Contemporary Water Governance: Navigating Crisis Response and Institutional Constraints through Pragmatism

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Abstract: Water has often been the source of crises and their frequency will intensify due to climate change impacts. The Niagara River Watershed provides an ideal case to study water crises as it is an international transboundary system (Canada-United States) and has both historical and current challenges associated with water quantity and quality, which resonates broadly in water basins throughout the world. The aim of this study was to understand how stakeholders perceive ecosystems and the relationship with preferences for governance approaches in the context of water governance. An online survey instrument was employed to assess perceptions of the system in terms of resilience (engineering, ecological, social-ecological, or epistemic), preferences for governance approaches (state, citizen, market, and hybrid forms), and the most pressing issues in the watershed. Responses showed that, despite demographic differences and adherence to different resilience perspectives, support was strongest for governance approaches that focused on state or state-citizen hybrid forms. The validity of the resilience typology as a grouping variable is discussed. The roles of institutional constraints, pragmatism in governance approach preferences, and the influence of multiple crises are explored in relation to the context of the study site, as well as to water governance scholarship more broadly.

1. Introduction

Water is regularly identified as a contemporary crisis of global proportion (e.g., [1–3]). This idea emerged in the early 1990s through specific works by Postel [4] and Gleick [5] and several phenomena have come to be associated with it [6,7]. Water stress and scarcity highlights the sufficiency of quality

water to a population [8–10]. Vulnerability is concerned with water availability in relation to threats, in particular environmental and climatic changes [11,12]. Security directs attention to the level of risk for humans and ecosystems in relationship to the ability of water (quality and quantity) for supporting human wellbeing, national safety, and ecosystem services [13,14].

Perhaps one of the more controversial interrogations into the meaning of the "global water crisis" calls into question the neutrality of discourse upon which it is founded [6,7,15]. Linton [6], for example, approaches the construction of the global water crisis from a critical perspective and challenges its emergence on physical circumstances alone, drawing attention to the role of social construction. In subsequent work, Linton [15] examines the history of water as a modern abstraction and problematizes the simplified notion of a global water crisis. In drawing upon Linton's arguments, Bakker [16] (p. 471) suggests the need to consider " . . . a set of interrelated water crises at multiple scales" with problems and solutions varying by context and scale. Numerous framings of environmental resource crises are often at work in a given problem domain [17].

In preparing a framework for action towards water security, the Global Water Partnership (GWP) re-oriented understanding and solving the water crises in terms of governance. They observed that "the water crisis is mainly a crisis of governance. Working towards effective water governance requires an enabling environment and appropriate institutional structures that allow stakeholders to work together for effective water management" [18] (p. 16). This sentiment, that water crises are actually governance crises, is now well established and extends beyond the matter of water security. Governance is gaining attention as a main aspect of water concerns broadly (e.g., [19–22]), as well as particular challenges, such as policy and policy-making [23,24], privatization [16,25], and environmental changes [26–28].

What is water governance? Several perspectives exist on the meaning of water governance, but early understandings draw upon works by prominent governance scholars [29]. In line with the dialogue initiated by the GWP, "water governance refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society" [30] and [31] (p. 7). Water governance thus includes legal instruments, policies, actions, and influential networks that may include governments, the private sector and civil society [31]. While scholarship on governance provides a common departure point, it is important to recognize that researchers interested in water governance are more than just a subset of those studying environmental governance; they draw upon vast research in the water field and add complementary value to issues emerging in the environmental governance literature [29]. As opposed to concentrating on the physical properties of water, governance emphasizes that " . . . the most important factors accounting for contemporary water problems relate to 'people issues' rather than to a lack of scientific knowledge or adequate technology" [20] (p. 87), and [32].

Water generates diverse and often opposing views because of its variety of functions and plurality of meanings [16]. Examining the connection between perception or understanding of the environment and the framing of solutions is a major theme within environmental psychology (e.g., [33–35]), and has emerged as a question related to risk and water resources (e.g., [36,37]). More recently, the need to examine the connection between how the environment is understood and how water is governed has been made. Using wicked problems as a departure point, Plummer *et al.* [38] explored the relationship between ecosystem perceptions in terms of resilience and the approaches to governance using document analysis. Their study of seven water dilemma cases revealed a connection between the presence of social-ecological resilience and non-state governance approaches, and also raised important questions about the nuances of this relationship and the persistence of command and control approaches. In finding that document type had a clear influence on the results (e.g., government *vs.* non-government published documents) Plummer *et al.* [38] have called for future research that directly engages individuals. Based on their applied experiences, Bruns and Frick [7] (p. 416) observe that "in practice, however, the same old preconceptions as to what the issues are, still tend to dominate, because alternative ways of assessing a problem are seldom part of any planned shifts in governance."

