WHERE SCIENCE AND POLICY MEET

ENVIRONMENT®

November 2004
Volume 46 Number 9
$5.00 U.S.
$6.50 Canada

Surveying the Impact

The Day After Tomorrow

ALSO . . .

SUVs: Perception versus performance

Stormwater on the Web

0 74820 64645 8

Before and After *The*

A U.S.

Day After Tomorrow

. Study of Climate Change Risk Perception

by Anthony A. Leiserowitz

On Memorial Day weekend 2004, Twentieth Century Fox released *The Day After Tomorrow*, a disaster movie depicting an abrupt and catastrophic climate change. In the movie, a global warming–induced shutdown of the North Atlantic thermohaline circulation system[1] triggers extreme weather events worldwide and subsequently a new ice age, with wrenching global consequences. Before it even hit the theaters, however, the movie generated an intense storm of media controversy as scientists, politicians, advocacy groups, and political pundits debated the scientific accuracy and political implications of the movie and global climate change.

Numerous predictions were made as to how the movie would influence risk perceptions and attitudes of the U.S. public toward global warming. Some commentators feared that the catastrophic plotline of *The Day After Tomorrow* would be so extreme that the public would subsequently dismiss the entire issue of global warming as fantasy. At the other end of the spectrum, others spun a scenario in which, panicked by the movie, the U.S. public would force Congress to pass climate change legislation, President George W. Bush would subsequently veto the bill, and challenger John Kerry would exploit public hysteria over global warming to win the U.S. presidential election. Some predicted the film would do more to raise public awareness of global warming than any number of scientific papers or documentaries, while others opined that the film would

have no impact at all.[2] *The Day After Tomorrow* went on to become one of the most commercially successful movies of all time, grossing nearly half a billion dollars worldwide in a little more than a month.[3] But what impact did the movie have on U.S. risk perceptions, behavioral intentions, and political preferences?

To answer this question, a national study was conducted to explore the public impact of *The Day After Tomorrow*. The study included two nationally representative surveys of the U.S. public. The first survey was implemented a week before the movie's release and the second was done four weeks later, after the movie had played in theaters for three full weekends. The second survey also oversampled movie "watchers" to allow comparative analysis with "nonwatchers." Finally, a media content analysis was conducted with two purposes in mind: to determine the quantity and quality of news coverage about the movie and to compare *The Day After Tomorrow* with two other recent controversial films and two real-world news events. The research tested the hypothesis that representations of risk in popular culture can have a powerful influence on public risk perceptions—in some cases more powerful than official risk communications from scientists, government officials, or special interest groups.[4] Anecdotal evidence suggests that this influence can, at times, be profound. For example, the film *Jaws* (1975) is thought by many to have greatly amplified public risk perceptions of shark attacks. The vivid imagery and theme music from this movie still reverberate in the public mind, stoking individual fears, influencing behavior (such as vacation and swimming preferences), and generating countless secondary ripple effects, including re-emergent, media-driven "shark panics" such as was seen in the United States in the summer of 2001. Likewise, the dramatic portrayal of a nuclear accident in *The China Syndrome* (1979), combined with the subsequent real-world accident at Three Mile Island, arguably shaped the public debate about the safety of nuclear power. This synergism of fiction and reality may have greatly amplified the perceived risk of nuclear power, with ripple effects that still reverberate in public opinion and fundamentally constrain the industry today. According to researchers Roger and Jeanne Kasperson, although these events resulted in "no fatalities, [they] shut down nuclear plants worldwide, cost billions of dollars, and eroded public confidence in nuclear power and (perhaps) other high technologies, industry and regulatory institutions."[5] Despite these intriguing examples, however, and even though

the mass media are widely recognized as having a large impact on other public attitudes and behaviors, almost no research has explored the role of motion pictures in public risk perception and behavior.[6]

Public Risk Perceptions of Global Climate Change

Global climate change has been described as a prototypical example of a class of "hidden hazards"—risks that, despite their serious consequences for society, generally pass unnoticed or unheeded until they reach disaster proportions.[7] Public opinion polls and academic studies consistently show that Americans regard climate change as a relatively low national priority, despite decades of scientific warnings.[8] For example, in a 2000 Gallup poll, the environment ranked sixteenth on Americans' list of the most important problems facing the country, while climate change ranked twelfth out of thirteen environmental issues, just below urban sprawl.[9] Further, climate change is commonly understood as a geographically and temporally distant concern. Climate change is often described as a global problem, with particularly severe consequences for marginalized people and places (such as small island or poor tropical countries)—not for the United States itself.[10] *The Day After Tomorrow*, however, depicted disasters spawned by climate change and impacting present-day New York City, Los Angeles, Washington, DC, and other global centers of economic, political, and cultural power. The film thus had the potential to significantly alter American risk perceptions of the likelihood and severity of climate change in the United States and to shift public conceptions of climate change from a linear warming trend to abrupt, nonlinear, and catastrophic change.

The Movie's Plot

The Day After Tomorrow tells the story of National Oceanic and Atmospheric Administration (NOAA) paleoclimatologist Jack Hall (played by Dennis Quaid), who survives the disintegration of a massive ice shelf breaking off Antarctica and returns to warn the world about the possibility of an abrupt climate change due to global warming. A few weeks after presenting his theory to a world climate conference, scientists monitoring the North Atlantic thermohaline circulation system discover that the system is rapidly shutting down. Using his paleoclimatic computer model, Hall forecasts that "the world is on the verge of a major climate shift" and attempts to warn the U.S. vice president. His warnings, however, go unheeded. Meanwhile, extreme weather events begin to occur throughout the world, with grapefruit-sized hail in Tokyo, tornadoes destroying downtown Los Angeles, and ultimately, a storm surge–driven tidal wave drowning Manhattan. Based on his model projections, Hall determines that three massive, hurricane-like supercells will form across the Northern Hemisphere and rapidly pull sub-zero air from the upper troposphere down to the ground, quick-freezing everything in their path and leading to the onset of a new ice age. Dr. Hall is called to brief the U.S. president, draws an east-west line through the center of the United States, and recommends that all people south of the line be evacuated to Mexico, which ultimately opens its borders after the U.S. president forgives all Latin U.S. debt. Meanwhile, Hall's teenage son (played by Jake Gyllenhaal), in Manhattan for a scholastic decathlon, survives the tidal wave and takes shelter with his friends in the New York Public Library, where they resort to burning books to keep warm as the ice age begins. The rest of the movie follows Dr. Hall, who must brave Antarctic conditions as he treks to New York to rescue his son.

Movie Reviews

The Day After Tomorrow sparked a heated national debate about the scientific accuracy and political implications of the film and the broader issue of global warming. The science underlying the film was criticized by many climatologists and other scientists, who were dismayed by some of the main elements of the movie. In particular, some of the scientists complained about the physical impossibility of a "quick-freeze" or a storm surge–driven tidal wave hundreds of feet tall and the fact that a thermohaline circulation shutdown would neither happen so quickly nor have such far-reaching consequences.[11] Other scientists, however, used the film and the controversy surrounding it as a "teachable moment"—an opportunity to not only critique the film but to more constructively educate the public about climate change.[12] Likewise, the political implications of the movie were debated by various pundits, ranging from Arianna Huffington to Rush Limbaugh. Finally, a number of environmental and political advocacy groups organized to greet moviegoers with leaflets and peti-

tions, while others worked the media to alternately hail or decry the message and politics of the film.[13]

Movie critics also greeted the film with widely divergent reviews. Some critics held the movie up against the standards of fine theater and subsequently blasted it for a weak plot, hokey situations, and pervasive use of standard movie clichés. Others approached the movie with the standards of the scientific documentary and found, despairingly, that while it had some elements of truth, it also included numerous scientific distortions and outright fabrications. Other critics, however, approached the film expecting a Hollywood blockbuster disaster movie, a genre infamous for weak plots and artistic license yet spectacular visual effects. These critics often found themselves pleasantly surprised at how much better the film was than many past disaster movies. In the end, the only thing most critics could agree on was the outstanding quality of the special effects.

