

Mapping Emergence: Network Analysis of Climate Change Media Coverage

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Abstract

Network analysis is an established methodology in many disciplines. Attention to both the roles of actors and network structure has contributed to our understanding of mechanisms that are neither internal nor external to actors, but depend on the interactions among them. Media portrayals of climate change have been investigated by a number of researchers but most of this work has either used content analysis to delineate trends in coverage, or discourse analysis to explore particular aspects of representation. Complex issues such as climate change present a challenge to both strategies because they consist of multiple story lines and emerge from the interactions of many actors. This paper presents an experimental network analysis of Canadian media coverage of climate change between 1997 and 2006. The technique successfully provided a systematic view of the roles of key actors in several distinct storylines, and created compelling visualizations of the emergent nature of climate discourse. The primary limitations of network analysis in this case resulted from its ambiguous stance on agency and from practical coding decisions, both of which suggest the utility of further exploration.

Keywords: climate change, media, network analysis, environmental risk, risk perception

1 Introduction

The media is a primary source of information on environmental risks for the public and climate change is no exception (Bell, 1994; Wilson, 2000). Beck & Ritter (1992, p. 53) argues that we have lost our “cognitive sovereignty” when facing risks such as climate change because they are beyond the powers of individual perception. Instead, we must turn to external sources for knowledge about this risk, and the media is important both in providing information and serving as a public arena for discussions about climate change. For these reasons

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media coverage of climate change has been explored by a variety of researchers (Bell, 1994; Trumbo, 1996; Shanahan et al., 1999; Wilson, 2000; Boykoff & Boykoff, 2004; Antilla, 2005; Carvalho, 2005, to mention a few). This body of work can be loosely divided into two research agendas. The first is interested in understanding trends in media coverage as issues develop over time, while the second is focused on describing media representations of climate change in more depth. Each of these research agendas has typically employed particular methods of analysis.

The first of these two agendas can be characterized by interest in the development of theories that help explain overarching patterns of public attention and media coverage. For example, work in this strain has debated the concept and mechanics of a repetitive cycle governing public attention to issues that do not immediately affect them (Downs, 1972; Trumbo, 1996; Brossard et al., 2004), the idea of narration and its importance in engaging public attention (Shanahan et al., 1999), and the idea that social attention is largely determined by social resonance with particular issues or key events (Ungar, 1992, 1998, 2003).

In the climate context, as in other areas (Nisbet & Huges, 2006), frame analysis has been used to explore the relationships between discourse and overall coverage. For instance, both Trumbo (1996) and Weingart et al. (2000) track the frames used by particular social groups involved in the climate issue and then analyze these across time to argue that the discourse as a whole has shifted. It is the shift in discourse as much as the general pattern of coverage that contributes to theory-building regarding the drivers of media and public attention. When frame analysis is combined with a focus on sources used in the media this can be a powerful technique for demonstrating the connections between actors and frames. The limitation of this technique is that the details of how issues are discussed and actors are interacting are eliminated, making it better equipped to map a single story line than a tangle of many.

A second major area of research examining media and climate change has focused on the intimate details of how climate change has been portrayed. This literature has investigated media's representation of science (Zehr, 2000; Smith, 2005; Carvalho, 2005; Antilla, 2005), the relationships between media coverage and biases due to journalistic norms and media structure (Wilkins, 1993; Nisani, 1999; Boykoff & Boykoff, 2004; Palfreman, 2006) and the effects of political orientation on the portrayal of climate change (Carvalho, 2007; Grundmann, 2007).

With some exceptions (Boykoff & Boykoff, 2004) this work has relied predominantly on discourse analysis of media texts. For example, by following discussions of specific scientific findings in newspapers, Antilla (2005) clarified how the media continued to construct a discourse of scientific uncertainty and skepticism long after the mainstream scientific community reached a broad consensus. Similarly, Carvalho (2005) used the technique to identify the political ramifications of the representations of climate science and particular rhetorical techniques used in media in the United Kingdom. One of the limitations of discourse analysis is that while it provides insight into specific media con-

structions and strategies, it is highly resource intensive and is not designed to develop ‘big-picture’ images. Much of the work within this tradition has dealt with this limitation by focusing on particular aspects of climate change—such as the representation of climate science (Zehr, 2000; Antilla, 2005). However, climate change is an issue which has multiple aspects debated by a wide range of actors. How do we capture and represent the complexity inherent in media portrayals of this type of risk?

The Social Amplification of Risk Framework (SARF) proposed by Kaspersen et al. (1988); Kaspersen (2004) is useful for understanding the complexities inherent in the portrayal of risks. This theory recognizes that the construction of risk is a social process in which cumulative layers of perception either amplify or attenuate an initial risk signal. In this model the media plays a central role as it is a primary means of information flow upon which amplification or attenuation depends. An addition to this framework was made by Murdock et al. (2003) who argued that multiple actors, including formal media institutions, governments, scientists, interest groups and the public, compete within the larger arena of the media system itself. In this view an issue such as climate change can be understood only by examining the competing representations of a single issue held by multiple actors as they get played out in the media. This framework recognizes that the construction of risk is not a linear process, passing from one player to the next but is an emergent property of the process of interaction amongst multiple players.

