MEDIATED KNOWLEDGE AND UNCERTAIN SCIENCE: MAPS IN COMMUNICATING CLIMATE CHANGE IN MASS MEDIA

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Abstract

From scientific reports to daily news, geographic information is part of our everyday understanding of the environment, both on a local and global scale. Maps have shaped the manner in which we understand our natural and human environment, allowing us to develop a deeper understanding of the complex implications of climate change. As the traditional role of maps as expert creations is replaced by images more easily created through technology and expanding access to geographic data, the use of maps and visual images to communicate climate change science to the public is increasing. While these images present the information and discoveries for specific regions or model predictions, the public are often faced with competing and conflicting scientific opinions. While maps are familiar and effective means for communicating complex information, the power of maps to persuade and reify often uncertain or abstract data may leave readers with the impression that scientific discoveries are certain and exact. As forms of mediated knowledge, maps in the media serve as emotional and evocative messengers, illuminating the long-term possibilities of climate change, bringing the reality into peoples' living rooms. The combination of maps, graphics, and pictures result in a powerful and persuasive medium, whose suitability to communicate uncertain science is unknown. To what extent does visual representation create certainty from uncertain science? In this paper, I review research relevant to this question, including the persuasive nature of visual science communication, and contend that if the communication of climate change science through mass media is meant to inform public understanding then these images must also communicate the risks and uncertainty of science.

Introduction
Scientific expertise and developments increasingly affect public policy and opinions, making public understanding of science critical. Mass media, and not direct involvement in scientific endeavors or publications, often informs public knowledge of science

(Corbett and Durfee, 2004, Smith, 2005), providing information that informs actions and knowledge about the world, and risks, beyond everyday experiences (Boykoff and Boykoff, 2007). Science communication relies on scientists and journalists to distill complex, often uncertain, results into easily consumed information, presented through a combination of language, art, graphics, and maps. Public risk perceptions, awareness, attitudes, and actions are, therefore, shaped (to some extent) by mediated information (Carvalha and Burgess, 2005). This is especially true for issues that occur outside of an individual's everyday experience or that occur at a scale that seems "invisible" on an individual level, such as global climate change.

Mass media has served a central role in the communication of climate change, serving as a dialogue between science, policy, and the public. Representation in mass media shapes public perception and articulates public opinion, and resultantly, influences public policy. Often, media representations effect public action and opinion in both climate change mitigation and adaptation. While communicating the science of climate change to the public is important for encouraging mitigation and adaptation, representations often avoid the explicit inclusion of contextual information, such as explanations of risk, uncertainty and the scientific process behind the results (Carvalha and Burgess, 2005). Instead, representation focuses on often competing and conflicting "scientific facts" presenting bleak futures and emotional images, such as maps of global heat waves (Figure 1a) and images showing the impacts of human action on climate (Figure 1b), in the hope of effecting societal and public action, by persuading individuals to believe the science behind the images (Abbasi, 2005). Visual representation builds certainty from uncertain science through the use of images as argument.
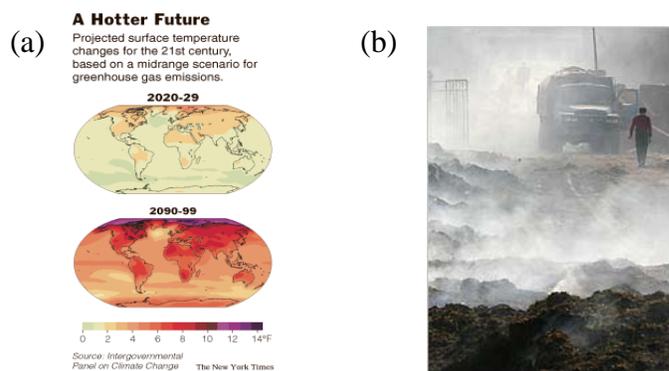

