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Article abstract

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Abstract

The application of Actor-Network Theory (ANT) to the case of water management in the municipality of Guelph, Ontario, located at the periphery of Toronto, highlights the interactions between the multiple water actors in Canada who, while organised as an informal network, build knowledge together on "blue" and resilient cities. It provides a cross-cutting look at water resource co-management and the process of multiscalar public policy development by considering exchanges and negotiations between administrative bodies, the pan-Canadian water network and the organized local civil society. The water soft path approach has federated the actors of the network who share/build ideas together about sustainable municipal water management. The study of the water nexus in Guelph, of its territoriality and its history, allows for a better understanding of how and why a conservationist culture embracing the principles of "green living" has developed in Guelph and why it has become a centre for water innovation in Canada.

Keywords

Actor-Network Theory, water management, Guelph, Ontario, water soft path.

Résumé

L'application de la théorie de l'acteur-réseau au cas de la gestion de l'eau à Guelph, ville située en périphérie de la métropole Toronto, en Ontario, a permis de comprendre les interactions existant entre les différents partenaires de l'eau au Canada qui, organisés en réseau informel, coconstruisent les savoirs portant sur les « villes bleues » et résilientes. La théorie permet de poser un regard transversal sur le processus de gestion intégrée de la ressource en eau et le développement multiscalaire de politiques publiques de cogestion de l'eau, en considérant les échanges et les négociations entre les instances administratives, le réseau d'acteurs de l'eau pancanadien et la société civile locale. L'approche *water soft path* a permis à ce réseau de fédérer les acteurs et de semer des idées autour de la question de la gestion durable de l'eau municipale. L'étude de Guelph comme un des noyaux du réseau sur l'eau au Canada permet de comprendre comment et pourquoi s'est créée une culture conservationniste mettant à l'avant-plan les principes de ville bleue à Guelph et pourquoi la ville est devenue un centre d'innovation pour l'eau, au Canada.

Mots-clés

Théorie de l'acteur-réseau, cogestion des ressources de l'eau, Guelph, Ontario, *water soft path*.

Version originale soumise en octobre 2016. Version révisée reçue en novembre 2017.

Resumen

La aplicación de la teoría de actor-red al caso de la gestión del agua en Guelph, ciudad de la periferia de Toronto, Ontario, permitió comprender las interacciones existentes entre diferentes interlocutores del agua en Canadá, quienes, organizados en red informal, construyen conocimientos sobre las "ciudades azules" y las ciudades resilientes, adaptables. Esta teoría permite una observación transversal del proceso de gestión integrada del recurso agua y del desarrollo multi-escalar de políticas públicas de cogestión del agua, teniendo en cuenta intercambios y negociaciones entre las instancias administrativas, el grupo de actores del agua pancanadiense y la sociedad civil local. El enfoque *water soft path* permitió a ese conjunto reticular de asociar los actores y lanzar ideas sobre la gestión durable del agua municipal. El estudio de Guelph, centro de la red del agua en Canadá, permite comprender cómo y porqué se ha creado una cultura de conservación, anteponiendo los principios de "ciudad azul" de Guelph y cómo la ciudad se ha convertido en un centro de innovación para el agua, en Canadá,

Palabras claves

Teoría del actor-red, co-gestión de las fuentes de agua, Guelph, Ontario, *water soft path*.

Introduction

While facing pressure caused by an uncertain climatic situation, increasing urbanization and demand for food production, and in view of the scientific knowledge produced to tackle or mitigate the possible outcomes, it is pertinent to ask how exactly science is included to decision-making processes at the different government levels. For example, how receptive are municipal authorities to existing science, regarding the sustainable management of their natural resources? The construction of scientific knowledge, as well as the gap felt between scientific production and decision-making have been issues of concerns for the experts assessing the Millenium Ecosystem Assessment carried on between 2001 and 2005, in an ex-post effort to determine the underlying factors responsible for restricting the scope of the overall achievement (Reid *et al.*, 2006). Apart from concluding on the importance to incorporate local and traditional knowledge to scientific rendering of ecosystems' dynamics, the experts stated that two other factors should be prioritized: the integration of multiscalar analysis to understand how ecological processes and human impact are carried on at the smaller scale of an ecosystem, and at the scale of individual communities; and that the findings should be informed and returned for ex-post evaluation to the multiple stakeholders sharing the resources and the responsibility within the limits of an ecosystem.