To some extent this framework resonates with the work of those trying to understand how an issue shifts over time (Trumbo, 1996; Mazur, 1998; Weingart et al., 2000; Shanahan et al., 1999), but it also provides a theoretical basis for more in-depth analysis of the interactions among sources. The basic structure underpinning Murdoch et al.s conceptualization of the media system is the network. Network analysis has been used to explore the connections between actors in a variety of situations and across several disciplines. For instance, in sociology it has been widely used to delineate and understand the diffusion of information or ideas (Strang & Soule, 1998; Valente, 1995; Rogers & Mares, 2000) and social network analysis has become an established methodology (Wasserman & Faust, 1994; Scott, 2000). Sociological work has emphasized both the specific characteristics of particular nodes or actors in a given network and the implications of particular structural elements of networks. Granovetter’s (1973) arguments about the strength of weak ties is a classic sociological use of networks to theorize mechanisms that are neither solely internal nor external to an actor, but depend on the interactions among actors. Network analysis has also been used to describe shifting relationships among actors over time. In his work Tilly (1997) divided the era of British parliamentary reform into periods, each of which contained a series of networks populated by a variety of actors. Each network visualized a type of public debate about the reforms as described in newspaper accounts which allowed changes in the roles of public actors and the understanding of governance to be traced across time.

Interest in the structural characteristics of networks has also resulted in research a range of natural sciences typically examining larger networks. For

instance, the idea of a scale free network, in this case characterized by several large hubs and increasing numbers of smaller ones, may be as applicable to the behaviour of atoms as to the development of the internet (Barabasi, 2002). Similarly, epidemiological interest in network structure has demonstrated not only that network structure can impact how diseases spread (i.e. a network characterized by a few massive nodes and many small ones is much easier to infiltrate comprehensively than one with no central hubs), but also that network structure depends on the characteristics of the vector (Meyers et al. 2005). This is reminiscent of Tilly's (1997) work in which multiple distinct networks, characterized by separate concepts of public debate, co-existed within a single pool of actors.

Network analysis has not been widely applied to media studies, although some work has applied its insights to online communities and media (Rogers & Marres, 2000; Madey et al., 2002; Medynsky et al., 2006). A challenge for media analysis has been to develop techniques which combine elements of both strategies discussed earlier to allow for broad overviews of complex problems that do not overlook multiple story lines and competing understandings. This study is an experimental integration of network analysis into traditional media analysis to see if this assists in understanding the emergence of climate change through the media-facilitated interactions of multiple actors. This methodology could result in important insights in two ways. First, it allows for an examination of the network structure of media discourse on climate change. Does the portrayal of climate change have scale-free properties? Large hubs in a sea of less connected nodes are both the glue and the weak link of a scale-free network. If the network is attacked, either by a disease or a particular discourse, once these hubs are infected they have considerable influence over the rest of the network. If a network is not scale free, but is a random network, then all nodes carry roughly similar amounts of influence over the entire system—meaning that 'infection' by an idea will travel much more slowly as it has to engage with each individual node and that all nodes' interpretations are equally influential. Understanding which network model climate change discourse resembles may give us hints about the way that ideas about climate change are likely to spread in the media playing field.

Second, network analysis may also provide insight into the roles of specific actors. If the network does have scale-free properties, network analysis will allow us to identify the key actors with greatest leverage in the media playing field. Because actors are likely to understand and shape the issue along different frames, the aggregate discussion of climate change can be seen as composed of several distinct although overlapping networks characterized by frames. Network analysis may help us understand how different actors have participated in the creation of the particular frames in which climate change is discussed.

2 Methodology

The Canadian media between 1997 and 2006 was the basis for this study. The Canadian Newsstand electronic database was used to search the two major national papers in Canada, the Globe and Mail and the Toronto Star for articles published in this decade. All articles that contained either “global warming” or “climate change” in their title or abstract were identified, resulting in over 1700 articles. Of these a non-stratified random 20 percent sample (n=353) was selected and coded for this study. This sample included articles from all newspaper sections, including letters to the editor and editorials. Media and climate change research has largely focused on science and news reporting but as the impetus of this study was to map the structure of the discussion as it has emerged in newspapers broadly, the inclusion of all sections was essential.

Simonson (2002, p. 36) writes that “we are taught in higher education to be close readers, but a wide angle lens sometimes gives a better view.” Developing a wide view of network structure was the goal of this work which made content analysis the appropriate base technique from which to begin. Articles were coded for year, newspaper section, source and frame. Through a pilot coding exercise, thirteen source categories were identified and are listed in [Table 4](#). Letters to the editor were included as sources because their authors can be understood to represent themselves as a source. The government category included all those who are involved in the governance of Canada and includes government bureaucracies, the ruling party and opposition parties. These sub-categories were included in initial coding but were not used in the final analysis due to small sample sizes.

With the exception of letters, articles were coded for sources only when direct quotations were used. This choice resulted in some articles being coded as having no sources, but also allowed for systematic coding and comparison. In addition, because the focus of the study was on the structure of the conversation coding was conducted at the article level. This means that each article was coded for all sources and frames present within it; sub-article level coding of the correlations between sources, frames and specific quotations was not conducted. Coding at this level, with the stringent requirements for source coding used would have resulted in a very small source sample size. More specific coding might have facilitated some aspects of content analysis but for this type of mapping the article level was more appropriate and resulted in a manageable dataset.

Five primary frames were identified based on previous studies of climate change in the media and on a pilot study. These frames were science, economics, politics, solutions and environmental impacts. As is outlined in [Table 1](#), each of these frames consisted of multiple sub-categories. Articles were coded based on their use of the frame regardless of how it was used. For instance, articles bemoaning the cost of climate mitigation, and those arguing that these costs were justified were both included in the “economic cost” code. Similarly all debates about controversial science regardless of the exact positions present in the article were coded under “controversial science”. Articles were coded non-exclusively to allow for the possibility that a single article could reflect multiple

aspects of climate change simultaneously.