The general public, however, overwhelmingly liked *The Day After Tomorrow*. By mid-July, the film had grossed more than $183 million in the United States alone and an additional $335 million overseas, for a total of more than half a billion dollars.[14] In the United States, an estimated 30 million tickets were sold. The study reported here found that 70 percent of adult moviegoers rated the movie as good or excellent, 18 percent rated it as average, and only 13 percent as poor or terrible.

In responding to the critics, the moviemakers, including director Roland Emmerich, screenwriter Jeffrey Nachmanoff, and producer Gordon Smith, repeatedly pointed out that their primary goal was to create a "popcorn movie"—a summer thriller that would draw a mass audience. However, the filmmakers also admitted to having the secondary goals of raising public consciousness and concern about global warming. These divergent goals—of mass entertainment, education, and political pressure—coexist in an uneasy tension within the film, with consequences (intended and unintended) that are hard to disentangle. What impact, if any, did the film have on public risk perceptions and conceptual models of climate change? Did the film make moviegoers more or less willing to take personal actions to reduce their own greenhouse gas emissions? Did it change their political priorities or voting intentions?

Risk Perceptions: Moviegoers versus Nonwatchers

To answer these questions, a representative survey (n = 529) of the U.S. adult population was conducted after the movie had played in theaters for three weekends.[15] The survey questionnaire measured public climate change risk perceptions, conceptual models, behavioral intentions, and political preferences. As of mid-June, approximately 21 million U.S. adults had seen *The Day After Tomorrow*. Demographically, moviegoers were more likely to be male (57 percent), 18 to 29 years old (38 percent), Hispanic (26 percent), and politically liberal (31 percent) than nonwatchers, who were demographically identical to the U.S. public as a whole.

Global warming risk perceptions were measured using broad questions about general concern and worry and likelihood estimates of specific climate change impacts. Moviegoers ("watchers") were found to have significantly higher risk perceptions than "nonwatchers." When asked, "How concerned are you about global warming?" 83 percent of moviegoers said they were somewhat or very concerned, compared to 72 percent of nonwatchers (see Table 1 on page 27). Likewise, a higher proportion of moviegoers (40 percent) than nonwatchers (31 percent) said that they worry about global warming "a fair amount" or "a great deal." A separate question asked moviegoers directly whether the movie had made them more or less worried about global warming. Forty-nine percent said that it had made them some-

what or much more worried, 42 percent said it had not changed their level of worry, and only 1 percent said they became less worried. Again, some commentators had warned that *The Day After Tomorrow* would so trivialize global climate change that the public would subsequently dismiss the whole issue. This forecast was clearly incorrect.

Overall, watchers and nonwatchers demonstrated high levels of concern about global warming yet lower levels of worry.[16] While many Americans are concerned about global warming, fewer of them actively worry about it. This helps to explain the seeming paradox between public opinion surveys that show Americans expressing high concerns about the issue yet giving it low priority in either national or environmental issue rankings.[17]

This study also included a series of questions measuring public likelihood assessments of various global-warming impacts on the United States (see Figure 1 on this page). Again, across the board, moviegoers perceived global warming as a greater threat than the rest of the general public. More than 80 percent of watchers responded that global warming is somewhat or very likely to produce more intense storms, hurricanes, and tornadoes over the next 50 years, versus 72 percent of nonwatchers. Likewise, higher proportions of moviegoers believed that the flooding of major cities, food shortages, and a decrease in living standards are likely to happen in the United States over the next 50 years.

Most telling, however, moviegoers were much more likely than nonwatchers to believe that global warming could lead to a shutdown of the Gulf Stream ocean current or a new ice age—two underlying premises of *The Day After Tomorrow*. Across the board, the movie appears to have had a strong influence on watchers' risk perceptions of global warming. To test this conclusion, multiple regression analyses were conducted

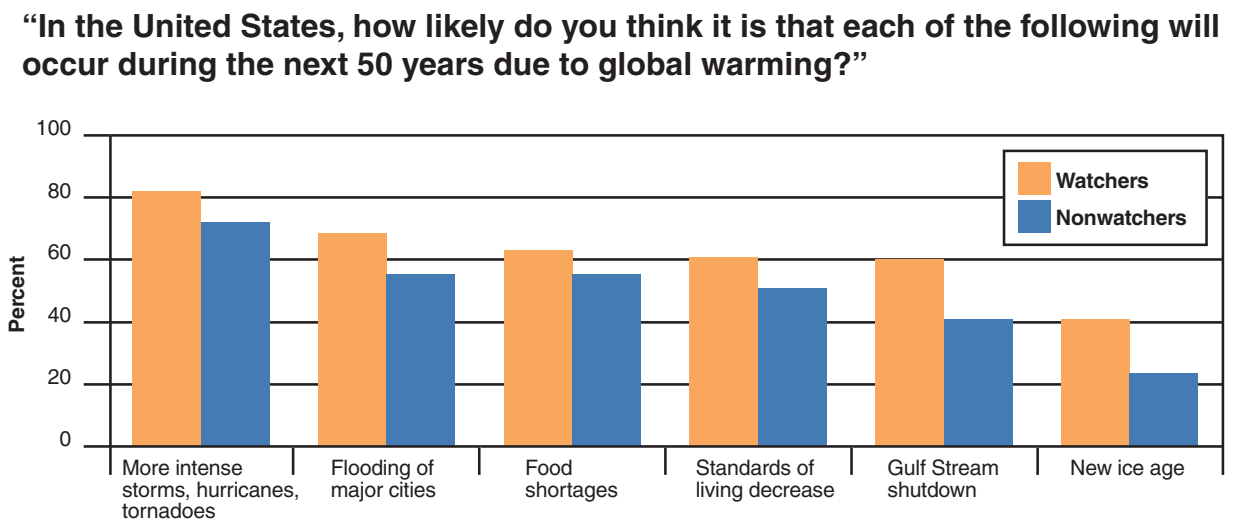
Table 1. Concern and worry about global warming

	Percent nonwatchers[a]	Percent watchers[b]
How concerned are you about global warming?		
a. Somewhat or strongly concerned	72	83**‡
b. Not very or not at all concerned	28	17
How much do you worry about global warming?		
a. Fair amount to great deal	31	40**
b. Only a little to not at all	69	60

[a]weighted (n = 390)
[b]weighted (n = 139)
**p < .01, watchers vs. nonwatchers
‡p < .05, watchers vs. nonwatchers after controlling for demographics and political variables

SOURCE: A. Leiserowitz .

Figure 1. Percent of watchers and nonwatchers who found each item *somewhat* or *very likely*.



NOTE: Nonwatchers weighted (n = 390), watchers weighted (n = 139).
SOURCE: A. Leiserowitz.