To follow up with these results, this paper uses the scale of a watershed to explore the challenges faced by a particular city, in order to grasp how knowledge surrounding water management is built and exchanged at multiple scales; how it is adopted and adapted by local managers; and how stakeholders in the watershed basin come together to co-manage the resource. The Grand River watershed in Southern Ontario has been chosen, and more specifically the city of Guelph, in view of the existing collaborative channels and the dynamic citizen involvement regarding the common goal of improving water management practices, and the health of the watershed. Actor-Network Theory (ANT) is applied as an approach facilitating the analysis of the pan-Canadian network that brought a number of water experts on the Guelph territory, and which seems to act as an attracting nexus for water innovations nowadays.

Context of the study and justification

Although the Southern Ontario context has been favourable to the emergence of water awareness, the biophysical limits of the city of Guelph—with its limited supply of fresh water, over-burdened aquifers, and risk of drought—have increased the urgency of collectively achieving sustainable management of the resource (O'Flanagan, 2015; Veale, 2015). If we add to this the growth threshold imposed by the Ontario government to reduce population pressure in Toronto through its 2006 Growth Plan, and the immediate reaction of elected officials of the City of Guelph, who decided to tackle water supply and demand management, it is possible to see the strength of the alliances between elected officials and citizens, as they share aspirations and visions of development. The high rate of response to green municipal initiatives, and the overall acceptance of the water bill by the population of Guelph are signs of agreement and willingness on the part of Guelph residents to contribute to water management efforts.

Contrary to the belief that Guelph has been a lone pioneer in water management in Canada (Clean Air Partnership, 2012), this case study suggests that the pan-Canadian water network played a role in the creation and exchange of knowledge on water management and was a source of inspiration for Guelph municipal water staff. This multi-actor and multi-scalar water network comprises several affiliated institutions and organizations (universities, non-governmental organizations, watershed authorities) and governments (provincial and municipal) who meet and exchange knowledge during workshops and city staff gatherings, courses, conferences, etc. The impact of this Canadian water network is mainly felt in the provinces of British Columbia, Alberta and Ontario, as reflected in the influential work of the POLIS Project on Ecological Governance at the University of Victoria, British Columbia, and from its partnerships (POLIS, 2017).

Despite the idea expressed in the document produced by the Clean Air Partnership entitled *Accelerating adaptation in Canadian communities*, where the following can be read: "Many of the programs and regulations that Guelph initiated were the first of their kind in Canada and North America. [...] This meant that the City researched new technologies and developed new standards with little external support and was unable to benefit from lessons learned from other experiences" (2012: 12), this paper suggests that without the pan-Canadian water network that facilitated scientific and technical support to the Guelph municipal staff, it would have been difficult to develop innovative practices in the city of Guelph and neighbouring watersheds (Grand River, Credit River, Lake Erie basin and Lake Ontario basin with the Peel Region initiative). The presence of the Grand River Conservation Authority (GRCA) should not be underestimated either, since it has also had a widespread influence over time in the region: As of 1948, this organization became a Canadian leader in river bank protection, rallying citizens to plant trees along the Grand River to control flooding (GRCA, 2013d; Veale, 2015: 342). Since then, it has developed communication tools to work with the riparian population in efforts to mitigate the impact of human activity in conservation areas and along the different tributaries of the Grand River (GRCA, 2013c; Veale and Cooke, 2017). The socio-environmental context of the Guelph-Kitchener-Waterloo region, with its concentration of higher education institutions and leaders in environmental management, has helped make Southern Ontario a winning region in the sense that George Benko and Alain Lipietz (1992) understood

it: a place presenting an accumulation of human resources and political will to make change happen. This stock of human and social skills has been used by the Guelph City Council and local and regional environmental non-governmental organizations (ENGOs) to mobilize citizens and channel public action to achieve the common goal of water sustainability (City of Guelph employees, 2012: Interview).

This paper will examine the multi-scalar composition of the water network that allows for relevant knowledge production on water sustainability and its application to Canadian cities. The partnerships that were built around the principles of the *soft path approach* to water management combine scientific knowledge and practical know-how and are believed to have had an influence on municipal water management in some Canadian cities, such as Guelph.[1]

The history of water co-management in Guelph and in the Grand River watershed, as well as the history of their stakeholders will be presented, starting with the local and watershed scales, all the way up to the provincial level. First, the history of water activism in Guelph will be discussed, followed by the study of the influence of the territorial embeddedness of the city of Guelph within its watershed, the outreach of the influence of the GRCA, and the role of the Ontario provincial government as a leader in natural resource management.

