Chapter 7

Communicating about Climate Change Through Art and Science

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A common stereotype is that art and science represent different ways of experiencing and understanding the world, and thus cannot be integrated. For example, Snow (1959/2012) described the divide between the "two cultures" – the literary, and the physical scientific – and argued that the absence of collaboration between these two cultures was responsible for lack of progress on solving important problems. Yet the more general dichotomy between art and science is not necessary, or necessarily true. Indeed, the two cultures debate has also served as a catalyst for showing how art and science can and should intersect. For just a sampling of books integrating these two "cultures," see Blackwell (2009), Briggs (1992), Campbell (2004), Gage (1999), Kemp (2000), Liounis (2009), Miller (2012, 2014), Scheffler (1997), or Wilson (2002).

Gabrys and Yusoff (2012) offer historical background on the role of politics in evolving boundaries and intersections between arts and sciences. They highlight how "shared encounters with politics" due to the rise of ecological awareness in the 1960s and 1970s have served as a catalyzing force for new "meetings and mutations" of arts-sciences collaboration "at sites of shared concern and creative 'obligation'" (p. 1). The potential of art to stimulate public and deliberative discourse through growth in ideas and emotion encourages scientific work to also consider artistic, humanistic, social, political, and economic dimensions (Gabrys & Yusoff, 2012). At the same time, some in the natural sciences see the need for the social sciences and humanities to be "rebooted" to provide better understanding of human behaviors and how they can be altered (Ehrlich, 2010).

A growing number of climate communication practitioners are now embracing artistic expression and entertainment media as ways to communicate about climate change and thus engage the public in increased awareness, knowledge, attitude change, and behavior (Moser, 2010). A likely stimulus for the growing interest in art as a venue for climate communication is the general failure of the

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"knowledge deficit" model of communication to motivate the desired changes in public sentiment and behavior. Simply stated, the knowledge deficit model is built on an assumption that given the facts, the public will change their knowledge, attitudes, and behavior in accord with science (see Gustafson, & Rice, 2016, for its application to sustainability communication).

Thus we aim to provide a brief overview of the extent and nature of representation of climate change issues and science through the use of art, entertainment, and media in media portrayals. For each data source our guiding focus and search strategy was art and mass media entertainment representations (including movies, museum or art exhibitions, performance arts, music, etc.) of the environment in the context of climate change messages, campaigns, news, or studies. The chapter reviews recent evidence of, and debates about, this integration based on three sources of data: (1) articles listed in academic reference databases and Google Scholar, (2) online sites, and (3) climate change news images. Each section summarizes data collection and analysis procedures, and then results. Though we used multiple data sources to find instances, discussions, or analyses of such representations, our goal was not to conduct a comprehensive or systematic review, but to identify a central set of primary topics based on a good range of examples across a variety of sources. This chapter contributes to the main goal of this book, which "examines the roles that journalism, entertainment, and strategic messaging play in mediating meanings of science, health, economy, and sustainable solutions" associated with climate change.

What does Research say about the Integration of Art and Climate Change Science?

Procedure

We searched academic databases, including: Art & Humanities Citation Index (Web of Science), ARTstor, Communication Abstracts, Earth and Environmental Sciences Databases (mostly hard science), Environment Index, International Index to the Performing Arts, Museums and the Online Archive of California, Sage Journals Online, Social Sciences Citation Index, and Social Sciences Databases, but not in news/magazine databases (e.g., Lexus/Nexus, ProQuest News and Newspapers Databases, periodicals). For each article that appeared relevant when browsing preliminary results, we also read the abstract. If the abstract confirmed relevance, we downloaded the full text (.pdf). There are hundreds of articles on environmental communication in general, and climate change in particular, but very few on representations of art/mass media entertainment in climate change communication. Therefore, the search terms became very specific, and the results (title and abstracts) had to be examined carefully, to end up with a small number that were relevant to the project topic. We then searched Google Scholar, using the same basic approach. However, Google Scholar provides a long list of entries across dozens of pages, in general order of decreasing relevance. We browsed through the first few pages or until the next page had no relevant entries. For relevant results, we copied the citation and the abstract, and downloaded the available full text (.pdf). We also noted the journals providing results in this Google Scholar search process, and returned to academic databases that might include the journals that were not already included in the academic database results.

Theory and Promise for Communicating Climate Change through Art

Scholars and practitioners increasingly highlight the potential of art (in a variety of modes including dance, theater, comedy, music, documentary, etc.) to overcome personal, social, and cultural barriers to engagement with climate change (e.g., Grant, Baldwin, Lieske, & Matin, 2015; Merrick, 2012; van Renssen, 2017). Corbett and Clark (2017) provide an excellent and comprehensive review of actual and potential roles of arts and humanities in fostering engagement with climate change issues. They focus, in particular, on five approaches for arts-based communication: engagement through storytelling, corporally sensed and felt experiences (see also Duxbury, 2010), development of a sense of interdependency with the world, intentional engagement with emotions (see also Burke, Ockwell, & Whitmarsh, 2018), and connection with place. Others highlight the potential for art to communicate abstract or complex concepts such as the remoteness of "climate" in time, scale, location, unpredictability, uncertainty, and society's complex relationships with nature and climate (Duxbury, 2010; Giannachi, 2012; Moser, 2010). Duxbury (2010) posits that art has ways of addressing mutability and change at global and local levels that science may not, and that art can transcend language and unite cultures through nonverbal communication and sensing or perceiving the world around us.

Art is considered to have special capabilities to elicit reverie and reflection (Duxbury, 2010), to stimulate imagination, including the sort needed to develop climate change mitigation and adaptation solutions (Nurmis, 2016), and to enable envisioning and creation of alternative futures (Ojala & Lakew, 2017). Nurmis (2016) credits art's unique imaginative potential to its freedom from expectations of instrumental value and assumptions that it will defy convention. Giannachi (2012) sees the simultaneous representation of climate change as a "natural" phenomenon and a "cultural" one as critical to art's ability to "reposition ... the viewer from spectator to participant, thinker, citizen scientist or even activist" (p. 131).