Figure 1. Article proclaims, "Scientist panel calls global warming unequivocal" (www.nytimes.com/2007/02/03/ science/earth/03climate.html?scp=2&sq=global+warming+map &st=nyt, last accessed 4/26/2008)

As an inherently geographic phenomenon, climate change research exists throughout geography, with model results and predictions commonly represented on maps. As ubiquitous representations of reality, maps offer an ideal method to communicate the risk and uncertainty of climate change to the public, as maps present a familiar, if not comforting, means of communicating geographic information. The use of maps for the communication of climate change science, risk, and uncertainty to the public through media images seems a likely area of cartographic inquiry, yet this issue seems to be largely missing from cartographic literature. A research framework that is filled with testable hypothesis and practical applications concerns the manner in which maps inform public understanding of uncertain science. This paper reviews literature that might inform such a framework as it relates to the communication of climate change. I review literature in the visual communication of science, and the power of visual images to mediate scientific knowledge and discourse, between experts and the public alike, and the manner in which maps as visual science might serve as a method to communicate the risk and uncertainty of climate change to the public.

Visual Science: The Use of Graphics in the Communication of Scientific Knowledge
Visual displays mediate the assessment and dissemination of scientific knowledge (Cleveland, 1984a, Cleveland, 1984b, Arsenault et al., 2006). Graphics can convey complex and dense information, not easily communicated through the written word, and as such, have been the focus of much research in the visual communication of science (Tufte, 1983, Cleveland, 1984b, Hedges, 1987). There are many reasons that visual displays, such as graphs and charts, are powerful means to support the dissemination and validation of scientific knowledge. First, graphics are absolute, transforming abstract ideas and ephemeral phenomenon into fixed, invariable patterns discernable by a wide range of individuals, scientists and the public alike. Second, graphics quickly convey an overall impression of research, accessible without a great deal of effort by the user. Graphs allow the visualization of phenomenon that might otherwise be unknowable due to their abstract, temporal, or physical scale. Finally, graphics can be combined, allowing the identification of relationships and connections that might otherwise be undiscovered (Arsenault et al., 2006). These characteristics lend to the critical role of graphics in science communication—they are powerful because they are persuasive (Latour, 1990). Graphics support the task of convincing other scientists and the public of the validity of an individual's scientific work. As such, visual inscriptions are central in science communication, with a variety of representation forms found throughout scientific literature and the media.

While much research has focused on the use of graphs in science communication (Butler, 1993, Tufte, 1983, Latour, 1990), scientists also use many other types of inscriptions. Non-graph illustrations include diagrams, pictures, maps, and montages (Arsenault et al., 2006). Diagrams, like graphs, represent information spatially to convey information, but

generally lack quantitative axes and empirical data. Examples of diagrams include flow charts, vector graphics, and network models (Butler, 1993, Tufte, 1983, Arsenault et al., 2006). Research has shown that diagrams aid scientific thinking, both among scientific experts, and through the use of diagrams in scientific literature and textbooks (Butler, 1993). Pictures include photographs or drawings, and unlike diagrams, they provide naturalistic views, mimicking vision in three dimensions. Pictures can be illustrations, such as computer-generated images of the inputs to climate models, or can be photographs that make the science more "real".

Maps exist between diagrams and pictures, both representing naturalistic views, and relying on abstraction to represent effectively the phenomenon under study. This combination of realism and abstraction makes maps a powerful medium for representing phenomenon that take place in physical space. Cartographic representation of abstract, uncertain, and potentially highly generalized data may give authoritativeness to the data that is unwarranted. Brief disclaimers in the captions about representations being one model result, or providing a verbal description of the uncertainty of the data, does not sufficiently overcome the persuasive power of graphics in general, or maps in particular. When used to support or concretize research results, maps become a method to support an argument more than tools of exploration or communication. Discussions relating to the power of maps and geographic representations to persuade and, often outright lie, have been the focus of many cartographers and GIScientists (Monmonier, 1996, Crampton, 2001, Crampton and Krygier, 2006).

