Climate Change Subsystem Structure and Change: Network Mapping, Density and Centrality

Kathleen McNutt

Johnson-Shoyama Graduate School of Public Policy, University of Regina. E-mail address: Kathy.McNutt@uregina.ca

Abstract. Policy capacity in web-based settings is largely the product of nodality, which provides centralized actors with enhanced opportunities to detect information and affect behavior. This paper examines four Canadian virtual policy networks (VPN) currently facing policy challenges associated with climate change adaptation including finance, infrastructure, transportation, and forestry. The four sectors each face specific types of challenges that will presumably influence government's policy capacity to respond to climate change adaptation, which in turn will affect the state's nodal positioning in the VPNs. At the macro level governing capacity will vary considerably among these sectors with some more able to affect social behavior and evidence-informed learning, while others will struggle to lead policy discourse and development. It is hypothesized that the Canadian federal government's nodality, which is shaped by both reputational capital and information credibility, will also be influenced by the nature of actors involved and the degree to which the VPN is internationalized.

Keywords. Virtual Policy Networks, Nodal Governance, Policy Capacity. Climate Change Adaptation

Résumé. La capacité d'élaboration des politiques publiques dans le cadre du Web est en grande partie le produit de la nodalité, qui procure aux acteurs centralisés des opportunités accrues pour trouver de l'information et influencer les comportements. Cet article se penche sur quatre Réseaux Virtuels de Politiques Publiques (RVPP) qui font actuellement face à des défis de politiques publiques liés à l'adaptation au changement climatique, notamment dans les secteurs de la finance, des infrastructures, du transport et de la sylviculture. Chaque secteur se trouve confronté à des défis spécifiques qui vont vraisemblablement influencer la capacité gouvernementale d'élaboration des politiques publiques pour répondre à l'adaptation au changement climatique, ce qui va à son tour affecter l'emplacement nodal de l'État dans le RVPP. Au niveau macro, la capacité de gouverner va varier considérablement dans ces secteurs, dont certains seront mieux à même d'influencer les comportements sociaux et l'apprentissage fondé sur des connaissances factuelles, alors que d'autres lutteront pour mener et conduire le discours politique. L'hypothèse retenue ici est que la nodalité du gouvernement fédéral canadien, façonné par son capital en réputation et la crédibilité de son information, sera aussi influencé par la nature des acteurs impliqués et le degré d'internationalisation du RVPP.

Mots clefs. Réseaux virtuels de politiques publiques, gouvernance nodale, capacité politique, adaptation au changement climatique

Introduction

Can government achieve its intended policy outcomes? This is a big question that has attracted a great deal of attention in recent years. Policy capacity is a function of both policy analytic capacity and governing capacity with the ability to learn and coordinate key requisites for managing policy change. The development and sustainment of high levels of public sector policy capacity is vital to achieving government's intended outcomes and circumventing negative impacts that could result in policy failures (Howlett 2009b). Low levels of policy capacity have been a recurrent theme in Canada at both the national and subnational levels with modern governance arrangements becoming more complex, particularly in policy areas that are cross-sectoral and multi-

level (Howlett and Lindquist 2004; McArthur 2007). Climate change is one of the most illustrative examples of this new governance environment with multiple interests producing a complex policy advice system (Howlett and Oliphant 2010). While organizational mandates concerning government's response to climate change adaptation have increased, policy capacity has not kept pace with demand (Wellstead et al. 2011).

In the future, governments will require high levels of policy capacity to respond effectively and strategically to climate change adaptation. From a national perspective the scale and diversity of climate change policies are enormous with the capacity to alter society's behavior dependant on the ability to alter individual belief systems and coordinate competing interests from across jurisdictions and between

sectors. In addition, globalization and international interde-pendencies operate as powerful influences on national government's climate change adaptation priorities with international actors and organizations shaping domestic policy making processes. Decision makers' fears of policy failure are common as coordination across multiple levels of governance systems slows climate change policy development and implementation processes (Rabe 2007). To make matters worse, there is concern that the Canadian public service lacks the policy analytical capacity to engage in the types of evidence-informed [1] learning necessary to address such wicked problems as climate change adaptation. This policy analytic deficit is particularly acute at the provincial and regional levels (Howlett and Joshi-Koop 2010; Wellstead et al 2009).

To combat this lost capacity governments are increasingly relying on network arrangements that facilitate learning and resource exchange. Years of scholarship on Canadian policy networks combined with several established social network principles provide a basic taxonomy of variables that would impact policy capacity (Atkinson and Coleman 1992; Coleman and Skogstad 1990; Montpetit 2003). At the level of the network, policy capacity is a function of macro-level governance structure with the capacity to coordinate determined by such system wide properties as permeability (closed vs. open), clustering (advocacy coalitions), and density (information volumes) (Howlett 2000; Howlett and Rayner 1995; Laumann and Knoke 1987). At the level of the network actor, capacity is a function of resource exchange (strength of ties), centralization (nodality) and geographic /organizational scale (internationalization/ federalism) (Burt 1980; 1992; Granovetter 1973).

Of all these network properties nodality is the most significant indicator of governing policy capacity (Hood and Margetts 2007; McNutt and Rayner 2012). Nodality is the property of being centrally located in the network with centralized actors better able to detect information and affect behaviour providing nodal actors with more opportunities to shape network outcomes (Hood 2007). A centralized network position confers power, as actors that are nodal have more access to network resources, more opportunities for exchange and a greater influence on how information flows through the network (Borgatti and Cross 2003; de Sola Pool and Kochen 1978). Numerous actors are engaged in Canadian climate change policy including the national government, fourteen sub-state governments, cities and municipalities, industry, advocacy groups, First Nations, researchers, think tanks and many more with an enormous amount of policy analytic advise being supplied into the network. [2] The impact of this supply will however be uneven across sectors as government ability to coordinate the network to facilitate information exchange and learning is variable.

Virtual policy networks (VPNs) are web-based networks with structural configurations produced by hyperlink connections between websites (McNutt 2010). VPNs are the product of policy actors publishing information online and linking their information to a target site that is relevant to the host's content. On the Web, government's capacity,

including the ability to disseminate information, undertake web-based education campaigns and market policy ideas and new programs is shaped by the extent to which the state is nodal in virtual settings (Escher et al. 2006). A policy actor's online influence is measured by its relative popularity in the VPN with websites receiving a large share of inbound links having more influence over policy ideas and debates. If governments are able to strategically manage the policy information circulating within the network then they have greater control over the policy development process (McNutt and Rayner 2012). However, if governments are unable to effectively coordinate participants and facilitate collaboration among competing interest governments may experience a loss of nodality.

In this paper four Canadian VPNs currently facing policy challenges associated with climate change adaptation including finance, infrastructure, transportation, and forestry are analyzed. The four sectors each face specific types of challenges that will presumably influence government's policy capacity to respond to climate change adaptation, which in turn will affect the state's nodal positioning in the VPN. At the macro level governing capacity will vary considerably among these sectors with some more able to effect social behavior and evidence-informed learning, while others will struggle to lead policy discourse and development. It is hypothesized that the Canadian federal government's nodality, which is shaped by both reputational capital and information credibility, will also be influenced by the nature of actors involved and the degree to which the VPN is internationalized.