Giannachi (2012) outlines three strategies or forms of climate change art: (1) representations that emphasize visualization and communication (e.g., imagery that includes climate change icons and post-apocalyptic landscapes); (2) performance environments that emphasize immersion and experience (e.g., sonification of climate science data); and (3) interventions that emphasize mitigation and behavioral change (e.g., creation of a community-specific system or activity, citizen science). Gabrys and Yusoff (2012) describe a move by communication practitioners away from performative approaches and toward art that involves political engagement. Miles (2010) provides examples of a shift from environmental and climate change art focused primarily on aesthetic "representation" to focus on material "intervention" through participatory modifications of the

environment or of the ways in which humans interact with the environment. Having found representational and performative arts approaches unsuccessful at motivating desired change, scholars, and practitioners have begun to focus their efforts [on] participatory art forms (e.g., Burke et al., 2018).

Visual communication about climate change includes both scientific and artistic representations of climate and associated issues, and has attracted attention in recent years. In particular, visual representations have played significant roles in both the development of, and communication about, science (Pauwels, 2006). Even science comics provide considerable scientific accuracy (although also myth, magic, legend), presented in entertaining as well as subtle and nuanced ways (Tatalovic, 2009). While most climate communication content studies (especially framing studies) are based on analysis of text, especially News (Nisbet, 2009; Olausson, 2009), recent research has increasingly considered visual representations of climate change issues (Doyle, 2007, 2011; Hansen & Machin, 2013; Manzo, 2010; Nicholson-Cole, 2005; Rebich-Hespanha et al., 2015; Schwartzenbach, Muller, Rentsch, & Lanz, 2012).

Scholars in the field highlight the importance of visual imagery in concretizing climate change impacts (Smith & Joffe, 2009), reaching difficult-to-engage audiences (Nurmis, 2016; Ojala & Lakew, 2017), and demonstrating the interconnectedness among ecological processes and organisms (Liounis, 2009). O'Neill and Smith (2014) synthesize an emerging literature of the visualization of climate change and identify three general themes in climate change imagery: time (past, present, and future), truth (faithfulness to reality, providing proof or witness, perceptions, and uncertainty), and power (who produces and chooses, for whom, and what aspects and frames are included). Svoboda (2016) analyzes artistic and fictional portrayals of climate change ("cli-fi") across a variety of media and found that extreme weather events (e.g., flooding and sea level rise) and Earth slipping into an ice age were the most common themes in this type of artistic representation. However, Wang et al. (2018) review several studies that critique the failure to draw connections between people, causes, effect, and solutions in visual portrayals of climate change.

(Lack of) Research to Demonstrate Effects of Art-based Climate Communication

There has emerged great hope for the potential for engagement with science through arts and the humanities, but there is a dearth of research that seeks to identify and demonstrate the assumed potential. A number of scholars have called for more research to investigate and demonstrate impact, especially in terms of motivating behavior change (e.g., Corbett & Clark, 2017; Maes, 2017; Wang et al., 2018). Ojala and Lakew (2017) also note that the scarce empirical evidence available demonstrates mixed outcomes that are far from conclusive. Burke et al. (2018) call for research to evaluate specifically (1) whether participatory art is more effective than passively viewed art; (2) the importance of the context or location in which the artwork is engaged with; and (3) the relationship between engagement with artwork and behavior change. They emphasize

that "...the instinctive expectation that the plethora of positive arts-based climate change initiatives that already exist will have a positive impact is not enough ... specific attention to how and why artistic interventions play a role in engaging people (and which people in particular) ... can only be achieved by careful, interdisciplinary collaboration ... in the design, execution and analysis of arts-based interventions" (p. 104). To leverage and enable such research in the arena of visual representation of climate, Wang et al. (2018) have developed the Climate Visuals project (2019), which provides imagery together with evidence-based evaluations.

The most called-for type of research is also most difficult to implement – studies that provide empirical evidence of links between art experience and behavioral change. Luke (2015) fundamentally questions the ability of art-based communication to motivate the types and degree of change needed to avert the worst impacts of climate change. Miles (2010) also questions whether the theorized superiority of interactive or intervention-focused (as opposed to representational or performative) art in overcoming the "gap between consumption of the spectacle and the step to personal action" (p. 31) actually stands up to empirical validation. Wang et al. (2018) point out that emotional responses and visual attention do not necessarily predict changes in attitude, knowledge, or behavior, so studies cannot presume a standard causal linkage.

A handful of studies have begun to explore the connection between art experience and behavior. Burke et al. (2018) explore the insight from social psychology that both cognitive engagement and affective/emotional engagement are prerequisites for behavioral change, and seek to evaluate the ability of art to motivate behavior change by engaging emotion. Participants in their study were visiting a pier on the coast of Scotland and had viewed an artwork (72 knitted terns with information about changing migration patterns). They ranked their agreement with 36 statements about climate change and their reactions to the artwork and discussed the reasoning behind their rankings. Analyses of the data revealed three primary outcomes: climate conscientious but unengaged with the artwork, undecided about climate change and engaged with the artwork, and climate skeptical and unmoved by the artwork. The researchers found support in these findings for the primacy of existing climate change attitudes. Sakellari's (2015) study of responses to three climate change films yielded similar insights. She found that films that attempt to correct knowledge deficits and elicit fear through representation of catastrophic scenarios resonate with audiences who are already engaged with the issue but are not effective at engaging those who are skeptical or unengaged. She also concluded that the observed lack of long-term changes to behavior and attitudes was due to fearful framing and a failure to resolve the issue of trust. Svoboda (2016) also discusses the possibility that "cli-fi" will reinforce existing views rather than shift them.