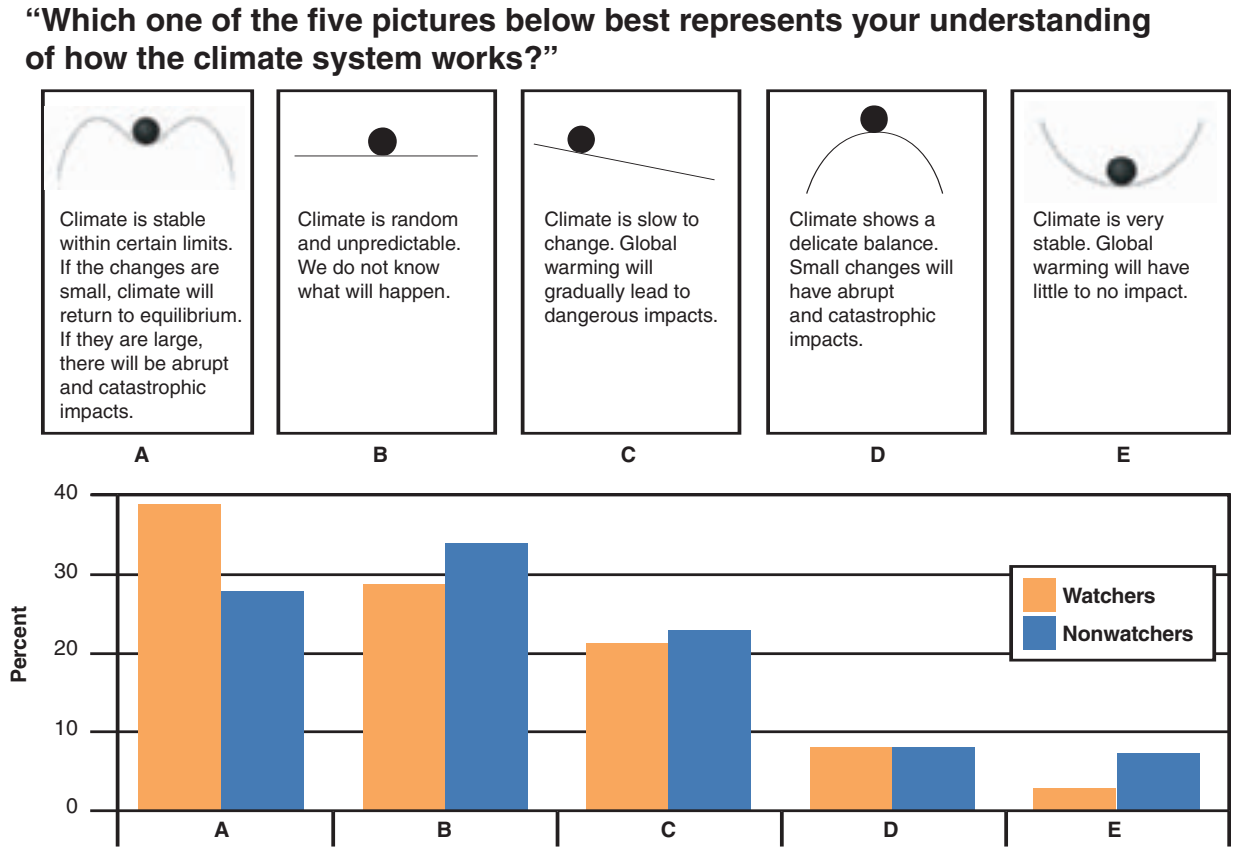
to control for the possible influences of gender, age, education, income, race, political identification, and political ideology on each result.[18] Even after controlling for these demographic and political factors, however, watchers were still significantly more likely than nonwatchers to perceive global warming as a greater risk.

Overall, these results show that *The Day After Tomorrow* had a considerable impact on the global-warming risk perceptions of those who saw the movie. Further, a majority of Americans, watchers and nonwatchers alike, currently believe that global warming will have a range of important impacts on the United States over the next 50 years—in particular, more intense storms, hurricanes, and tornadoes. From a scientific standpoint, by far the least likely of these impacts—the onset of a new ice age—is currently and correctly perceived as unlikely by a clear majority of Americans. The movie, however, does appear to have led a substantial minority of moviegoers (41 percent) to believe such an event is likely to happen.

Conceptual Models of the Global Climate System

How do Americans conceptualize the global climate system? Do they view global climate as stable and strongly resilient to human interference, or do they view the climate system as extremely sensitive and vulnerable to abrupt and catastrophic shifts? The story line of *The Day After Tomorrow* was based not on a gradual, linear warming but rather an abrupt and catastrophic climate change, greatly compressed into just a few weeks. Did the movie shift public conceptual models of how global warming and the climate system work? To answer this question, the survey presented respondents with five different and highly simplified models of the climate system. Respondents were asked to pick the one that best reflected their current understanding. The models were provided in graphic and textual form and can be seen in Figure 2 on this page. Significantly, moviegoers were much more likely (39 percent) than the nonwatchers (28 percent) to choose model (A), which depicts a threshold model of the climate system. This model describes a

Figure 2. Conceptual models of watchers and nonwatchers, percent of respondents



NOTE: Nonwatchers weighted (n = 390), watchers weighted (n = 139).
SOURCE: A. Leiserowitz.

system that is resilient to disturbance within certain limits; however, forcings beyond these thresholds lead to abrupt and catastrophic impacts. This was the model implied by *The Day After Tomorrow*, in which global warming gradually increased until it reached a critical tipping point, causing the thermohaline circulation system to collapse and climate chaos to ensue.

Interestingly, moviegoers were no more likely than those who did not see the movie to choose the most extreme model (D), which depicts the climate system as extremely sensitive to human disturbance. Thus, the catastrophic impacts depicted by *The Day After Tomorrow* did not lead moviegoers to suddenly adopt an extreme model of climate sensitivity. Further, the movie appears to have influenced moviegoers to reject the other extreme models: (E), which depicts a very stable system and (B), a totally random and unpredictable system. Overall, however, the random and unpredictable model (B) is still preferred by a large proportion of watchers (29 percent) and nonwatchers (34 percent) alike. This most likely reflects the common (mis)interpretation of climate change using widespread cultural models and the personal experience of daily weather, well known for its unpredictability beyond short time horizons.[19]

