

# Policy on the Web: The Climate Change Virtual Policy Network

*Kathleen McNutt, (University of Regina)<sup>1</sup>*

## **Abstract:**

*This paper analyses policy information on the Web to understand how the hyperlinked organization of webpages, produced by real world, web-enabled policy communities, influences the structure and content of the Web's information supply. These virtual networks of information will be referred to as virtual policy networks (VPN), which are defined as observable patterns of relations among web-enabled policy communities. The organization of virtual teams, social networks and online communities is well documented; however, similar considerations of real world policy communities that are fully established, and then become web-enabled are sparse. This project takes tentative steps towards addressing this dearth in the literature by examining the networked relations of the Canadian climate change VPN. The key research questions addressed are what policy actors are participating in the web-based policy community, who has the most influence in the virtual climate change domain, and how is information organized.*

## **Introduction<sup>1</sup>**

The World Wide Web is the single largest searchable collection of information the human species has ever produced with more than 11.5 billion webpages (Gulli and Signorini 2005). The Internet is a physical communication infrastructure (a network of networks) that supports numerous types of communication (email, interactive discussion groups). The Web is a document delivery system that rides atop the Internet. The organizational structure of the Web is determined by the networked arrangement in which webpages are connected through hypertext. The Web's link structure is often called the web graph.<sup>2</sup> Unlike the Internet, the Web's networked structure is unimpeded by hard wire or territory – the network is purely virtual. The term virtual refers to communication that is mediated by software and computer networks with no temporal or geographical boundaries.

Policy communities are using the Web to supplement existing policy making activities; however, studies of the Web's influence on policy networks are rare (van den Bos 2006). The

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<sup>1</sup> Kathleen McNutt, Johnson-Shoyama Graduate School of Public Policy, The University of Regina 110 - 2 Research Drive Regina, SK, S4S 0A2 [kathy.mcnutt@uregina.ca](mailto:kathy.mcnutt@uregina.ca)

organization of virtual teams, social networks and online communities is well documented (see for examples Bargh and McKenna 2004; Nandhakumar and Baskerville 2006). Surprisingly, similar considerations of policy communities' uses of the Web are sparse and remain in the exploratory stages of research. This paper provides a descriptive analysis of the Canadian climate change policy community on the Web. The key research questions addressed are what policy actors are participating in the web-based policy community, who has the most influence in the virtual climate change domain, and how is information organized.

Web-based Canadian climate change policy information is analyzed through the study of hyperlinked webpages created by policy actors and institutions engaged in the climate change debate and policy development process. Policy communities' use of the Web to share information and communicate policy preferences is growing and may be observed by studying virtual policy networks. Virtual policy networks (VPN) are informational networks produced by groups of actors and institutions engaged in policy making activity both online and off (McNutt 2006). The webpages that populate these networks of information are connected through hyperlinks providing observable patterns of relations among policy actors on the Web.

Policy communities are sectorally based constellations of interests with different stakeholders conferred with varying degrees of influence in the decision-making process (Coleman and Skogstad 1990). All policy communities, both online and off, may be subdivided into a core group of actors that participate in decision-making processes and a larger group comprised of an interested audience that is attentive to a certain policy sector (Pross 1986). The core is often described as having the characteristics of a club with membership based on varying levels of openness or exclusivity. As in any club, membership confers important benefits such as influence, knowledge, or status. The core of the policy community constitutes a network in that members have a mutual interest in a particular policy issue, share knowledge about that policy issue and exchange resources (information, money, support) to influence public support and shape decision making process.

On the Web the community of policy actors is represented by the total set of webpages that contain information pertaining to a particular policy domain or sectors. Inclusion in the policy community does not assume an actor or organization has power in the decision-making process but rather that an actor has an interest or is attentive to a particular policy field. Alternatively, the core of the community, the virtual policy network, is comprised of actors that communicate, share, and exchange information. Unlike belonging to the larger community where membership is constituted by simply publishing information, core network actors are engaged in networks relationships established through hyperlink connections.