ANT will be used to gain an understanding of the interconnections between the different actors, and of the structure of the network that sustains the efficient production of knowledge and communication. In the process, and according to the principles of ANT, external inputs and all things facilitating the communication process, whether human or non-human, will be taken into account.

A review of the water soft path approach, which inspired many of the Guelph water management and planning actors, as was expressed in the interviews, will be presented, followed by the presentation of ANT and its implications. As this paper deals with the application of ANT to a case study of water management, it does not offer an encompassing view on Canadian water management issues and its results are not meant to be generalized. The case study of water management in Guelph will be analyzed through the lenses of ANT, the possibilities it offers, as well as its drawbacks.

Data collection and research methods

This research is based on a diversified data collection strategy during a one-year sabbatical as a professor at the University of Guelph in 2011-2012. This stay included participatory observation, networking activities within the local environmental network, attendance at conferences, visits to fairs, workshops and gardens, daily observation of residents' practices, fifteen interviews with Guelph City staff and leaders of environmental groups, six conferences given by the main author as a guest speaker at Southern Ontario universities and at the POLIS Project on Ecological Governance of the University of Victoria (British Columbia), as well as interviews and on-site visits in the cities of Waterloo, Kitchener and Toronto, and on Salt Spring Island (British Columbia). The main question asked to interviewees was: "Where did

1 The water soft path approach calls for a "paradigm shift in water management practice that would focus on demand rather than supply" (Gleick, 1998, in Brooks *et al.*, 2011: 5).

the idea of water management in Guelph come from?" Other subsequent questions directed to key actors dealt with the influence of the water soft path approach on local decision-making, the identity of the main partners in water management, and how other Canadian cities have contributed to raising awareness about water resource planning and management in Guelph.

Theoretical framework

The *soft path approach* was first developed by Amory Lovins to tackle energy production and consumption in the 1970s (Brooks *et al.*, 2011: XIX). Its contribution was meaningful in recognizing the existence of numerous small-scale, often local, alternative energy sources and, parallel to that, the need to curb demand through better demand management. It became important to think of energy as a service and not an end in itself (Brandes and Brooks, 2005; 2006; 2007). Along with other Canadian water researchers, Brandes and Brooks from the POLIS Water Sustainability Project suggested that this thinking be applied to water using the following principles: "1) Treat water as a service rather than an end in itself; 2) Make ecological sustainability a fundamental criterion; 3) Match the quality of water delivered to that needed by the end use; and 4) Plan from the future back to the present" (Brandes and Brooks, 2007: 10; Binstock, 2010: 2; Maas and Porter-Bopp, 2011). The difference between water demand management and the water soft path approach is that the latter considers the carrying capacity and the long-term attainment of collective objectives. The water soft path approach encourages a community to draw scenarios for the next 15, 30, and 50 years. A collective reflection follows to delineate the contours of the kind of future the community wants. For example, if water consumption remains unchanged, a *status quo* scenario shows that the resource will become scarce and will not be sufficient to fulfill the basic needs of future generations at low cost. It may mean a stratification of society, where the wealthiest strata have greater access to cleaner water (*Idem*). Brighter scenarios can be achieved by a 20% or 40% reduction in demand, allowing the community to see the impact of water reduction on future generations' quality of life. At the end of this collective exercise, the community draws a plan for managing water resources which respects the values and beliefs of its members. A community may choose a "zero-growth policy" where no new water supplies will be created. This can be attained through better resource management, leak repairs, more intelligent consumption (using clean water for consumption and grey water for domestic or commercial uses that do not require potable water, e.g., washing the car, flushing the toilet, etc.).

The different time horizons in this planning exercise must account for potential urban growth. The question is, how can a city under population growth pressure plan to use existing water sources without adding any new infrastructures, while fulfilling the needs of its population in the future? Part of the answer lies in the hands of governing bodies, such as municipal governments that can become leaders in water education (campaigns, activities, events, programs) and reach out to citizens and business owners, sometimes through the use of restrictive rules (under low water level conditions) and fines; and partly in the goodwill of citizens, civil society and elected city councillors. This finely tuned combination is difficult to achieve in most cases, but in the city of Guelph, Ontario, a special combination of thriving civic culture and citizens' environmental

awareness has made it possible. What follows will explain how it was possible in 2005 to adopt a plan for co-managing water resources and how citizens' involvement has made a difference, with a participation rate above 50% (Binstock, 2010).