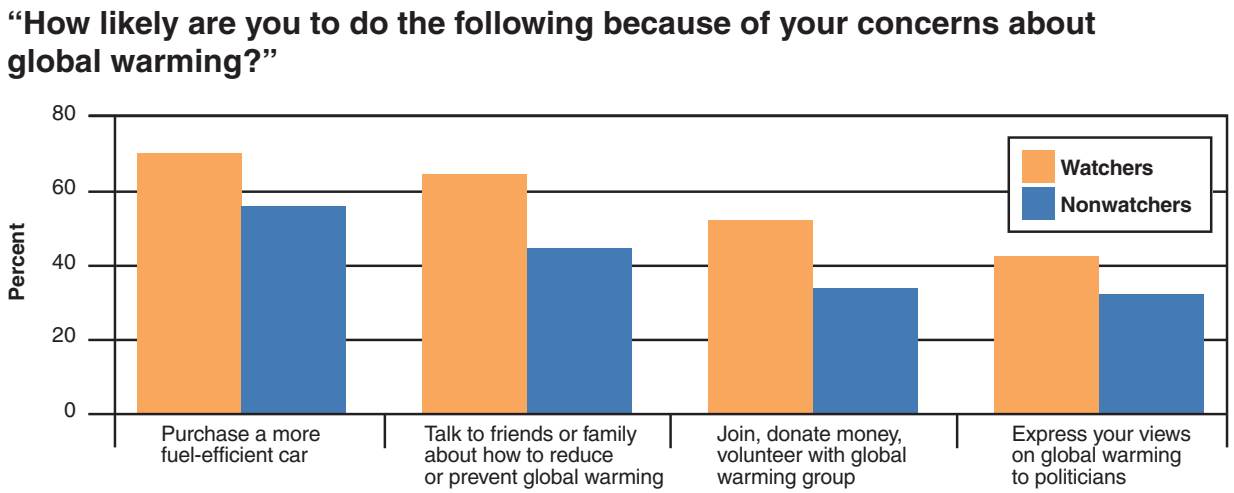
Behavioral Intentions

The Day After Tomorrow had significant impacts on public risk perceptions and conceptual models of climate change, but did it influence respondents' willingness to undertake individual actions to address global warming? The survey asked respondents, "How likely are you to do the following because of your concerns about global warming: Purchase a more fuel-efficient car? Join, donate money to or volunteer with an organization working on issues related to global warming? Make your views on global warming clear to politicians (by writing letters, telephoning, sending e-mails, signing petitions, etc.)? Talk to friends and family about how to reduce or prevent global warming?" The first item reflects willingness to take action to reduce one's own emissions, while the next three indicate willingness to take activist, political, or social action. The last item, the willingness to talk to family and friends about global warming, is particularly important as it reflects issue salience. The more important an issue is perceived to be, the more people talk about it, which in turn leads to an increase in perceived issue importance, and so on, in a positive feedback loop. This process is commonly referred to as "word of mouth" or "buzz" and is a critical element in social change. Moviegoers were found to be much more likely to engage in all four behaviors than nonwatchers (see Figure 3 on page 30). With the exception of respondants' likelihood to express their viewpoints to politicians, the difference between watchers and nonwatchers remained statistically significant even after controlling for the influence of demographic and political variables.

National Policy Preferences and Politics

Did this increased willingness to take individual action also translate to the national policy agenda? The survey examined whether *The Day After Tomorrow* led moviegoers to elevate the priority of global warming as a national or environmental issue or whether the movie influenced presidential voting preferences. The survey asked respondents, "Here are some issues now being discussed in Washington. Among these, which do you think should be the top priority for Congress and the President?" Among the general public, global warming ranked tenth out of ten national issues and sixth out of nine environmental issues (see Table 2 on page 30). Moviegoers, however, ranked global warming higher: eighth among national issues and fifth among environmental issues.

Figure 3. Behavioral intentions of watchers and nonwatchers, percent *somewhat* or *very likely*.



NOTE: Nonwatchers weighted (n = 390), watchers weighted (n = 139).
SOURCE: A. Leiserowitz.

Table 2. National and environmental priorities

Priority ranking of national issues

Rank	Movie watchers[a]	Nonwatchers[b]
1	Economy	Economy
2	Health care	Terrorism
3	Terrorism	Health care
4	Education	Education
5	Social Security	Social Security
6	Medicare	Medicare
7	Federal budget deficit	Federal budget deficit
8	**Global warming*****‡‡‡	Crime
9	Tax cuts	Tax cuts
10	Crime	**Global warming**

Priority ranking of environmental issues

Rank	Movie watchers[a]	Nonwatchers[b]
1	Air pollution	Water pollution
2	Water pollution	Air pollution
3	Damage to Earth's ozone layer	Toxic waste
4	Toxic waste	Damage to Earth's ozone layer
5	**Global warming*****‡‡	Loss of tropical rain forests
6	Loss of tropical rain forests	**Global warming**
7	Extinction of plant and animal species	Extinction of plant and animal species
8	Acid rain	Urban sprawl and loss of open space
9	Urban sprawl and loss of open space	Acid rain

[a]weighted (n = 384)
[b]weighted (n = 134)
***p < .001
‡‡p < .01, watchers vs. nonwatchers after controlling for demographic and political variables.
‡‡‡p < .001, watchers vs. nonwatchers after controlling for demographics and political variables

SOURCE: A. Leiserowitz.

The differences between watchers and nonwatchers remained statistically significant even after controlling for demographic and political variables. Interestingly, moviegoers also ranked damage to the ozone layer higher than nonwatchers, which may reflect the common conflation of global warming with ozone depletion among many members of the public.[20]

Finally, what impact did the movie have on U.S. voter preferences? Many commentators noted that the film cast the Bush administration in a relatively negative light. For example, the actor (Kenneth Welsh) who played the U.S. vice president looked strikingly like current Vice President Dick Cheney and played the role of a global-warming naysayer. At one point in the movie, after his warnings are again brusquely ignored, the hero, Professor Hall, raises his voice in urgency: "Mr. Vice President! If we don't act now it's going to be too late!" At a later point, once the enormity of the climate shift has become apparent, the director of NOAA says angrily to the vice president, "You didn't want to hear about the science when it would have made a difference." But did

these less-than-subtle characterizations have an impact on public attitudes toward the Bush administration?

The survey measured this in two ways. First, respondents were asked how much they trusted a number of different groups—including the Bush administration, the National Aeronautics and Space Administration (NASA), NOAA, the U.S. Environmental Protection Agency (EPA), scientists, and environmental groups—to tell them the truth about global warming (see Table 3 on page 32). Moviegoers were more likely to distrust the Bush administration and more likely to trust scientists and environmental groups than nonwatchers were.

A second question asked respondents, "If the 2004 presidential election were held today, who would you vote for?" Moviegoers were less likely to vote for George Bush and more likely to vote for John Kerry (see Figure 4 on page 32). This difference between watchers and nonwatchers remained statistically significant even after controlling for demographic and political variables. Thus, it is likely that *The Day After Tomorrow* did have an impact on voter preferences, if only on those individuals who saw the movie.

As a whole, these results suggest that popular movies can have a considerable influence on the risk perceptions, conceptual models, behavioral intentions, policy preferences, and even the voting intentions of the movie-going public. *The Day After Tomorrow*, although hailed by some critics and reviled by others, was well received by the movie-going public and became an enormous commercial success. Individuals who saw *The Day After Tomorrow* were more likely to perceive global warming as a threat, to be willing to act as consumers and citizens to mitigate this threat, and to translate their heightened concern into political action. Given these results, however, was there a measurable shift in public opinion at the national level?

To answer this question, a representative survey ($n = 472$) of the U.S. public was conducted one week before the release of the movie (14–23 May), measuring the same variables described above.[21] Across the board, no differences were found in U.S. risk perceptions, policy priorities, or behavioral or voting intentions. As a whole, Americans before and after *The Day After Tomorrow* were no more likely to be concerned or to worry about global warming—or to believe that climate change impacts were more likely to occur. They also were no more likely to prioritize global warming as an issue, take personal actions, or to vote differently.

