers. Moreover, as the images are often renderings of imagined futures, they may not resonate with audiences who prefer realistic representations.

IMAGE SOURCE: The New York Times, June 1, 2008

Headline: Today's Landscapes, Tomorrow's Dystopia
Caption: PARADISE LOST: Jean-Pierre Roy's "The Defeat of Anthropy" (2007)

Figure 10. Image containing the "future climate, vulnerable landscapes, and adaptation" frame.

Citizen Leaders

The citizen leaders frame establishes nonpolitical figures like entrepreneurs and leaders of environmental nonprofit organizations as agents of definition for climate change. People represented in images containing this frame are typically advocating viewpoints or working toward specific actions (e.g., Figure 11). This frame provides a possible counterpoint to the government, politics, and negotiation frame and the assumption that politics and government are necessarily the primary locus of action on climate change. Still, imagery focused on citizen leaders reinforces the distinction between influential leaders and regular people. Whereas these leadership figures might inspire some audiences to take action, others may fail to engage or may be left feeling that the more modest actions they can take personally are inconsequential or unnecessary (O'Neill et al., 2013). As is so for all frames involving representations of people, audiences who do not identify with the depicted individuals' backgrounds, social identity, or values may feel alienation when viewing such imagery.

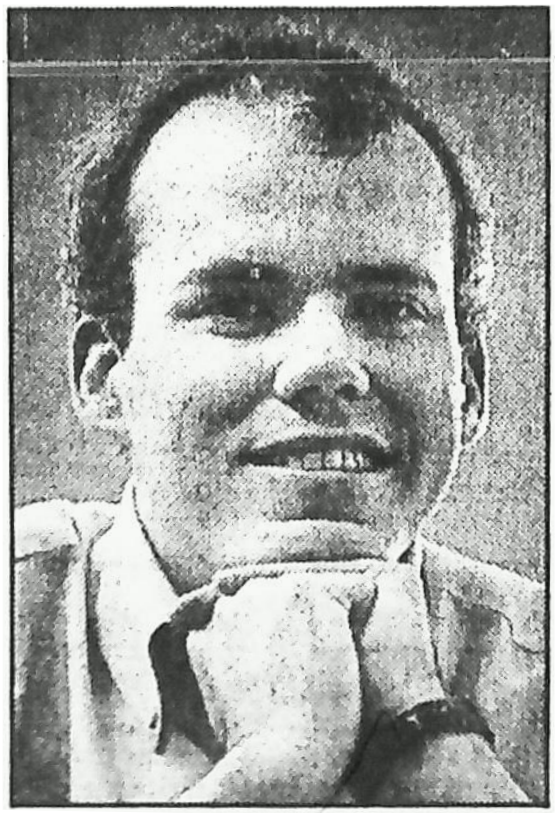

IMAGE SOURCE: San Francisco Chronicle, February 2, 1990
CREDIT: Steve Ringman

Headline: Grim View of Man's Effect on Nature
Caption: Author Bill McKibben believes man has doomed the Earth

Figure 11. Image containing the "citizen leaders" frame.

Wilderness and Nature Recreation

The wilderness and nature recreation frame represents climate change as a threat to the use and nonuse values of wild and natural places. Often tied to sublime views of nature, this frame emphasizes both the value of the mere existence of those wild places and the recreation value that can be derived from them. Images containing this frame are often photographs of magnificent vistas or natural scenes, sometimes including representations of people who have traveled to experience these special places.

One might expect such images to appeal to audiences who participate in nature recreation or place high value on the existence of wilderness. Paradoxically, however, using this visual frame to communicate about wild places' vulnerability to climate change and environmental degradation may stimulate demand for more environmentally costly travel to experience such places. Further, the beauty and vigor of such portrayals may make it harder to imagine the threats to and vulnerability of wilderness.

Storms

The storms frame associates climate change with devastating storms and the resulting loss of land area (see Figure 12). Despite the difficulty of establishing a scientifically based causal connection between particular extreme weather events and climate change, this frame may, for some audiences, reinforce a sense of vulnerability, risk, and need for urgent action in the face of a changing climate (Leviston et al., 2014). However, because images associated with this frame usually represent the here and now, use of the frame may also invoke a sense that dangerous climate change is already inevitable and it is too late to do anything about it (Doyle, 2007). In addition, such imagery is generally linked to particular locations, which can make the message feel relevant to local audiences but might also reinforce a sense of distance in audiences who are farther from the location of the weather event.

IMAGE SOURCE: San Jose Mercury News, September 25, 1999 CREDIT: Wilfredo Lee, AP

Headline: Hurricane Hype: Global Warming Won't Affect Intensity of Future Storms
Caption: A beach-goer watches waves generated by Hurricane Floyd smash an ocean pier at Jacksonville beach in Florida.

