Advanced Review

Political economy, media, and climate change: sinews of modern life

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In this 21st century, examining how climate change is described and considered, largely through mass media, is as important as formal climate governance to the long-term success or failure of efforts to confront the challenge. Mass media stitch together formal science and policy with the public sphere. And many dynamic, contested factors contribute to how media outlets portray climate change. This paper addresses contemporary political economics—from greater workloads and reductions in specialist science journalism to digital innovations and new media organizational forms—as they relate to media coverage of climate change. By way of recent studies and indications of these dynamics, we appraise how power flows through culture, politics, and society, to construct coverage, public discourses, and knowledge on climate change. In so doing, we explore how media representations of climate change have changed over time, and particularly how the rise of digital media has reshaped climate coverage. Considerations of climate change, arguably the most heavily politicized scientific issue at the turn of the new millennium, seek to inform and anticipate corollary science issues, such as ongoing concerns for genetically modified organisms, nanotechnology risks, and increased threats to water quantity and quality. The focus on political economy—the 'sinews' of modern life—can also then help to inform perceptions and decision making in associated environmental challenges.

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INTRODUCTION

> The world is going one way, people are going another
>
> —'Poot' in David Simon's *The Wire*[1]

Anthropogenic contributions to climate change have become a defining symbol of our relationship with the environment. How we live, work, play, and relax—and thus our modern lifestyles and livelihoods—depend directly on our exploitation of carbon-based fuels.[2] *New York Times* journalist John Broder[3] wrote that these issues are 'the sinews of modern life'. The quip at the top of this introduction, taken from David Simon's critically acclaimed series *The Wire*,[1] provides insights into a certain stubbornness of the human condition, particularly in relation to the way the world is going through changes in the climate.

Scientists now posit that we are living in the 'Anthropocene Era', a time defined by humankind's domination of Earth's ecosystems and life-support systems. The Greek *anthropo-* (signifying 'human') and *-cene* (signifying 'new') capture this movement from the previous Holocene era. This term gained traction through comments by Paul Crutzen,[4] first in a set of talks, and then in his writing a decade ago. A decade before that, *New York Times* journalist Andrew Revkin actually coined a similar term when

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he wrote, 'we are entering an age that might someday be referred to as, say, the Anthrocene. After all, it is a geological age of our own making' (Ref 5, p. 176).

Thanks to the effects of naturally occurring greenhouse gases (GHGs), including carbon dioxide, methane, nitrous oxide, ozone, and water vapor, the temperature of the Earth's surface and lower atmosphere is warmer than it would otherwise be. By adding more GHGs to the atmosphere through the burning of fossil fuels, as well as land-use change and other activities, humans have altered the radiative balance between incoming sunlight and outgoing infrared radiation, causing an enhanced greenhouse effect. This has led to a measurable net warming at the Earth's surface and the upper several hundred meters of the oceans. As the Intergovernmental Panel on Climate Change concluded in its Fourth Assessment Report,[6] 'Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations'.

Despite some fluctuations, the human contribution to climate change does not appear to be subsiding. In 2009, the news was that the global economic meltdown contributed to a drop in GHG emissions of 1.4%. Glen Peters of the Center for International Climate and Environmental Research in Oslo (CICERO) posited that this was an opportunity to move the global economy to lower emissions trajectories.[7] But on a global level, that has not occurred. The U.S. National Oceanic and Atmospheric Administration (NOAA) reported in 2013 that emissions have continued to increase, and atmospheric carbon dioxide levels went up to nearly 395 parts per million.[8] Longer term forecasts predict an ongoing steady increase of global GHG emissions of around 3% per year over the next decade.[9]

Yet the movement from 'what is going on' to 'what we should do about what is going on' is complex and contested. And situated in the vortex of scientific evidence, decision making, political economy, and climate change, are mass media—the main source of large-scale communication to the broader public (as a dynamic and heterogeneous community). Mass media involve publishers, editors, journalists, content producers, and other people in the communications industry who produce, interpret, and communicate texts, images, information, and imaginaries. In today's world, relatively few people have direct access to the peer-reviewed research that informs our understanding of climate change. Therefore, few people typically begin each day with a morning cup of coffee and the latest peer-reviewed journal article. Instead, citizens more often rely on mass media—television, newspapers, magazines, radio, online news and aggregation sites, blogs, and social media—to gain access to news and information about climate change. Journalists in particular have become vital disseminators and interpreters of climate information. In fact, research spanning the past three decades has consistently found that the general public gains understanding of science (and more specifically climate change) largely through mass media accounts (e.g., Refs 10 and 11).

Do contemporary news media have the capacity to cover the high-profile, high-stakes, and highly politicized issues of climate science and policy in nuanced ways that can enhance democratic processes through better public understanding? Do trends in political economy help or hamper the ability of media to avoid issue conflation and responsibly represent climate science and policy issues in the 21st century? To help answer these questions, in this paper, we gauge how power flows through society to construct coverage of climate change. And toward that end, we survey the news media ecosystem, and focus on how political economics affect media processes and portrayals of climate science, politics, and policy.