How could this be? The answer is simply a matter of numbers. Based on box office totals and survey data, *The Day After Tomorrow* was seen by approximately 21 million adults aged 18 and older—an enormous movie audience. Yet this represents only 10 percent of the U.S. adult population, not enough to change public opinion as a whole. A movie, even one as commercially successful as *The Day After Tomorrow*, is rarely viewed by a majority of all Americans.[22]

In addition, moviegoers did not universally leave the theater transformed into global warming alarmists or naysayers. While the results reported above suggest that on balance, the film tended to make people more concerned, not all people responded in the same way or with the same intensity. This is a critical point almost completely missed by many pundits, scientists, and critics before the film was released. Many commentators treated the public as a single, homogenous mass, like a great herd about to be spooked into a mass stampede, either toward climate change alarmism or outright denial. A truism of social science and public

Table 3. Trust

	Percent nonwatchers[a]	Percent watchers[b]
How much do you trust the **Bush Administration** to tell you the truth about global warming?		
a. Somewhat or strongly trust	54	38***
b. Somewhat or strongly distrust	46	62
How much do you trust **NASA** . . .		
a. Somewhat or strongly trust	73	68
b. Somewhat or strongly distrust	27	32
How much do you trust **NOAA** . . .		
a. Somewhat or strongly trust	82	87
b. Somewhat or strongly distrust	18	13
How much do you trust **EPA** . . .		
a. Somewhat or strongly trust	66	64
b. Somewhat or strongly distrust	34	36
How much do you trust **scientists** . . .		
a. Somewhat or strongly trust	78	86*
b. Somewhat or strongly distrust	22	14
How much do you trust **environmental groups** . . .		
a. Somewhat or strongly trust	56	63*
b. Somewhat or strongly distrust	44	37

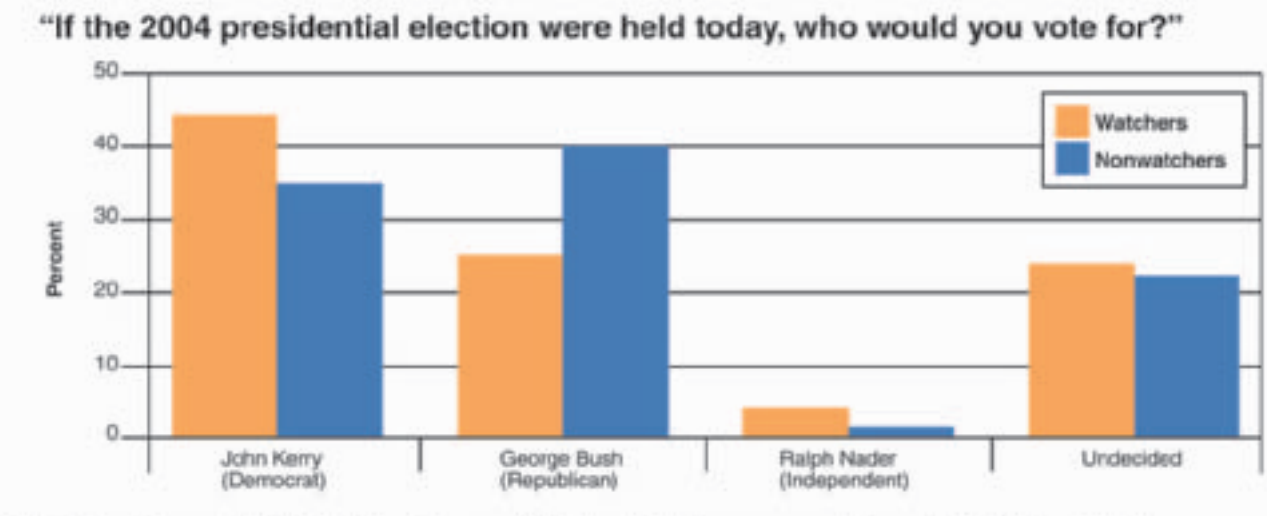
[a]weighted (n = 390)
[b]weighted (n = 139)
*p < .05, watchers vs. nonwatchers
***p < .001, watchers vs. nonwatchers
SOURCE: A. Leiserowitz.

opinion research, however, is that the "U.S. public" is in fact many publics—a plurality of different groups and interpretive communities, each predisposed to attend to certain risks and issues and to discount or ignore others. Very few events have the power to move public opinion *en masse* in the same direction; September 11 is an obvious exception.

Further, the mass media plays a critical role in this process of risk amplification or attenuation. As mentioned above, *The Day After Tomorrow* sparked a heated debate about the science and politics of global warming in the U.S. press. This debate was conducted at all levels of the media, from broadcast networks to local papers and Internet Web sites. But how many and what kind of news stories were generated? A media content analysis was undertaken to answer these questions.

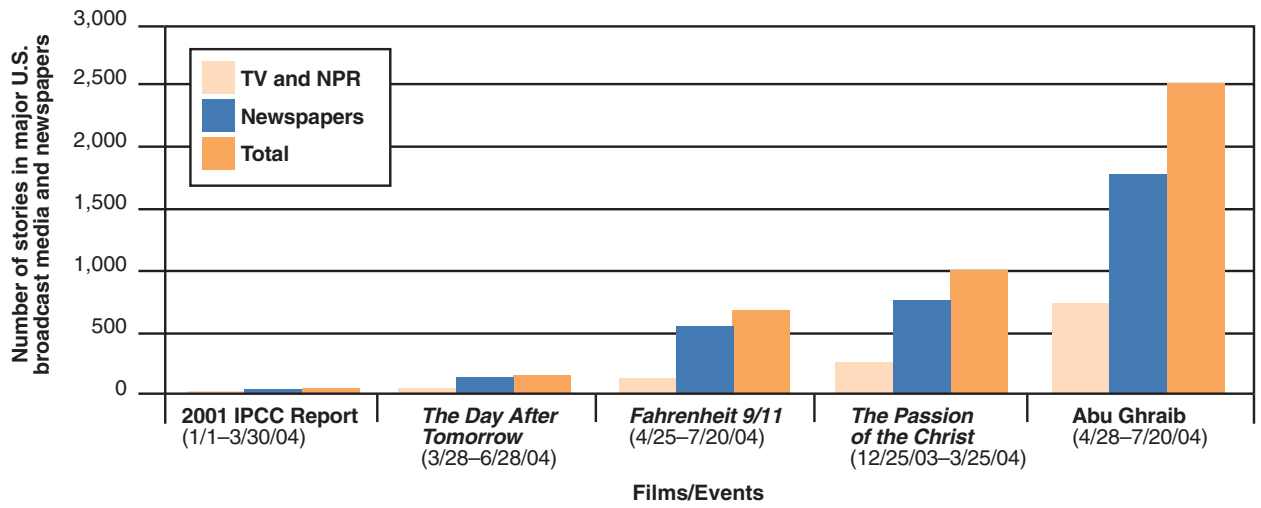
Using Lexis-Nexis, media coverage of the film *The Day After Tomorrow* was analyzed from 1 April through 30 June 2004 (see Figure 5 on page 33). "The Day After Tomorrow" was used as the search term, and analysis was restricted to substantive articles (movie

Figure 4. Presidential politics of watchers and nonwatchers, percent of respondents



NOTE: Nonwatchers weighted (n = 390), watchers weighted (n = 139). (The survey was implemented 15–27 June 2004.)
SOURCE: A. Leiserowitz.

Figure 5. Media coverage



SOURCE: Lexis-Nexis.

listings were not included). Three levels of media were examined:

- national television and radio broadcasts, including national networks ABC, CBS, NBC, FOX, PBS, and NPR and cable networks such as CNN and MSNBC;
- national newspapers such as *The New York Times*, *The Washington Post*, *USA Today*, and *Los Angeles Times*; and
- major metropolitan newspapers such as *The Boston Globe*, *Chicago Sun-Times*, *The Denver Post*, and *The San Diego Union-Tribune*.

News stories were coded into four categories:

- science stories that focused on the veracity of either the movie or global warming;
- political stories that focused on the political implications of the movie;
- entertainment stories that interviewed the stars of the movie or focused on the special effects; and
- movie reviews.

These categories were not mutually exclusive, as a number of news stories discussed the scientific and political dimensions of the movie. Entertainment stories, however, were almost always focused exclusively on the entertainment aspects of the film.