The final category of non-graphic illustrations is montages, which utilize the combinability of graphics. Montages bring together several images into one display, through either superimposing them (such as layers in a GIS) or displaying them side-by-side (Figure 2). This form of representation compounds the inherent power of the visual displays, compressing several inscriptions of scientific information, normally viewed through a temporally extended process, into a single, simultaneous display (Lynch, 1985, Golinski, 1998). Regardless of any caveats or qualifications attached to these representations (as seen in the captions for Figure 2, which identify that this representation is only one possible model result), the persuasive ability of these methods often overrides any inherent variability or uncertainty in the data or underlying science.

The power of visual representations to make science accessible, as well as persuade both experts and the public towards acceptance of a new or contrary scientific argument or fact, make them a perfect tool for mass media coverage of climate change science and policy. While they provide an effective means for making complex science accessible, public understanding and action suffers when images are used to present conflicting and contradictory views in an effort to persuade the public that climate change is, or is not, occurring. These conflicting views are emphasized as maps become a means to support

positions and argument relating to climate change, with the careful choice of content and presentation making a case to support the propositions of the researcher (Wood and Fels, 2008).
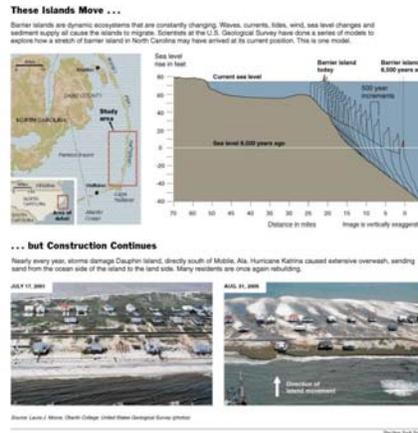

Figure 2. Montage using pictures, illustrations, graphs, and maps to show model predictions. (http://www.nytimes.com/2006/06/20/science/earth/20sea.html?scp=7sq=climate+change+maps &st=nyt, last accessed 4/26/2008)

Discussions of climate change in media occurred in newspapers as early as the 1930s, progressing and evolving to almost daily coverage this century in newspapers, the nightly news, and internet sites. As the presence of climate change science in peoples' lives increases, so do the conflicting viewpoints presented in the media.

Climate Change in the Media: A Brief History
Discussions of climate change and the impacts of human endeavors on the environment have existed in the media for decades. Climate change science and mass media is evidenced as early as the 1930s, when the *New York Times* wrote, "The earth must be inevitably changing its aspect and its climate. How the change is slowly taking place and what the result will be has been considered…" (New York Times, 1932, Boykoff and Roberts, 2007). The human impact of climate change was evidenced more clearly in the 1950s, when the *Saturday Evening Post* published a story exploring the link between atmospheric temperature change, sea level rise and changes in agriculture (Abarbanel and McClusky, 1950, Boykoff and Roberts, 2007). Several years later, in 1957, the *Christian Science Monitor* published a story investigating how industry was responsible for releasing carbon dioxide into the air, and resultantly changing the earths temperature (Cowen, 1957, Boykoff and Roberts, 2007). Over the next several decades, media coverage of climate change was rare.

In the mid-1980s, international research efforts on climate change and greenhouse gas emissions resulted in the beginning of changes in climate policy. A shift in political focus

to the mitigation of climate change pushed the issue of global warming to prominence in the United States and United Kingdom in the late 1980s and 1990s. Political campaigns focused on the need to reduce chlorofluorocarbons and the hole in the ozone, with media publicizing the detrimental and scary impacts of human activities on the environment. The 1990s also saw the beginning of the polarization of the climate change debate in science and public policy, as some groups emerged to refute scientific claims that humans were contributing to the problem. These conflicting views fueled media coverage of the climate change debate. Media, science, and policy came together during this time, resulting in a significant increase in media coverage of climate change and global warming, which continues through today (Boykoff and Roberts, 2007, Boykoff and Boykoff, 2007). During this time, discussions and coverage of adaptation began to emerge and increase (Boykoff and Boykoff, 2007).