HOW POLITICAL ECONOMY INFLUENCES 'CLIMATE STORIES'

Ciphers and Siphons

Mass media representations arise through large-scale (or *macro*) relations, such as decision making in a capitalist or state-controlled political economy, and individual-level (or *micro*) processes such as everyday journalistic practices. For example, while recent years have seen significant reductions in many media organizations (which this review will document in some detail), journalists, producers, and editors continued to strive to 'do more with less'. Yet their efforts to provide fair and accurate reporting have been challenged by large-scale economic pressures, such as shorter time to deadline and the requirement to simultaneously cover a wider range of 'beats'.[12] In this context, overworked and highly scrutinized journalists have faced perennial questions about what it means to be 'truthful', 'objective', and 'fair' (e.g., Ref 13).

Corollary questions have persisted about potential tradeoffs between covering climate change in both 'accurate' and 'effective' ways.[14] These are not easy questions, and they engender a variety of answers and explanations. In the U.S. context, journalistic 'truth' has come to be seen as more than mere accurate reporting of facts. It has been defined as a 'sorting out process', and a 'continuing journey toward understanding'. It is the kind of truth rendered

by juries in trials—a form of practical truth that may be revisited as new evidence comes to light.

Objectivity is similarly a slippery subject. Bill Kovach and Tom Rosenstiel[15] point out in their seminal work, *The Elements of Journalism* that while journalists themselves may not be objective, their *method* should be. Brett Cunningham picked up on this thread when he commented, 'journalists (and journalism) must acknowledge, humbly and publicly, that what we do is far more subjective and far less detached than the aura of objectivity implies—and the public wants to believe. If we stop claiming to be mere objective observers, it will not end the charges of bias. But will allow us to defend what we do from a more realistic, less hypocritical position' (Ref 16, p. 26).

'Accuracy' is widely seen as necessary but not sufficient for good journalism, especially with complex scientific, economic, and political issues such as climate change. That it is an insufficient form of journalism was recognized as long ago as the 1940s, with the publication of the report of the Hutchins Commission (Ref 17, p. 22). The report was called 'A Free and Responsible Press', and dealt with emergent obligations of modern journalism. The report stated, 'It is no longer enough to report *the facts truthfully*. It is now necessary to report *the truth about the facts*' (Ref 17, p. 22). Such nuanced distinctions, however, have the potential to give rise to a disconnect between professional normative behaviors and audience expectations—one that can be particularly difficult to bridge on contested issues such as climate change.[18] Moreover, at a time when news organizations are trying to squeeze ever more content out of a shrinking workforce of journalists, the pressure is high to adopt these simplistic notions of truth and objectivity. It increasingly seems good enough to accurately transmit the facts with little regard for determining the actual veracity of claims or their significance, and to let the audience do most of the sorting out to determine 'truth'.

On a larger scale, state or corporate control of media through ownership or other means influences media coverage differently in different countries and contexts around the world. In Western countries, media organizations have continued to consolidate power and resources.[19] This has affected the functions of news media in a variety of ways.[20] While the main principle of democratic news production has been that news media serve as a check on the state, and hold those in power accountable to the public, in practice corporate-controlled media have been argued to act systematically in the service of state power.[21] Many researchers have explored how economic pressures and ownership structures have impacted news production.[22,23] Robert McChesney (Ref 24, p. 31) has argued that profit motivations, 'can go a long way to providing a context (and a trajectory) for understanding the nature of media content'. Furthermore, Anabela Carvalho (Ref 25, p. 21) has commented, 'factors like ownership and the wider political economy of the media can provide significant contributions [to media content] . . . as well as the press's relations with established interests and the social distribution of power'.

In the United States, newspapers in particular have suffered from a long-term trend of disinvestment in journalism, one that actually began before the economic meltdown of 2008 and the disarray wrought by the digital revolution. Journalists themselves have documented this trend by large media corporations in the United States—a sustained reduction in resources for in-depth investigative journalism, as well as specialty reporting, such as science journalism. Among this work was a 2009 investigation by *Exposé*, a PBS documentary series. The lead reporter, Laura Frank, interviewed Brant Houston, former head of the U.S. Investigative Reporters and Editors organization and now the Knight Chair in investigative reporting at the University of Illinois. Houston had worked in the newsrooms of many major media outlets, and he was witness to disinvestment in in-depth reporting for many years. In the *Exposé* story, Houston made this observation:

> I was seeing first-hand that places weren't putting their resources in in-depth reporting, or training, or actually doing the things that would have ensured efficiency and quality . . . Corporations came and harvested the profits.[26]

In 2006, U.S. newspapers began to experience an economic meltdown—2 years before the nation itself did—with print advertising revenue and operating revenue overall falling off the table. Staffing in newsrooms, which had been slipping for about 5 years, also plummeted.[26] Not surprisingly, that trend continued during the global economic collapse. Yet shockingly, profits at many large newspaper companies did *not* drop. Quite the contrary, Frank and her *Exposé* investigative team analyzed the financial records of what were then the five most profitable publicly traded newspaper companies in America. She found that 'in the worst economy since the Great Depression, these top media companies made more profit than they had on average for the past two decades'. In part, they accomplished this by 'siphoning money from their newsroom budgets to pad profits, which many then leveraged to buy more properties in recent years'.[26]

Among the first to go in shrinking newsrooms has been investigative reporting. Specialists covering beats like international affairs, government, and politics, as well as entertainment have been hard hit too. And most relevant to the coverage of climate change, so have journalists dedicated to science. A report by the Pew Research Center's Project for Excellence in Journalism (PEJ) found that even by 2008, only 8% of newspaper editors surveyed said their papers had dedicated more resources to covering science since 3 years prior, whereas 24% said resources dedicated to the topic had declined. The same survey also found that nearly 50% of newspaper editors considered coverage of science and technology to be 'nonessential'.[27] In 2009, a survey by *Nature* of 493 science journalists found that many jobs in that field were being lost; yet, those who remained found that their workloads increased.[28]

The PEJ's 2012 State of the News Media report (released in March 2013) notes that media industry newsroom cuts have brought newspaper staffing to their lowest levels in over 35 years.[29] As the report puts it, 'this adds up to a news industry that is more undermanned and unprepared to uncover stories, dig deep into emerging ones, or to question information put into its hands'.