This research study was designed to identify water issues in a complex transboundary basin and stakeholders' preferences for governance. The relationship between how the ecosystem is understood/perceived and preferred governance approach is examined, as suggested by the recent scholarship set out above.

2. Materials and Methods

Central to this study are resilience and governance concepts. These two concepts are briefly explained in this section, and for greater detail the reader is directed to Plummer *et al.* [38].

2.1. Resilience

The perceptions of stakeholders were assessed in terms of their understanding of the ecosystem from a resilience perspective. Resilience, as employed in this context, relates to four criteria that identify distinguishing features among four resilience "types". These types have been identified from the resilience literature and reflect the range of ways in which resilience is understood [38]: (1) how disturbances affect the ecosystem; (2) how the ecosystem responds to disturbances; (3) how disturbances should be managed; and (4) how the ecosystem will function within the desired management regime. Several resilience types are mentioned in the literature with varying definitions. In this study, the four resilience types examined were: engineering, ecological, social-ecological, and epistemic. *Engineering resilience* assumes that ecosystems function within a single state or stability domain [39–41] and relationships among system elements are linear and predictable [40,42,43]. *Ecological resilience* recognizes the existence of more than one stability domain and multiple equilibria are possible [40,42,44,45] and is defined as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to retain essentially the same function, structure, identity, and feedbacks" [45] (p. 558). This resilience type acknowledges that relationships between system elements are dynamic, nonlinear, and unpredictable and instability may cause the ecosystem to cross a threshold into a new stability domain [44,46,47]. *Social-ecological resilience* shares similar features with ecological resilience but an important difference is that it acknowledges the inextricable linkage among social and ecological systems [39,48,49]. This type of resilience is frequently defined as "(1) the amount of disturbance a system can absorb and still remain within the same state or domain of attraction; (2) the degree to which the system is capable of self-organization (*versus* lack of organization, or organization forced by external factors); and (3) the degree to which the system can build and increase the capacity for learning and adaptation" [39] (p. 259). Finally, *epistemic resilience* is based on social constructivism epistemology and post-normal science [50–52]. From this perspective, humans and their environment are considered structurally coupled and they influence each other [53]. In relation to the other resilience types, the distinguishing feature of epistemic resilience is multiple and subjective definitions of the ecosystem based on the perceptions of each stakeholder [54].

2.2. Governance

Governance approaches were developed by drawing upon the work of Glasbergen [55], Lemos and Agrawal [56], and Armitage *et al.* [57]. Specifically, the idealized state-centred, civil society-based, and market-based forms of governance were identified [55,57], as well as hybrid state-civil society, state-private, and state-civil society partnerships [56,57]. These governance forms are more established in the literature than the resilience types described above, and thus a literature search yielded descriptions of each approach. Three criteria were identified that offered distinguishing features among the governance approaches identified: (1) actors involved in governance; (2) tools used for governance; and (3) outcomes of governance approaches.

Connections among resilience types and governance approaches are evident in the resilience literature. For example, the command-and-control approach to resource management has been linked to engineering resilience [43]; adaptive management that acknowledges the need for flexibility, experimentation, and learning is often described in relation to ecological and social-ecological

resilience [39,45] with the addition of collaboration of multiple stakeholders representing diverse interests and scales in the social-ecological resilience literature [39,58]; and, public participation and collective action through dialogue and social learning is emphasized in relation to epistemic resilience [59]. However, the relationship between resilience types and governance approaches in terms of stakeholder perspectives is unclear and is assessed in this study using a survey instrument.

2.3. Case Study: The Niagara River Watershed

Situated within the Great Lakes Basin of North America, the Niagara River Watershed is an international transboundary system set within Southern Ontario, Canada and Northern New York in the United States. The 58-km long Niagara River is the main waterway flowing northward from Lake Erie to Lake Ontario and forms the political border between Canada and the United States [60]. The watershed serves a combined population of approximately one million people and is highly managed in response to ever-increasing and competing water demands from both sides of the border. The river drains an area of approximately 684,000 km^2 largely comprised of extensive agricultural land on the Canadian side and heavily industrialized areas on the American side. Historical and ongoing agricultural and industrial activities have led to high levels of pollution and contamination along the river and in several tributaries of the watershed. In fact, in 1987, the Niagara River was listed as a Great Lakes Areas of Concern (AOC), under the Canada–United States Great Lakes Water Quality Agreement, given ongoing concerns about severely degraded water quality and environmental health. While a coordinated approach to restoring environmental quality and beneficial uses through a remedial action plan has been identified by government, community and industry partners, the river has yet to be "delisted". Responsibility for this AOC is jointly shared between Canada and the United States [60,61].