Nodal Governance

Policy capacity is a combination of policy analytic capacity and coordination capacity. Policy analytic capacity refers to the government's capacity to produce or collect information that may be used in the formulation and decision making processes (Howlett 2009c; MacRae 1991). This type of policy capacity has traditionally been characterized by a professionalized bureaucracy, advisory boards, and policy units within departments, and commissions—all providing policy analysis and advice. In Canada provincial governments tend to have lower levels of policy analytic capacity than the federal government (Howlett and Newman 2010; McArthur 2007). To combat the loss of public sector expertise, governments at all levels have begun to rely on collaborative network arrangements to replace lost knowledge and facilitate inter-jurisdictional, evidence-informed learning (Carpenter al. 2004). In contrast, governance capacity refers to the ability of an actor or a group of actors to take action to direct a social system's collective behavior. In this sense capacity refers to the ability to coordinate multiple competing interests in complex formulations of policy development. Network arrangements may either empower or impair governing capacity as the social structural organization of policy actors is variable between the international, national and regional levels and across sectors.

Policy capacity in a network context depends on both the structural configuration of actors and the volume of information circulating among those actors. Hood (1983) identifies four social resources governments use to direct policy outcomes by creating various incentives and disincentives: nodality, authority, organization, and treasury. Hood's (2007) model "divides policy instruments into those that are used for gathering information and those that are used for modification of behavior (two basic components of any control system) and then identifie[s] four basic social resources that are normally available to government for gathering information from its citizens and modifying their behavior" (2007, 129). Nodality refers to government's informational capacity and its ability to operate at the centre of informational networks. Authority denotes the state's official power and its authority to make laws and regulations. Organization is used to describe government capacity to act through the military, police, or bureaucracy. Finally, treasury refers to government's ability to tax and spend.

These four resources are often used in combination with different instrument mixes implemented in different policy sectors producing complex formulations. Still at the macro level, governance capacity involves detecting information and effecting behavior. Hood's model is particularly useful for evaluating governance capacity online, as it focuses on the government-society interface and does not include any analysis of internal government controls. The theory is free of institutional analysis and does not include administrative technology treating government as undifferentiated (Hood 2007). It allows analysts to capture broad trends by viewing 'government' as a force that acts upon the citizenry, and 'society' as an entity that responds to government. The trend towards network learning and organization have established nodality as a key governing instrument used to address increasingly complex formulations of policy processes often characterized by multi-stakeholder contexts, problems spanning across sectors, the expanded politicization of policy formulations, and the challenge of producing coherence between ends (policy goals) and consistency between means (policy instruments) (Howlett et al. 2009; Howlett and Rayner 2007).

Historically, most Western governments garnered control from their constitutions and national treasury expenditures, which led to predicable instrumental usages (i.e., tax, spend, and regulate). Today, placing the conceptual priority on the state and assuming that the state is able to control policy processes is a dangerous assumption. Being nodal confers influence by placing certain actors at the center of network where they have greater access to information and more opportunities to establish diverse relationships with other network actors (Burt 1992; Granovetter 1973). Operating from the centre of policy networks expands the nodal actor's capacity to collect information, affect behaviour and broker relationships among various policy actors. As nodality is a social resource that can be garnered by any actor in the network the state's vulnerability to competing players who may also posses the capacity to shape policy outcomes, behaviours and discourses (Burris, Drahos and Shearing

2005; Carroll and Carson 2003; Harris and Wood 2008). In other words, in network setting influence garnered through nodality is not derived from administrative authority but rather from reputational capital.

The capacity to adapt to climate change has been a major cross-government policy problem in Canada for national, provincial and local governments with spill-over effects and uncertainly surrounding outcomes and impairing strategic planning processes. At its core a government's capacity to formulate and implement successful climate change adaptation policy depends on the society-government interface and the opportunities available to alter social behavior towards more sustainable activities. The Internet and the Web are an important means to help government achieve such goals with government websites expanding the state's capacity to collect information and affect behavior. Governments should aim to have the most popular websites online in subject areas where governments have authority, spend money, provide information, or organize partnerships. As website popularity is based on the number of inbound hyperlinks received, government websites require high degrees of nodality to be effective. As Tobias Escher et al. (2006) suggest, the "greater a government's nodality, the more likely that it can use the dissemination of information alone to change societal behaviour, rather than resorting to the use of the more costly tools of authority, treasure or organization".

Virtual Policy Networks and Governing Capacity

Policy networks are key sites of idea production populated with various experts, key stakeholders, government officials and advocacy groups. Historically, in Canada, the public service has been a closed system with limited public participation and only moderate opportunities for democratic engagement. Today increased access to participation in the policy process combined with the ubiquity of information has created a plurality of expertise, with ideas coming from a wide variety of sources, including think tanks (Abelson 2007; Lindquist 1993), consultants (Spears 2007), academics (Borins 2003; Cohn 2007), and advocacy groups (Stritch 2007). Although the constitution of these relationships is diverse, there is a tendency to favour informal policy networks that incorporate participants from various intergovernmental, private, and not-for-profit sectors (Johns, O'Reilly, and Inwood 2007; Wellstead and Stedman 2007).

Despite its short history the Internet and Web have fundamentally changed politics and public policy with all of government's traditional partners and stakeholders using the Internet and the Web to supplement their day-to-day activities, including their participation in the policy process (Margetts 2009). Governments host massive websites offering services, information, and direct communication opportunities (Borins et al 2007; Roy 2006). Politicians use websites and email lists to campaign and communicate with constituents (Bimber and Davis 2003). Policy research institutes and think tanks are becoming increasingly virtual, expanding their audience bases and influence as they be-

come proficient in building a web presence (McNutt and Marchildon 2009). Open-access journals and other online academic publishing venues increase accessibility to policy related research and expand the impact of scholarship (Hajjem et al 2005; Swan and Brown 2004). Interest groups use the Internet to organize various types of activism while nonprofit organizations use their web presence to serve clients, elicit donations and call for volunteers (Eagleton-Pierce 2001; Waters 2007). Financial institutes and private firms are using the Internet for everything from improved supply chains to new retail markets (Baily and Lawrence 2001). In other words all of the usual policy suspects active in the policy process are present in virtual policy making settings.

Virtual policy networks are issue specific networks created by Web-enabled policy actors whose political organizational forms have been recreated online (McNutt 2006; Rethemeyer 2007; van den Bos 2006). These communities of websites tend to mimic the behavior of informal coordination networks engaged in policy-related information exchange (Elmer 2006; McNutt 2010; McNutt and Wellstead 2010). Previous studies on the state's governing capacity in VPNs demonstrate that the ability to coordinate network participants and the volume of state provided information available across sectors is highly variable[3] (McNutt 2012; McNutt and Rayner 2012). In terms of coordination thousands of webpages focused on specific policy issues or sectors exist on the Web; however, only a limited number of these issue specific webpages will be interconnected in a meaningful way.