Bridging scales within a knowledge system

The pan-Canadian network of experts focused on the water soft path approach will serve as a framework of reference to understand how knowledge about water resource management is exchanged and generated across Canada, allowing for contacts between academics, water activists, conservation authorities and the different levels of government, including municipalities. A knowledge system can be defined as "a body of propositions actually adhered to (whether formal or otherwise) that are routinely used to claim truth" (Feyerabend, 1987, in Reid *et al.*, 2006: 11).

Integrative knowledge systems allow for a merging of both scientific and local knowledge operating as a closed loop: Flexible feedback loops are allowed in order to learn from previous actions and from others' experiences and be able to adjust the course of action. In the literature on knowledge production, "*science* is defined as systematized knowledge that can be replicated and that is validated through a process of academic peer review by an established community of recognized experts in formal research institutions" (Zermoglio *et al.*, 2005, in *Ibid.*), whereas *local knowledge* refers to place-based experiential knowledge, knowledge that is largely oral and practice-based, in contrast to that acquired by formal education or book learning (*Ibid*).

Reasons why multiple knowledge systems should be integrated into decision-making processes for natural resource management are listed below (*Idem*: 11-12):

- They broaden perspectives and augment the data base;
- The inclusion of local knowledge and actors increase the legitimacy and veracity of findings as it taps into knowledge held by local environmental stewards;
- And local knowledge-holders will feel respected and included in decision-making.

Knowledge is hereby defined as "a construction of a group's perceived reality, which the group members use to guide behavior toward each other and the world around them" (Zermoglio *et al.*, 2005, in *Ibid.*). These knowledge systems embrace multidisciplinary research as described by the authors of *The New Production of Knowledge* (1994), who explained the role of alliances, exchanges and negotiations in more informal and constantly changing scientific contexts. According to them, this collective mode of knowledge production characterizes the post Second World War period, dominated by transdisciplinarity (Gibbons *et al.*, 1994, in Lamy, 2007: 9). "Research groups are less firmly institutionalised; people come together in temporary works teams and networks which dissolve when a problem is solved or redefined" (*Ibid.*). In order to tackle complex and newly emerging problems, such as post-industrial watershed management, research networks have to be flexible to respond swiftly to the varied demands of society (*Ibid.*).

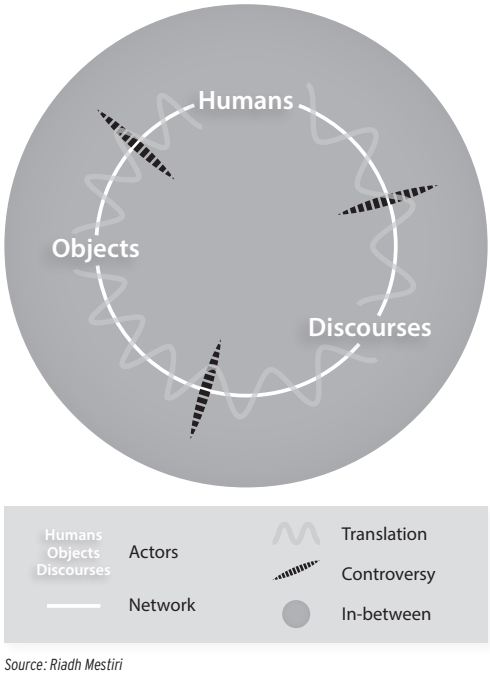
Actor-Network Theory

ANT, also called "the sociology of translation" or "the sociology of actor-network", is a concept both anthropological and sociological. ANT was mainly developed by researchers from the French School of Mines, Michel Callon, Bruno Latour and Madeleine Akrich, and by John Law, sociologist currently at the Open University in the United Kingdom, and proponent of ANT.

It combines conceptual and methodological tools based on the controversial idea that technologies and scientific discoveries are socially adopted because networks of scientists, engineers, entrepreneurs and others allow scientific objects and new concepts to be taken for granted. The ANT approach is used in the social sciences; it is different from the analysis of social networks, an approach employed in sociology that focuses on the study of social networks (individual or organizational) (Case, 2016).