Figure 12. Image containing the "storms" and "regular (sometimes vulnerable) people" frames.

Impact on Polar Animals and Landscapes

Another frame emphasizes the climate-related risks faced by sensitive species and ecosystems like those in the polar regions (e.g., Figure 13). The impact on polar animals and landscapes frame has been repeatedly represented in two types of iconic imagery: photographs of polar bears stranded on ice floes, and images of calving glaciers or melting sea ice. Such imagery may engage audiences with the issue via identification with the plight of charismatic megafauna (Feldhamer, Whittaker, Monty, & Weickert, 2002) or anticipation of nostalgia for spectacular frozen landscapes that are quickly disappearing. However, as noted earlier, others (e.g., Doyle, 2007; O'Neill, 2013) have warned that

recurrent use of imagery depicting impacts and vulnerabilities in remote locations may have a distancing effect on audience perceptions, and that frequent repetition of the same iconic images may habituate audiences so much that they no longer pay much attention to them (Schneider, 2011).

Figure 13. Image containing the "impact on polar animals and landscapes" frame.

View of Globe from Space

Depictions of the Earth from space present a frame that reinforces the status of climate change as a global issue and may diminish the influence of individual, local, and ideological differences. At the same time, by providing the viewer with a technologically enabled view from afar (see, e.g., Figures 5 and 6), this frame encourages audiences to adopt the role of the detached observer, so it can also have a

"distancing" effect (Ingold, 1993). This frame may also imply that a global problem requires a global solution and therefore reduce audiences' willingness to consider possible local and small-scale solutions. Scannell and Gifford (2013) found that engagement with climate change messages was stronger when messages were locally relevant and participants had strong attachment to place. On the other hand, there is also evidence that a focus on local issues can lead to lack of engagement by individuals with a perception of control over the local environment (O'Neill & Hulme, 2009).

Energy Efficiency

The final dominant frame positions energy efficiency as an important means of addressing climate change. Images associated with this frame are often charts or graphs showing energy consumption rates, or photographs and illustrations of technologies like CFL and LED lightbulbs and high-efficiency automobiles. This frame may encourage audiences to demand more efficient versions of the technologies they currently use, but it may also constrain their ability to consider energy reduction possibilities other than incremental improvements to existing technologies. Moreover, as a technical frame it may discourage audiences from considering potential nontechnical approaches to reducing energy demand (Dewulf, 2013).

Summary

The 15 most frequent visual frames may have considerable influence both separately and as elements of related news stories. Further, they have the potential to influence climate-change-related knowledge, attitudes, and behavior both positively and negatively. Climate change communication campaign designers should at least take note of these frames' potential and assess how representative audiences interpret or respond to the frames. The next section proposes a formative-evaluation strategy for assessing the relevance and effects of the frames' possible interpretations and salience.

A Strategy for Formative Evaluation of Visual Elements of Climate Change Communication Campaigns

During the formative evaluation process, awareness of dominant visual climate change frames can guide selection of promising visual imagery and communication strategies. Recognizing that the preproduction and production testing phases of formative evaluation involve a broad array of tasks, considerations, and methodologies (Atkin & Freimuth, 2012; Bator & Cialdini, 2000), we focus primarily on aspects that can be used to evaluate the relevance and utility of common visual frames for climate change.

Following the formative evaluation process outlined by Atkin and Friemuth (2012), Figure 14 presents a strategy for incorporating strategic selection and evaluation of visual imagery into formative evaluation for climate communication campaigns.[3] Preproduction, the first phase of formative evaluation, begins with goal identification and information gathering, and can rely on conventional techniques (e.g., surveys, interviews, observations), or a participatory/co-development approach, or both (Bracht & Rice,

[3] A case study illustrating each step in this process is beyond the scope of this overview.

2012). Once this information has been gathered and the initial campaign goals identified, message designers can decide which communication functions the visual message elements will serve.