The Niagara Falls is a defining geographical feature of the watershed, and water is also critical to the regional economy and culture. Given the elevation difference between the two lakes, water rapidly flows from Lake Erie to Lake Ontario and is harnessed for hydroelectricity by both countries. The river serves as a major international waterway for commercial and recreational navigation; supports a highly productive agricultural industry (including wine and fruit production); and, supports a strong tourism industry. Tourist activities occur on both sides of the river; these activities are highly concentrated in Niagara Falls [60].

The region is also experiencing much change. The population is increasing and there are corresponding increases in demand for water. The economy is transitioning from manufacturing and primary natural resource industries to tourism and technology-focused industries [62]. The legacy of past industrial pollution remains a challenge. Climate change is also exacerbating water demands for irrigation and has led to an increase in severe weather events [63]. These conditions and trends raise important questions regarding water quantity and quality in the watershed.

The complexity of interactions among demographic, geographic, and climatic conditions is paralleled by the complexity of governance arrangements. There are several levels of government that hold varying responsibilities for quantity and quality of water resources, including municipal/county, provincial/state, and federal (see Table 4.1 in Reference [62] for a summary). In addition, other bodies at the regional and international levels (e.g., the Niagara Peninsula Conservation Authority and the International Joint Commission, respectively) hold mandates for water resources. Thus, while some management is conducted independently by Canadian and American agencies, much is carried out jointly through the International Joint Commission. For example, water flows and diversions to hydroelectric facilities are managed through the International Niagara Board of Control. Finally, public-private-civic groups also hold a stake in watershed governance, including First Nations, residents, private businesses, and environmental groups [63]. There has been a relatively recent shift in the region from a focus on government (*i.e.*, state-based) to include non-governmental organizations, private industry and local citizens in decision-making (*i.e.*, hybrid forms of governance). The complexity of the governance arrangements and recent shifts in approaches to governance, along

with ongoing shifts in climate and economic activity, make this case ideal for studying preferences for governance approaches and how these relate to perceptions of the system.

2.4. Survey Administration

The survey population was defined as individuals living and/or working within the Niagara River Watershed. This included members and employees of an organization, association, agency/department or other group with an interest in water. A purposive sample was created through a desktop study of these groups, with 85 groups identified, and individual contact information was collected from group websites and the personal knowledge of researchers involved in the study. An "interest in water" was defined by an obvious link to water (e.g., municipal water treatment) or groups where water resources issues (quality or quantity) were mentioned on the group website. With ethics approval, all individuals (123 in total) on this list of stakeholders were invited to participate by e-mail in January 2014, and sent a unique link to the online survey (FluidSurveys software). The electronic invitation included information about the study, terms of consent and data management, and contact information. A reminder e-mail was sent to those who did not participate two weeks later, and a phone call (where this information was available) was made as a third follow-up attempt.

2.5. Survey Design and Analysis

An online survey was developed in five sections. First, adherence to one (or more) resilience types was assessed using a series of four multiple choice questions with one response statement for each question representing each resilience type. The term "resilience" was not used in this section in order to avoid differences in understanding of the concept. However, each statement representing a resilience type was carefully crafted based on the available literature describing it (see Section 2.1). Second, the modified New Ecological Paradigm (NEP) scale [34] was used to assess the environmental worldview of respondents. This scale employs a five-point Likert scale to assess degree of agreement or disagreement with a series of 15 statements. Third, preferences for governance approaches were assessed by a five-point Likert scale indicating the degree to which respondents agreed or disagreed with a series of statements related to each criterion for each resilience type (1 = strongly disagree; 5 = strongly agree). Three questions were posed relating to three aspects of governance approaches: actors, processes, and outcomes. The responses to the three questions were summed for each respondent and descriptive statistics were generated in SPSS 20. Next, respondents were asked to identify the issue they felt was most pressing in the watershed in an open-ended question. Follow-up questions requested further information regarding the resilience of the watershed in relation to the issue they identified, and the strengths and weaknesses of the watershed in terms of its resilience. Several demographic questions were also posed to the respondents, including age, sex, education, career type, income, political affiliation, religion and religiosity, and environmental activism to identify potential explanations for choice of a particular resilience type or governance approach.