The actor-network approach takes into account humans, as well as objects (non-human) and discourses, also called actors or actants. The application of ANT is based on the following concepts (Akrich *et al.*, 2006) (figure 1):

Figure 1 ANT diagram



Source: Riadh Mestiri
Realization: Department of Geography, Université Laval, 2016

The *network* means an organization that brings together humans and non-humans. All players participating in the network operate with each other.

Translation is a type of interpretation, a linkage that always implies a transformation, that is to say, an operation that clarifies the meaning of the issues around which the network is formed. It brings together the different issues and actors of the network.

Controversy is the process that allows facts to build. The analysis of controversies is important to ANT, because it highlights the oppositions and alliances among actors.

In-between definition (*l'entre-définition*) is a kind of explanation that is established between the fact and the network. The fact is the result of the network that carries it, which makes sense only by the situation around which the network has formed.

The *principle of symmetry* requires the researcher to give equal importance to humans and non-humans, and also to study the controversies that animate the research by paying attention to both failures and successes.

One of the most discussed sources using ANT was written by Michel Callon in 1986 and is entitled *Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St. Brieuc Bay*. Through this case study, Callon illustrates the contribution of ANT in an analysis of a fishermen's network within an unpredictable, shifting and unstable society. The case study analyzes resource management at a fishery: Saint-Brieuc Bay, its St. James scallops, its scientists and its fishermen. In a masterful demonstration, Callon applies a bottom-up approach, making use of three principles. The first is the objectivity of the observer, who shall be impartial, avoid censuring actors, refrain from judgments and not favour any one perspective. The second is that one should not change register when going from the technical/scientific to the social dimension of a problem. The third principle is that of free association between acting entities. The study showed that the actor-network approach enabled the establishment, through a continuous improvement process, of an acceptable method for managing the fishery resource.

According to Callon (1986), one can understand the management of change processes through four major stages: problematization, incentive, enrolment and mobilization (explained below). Many studies use these four stages to understand the build-up of interest and mobilization for a cause.

Application of ANT to water management in Guelph

The Governement of Ontario's *Places to Grow Act of 2005* orients development and legislation for the next 25 years in the region centered on the province's largest city, Toronto (in 2015, the Greater Toronto Area was home to 8 million people). According to the plan, it is expected that decentralizing population growth and work opportunities to neighbouring areas will improve quality of life in the metropolis. This should also help achieve environmental conservation objectives, such as reducing car exhaust pollution, increasing shared green spaces in the city, reducing the need to commute to work and creating lively planned green neighbourhoods. The protection of the Lake Ontario shoreline (part of the Great Lakes) is also a sensitive issue where partnerships between towns and municipalities within its watershed were made possible (e.g., the *Peel Region Climate Change Strategy* was issued in 2011 and is a result of a collaboration between seven governing bodies and local ENGOs). Municipalities drawing water from Lake Ontario are encouraged to return water to the lake after appropriate treatment (Region of Peel, 2011; 2012; Peel Region Staff, 2012: Interview). Nonetheless, nowhere in the Ontario government's *Places to Grow Act* are there any provisions for a water policy, despite the fact that a growing population with a high water-consumption rate—Canada has the fourth highest water consumption per capita in the world (Statista, 2016)—can mean expensive construction of new water facilities (new sources, transport, and treatment with attendant environmental costs).

The city of Guelph (population 115,000) lies on the outskirts of the Greater Golden Horseshoe region (figure 2), West of the Toronto greenbelt, and is targeted by the Growth Plan despite the fact that it has important constraints in its access to water

(*controversy* according to ANT). Guelph is among the fastest growing cities in Canada (Binstock, 2010: 7). Due to a lack of streams and rivers on its territory, almost only groundwater is available (two rivers cross the city but have low water levels year-round and experience problems with their discharge capacity). For the whole Grand River watershed, 70% of the supply for drinking water comes from underground and 30% comes form superficial waters (Veale and Cooke, 2017: 380). Groundwater is a finite source of water, renewable at a very slow rate and some beverage companies are already exploiting aquifers (bottled water and beer production). Nestlé's Aberfoyle Springs plant operate in the hamlet of Aberfoyle, located at the south-eastern end of Guelph, and withdraws water from the Gasport aquifer beneath (at an annual rate of 762 million liters, in 2015) (Robinson, 2016). Nestlé Waters Canada benefits from special advantages and rates for bottling Guelph's water and selling it around the world "because of outdated regulations that allows for the wholesale extraction of the water" (Mike Nagy, 2016: Interview) (other *controversy* according to ANT). Local water activists have been opposed to the multinational corporation's withdrawing activities for more than two decades in relation to the potential environmental costs it may induce to the Aberfoyle Creek ecosystem and local underground water, and to the loss of sovereignty over this aquifer (Leslie, 2016; Robinson, 2016).