As in any policy network both the composition of actors (nodal attributes) and the relational context (structural configuration) among these actors will influence governance capacity (Provan and Kenis 2008; Wasserman and Faust 1994). The relational context of the network will shape the level the diversity of information in the network with centralized actors more able to promote particular solutions to policy problems (Borgatti 2005; Freeman 1979). The composition of actors may range from highly centralized networks with a lead organization driving agendas to intergovernmental networks where governance is shared, to interest group coalition where power is dispersed (Koliba et al. 2011).

Network centrality is a key operational concept in policy network analysis as it explains "the social or political structure of policy making and, second, it is assumed to be a relevant factor for the policy outcomes that networks produce" (Brandes, Kenis and Wagner 2003, 242).

Macro-level network governance structures produced by virtual policy networks are studied by analyzing VPNs hyperlink structure. The Web provides an ideal laboratory to measure governance capacity as it is a network comprised of webpages (nodes) connected through hyperlink (ties) with associational relationships determined by source webpages creating links to target webpages. The presence of a hyperlink is a strategic decision reflecting 'a communicative choice made by the designer' (Jackson 1997, 9). The utility of hyperlinks enables Web authors to connect their webpage (source) with other webpages (targets) providing the electronic capability for the sharing of web content (documents, pictures).

As Hindman, Tsioutsiouliklis and Johnson (2003) have shown the "the visibility of a site within an online subcommunity is largely a function of the number of inbound hyperlinks it receives" (3) with inlinks acting as an endorsement of a website's content and increasing site visibly and credibility simultaneously (see also Cugelman et al. 2008). These hyperlinked collections of pages possess many network properties with the organizational, thematic, and structural features of link information used to analyze policy actors' organization, behavior and modes of governance (Park and Thelwall 2003).

Macro-Level Capacity in Virtual Policy Networks

To measure governing capacity on the Web is to measure the capacity governments have to influence policy development. Climate change represents a significant threat to national and sub-national governments and has shifted organization mandates significantly in recent years affecting both governance capacity and offline policy networks configurations. In this project four sectoral responses to climate change adaptation are analyzed including finance, forestry, infrastructure, and transportation. Previous research on the affects of climate change policy on different sectoral VPNs has shown that in Canada the federal government is typically nodal yet levels of internationalization, density and centralization vary considerably (McNutt 2008; McNutt 2010). However as Petricek et al. (2006) warns, state nodality cannot be assumed as competition from other actors and institutions may decrease governments' web-based capacity. While traditional governance was embedded in hierarchal control, nodal governance is leveraged through reputational capital.

The four sectors analyzed are expected to demonstrate changing governance context as multi-level stakeholder interests shift nodal positioning and power distribution. While much of the Canadian federal government's capacity to effect domestic policy development in the area of climate change is determined by its jurisdictional authority and willingness to invest in national initiatives, inter jurisdictional competition over policy goals and the influence of international actors on domestic climate change agenda will also shape capacity levels. The policy network analysis undertaken in this project applies simplified principles of social network theory to study relational data among websites. This project considered three key variables: density, centralization, and levels of internationalization. Density and centralization are quantitative structural network variables (Wasserman and Faust 1994). Density measures levels of network integration, and in the case of VPNs, the volume of information in each network. Centralization refers to the influence of the most connected node in the network as compared to the influence of all other nodes. Finally internationalization is a qualitative measure that examines the geographic

composition of actors to analyze who is influencing the network.

As shown in Figure 1 it is theorized that VPNs with high levels of density and high levels of centralization are the product of established governance arrangements that produce consensus around goals requiring only nominal additional organizational capacity to address climate change adaptation. In networks where centralization is high and density low, a lead organization is typically driving the agenda.

In instances where centralization is low yet density high, the federal government typically lacks the capacity to govern effectively as competing goals and a lack of consensus undermines federal authority. These are typically networks where consensus may exist but the capacity to coordinate preferences is weak. Finally in VPNs with both low levels of density and low levels of centralization, additional capacity is required as government is not able to coordinate activities.

In addition to these structural properties, some VPNs tend to be highly internationalized with large international organizations or other national governments controlling policy discourse (McNutt and Pal 2011, McNutt and Rayner 2012). As such, additional qualitative consideration must be given to the nodality of the federal government more generally, and the lead federal department specifically. Even in networks where density and centrality are high, if the nodality of the Canadian government is low we can assume additional organizational resources are required.

Figure 1
Subsystem Structures and Capacity: Theory One

		Density	
		Increases	**Stable or Decreases**
Centrality	**Increases**	Stable – May require little additional organizational capacity	Enhanced – May have capacity surplus
	Stable or Decreases	Require additional capacity	Require additional capacity

Network density, the networks volume of information, is determined by calculating the entire population of potential ties ($n(n$-1) where n=all nodes) as compared to the actual population of unidirectional links ($m/n(m)$, where m= set of all edges or links). Centrality identifies those actors in the network with the most influence over formal relations and the greatest access to network resources. Network centrality is calculated through a summation of all inbound links received by an individual node divided by the number of inbound links received by the most linked to website (($k_{(max)}$)/∑m, where $k_{(max)}$= the node in the network with the highest in-degree and ∑m = the aggregate summation of all inbound links). The network's level of internationalization is measured as the aggregate sum of all links contained in the VPN pointing towards a target website that does not originate from Canada and is not associated with Web 2.0.[4]

To determine (1) what quadrant a sector falls into; (2) what level of change has already occurred in the sector and (3) if additional organizational resources are required data for each of the four VPNs was collected in May 2010 and again in May 2011. Based on the activities and governance arrangements characterizing the four sectors, it is hypothesized that these four VPNs will mimic the behaviors of their respective offline policy networks. As the federal government has lead agencies advancing national policy initiatives in these fields, federal web-based nodality in all of these sectors is predicted to be relatively high. However, considering the complex global nature of climate change adaptation policy, we can also expect competing Web content produced by provincial governments and non-domestic actors, which could serve to decrease government nodality. The four sectors are hypothesized to fall into the quadrants set out in Figure 2.

Figure 2
Subsystem Structures and Capacity Empirics

		Density	
		Increases	**Stable or Decreases**
Centrality	**Increases**	Infrastructure	Finance
	Stable or Decreases	Transportation	Forestry

It is assumed that VPNs characterized by lower levels of centralization are less coordinated suggesting greater capacity in the sector may need to be developed. It is hypothesized that the infrastructure and climate change VPN will be increasing in terms of both density and centralization, while the transportation and climate change VPN's centrality will be stable or decreasing while its centrality is increasing. Alternatively the finance and climate change VPN is predicted to have increasing centrality and decreasing density, while the forestry and climate change VPN should be decreasing in both density and centralization.

Methodology

Data collection in this project was achieved using *IssueCrawler*, an innovative Web analysis package designed to map issue spaces and made available to the academic community for the explicit purpose of producing social science research in a collaborative environment (Rogers 2006). *IssueCrawler* is used to generate raw data, provide adjacency matrixes, and create network visualizations. *IssueCrawler* uses a specific algorithm designed to crawl through the Web's link-structure, extracting informative links that are recorded in a large database. Using an adjacency matrix to determine centrality, tie strength, and connectedness, the data capture algorithm is designed to determine a ratio for each source point and provide a weighted ranking. The engine is a topic-specific crawler that collects relevant hyperlinks from webpages hosting content on a particular subject.