The respondents were grouped using responses to one of the four resilience type questions, "How does the system behave when disturbed?" related to the criterion "how do disturbances affect the ecosystem" identified above. This question was chosen as a grouping variable due to its relevance to perceptions of the ecosystem in terms of resilience, and also due to the variability in responses to the four questions related to resilience in the survey (corresponding to the four criteria). That is, respondents tended to select responses that represented different resilience types, displaying inconsistency in their perspective. This challenge is described in detail in the results and discussion, and the degree of variability (*i.e.*, internal consistency) among responses to the four resilience type questions was evaluated by calculating the mean number of resilience types selected by responses to the set of questions, as well as the distribution. Using the responses to the question about system behaviour, respondents were grouped into one of the four resilience types and descriptive statistics were generated for each group's demographic information, NEP scores (reciprocals for responses to negative statements were taken and means and standard deviations were then calculated), and

preferences for governance approaches. The internal consistency of responses to the three governance approach questions was also evaluated using Cronbach's alpha. A one-way analysis of variance was undertaken to evaluate differences in means among the resilience type groups.

Qualitative responses to the open-ended question regarding the most pressing issue facing the watershed were coded in two rounds in Microsoft Word. The first round used open coding, identifying and grouping responses into themes, or main concepts, as they emerged [64]. A second round of axial coding ensured all aspects of responses were represented by themes and that no new themes were needed [64]. The frequency of responses aligned with each theme was calculated, and where a single response required more than one theme, it was counted in both relevant themes. A similar protocol was followed for the open-ended question requesting information about the strengths and weaknesses of the watershed in regard to its resilience.

3. Results

3.1. Demographics

Forty-two completed surveys were returned, resulting in a response rate of 34%. Representativeness of the sample is based on the population of stakeholders identified in the Niagara Watershed and known information about them. Males were slightly underrepresented in the sample as they constituted 75% of the population. Sectors represented were generally consistent in terms of proportions in the population and sample, with a slight overrepresentation of government (51% of sample; 39% of population) and slight underrepresentations of community groups and agriculture (2% of sample, 10% of population).

There were few differences between the Canadian and American respondents. Briefly, a greater proportion of the respondents were males in Canada (70%) as compared with the United States (57%); more American respondents were members of a political party (64%) compared with Canadians (7%); and, more Canadian respondents were members of an environmental organization (77%) compared with Canadian respondents (48%). There were no significant differences between the countries in terms of responses to questions about resilience types or governance, and so responses were combined.

3.2. Stakeholder Perceptions of the Ecosystem

Four questions probing views on ecosystems from a resilience perspective were presented, and respondents tended to choose more than one resilience type among their four responses, with a mean of 2.6 different resilience types chosen per respondent. The mode was 3 types, with a minimum number of 1 (1 respondent) and a maximum of 4 (4 respondents). As a result, the respondents were grouped by resilience type (engineering, ecological, social-ecological, or epistemic) to which they adhered, based on their selection of a corresponding statement to a single resilience type multiple choice question: "How does the system behave when disturbed?" The number of respondents grouped into each resilience type and demographic data for each group is presented in Table 1. Most respondents' perceptions related to ecological or social-ecological resilience. Epistemic resilience was also selected by some respondents. The presence of only one respondent in the "engineering resilience" group resulted in the omission of this group from further analysis. The descriptive statistical data in Table 1 showed that there was little difference among the other three resilience types in terms of their demography. It is worth noting that most respondents identified themselves as working in government or environment/conservation, leading to a high proportion of these sectors in each resilience type.

Table 1. Demographic data for respondents grouped by resilience type. Most common response (mode) and percentage of responders choosing the option are presented first, followed by means and standard deviations presented unless otherwise indicated.

	Resilience Type (Grouping Variable)			
	Engineering	Ecological	Social-Ecological	Epistemic
n	1	18	16	7
Gender [1] (proportion of group)	0	Male: 66.7% 0.29	Male: 62.5% 0.38	Male: 57.1% 0.43
Age [2]	5	45–54: 38.9% 3.18 (1.29)	55–64: 37.5% 2.94 (1.00)	18–34, 35–44, 55–64: 28.6% each 2.43 (1.27)
Education [3]	7	Master's: 33.3% 6.65 (0.86)	Bachelor: 31.3% 6.38 (1.26)	Bachelor: 57.1% 6.00 (1.00)
Income [4]	5	$100k +: 44.4% 4.44 (0.63)	$100k +: 62.5% 4.33 (1.11)	$100k +: 42.9% 4.33 (0.82)
Size of community [5]	3	Medium: 44.4% 2.72 (1.07)	Medium: 50.0% 3.13 (0.72)	Large: 42.9% 3.00 (1.16)
Religion [6]	4	Not that important: 50.0% 2.41 (0.94)	Strongly important: 37.5% 2.81 (1.17)	Strongly important: 37.5% 3.17 (1.17)
Religiosity [7]	5	Never: 44.4% 2.35 (1.58)	Seasonally: 31.3% Never: 31.3% 2.75 (1.57)	Weekly: 42.9% 3.83 (1.60)
Time spent outdoors [8]	3	0–29 min/day: 50.0% 1.59 (0.71)	30–59 min/day: 50% 2.00 (0.73)	30–59 min/day: 50.0% 1.71 (0.49)
Member of an environmental organization (proportion of group)	0	Yes: 44.4% 0.50	Yes: 75.0% 0.75	Yes or No: 42.9% each 0.50
Member of a political party (proportion of group)	0	No: 66.7% 0.29	No: 68.8% 0.31	No: 85.7% 0.14
Sector (Proportion of Group)				
Government	1.0	0.47	0.39	0.71
Environmental		0.18	0.39	0.29
Science/research		0.12	0.06	
Community group		0.06	0.06	
Agriculture		0.06		
Other		0.12	0.06	