Description of Frame Codes

Code	Description
Science	
Background	Articles provide background explanations of the basics of climate science, are not focused on new research and present information as accepted.
New	Presents new research that is being done on climate change. For example, covers discussions of current work, recent findings or new evidence.
Controversy	Present when science is debated or the focus of the article is the conversation between climate skeptics and advocates. The focus of this theme is the debate about the existence/non-existence of the phenomena of climate change.
Economics	
Cost	Focus on economic costs of (in)action on climate change. This includes debates about the ramifications of particular actions or policies in which concerns are framed in monetary terms or general concern about long term economics costs of climate change. Some typical issues raised would be crop losses, employment, taxation, impacts on industry etc.
Competition/ Coordination	Focus on the importance of coordinating national efforts with other nations to avoid harming domestic competitiveness.
Opportunities	Focuses on the possible economic opportunities created through particular climate policies including possibilities for new products and services, niche market developments, win-win- conservation efforts etc.
Market	Focused explicitly on creating or using market approaches to combating climate change, including carbon markets.
Politics	
Conflict	Coverage of conflicts about particular policies in which focus is on political leadership or governance issues.
Call for (in)Action	General demands for either action or inaction on the issue of climate change, not focused on particular policies. Includes critiques of general approaches to climate change policy.
Lobbying	Discussions specifically aimed at the weight of lobbying in climate debates either accusations or defenses of lobbying by interest groups including industry, NGOs and others.

Description of Frame Codes

Other Issues	Climate change is not actually the main focus of debate but is linked to other political issues such as budgets, particular policies not explicitly aimed at climate change, or election coverage in which climate change is part of a larger discussion about candidates.
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Solutions	
Adaptation	Discussion of adaptation to climate change, either in general or focused on particular areas or projects.
Business Solutions	Focus on specific business oriented solutions such as companies that are developing new products or engaging in carbon trading
Technical	Focus on technological solutions to climate change including carbon sequestration, energy efficiency improvements, renewable fuels and alternative energy.
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Impacts	
Environmental	Level and type of environmental impacts predicted from mild and local to catastrophic. Economic impacts were included in the economic cost theme. ¹

¹Differentiation between the science and impacts frames was based on the way in which impacts were discussed. For example, if the article merely listed a series of possible impacts of climate change but did not explain the science behind this, it was coded only in the impacts frame. In the case of natural disasters, such as Hurricane Katrina, mentions of the link between the natural disaster and climate change alone, without any scientific explanation were coded as impacts.

For network analysis all articles were paired with their associated sources and frames. This was condensed into a series of spreadsheets which were used as the basis for network development using VisuaLyzer 1.2, a commercially available software designed for medium sized networks. In addition to the comprehensive network which included all sourced articles, five additional networks were created to reflect the idea that each frame may represent a quasi-distinct aspect of the climate change discussion. This program calculates the shortest distance between nodes based on links to other nodes. For this study attention was directed at understanding the structure of the conversation as it emerged through the representations of multiple actors so articles were fitted into the network through their sources. This means that articles sharing the same sources would be closer together than articles that did not. Due to this lens articles without sources were not represented in these network visualizations.

In addition to network visualization, this method of analysis allowed for the calculation of basic network statistics. As discussed earlier, both the structure of the network itself, and the location of individual nodes may hold insights into how the climate change discussion is structured. Two key measures of network properties are described here:

Distance is measured as the number of links between nodes—network distance reflects the number of link between the two most distant nodes. The diameter of a network is a calculation of how many links lay between the two farthest nodes. Average distance and diameter of networks may give an indication of how diverse the participants of a discussion are, how closely they are interconnected in the media and how tightly a given topic is bound by certain actors.

Betweenness is one method of measuring the centrality of a given node in a network—it represents the number of times a node is on the path between nodes. Betweenness scores are derived by calculating the shortest path from each node to every other node. Each time a node falls on this path it is given a score which are then summed to result in a betweenness measure (Scott, 2000, p. 86.). As such, betweenness is a function both of the number of other nodes to which a node is connected and the distribution of links among nodes. Betweenness scores may help differentiate the roles played by actors in the media arena.

3 Results

Woven throughout the work on media and climate change has been an interest in understanding the processes that impact media coverage. As discussed earlier, this has manifest in exploration of attention cycles (Trumbo, 1996; Brossard et al., 2004), narrative cycles (Shanahan et al., 1999) or cultural resonance (Ungar, 1992, 1998)—each of which predicts conversation shifts over time as the issue evolves. A central strategy for this work has been to compare overall patterns in coverage with evidence of evolution in meaning or structure of the

debate. It is the second half of this that is of interest in this paper. Any theory of an attention or narrative cycle depends on the demonstration that the conversation, as a cohesive unit, has altered in some critical element. Earlier work on climate change in the media (Trumbo, 1996; Weingart et al., 2000) observed a shift from the scientific to the political frame, accompanied by a shift in importance from scientists to politicians. If the discussion of climate change continued to evolve along these lines, between 1997 and 2006 we would expect to see a crystallization of the transition from science and academics to politics and politicians. However, a continued transition is not apparent in the Canadian newspaper data from 1997 to 2006.

Figure 1 presents a breakdown of articles utilizing each major frame (1a) and by each direct source (1b)². No clear shifts are apparent over this decade in either the frames or the sources utilized in climate change coverage. If we accept the hypothesis that the conversation switched from science to politics in the decade earlier, by 1997 politics is central in climate change articles and in almost every year it maintains its privileged position. Politics is both the most commonly used frame (it is present in over 60 percent of all articles), and the most common stand-alone frame in climate change coverage (see Table 2). However, despite its centrality it does not become more dominant over the decade in fact while total coverage of climate change increases, the proportional representation of both frames and sources remains remarkably stable.