To locate a network the researcher enters a set of seeds (URLs) into *IssueCrawler,* which then maps the Web graph from the outgoing links. In this project initializing nodes were gathered from a Google search for top-level domains in the area specified with the top returned Web addresses acting as the starting points for mapping each network.

After the seeds have been entered into the engine, *IssueCrawler* begins tracing the network by following several layers of outgoing links with the organization of hyperlinks determining which sites are visited and the course the crawl will take. Once the parameters of the Web space are determined and unrelated links discarded, a second iteration occurs mapping the network through co-link analysis. As Bruns (2007) explains, co link analysis "identifies sites which are linked to by at least two of the starting points and which can therefore be considered to be at least part of a loosely interconnected network of Web sites." In the information sciences the principles of link-structure research are often based on citation and reference style analysis, which is ideal for studies that seek to study how inbound and outbound links compare, and what these networked exchanges reveal about formal relations among actors. Co-link analysis however does not assume direct exchange is necessary for inclusion, but instead is premised on networked relations that recognize not all participants are aware all other network actors. In the case of *IssueCrawler* "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" (McNally 2005, 3011).

IssueCrawler also provides a network rendering using Scalar Vector Graphics (SVG), a standard for two-dimensional graphical representations. The data elements included in the graphical renderings include the size, position, and colour of the nodes. The size of the node is determined by the observed frequency of inbound links. While the size of an actor's representative node is determined by the quantity of links received from the crawled population, the placement of the node is determined by which websites share the most number of hyperlinks. Dominant flows are mediated by the distance between nodes and the direction of the arrow. The larger distance the weaker the flow of information. Each node is coloured according to its domain name allowing for fast identification of national and internationalized policy actors, and the extent to which commercial interests are active in policy communities. Some maps also include a sample measure, which refers to the number of pages visited to generate the VPN.

Each of the four networks was initially crawled in April and May 2010 and then again one year later. For each crawl 15 initializing URLs were gathered from the top ranked list returned from a Google string search in the policy field under investigation. For example the top 15 domains returned on a Google search for foresty+climate change+Canada acted as the initializing seeds for the forestry and climate change network with the same approach applied to the other three policy areas. The seeds were all limited to webpages originating from Canada to ensure that the crawl represented the specific national context under investigation. *IssueCrawler*

provided data on the total number of inbound links the network received and the total number of webpages the crawler visited (the sample), and reported all the websites included in the network and the number of inlinks the websites received from the crawled population. The basic structural data is provided in Table 1 (See Appendix E).

Results

Finance

It was hypothesized that the finance and climate change VPN would have increasing centrality and stable or decreasing density. This hypothesis was refuted as the VPN increased in both density and centralization as can be seen in Table 2. In addition, the VPN became smaller which was a trend across all the networks analyzed.

Table 2
Finance and Climate Change VPN

	2010 VPN	2011 VPN
Number of Actors	73	39
Total number interlinkages	791	432
Centralization	.05	0.12
Density	0.15	0.29
Internationalization	0.21	0.08
Government of Canada Nodality	0.06	0.13
Finance Canada	0.03	0.02

International actors and organization were strongly represented in the 2010 VPN, as can be seen in Table 3 with 163 links pointing to websites hosted by non-Canadian actors (Appendix A). For the most part these actors were comprised of international organizations such as the World Bank (19 inlinks), International Organization of Securities Commissions (19 inlinks), Organisation for Economic Co-operation and Development (OECD) (14 inlinks), International Monetary Fund (IMF) (13 inlinks), World Trade Organization (10 inlinks), UN Development Programme (7 inlinks), UN Environment Programme and so forth. The United States also had a presence in the VPN, with the US Securities and Exchange Commission receiving 13 inlinks and the US Department of Treasury receiving 5 inlinks. Professional associations and boards were also represented, including International Federation of Accountants (9 inlinks), the International Accounting Standards Board (8 inlinks), the North American Securities Administrators Association (8 inlinks), the International Association of Insurance Supervisors (7 inlinks), and the Financial Stability Board (6 inlinks). The UK Financial Services Authority and the Asian Development Bank were also present in the network. In the 2011 VPN the volume of international hyperlinks dropped significantly to a total of 36, with the Intergovernmental Panel on Climate Change receiving 12 inlinks, the UN Framework Convention on Climate Change receiving 8 inlinks, the OECD receiving 6 inlinks and the US Environmental Protection Agency receiving 4 inlinks. [5]

Provincial participation in the VPN in 2010 was moderate with combined provincial government inlinks totaling 92 which accounted for only 11.6% of all interlinkages in the network. In addition, not all provincial governments were represented with the British Columbia Securities Commission and the Saskatchewan Financial Services Commission each receiving 13 inlinks, while the Government of the Yukon, the Government of Nova Scotia, the Alberta Securities Commission and the Manitoba Securities Commission received 12 inlinks, the Government of Prince Edward Island receiving 11 while the Yukon's Department of Community Services received 7 inlinks. In 2011 provincial inlinks were considerably diminished to 3% with only the Government of British Columbia (7 inlinks) and the Ontario Ministry of Environment (4 inlinks) represented in the VPN.

Forestry

It was hypothesized that the forestry and climate change VPN would have stable or decreasing centrality and stable or decreasing density. This hypothesis was refuted as density actually increased by 0.09, while centralization decreased as seen in Table 3.

Table 3
Forestry and Climate Change VPN

	2010 VPN	2011 VPN
Number of Actors	72	56
Total number interlinkages	772	745
Centralization	0.07	0.05
Density	0.15	0.24
Internationalization	1.9%	86.4%
Government of Canada Nodality	0.40	0.02
Natural Resources Canada *	0.10	0.03

* In the case of the lead organization the inlinks received by Natural Resources Canada and Canadian Forest Service, an NRCAN agency were combined.

In the 2010 VPN various provincial governments were represented with the aggregate sum of provincial inlinks equaling 9% of the total (Appendix B). The Government of British Columbia was by far the most influential with 35 inlinks, followed by the Government of Prince Edward Island with 8, the Governments of Manitoba, Nova Scotia and the Yukon each with 7, and the Government of Saskatchewan with 6. The only province with a presence in the 2011 VPN was British Columbia with 7 inlinks suggesting the provinces have lost extensive macro level capacity on the Web in terms of governance.

Levels of internationalization in the forestry and climate change VPN grew dramatically from 2010 to 2011. In the first crawl the Engineered Wood Association, the American Forest & Paper Association, the Louisiana-Pacific Corporation and the Intergovernmental Panel on Climate Change were the only actors with a network presence. In the second crawl in 2011 however, the network becomes captured as international organizations take over and dominate network participation. Indeed almost every international organization associated with climate change adaptation initiatives is present including the United Nations and its Environment Programme, Framework Convention on Climate Change, Food and Agriculture Organization, Development Programme System of Organizations and many more. In addition a number of websites dedicated to specific conventions are also present such as the Convention on Biological Diversity Convention on International Trade in Endangered Species, the Ramsar Convention on Wetlands, and the Convention to Combat Desertification. There was also a strong presence from the Intergovernmental Panel on Climate Change, the Global Environment Facility, the World Trade Organization, the International Labour Organization and International Monetary Fund. Indeed the only national actors that retained a presence in the 2011 VPN were Natural Resources Canada with 16 inlinks, the Government of Canada with 13 inlinks, Canadian Forest Service with 7 inlinks and Parks Canada with 5 inlinks.