Human drama and other components that make a "good" news story play a large part in news stories in general. Human drama and conflict, not necessarily emerging science and risk, influence a story's dramatic value and extent of coverage (Mazur and Lee, 1993, Smith, 2005). Discussions of conflicting opinions, the uncertainty of climate change, and the desire of different groups to influence societal and individual change, encourage an abundance of visual images of climate change science on both sides of the debate. The tendency of mass media to focus on conflict and drama, results in images that inflame the imagination and evoke emotions, making maps a natural choice for communicating climate change science to the public. Media stories combine maps with evocative photographs, scientific charts, and objective narratives to portray the impact and risk of climate change. As seemingly objective depictions of reality, peoples' instinctive trust of information presented on maps, and visual images in general, make them uniquely effective for mass media representations of the inherently uncertain and evocative topic of climate change.

Maps, Climate Change, and Mass Media: Evocative Representation
A review of newspaper, television, and internet media coverage of climate change over the past several decades, reveals the consistent use of maps, both individually and in montages, to represent often-conflicting views of climate change science. These representations appear as objective and informed proclamations about risks or future conditions that are certain to arise. This research focused on a limited survey of electronic media, including electronic editions of print media such as newspapers and online magazines, as well as websites specifically focused on climate change dialogues. In reviewing the varying types of representations found in the media, several general consistent themes are present in the use of maps in climate change media: long-term impacts, making it real and challenges to climate change. While a more detailed classification is possible, these categories provide a general framework to encompass the themes observed.

Long Term Impacts. Maps in this category show the long-term impacts of climate change, including drought, floods, heat wave, and disease. Future catastrophes, depicted as certain futures, combined with images showing the existing impact of climate change, create powerful messages of the need mitigate our impact on the climate (Figures 3 and 4).
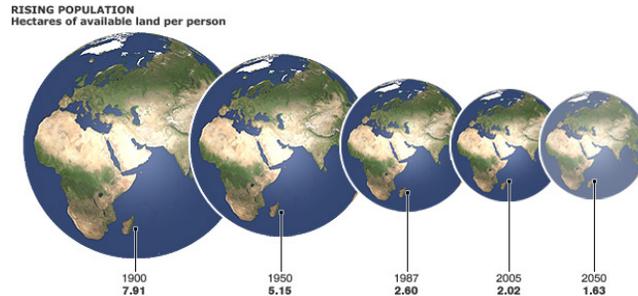

Figure 3. The impact of human development and population increases on the planet and climate are popular topics in the media (http://news.bbc.co.uk/2/hi/in_depth/629/629/7056601.stm, last accessed 4/20/2008)
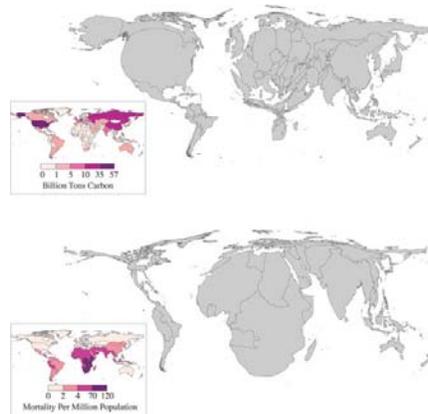

 Figure 4. Depictions of regions currently at risk instill a sense of urgency, and are often used in combination with depictions of long-range predictions of the future. Future conditions appear much more plausible when compared with similar conditions now. (http://news.bbc.co.uk/2/hi/in_depth/629/629 /7056601.stm, last accessed 4/26/2008)

Making it Real. Maps in this category include maps related to everyday experiences-stories that individuals can relate to their lives. These stories might include maps of potential flood zones due to increased hurricane risk, combined with pictures of families trying to avoid that risk (Figure 5). This category may highlight or encourage adaptation to climate change, or may suggest ways in which human behaviors affect global conditions and other people (Figure 6).