Another measure of the decline of science coverage in the context of corporate disinvestment in newsrooms has been the decline in the number of dedicated science sections. Such sections were popular in U.S. newspapers in the 1980s, and their number peaked at 95 in 1989. By 2006, only 34 daily U.S. newspapers featured science sections dedicated in some way to science, and those that did often had a concentration on health and lifestyle.[30]

Decreases in mass-media budgets for in-depth journalism, and the huge cuts in manpower, have adversely affected communication of scientific information, often leading to oversimplification of complex scientific material.[31,24] *Guardian* journalist Paul Brown has commented, 'The amount of resources in travel and time the reporter is allowed to use to chase the story has diminished. All over Europe and America staffs are being cut and budgets for getting out of the office slashed' (Refs 32, p. 5 and 33). Along the same lines, U.S. photojournalist Ted Wood (whose work has appeared in such publications as National Geographic and Smithsonian) has lamented a steep decline in support for the kind of environmental work he had been doing. 'For many major American magazines, travel budgets no longer exist', he said (Wood T, personal communication). 'The world of freelance magazine photojournalism as we knew it no longer exists' (Wood T, personal communication). As evidence of such shifts, Wood now has to turn to foundations and other nontraditional sources to find support for his work.

Focused on efficiency, media organizations have forced journalists to cover an increasing range of beats under tighter deadlines. Moreover, content producers in publishing organizations that have survived newsroom cuts and shortfalls have faced increased multiplatform demands (video, audio, and text, along with blogs, Twitter, Facebook, Tumblr, Reddit, 4chan, and YouTube). This has posed significant challenges even to the most skilled and experienced reporters, including the likes of environmental journalist Andrew Revkin, whose *Dot Earth* blog at *The New York Times* is one of the best known outlets for information and commentary on global environmental issues, including climate change.

Revkin refers to the tightening time demands he faced toward the end of his tenure as a staff reporter at the Times as the 'tyranny of time and space'. Revkin attributes his 'worst misstep as a journalist in 26 years'—a mischaracterization of the activities of the contrarian Global Climate Coalition—to the phenomenon.[34] The story, titled 'Industry Ignored its Scientists on Climate', ran on the front page in April of 2009. A correction, appended to the story online, ran four paragraphs long.[35]

Internationally, science and environmental journalism, as well as other specialty beats (including international journalism), have not suffered the same dire fate. But there are signs of mounting challenges. Overall, as of 2010, circulation of print newspapers globally had dipped only slightly. But declining readership and revenue has hit Europe, Australia, and other parts of the developed world—just not as severely as in the United States.[29]

In the United Kingdom, the number of science, health, and environmental journalists almost doubled between 1989 and 2005. But over the next 4 years, there was a slight decline in the number of journalists on these beats. Just as important, workloads have been increasing 'and in many cases are becoming problematic', according to a 2009 report from the Cardiff School of Journalism, Media and Cultural Studies. 'A major consequence of increasingly resource-strapped newsrooms is that specialist reporters complain they are expected to rely too much on 'diary stories', and are not given enough time for independent journalistic work'.[36]

Anecdotal evidence suggests that some journalists in other European countries are experiencing similar pressures. One of the coauthors of this paper, Tom Yulsman, has been co-organizing a series of international conferences that bring together European and

North American environmental journalists: the Forum on Atlantic Media and the Environment. Participants have observed that workloads are increasing, with many reporters being asked to file content multiple times a day. As a result, there is less time to devote to nuanced, in-depth reporting designed to 'tell the truth about the facts'.[36]

Investigative journalist Nick Davies has referred to these trends this way:

> Where once we were active gatherers of news, we have become passive processors of second-hand material generated by the booming PR industry and a handful of wire agencies, most of which flows into our stories without being properly checked. The relentless impact of commercialisation has seen our journalism reduced to mere churnalism.[37]

And what about trends beyond North America and Europe? Particularly in countries where population, education, literacy, and income are rising, newspapers are actually thriving.[38] In this environment, science journalism seems to be a growing endeavor. Formed in 2002, the World Federation of Science Journalists (WFSJ) grew rapidly to include 40 national, regional, or international associations of science journalists by 2009.[39] As of that year, there were at least 600 science journalists working in Arab and African nations alone.[40] Sustained over the long run, this could enhance coverage of the scientifically complex issue of climate change in parts of the world where impacts could prove to be quite significant. But as developing nations continue to grow and mature, they could begin to see the same kinds of problems that have beset news media in the developed world.

The reasons why mainstream media organizations around the world continue to face capacity challenges are clearly multifaceted. But, one factor stands above all others: the digital revolution.