Infrastructure

It was hypothesized that the infrastructure and climate change VPN would have increasing centrality and increasing density. This was confirmed as can be seen in Table 4.

Table 4
Infrastructure and Climate Change VPN

	2010 VPN	2011 VPN
Number of Actors	65	41
Total number interlinkages	761	679
Centralization	.08	0.10
Density	0.17	0.41
Internationalization	4%	2%
Government of Canada Nodality	0.08	0.10
Infrastructure Canada	0.01	0.01

In the 2010 infrastructure and climate change VPN, provincial governments were well represented including British Columbia (26 inlinks), Nova Scotia (10 inlinks), Northwest Territories (9 inlinks), Newfoundland (9 inlinks), Nunavut (9 inlinks), Prince Edward Island (8 inlinks), Yukon (8 inlinks), Saskatchewan (7 inlinks), Ontario (6 inlinks), Manitoba (6 inlinks), New Brunswick (6 inlinks), and Alberta (6 inlinks). In total the aggregate of all inlinks received by provincial governments' main websites was 14% of total links in the network. Municipal organization was also present in the VPN including the Federation of Canadian Municipalities with 12 inlinks, Union of British Columbia Municipalities with 8, and Fraser Basin Council with 6. British Columbia was particularly well represented with a variety of different government sponsored sites in the network including BC Ministry of Community and Rural Development and Ministry of Transportation and Infrastructure, Civic Info BC, Government of British Columbia-Waterbucket, BC Hydro, BC Water and Waste Association and BC Transit. In the 2011 VPN the aggregate inlinks received by provincial governments' main websites was 11% which was a slight drop, but still includes the Government of British Columbia (12), Government of the Northwest Territories (11), Government of Nova Scotia (9), Government of Prince Edward Island (9),

Government of Saskatchewan (9), Government of the Yukon (9), Government of Newfoundland and Labrador (8) and the Government of Nunavut (7). The over representation of BC websites did not characterize the 2011 VPN, nor were any municipal representatives retained.

The level of internationalization in both the 2010 and 2011 VPNs was very low, with the Intergovernmental Panel on Climate Change (19) and UN Framework Convention on Climate Change (14) receiving inlinks in 2010, while in 2011 only the Intergovernmental Panel on Climate Change (9) was included in the VPN (Appendix C).

Transportation

It was hypothesized that the transportation and climate change VPN would have stable or decreasing centrality and increasing density. This was confirmed as can be seen in Table 5.

Table 5
Transportation and Climate Change VPN

	2010 VPN	2011 VPN
Number of Actors	66	47
Total number interlinkages	719	536
Centralization	0.11	0.09
Density	0.17	0.25
Internationalization	52%	71%
Government of Canada	0.05	0.04
Transportation Canada	0.03	0.01

Aggregate provincial government inlinks accounted for only 4% with the Government of Ontario, Government of Prince Edward Island and the Government of Saskatchewan each receiving 5 inlinks, while Transports Quebec and the Ontario Ministry of Transportation received 6 each. The Federation of Canadian Municipalities also received 10 inlinks from other network participants. In the 2011 transportation and climate change VPN there was absolutely no provincial or municipal representatives.

In terms of internationalization the transportation and climate change VPN was highly internationalized with 52% of inlinks in 2010 and 71% of inlinks in 2011 pointing to non-Canadian content. In the 2010 VPN the non-North American content were largely comprised of international organizational websites such as Intergovernmental Panel on Climate Change (17 inlinks), UN Framework Convention on Climate Change (14 inlinks), UN Environment Programme (12 inlinks), OECD (11 inlinks), UN Climate Change Conference 2009 (11 inlinks), The World Bank (9 inlinks) and the International Energy Agency (7 inlinks). The UK Transport Research Laboratory (7) and the Asian Development Bank (9) were also present in the network. The American inlinks was also high with the US Department of Transportation (28 inlinks) the second most linked to site in the VPN while the US Government Web Portal (24 inlinks) was the third most linked to website. In addition, numerous other American government sponsored websites were present including the Whitehouse (24 inlinks), Bureau of Transportation Statistics

(15 inlinks) US Environmental Protection Agency (10 inlinks) and many more.

In 2011 the VPN was again heavily influenced by the United Sates with 35% of linkages pointing towards an American Government host. The US Department of Energy was the most nodal actor, receiving 47 inlinks, followed by United States Government main websites in the number two spot with 22 inlinks while Intergovernmental Panel on Climate Change was number three with 21 inlinks. The California Energy Commission was the only state sponsored website present in the 2011 VPN. Again international organizations had a strong presence receiving 36% of all inlinks in the network including the aforementioned Intergovernmental Panel on Climate Change (21), the UN Environment Programme (20), UN Framework Convention on Climate Change (17), The World Bank (14), the International Atomic Energy Agency (10), the International Energy Agency (9) and many more (Appendix D).

Discussion

Having the policy capacity to deal with the realities of climate change adaptation will require that governments are able to both learn and coordinate across multilevel and cross sectoral network governance arrangements. Policy networks are typically described as constellations of inter-organizational actors working together in various types of policy processes. As Weible and Sabatier (2005) contend, the most common rationale for policy network formation is "the exchange of information and advice related either to substantive policy issues or to policy efficacy" (181). Policy networks vary considerably with participants often spanning sectors and levels of government. Virtual policy networks are a type of policy network where the activities of offline network actors are reproduced in online environments. While previous VPN studies suggest that these online networks do imitate offline network behaviors, there are also several critical differences associated with virtual settings.

Traditional policy network analysis treat nodes as 'actors', while nodes in virtual policy networks are websites that might represent an individual person, an organizational, a government initiative, an event, and so forth. Second, various web applications such as Adobe are critical hubs that are present everywhere online, and thus are almost always present in VPNs. Ideally these nodes would be removed, which is often done in VPN analysis; however, removing actors changes the organization and graphing of the nodes and consequentially the visual rendering. As such, for this project these websites have been included which has not fundamentally changed the network structure.

It should also be noted that there is a growing presence of social networking sites in VPNs, with the consequences of these new websites largely unknown. Social media sites cannot be treated as an undifferentiated network actor with Facebook, for example, currently hosting over 6 million active members. Yet Twitter,[6] for example, was present in all four 2011 VPNs analyzed, while Facebook ranked fairly highly in the 2011 forestry and climate change VPN with

numerous inlinks coming from environmental advocacy Facebook pages. Research examining the implications of this content in VPNs is only in the preliminary stage; however, there is some evidence that suggest that much of this social media can be treated as the online influence of civil society (Castells 2008).