Figure 5. In an article about increased hurricane risk, potentially effected areas mapped along with a picture of a family who recently sold their home (http://www.nytimes. com/ 2007/ 03/11/realestate/11cov.html?_r=1&scp=4&sq =global% 20warming%20 map&st=nyt, last accessed 4/26/2008)
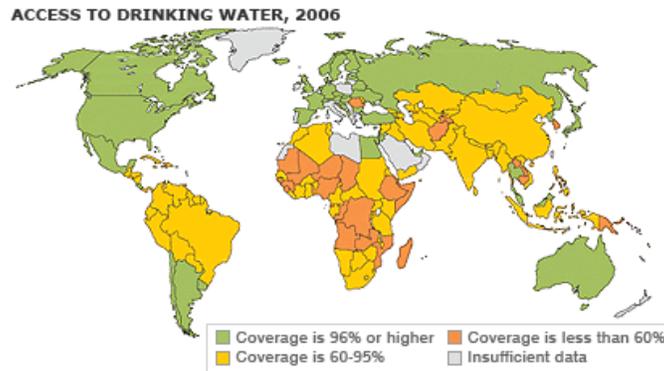

Figure 6. Maps depicting the health tolls of climate change, the implied cause and effect are shown as definitive (http://www.news.wisc.edu/14413, last accessed 4/26/2008)
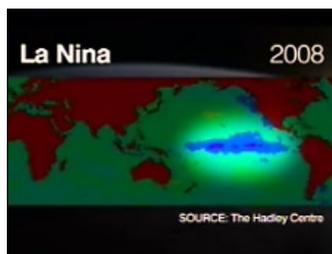

Figure 7. This story caused quite a stir when an accusation arose that the BBC softened the "cooling" message of the story in response to an activist complaint (http://news.bbc.co.uk/2/hi/science /nature/7329799.stm, last accessed 4/20/2008)

Challenges to Climate Changes. This category of maps relates to the conflicting messages about the causes and existence of global warming. Many of these images relate

to the cyclical nature of climate, supporting arguments that the current trends are part of cyclical changes that are natural parts of the environment. These maps, often combined with graphics representing historical climate and environmental data, show that past conditions reflect future trends, indicating that human development and agency is not the cause of, and cannot combat climate change. These maps represent the conflicting and contradictory views of the climate change debate, and like the maps previously show, reflect uncertain science as concrete and certain facts (Figure 7).

Conclusion. Maps, Visuals, and Science in the Media: A Certain Future?
Visual images are crucial tools in the effort to communicate complex science to both experts and the public. This is especially true for the complex, and sometimes conflicting, science of climate change. The use of maps in the media to represent this inherently geographic phenomenon is not surprising. While maps are familiar and effective means for communicating complex information, the power of maps to persuade and reify often uncertain or abstract data may leave readers with the impression that scientific discoveries are certain and exact. The use of maps to support scientific arguments and positions makes this implied certainty difficult to overcome.

As forms of mediated knowledge, maps in the media serve as emotional and evocative messengers, illuminating the long-term possibilities of climate change, bringing the reality into peoples' living rooms. The combination of maps, graphics, and pictures result in a powerful and persuasive medium, whose suitability to communicate uncertain science has not been evaluated. If one of the purposes of maps in media is to present an argument to support research results, the implied certainty is a vital part of this communication. As the place of science continues to grow in the public domain, consideration of the communication of scientific uncertainty must be addressed.

As scientific evidence and opinions change, or alternative evidence or opinions arise, this conflicting information is often communicated to the public as the new "scientific future". While this approach successfully underpins the uncertainty of scientific inquiry into climate change, these multiple and ever-changing viewpoints lead to confusion about potential solutions and mistrust of the underlying science. If the goal is to raise public awareness and encourage action on climate change, representation of the underlying science, consequences and potential solutions to the public must incorporate effective methods of risk communication that inform the public about the problem and potential solutions. Future research relating to cartographic representations of science, and its uncertainty, to the public should include approaches that both educate and inform, ultimately balancing the need to present a persuasive argument with the need for a clear understanding of the information presented.