Examining the climate change virtual policy network in July 2005 and July 2006, this paper sketches an analytical portrait of policy information on the Web. The climate change domain was selected as an example of a Canadian virtual policy network because issues surrounding climate change have been high on both political and policy agendas (Barnsley 2006). It is an unsettled domain as members of the network debate regulatory approaches, best practices and jurisdictional authority while solutions to problems remain very contestable (Peterson 2006; Stedman 2004; Webster 2003). In addition, the climate change sector is influenced by a number of nondomestic players including the American government and international policy organizations. This internationalization results in foreign interests influencing the web-based supply of domestic policy information.<sup>3</sup>

Furthering political scientists' understanding of policy activities on the Web is crucial in comprehending the larger impacts of information communication technologies on politics and government. This paper explores three key characteristics of virtual policy networks

including the constellation of actors, the network's structure, and informational influence shaping the flows of policy information. Identifying key actors in the climate change policy community provides insight into who belongs to the network and who enjoys stable membership. Next structure is analyzed to determine the network's tendency towards hierarchal organization, measuring the extent to which the VPN is organized around a focal actor. Finally credibility and trust are considered to evaluate the dependability of the network's information supply. Before turning to the specific examination of the climate change virtual policy network the paper provides an account of how virtual policy networks are discovered and analyzed.

## **A Hyperlinked Portrait of a Network**

The Web provides a massive repository of information supplied by a collection of individual contributions, with latent human decisions determining the cumulative content of the Web. The Web was invented by Berners-Lee in 1989 using hypertext markup language, which enabled the linkage of documents and data in physically disparate geographic locations. The result was a network premised on hypertexts facilitating "associations between chunks of information" (Andersen and Kanuka 2003, 19). In other words, information stored on the Web is a decentralized collection of independently created webpages (nodes) and hypertext (links) providing an abundance of latent human information concerning political organization and communication. The Web's architecture, its link structure, is determined by hyperlinked connection among webpages.<sup>4</sup> Unlike the Internet, the Web's networked structure is unimpeded by hard wire or territory and is thus virtual as its design is mediated by software and computer networks with no temporal or geographical boundaries.

Virtual policy networks are created by web-based policy communities that use the Web to supplement existing policy activities with many policy actors and organizations creating webpages and publishing policy content. The method used in the VPN discovery process is referred to as hyperlink analysis, a method used in both computer science and the social sciences to collect and analyze data embedded in webpages and hyperlinks (Park 2003). Webpage hosts will publish various topical pages that provide links to alternative sources of information on the same subject. Among government organizations, corporations, NGOs and policy institutes, there has been a strong tendency to publish partnership/membership lists that contain critical information concerning the ties among policy actors and the larger policy communities. These processes of social organization and web-based communication patterns leave observable patterns of change, coalition building, and information flows in virtual policy networks.

In this project, linking behavior is considered a form of political activity with a hyperlink deliberately chosen by an actor. Studying linking behavior in this way does not assume that the Web author agrees with the information being published, it suggests that the cited webpage is relevant to the topic and that the author views the content as related to the information they themselves are publishing. Hyperlinking is a strategic action with a hyperlink conferring informational authority (source credibility) on an alternative website's informational content (Smith, Newman, and Parks 1997). These communication behaviors are stamped on the subgraph of the Web providing a networked portrait of individuals' and institutions' relationships and affiliations (Elmer 2006; Roger 2006) as Web-mediated exchange and communication are observable through hyperlink analysis. Hyperlink analysis is organized around two primary activities: crawling (data collection) and connectivity-based ranking (data analysis). Crawling refers to the process of collecting webpages using a computer-based algorithm designed to visits pages and retrieve information that is recorded in a large database while the connectivity-based ranking is a measurement used to evaluate the dependability of information in online environments.