Several scholars have paid close attention to the representation and use of science in climate change media (Zehr, 2000; Antilla, 2005). Science is one of the most commonly used frames and is second only to politics in the number of times it is used as a sole-frame (eight percent of all articles use only this frame) which suggests its importance in the total discussion. There is little variation in the use of science over the decade although it does have two slight increases in 1998 and 2004. To investigate these two occurrences and to see if there have been large scale shifts in the way that science is being used in these articles, the sub-categories within the science frame were also examined. Yet again no decade-long trends emerge, although both 1998 and 2004 do demonstrate an increase in the application of the controversial science frame. Connection to the progress of the Kyoto protocol can be seen in both these years; Canada signed in 1998 and February 2005 marked the deadline for Kyoto to come into international force which may have contributed to debates about Canadas continued role in the protocol, and by extension, a renewal of interest in controversial science.

The evolution of a discussion could appear through a shift in the use of particular frames or sources, but could also be demonstrated through a change in complexity. For instance, as a conversation matures it may become more complex and articles may be more likely to reflect multiple frames, or certain elements may be simplified as the background knowledge of the public becomes greater. Figure 2 provides a summary of the histogram curves derived from the number of frames contained within articles annually. A sustained shift over the

²Because coding was non-exclusive, this chart shows comparative representation of frames per annum but does not show the total percentage of articles per year referring to a particular frame.

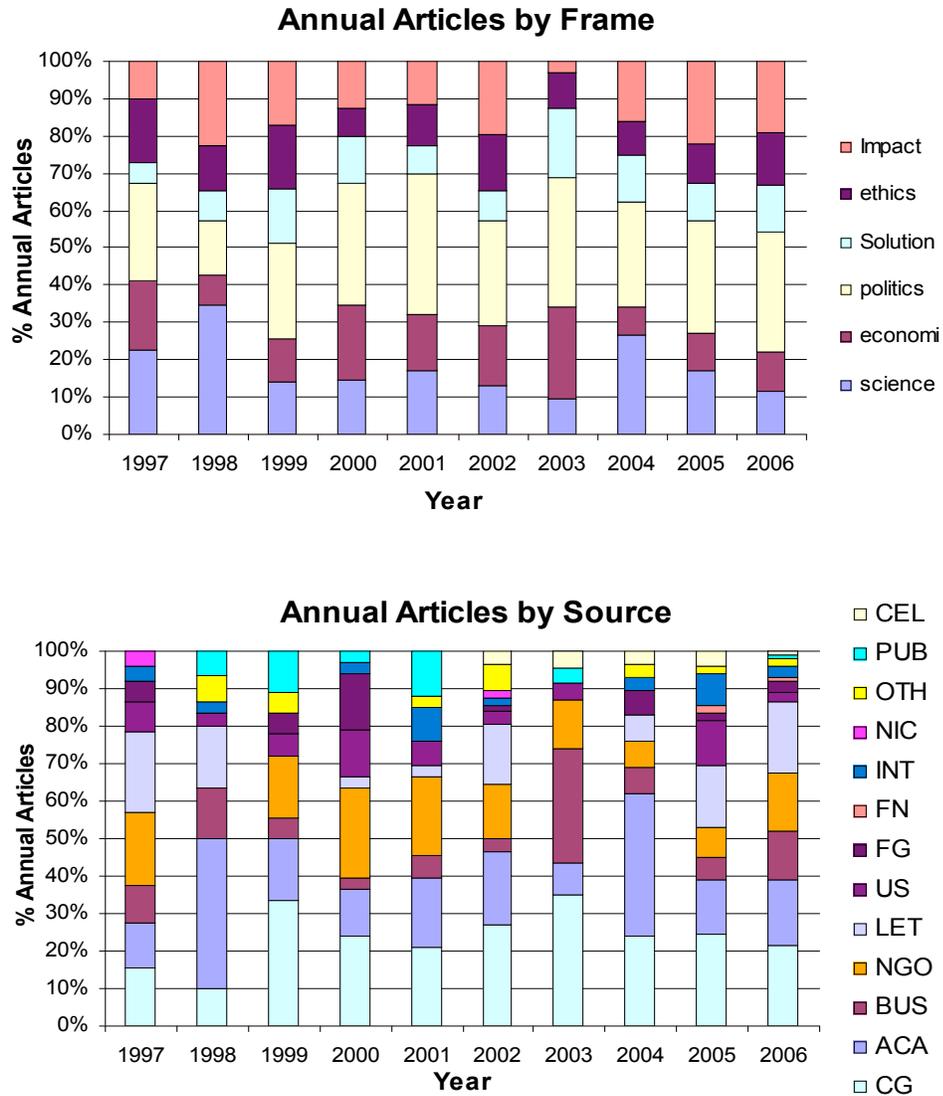


Figure 1: Annual breakdown of articles by major frame and by source.

Table 2: Articles per frame

	Total # of Articles per Frame ^a	# of Sole-Framed Articles
Politics	213	50
Science	122	29
Economics	98	9
Impacts	121	8
Solutions	77	5

^aTotals sum to more than the full sample of 353 because many articles utilize more than one theme.

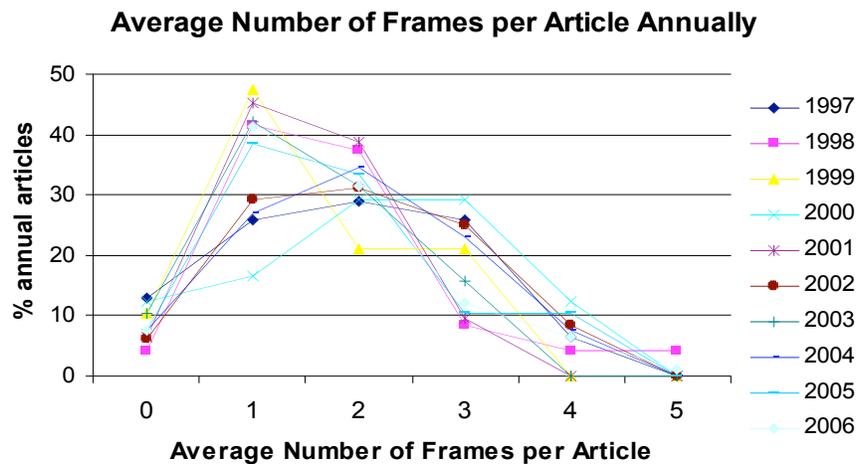


Figure 2: Average number of frames per article annually

decade suggesting that the conversation has steadily changed in complexity is not apparent.