With its limited water sources and highly variable annual precipitation, the Guelph area can be semi-arid, particularly during hot summer seasons. In the past 15 years, it has registered increased temperatures and particularly dry periods: the 1997-2003 span were considered drought years, with other dry years in 2007 and 2011 (Clean Air Partnership, 2012: 9). Despite its humid continental climate, with average annual precipitation of 905 mm, the bulk of it is distributed between the months of April and November, and the river flow varies widely within the watershed (Farmzone, 2013; GRCA, 2013b).

The Eramosa and Speed rivers (figure 3), which cross the city of Guelph, are among the slowest flowing rivers of the watershed and their average summer flows are 0,9 and 1,7 m^3/s, respectively, compared with other tributaries of the Grand River such as the Conestogo and Nith rivers, each of which has an average summer flow of 3,9 and 2,6 m^3/s (GRCA, 2013a). This low water flow induces constant problems with wastewater disposal through river channels in Guelph, as water volumes are not sufficient for efficient drainage.

Figure 2 Growth plan for the Greater Golden Horseshoe

Source: Government of Ontario, 2006
Realization: Department of Geography, Université Laval, 2016

In the current state of affairs, the carrying capacity of the Eramosa and Speed rivers is expected to be reached in 2024, thus limiting potential population growth (this was the response of Guelph's City staff to the Ontario government Growth Plan, which initially ignored these ecological limits) (Binstock, 2010: 9). In 2009, the City of Guelph proposed its water conservation and efficiency program (Galliher, 2010) and began negotiating "with the provincial government to reduce its growth target under the Growth Plan to reflect the assimilative capacity of the Speed River" (Binstock, 2010: 9). Its population was originally expected to reach between 175 000 and 195 000 by 2031 (*Idem*).

Figure 3 The Grand River watershed

Source: GRCA, 2008a, 2008b
Realization: Department of Geography, Université Laval, 2016

Prior to this negotiation, Guelph was already recognized in the province as being an environmentally progressive city. De Loë *et al.* found that this environmental awareness, apart from factors such as size and human resource capacity that play in its favour, was due to "political commitment, citizen involvement, linkages with outside agencies, and institutional arrangements" (2002, in Binstock, 2010: 9). According to these authors, the "main feature that distinguishes Guelph from the other municipalities studied was 'continual and multidimensional' community involvement" (*Ibid.*) (*in-between definition* according to ANT). After a decade, Guelph is drawing attention as a regional leader in water conservation and efficiency strategies (*Ibid.*). Researchers have shown that municipal staff, local politicians and the broader community have always insisted on integrating sustainable principles in their discourse and actions, thus influencing multilevel governmental administrations to adopt water-wise planning strategies (*Idem*).

The actors of the Grand River water network

What allows the actors of the water soft path network to disseminate information so efficiently is the way in which their network bridges geographical scales, creating links between decision-making authorities and knowledge-production sites, from the local scale (and even micro sites) to the national and even continental scales (Fabricius *et al.*, 2006). The diversity of water conservation techniques available on the municipal website of the city of Guelph and in brochures allows consultative bodies and citizens to implement solutions that are most appropriate to their needs and context (non-human component of the *network*). In 2009, after consulting its citizens, the municipality of Guelph established sustainable water management as a priority, followed in 2011 by the neighbouring municipalities of Fergus and Elora (Waterbucket, 2011; Leslie, 2016).

The most significant groups of actors in Guelph water management will be presented in what follows, along with their strategies to reach out to the public. For each, their role in terms of the four types of knowledge generation according to Morgan and Murdoch (2000, in Le Heron, 2002: 84) will be outlined: 1) "know-what" (information, facts); 2) "know-why" (science, laws and principles); 3) "know-how" (capabilities); and 4) "know-who" (social skills, networking). The latter authors state that "these components of knowledge are forged within particular institutional structures" (*Ibid.*). Networking allows these structures to come together and share information, human and financial resources and know-how. It enables them to learn from each other, as in a learning community (*Idem*).