Central actors are identified through a two step process using both Google and *Issue Crawler*. Initializing seeds are drawn from Google, which rank orders returned searches by the number of inbound links a webpage receives with the more inlinks received the higher the site's rank (Brin and Page 1998). The course of the crawl is determined by tracing hypertext links that direct the engine from one webpage to another following the networked patterns of the Web's structure (Evans and Walker 2004). In this project Richard Roger and the Gov.com Org foundation's *Issue Crawler* was used to gather link information. *Issue Crawler* is a web engine and analysis package used to map informational networks on the Web with the organization of hyperlink text determining which sites are visited and the course the crawl will take (Roger 2006). The researcher selects URLs which are entered into the *Issue Crawler*, which then maps the hyperlink structure of the network collecting raw relational data which is stored in a database. All initializing nodes or starting points were collected from Google using the top fifteen URLs returned from a search of climate change plus policy in the .ca informational domain. As Bruns (2007) suggests seeds "are equivalent to a set of coordinates around which geographical terrain is to be mapped" (1). Once these initializing points are entered the engine crawls three layers of hyperlink text, beginning with the pages derived from the seeds and tracing two more levels there after. In policy terms all webpages crawled would be members of the policy community. After the parameters of the Web space are determined and unrelated links discarded, a second iteration occurs mapping the link-structure of the networks by measuring co-linkage occurrences providing a catalogue of actors belonging to the virtual policy network and the number of inbound links each core actors received from the community and from other members in the core network. Once the crawl is completed and core actors identified website's influence in the network may be measured by simply summing the number of link it receives and then rank ordering the actor's associated with this Web-based content.

On the Web reputations are built through a hyperlink popularity contest, using links to other information as a proxy for a vote for the reliability and credibility of that information (Park 2003). As Henzinger (2001) explains this "means that the number of hyperlinks to a given page can be used to measure its quality" which then allows for the ranking of webpages by "ordering the returned documents in decreasing order of relevance" (46). Numerous cognitive activities may occur during the decision to link; however, once that decision is made there is a process of self-reporting trust through link information. Websites self report communication relationships through their selection of outbound links, which reveals who is connected to who in the virtual policy network. Websites with numerous inbound links or high in-degrees have good reputations for producing trustworthy information. Actors will presumably avoid risk and uncertainty, and thus avoid providing hyperlinks to unknown sources. The approach is based on the premise that the more links a website receives, the more relevant the information and the higher the source credibility of that information (Kleinberg 1999). In other words, the more inbound hyperlinks a website receives the more relevant the information hosted by that policy actor is considered to be by other members of the community. Websites with numerous inbound links or high in-degrees<sup>5</sup> have good reputations for producing trustworthy information. Thus in a web-based policy community a policy actor's global popularity may be measured by simply summing all inbound links received from the crawled policy community so as to determine the actors indegree.

While connectivity-based rankings inform the analysts about the global popularity of an actor, it is well know that a network is more than the sum of its parts and thus a website's global popularity does not necessarily translate into power in the network. To understand the organization of information and how policy actors communicate the network's informational structure is studied to identify who influences the network's information supply. To achieve this *Issue Crawler* uses co-link analysis which is a type of analysis that discovers networks through the pairing of hyperlinks. Co-link analysis considers shared links (bi-direction) and determines inclusion in the network by pairing two webpages through

shared inbound links from a third webpage (Thelwall 2004). As McNally (2005) explains “co-link analysis results in a pluralistic network, in that to be included as a node, each linkee must be linked to by at least two starting points” (3011), which does not assume direct exchange is necessary for inclusion but instead is premised on networked relations that recognize not all participants are aware of one and other and that information resides in a fluid environment where linear patterns of communication are unlikely. In climate change policy communities information is a key resource because as Jost and Jacobs (2004) suggest to be “accepted by the network as an important information source implies influence” (11).