Cases in which researchers have demonstrated impacts of art experiences on climate change attitudes confirm the importance of an appropriate match between audience and art genre and thematic content. Burke et al. (2018) found, for the small segment of their research participants who were undecided and open to learning about climate change, positive imagery and humor were important motivators of engagement. They also found that situation within the local,

everyday lived environment and focus on locally perceptive impacts led to higher engagement within this audience. Ohala and Lakew (2017) used video games and other interactive and visualization-based media to interact with high school students. Pre-post surveys demonstrated increased knowledge about climate science, self-efficacy, pro-environmental intention, and short-term behavior in response to this experience.

Critiques of Art as a Vehicle for Climate Change Communication

Some scholars contend that the assumed potential for art-based climate communication to achieve impact where more traditional scientific communication has failed has been overstated and over-generalized. These critiques raise questions that go beyond the scarcity of empirical evidence and inconclusive results in previous work. There are criticisms related to the fundamental difficulties inherent in representing phenomena that are uncertain or incompletely understood (Luke, 2015; Nicholson-Cole, 2005; O'Neill & Smith, 2014; Rice, Gustafson, & Hoffman, 2018; Schneider, 2011), and concerns that standard artistic images of the more complex aspects of climate change may foster a superficial and stereotyped perspective (Hansen & Machin, 2013; Meisner & Takahashi, 2013). Maes (2017) notes that engagement with interactive visual projects often requires levels of literacy and numeracy that are not common among large vulnerable populations around the world, and that even strictly visual codes must be learned.

Svoboda (2016) and Wang et al. (2017) observe lack of focus on examples of efforts to mitigate the causes of climate change and on potential solutions more generally. The representations and visions of climate change impacts that are common in art-based communication often fall under the rubric of what Nurmis (2016) refers to as the "apocalyptic sublime" – observation of potential for pain from a safe distance that "...risks merely providing images and sensory experiences which inspire a sort of catharsis that does not result in any essential reconfiguration of the mind with regard to our relationship to the environment..." (p. 510). Similarly, Miles (2010) raises concerns that art can serve to distance its content and lead to familiarization or normalization of things that should cause alarm.

An obvious concern is that even the most apparently factual and explicit climate change science representations can be variably interpreted, contestable, value-laden, and politicized (O'Neill & Smith, 2014), and artistic representations are especially vulnerable to critique as rhetoric. Nurmis (2016) observes that art that seeks to be practical, propagandistic, or didactic is dismissed as not being art and only engages those who are already concerned. Miles (2010) reinforces such concerns when he notes, "Art which charts a course of social change reproduces the instrumentalism of the dominant society, and fails to challenge the mind-set which is one of the causes of climate change" (p. 32).

Opportunities and Constraints at the Intersection of Art and Media

Because climate change communicators desire broad impact for art-based communication efforts, venues or media capable of reaching many people are often sought out for climate-themed art. With such goals in mind, museums have been identified as potentially influential venues for communicating about climate change (Rees, 2017). Museums are part of an international infrastructure, yet typically have a strong local identity, and are designed in ways that can be used to disseminate information about climate change. High-quality museum projects prioritize communication and dialog over information and transmission, translate scientific language to be more accessible, and focus on engagement through storytelling. These arts and cultural institutions offer potential for engaging the public in non-partisan venues for public participation, and can span boundaries between disciplines and sectors.

Beyond museums, live performance venues, and the interactive public experiences they can provide, much climate-themed art is distributed and consumed via mass media. For this reason, many of the challenges of communication through media are relevant to the discussion of the potential for art-based communication about climate change. Scholars from a variety of disciplines have expressed concerns about the effects of media consolidation and the resulting constraints on messages (e.g., Moore, 2017) and pressure due to market and policy demands and production norms (e.g., Boykoff, 2011, chapter 8; Cozen, 2013; Hansen & Machin, 2013; McCright & Dunlap, 2003). Debrett (2017) shows that even the genres of climate change public service programing on television are constrained by fixed time storytelling, limited audience participation, the influence of ratings, and an emphasis on spectacle and controversy that blurs the boundaries between fact and fiction.

Social media have also become important arenas for creation, consumption, and critique of art-based climate communication. In general, developing social media associated with an article or media project to foster audience engagement with climate change issues risks greater dissemination of controversy, inaccuracy, and denial (Debrett, 2017). Social norms, such as those signaled by the number of views for a video or by the content and tone of the comments submitted in response, can have a strong influence on media viewing and perceptions of the topic being depicted (Shapiro & Park, 2015; Spartz, Su, Griffin, Brossard, & Dunwoody, 2017). Shapiro and Park (2018) conclude that comments posted with YouTube climate change videos do not represent the deliberative discourse needed for democratic and informed bases for public opinion and climate change policies. The influence of these media-specific social norms places important constraints on the impact of art-based climate communication delivered on such platforms.

What are the Kinds of Art Media, Content, and Goals of Online Sites and Videos about Art and Climate Change?

Procedure

We searched for relevant online sites, YouTube videos, and other web resources. There are of course millions of relevant websites; there are 5 million YouTube videos tagged as "climate change" as of June 2018, and TED talks on science communication are viewed by more than half a million viewers each day

(Sugimoto & Thelwal, 2013). Therefore, the central goal was to briefly summarize an illustrative set of online sites, YouTube videos, and other web resources that met our general search strategy.

For each entry that seemed very relevant, we noted the URL or other reference, its date, the media type (website, video, story, academic article). We read the complete first page or watched the full video to determine if it was a relevant and useful example. If so, we then identified main topics portrayed in each that were relevant to our search. After listing and standardizing the terms for these topics, we then grouped the topics of the online sites or videos into three main categories: (1) the art medium or form discussed, (2) the primary content related to climate change, and (3) the apparent goal. Table 1 lists the 49 websites along with their main topics, while Table 2 provides the number of topics within the three categories used to describe the 49 sites.