Notes: [1] Gender: 0= Male; 1 = Female; [2] Age: 1 = 18–34; 2 = 35–44; 3 = 45–54; 4 = 55–64; 5 = 65–74; 6 = 75+; [3] Highest level of education completed: 1 = Elementary school; 2 = High school; 3 = Some college; 4 = College diploma/certificate; 5 = Some undergraduate university studies; 6 = University bachelor degree; 7 = Master's degree; 8 = Doctoral degree; [4] Current household income before tax: 1 = $0–24,999; 2 = $25,000–49,999; 3 = $50,000–74,999; 4 = $75,000–99,999; 5 = $100,000+; [5] Size of the community in which you were raised: 1 = Rural area (<1000); 2 = Small population centre (1000–29,000); 3 = Medium population centre (30,000–99,000); 4 = Large urban centre (100,000+); [6] Importance of religion: 1 = Not at all important; 2 = Not that important; 3 = Somewhat important; 4 = Very important; [7] Frequency of attendance to religious events: 1 = Never; 2 = Once yearly; 3 = Seasonally; 4 = Monthly; 5 = Weekly; 6 = Daily; [8] Time spent outdoors per day: 1 = 0–29 min; 2 = 30–59 min; 3 = 1–3 h; 4 = More than 3 h.

3.3. New Ecological Paradigm

Respondents were asked to rate the degree to which they agreed or disagreed with the NEP statements (1 = strongly disagree; 5 = strongly agree). Due to strong indications of internal consistency among the statements (Cronbach's alpha = 0.83), the statements were treated as a scale measuring a single construct and means and standard deviations were calculated for each resilience type group. The ecological resilience group's mean score was 3.52 (SD = 0.63), the mean score for the social-ecological resilience group was 3.79 (SD = 0.54), and the mean score for the epistemic resilience group was 3.61 (SD = 0.55). There were no significant differences among the groups in terms of NEP scores and respondents showed a strong pro-ecological worldview in general.

3.4. Governance Approaches

Respondent preferences for water governance approaches were measured using a five-point Likert scale for a series of three questions. The internal validity of the ratings for the three statements representing each governance approach was tested using Cronbach's alpha and only one governance approach—State + Civil society—achieved an acceptable level of alpha at 0.71. The remainder of the governance approach alpha values were between 0.11 and 0.57 and, thus, are not considered internally consistent. However, due to the low number of statements assigned to each governance approach, the Cronbach's alpha values are not taken as an accurate indication of internal inconsistency.

Mean responses and standard deviations for the summed Likert scale ratings for each governance approach (six in total) were calculated for each resilience type group (excluding the engineering resilience type) and are presented in Table 2. There were no statistically significant differences among resilience type groups in terms of their preferences for governance approaches; however, there was a tendency across groups for respondents to prefer State and State + Civil society approaches over others. Civil society alone was the least preferred governance approach of those queried.

Table 2. Preferences for governance approaches for resilience type groups. Means and standard deviations (in parentheses) are presented.

Resilience Type	Governance Approach					
	State	**Civil Society**	**Market**	**State + Civil Society**	**State + Market**	**Civil Society + Market**
Engineering	11	8	10	13	10	11
Ecological	11.44 (1.54)	6.94 (2.04)	7.89 (1.78)	11.22 (2.51)	8.06 (2.01)	8.61 (2.20)
Social-ecological	10.88 (1.89)	6.43 (1.63)	7.81 (1.52)	12.00 (1.55)	7.13 (2.85)	8.38 (2.09)
Epistemic	10.86 (0.90)	7.00 (1.41)	7.57 (1.40)	11.57 (1.72)	8.00 (2.45)	7.70 (1.38)
One way ANOVA	NS [1]	NS	NS	NS	NS	NS

Note: [1] Not significantly different.

3.5. Most Pressing Issue and Resilience

When asked to identify the most pressing issue facing the Niagara River Watershed, a wide range of issues was raised by respondents. The themes that emerged from the qualitative coding process are presented in Table 3 along with the number of responses related to each theme, organized by sector. Some responses were coded in multiple themes. Respondents were also asked to identify whether they considered the watershed sufficiently resilient to deal with the issue they raised. Only five respondents (mostly from the government sector) identified that it was, and this suggested that, in general, respondents did not consider the watershed to be resilient enough to deal with these issues.