Digital technology innovations such as YouTube and other video sites, blogging platforms such as Wordpress, and social media such as Facebook and Reddit and Twitter have democratized the production and mass dissemination of information.[41] Today, anyone with Wordpress and YouTube accounts can virtually run their own newspaper and television station. At a time when traditional media have been experiencing political economic challenges, this democratization of information has drawn eyeballs to other places.

Even as traditional news organizations have tried to adapt and even embrace these changes, 'in the digital realm, the news industry is no longer in control of its own future', according to the State of the News Media Report 2012 from the PEJ.[38] Traditional news outlets now rely on aggregators such as Google and social media networks such as Facebook to bring them much of their audience—which means they must share a lot of the advertising revenue that once went exclusively to them.[38] The report stated, 'Already in 2011, five technology companies accounted for 68% of all online ad revenue, and that list does not include Amazon and Apple, which get most of their dollars from transactions, downloads and devices. By 2015, Facebook is expected to account for one out of every five digital display ads sold'.[38]

At the same time, the online audience at newspapers has continued to grow. This has been a great hope of the industry. But the most recent PEJ report, State of the News Media 2013, shows that declines in print advertising revenue at newspapers in 2012 outpaced gains in online ad revenue by about 16 to 1—worse than just a year prior. The result has been continuation and even acceleration in the disinvestment by media corporations in their journalistic enterprises that began years ago.

In the United States, newspapers in particular have been struggling to adapt through a variety of means. Some examples include: digital 'paywalls', which have been introduced now at 450 of the country's 1380 dailies; making content available for mobile devices; and cutting back on the frequency of print editions from daily to several times a week, which saves revenue owing to greatly reduced production costs. And in 2012, some signs began to emerge that these and other steps were beginning to stabilize the situation. In that year, for example, publicly traded newspapers in the United States actually experienced a rise in their share prices.[29]

Meanwhile, at the level of journalistic reporting, at least two major newspapers appear to be searching for new ways to cover climate change and other environmental issues in an era of journalistic downsizing. In early 2013, the *New York Times* disbanded its environmental desk. It also ceased production of its 'Green Blog'.[42] Meanwhile, longtime *Washington Post* environment reporter Juliet Eilperin was reassigned to cover the White House.[43]

These moves can be seen in a positive light, because they represent a decrease in segregated environmental coverage, and an effort to integrate it into more widely read reporting. For example, Eilperin, whose coverage of climate issues is highly regarded, will now bring that experience to bear on her reporting about the Obama administration—something that could prove quite valuable if the administration follows through on efforts to enact climate change policy. Moreover, her move does not necessarily represent a diminution of environmental coverage

at the Washington Post: A Pulitzer-Prize winning journalist has taken her place.

At the *New York Times*, Managing Editor Dean Baquet argued that disbanding the environment desk and the Green Blog were positive moves for a similar reason — reporters were not let go, and environmental coverage will now be spread more widely throughout the paper, he said. But the paper's public editor, Margaret Sullivan, sees a downside. Quoted in the Columbia Journalism Review, she said, 'I'm not convinced that The Times' environmental coverage will be as strong without the team and the blog. Something real has been lost on a topic of huge and growing importance'.[42]

In another form of adaptation, nonprofit and independent media models are being pursued to achieve greater diversity in coverage. These trends have been explained by Gillian Doyle (Ref 44, p. 14) as being concerned with 'sustaining representation within a given society for different political viewpoints and forms of cultural expression'.

Laura Frank, author of the PBS Exposé investigation, was both a casualty of the corporate downsizing of newsrooms and the creator of just such an alternative nonprofit, independent media model. An investigative reporter with Denver's Rocky Mountain News, Frank lost her job in 2009 when E.W. Scripps & Co. shuttered the paper. In early 2011, and with funding from major foundations, she launched iNews, a nonprofit news service that collaborates with numerous news outlets in Colorado to do in-depth and high-impact journalism. iNews is one of at least 60 independent, nonprofit news organizations in the United States that are members of the Investigative News Network.[45]

Nonprofit journalism is also focusing on environmental issues more specifically. 'Climate Central' is a recent example. Founded in 2008, it is a collective of scientists and journalists who provide specialist reporting on climate change.

The web-based magazine 'Grist' was a trailblazer in this realm. Founded in 1999, Grist has been very influential through its innovative partnerships with traditional news sources like the *Washington Post*, and it has developed a following of 800,000 readers.[46]

Both organizations have found their success through a nonprofit organizational structure and strong foundation support. Such an approach is seen as a potential way forward for environmental journalism in the 21st century, in place of the faltering for-profit industry structure.[47] Over the last decade there have been dozens of other new and emerging organizations popping up under this nonprofit model across the globe.

These organizations have produced critically acclaimed work in the public interest, but it is too soon to say whether this model for doing journalism can be sustained over the long run. And while there may well be signs of some improvement for newspapers, the situation is only somewhat less dire than it has been. Or as the PEJ's State of the News Media 2013 report posited, 'If the newspaper industry had theme music in 2013, it might use 'Been down so long it looks like up to me', the much-recycled line from a 1920s blues song'.[29]

What broader societal impact is 'being down so long' having, especially when it comes to understanding of climate change issues by the public, and possible policy action?

In a talk in 2009, Robert G. Picard, director of the Reuters Institute for the Study of Journalism at Oxford, took a particularly pessimistic view: 'Today the value created by the practice, functions, and skills of journalism are being severely challenged. The fundamental challenge comes from technology that is deskilling journalists' (Ref 48, p. 3).