Wide Variety of Art Media, Content, and Goals

The sites mention or involve a variety of art media. Those portrayed more than once were climate change art in general, film, painting, visual art, exhibition(s), theater, comics, dance, and photographs. Intriguing art media mentioned once included architecture, puppetry, sculpture from weaving, and travel documentary. Frequent primary content discussed in the videos was using art as a tool for climate change efforts, climate change impact, sustainability, media as a tool, culture shifts, debates about climate change effects, and scientific data. Interesting content mentioned once included debates about the effect of climate change art itself, energy, local issues and culture, and sport as a tool. Many of the sites indicate specific goals or purposes, with the most frequent being promote action, collaboration, raise awareness, climate change communication, discussion, empowerment, reshape public perception, and engagement.

Of particular interest is that several sites provided debates or discussions about whether art has much effect on climate change attitudes and behaviors, and for which issues or contexts. For example, art provides occasions or catalysts for collaboration and alliances, and can evoke emotional responses and engagement. On the other hand, climate change issues may be too abstract, complex, and distant to represent well through art, which is therefore unlikely to affect politicians. The vast majority of sites do, however, highlight how art, media, sport, and other non-science activities can be useful tools in communicating climate change science and topics, and bringing together diverse stakeholders.

Main Insights

Several other issues emerge from these videos. First, we need a cultural shift in how people view climate change. Integrating art (broadly defined, ranging from puppetry and ceramics through international exhibition series and online film) and science can heighten awareness, emotional response, knowledge, and even action. Typically, people don't know or understand the science, so visualization helps them, especially through integrating science data and making it relevant

Table 1. Online Sources Involving Art, Science, and Climate Change.

Source and Summary	Themes
https://www.canary-project.org. The Canary Project develops art and media projects about issues such as climate change, extinction, food systems and water resources. Participants include artists, designers, scientists, writers and volunteers	Art as tool; collaboration; media as tool; promote action; raise awareness
https://www.capefarewell.com. Cape Farewell is an international not-for-profit program that brings creatives, scientists and informers together to develop cultural narratives emphasizing a sustainable and vibrant society	Collaboration; promote action; sustainability
https://www.climatestoriesproject.org. The Climate Stories Project emphasizes personal, emotional, and community impacts of climate change from the perspectives of people around the world	Climate change impact; story sharing
https://www.culturesofenergy.com/arts-media/. The Arts and Media cluster of the Center of Energy and Environment develops and supports curriculum, programing, and research on how artists and media respond to crises in, and influence thinking about, energy and ecology issues, particularly in the context of Houston's energy and arts contexts	Art as tool; climate change impact; media as tool; reshape public perception
https://www.desmogblog.com/2014/09/22/artists-behind-people-climate-march. Artists from the around the country created much of the art for the People's Climate March, the largest climate march in history	Climate change art
https://www.dothegreenthing.com. Do The Green Thing helps a global community of creatives responding to climate change issues, via films, podcasts, posters, etc.	Climate change art; multiple media; promote action; sustainability
https://www.earthmattersonstage.org. Earth Matters On Stage (EMOS) involves artists, educators, activists, and scholars working in theater and the performing arts to respond to environmental issues. Two major activities are a new play competition and a symposium on this intersection	Art as tool; collaboration; promote action; raise awareness; theater

Table 1. (*Continued*)

Source and Summary	Themes
https://www.eco-fiction.com. Eco-fiction.com is a news site covering works by environmental authors, via reviews, a book database, posts, and author highlights	Books; news site
https://www.extremeicesurvey.org. The Extreme Ice Survey is photography program combining science and art, providing a "visual voice" to ecosystems, in order to influence public perception and action	Photographs; reshape public perception
https://www.highwaterline.org. HighWaterLine helps communities visualize difficult scientific data and potential climate change effects (e.g., sea level rise) through art to foster stakeholder communication and action, and provides a guide to creative community engagement	Collaboration; promote action; scientific data; visual art
http://americanarchive.org/catalog/cpb-aacip_15-v5bc3t03w. Artist Nathalie Miebach explains how she literally weaves scientific data related to meteorology, climate change, and astronomy into brightly colored, three-dimensional sculptures	Scientific data; integration; sculpture from weaving
http://americanarchive.org/catalog/cpb-aacip_15-cc0tq5rf2m. A panel discussion by scientists and journalists regarding the issue of global warming and the use of film to influence the human impact on the planet	Climate change impact; discussion; film; promote action
http://theconversation.com/why-art-has-a-part-to-play-in-tackling-climate-change-51537. An article about the value of creative responses to climate change	Art as tool; art effect debated; promote action; raise awareness
http://www.artworksforchange.org/. Art Works for Change creates traveling museum exhibitions focused on social and environmental themes	Climate change art; exhibition(s); museum; social change
http://www.tate.org.uk/art/tate-etc/climate-change-an-artists-have-any-influence. A debate regarding whether artists can make a difference in the topic of climate change. While climate change art can increase alliances between art and science, the topic may be too abstract, distant, complex for art to make much change	Climate change art; effect debated
https://artistsandclimatechange.com/. This blog tracks and gathers interesting artistic work about climate change all over the world, in all kinds of venues	Art library; climate change art
https://climateoutreach.org/. Climate Outreach is the world's first evidence-based climate change image library with the mission to increase public awareness and understanding of climate change and its impacts	Climate change impact; discussion; film; promote action
https://theconversation.com/climate-science-is-looking-o-art-to-create-change-41185. How scientists are using art for climate communication	Art as tool; climate change communication
https://www.artclimatechange.org/. CLIMARTE is an independent not-for-profit organization that harnesses the creative power of the arts to inform, engage and inspire action on climate change, primarily through a series of exhibitions at museums and galleries in Australia in 2017	Architecture; climate change impact; collaboration; film; music; promote action; sustainability; theater; visual art
https://www.leonardo.info/isast/art-science-nvironment.html. Leonardo On-Line: Art, Science and the Environment is an evolving list of artists, scientists, art/science collaborations, projects and organizations who are working on issues related to the intersection of art, science and the environment; it also provides a bibliography	Collaboration; resources
https://www.npr.org/2017/07/27/539734176/-an-inconvenient-sequel-is-an-effective-cautiously-ptimistic-i-told-you-so. Explains how Al Gore's new film: *An Inconvenient Sequel: Truth to Power* was hugely effective in communicating climate change	Climate change communication; film
https://www.theguardian.com/global-development-professionals-network/2013/sep/23/climate-is-ulture-global-warming-art. An article talking about how art can be an effective tool for climate communication	Art as tool; climate change communication
https://www.weforum.org/agenda/2016/01/why-art-has-he-power-to-change-the-world/. Engaging with a good work of art can connect people to their senses, body, and mind, and can thus be used to promote awareness of, and action about, climate change	Art as tool; engagement; raise awareness; promote action
https://www.yaleclimateconnections.org/2017/02/cliate-films-to-watch-in-2017/. The 15th Wild and Scenic Film Festival in Nevada City featured 120 climate films (4 linked here) to inspire audiences to take action on the challenges facing our planet	Film; promote action
https://www.yaleclimateconnections.org/2017/07/climate-art-more-and-better-with-time/. Artists in all media are increasingly conveying important climate change messages in ways that can inform, empower, and lead to more collective action	Empowerment; promote action; raise awareness