Water contamination by agriculture, other industries, and residential areas were the most common issues raised by respondents. Governance issues, such as a lack of coordination among non-state actors and lack of political will were also represented in the responses. Some themes were identified by multiple sectors, such as agricultural pollution and wastewater treatment. Others, such as water conservation and lack of coordination among stakeholders, lack of action by non-governmental organizations and citizens were identified primarily by a single sector (government and environmental, respectively).

When asked about the strengths and weaknesses of the Niagara River Watershed in relation to its resilience, the following were identified as strengths: multi-level governance structures (*n* = 2), positive contributions from both Canada and the United States (*n* = 1), regulations and inspections (*n* = 1), and natural processes (*n* = 1). There were many more weaknesses identified than strengths, and most of the weaknesses focused on governance (*n* = 19), including lack of: government policy, oversight, monitoring and enforcement; public awareness and understanding; political will and understanding; sufficient cooperation among existing entities and new entities needed using biophysical boundaries; leadership and funding to develop an integrated watershed management

approach; and long-term planning. Three responses referenced ecological weaknesses, including: a lack of ecosystem connectivity and lack of clean-up of contaminated sites.

Table 3. Most pressing issues identified by respondents in the Niagara River Watershed.

Most Pressing Issue	Number of Responses						Sufficient Resilience to the Pressing Issue (Number of Respondents)
	Government	Environmental	Science/Research	Community	Agriculture	Other	
Agricultural pollution	5	2	2	1			1 (Government)
Industrial pollution (including legacy/historical pollution)	3	2					0
Balancing or adapting to changing climatic conditions and changing land uses	3	1			1		1 (Government)
Wastewater treatment and sewage contamination concerns	1	1	1	1			0
Lack of coordination among stakeholders, lack of action by non-governmental organizations and citizens		3			1		0
Specific concerns about pharmaceuticals and chemical contaminants	2	2					0
General mentions of water quality	1		1		1		1 (Government)
Lack of political will to put forth and enforce appropriate water policy		2			1		1 (Environmental)
Development pressure impact on quality and quantity	1	1			1		1 (Government)
Education and awareness of public		1		1			0
Water conservation concerns	2						0
Lack of availability of adequate information about water quality/quantity	1						0

4. Discussion

In recent years, an increasing number of scholars have characterized water governance as a wicked problem (e.g., [24,65,66]). Wicked problems are wicked because they are not readily solvable. They usually involve a complex web of interdependent social and environmental factors that are not easily reducible and are constantly changing. This produces a high degree of scientific uncertainty and invites actors to try to make sense of the problem based on their own values and worldviews [67] (p. 2). When multiple worldviews are present, as is typical of a wicked problem and shown to be the case in this study in terms of resilience types, the result is competing problem definitions, so that stakeholders cannot even agree on the problems to be addressed, much less on their solutions. In support of their positions, stakeholders often point to conflicting sources of evidence and advocate a wide range of policy solutions, none of which can be considered as objectively or scientifically optimal due to the presence of conflicting and plausible policy goals [67]. Stakeholders mired in a wicked problem usually have difficulty getting analytical traction on the problem, are frequently frustrated in their efforts to develop solutions (e.g., no right or wrong answers, just good or bad for certain groups), and are often disappointed in the results from solutions that are implemented.

There are a number of indications from the survey data that water governance actors in the Niagara River Watershed are locked in a wicked problem. The first indication is the wide range of responses

pertaining to the watershed's most pressing issues. Agricultural pollution was the most frequently identified issue, but many other issues were also identified ranging from climate change adaptation, to a lack of political will, to the need to increase public awareness. This suggests that stakeholders are grappling with a complex set of environmental, economic, social, and political relationships, and that there is little agreement on the most pressing problems to be addressed, even amongst professionals in the water management field. Another indication is the stakeholders' assessment of Niagara's strengths and weaknesses related to resilience. Many more weaknesses than strengths were identified, once again suggesting that stakeholders have an awareness of water governance problems in the watershed, but cannot agree on their definition. Competing problem definitions are also prevalent on both sides of the international border: Both Canadian and American respondents showed considerable diversity in their responses to the most pressing issues and resilience questions, suggesting that wickedness is a general condition spanning the watershed.