Throughout the decade, articles typically combined elements of between one and three frames. The majority of single framed articles fall into either the politics (fourteen percent of all articles) or science (eight percent) frame. Combined with lack of evidence of a sustained shift in frame or source use, these findings suggest that for the decade between 1997 and 2006 the discussion of climate change in the Canadian media remained stable in both content and complexity; increases in coverage have quite simply meant more of the same instead of an evolution in the conversation. This facilitates consideration of articles from all years as a single unit from which to create snapshot networks, but makes theorizing about the connections between content and coverage more difficult as overall coverage increased dramatically by the end of the decade. It also leaves open questions about what might be needed to substantially shift the national conversation into new territory.

Table 3: Number of articles per source combination

	ACA	BUS	CG	LET	NGO	US
ACA	82					
BUS	7	40				
CG	10	11	96			
LET	7	1	7	56		
NGO	8	9	31	6	61	
US	3	4	10	1	4	24

When attention is focused on sources, academics, the business community, the Canadian government, non-governmental organizations and letters to the editor emerge as the largest players (Table 4). This is well visualized in the comprehensive network (Figure 3), which not only shows which actors are the most frequently used as sources in media discussions of climate change but how these sources are placed in relation to one another. For instance, although all five major sources are distinct, non-governmental organizations and the Canadian government remain much closer together than the academic community, the business community or letters to the editor. Similarly, some of the smaller sources can be seen in and around these larger players, the United States government is tucked closely to the Canadian government, international institutions appear to almost be at the centre of a burgeoning node on their own. This visualization quickly lets us see that many of the articles using academics and letters to the editor are somewhat isolated from the other sources, suggesting less intense common referencing of these sources with others and perhaps a fundamentally different approach to issue characterization and argumentation.

Table 3 and Table 4 show not only that representations of climate change are dominated by some sources but also that there is an extremely tight connection between certain sources. While the Canadian Government is the most common source, it has a particularly close connection to the NGO community. As is seen in Table 3, fifty percent of all articles coded in the NGO category also reference the Canadian Government (the reciprocal share of referencing is 32 percent). This is the highest level of correlation between two sources by far. An additional pattern of interest is how often articles used just one source. Presented in Table 4, it is observed that some sources, such as the academic community have a high ratio of single-source articles (56 percent), compared to other extreme of NGOs (18 percent). This suggests that journalists are either reluctant to use NGOs as authoritative sole-sources in the same way they might use academics, or that NGOs themselves are more likely to contribute to public discussion in relation to action by other actors—such as the government.

When the frame specific networks are considered it becomes apparent that somewhat distinct conversations are being led in the newspaper media by particular sources. Each network appears unique as they are composed of different source configurations and differ by size. Table 5 presents network size, diameter and average distance. As can be seen, except for the number of nodes, substan-