Actors at the center of the network wield the most informational influence, which directly impacts the network’s tendency toward hierarchal organization.<sup>6</sup> Measuring the level of hierarchy in a VPN provides insight into how information flows through the network and the extent to which the network is centralized around one actor. Verweij et al. (2006) describe a hierarchical setting as one in which “actors see the world as controllable. Nature is stable until pushed beyond discoverable limits, and man [sic] is deeply flawed but redeemable by firm and long-lasting institutions.” This is opposed to the individualistic setting where “actors view nature as resilient – able to recover from any exploitation – and man as inherently self-seeking and atomistic...They prefer institutions that work with the grain of the market (820). Ahuja and Carley (1998) suggest that the level of hierarchy in virtual organizational structure “is reflected by the degree to which relationships in a network are directly or indirectly reciprocal” and “reflects the extent to which a network or group is organized around its focal point.” In a hierarchical informational network actors must go through an intermediary to obtain information providing more opportunities for a centralized actor to strategically manage the relational context of the network, which is often considered desirable in modern administration strategies. As Lemos and Agrawal (2006) explain decentralization “disperses multiple points of political leverage throughout an administrative structure and makes them available to central decision makers” (30). The level of hierarchy is calculated  $k_{(max)}/n^\circ$  where  $k_{(max)}$  is the value of the webpage ( $k$ ) with the highest number of inbound links divided by the total number of inbound links in the network ( $n^\circ$ ). If the relationship among the actors representing the websites has been institutionalized over a long period of time, the network will presumably have a tendency towards hierarchal organization, with trusted informational sources building good reputations as information authorities.

## **The Canadian Climate Change VPN**

Climate change is high on both policy and political agendas in Canada. The Liberal government, which was in power in Canada from 1993 until 2006, was always extremely committed to multilateral environmental agreements and upholding Canada’s international reputation as a good global citizen (Lantis 2005). However, following an election on January 23, 2006 a change in federal political leadership shifted the climate change policy agenda as a new Conservative party took power in Ottawa. The Conservative government has aligned itself more closely with domestic and regional interests, moving away from the international consensus. The offline Canadian climate change policy network is characterized by two key advocacy coalitions including an industrial coalition, which includes the Canada Department of Natural Resources, and an environmental coalition that includes Environment Canada (Litfin 2000). In addition other members of the network include a number of advisory non-governmental organizations (NGO), which largely operated as an epistemic community producing policy information on the environment, the economy, and green technologies (Gough and Shackley 2001).

During the Liberal reign industrial actors had argued that the American government's withdrawal from Kyoto and the intensity of North American economic integration, combined with the two nations' geographic proximity, necessitated a harmonization of Canadian and American policy instruments (Barnsley 2006). Although the Liberal government did ratify the Protocol and unilaterally committed to a six percent reduction in GHG emissions, their policy capacity to take decisive action was restrained by institutions of federalism and by domestic and regional interests, both environmental and industrial. The environment is largely a provincial domain and despite the creation of several intergovernmental mechanisms designed to address national climate change policy development there was a great deal of disparity among provincial governments' priorities (Macdonald, VanNijnatten, and Bjorn 2004). The aggregate affect meant that the Liberal government's commitments to climate change were largely political, and were considered economically infeasible and environmentally ineffective in many parts of Canada (Böhringer and Vogt 2003; Page 2002; Van Kooten 2003).

Under federal Conservative leadership the approach to climate change in Canada has shifted with the federal government focused on managing trade relations with the United States while serving various interests from Western Canada, and accommodating the demands of industry and business. The environmental portfolio has been governed as an increasingly domestic or continental affair with the government focusing on sustainable economic development and the removal of trade obstacles, as opposed to environmental protection and climate change adaptation. Although Canada has not yet opted out of the Accord, the government has announced that Kyoto targets are unobtainable and thus a made-in-Canada solution is necessary for producing realistic initiatives to reduce greenhouse gases. As the Canadian government distances itself from its Kyoto commitment it has also aligned Canada's climate change priorities with the United State's agenda. The change in federal leadership, the shift in policy priorities, and the constellation of actors participating in the climate change network are observable in the membership and structure of the Canadian climate change virtual policy network.