Table 1. (*Continued*)

Source and Summary	Themes
https://www.youtube.com/watch?v=8tZ264GML98. Featured in CGTN Africa (a News network), over 60 artists from around the world display effects of climate change through their art works at the COP22 summit in order to raise awareness	Climate change impact; painting
https://www.youtube.com/watch?v=-AiPu9jk6vU. An Ethiopian man is using his artistic talent and strong visual image to increase awareness about climate change	Painting; raise awareness
https://www.youtube.com/watch?v=AVqoTEcHrsI. Why art plays an important role in addressing climate change, especially regarding the associated cultural shifts and social impacts	Climate change art; effect; culture shift
https://www.youtube.com/watch?v=ay-m6EIxFzU. Conveying the urgency of climate change through large scale drawings documenting travels to the polar region	Painting; raise awareness; travel documentary
https://www.youtube.com/watch?v=b6if9TpK82E. Experts address how arts and the media are very influential tools in shaping the public's perception of climate change	Art as tool; media as tool; reshape public perception
https://www.youtube.com/watch?v=iZRGUADAu2Q. Collaboration on using art (in particular, ceramics) and science to foster community conversations and action about global climate change	Ceramics; climate change impact; collaboration; empowerment
https://www.youtube.com/watch?v=JNaBGtRpN6E. Traveling exhibit at the United Nations in New York of children's paintings to raise awareness about climate change	Exhibition(s); painting; raise awareness
https://www.youtube.com/watch?v=wb3j_gpoL50. Objective science and creative art and dance must be used together to not only deliver the facts of climate change but also to persuade people into believing its presence	Art; dance; persuasion
https://www.imagine2020.eu. Imagine 2020 (2.0) is a network of 10 EU based arts organizations, focusing on raising awareness around the issues of the current socio-ecological crisis, via funding, R&D, and resource sharing	Collaboration; promote resource/idea/ knowledge sharing; raise awareness
https://www.kinnarieco-theatre.org/index.html. The Kinnari Ecological Theatre Project uses local Southeast Asian legends as the basis for staging new plays on local environmental issues, using local languages, dance, puppetry, and songs	Dance; local issues and culture; puppetry; reshape public perception; songs; theater
https://www.landartgenerator.org. The Land Art Generator offers an online resource for a variety of creatives, engineers, and scientists developing sustainable energy solutions, aiming to improve energy infrastructure that is also public art	Collaboration; empowerment; energy; solution
https://www.projectaspect.org/about_aspect?page=project_backgound. Project ASPECT is interested in new communication approaches such as digital storytelling for engaging the public in complex and difficult issues, such as climate change	Digital storytelling; engagement; media as tool
https://www.sustainablepractice.org. The Center for Sustainable Practice in the Arts integrates issues of environment, social equity, economics, and cultural infrastructure, grounded in the Agenda 21 for Culture policies, to promote arts and culture as a main influence on sustainable society	Art as tool; culture; sustainability
https://www.thearcticcycle.org/about/. The Arctic Cycle engages collaborative theater and interdisciplinary and international artists, social scientists, and educators to promote communication about and action on the climate crisis	Climate change; collaboration; discussion; empowerment; promote action; theater
https://www.theconversation.com/living-data-how-art-helps-us-all-nderstand-climate-change-36890. Art and science are not incompatible perspectives. Artists can play an important role in climate change communication because art expresses personal understanding and experience	Art as tool; climate change communication; sustainability
https://www.theguardian.com/artanddesign/2009/dec/02/climate-hange-art-earth-rethink. Three artists are interviewed concerning their work as a response to climate change, and the importance of art involvement	Art as tool; climate change response; engagement
https://www.theguardian.com/artanddesign/2009/dec/11/copenhagen-climate-change-art. This author raises doubts towards climate change art, especially its impact on authority figures like politicians, though he agrees about the emotional impact of artwork	Climate change art; effect debated

Table 1. (*Continued*)

Source and Summary	Themes
https://www.theguardian.com/artanddesign/gallery/2014/may/12/when-nature-calls-artists-climate-change-art-and-cology-in-pictures. A collection of climate change photographs and installations by 12 artists from around the world	Art installations; photographs
https://www.theguardian.com/artanddesign/jonathanjonesblog/2010/fb/02/comics-climate-change. This story wonders whether graphic novels could be an effective way to make sense of the climate change controversy	Art as tool; climate art effect debated; comics; controversy
https://www.theguardian.com/environment/2008/jul/23/climatechnge.art. In response to a memorial competition, cartoonists from over 50 countries have used biting humor to fight global warming in ways that traditional media forms cannot	Art as tool; comics
https://www.theguardian.com/environment/chinas-choice/2013/may/25/climate-change-art-exhibition-beijing. A Beijing art exhibition covers climate science themes and debates to inspire dialogue in China	Art as tool; discussion; exhibition(s)
https://www.theguardian.com/environment/gallery/2008/oct/21/cimatechange. Paint for the Planet is a United Nations Environment Programme competition for children to use painting to display their concerns for the planet	Climate change communication; painting
https://www.theguardian.com/global-development-professionals-network/2013/sep/23/climate-is-culture-global-arming-art. The Cape Farewell project brings together artists and climate scientists in exhibitions, expeditions, concerts, digital media, film, festivals, and publications	Art as tool; collaboration; culture shift; digital media; exhibition(s); film; public perception
https://www.theguardian.com/global-development-professionals-network/2015/jan/27/13-ways-arts-sport-inspire-ction-climate-change. This panel discusses 13 ways to use arts and sport to communicate about climate change. Examples include a community developing a photo-story, greening museums, creating exhibitions in public spaces, and designing new football stadiums to include underground water reservoirs	Art as tool; climate change impact; sport as tool

Note: All sites active as of June 2018.