Overall, these media sources generated 151 substantive news stories about the movie. Of these, 39 percent addressed the science underlying the movie, 37 percent focused on the politics, 29 percent provided movie reviews, and only 23 percent were entertainment stories. The articles and broadcasts included numerous editorials, opinion pieces, interviews with leading climatologists, and debates between global warming advocates and opponents. News stories also included coverage of efforts by Al Gore, MoveOn.org, and environmental groups' efforts to use the movie as a "teachable moment"; a leaked memo from NASA administrators allegedly stifling comment on the movie from NASA scientists; and a Pentagon-commissioned report on the geopolitical implications of abrupt climate change.[23] Many news stories addressed the science underlying the movie and the broader political implications in the midst of a presidential election.

Media controversy helped drive people to the theater. But how big was this media storm, relative to other recent controversial films or real events? To answer this question, an analysis of media coverage of two other recent movies was conducted for comparison: *Fahrenheit 9/11*, Michael Moore's documentary on alleged ties between the Bush family and Saudi Arabia and the consequences of the Iraq War, and *The Passion of the Christ*, Mel Gibson's controversial depiction of the last days of Jesus Christ. News stories generated about two real-world events were also analyzed to put media

coverage of *The Day After Tomorrow* in context: the release of the 2001 Intergovernmental Panel on Climate Change (IPCC) synthesis report on climate change and the Abu Ghraib prison scandal in Iraq.[24]

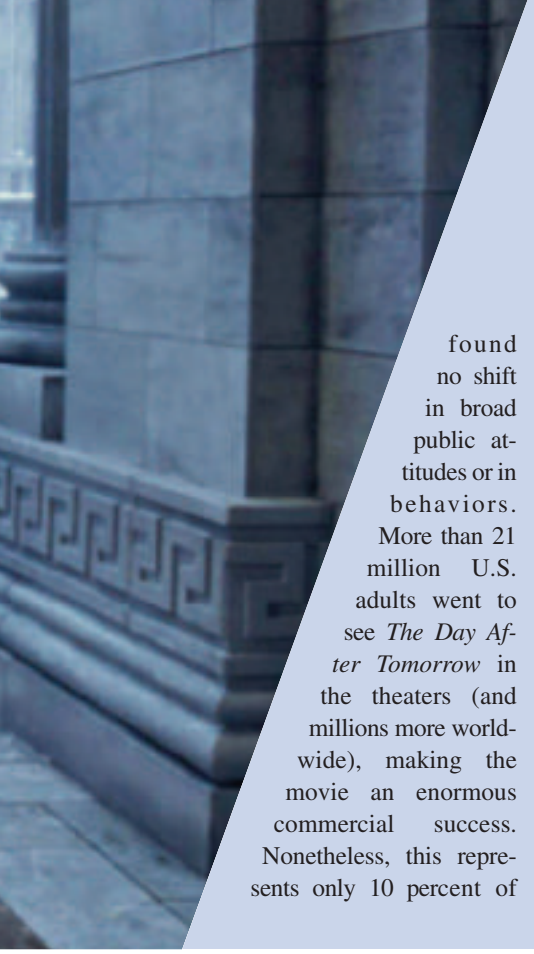
Some commentators had predicted that the film would bring more public attention to the issue of global warming than the publication of most scientific articles, reports, or congressional testimonies, and this prediction appears to have been correct. *The Day After Tomorrow* generated more than 10 times the news coverage of the 2001 IPCC report—which summarizes the latest international scientific consensus on the causes, consequences, and solutions to global climate change and serves as the scientific basis for international negotiations (see Figure 5). However, while *The Day After Tomorrow* did generate media controversy and attract national attention, it paled in comparison to either *Fahrenheit 9/11* or *The Passion of the Christ*. Michael Moore's *Fahrenheit 9/11* generated three times more news stories than *The Day After Tomorrow* despite earning only half as much at the box office in its first month of play. Likewise, *The Passion of the Christ* generated nearly five times more news stories while earning only about 60 percent more in its first month.

Dwarfing the coverage of all these stories, however, was coverage of the Abu Ghraib prison scandal, which had more than 10 times the coverage of *The Day After Tomorrow*. Note as well that this event, as important and shocking as it was, was still only a subtheme of the much larger story about the Iraq war.

Conclusions

The Day After Tomorrow had a significant impact on the climate change risk perceptions, conceptual models, behavioral intentions, policy priorities, and even voting intentions of moviegoers. The film led moviegoers to have higher levels of concern and worry about global warming, to estimate various impacts on the United States as more likely, and to shift their conceptual understanding of the climate system toward a threshold model. Further, the movie encouraged watchers to engage in personal, political, and social action to address climate change and to elevate global warming as a national priority. Finally, the movie even appears to have influenced voter preferences. These results demonstrate that the representation of environmental risks in popular culture can influence public attitudes and behaviors.

Critically, however, this influence was limited by the level of national exposure. Surveys conducted immediately before *The Day After Tomorrow* was released and three weekends afterward



found no shift in broad public attitudes or in behaviors. More than 21 million U.S. adults went to see *The Day After Tomorrow* in the theaters (and millions more worldwide), making the movie an enormous commercial success. Nonetheless, this represents only 10 percent of the U.S. adult population—not enough to measurably shift public opinion as a whole. This percentage, however, will certainly increase once the film is released on video and later broadcast on national and international television. Will the movie thus influence a larger proportion of the U.S. public? It also remains to be seen whether the movie will have the same influence over time—in other words, was the influence temporary? It is possible that the observed shift in public perceptions and behavioral intentions represents a momentary blip—that after time, the experience and imagery of the movie will recede in public memory, along with heightened worry and concern about global warming. A follow-up study will be conducted in coming months to address these critical questions.

Additionally, a key com-

© TWENTIETH CENTURY FOX

ponent of the risk amplification process is media attention. Issue salience and priority is, in no small part, driven by the sheer number and repetition of news stories. This research suggests that, relative to other news stories, global warming is a rarely reported issue. These results help contextualize and explain why global climate change remains a relatively low national and even a low environmental priority for most Americans. Unfortunately, without strong and concerted leadership from the local to international levels, it may take a series of real-world extreme events linked to climate change to permanently raise the salience and priority of global warming among the mass media and the broader U.S. public.

Anthony A. Leiserowitz is a research scientist at Decision Research, Inc. and an adjunct professor of Environmental Studies at the University of Oregon in Eugene. His research focuses on environmental risk perception, decisionmaking, and behavior. Leiserowitz may be reached at (541) 485-2400 or by e-mail at ecotone@uoregon.edu.The author thanks his colleagues at Decision Research, particularly Paul Slovic and research assistants Philip Solomon Hart and C. K. Mertz, as well as independent scholar Robert W. Kates, for their help, encouragement, and constructive criticism. This paper is based on research supported by a grant from the National Science Foundation (SES 0435622).

NOTES

1. Thermohaline circulation refers to a system of ocean currents that distribute heat from the tropics northward to the North Atlantic. These warm ocean currents maintain a relatively warm, temperate climate in northern Europe. Recent paleoclimatology research has demonstrated that this system has sporadically flipped on and off, resulting in abrupt climate shifts, at least at the regional scale. While a future thermohaline shutdown is currently considered a low-probability event, growing scientific concern about the potential for abrupt climate change from this and other possible triggers has led recently to a report by the U.S. National Research Council, a Pentagon-commissioned study on the geopolitical implications, and widespread media attention. See National Research Council, Committee on Abrupt Climate Change, *Abrupt Climate Change: Inevitable Surprises* (Washington, DC: National Academy Press, 2002); P. Schwartz and D. Randall, *An Abrupt Climate Change Scenario and Its Implications for United States National Security* (Washington, DC: Institute for National Strategic Studies, 2003), http://www.ndu.edu/library/docs/pentagon%5Fclimate%5Fchange.pdf; and W. Steffen et al., "Abrupt Changes: The Achilles' Heels of the Earth System," *Environment*, April 2004, 8–20.