Overall, declines in the health of newspapers and the ranks of newspaper journalists are particularly significant because of their role in public discourse. For more than 100 years, a 'core of reported news has been the starting place for a raucous national conversation about who we are as a people and a country' (Ref 49, p. 3) writes Alex Jones, Director of the Joan Shorenstein Center on the Press, Politics and Public Policy at Harvard University. 'Just as the Earth is surrounded by a blanket of atmosphere, so too is this core enveloped by a thick layer of talk and opinion' (Ref 49, p. 3). The vast majority of that reported core, consisting of what Jones calls 'accountability news', comes from newspapers, and their decline thereby impoverishes the rest of public discourse—including the discussion of climate change.

That impoverishment has been particularly significant in the realm of cable television news in the United States, which has traditionally depended in large measure on the accountability news produced in newspapers to inform its own work. In cable television news, technological change is now tending to encourage superficial coverage.

In this realm, the success of programming has traditionally been determined by Nielsen Ratings, notes Peter Dykstra, former head of CNN's science and environment unit, and now publisher of Environmental Health News and The Daily Climate.

> No one likes or trusts the Nielsen ratings. They are expensive and unreliable, and everyone thinks they are manipulative and dishonest. Now, we have web clicks. The numbers are instantaneous. The channels

> trust them . . . And they're free. What gets them clicks? "I can tell you that it's not Stephen Schneider or Pat Michaels," Dykstra said in an interview before Schneider, a noted climate scientist, passed away in 2010. "It's water skiing squirrels." It's Casey Anthony's trial. And it might be a good war story. But it's not science, it's not the environment. If web clicks are ruling the day and Fox News is your competition, it does not bode well for covering climate or environment on television (Dykstra P, personal communication).

In this way, seeking news on climate change through cable television is like filibustering one's analytical engagement with these critical issues, as the discourses put forward have obstructed—rather than delivered—productive, effective, and content-rich climate coverage.

In addition, among these political economic issues are notions of how larger ideological cultures shape news content and the news agenda. A clear example is found in the United States, where the cable television news channel *MSNBC* is tied to the ideological left, while *Fox News* is associated with movements from the ideological right. These relationships can be subtle, evidenced by what issues may get traction on particular channels and how. But they can also be quite explicit, such as the close coverage of early U.S. Tea Party demonstrations by *Fox News*.

Anabela Carvalho has examined how ideological cultures have influenced media reporting on climate change in the United Kingdom. Through analyses of *The Guardian* (and *Observer*), *The Independent* (and *Independent on Sunday*), and *The Times* (and *Sunday Times*) from 1985 through 2001, she found that the left-leaning *Guardian* and *Independent* provided more coverage to market regulation, the precautionary principle, and climate mitigation than their right-of-center counterpart *The Times*. Furthermore, *The Times* 'advocated business-as-usual, using the lack of definitive proof as justification for the continuation of [status quo] policies and practices' (Ref 50, p. 238).

Spatial dimensions—by way of varied national and cultural contexts—feed into differentiated interactions between media representations and policy prioritization.[51] In fact, divergent climate policy stances emerge from dynamic and complex mosaics of public trust in authority and structures of media institutions as well as architectures of decision making.[52] Sheila Jasanoff[53] has attributed differences to the divergent architectures of governance. In terms of media representations, the U.K. press itself is known for being more adversarial, while the U.S. press has been seen to be more deferential to their sources.[54] Leonard Doyle, foreign editor of *The Independent*, has called U.S. mass media 'too trusting' (Ref 55, p. 49). However, Michael Getler, ombudsman at *The Washington Post*, has argued that 'European readers, in contrast to Americans, are much more accustomed to, and accepting of, newspapers with political leanings' (Ref 55, p. 45). In combination, these influences have manifest in divergent representations of U.S. and U.K. roles in international negotiations, from foot-dragger to climate champion.[56]

Media Effects (on Climate Coverage)

These myriad challenges have proven to be detrimental to effective communication of climate change. A number of authors (e.g., Ref 57) have detailed general declines in the quality of reporting, particularly in North America. Bridging specifically to climate change, as well as issues of quantity of press attention, long-time journalist Eric Pooley has noted, 'A vigorous press ought to be central to both climate policy and climate politics, but this is not a time of media vigor. The North American press has been hit by a meteor of its own, a secular revenue decline that is driving huge reductions in newsroom staff and making disciplined climate coverage less likely just as it becomes most crucial' (Ref 58, p. 1).

While it is difficult to quantify the impact that the lack of 'media vigor' has had on coverage of climate change, it is useful to draw some inferences from an ongoing monitoring of climate coverage in a set of influential newspapers around the world (see Figure 1).