Table 2. Number of Online Sites Portraying Topics in Three Categories.

Art Medium	Total	Content	Total	Goal	Total
Climate change art	7	Art as tool	16	Promote action	13
film	6	Climate change impact	8	Collaboration	11
Painting	6	Sustainability	5	Raise awareness	9
Visual art	5	Media as tool	4	Climate change communication	5
Exhibition(s)	4	Culture shift	2	Discussion	4
Theater	4	Effect debated	2	Empowerment	4
Comics	2	Scientific data	2	Reshape public perception	4
Dance	2			engagement	3
Photographs	2				
Architecture, art installations, art library, art, books, ceramics, digital media, digital storytelling, multiple media, museum, music, news site, puppetry, sculpture from weaving, songs, story sharing, travel documentary	1 each	Art effect debated, climate art effect debated, climate change, controversy, culture, effect, energy, local issues and culture, public perception, resources, sport as tool	1 each	Climate change response, integration of art and science, persuasion, promote resource/idea/ knowledge sharing, social change, solution	1 each

$N = 49$ online sites. *Note*: A site could be coded for 1 or more of any of the topics.

to society. Art allows people to see and be aware of things not otherwise available or understood. Art doesn't (necessarily) require text or numerical literacy. Bridging the audience, art, artists, and science communication may change public perception and eventually policy; thus art can be an opinion leader. Art activities, exhibitions, museums, and projects also foster collaboration and resource sharing across disciplines, participants, and stakeholders. Collaboration is a form of, and can lead to more, collective action, which is crucial for responding to pervasive, interdependent, societal, and global issues such as climate change. Engagement with and participation in multiple forms of art activities seems a crucial element in this process.

How is Art Representation Associated with Main Image Frames in Climate Change News Stories?

There has been, to our knowledge, no systematic evaluation of which aspects of the climate change issues are most often highlighted through artistic representations used as news story images. The following analysis examines the strength and direction of relationships in climate change news stories between dominant visual frames in climate change news and representations of an art/entertainment/mass media representation of environment theme. These relationships offer insight into the aspects of the climate issue that are typically made salient by artistic representations that appear in the news.

Procedure

We have previously reported on a content analysis of 350 images and accompanying captions and headlines that appeared with 200 randomly selected US newspaper and magazine stories about climate change from a set of 5,637 articles from 1969 to 2009 (Rebich-Hespanha, & Rice, 2016; Rebich-Hespanha et al., 2015). In that earlier work, we first identified and reliably coded 118 visual themes appearing in the images, and then performed a cluster analysis of the co-occurrences of the 103 non-geographic coded visual themes across the 350 images. The cluster analysis provided a hierarchical dendogram "tree structure" from which we could interpret clusters as visual frames. To break the tree into discrete clusters, we evaluated the clusters that resulted from different cutoff level choices, and then chose the cutoff level that we judged to be most useful or appropriate for visual frame analysis. Forty-two overall visual frames emerged.

Climate Change Visual Frames and Themes

Table 3 lists the visual frames (clusters of themes), as well as the individual themes that did not belong to specific visual frames.

The six most frequent visual frames (each involving at least 10% of the images) included: government, politics, and negotiation; climate science, research, and scientists; monitoring and quantifying; temperature record; regular (sometimes vulnerable) people; and food and agriculture.

Table 3. Frames and Themes in Climate Change News Story Images.

Frames and Themes	Themes Included in Frame Cluster	% of Total Images with This Frame Or Theme
9. *Government, politics, and negotiation*	8	34
1. *Monitoring and quantifying: Greenhouse gas emissions, energy generation and use, economic implications*	13	21
12. *Climate science, research, scientists*	5	21
14. *Temperature record*	3	15
25. *Regular (sometimes vulnerable) people*	2	13
21. *Food and agriculture*	3	10
2. *Industry impact on environment*	3	9
3. *Alternative energy and energy prices*	7	9
19. *Future climate, sea level rise, and landscapes*	7	9
32. *Citizen leaders*	2	8
18. *Storms*	2	7
35. *Wilderness and nature recreation*	2	7
5. *Energy efficiency*	4	6
20. *Impacts on polar animals and landscapes*	5	6
13. view of globe from space	1	6
22. educational institution	1	6
17. *Water-related impacts*	4	5
27. general environmental problems	1	5
31. general reference to science	1	5
33. 'green' or 'eco-' activities, choices, items, or lifestyles	1	5
10. *Public action*	3	4
7. solar energy technology	1	3
8. *Celebrities raising awareness*	2	3
15. atmospheric GHG concentrations	1	3
23. private space, scene, or landscape	1	3
4. journalist/columnist	1	2
11. US iconography	1	2
26. impact on human health	1	2

Table 3. (*Continued*)

Frames and Themes	Themes Included in Frame Cluster	% of Total Images with This Frame Or Theme
29. *Disaster response*	3	2
37. non-specific government programs or policies, legislation, legal issues	1	2
6. emissions projections	1	1
16. drought or water shortage	1	1
24. child/children	1	1
28. recycling/waste disposal	1	1
30. *Urban pollution*	2	1
34. tourism	1	1
36. forest/tree loss	1	1
38. health and medical institutions, personnel, or conditions	1	1
40. abnormal weather patterns	1	1
42. forest management/tree planting	1	1
39. public opinion	1	0
41. volcanic eruptions	1	0

$N = 350$ images.