For example, will imagery be used to prime existing knowledge, beliefs, or attitudes; or will it be used to motivate creative thinking or alternative perspective taking? If the goal is to activate prior knowledge, choosing a dominant visual frame can quickly elicit existing attitudes, emotions, and cognitions relevant to the issue by relating audiences' existing understandings to new information (Entman, 1993; Lang et al., 1999). If, in contrast, the goal is to motivate audiences to think creatively or take new perspectives on the issue, communicators might consider avoiding use of iconic imagery that represents dominant frames, as noted above. Such imagery may actually reinforce underlying values and entrenched ways of thinking about the issue (Boykoff, 2011; O'Neill, 2013; Peeples, 2013); emphasize vulnerability (Manzo, 2010a); disconnect viewers from deeper, more complex issues (Doyle, 2007; Hansen & Machin, 2013); foster defeatism (Doyle, 2007); and limit consideration of other relevant issues (a central goal of framing; Entman, 1993). Far from arguing that dominant visual frames cannot be used innovatively, we suggest that communicators who aim to use these frames to support alternate perspectives apply established frames in novel ways. For instance, applying dominant visual frames in atypical combinations (e.g., "alternative energy and energy prices" with "storms," or "wilderness and nature recreation" with "energy efficiency") could promote positive engagement in particular audiences. Furthermore, a dominant frame or typical combination of dominant frames could be used effectively by a novel messenger (e.g., polar impacts framing used by native people rather than environmental NGOs or climate scientists).

Once the intended purposes of visual communication are established, a set of candidate visual elements or frames can be identified. Preliminary evaluation (e.g., via questionnaires, informal interviews, responses to images, participatory processes) involving representatives of the intended audience(s) can inform the selection of the most promising of the candidate visual elements and frames. The selected visual elements can then be developed into more complete concepts incorporating both visual sketches and key phrases. Concepts developed during this phase should also undergo preliminary evaluation, and several rounds of concept development and preliminary evaluation may be needed to support visual concept selection before communicators move on to draft-message development and production testing.

Following concept development and selection, full-scale production testing can begin. To prepare for production testing, message designers prepare a set of draft messages that include images and text (i.e., visual and textual message components that can be combined variously for comparative analysis). These draft messages are then tested on members of the intended audience(s), and messages are selected and refined based upon evaluation outcomes.

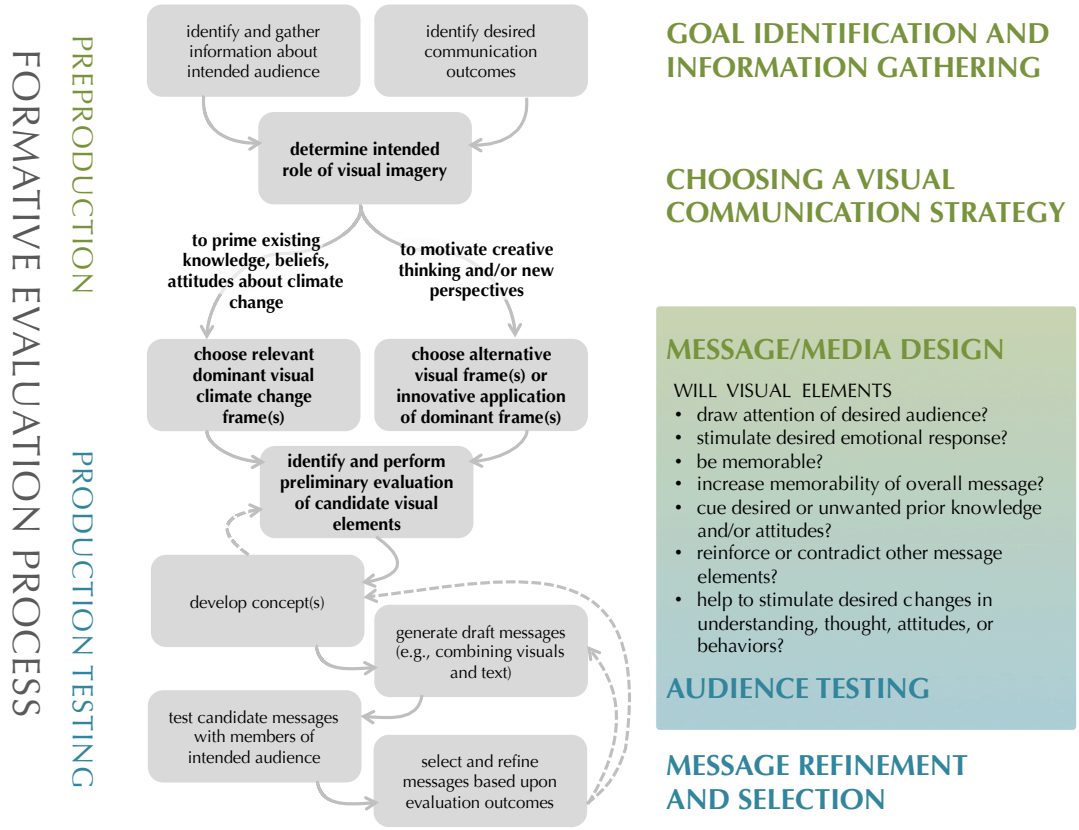

Figure 14. Considerations for visual imagery in preproduction and production testing phases of formative evaluation (based on Atkin & Freimuth, 2012).