In July 2005 the web engine crawled 32,134 pages of information; while in July 2006 47,176 pages were crawled. The 2005 crawl identified ninety-eight websites in the network that received 41,722 inbound links from the policy community. In July 2006 the Canadian climate change VPN had sixty-five websites with 37,894 inbound links. Forty-seven websites had a stable presence in the network over the year. Of the total 41,722 hyperlinks into the Canadian climate change VPN in 2005, the federal government received 59.6 percent, the provincial and territorial governments received 15.17 percent, intergovernmental websites received 1 percent, the American government received 11.78 percent, international policy institutes received 5.72 percent, and NGOs received 4.5 percent. In 2005 there were thirteen environmental and twenty industry-based NGOs participating in the climate change VPN. Of the total 37,894 hyperlinks into the Canadian climate change VPN in 2006, the federal government received 55.19 percent, the provincial and territorial governments received 0.23 percent, intergovernmental websites received 0.29 percent, the American government received 24.21 percent, international policy institutes received 13.365 percent, and NGOs 6.45 percent. In 2006 there was fourteen environmental and ten industrial NGOs were participating in the climate change VPN.

The transmission of information through a hierarchal network will provide some actors with more opportunities to direct flows of information making it particularly important for understanding "the actual architecture of information diffusion" and the "prescriptive governance implications of an informational network perspective" (Lazer, 2005: 64). The Canadian federal government received the highest indegree from the policy community with 24,865 inbound links, producing a fairly hierarchal network (0.60) organized around federal government information. In July 2006 the climate change virtual policy networked received

37,894 inbound links from the crawled population. Again the Canadian federal government received the highest indegree with 20,915 inbound links. Thus at time two the climate change VPN's level of hierarchy was 0.55 (Table 1).

**Table 1 - Federal Website Inbound Links**

	2005	2006
Government of Canada	9801	5358
Canadian Department of Natural Resources	3504	591
Environment Canada	2954	6749
Canadian Department of Justice	2009	7211
Canada Climate Change	1320	392
Fisheries and Oceans Canada	1246	0
Health Canada	1206	0
Canada's National Climate Change Process	834	108
Transport Canada	492	0
The Parliament of Canada	428	0
Office of the Prime Minister	329	0
Statistics Canada	294	0
Industry Canada	173	0
Privacy Commissioner of Canada	114	46
Canada Gazette	84	111
National Energy Board of Canada	45	0
Canadian Environmental Assessment Agency	32	0
Agriculture Canada	0	191
Canadian Government Publications	0	108
Canada Mortgage and Housing Corporation	0	50
Total	24865	20915

This suggests that the VPN is very focused on the informational priorities of the federal government; however, this authority is dispersed across a collection of federally-sponsored websites. In the case of the Canadian climate change VPN the architecture of information diffusion is hierarchal, with the Canadian government largely controlling the flows of information. In July 2005 the climate change VPN included seventeen federal departments and agencies, with combined inbound links totaling 24,865. In July 2006 the climate change VPN only included 11 website with 20,915 inbound links. Thus while information remained distributed across government websites, there is increased centralization in 2006 with hyperlinking concentrated in fewer websites.

There were five main groups of actors publishing information in the Canadian climate change VPN. The first group was Canadian governments including federal, provincial, territorial, and municipal, all of which engage in environmental policy decisions and programme implementation. The second key participant was the American government and the various

federal agencies that produce and disseminate information on the Web. International intergovernmental institutes providing policy advise and coordinate binding environmental agreements constituted the third group of actors. The forth category of participants was industry and the fifth groups was comprised of non-governmental organizations both advisory and activist. While all five groups of policy actors were represented in both 2005 and 2006 there was a significant shift in connectivity-based ranking (Table Two).