The University of Guelph

The University of Guelph often appears as a supportive instance that supplies relevant information to help make enlightened decisions. Partnerships between citizens and university students in local conservation projects (e.g., rain barrels) and community groups have been active in the production of knowledge funded by some faculties, and have gained influence in local planning decisions (Binstock, 2010: 10). Various dependencies on campus, such as the Arboretum, allow for direct contact with the public and the promotion of nature appreciation experiences. Expert knowledge developed and shared in this institution accounts for the "know-why" part of the community's strengths.

Grassroots initiatives, including water activists groups, have shaped public opinion over the years regarding the conservation of natural and heritage assets in the Guelph region, through effective communication, using local media and the organization of family events such as the 2 Rivers Festival and conferences with local partners. These gatherings are excellent opportunities for cross-pollination of ideas and networking as people from different allegiances meet and exchange. Among them, we note the Transition Guelph movement that has emerged to promote alternative energy sources and efficient strategies (transportation, house fixtures) to put Guelph on the road to becoming a green city (Transition Guelph, 2017). The Guelph Civic League supports many of these groups/initiatives while fostering civic values and engagement in the community. It has access to provincial funding to run an in-school water education program (Guelph Civic League, 2009, in Binstock, 2010). Civil society and church groups account for the "know-how" and "know-who" elements of the community's strengths.

A research made on water activism in Guelph found a network of over 158 water activists (Case, 2016). Among them are the members of the ENGO Wellington Water Watchers (WWW), who, along with the Canadian Council, have been fighting to have water recognized as a common good, confronting Nestlé Waters Canada in court in an effort to prevent the multinational from extracting water from the local aquifer, especially during drought periods under the favourable terms of its permit (Leslie, 2016).

The City of Guelph staff and councillors

Things were not always so bright in Guelph. In 1999, the City of Guelph developed a water conservation and efficiency strategy, and in 2006 adopted a Water Supply Master Plan (updated in 2014). The City Council at that time was not in favour of implementing the different measures to reach the Plan's targets and former councillors reported

difficulties in getting even minor changes approved (Binstock, 2010) (*principle of symmetry* according to ANT). The City Council elected in 2009 was seen as much more supportive of environmental innovation and had developed very effective communication strategies to reach out to citizens through a dynamic website with daily updates, e-newsletters, rebate programs for water-saving household fixtures, prizes for citizens and business owners demonstrating exceptional environmental stewardship, etc. Since 2006, citizen engagement (*in-between definition* according to ANT) in water conservation and efficiency strategies has been instrumental in enabling a shift in focus from infrastructure (hard path) to demand management (soft path). Municipal initiatives such as the Landscape Visit Program focusing on water-wise gardening allow citizens to make an appointment with a landscape assessment advisor, who can give them tips on how to make their front yard and backyard "greener" by reducing watering needs (figure 4), adopting organic gardening methods, and installing a rainwater harvesting system (City of Guelph, 2013).

Figure 4 Xeriscaping in a Guelph residential area showing complete lawn removal[2]

Source: Gravel, 2012

Another successful initiative is the Guelph Outside Water Use Program, created in 2002 in response to the Ontario Low Water Response Plan (Government of Ontario, 2012; City of Guelph, 2012; 2016), whose objectives are "to conserve Guelph's groundwater supply and protect against the impact of drought during the hot, dry summer months". Three water use levels are established according to weather and local watershed conditions: Level 0, Blue, Careful use; Level 1, Yellow, Reduce outside use; Level 2, Red, Reduce and stop non-essential use. Created by the City of Guelph Water Services division and applied by bylaw enforcement officers, it is defined as a "mitigation strategy, not a disaster relief or emergency response plan" (Roth and De Loë, 2015: 21). More than 95% of Guelph citizens comply with the Program, resulting in water savings of 8,6 million litres a day in the summer *(Idem*; City of Guelph Water Services employees, 2012: Interview). One positive outcome of the work of the Guelph water connection and the City Council is that it has been possible to reach out to the provincial government via the Low Water Response Plan (*translation* according to ANT) and have the population growth threshold revised downward within the Ontario Growth Management Plan (response to *controversy*) (Clean Air Partnership, 2012). The successful management of water resources has essentially been based on the principles of negotiation and compromise. It has also shown the flexibility to accommodate new actors and initiatives, allowing the network to maintain itself over time and take changes in elected officials in stride.