#, Frame or theme number. Closeness of number by each *Frame* or theme indicates closeness in overall clustering results (e.g., 19. Future climate, sea level rise, and landscapes; 20. Impacts on polar animals and landscapes; and 21. Food and agriculture were three separate clusters that had more common images with each other than with other clusters).

Italics, Frames (including more than 1 theme in the cluster).

%, the proportion of the 350 images associated with the particular *Frame* or theme.

As part of this clustering-based approach to identification and interpretation of dominant visual themes in climate change news imagery, a small number of individual themes was identified as co-appearing frequently with themes that comprise the dominant frames, but meriting consideration on their own. Among these was our focal theme of art and mass media representations of the environment (occurring in 16% of all images), which frequently co-appeared with the other themes in the industry impact on the environment cluster, but also with other themes and frames (see Rebich-Hespanha et al., 2015, especially Table 1, and its supplement, for full details on data sources, coding, and clustering of all the images, and explanations of the frames and themes). Table 4 provides the coding operationalization and reliability for this focal theme. Table 5 provides brief summaries of selected images coded for this theme. The 55 images including this theme were portrayed through chart/illustration (1.8%), illustration (72.7%),

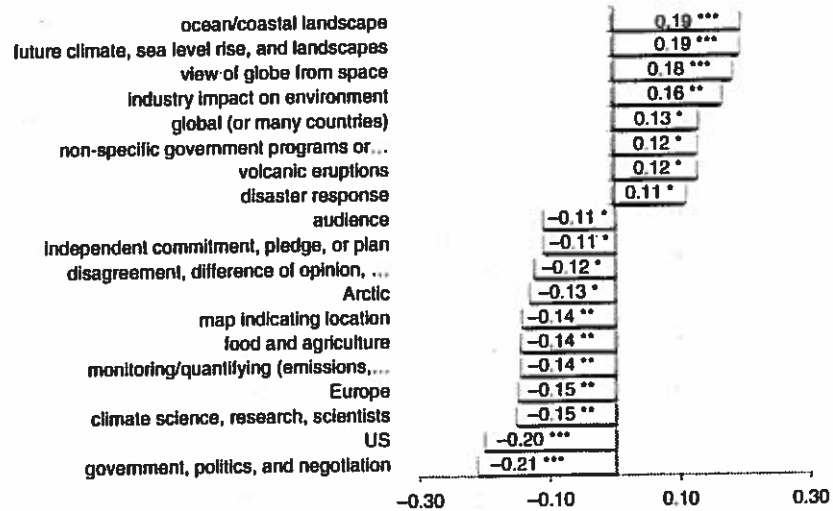

Fig. 1. Significant Correlations for Co-occurrence of *Art/Entertainment/Mass Media Representation of Environment* Theme with Other Climate Change Visual Frames and Themes. *Note*: Values in bars are Pearson correlations: * $p<0.05$, ** $p<0.01$, and *** $p<0.005$. Negative correlations means that the theme co-occurred significantly less frequently with those frames or themes than would be expected by chance.

photo (14.5%), and photo-illustration (10.9%); many of the photos were stills from films, or of drawings or paintings.

Fig. 1 shows the percentage occurrence of relevant frames and themes, and significant Pearson correlations of the art/media/entertainment theme with major frames, themes, and portrayals of geographic regions.

Table 4. Coding Operationalization of the Theme of *Art/Entertainment/Mass Media Representation of Environment* in Context of Climate Change.

Climate change issues visually represented in art or in entertainment or other mass media. Includes visual or performance art, film, or music focused on climate change issues. Includes editorial news illustrations that refer to climate change issues. With the exception of editorial illustrations, includes only instances in which the climate change issues are viewed through a "double lens" (i.e., the image is a presentation of a visual representation of the environment that was created by a third party for a purpose other than supporting the news story that the image accompanied). Does not include images of celebrities who advocate taking action on climate change issues unless the image also represents or refers to an art/media/entertainment representation of the climate change issue itself.

Note: Final I_r adjusted reliability (Perreault & Leigh, 1989) = 0.98; KA, Krippendorff's Alpha (Krippendorff, 1980) = 0.93.

Table 5. Summaries of Selected Images Coded as Including *Art/Entertainment/ Mass Media Representation of Environment in Context of Climate Change* Theme.

010o	Image about Leonardo DiCaprio as narrator of "The 11th Hour" documentary
036a	Architectural drawing imagining a "ventilated levee" as geoengineering solution
036b	Artistic rendering of using green laser beams indicating height and location of earthen dikes that might be needed to protect San Francisco from sea level rise
036c2	Photograph of Rising Tides art competition
039o	Still from Al Gore's "Inconvenient Truth"
049o	Futuristic painting of geo-engineering solution of unmanned vessel spraying salt water into the clouds
052o	Photo at Cannes Film Festival of main participants in "The Inconvenient Truth"
079o	Photograph from "Penguins of the Antarctic" documentary
097a	Use of spatial view of global as "O" in "Hot Stuff?" guide to global warming
100o	Black/white drawing of penguin on shrinking ice floe, reading the "Weather" section of a newspaper
102o	Photo still from "The Great Warming" documentary, juxtaposing close-up of face of local man with parched crops and three reactor chimneys in background
106a	Photo of Newsweek's cover on "The Greenhouse Effect," with image of family in a glass bell jar with dirty clouds in background
111o	Impressionist painting of swiftly melting planet, with tall chimneys spewing black clouds, and jagged lines from hot sun
117o	Cartoon line-drawing of small man looking up at stars and large question mark, for story about environmental delusions
118o	Still from Chevron's TV spot about its "Human Energy" ad campaign
129o	Colorful Matisse-like angel in cloud of green leaves flowing over image of a globe with a round thermostat in the middle
140a	Still from "The Day After Tomorrow" accompanying story on flaws and effects in how the science is presented
147o	Accompanying a story on Bush's avoiding the Global Warming Treaty, an image of a disrespectful Uncle Sam holding money and stepping on a globe that's on top of a "Treaty"
157a1	A photo of what looks like a woven image of smokestacks, dark smoke, and gray atmosphere