Figure 1 shows the number of articles on climate change or global warming in each of a selected group of newspapers, month to month from January 2004 through March 2013. The regions have been 'normalized' to depict frequency of articles per source, in order to enable more effective comparisons between regions. In North America, where the challenges to newspaper journalism have been most severe, the data show that coverage expanded at an increasing rate, from less than 20 articles per newspaper each month at the beginning of 2004 to about 100 at the start of 2007. This rise made sense in light of several intersecting and concatenate developments in the areas of science, policy, ecology/meteorology, and culture.[59]

Among them, the period from 1998 through 2007 saw the eight warmest years in the instrumental records kept by NASA. The year 2005 had gone down as the very warmest on record, 2006 was the fourth warmest, and by the end of 2007, the year had tied with 1998 as the second warmest.[60] This period of remarkable global warming also coincided with the

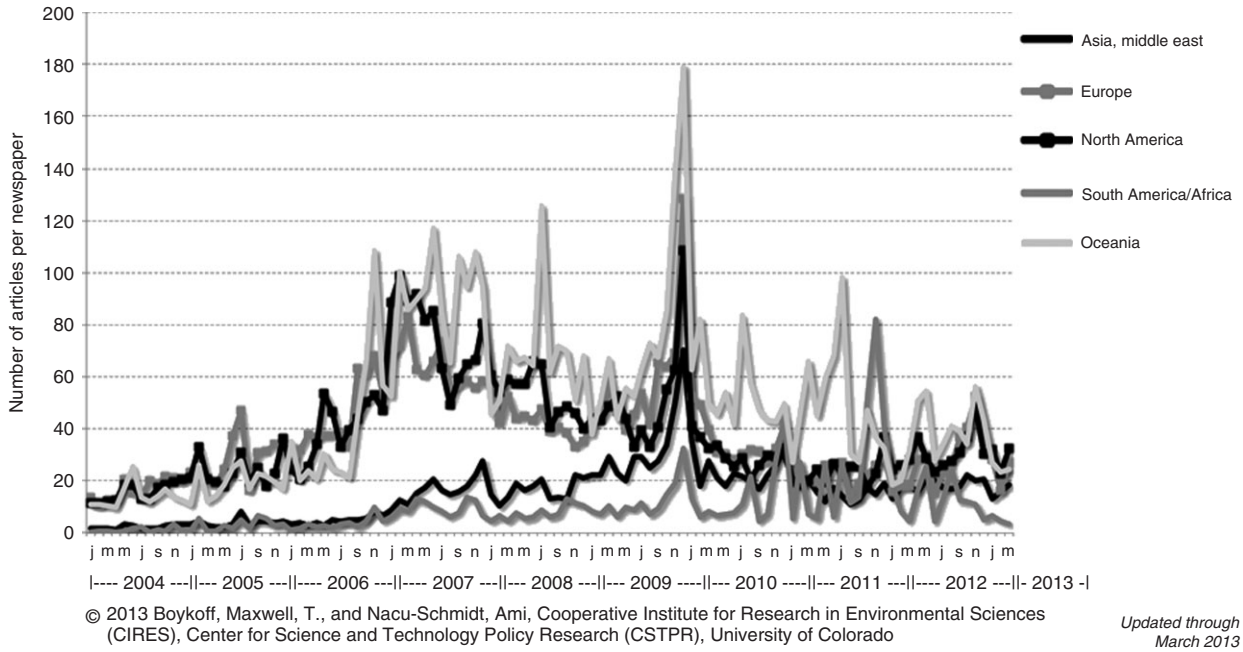

FIGURE 1 | Newspaper coverage of climate change or global warming in 50 newspapers across 20 countries and six continents from January 2004 through March 2013. For comparative purposes regional numbers have been assembled by assessing the number of articles per newspaper per month. These newspapers (appearing alphabetically by newspaper) are as follows: *The Age* (Australia), *The Australian* (Australia), *Business Day* (South Africa), *Clarín* (Argentina), the *Courier-Mail* (Australia), the *Daily Express* (and *Sunday Express*) (United Kingdom), *Daily Mail* (*Mail on Sunday*) (United Kingdom), the *Daily News* (United States), the *Daily Telegraph* (Australia), *Dominion Post* (New Zealand), *Fiji Times* (Fiji), the *Financial Mail* (South Africa), *Globe and Mail* (Canada), the *Guardian* (and *Observer*) (United Kingdom), *The Herald* (United Kingdom), the *Hindu* (India), *Hindustan Times* (India), the *Independent* (and *Sunday Independent*) (United Kingdom), *Indian Express* (India), the *Irish Times* (Ireland), *Japan Times* (Japan), the *Jerusalem Post* (Israel), the *Jerusalem Report* (Israel), the *Korea Herald* (South Korea), the *Korea Times* (South Korea), the *Los Angeles Times* (United States), the *Mirror* (Sunday *Mirror*) (United Kingdom), the *Moscow News* (Russia), the *Nation* (Pakistan), *the Nation* (Thailand), *National Post* (Canada), the *New Straits Times* (Malaysia), *The New York Times* (United States), *New Zealand Herald* (New Zealand), the *Prague Post* (Czech Republic), *The Press* (New Zealand), *The Scotsman* (and *Scotland on Sunday*) (United Kingdom), the *South China Morning Post* (China), the *South Wales Evening Post* (United Kingdom), *The Straits Times* (Singapore), *The Sun* [and *News of the World* (until July 2011)] (United Kingdom), *Sydney Morning Herald* (Australia), the *Telegraph* (and *Sunday Telegraph*) (United Kingdom), the *Times* (and *Sunday Times*) (United Kingdom), *The Times of India* (India), the *Toronto Star* (Canada), *USA Today* (United States), the *Wall Street Journal* (United States), *The Washington Post* (United States), and *Yomiuri Shimbun* (Japan). For monthly updates and for country-level assessments of the United States, United Kingdom, India, Japan, New Zealand, Australia, and Canada, go to http://sciencepolicy.colorado.edu/media_coverage/.

release of two reports from the Intergovernmental Panel on Climate Change (The Third Assessment Report in 2001 and the Fourth Assessment Report in 2007), as well as the release (in stages around the world) from 2006 to 2007 of the Al Gore-led documentary *An Inconvenient Truth*. Consequently, there was much to report about the issue of climate change, and it was propelled to further prominence by an important figure in U.S. politics, the former vice president.