**Table 2 – Connectivity Rankings**

	July 2005	July 2006	Change
Canadian Governments			
Federal	24865	20915	-15.89
Provincial Territorial	6328	87	-98.63
Intergovernmental	418	110	-73.69
US Government	4915	9175	+86.67
International Institutions	2386	5061	+112.11
Industry	463	53	-88.55
Non-governmental Organizations	2251	2445	+8.62
Other	96	48	-50.0

The number of inbound ranks received by both the Canadian federal government and the Canadian Department of Justice are common to all Canadian virtual policy networks. Canadian government websites are largely templates, and always include hyperlinks to The Government of Canada main portal and a separate webpage that links any relevant legislation and regulations to the Canadian Department of Justice. The high rankings of federal institutions are not however superfluous and may be adopted as a measure of the state’s involvement in a network. Leaving aside these two federal sites, the most influential information in the Canadian climate change VPN in 2005 was provided by the Department of Natural Resources and in 2006 by Environment Canada. In 2006 Environment Canada received the most inbound links more than doubling is connectivity over the year, while the Department of Natural Resource’s ranking fell significantly. This was expected as the Harper Conservatives have concentrated climate change information in the Environment Canada website, eliminating the Canada Climate Change portal, removing any references to climate change in the Natural Resources department and shutting down several related websites. Climate change policy during the Liberal era was spread across a number of different departments including Environmental Canada, Natural Resource Canada, Health Canada, Fisheries and Ocean and so forth. However, in 2006 is appears web-based policy information is being condensed in the Environmental Canada website. Federal departments and agencies that receive 100 inbound link or more that were present in 2005 and then absent in 2006 included the Office of the Prime Minister, Parliament of Canada, Fisheries and Oceans Canada, Health Canada, Transport Canada, Statistics Canada, and Industry Canada.

**Table 3 – Top Ten Ranked Website**

2005	2006
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1	Government of Canada	980	1	Canadian Department of Justice	721
		1			1
2	Canadian Department of Natural Resources	350	2	Environment Canada	674
		4			9
3	Environment Canada	295	3	Government of Canada	535
		4			8
4	Government of Alberta	260	4	US Environmental Protection Agency	426
		8			9
5	Canadian Department of Justice	200	5	US Department of Energy	279
		9			2
6	Government of the Yukon	171	6	UN Framework Convention on Climate Change	172
		4			0
7	US Environmental Protection Agency	151	7	National Oceanic and Atmospheric Administration	164
		1			8
8	US Department of Energy	143	8	World Bank	119
		3			3
9	Government of Saskatchewan	133	9	International Institute for Sustainable Development	916
		9			
10	Canada Climate Change	132	10	Canadian Department of Natural Resources	591
		0			

The government of Alberta, the Government of Saskatchewan and the Yukon Government were all ranked in the top ten most linked to website in 2005 while in 2006 the combined informational influence of these subnational governments was nominal (Table 4). In 2005 these three provincial governments were arguably the most ardent critiques of the federal government Kyoto commitments. Alberta and Saskatchewan, two Prairie Provinces with resource dependent economies, bearing the greatest financial costs of reducing emissions, have been more vocally opposed to the federal government's ratification of Kyoto (Jaccard, Nyboer, and Sadownik 2002; Kukucha 2005). Alternatively, the Yukon, which is home to a large Canadian indigenous population is particularly vulnerable to climatic risk often experiencing the early impacts of global warming (Ford, Smit, and Wandel 2006; Gajewski and Atkinson 2003).