There are also a number of collaborative and intergovernmental websites that represented established offline network relations. For example Canada's Wood Works is a national collaborative initiative lead by the Canadian Wood Council with funding from industry, the federal government and the provinces with a mandate to 'increase the use of wood in commercial, industrial and institutional construction.' This website represents a substantive example of the interdependencies characterizing the network and the difficulty sometimes associated with classifying such websites as 'actors'. The Western Climate Initiative was another common example of a collaborative website that represented several key actors engaged in a shared policy initiative.

The four sectors used in this study were selected because each faces long-term climate change challenges, and it was assumed that overlapping jurisdictional authority and varying governing capacity levels would influence the structural configuration of the VPNs in terms of density, centralization and internationalization. Four key hypotheses were tested 1) increased centrality and decreased density in the finance VPN; 2) decreased density and centralization in the forestry; 3) density and centralization would increase in the infrastructure VPN; 4) centrality would stabilize or decrease while centrality increased in the transportation VPN. Two of these hypotheses were confirmed (infrastructure and transportation) while two were refuted (finance and forestry). In the case of the forestry VPN the federal government suffered a large net loss of nodality receiving 40% of all in bound links in 2010 and only 2% in 2012, while at the same time the level of internationalization increased by 85%. This would suggest that the federal government's lost nodal positioning is a major loss of capacity. In the case of the finance VPN centrality did increase; however, density also went up which was not expected.

Indeed the results suggest that density is increasing dramatically across all four sectors analyzed here with volumes of information concentrated among fewer actors. Another phenomenon was the degree of network decay that occurred between 2010 and 2011 with the finance VPN contracting 34 nodes, the forestry VPN losing 16 nodes from 2010 to 2011, the infrastructure VPN losing 24 nodes while finally the transportation VPN lost 25 nodes (see Table 1), which leave us with the question of why the networks are getting smaller. This may suggest that the climate change policy sector is increasingly closed off with established advocacy coalitions controlling network behavior.

One possible hypothesis that might explain this change in the network nodal size and density is that the overlapping authority among government actors has actually produced a closing off of engagement opportunities so as to align goals more efficiently. As Provan and Kenis (2007) suggest, shared governance arrangements, and in particular horizontal coor-

dination, often require high levels of trust with network membership purposefully limited in order to produce consensus and coherence. There is thus the possibly that were once 'issue networks' as articulated by Heclo (1978) are transforming into more formalized network structures (Coleman and Skogstad 1990), a process described by Rhodes (1997).

Across all four networks the nodal position of most lead departments is rather weak. In the finance and climate change VPN Finance Canada has a nodal degree of only 0.03 in 2010 and 0.02 in 2011. In the infrastructure and climate change VPN, Infrastructure Canada had a nodal degree of 0.01 in both 2010 and 2011. In the forestry and climate change VPN, Natural Resources Canada has a nodal degree of 0.10 in 2010 and 0.03 in 2011. In the transportation and climate change VPN, Transportation Canada had a nodal degree of 0.03 in 2010 and 0.01 in 2011. This is clear evidence that these lead departments, with the exception of NRCAN, are not coordinating the networks activities efficiently.

Across all four networks there was a core collection of actors that appeared in a majority of VPNS; however only the Government of Canada's main web portal was in every network. Indeed with the exception of the 2011 forestry and climate change VPN, the Canada Site was in the top five linked to websites in all the other crawls. Natural Resource Canada also appears in all the networks minus the 2010 finance and climate change VPN, while Environment Canada is present in the infrastructure, transportation and forestry VPNs. Websites for the Canada Economic Action Plan and the Budget were also included in a number of VPNs. The two most commonly included international websites were for the Intergovernmental Panel on Climate Change and the United Nations Framework Convention on Climate Change.

Macro-level governance arrangements are increasingly formed around network structures that facilitate learning and promote collaboration among competing interests. Nodality is one of the key social resources available to governments that seek to coordinate policy formulation across various sectors and scales. Strategies for increasing nodality are limited but are a fruitful area for future research. Studies into possible tactics for increasing the cumulative inlinks received or using websites to shape public perceptions will provide governments with new approaches to using the Web to govern policy processes and outcomes. Linking decisions in the context of policy activity would also improve the reliability and viability of using nodality as a measure of governing capacity. While current research does show that linking behavior is largely based on perceptions of information credibility and reliability, and on an organizational reputation and authoritativeness (Briggs et al. 2002; Wang and Emurian 2005), further analysis of policy-specific linking behavior will provide further precision for analyzing the effects of e-government on policy activity.

It is obvious that much research is still required in this area, including in-depth network analysis, comparative case studies, and large descriptive studies to establish standardized measurements. Ongoing monitoring of issue-specific

networks will provide some of the necessary feedback for the coordination and management of the state's presence on the Web. At the operational level, government capacity to identify and foster relationships with key policy players is vital to successful planning and development. At the institutional level, the evaluation of government activity in VPNs is a clear indicator of government capacity on the Web. In 2002, the United Kingdom's Auditor General advised that, "government organizations have to think creatively about increasing their 'nodality'" (217). Nodality is desirable both in terms of policy effectiveness and policy influence. Unlike studies that analyze the impact of individual websites on policy outcomes, nodality evaluates the macro-level capacity of government. Governments should seek to be nodal as public sector websites with high levels of nodality maximize government influence online (Escher et al. 2006; Hood and Margetts 2007) and increase the state's capacity to affect policy debates and shape policy preferences (Burris, Drahos and Shearing 2005; Kebonang 2008).

Bibliography

Abelson, Donald. 2007. Any Ideas? Think Tanks and Policy Analysis in Canada. In *Policy Analysis in Canada: The State of the Art*, ed. L. Dobuzinskis, M. Howlett, and D. Laycock. Toronto: University of Toronto Press.

Atkinson, Michael M. and William D. Coleman. 1992. Policy Networks, Policy Communities and The Problems of Governance. *Governance* 5(2):154-180.

Baily, Martin and Robert Lawrence. 2001. Do We Have a New Economy? *American Economic Review* 91(2): 308-312.

Bimber, Bruce and Richard Davis. 2003. *Campaigning online: The Internet in U.S. elections*. New York: Oxford University Press.

Borgatti, Stephen P. and Rob Cross. 2003. A relational view of information seeking and learning in social networks. *Management Science* 49(4): 432–445.

Borins, Sandford. 2003. From Research to Practice: A Survey of Public Administration Scholars in Canada. *Canadian Public Administration* 46(2): 243–256.

Borins, Sandford, Kenneth Kernaghan, David Brown, Nick Bontis, Perri 6, and Fred Thompson. 2007. *Digital state at the leading edge*. Toronto: University of Toronto Press.

Briggs, P., B. Burford, A. De Angeli, and P. Lynch. 2002. Trust in online advice. *Social Science Computer Review* 20(3): 321-332.

Bruns, Axel. 2007. Methodologies for mapping the blogosphere: An exploration using the *IssueCrawle*r Research Tool. *First Monday*. 12(5).

Burris, Scott, Peter Drahos, and Clifford Shearing. 2005. Nodal Governance. *Australian Journal of Legal Philosophy* 30:30-58.

Burt, Ronald. S. 1980. Models of network structure. *Annual Review of Sociology* 6(1): 79-141.