However, in 2007 coverage in North American newspapers began to decline. This was primarily attributed to media attention to the global economic recession, which, in turn, shrunk the news hole for climate stories. Of course it also occurred just as declines in U.S. newspaper newsrooms were accelerating. While immediate worries regarding job security and economic well-being dominated the news through 2008, a public 'caring capacity' for climate change was tested by these seemingly more pressing concerns.[59] Stalled out climate-related news coverage was also compounded by the lack of large-scale Katrina-like disaster events that could be potentially hitched to the wagon of climate impacts.

With the exception of a spike in 2009 associated with United Nations Conference of the Parties (COP) meeting in Copenhagen, Denmark, the Waxman-Markey climate legislation, and the University of East Anglia email hacking scandal (referred to by some as 'Climategate'), coverage has since steadily declined. Today, the North American newspapers in this survey are publishing about 20 articles per month, compared to 100 at the peak in 2006. Furthermore, coverage of global warming at the

three U.S. broadcast news networks, ABC, CBS, and NBC, has been vanishingly small for more than 10 years—through warm years, cold years, floods, droughts, and heat waves.[61] Nonetheless, by NASA's accounting, temperatures in the new millennium have been anomalously warm. Moreover, 2010 and 2011 brought a series of extreme weather events, including searing heat waves, record breaking drought, and deadly flooding, that the IPCC Special Report for Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation[62] stated are consistent with climate change.

More generally, stories tracking issues, events, and information on 'environmental issues' (of which climate change is a subset) have continued to occupy a small nook in news overall. In other words, relative to other issues like health, medicine, business, crime, and government, media attention to climate change remains a mere blip.[63]

POLITICAL ECONOMY, MEDIA, AND CLIMATE CHANGE IN THE NEW MILLENNIUM

In the face of many ongoing climate science and climate-related weather events to report on, we must look for explanations for this decline in the realm of political economy. While the total amount of coverage devoted to climate change is an important metric, to get a fuller sense of how the continuing hollowing out of news organizations is affecting coverage of climate change, we also have to consider quality. And there is little doubt that it is suffering. The 'tyranny of time and space' described by Andrew Revkin can lead to superficial and simplistic treatments of what is obviously a highly complex and nuanced subject. That can take several forms, including pitched battles between personalities, and it can then displace more nuanced and contextualized reporting.

As Kathleen Quinn, the former Op-ed Editor at *The New York Times*, summed it up, 'let's face it, newspaper editors prefer bullies' (Ref 64, p. 29).

Under these pressures, reliance on journalistic norms of personalization, dramatization, novelty, balance, and authority order can subvert fair and accurate coverage.[65] Moreover, as distinct issues, across a spectrum of science and policy issues, are conflated by a hollowed out news media into a single 'great climate change debate', pundits, activists, contrarians, and other non-nation-state actors (at times with outlier viewpoints) find traction more through comments that skew public discourse.[66] Issue conflation, paired with journalistic pressures, then undermine informed decision making regarding climate mitigation and adaptation alternatives. And with the news media being less capable of providing textured coverage of climate science and policy, public understanding and engagement suffer.

These tendencies are evident in what some prominent journalists have themselves said about the nature of their work. According to Bill Kovach and Tom Rosenstiel, citing other journalists' comments on these issues, 'The press is a 'mirror' on society . . . journalism is a reflection of the passions of the day . . . and news is whatever is 'most newsworthy on a given day'.[15]

The concept of journalism as being merely a mirror on what is going on in the world embodies a form of practice that has been described as a kind of 'stenography'.[58] A stenographic approach leads to he said/she said reporting, in which a reporter seeks out representatives of 'different sides' of an issue to provide a 'balanced' view. But it should be the journalist's job to move beyond he said/she said by determining the status of scientific thinking on a subject and accurately conveying that nuance to the audience. That takes sophisticated knowledge, not only of the subject matter but also of how science itself works. In today's economically starved newsrooms, that kind of knowledge, as well as labor power, is often is missing. *Columbia Journalism Review's* Alissa Quart has posited, 'When journalists are generalists, they rely, often uncritically, on outside experts for specialized things. They are famously able to immerse themselves in a fresh subject and report back. But they carry with them their ignorance or the area's debates and politics' (Ref 67, p. 18).

That said, ongoing research has actually found pockets of improvement in coverage. For instance, there has been increasingly accurate representation of the convergent agreement among experts that humans do indeed contribute to climate change.[59] Moreover, by focusing on an occasional outlier example of 'balance as bias', such as a Fox & Friends news clip, researchers and critics can inadvertently amplify these instances beyond their actual presence in wider media discourses.

Yet, as a counter-example, singular and influential pieces like a *Washington Post* George Will column may have influence beyond that of a few dozen articles buried in lower circulating publications. In other words, to rely merely on systematic readings of media portrayals of climate change (through methods of content analysis), the potential influence of a prominently placed article or an attention-grabbing image accompanying an article or segment can be undervalued. Thus, more research needs to be done to account for 'selective listening' or 'selective reading',

and weighting of the influence of particular stories that appear in the news stream of our daily lives.