References

ABARBANEL, A. & MCCLUSKY, T. (1950) Is the World Getting Warmer? *Saturday Evening Post.*

ABBASI, D. R. (2005) *Closing the Gap Between Science and Action: A Synthesis of Insights and Recommendations from the 2005 Yale F&ES Conference on Climate Change,* New Haven, Yale.

ARSENAULT, D. J., SMITH, L. D. & BEAUCHAMP, E. A. (2006) Visual Inscriptions of Scientific Hierarchy: Mapping the "Treasures of Science". *Science Communication,* 27**,** 376-428.

BOYKOFF, M. T. & BOYKOFF, J. M. (2007) Climate change and journalistic norms: A case-study of US mass-media coverage. *Geoforum,* 38**,** 1190-1204.

BOYKOFF, M. T. & ROBERTS, J. T. (2007) Media Coverage of Climate Change: Current Trends, Strengths, Weaknesses. IN 2007, U. N. D. P.-H. D. R. (Ed.).

BUTLER, D. L. (1993) Graphics in Psychology: Pictures, data and especially concepts. *Behavior Research Methods, Instruments and Computers,* 25**,** 81-92.

CARVALHA, A. & BURGESS, J. (2005) Cultural Circuits of Climate Change in U.K. Broadsheet Newspapers, 1985-2003. *Risk Analysis,* 25**,** 1457-1469.

CLEVELAND, W. S. (1984a) Graphical Methods for Data Presentation: Full Scale Breaks, Dot Charts and Multibased Logging. *The American Statistician,* 38**,** 270-280.

CLEVELAND, W. S. (1984b) Graphs in Scientific Publications. *The American Statistician,* 38**,** 261-269.

CORBETT, J. B. & DURFEE, J. L. (2004) Testing Public (Un)Certainty of Science: Media Representations of Global Warming. *Science Communication,* 26**,** 129-151.

COWEN, R. (1957) Are Men Changing the Earth's Weather? *Christian Science Monitor.* Boston.

CRAMPTON, J. W. (2001) Maps as social constructions: power, communication and visualization. *Progress in Human Geography,* 25**,** 235-250.

CRAMPTON, J. W. & KRYGIER, J. (2006) An Introduction to Critical Cartography. *ACME: An International E-Journal for Critical Geographies,* 4**,** 11-33.

GOLINSKI, J. (1998) *Making natural knowledge: Constructivism and the history of science,* Cambridge, UK, Cambridge University Press.

HEDGES, L. V. (1987) How hard is hard science, how soft is soft science? The empirical cumulativeness of research. *American Psychologist,* 42**,** 443-455.

LATOUR, B. (1990) Drawing things together. IN LYNCH, M. & WOOLGAR, S. (Eds.) *Representation in scientific practice.* Cambridge, Massachusetts, MIT Press.

LYNCH, M. (1985) Discipline and the material form of images: An analysis of scientific visibility. *Social Studies of Science,* 15**,** 37-66.

MAZUR, A. & LEE, J. (1993) Sounding the global alarm: Environmental Issues in the US National News. *Social Studies of Science,* 23**,** 681-720.

MONMONIER, M. (1996) *How to Lie with Maps*, University of Chicago Press.

NEW YORK TIMES (1932) Next Great Deluge Forecast by Science. *New York Times.* NY.

SMITH, J. (2005) Dangerous News: Media Decision Making about Climate Change Risk. *Risk Analysis,* 25**,** 1471-1482.

TUFTE, E. R. (1983) *The Visual Display of Quantitative Information,* Cheshire, Connecticut, Graphics Press.

WOOD, D. & FELS, J. (2008) *The Nature of Maps*, University of Chicago Press.