4.1. Pragmatism

In the face of this wicked problem, survey responses reveal the presence of a pragmatic mindset regarding issues around water governance in the Niagara Region. This is evidenced by the lack of differences among resilience types in terms of preferred governance approaches, with all resilience type groups preferring state and State + Civil society approaches over other options. This is in contrast with existing literature linking engineering resilience with government interventions [41,43,45], ecological and social-ecological resilience with adaptive and collaborative governance [44,68,69], and epistemic resilience with participatory collective action focused on negotiation and co-dependence [53,59]. Further evidence is provided from responses to an open question about what resources/characteristics respondents believe to be lacking for the region to be resilient. Responses showed uniformity on issues including a lack of leadership and funding, as well as political will and understanding, around issues of integrated watershed management. Others noted that clear and definitive policies are absent, leading to an absence of long-term planning. Since many respondents were involved in water resources governance, a pragmatic approach provides a path forward. For example, a number of respondents identified the need to provide education and information to the general public while others identified a need to explore new options and less costly alternatives.

According to the Oxford English Dictionary online [70], to be pragmatic means to " . . . deal[]with things sensibly and realistically in a way that is based on practical rather than theoretical considerations." Charles Peirce, an American philosopher from the late 1800s and early 1900s, provided the earliest and most influential way of thinking about pragmatism from a philosophical viewpoint in his 1878 paper [71]. To Peirce, pragmatism was a means of " . . . express[ing] a complex of ideas about logic (good thinking)" [72] (p. 31). Central to pragmatism was the notion of "abduction." This employs elements of both deductive and inductive reasoning [73]. Abduction meant combining experience within a specific context with new ways of thinking in order to gain insight into a situation. A pragmatic approach would necessarily be adaptive and self-reflective as both data about a situation and context changed. Peirce's work subsequently influenced many philosophers and thinkers in both the 20th and 21st centuries. More recently, it has been invoked as a way forward in the impasse around conflicts between economic development through international trade and environmental concerns [74]. It has also been adopted in the area of water management. In 2004, the World Bank issued its Water Resources Strategy [75] which outlined a water management strategy that embraced a "pragmatic but principled approach" (p. 3). Specifically, it promoted the idea that water management solutions need to be context-driven and capable of respecting " . . . natural, cultural, economic and political circumstances" (p. 22).

One of the key pieces of data with which many of our survey respondents, as stakeholders in water resources in the watershed, have experience is the extent to which institutional factors constrain choices, particularly, in the presence of transboundary water use. Varady *et al.* [76] describe a situation between the Western United States and Mexico that is similar in complexity to the Niagara situation.

They contrast formal and informal arrangements for transboundary water governance and note that effective "science-policy dialogues" involves the use of a pragmatic approach, as opposed to idealism. They also talk about the key roles played by strong institutions. Similar contextual factors appear to be at play in the Niagara Region. Some of the open-ended responses provided by our survey respondents shed a light on this. For example, one individual noted . . . "Currently, the greatest deterrent to water resources management is weak governmental policy and public complacency." Another argued that a challenge to clean up was " . . . cost and political will to protect and manage water resources." This, indeed, was a common theme amongst many respondents, as was the feeling that too many contrasting rules were at play, leading to a lack of co-operation and understanding. In the face of these contextual constraints, a pragmatic approach that recognizes the reality of institutional constraints and, consequently, discards idealistic precepts, is a rational response.

4.2. Resilience

Wicked problems and pragmatism have been recently linked to resilience through the lens of governance, or lack thereof. Current governance institutions and policies tend to respond to short-term crises instead of examining their greater implication in the long term [77]. Despite the need for more integrated and long-term solutions to enhance the resilience of a system, the short-term view of the public and decision makers results in frustrations and inconsistencies among those who have to deal with the problems. In our case, the lack of consistency in perception of the problems and views of what types of resilience is needed demonstrates the challenge to move forward in finding long-term solutions.

The NEP data indicate that people are consistent in terms of their attitudes towards the environment and these values are relatively similar to those of the general public, which varies between 3.54 and 3.76 [78]. Environmentalists in British Columbia scored between 4.04 and 4.63 [79]. These scores suggest two things: First, the respondents are all working in a sector that is not always directly linked to environmental protection and activism thus keeping scores similar to the general public and reflecting the way most people would perceive water issues in the region. The second observation is that, despite the consistency in their scores, respondents can take different pragmatic approaches to solve their problems related to water management. The type of resilience that they select may be related to their perceptions and the crisis that they have to deal with at the moment rather than their environmental attitudes.