2. S. Connor, "Warming Up: The Debate over a Movie That Claims to Be a Vision of the Future," *The Independent*, 8 May 2004; G. Easterbrook, "Blast-Frozen Nonsense," *The New Republic Online*, 10 May 2004; A. Freedman, "Disaster Movie's Focus on Rapid Change Expected to Set Off Renewed Debate," *Greenwire*, 5 April 2004; G. Lean, "How Rupert Murdoch Saved the Planet (and Other Tall Stories)," *The Independent*, 16 May 2004; and P. J. Michaels, "Apocalypse Soon? No, but This Movie (and Democrats) Hope You'll Think So," *The Washington Post*, 16 May 2004.

3. BoxOfficeMojo.com, *The Day after Tomorrow* (24 July 2004), available at http://www.boxofficemojo.com/movies/?id=dayaftertomorrow.htm.

4. This research also contributes to recent developments in risk perception theory, including work on the role of affect and emotion in risk perception and The Social Amplification of Risk Framework, which "aims to examine broadly, and in social and historical context, how risk and risk events interact with psychological, social, institutional, and cultural processes in ways that amplify or attenuate risk perceptions and concerns, and thereby shape risk behavior, influence institutional processes, and affect risk consequences." J. X. Kasperson et al., "The Social Amplification of Risk: Assessing Fifteen Years of Research and Theory," in N. Pidgeon, R. E. Kasperson, and P. Slovic, eds., *The Social Amplification of Risk* (Cambridge, UK: University of Cambridge Press, 2003), 13–46; P. Slovic, *The Perception of Risk* (London: Earthscan, 2000); and P. Slovic et al., "Risk as Analysis and Risk as Feelings: Some Thoughts About Affect, Reason, Risk, and Rationality," *Risk Analysis* 24, no. 2 (2004): 311–22.

5. R. E. Kasperson and J. X. Kasperson, "Hidden Hazards," in Deborah G. Mayo and Rachelle D. Hollander, eds., *Acceptable Evidence: Science and Values in Risk Management* (New York: Oxford University Press, 1991), 9–28.

6. Very few studies have examined the impact of popular movies on risk perceptions. But see W. C. Adams et al., "Before and After 'The Day After': A Nationwide Survey of a Movie's Political Impact," paper presented at the Annual Meeting of the International Communication Association, San Francisco, CA, 27 May 1984; C. A. Anderson et al., "The Influence of Media Violence on Youth," *Psychological Science in the Public Interest* 4, no. 3 (2003): 81–110; and C. M. Bahk and K. Neuwirth, "Impact of Movie Depictions of Volcanic Disaster on Risk Perception and Judgments," *International Journal of Mass Emergencies and Disasters* 18, no. 1 (2000): 65–84.

7. Kasperson and Kasperson, note 5 above.

8. R. J. Bord, A. Fisher, and R. E. O'Connor, "Public Perceptions of Global Warming: United States and International Perspectives," *Climate Research* 11 (1998): 75–84; R. E. Dunlap and R. Scarce, "The Polls-Poll Trends: Environment Problems and Protection," *Public Opinion Quarterly* 55 (1991): 651–72; J. J. Houghton, G. J. Jenkins, and J. J. Ephraums, *Climate Change: The IPCC Scientific Assessment* (Cambridge, UK, and New York: Cambridge University Press, 1990); Intergovernmental Panel on Climate Change, Working Group 1, *Climate Change 1995: The Science of Climate Change. Summary for Policymakers and Technical Summary of the Working Group I Report* (Cambridge, UK, and New York: Cambridge University Press, 1996); Intergovernmental Panel on Climate Change. Working Group I, *Climate Change 2001: The Scientific Basis. Summary for Policymakers* (Cambridge, UK, and New York: Cambridge University Press, 2001); National Academy of Sciences, *Energy and Climate: Studies in Geophysics* (Washington, DC: National Academy of Sciences, 1977); and "Editorial: Costs and Benefits of Carbon Dioxide," *Nature*, 3 May 1979, 1.

9. R. E. Dunlap and L. Saad, *Only One in Four Americans Are Anxious About the Environment*, http://www.gallup.com/poll/releases/pr010416.asp.

10. A. Leiserowitz, "Global Warming in the American Mind: The Roles of Affect, Imagery, and Worldviews in Risk Perception, Policy Preferences and Behavior," PhD dissertation, University of Oregon, 2003.

11. See for example, K. Davidson, "Film's Tale of Icy Disaster Leaves the Experts Cold," *The San Francisco Chronicle*, 1 June 2004; S. Palmer, "Global Warming: The Warm, Hard Facts," *The Register-Guard* (Eugene, OR), 23 May 2004; D. Vergano and S. Bowles, "Killer Weather, or Not?" *USA Today*, 26 May

2004; and A. J. Weaver and C. Hillaire-Marcel, "Global Warming and the Next Ice Age," *Science*, 16 April 2004, 400–02.

12. Likewise, a number of educational Web sites were created to separate movie fact from movie fiction. See for example, The Woods Hole Oceanographic Institution Web site, http://www.whoi.edu/institutes/occi/currenttopics/abruptclimate_dayafter.html; and the Union of Concerned Scientists Web site, http://www.ucsusa.org/global_environment/global_warming/page.cfm?pageID=1405.

13. Groups advocating a viewpoint on the film included MoveOn.org, the Rainforest Action Network, the Natural Resources Defense Council, the Union of Concerned Scientists, Greenpeace, Future Forests, The Cato Institute, and the Competitive Enterprise Institute.

14. See BoxOfficeMojo.com, note 3 above.

15. The survey was implemented 15–27 June by Internet survey firm Knowledge Networks (KN), using their online research panel, which is representative of the entire U.S. population (see http://www.knowledgenetworks.com/ganp/index.html for more information about the KN methodology). The survey also included an oversample of 98 randomly selected adults who had seen the movie, for a total of 139 movie "watchers." The within-panel response rate was 74 percent. The combined sample was weighted to correspond with U.S. Census Bureau parameters and the demographic profile of moviegoers. For more details, please contact the author.

16. This is an important distinction to bear in mind when interpreting public opinion data. While "concern" and "worry" are often used synonymously, they can produce different results. One may have a general concern for an issue without actively worrying about it. Worry is a more active emotional state and as such is arguably a stronger predictor of action and behavior.

17. For a synthesis of public opinion data on global warming, see Program on International Policy Attitudes (PIPA), *Global Warming* (PIPA, 2003), http://www.americans-world.org/digest/global_issues/global_warming/gw_summary.cfm.

18. Multiple regression (partial correlation) is a statistical technique used to determine whether an observed relationship between an explanatory variable and a dependent variable persists, even after the effects of one or more additional explanatory variables are removed. For example, there is an observed negative relationship between height and hair length—that is, short people have longer hair than tall people. This may seem odd at first, but if the explanatory variable gender is added to the regression equation, the observed relationship disappears (because women tend to be shorter and have longer hair than men). If the relationship between height and hair length persists even after the effect of gender is removed, then one can be more confident that the observed correlation is not spurious (StatSoft, Inc., "Multiple Regression," http://www.statsoft.com/textbook/stmulreg.html#cunique).