Figure 3: Network maps

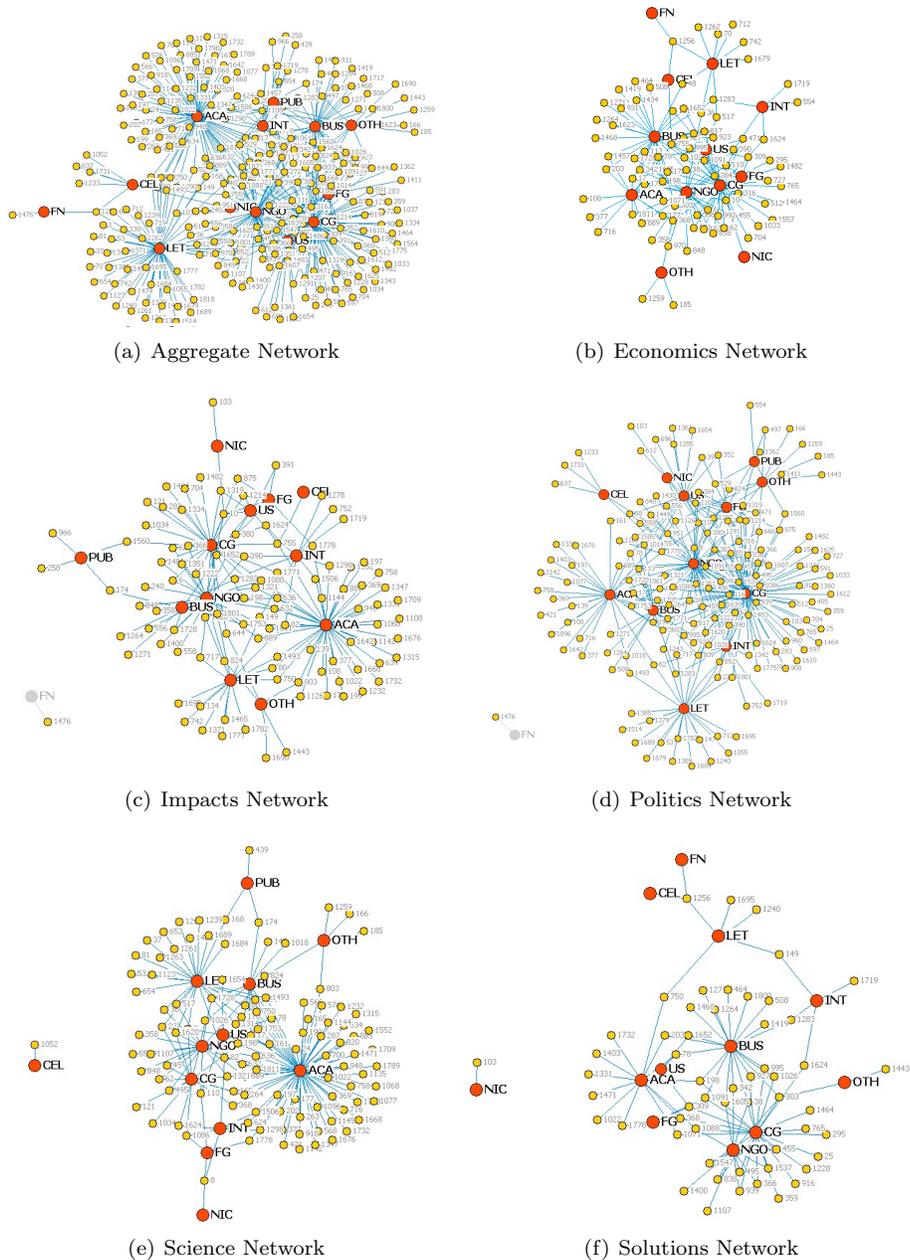


Table 4: Sources Used in Aggregate Network

Source	Code for Network Diagrams	Number of Articles	% of total articles ^a	Number of Sole-Source Articles ^b
Academics	ACA	82	23.2	46 (56%)
Business Leaders	BUS	40	11.3	12 (30%)
Celebrities	CEL	7	1.9	1 (14.3%)
Canadian Government	CG	96	27	31 (32.3%)
Industrialized Governments ^c	FG	16	4.5	3 (18.8%)
First Nations	FN	2	0.6	1 (50%)
International Institutions	INT	16	4.5	4 (25%)
Letters to the Editor	LET	56	15.8	35 (62.5%)
Non-governmental Organizations	NGO	61	17.2	11 (18%)
Developing Country Governments	NIC	3	0.8	1 (33.3%)
Other	OTH	12	3.4	5 (41.7%)
Public (including polls)	PUB	11	3.1	3 (27.3%)
United States Government	US	24	6.8	6 (25%)

^aPercentages add up to considerably more than 100 because each article can have multiple sources.

^bPercentages shown as percentage of articles coded per source.

^cAll governments of industrialized countries other than Canada and the United States.

Table 5: Network Property Statistics

	Aggregate	Economics	Impacts	Politics	Science	Solutions
# of Nodes	285	94	114	180	122	67
Diameter	8	7	6	6	8	9
Av. Distance	3.4	3.1	3.3	3.2	3.1	3.4

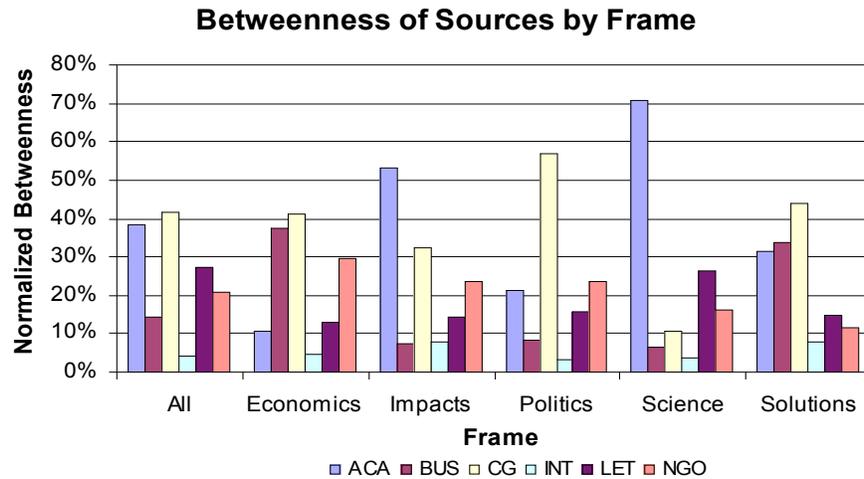


Figure 4: Betweenness of sources by frame (network)

tive differences in structure are negligible, with the possible exception of the solutions frame which appears less tightly connected.

However, the betweenness scores show that while network structure may not strongly differ, actor composition and centrality does vary significantly. [Figure 4](#) presents the betweenness scores for each source by network. These scores do not capture the closeness of sources to one another but they are an indication of centrality of each source in each network. While these scores do reflect the overall weight of each source in each network it is not a perfect measure. For example, the academic community has a high betweenness score in the science network and yet, as seen in [Figure 3](#), the academic community is somewhat insular in the conversation. Although the academic community has a high betweenness score, this is influenced by the fact that it accounts for a large proportion of the total number of articles in the network.

Politics is the largest network and is dominated by the Canadian government category, which includes opposition leaders and government employees. The NGO community is located very near the Canadian government node and also plays an important role, as does the academic community, although this community is less integrated into the main body of the network. The comparative betweenness scores of these actors are seen in [Figure 4](#), although the network visualization highlights the relationship between the NGOs and the Government. Overall, politics is the most common frame used for portraying climate change.