Grasping the concept of resilience in an operating system is often difficult for most people. In coastal communities of Atlantic Canada, people generally associate resilience with their ability to cope and relate the concept to their own personal need, not necessarily connecting to their own environment [80]. Individuals tend to react using their personal life experience, not always thinking about resilience in terms of their ecosystem. Hegney *et al.* [81] also observe a stronger link between people (the personal) and resilience. Their personal experience will dictate their approach in relation to an issue and what solutions in the short term can be found to solve it. If the problem is physical in nature, people will tend to find a tool they have on hand rather than analyzing the global situation in terms of the social-ecological system. Even if the information was available and known, rapid decisions based on a person's experience usually leads to very short term and pragmatic responses. In addition, our findings showed no differences in perceptions of the ecosystem and the demographic variables measured. Levin *et al.* [77] argue that to solve wicked problems, the focus should be on institutions and the policy-making process and our findings support this argument.

Similarly, Powell *et al.* [59] suggest that there is insufficient attention being paid to how institutions and governance are evolving, as well as how the concept of resilience can be operationalized to find solutions to wicked problems. In their paper, they label this combination that we obtained of pragmatism, situational with inconsistent discourses, as intersubjective resilience. They argue that the other types of resilience are based on a separation of object and subject, which leads to multiple representations. This intersubjective resilience narrative differs from the others as it acknowledges

"the pragmatist philosophy of science and its experiential learning traditions, which regard knowing as a process of 'doing'" [59] (p. 146).

Is the concept of resilience invalid? Powell *et al.* [59] argue that when dealing with wicked problems, which are ill-defined, the current institutions and resilience narratives are ill-suited to respond. Intersubjective, and even epistemic, resilience types may be more advantageous to solve some of these problems. However, the concept of resilience remains valid but its use must be considered within the context of the situation. It is therefore possible that resilience types can coexist. As stated "resilience narratives are capable of serving as 'governance narratives', and informing policy choices and institutional interventions" [59] (p. 150). This study further contributes to the analysis of the usefulness of these toolkits, resilience and governance, and how they vary in relation to people, issues and situations.

5. Conclusions

Our main conclusions flow from our original entry point for this research, which was to identify water issues in a complex transboundary basin and stakeholders' ecosystem perceptions and preferences for governance. We sought to clarify the relationship between resilience types and governance approaches in terms of stakeholder perspectives, while acknowledging that the results of this research are specific to the context in which it was conducted. Below, we set out conclusions and implications for theory, practice and future research.

The first main conclusion relates to types of resilience as defined in the academic literature and whether they can provide a suitable typology for consistently organizing stakeholder views and scholarly inquiry in complex settings. It may be that resilience types are best understood as overlapping and not mutually exclusive categories. It is also possible that resilience, as understood by academics, is not understood the same way by the general public and other stakeholders. While the framework presented here is helpful for researchers, it masks the diversity of realities at work in actual framing processes in complex settings where pragmatism prevails. Our analysis speaks to some of the methodological issues associated with applying resilience to practical situations (*i.e.*, how do we create conceptual categories when boundaries are fuzzy?). Moreover, that no significant differences were found among resilience categories for governance or ecosystem perception could suggest that differences among resilience types, or indeed respondents, are not readily discernible. After all, ecological and social-ecological resilience share a scholarly lineage, and social-ecological resilience can be seen as an extension of earlier resilience work.

Another main conclusion relates to ecosystem perception and governance preferences. Considering the importance of framing to wicked problem management, it is noteworthy that support was strongest for government and citizen-state hybrid forms even though numerous challenges were outlined that focussed on government roles and processes, as well as public involvement. In a wicked context shaped by agriculture, industrial development and expanding urbanization, preferences for governance may be shaped by a pragmatic approach that focuses on working with familiar and expected institutions (and known institutional constraints) as a way to mitigate and navigate uncertainty and complexity, rather than to experiment with new or untested models. The role of pragmatism in contemporary water governance, and particularly in the face of water crises, may require more explicit consideration in future studies. At the same time findings illustrate that there is much work to be done to make water governance work better for water interests in the Niagara River Watershed.

Finally, the transferability of NEP and governance typologies is facilitated by past work to refine these emerging frameworks. The NEP in particular has gone through several iterations of revision to sharpen the instrument and reflect contextual changes, as well as revisions by other researchers over time to suit their purposes [34]. Just as the NEP instrument has gone through revision or been improved, so too this resilience typology and governance approach typology will require refinement over time. In particular, methods and terminology to clarify and tease out the nuanced differences

among resilience types, or collapsing of closely related resilience types, may be required. Phrasing around governance approach questions may require similar consideration. Both offer opportunities for improvement in future research efforts.

Author Contributions: All authors contributed to the conception and design of the study. Julia Baird led the collection and analysis of data, with input from all authors. Ryan Plummer and Julia Baird wrote the paper, with contributions of text from Ryan Bullock, Diane Dupont, Tim Heinmiller, Marilyne Jollineau, Wendee Kubik, Steven Renzetti, and Liette Vasseur.

Conflicts of Interest: The authors declare no conflict of interest.

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