Burt, Ronald. S. 1992. *Structural holes: The structure of competition*. Cambridge, MA: Harvard University Press.

Carpenter, Daniel, Kevin, Esterling and David Lazer. 2003. The strength of strong ties a model of contact making in policy networks with evidence form U.S. health politics. *Rationality and Society* 15(4): 411-440.

Castells, Manuel, 2008. The New Public Sphere: Global Civil Society, Communication Networks, and Global Governance *The ANNALS of the American Academy of Political and Social Science* 616(1): 78-93.

Castells, Manuel. 2000. *The Rise of the Network Society*. 2nd ed. Massachusetts: Blackwell Publishers.

Cohn, Daniel. 2007 Academic and Public Policy: Informing Policy Analysis and Policy Making. In *Policy Analysis in Canada: The State of the Art*, ed. L. Dobuzinskis, M. Howlett, and D. Laycock. Toronto: University of Toronto Press.

Coleman, William D. and Anthony Perl. 1999. Internationalized Policy Environments and Policy Network Analysis. *Political Studies* 47(4): 691–710.

Coleman, William and Grace Skogstad, eds. 1990. *Policy Communities and Public Policies in Canada*. Toronto: Copp Clark.

Cugelman, Brian, Mike Thelwall and Phil Dawes. 2008. Website Credibility, Active Trust and

Behavioural Intent. *Lecture Notes In Computer Science* 5033: 47-57.

de Sola Pool, Ithiel and Manfred Kochen. 1978. Contacts and Influence. *Social Networks* 1(1):5–51.

Eagleton-Pierce, Mathew. 2001. The Internet and the Seattle WTO protests   *Peace   Review*. http://www.informaworld.com/smpp/title~db=all~content=t713441298~tab=issueslist~branches=13 - v1313(3): 331-337.

Elmer, Greg. 2006. Mapping the Cyber-Stakeholders: U.S. Energy Policy on the Web *The Communication Review* 9(4): 297-320.

Escher, T., H. Margetts, V. Petricek and I.J. Cox. 2006. Governing from the centre? Comparingthe nodality of digital governments. Prepared for delivery at the 2006 *Annual Meeting of the American Political Science Association*, Philadelphia August 31–September 4, 2006.

Grande, Edgar. 2001. The erosion of state capacity and the European innovation policy dilemma: A comparison of German and EU information technology policies *Research Policy* 30(6): 905-921.

Granovetter, Mark S. 1973. The Strength of Weak Ties. *American Journal of Sociology* 78(6): 1360- 1380.

Hajjem, C., S. Harnad and Y. Gingras. 2005. Ten-year cross-disciplinary comparison of the growth of open access and how it increases research citation impact. *IEEE Data Engineering Bulletin,* 28(4): 39-47.

Heclo, Hugh. 1978. Issues Networks and the Executive Establishment. *The New American Political System*. A. King, ed. Washington: American Enterprise Institute for Public Policy Research.

Hood, Christopher. 1986. *The Tools of Government*. Chatham: Chatham House Publishers.

Hood, Christopher. 2007. Intellectual Obsolescence and Intellectual Makeovers: Reflections on the Tools of Government after Two Decades. *Governance* 20(1): 127–144.

Hood, Christopher and Helen Margetts. 2007. *The Tools of Government in the Digital Age*. London: Palgrave.

Howlett, Michael. 2009a. A Profile of B.C. Provincial Policy Analysts: Troubleshooters or Planners? *Canadian Political Science Review* 3(3): 50-68.

Howlett, Michael. 2009b. Policy Analytical Capacity and Evidence-based Policy-Making: Lessons from Canada. *Canadian Public Administration* 52(2): 153–175.

Howlett, Michael. 2009c. Policy Advice In Multi-Level Governance Systems: Sub-National Policy Analysts And Analysis *International Review of Public Administration* 13(3): 1-16.

Howlett, Michael and Evert Lindquist. 2007. Beyond Formal Policy Analysis: Governance Context, Analytical Styles, and the Policy Analysis Movement in Canada. In L. Dobuzinskis, M. Howlett, and D. Laycock, eds. Policy Analysis in Canada. Toronto: University of Toronto Press.

Howlett, Michael and Sima Joshi-Koop. 2011. Transnational Learning, Policy Analytical Capacity, and Environmental Policy Convergence: Survey Results from Canada *Global Environmental Change* 21(1): 85–92.

Howlett, Michael and Josh Newman. 2010. Policy Analysis and Policy Work in Federal Systems: Policy Advice and Its Contribution to Evidence-Based Policy Making in Multi-Level Governance Systems. *Policy and Society* 29(1): 123–136.

Howlett, Michael and Samuel Oliphant. 2010. Environmental Research Organizations and Climate Change Policy Analytical Capacity: An Assessment of the Canadian Case. *Canadian Political Science Review* 4(2-3), 18-35.

Howlett, Michael and Jeremy Rayner. 1995. Do Ideas Matter? Policy Network Configurations and Resistance to Policy Change in the Canadian Forest Sector *Canadian Public Administration* 38(3): 382-410.

Howlett, Michael, M. Ramesh and Anthony Perl. 2009. *Studying Public Policy: Policy Cycles and Policy Subsystems* 3rd ed. Toronto: Oxford University Press.

Jones, Bryan D. and Frank R. Baumgartner. 2005. *The Politics of Attention: How Government Prioritizes Problems.* Chicago: University of Chicago Press.

Kebonang, Zein. 2008. Of international actors, nodal governance and the African Peer Review Mechanism *Africa Insight* 37(4): 98-107.

Laumann, Edward O. and David Knoke. 1987. *The Organizational State: A Perspective On National Energy and Health Domains.* Madison: University of Wisconsin Press.

Lindquist, Evert. 1993. Think Tanks or Clubs? Assessing the Influence and Roles of Canadian Policy Institutes. *Canadian Public Administration* 36(4):547-79.

MacRae Jr., D. 1991. Policy Analysis and Knowledge Use. *Knowledge and Policy* 4(3): 27–40.

Margetts, Helen. 2009. The Internet and Public Policy. *Policy & Internet* (1)1: 1–21.

McArthur, Douglas. 2007. Policy Analysis in Provincial Governments in Canada: From PPBS to Network Management. In *Policy Analysis in Canada: The State of the Art.* Edited by L. Dobuzinskis, M. Howlett and D. Laycock. Toronto: University of Toronto Press.

McNally, Ruth. 2005. Sociomics! Using the IssueCrawler to map, monitor and engage with the global proteomics research network. *Proteomics* 5(12): 3010–3016.

McNutt, Kathleen. 2012. From the Outside In: The External Face of e-Government. *The Journal of Information Technology and Politics. Forthcoming.*

McNutt, Kathleen. 2010. Virtual Policy Networks: Where all Roads Lead to Rome *Canadian Journal of Political Science.* 43(4): 915-935.

McNutt, Kathleen. 2008. Policy Actors on the Web: The Canadian Climate Change Virtual Policy Network. *Canadian Political Science Review* 2(1): 1-15.

McNutt, Kathleen and Gregory P. Marchildon. 2009. Think Tanks and the Web: Measuring Visibility and Influence. *Canadian Public Policy.* 35(2):219-236.