In 2006 the provincial and territorial governments' websites received very few inbound links with a radical decline in connectivity. Saskatchewan and Alberta are both strong Conservative constituencies (holding forty out of forty-two seats in the two provinces). These principal emissions-generating Canadian provinces are well-served by flexibility and discretionary targets preferring the climate change discussions be moved away from environmental protection towards sustainable development. As a result both provinces have lessened their campaigns opposing the implementation of the Kyoto Protocol and are operating in a policy as usual context. Harper's domestic relationship with the provinces does not imply increased cooperation among levels of government but rather a closer alignment of the federal government with previously vocal provincial opponents of Kyoto and industrial preferences concerning a system of compliance. The fall in the Yukon's ranking is less easily explained, as is the absence of Canada's northern indigenous population, who are particularly vulnerable to climatic risk. It is also surprising the province of Quebec is not represented in the policy community as they have been ardent supporters of the Kyoto from its inception.

Canada's autonomy in the climate change policy has also been influenced by its long-standing economic relationship with the United States, which is replicated here with the United States Environmental Protection Agency and the United States Department of Energy's ranked in the top-five most linked to websites in the Canadian climate change VPN. While the Liberal government's diplomatic relations were often strained with the Bush administration this did

not affect sub-national agreements between regions, provinces and states (Selin and VanDeveer 2005; Vannijnatten 2004). In 2005 there were ten United States Government websites in the VPN with 4,915 shared inbound links. Under Conservative leaderships, the informational influence of the American government has grown significantly receiving 9,175 inbound links in 2006; however, these links were concentrated in fewer (eight) websites. Links to the National Oceanic and Atmospheric Administration, which is a federal agency that monitors changing climatic conditions for the American Department of Commerce, jumped from an in-degree of 33 in 2005 to 1,648 in 2006. The United States Government portal, the Library of Congress, the National Science Foundation and the US Geological Survey were all dropped from the network in 2006, while the Carbon Dioxide Information Analysis Centre and the Agency for International Development websites were new editions.

The United States has traditionally employed economic policy instruments to implement pollution markets for tradable greenhouse gas emissions, a climate change strategy that has been further institutionalized by the Bush administration's close relationship with industrial interests (Parenteau 2004). American environmental policy has increasingly supported "environmental regulatory compliance through use of flexible, sustainable, and management system-based strategies" (Graziana 2006, 11). This approach resonates closely with the new policy priorities of the Canadian federal government and particularly with the Conservative government's adherence to a system of flexible and cooperative compliance. While this is speculation it may help partially explain the radical increase in the number of inbound links to US Environmental Protection Agency.

Membership in the climate change network did go beyond Canadian and American actors, which reflects the internationalization of the domain. International intergovernmental institutes' participation in the Canadian climate change VPN increased significantly from 2005 to 2006. At time one international institutes received 2,389 total inbound links, with the United Nations Framework Convention on Climate Change website receiving the most links with a 674 indegree. The United Nations Framework Convention on Climate Change website remained the most linked to site in 2006, more than doubling the number of inbound links received (1,720). Similarly, the Intergovernmental Panel on Climate Change website jumped from 276 links in 2005 to 529 links in 2006. The organization with the largest net increase in hyperlinks was the World Bank with an indegree of 56 in 2005 to an indegree of 1,193 in 2006.

Industry participation in the VPN was limited in 2005 and nominal in 2006. It appears that industry has been predominately represented through NGOs and umbrella associations. Numerous non-governmental organizations, both activist and advisory, were participating in the Canadian climate change VPN. NGOs use information to "exert influence" (Corell and Betsill 2001, 106) and pressure both domestic and international government policy makers to adopt the regulatory mechanisms set out by the United Nations (Gulbrandsen and Andresen 2004). Activist NGOs include all organization that campaign for or against an issue such as the Climate Action Network, which is a global umbrella organization that represents environmental NGOs at international conferences, seeking to "influence climate negotiations and policies and measures at national and international levels" (Gough and Shackley 2001, 342). Advisory groups produce information intended to address climate change problems and provide policy solutions. Orr (2006) has suggested that due to number of technical expertise surrounding climate change policy think tanks are the most common type of organized interest participating in the policy community, which was replicated in the Canadian climate change VPN.