The network looks quite different in the case of science. The academic community is clearly dominant in this discussion, although again, it appears somewhat isolated. Letters to the editor play an important role in this frame as is seen in [Figure 4](#). Very few articles quote members of the public or report

polling information (coded as PUB in the network diagrams, see [Table 4](#)) which means that the most direct method of public representation is through letters to the editor. There could be several reasons for the extremely low number of articles quoting either polls or direct members of the public. First, significant public concern about climate change in Canada dates back clearly until the early 1990s ([Dunlap et al., 1993](#)) and possibly earlier. Reiterations of these public opinion findings may be seen as old, and thus irrelevant or uninteresting, news. Only two instances of polling data were encountered in this study sample. Second, it may also be the case that the climate debate is still seen as an issue for ‘experts and politicians’, thus rendering public input in formal coverage irrelevant. A third possibility may be that to some extent the media itself or sources such as academics, NGOs or governmental bodies, sees the media as a means of educating the public. In this view the media is conceptualized as a unidirectional vector of information’ rather than a forum for public input except through letters to the editor. Without further investigation and comparison with other environmental issues these three possibilities must remain hypothesis, but the high score of letters in the science frame suggests that this is a frame of strong interest for the broader public. [Rayner \(2006, p. 4\)](#) suggests that in situations characterized by a surfeit of scientific information without clear guidance “public disagreements about science become a surrogate for political debates about values” and this may be what is being observed in this study.

The discussion of solutions is particularly interesting from a network perspective. The betweenness scores for academics, the business community and the Canadian government are close and dwarf all other sources. Non-governmental organizations are conspicuously quiet in this discussion, and very few letters to the editor address the idea of solutions. Solutions is also one of the frames that has very few stand-alone articles; only one percent of articles reference solely this frame. Together these findings may suggest that this area is still a relatively undeveloped conversation, or that it has been tightly grafted onto others—namely politics and economics. It also has the largest diameter and longest average distances despite being the smallest network, suggesting that this is a less cohesive discussion than the others.

Like the solutions frame, the business community plays a strong role in the composition of the economics frame. The biggest difference from the solutions frame is that the academic community is considerably less central in economics, while NGOs are more central. This suggests that NGOs are using the language of economics to discuss climate policy even though they are not talking about solutions. The role of the business community in both the economics and solutions frames may reflect the widespread interest in market-based solutions such as carbon markets and in the opportunities presented by low emission technologies and practices.

Impacts to some extent echoed the larger science frame as this frame too was dominated by the academic community, and was a free-standing frame in very few articles. However, unlike the science frame the Canadian government and the NGO community played more important roles, and letters to the editor played a much weaker role. If the government and NGOs are using discussion of

impacts in their arguments for climate policies, why is this not also happening in letters to the editor? It is suggested that the interest in science observed in letters is tightly tied to the use of the controversial science frame—eighteen of the twenty five letters that use the science frame focused on scientific controversy (the majority of which argued that the controversy should not impede action).

4 Discussion

While not focused explicitly on the discussion of an attention cycle this study suggests that there has not been a systemic shift in the type or complexity of the discussion between 1997–2006 in the Canadian newspapers. Overall coverage has seen a marked increase which has two waves within the decade—the first cresting in 2002 and the second in 2006. Without further delving into the history of Canadian climate change debates in a comparative context, the drivers of this wave pattern are left unclear. [Downs \(1972\)](#) argued that coverage would build to a crescendo which would taper off as the public became bored and as the institutional changes needed to manage the issue are put into place. The 2002 peak in coverage would fit this description well as the Canadian government ratified its commitment to the Kyoto Protocol that year. While a dip in coverage was observed in 2003, attention started growing immediately afterwards. This could be due, in part, to the change in government in 2004 and the subsequent cancellation of many federal climate change programs. It may be that coverage will continue to increase, fed by political debate, as long as it is perceived that there has been inadequate institutional response to an identified problem. Although this is a speculative conclusion it does resonate with the central importance of politics observed in these articles.

Both the traditional techniques and the network analysis employed in this study revealed that the political frame and the Canadian government hold privileged positions in the discussion of climate change. Not surprisingly the Canadian government dominates the political frame, and continues to be important in discussions of economics, solutions and impacts. Similarly, the political frame is used in a majority of all articles, and appears in combination with every other frame. From the perspective of Canadian newspapers, politics is a highly legitimate frame in which to debate climate change, and the Canadian government is absolutely integral to this aspect.

The other strong discussion revolves around climate science. In this frame academics are dominant, and of all frames it has the least overlap with the political frame. All other frames rarely appear in isolation but are tightly linked to one or both of politics and science. This suggests that the discussions of economics, solutions and impacts are derivatives of these two basic frames although they do appear somewhat distinct in their network characteristics. It is not surprising that consideration of impacts would draw on discussions of climate science. Similarly, as many policy decisions are debated in economic terms and have important economic ramifications, it is understandable that these two frames are tightly associated. The solutions frame presents a somewhat unique

picture as the government, academics and the business community appear to play almost equal roles and yet are not tightly connected. Network analysis suggests that this discussion is less cohesive, which may reflect the reporting style of climate solutions as these articles are often focused on a particular technology, business opportunity or single policy. At present it is impossible to tell if these derivative discussions will separate themselves from their parents over time or if these frames will remain somewhat subordinate to established archetypes of political conflict and scientific debate and discovery. No trends were detectable in this decade but it may be that we are still in the infancy of these discussions.

One of the strengths of the network analysis technique is that it allows a focus on the roles of particular sources. For instance, attention to betweenness scores and network location reveals that NGOs are so tightly tied to the Canadian Government, and so rarely appear as a sole source that they appear as a counter-weight to government rather than as a source on their own. In comparison, the academic community is often somewhat isolated in the networks, and has a high proportion of single-source articles. Similarly, while the academic community dominates some frames and is absent in others, NGOs are, with the exception of the solution frame, almost uniformly present. This suggests that the realm of subjects on which members of the academic community are considered authorities is narrow compared to the breadth of subjects addressed by NGOs, but that the academic community may also have more validity as an independent source for views and information. In the newspaper media NGOs have taken on the role of general commentator and critic while the academic community remains isolated and expert oriented. Overall both of them remain shadowed by the ubiquitously present Canadian Government.