It is important also to keep in mind that external pressures factor into what manifests as 'climate coverage'. Stephen Hilgartner and Charles Bosk have usefully attended to the various ways in which there are dynamic '"arenas" where social problem definitions evolve' and how these spaces influence 'both the evolution of social problems and the actors who make claims about them'.[68] Their conceptual model has helped to move analyses beyond static representations, where there has been a careful accounting for dynamic and competitive processes to define and frame 'climate stories'. Ultimately, the model has sought to organize and make sense of the 'institutional, political, and cultural factors that influence the probability of survival of competing problem formulations' within the mass media as well as climate politics, policy, and practices.

CONCLUSION

The cultural politics of climate change are situated, power-laden, mediated, and recursive in an ongoing battlefield of knowledge and interpretation.[69] Mass media link these varied spaces together, explaining what can often be alienating, jargon-laden information, and interpreting climate science and policy for citizens and policy makers alike. Media workers and institutions powerfully shape and negotiate meaning, influencing how citizens make sense of, and value, the world.[59]

Our review provides significant reason for concern about the ability of news media to help inform the policy decisions that are surely coming in the realm of climate change. Nonetheless, within this larger context there are still opportunities for enhancing media representations of climate change. If these opportunities could be seized, the public and policy makers could be better informed about the spectrum of possible actions to take in the face of anthropogenic climate change.

Clearly, the road from awareness through media representations to various forms of engagement and action is far from straightforward. Connections are complex, and contested: mass media portrayals simply do not translate truths or truth claims, nor do they fill knowledge gaps for citizens and policy actors to make 'the right choice(s)'. And, media representations do not dictate particular behavioral responses.

Stanford University communication and political science professor Jon Krosnick et al. have found that 'knowledge about an issue *per se* will not necessarily increase support for a relevant policy. It will do so only if existent beliefs, attitudes, and beliefs about human responsibility are in place to permit the necessary reasoning steps to unfold' (Ref 70, p. 37). Moreover, research by O'Neill et al. has shown that fear-inducing and catastrophic tones in climate change stories can inspire feelings of paralysis through powerlessness and disbelief rather than motivation and engagement.[71] Yet, it is important to point out the journalists are often compelled to cover the stories in these ways because the stories themselves frequently are prompted by fear-inducing and catastrophic news hooks.[72] O'Neill et al. also found that imagery connected with climate change influences saliency (that climate change is important) and efficacy (that one can do something about climate change) in complex ways in civil society. Among their results, they found that imagery of climate impacts promoted feelings of salience, but undermined self-efficacy, while imagery of energy futures imagery promoted efficacy.

Overall, media portrayals continue to influence—in nonlinear and dynamic ways—individual to community- and international-level perceptions of climate science and policy decision making. This review has sought to emphasize political economic factors that shape institutional constraints and opportunities to report on climate change fairly and accurately. And the authors here acknowledge unresolved tensions. We recognize that these large-scale features aggregate from the locus of individual agency. In other words, institutional and long-term improvements derive in part from individual and daily changes in attitude, intention, and behavior. Nonetheless, we see individuals as 'vehicles of power, not points of application'.[73]

Thus, individual journalists can (and often do!) heroically swim upstream to provide fair and accurate coverage of climate change, but they do so by paddling against a strong current of political economy, such as newsroom cuts. Suffice it to say, the evidence is that this paddling is tiring and ultimately unsustainable.

Responsibilities for enhanced media representations of climate change certainly do not rest solely with media actors and media institutions themselves. Rather, sustained and long-term improvements will require a recasting of relationships between and within the realms of science, policy, media, and civil society.[74] While our focus has been on the institutional features of the news media in its coverage of climate change, this wider set of considerations is also very important.

'The more scientists and journalists talk, the more likely it is that the public—through the media—will appreciate what science can (and cannot) offer as society grapples with difficult questions about

how to invest scarce resources', *New York Times* journalist Andrew Revkin has said. 'An intensified dialog of this sort is becoming ever more important as science and technology increasingly underpin daily life and the progress of modern civilization' (Ref 75, p. 158).

Not everyone in the scientific community has been ready to accept this reality. For example, in July 2010 it was revealed that IPCC chair Rajendra Pachauri had circulated an email to IPCC Fifth Assessment Report authors stating, 'My sincere advice would be that you keep a distance from the media . . .'[76] He included a document assembled by the group 'Resource Media' providing 'tips for responding to the media'.[77] These served to demonstrate an archaic view of science in society. The affair also inflamed, rather than assuaged, concerns regarding IPCC openness, transparency, effective communications, and dialog.[78]

Policy actors and scientists must recognize that dialog and, where appropriate, even collaboration with journalists, is increasingly a fabric of their professional obligations and responsibilities, rather than an annoyance that can be avoided while the science or the policy 'speaks for itself'. But thankfully, those who fail to step outside their climate-controlled laboratories and boardrooms to acknowledge this key need and responsibility are increasingly seen within science as relics of an almost bygone era.

It is possible that the situation the news media find themselves in now can be summed up by this familiar proverb: It's always darkest before the dawn. As we have documented, a faint hint of reassuring news about the state of the news media has begun to emerge. Does this constitute the first rays of the sun—and does it herald improvements in the ability of journalists to cover climate risk, and our collective responsibility to do something about it? It is clearly still too soon to tell. Since the way these issues are covered in the media will have far-reaching consequences for society, let us hope so.

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