In 2005 the number of NGO websites participating in the climate change VPN totaled 33 with an aggregate in-degree of 2,251. Thirteen environmental NGO websites receiving 1,136 inbound links while twenty industrial NGOs shared 1155 links. In 2006 the number of NGOs

had fallen to 25 websites with 2445 inbound links among them with environmental NGOs websites receiving 1,905 while ten industrial NGOs received 540. In 2005 the NGO with the highest number of inbound links (425) was The Pembina Institute, a Canadian environmental policy research institute that monitors the federal government's policy activity and educates policy makers and the public on the environmental issues. In 2006 the International Institute for Sustainable Development, a Canadian policy research organization that facilitates dialogue concerning corporate leadership and best practices among industry, government and NGOs received the largest number of in-links (916). None of the major United State's conservative think tanks identified by McCright and Dunlap (2003) as defining "global warming as non-problematic" (349) were represented in the Canadian climate change VPN.

## **Conclusion**

Virtual policy works are produced by real world web-enabled policy communities that publish policy information in web-based environments. Studying the organization of web-based policy information published by technologically-enabled policy communities provides new insight into the use of web-based policy information on policy making and governance. Lazer (2001) has suggested that studies of the international regulatory regimes be expanded from the traditional cooperation and competition approaches to include informational interdependencies in which the production and dissemination of critical policy activities guides decisions and conditions innovation. Virtual policy networks represent such information interdependences as human systems of communication and organization intersect with the link structure of the Web.

The Web hosts a massive repository of information pertaining to policy information created by a collection of individual contributions, with each latent human decision affecting the cumulative content of the information supply. These human communication patterns are stamped on the subgraph of the Web providing a networked portrait of individuals' and institutions' relational contexts. As the relational contexts of VPNs are premised on topical affiliation, the potential for research using this method is infinite. However limitations do apply. The results reported in this project are expressed cautiously so to dissuade generalizations, as the study of web-based information network remains sparse. One of the key limitations is that the networks studied here are snapshots of the VPN structure and membership on a particular moment in the domain's history. The web is extremely dynamic and the particularities of VPNs variable as membership varies, issue saliency changes and international influences ebb and flow.

Policy research using hyperlink analysis remains meager; nonetheless, the approach has a great deal of potential in expanding our understanding of the Web's influence on policy making and policy communities. This project has explored various aspects of the Canadian climate change virtual policy network. Policy activity is clearly occurring on the Web however the types of activities and the implications for government, policy making and democratic participation are unclear. For example, if policy learning is occurring on the Web, which most research would support, then how does the supply of policy information affect policy development and public opinion. Alternatively, should government attempt to become central in VPN so as to govern this information? Conversation concerning democracy online would also profit from analyzing whether such networks expand opportunities for participation or simply replicate the existing relationships of power.

## Endnotes

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- 1 The author is grateful for the insights and suggestions of Joe Muldoon and Adam Mills and for the valuable comments provided by the Journal's anonymous reviewers. Finally, this research would not have been possible without Richard Rogers and the govcom.org foundation in Amsterdam, which provided the author with access to the *Issue Crawler* engine.
- 2 The Web's hyperlink structure produces various properties associated with the connections between webpages and hypertext such as the path links follow, the content of pages and how content is linked. In this project the subgraph of the web or the web graph refers to the structure of connectivity that is produced by studying a set of webpages sharing link
- 3 Internationalization refers to the process through which foreign policy actors participate in domestic policymaking arenas and influence policy outcomes (Coleman and Perl 1999).
- 4 The Web's hyperlink structure, also known as the web graph, produces various properties associated with the connections between webpages and hypertext such as the path links follow, the content of pages and how content is linked. In this project the subgraph of the web or the web graph refers to the structure of connectivity that is produced by studying a set of webpages sharing links.
- 5 A summation of all inbound links received provided the analysts with a webpage's indegree.
- 6 The organization of hyperlinks is a network property, as opposed to an individual attribute of an actor.

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