As discussed above, the visual imagery used in public communication campaigns is often believed or intended to perform special functions related to the unique communicative properties of images. Thus message designers should ensure that their formative evaluation strategy includes assessment of whether the candidate visual elements can achieve the desired effects with the intended audience(s) (McGuire, 2012). For example, do the images draw the attention of the desired audience(s) and stimulate the desired emotional response? Is the visual imagery memorable, and does it increase the memorability of the overall message? Do the visual elements cue desired (or unwanted) prior knowledge or attitudes? Do the visual and textual components of the message reinforce or contradict one another? How do audience characteristics—existing knowledge, beliefs, attitudes, values, behaviors—influence responses to particular message elements or strategies? Such relationships can be explored through well-designed comparative analyses implemented throughout the concept development, preliminary evaluation, and production testing phases of formative evaluation. Further, ongoing formative evaluation is necessary to respond to insights or changing contexts during the campaign.

Vivid imagery that presents dominant visual frames is often a key element of climate communication strategies based on emotional appeal. Although current understanding of emotional appeals' potential to motivate change in attitudes or behaviors suggests that appeals to positive emotions are likely more effective (O'Neill & Nicholson-Cole, 2009; Ruiter, Abraham, & Kok, 2010; Searles, 2010), climate communication still very commonly uses potentially fear- or anxiety-inducing imagery. Dramatic use of dominant visual frames related to temperature anomalies; climate impacts on humans, animals, and landscapes; industry impacts on the environment; and storms and other natural disasters, for example, are meant to stimulate motivation through strong emotional involvement. Formative evaluation is therefore especially important to communicators who are considering use of fear-evoking imagery, as such messages should be tested with the intended audience to verify that the message truly elicits the desired emotional response, and that the expected changes in attitudes, beliefs, intentions, and behaviors are actually observed.

Limitations

The 350 images analyzed here are a random sample from 200 climate change news stories selected from a much larger sample of news stories published over a lengthy period. However, images in print news stories form only a very small portion of the climate change content available to potential audiences. Moreover, this analysis focused specifically on visual images, and aside from their associated headlines and captions did not consider the text of the accompanying news stories. Climate-related news imagery often presents messages unrelated to or contradicting the messages in the accompanying text (DiFrancesco & Young, 2011). Additionally, we did not report on issues related to editors' and journalists' selection and creation of such images, readers' interpretations of them, or any directly observed effects of viewing them (Nicholson-Cole, 2005).

Like most content analysis studies, this one makes no claims about the choices behind, or effects of, the visual frames identified in these news stories (see Olausson, 2011, p. 282). In particular, suggestions about which visual frames to use (or avoid) to achieve particular climate change communication goals, or regarding the likely effectiveness of such combinations, though based on insights from our work and that of others, are at this point speculative. Certainly some next steps in this area of research would be to assess how audiences interpret and respond to specific visual frames (through, e.g., their knowledge, attitude, behavior, or commitment) and then their combination with textual climate change frames. Finally, though this study presents a rigorous basis for considering possible combinations of climate change visual frames and text elements as part of a preproduction phase of formative evaluation for climate change campaigns, it represents only a small, initial aspect of formative evaluation.

Conclusion

This study is grounded in, and contributes to, research on visual framing, formative evaluation in public communication campaigns, and climate change communication. Using a set of more than 100 highly reliable image themes clustered into 15 dominant visual climate change frames, and drawing upon insights from other studies of audience responses, we have shown how designers of climate change messages and campaigns can make more informed decisions about the most appropriate types of frames

for varying audiences and message goals. Because visual imagery is meant to serve a variety of functions in communication campaigns (e.g., to draw attention, stimulate emotional response, enhance memorability, cue prior knowledge and attitudes, or represent complex or abstract concepts), formative evaluation should explicitly assess whether or not selected imagery fulfills its intended purposes. In designing climate communication strategies, choices between well-established and novel frames should be informed by evaluation of whether the campaign's goals are best served by priming existing cognitions, or by relying on creative thinking or new perspectives in the intended message. In cases where dominant frames are considered suitable, prior research provides a useful basis for anticipating the types of audience responses that dominant image frames are likely to evoke. The results and suggestions presented here have laid a foundation for much more comprehensive formative evaluation research that could provide testable propositions and informed guidelines for using or avoiding particular visual frames in climate change campaign messages aimed at specific audiences or communication outcomes. Of course, even successful climate change campaign messages that use images appropriately and effectively are only a very small component of the necessary ongoing efforts at the community, national, and global levels.

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