It is also striking that compared to the business community, academics and the government, NGOs are almost absent in the solution frame. This absence and the centrality of the business community highlights the role of NGOs as critics, and places the business community in the role of problem-solvers. The connections between the business community, the solutions frame and the economics frame underlines the increasing recognition of the importance both of corporate social responsibility and the economic opportunities of environmental entrepreneurship. It remains an open question for NGOs if they wish to maintain their role as critics rather than problem-solvers.

These observations accentuate network analysis' ambiguous portrayal of agency. By using the sources as they appear in the media, it is unclear whether agency for message dissemination resides with sources or the media system. Presumably agency is shared; the media cannot portray ideas that are not promulgated by particular sources but it can choose how sources are used in each circumstance. Is it truly that NGOs have contributed little to public discussion of solutions or is it rather that the media system has decided that this is not an area in which NGOs offer sufficient authority? Source use in the media is likely a combination of actions by these sources, selection decisions based on internal media mechanisms and editorial normative decisions. Perhaps the centrality of the Canadian government is as much a normative call for federal responsibility as it is an observation of demonstrated responsibility. One of the strengths of

network analysis is that it accepts this ambiguity and simply presents the array of sources as a feature of the landscape, mimicking to some extent the wide-angle view of a public faced with a large and varied discussion of a topic about which it might have little knowledge or interest. However, this ambiguity is also a weakness as it does not easily contribute to theory building about the process of creating either media stories or public attention.

An additional limitation for theory building in this particular study stemmed from the limited success experienced in using network analysis to compare descriptions of network characteristics. Although average distance and diameter were calculated for all networks these figures were not significantly different, and in the solutions frame, the one case in which there was a difference, it was seen that this was largely due to tenuous bridges to several single articles. To what extent can these few weak connections be seen to accurately characterize the discussion? Without being able to evaluate these characteristics, the study was unable to address the theoretical questions about network structure and internal information flows.

It is suggested that the limitations experienced in this last regard stemmed from the combined use of a partial sample and a coding system that depended on article-level aggregate source coding. The choice to work with the minimum possible number of codes was made to test the methodology and to facilitate the creation of a workable dataset. When several of these codes were disaggregated (Canadian government and NGOs) the global network structure became much more complex, to the point of becoming undecipherable, and the multitude of sub-categories with small sample sizes made analysis difficult. Aggregate coding meant that the networks necessarily assumed characteristics of scale-free networks, which eliminated one of the theoretical questions of interest about the structure of these discussions and about the nature of the flow of information through a media network. Fully disaggregated source coding, possibly down to the level of specific individuals (e.g. particular politicians or academics or NGO leaders), would be a next step for this work as this would facilitate more accurate evaluation of the nature of these networks but it would likely require a larger initial sample. Alternately, coding could also have been conducted at a sub-article level so that specific statements were linked with specific sources. This would have likely resulted in smaller networks, but could have facilitated stronger assertions about the associations between sources and frames. On the other hand, limiting source coding to direct quotations may have unnecessarily shrunk the overall networks and loosening the stringency of this selection criterion might provide important insights. To some extent the utility of these strategies depends on the underlying assumptions about the nature of the relationship between the media and the public. If the public is reading articles in-depth, then more finely tuned codings may be useful. On the other hand, if climate change articles are more likely to be skimmed and read for essence rather than detail, fine coding may not be an appropriate methodology. These remain areas for future investigation and stress the need for work investigating the actual use and public understandings of media in this case.

5 Conclusion

As presented in this network analysis of the Canadian newspaper media, climate change is a multi-faceted topic which, while based in discussions of politics and science also involves the use of frames that focus on climate impacts, economics aspects and possible solutions. These last three frames seem to be derivatives of the politics and science, and their tenacity and development paths remain open questions. Between 1997 and 2006 there appears to have been no significant shifts in the frames utilized over time or the complexity of the discussion, suggesting that the growth of the Canadian media coverage is not directly linked to a specific shift in narrative although it may be triggered by particular events. Further analysis of the Canadian media landscape also remains an area for future research.

One of the strengths of using network analysis in this case is that it provides a systematic means of examining the relationships among sources. The Canadian government is seen to be the central body grounding much of the climate change coverage, but a variety of other actors including academics, NGOs, the business community and the public are also of importance in shaping the structure of these debates. The strong association between the government and the political frame, and the subsequent linkages between the political frame and all other frames means that the influence of the Canadian government is felt in almost all aspects of the climate discussion in Canada. The exception to this is science, and to some extent the consideration of climate impacts, in which the academic community assumes a dominant role. NGOs have a very distinct pattern of representation as they appear in a secondary role in almost every frame except for solutions, and are tightly tied to the Canadian government. As they are portrayed in this media analysis NGOs are not used as independent sources but as foils for government actions. Their absence and the strong presence of the business community in the solution frame also suggests that they have largely been excluded, either through their own actions or through media perceptions, from participation in the realm of solutions.

Overall, network analysis was useful in providing a systematic way of looking at the relationships among sources and creating a compelling visualization of the emergent nature of climate discourse. Both of these features were valuable in themselves and also helped direct research questions and analysis. The actual visualization of the networks was found useful as a tool to spur further consideration of the relative positions of both sources and frames in ways which would have been possible but not intuitive through traditional media analysis alone. The utility of the analysis was however limited partly through its ambiguous stance on agency and partly through the particular methods of coding and aggregating. Overall, network analysis is a promising tool for the investigation of risk construction in the media but like any other tool, the resulting images and analysis are dependent upon the assumptions made at the beginning of the process.

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