19. See W. Kempton, "How the Public Views Climate Change," *Environment*, November 1997, 12–21.

20. See Kempton, ibid.; and W. Kempton, J. S. Boster, and J. A. Hartley, *Environmental Values in American Culture* (Cambridge, MA: MIT Press, 1995).

21. This survey was implemented by Knowledge Networks from 14–23 May (see note 15 above). The questionnaire used in both national surveys was identical, with several questions added to the second, post-movie survey. The within-panel response rate for the first survey was 71 percent.

22. *The Day After Tomorrow*, however, will likely influence a larger audience once it is released on video (scheduled for 12 October 2004).

23. G. Mahone, "No NASA Role in Movie," *The New York Times*, 1 May 2004; A. Revkin, "Global Freezing? Do Tell, NASA Says," *The New York Times*, 4 May 2004; and A. Revkin, "NASA Curbs Comments on Ice Age Disaster Movie," *The New York Times*, 25 April 2004. See also Schwartz and Randall, note 1 above.

24. News stories about each film and event were collected using a three-month sampling frame that included stories from two months prior and one month after each movie release and the three months after each real-world event.

rates second in Japan and Germany after viewers have watched the film, it performed poorly in the United States and—even stranger from a non-U.S. view—is not affected by the film: About 7 percent of watchers and nonwatchers chose it.

There is much more to comment and compare about the studies mentioned, and the participants of the Potsdam workshop agreed to unite forces to create such a comparison. For now it is worth noting that the impact studies of *The Day After Tomorrow* have entered a new, reflexive area of climate change research: the area of the impacts of impacts. Twentieth Century Fox Germany has established an initiative to facilitate emissions trading rights and reducing CO_2 emissions of services, events, and traffic (see http://www.climatepartner.de). One might take it as image work, but it is also an indication that *The Day After Tomorrow* might not be the last of the global warming movies. Thus, it will be helpful for climate scientists to continue researching media and film representations of climate change and the public's response to them. It is doubtful that the creators of the United Nations Framework Convention on Climate Change had Hollywood on their minds when they drafted Article 6, which asks for improved communication and education on the issue of climate change. But the entertainment industry seems to have done quite a lot for the public awareness of climate change, and Anthony Leiserowitz gave us a very useful look at this new domain of climate impact research.

Fritz Reusswig
Potsdam Institute
for Climate Impact Research
Germany

1. See http://www.boxofficemojo.com/movies/?page=main&id=dayaftertomorrow.htm.

2. A. Leiserowitz, "Before and After *The Day After Tomorrow*: A U.S. Study of Climate Risk Perception," *Environment*, November 2004, 22–37.

3. F. Reusswig, J. Schwarzkopf, and P. Pohlenz, *Double Impact. The Climate Blockbuster* The Day After Tomorrow *and its Impact on the German Cinema Public*, Potsdam Institute for Climate Impact Research (PIK) Report No. 93 (Potsdam, Germany: PIK, 2004), http://www.pik-potsdam.de/publications/pik_reports.

4. M. Aoyagi-Usui,"*The Day After Tomorrow*: A Study on the Impact of A Global Warming Movie on the Japanese Public," National Institute for Environmental Studies (NIES) Working Paper (unpublished), October 2004; T. Lowe et al., "Does Tomorrow Ever Come? Disaster Narrative and Public Perceptions of Climate Change," Draft Tyndall Working Paper (unpublished), October 2004; and A. Balmford et al., "Hollywood, Climate Change, and the Public," *Science*, 17 September 2004, 1713.

As the article "Before and After *The Day After Tomorrow*" was going to press, I was very pleased to learn that somewhat similar studies had been conducted in the United Kingdom, Germany, and Japan. Thanks to the generous hospitality of Fritz Reusswig and the Potsdam Institute for Climate Impact Research, the primary investigators of all these studies gathered for a workshop in October 2004 to share our respective findings. This meeting was quite stimulating and led to the formation of an international research team to conduct cross-cultural experimental research.

I thank Reusswig for his comments on the paper and would like to take this opportunity to address his primary concern. We conducted three national surveys of the American public—before, during, and several months after the movie played in theaters. The article reported results from the first two waves, in particular the second, which compared a randomly selected group of movie watchers and nonwatchers from a national sample in June 2004—several weeks after the movie debuted. The first two surveys were not based on a within-subject (panel) design, so this study was unable to directly measure whether watching the film changed an individual's attitudes toward climate change. Thus Reusswig raises a legitimate question: Are the significant differences observed in the U.S. study between movie watchers and nonwatchers really due to the impact of the film, or did movie watchers already have "more pro-climate or pro-environment attitudes before entering the cinema"? In other words, perhaps moviegoers went to the film because they were already more concerned about global warming.

Are the significant differences observed in the U.S. study between movie watchers and nonwatchers really due to the impact of the film, or did movie watchers already have "more pro-climate or pro-environment attitudes before entering the cinema"?

Three streams of convergent evidence suggest this hypothesis is incorrect. First, our own and other previous national surveys have found that climate change is not a highly salient concern of the American public, yet by the time of our second survey, 21 million American adults had seen the movie in the theater. Our respondents were randomly selected to represent this group. On its face it seems unlikely that 21 million Americans went to the film because they were already highly concerned about global warming. It is more likely that most people went to see the film because it was a summertime, blockbuster disaster movie.

Nonetheless, we explicitly tested this hypothesis in our third and final survey, completed in

We have only scratched the surface in the effort to understand the role of popular representations of risk.

November 2004. In this survey (not reported in our article because it had not been conducted yet) we re-interviewed the same respondents as in wave two, including movie watchers. We asked them, "Why did you watch this movie?" Of all movie watchers, only 17 percent said they went because they were "interested in global warming." By contrast, 83 percent of moviegoers went because they "liked the trailer" (29 percent), "like disaster movies" (21 percent), "like to see all big films" (21 percent), or "another reason" (12 percent). In contrast, Reusswig's team found that among German moviegoers, 36 percent said a prior interest in climate change led them to watch the film. As he writes, "The German panel study demonstrates a rather strong self-recruitment of . . . more engaged visitors of the film." Again, by contrast, only 17 percent of American moviegoers said they went because of a prior interest in global warming. Thus, the results on which he bases his conclusion that "there is a significant self-selection effect" are probably more indicative of very interesting cross-cultural differences between German and American climate change risk perceptions.

Second, as reported in the article, we determined that movie watchers were demographically different from the general public—they tended to be slightly younger, male, Hispanic, and politically liberal. We therefore used multiple regression to control for sociodemographic and political variables, including sex, age, education, income, race, political party, and political liberalism. In almost all cases and as reported in the article, we found that even after controlling for these variables, there remained significant differences between the attitudes of watchers and nonwatchers.

Third, as reported in the *Environment* article, we directly asked movie watchers whether the movie made them more worried about global warming. Forty-nine percent of moviegoers said the film made them somewhat (36 percent) or much more worried (13 percent), 42 percent said it did not change their level of worry, and finally, only 1 percent said it made them less worried. These three streams of convergent evidence all suggest that indeed, the reported differences in perceived risk between watchers and nonwatchers were due to the impact of the film.

During the meeting in Potsdam, the principle investigators of all five studies identified a number of other intriguing cross-cultural differences in American, British, German, and Japanese responses to the movie, which we intend to investigate further with a multinational experimental study, using exactly the same research design and instruments in these and other cultural contexts. We have only scratched the surface, however, in the effort to understand the role of popular representations of risk (such as movies, books, television, fiction, and nonfiction) or of cross-national differences in public risk perception and behavior.

Anthony A. Leiserowitz
Decision Research
Eugene, Oregon