Table 5. (*Continued*)

166o	Cover of *The New York Times Magazine* issue on "The Green Mind," with a drawing of an outline of a person's head with a green brain made up of green human bodies curled up together
174a	Photo of a 19th engraving showing the effects of the "Little Ice Age" at the annual Frost Fair on a frozen river during the winter of 1683–1684
188a	Photo of 2007 painting "The Defeat of Anthropy," representing decaying buildings being taken over by vines and surrounding plants
188c	Creative image accompanying story on "Is Earth near its 'tipping points'?," with tilted globe with reflection of sun in the Atlantic, with several shadow images of humans slipping off the top, and a chart of rising annual temperatures below
209a	Evocative gray-scale drawing of hot thermometer located at a left-leaning angle over the earth, as in a gas gauge nearing empty

Results and Implications

The art/entertainment/mass media theme was positively significantly correlated with frames or themes of ocean/coastal landscapes; future climate, sea level rise, and landscapes; industry impact on the environment; volcanic eruptions; and disaster response – in other words, impacts or possible changes in the natural environment. Views (either photorealistic or interpretive) of the globe as seen from space were also positively correlated with artistic imagery, a pattern that begs further inquiry in light of the potential for this technologically enabled view of the Earth to offer the perspective of a detached and impartial observer and therefore contribute to a sense of distance from the issue (Hansen & Machin, 2013).

On the other hand, our focal theme was negatively significantly correlated with representations of the government, politics, and negotiation; climate science, research, and scientists; monitoring/quantifying; food and agriculture; disagreement, difference of opinion, debate, or controversy; independent commitment, pledge, or plan; and audience. The theme was also negatively associated with three geographic locations: the United States, Europe, and Arctic, as well as with map indicating location. Note that the art/entertainment/mass media visual theme was not significantly associated with the remaining most frequent visual frames of regular people, temperature record, alternative energy and energy prices, citizen leaders, wilderness and nature recreation, storms, impacts on polar animals and landscapes, or uncertainty.

Associations with the art/entertainment/mass media theme suggest that artists who explore environmental issues (and/or the editors and journalists who create and select imagery for news stories) prefer impacted natural environments over complex social and technical phenomena such as politics and science as subjects for artistic work. Representing some kinds of effects on natural environments may

well be well suited to more artistic approaches, while more subtle and abstract issues may not. For example, we might expect that artistic/entertainment-oriented images would be especially suitable for portraying the sometimes abstract and macro concepts of climate and global warming.

The fact that certain themes/frames (impacts on the natural environment, especially due to industrial activity) are often present in artistic representation of climate change (described above) does not necessarily mean that these are the frames or theme that should be focused on in such representations. Conversely, artists, journalists, and editors would do well to consider how artistic representation can be used to communicate about the types of frames and themes that currently are negatively correlated with arts/media/entertainment images. Frames and themes negatively correlated with art/media/entertainment representations provide possible opportunities for communicating those topics in more artistic ways. For instance, artistic imagination/editorial selections could include more imagery that focuses on ways people are having or can have an impact on finding solutions. But perhaps the negative correlations reflect something about the nature of those topics that make them difficult to visualize. Or, also as noted above, perhaps those are topics that market forces, journalistic norms, and implicit biases render more "invisible." However, as Wang et al. (2018) noted, in general there are few interconnections among central issues in climate change visual portrayals.

Conclusion

The integration of artistic representations and climate change science is an important but challenging arena for artists, website designers, online video creators, exhibition and museum administrators, journalists, scientists, and researchers – as well as for the general public. Our brief and largely impressionistic analyses of academic databases, online sites, and climate change news story images raise a variety of questions for future research and practice.

What specific goals do those artists, journalists, and researchers integrating art and climate change science have? Without specifying clear goals (ranging from exposure, awareness, and engagement to changes in knowledge, attitude, or behavior), it is impossible to either assess the effects of those representations, or learn how the material or experiences can be improved. This is not arguing that art should be measured and evaluated; only that if teams involving creatives, scientists, researchers, and administrators develop climate change material with intentions to foster some kind of change, and if they wish to understand what worked and what did not, they must clarify and then evaluate their specific goals. As we have argued elsewhere (Rebich-Hespanha & Rice, 2016), formative evaluation approaches associated with rigorous communication campaigns could be applied to better understand the meanings and effects of particular climate change images.

What background knowledge about climate change, art, and science, and what ideologies, values, and personal experiences influence who is exposed or attracted to this type of art? How do art exhibits, museums, films, and music attract

people who are not already supportive of or interested in climate change issues? What forms and types of participation and engagement with artistic representations of climate change science are more effective, in which contexts, for what goals?

While, as noted in the above reviews, there is considerable work on effects of images and visuals in general, and in news framing more specifically, there are only a few studies about climate change images in particular and fewer about artistic representations (especially of the "double lens" form in which a visual image also includes a representation of some other media image or content). Our own work in content analysis of climate change news images explicitly acknowledges that such research can say only a little about a range of possible interpretations of content, but does not relate the images to the accompanying text content (as do Shapiro & Park, 2015; Wessler, Wozniak, Hofer, & Lück, 2016), and says nothing about either the production choices or possible effects. As noted, there is little research on why given images are used in climate change news, though one study cited shows there is no obvious relationship between images and text in sampled news stories in general (Hansen & Machin, 2013; but see Wozniak et al., 2015).

Overall, studies should more frequently integrate critical and social science research about, and evaluation of, the attraction, engagement, interpretation, and effects of combinations of art, entertainment, and mass media representation with climate change science.

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