McNutt, Kathleen and Leslie A. Pal. 2011. Modernizing Government: Mapping Global Public Policy Networks. *Governance* 24(3): 439-467

McNutt, Kathleen and Jeremy Rayner. 2012. Nodality in Information Networks: A Discursive Institutionalist Account of Global Forest Governance in *The Diffusion of Authority.* Stefan Guzzini and Iver Neumann, eds. Palgrave. *Forthcoming.*

McNutt, Kathleen and Adam Wellstead. 2010. Policy and the Web: Forest and Climate Change Virtual Policy Networks. *Policy and the Internet.* 2(2): 33-59.

Montpetit, Éric, 2003. *Misplaced Distrust: Policy Networks and the Environment in France, the United States, and Canada.* Vancouver: UBC Press.

Parsons, Wayne. 2004. Not Just Steering but Weaving: Relevant Knowledge and the Craft of Building Policy Capacity and Coherence. *Australian Journal of Public Administration* 63(1): 43-57.

Petricek,V., T. Escher, I. Cox & H. Margetts. 2006. *The Web structure of e-government: Developing a methodology for quantitative evaluation.* Paper presented at WWW2006 (23-16 May 2006) Edinburgh.

Polidano, Charles. 2000. World Measuring Public Sector Capacity. *Development* 28(5): 805-822.

Press, Daniel. 1998. Local Environmental Policy Capacity: A Framework for Research. *Natural Resources Journal* 38: 29-52

Provan, Keith G., and Patrick Kenis. 2008. Modes of Network Governance: Structure, Management, and Effectiveness J*ournal of Public Administration Research and Theory* 18(2): 229-252.

Rabe, Barry G. 2007. Beyond Kyoto: Climate Change Policy in Multilevel Governance Systems. *Governance* 20(3): 423–444.

Rethemeyer, Karl. 2007. Policymaking in the Age of Internet: Is the Internet Tending to Make Policy Networks More or Less Inclusive? *Journal of Public Administration Research and Theory* 17 (2): 259-284.

Rhodes, R. A. W. 1997. *Understanding Governance. Policy networks, governance, reflexivity, and accountability.* Buckingham, UK: Open University Press.

Rogers, Richard. 2006. *Information Politics on the Web.* 2nd ed. Cambridge MA: MIT Press.

Roy, Jeffrey. 2006. *E-Government in Canada: Transformation for the digital age.* Ottawa: University of Ottawa Press

Spears, Kimberly. 2007. The Invisible Private Service: Consultants and Public Policy in Canada In *Policy Analysis in Canada: The State of the Art*, ed. L. Dobuzinskis, M. Howlett, and D. Laycock. Toronto: University of Toronto Press.

Stritch, Andrew. 2007. Business Associations and Policy Analysis in Canada. In *Policy Analysis in Canada: The State of the Art*, ed. L. Dobuzinskis, M. Howlett, and D. Laycock. Toronto: University of Toronto Press.

Swan, Alma and Sheridan Brown.2004. Authors and open access publishing *Learned Publishing* 17: 219–224

Tompkins, Emma L. and W. Neil Adger. 2005. Defining response capacity to enhance climate change policy *Environmental Science & Policy* 8(6): 562-571.

United Kingdom National Audit Office. 2007. *Government on the Internet: Progress in Delivering Information and Services Online*. Report by the Comptroller and Auditor General | HC 529 Session 2006-2007 | 13 July 2007. National Audit Office LONDON.

Wallsten, Kevin . 2008. Political Blogs: Transmission Belts, Soapboxes, Mobilizers, or Conversation Starters? *Journal of Information Technology & Politics* 4(3): 19-40.

Waters, Richard. 2007. Nonprofit organizations' use of the internet: A content analysis of communication trends on the internet sites of the philanthropy. *Nonprofit Management and Leadership* 18(1): 59-76.

Weible, Christopher M. and Paul A. Sabatier. 2005. Comparing Policy Networks: Marine Protected Areas in California. *The Policy Studies Journal* 33(2): 181-201.

Wellstead, Adam and Richard C. Stedman. 2007. Coordinating future adaptation policies across Canadian natural resources *Climate Policy* 7(1): 29-45.

Wellstead, Adam M., Richard C. Stedman and Evert A. Lindquist. 2009. The Nature of Regional Policy Work in Canada's Federal Public Service. *Canadian Political Science Review* 3(1): 34-56.

Wellstead, Adam M., Richard C. Stedman and Michael Howlett. 2011. Policy Analytical Capacity in Changing Governance Contexts: A Structural Equation Model (SEM) Study of Contemporary Canadian Policy Work. *Public Policy and Administration* 26(3): 353-373.

Williams, Russell Alan. 2011. Climate Change Adaptation in Canadian Finance Agencies - Operationalizing "Policy Capacity" *Assessing Canada's Policy Capacity for Climate Change Adaptation: The Dynamics of Multi-Level, Multi-Sectoral Policy Making*. Presented to the Western Economics Association Annual Meeting San Diego, California July 1, 2011.

Wang, Y. and H. Emurian. 2005. An overview of online trust: Concepts, elements, and implications. *Computers in Human Behavior* 21(1): 105-125.

Wasserman, Stanley, and Faust, Katherine. 1994. *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University Press.

Endnotes

1   Policy analytic capacity has been a major focus of the modern policy analysis movement in Canada, which promotes a contextualized approach to policy analysis, rejecting pure traditionalist methods in favour of evidence-informed approaches that move beyond statistical data analysis and analytical evidence to include evidence from citizens and stakeholder as well as from practice (Howlett and Lindquist 2007). While "evidence-based policy" analysis draws exclusively on hard facts using scientific data (e.g., health, environment), quantitative analysis, and social science methods (cost-benefit analysis, network analysis), "evidence-informed" analysis is based on studying hard facts within a given social, political, cultural, or economic context. In the case of evidence-informed policy analysis, normative assumptions (about how things *should* be) are used to interrupt data and ensure that the realities surrounding a proposed program or policy are taken into account Radin 2000.

2   The capacity to learn and organize information is a key competency for future policy analysts. For the first time in human history mass amounts of information may be collected, stored, and searched using networked technologies producing an extraordinary increase in the volume of available information. In an information-rich environment an over-abundance of information may results in information overload if the information is chaotic, and thus assessing the relevance and accuracy of existing information takes precedent over seeking out more information (Jones and Baumgartner 2005).

3   The amount and types of policy information available online are extensive ranging from collaborative initiatives, frameworks, policy research, policy analysis, program evaluation, strategic plans, environmental scan, and briefings to position papers, advocacy, propaganda, and individual commentary(blogs). Considering the sheer volume of online policy information available the competition over user's attention is fierce.

4   Web 2.0 refers to web applications and hosted services that promote participatory information sharing, online collaboration, and interoperability including social networking sites, mashups, blogs, wikis, and so forth.

5   The Western Climate Initiative also received 6 inlinks but was not categorized as an international actor as the initiative is a partnership between seven U.S. states and four Canadian provinces and was thus considered to be intergovernmental as opposed to international.

6   Twitter is a microblogging and social networking site that allows members to use instant message to share information.