2 Xeriscaping consists in adapting gardening methods to dry conditions instead of attempting to change the local environment (Brandes and Brooks, 2011: 8).

The GRCA

The existence since 1946 of Conservation Authorities in Ontario has created an actor that has a structuring impact on watershed management and who reports to the Ontario Ministry of Environment. The role of coordinator of the GRCA will be exemplified to understand its implication in watershed decision-making and planning efforts informed by ample territorial knowledge. The relationship established with the citizens of the watershed has allowed for their guided participation in local environmental conservation issues. Since 1946, a consciousness among citizens about water quality issues has arisen leading to the engaged presence of a number of them at different water-related events (*in-between definition*) (Binstock, 2010; Case 2016).

In collaboration with local universities and the Ministry of Natural Resources of the Ontario government (under the *Conservation Authorities Act of 1946*), the roles of the GRCA are: to coordinate planning efforts in the watershed (e.g., it was made the leader of the Grand Strategy for Managing the Grand River as a Canadian Heritage River in 1994) (Veale, 2015: 345); to implement and monitor water management measures and programmes with the collaboration of the riparian populations; and to be a dispensary for water resources and river data, publications and studies, allowing the public and scientists to be informed. The different roles of the GRCA make it appear in the application of ANT as responsible for mediation between partners of the network, and as the one that conveys the message, that is the "action of translation" to use the same term as Callon (1986). Furthermore, as part of its implementation role, the GRCA works to improve water quality in rural and urban areas; protect wetlands and biodiversity; provide environmental education through its nature centres; assist watershed planning actors; and reduce flood damage through reservoir and dam maintenance (Farwell *et al.*, 2008).

In line with the Ontarian water governance model, public participation is mandated within the GRCA, contrarily to the Quebec or Alberta model where public involvement and initiatives are encouraged by the "voluntary nature" of the watershed management organizations (Shrubsole *et al.*, 2017: 355). The GRCA values "extensive public participation" (Veale and Cooke, 2017) in the forms of open consultations, workshops, and partnerships with interest groups in order to seek their collaboration and lay out activities engaging riparian citizens.

The Grand River and its major tributaries were designated Canadian heritage rivers in 1994 (Veale, 2015: 345), and in 2000, the GRCA was awarded the prestigious Thiess International Riverprize in Brisbane, Australia, for its "outstanding achievement in river management and innovations in science, technology, planning, policy and stakeholder partnerships" (CHRS, 2017). Its collaborative approach in managing water resources was praised as can be read on the Canadian Heritage Rivers System (CHRS) website, "Its long-term planning is based on community engagement: The GRCA relies on hundreds of partnerships to identify priorities for action and address issues [...] These committed partnerships have strengthened a sense of community ownership in the stewardship of the river" (*Idem*).

The Government of Ontario

According to Veale, coordinator of Policy Planning and Partnerships for the GRCA, the "governance model adopted for water management in Ontario allows conservation authorities to play a pivotal role in facilitating participatory approaches to improve watershed health and resiliency" (2015: 353). An example of this is that, with the help of the Ontario government and other partners, funds were made available to prepare, over a two-year period, the Grand River Water Management Plan, launched in March 2013. The Plan is part of the *Ontario Water Opportunities Act* passed in 2010 "to help conserve water supplies, sustain water infrastructure and make Ontario the North American leader in the development and sale of new technologies and services for water conservation and treatment" (GRCA, 2012). Beginning in 2006, measures were undertaken to make the Grand River Watershed more resilient to climate change, as abrupt changes in rainfall patterns (extreme events, as they are called) may trigger unknown consequences such as increased flooding and surface erosion, as well as reduced fisheries, wetland and marsh habitat in the basin and along the Lake Erie shores (Farwell *et al.*, 2008). Global warming has become a uniting cause around which environmentalists and the general population have gathered to work together (*in-between definition*). It has proved a very effective catalyst for making cities "more blue" and reviewing water resource management provisions in Canada (City of Guelph Water Services employees, 2012: Interview). In the fulfillment of these functions, the GRCA and other collaborative watershed stakeholders represent the "know-what" and "know-how" strengths of the region in terms of water conservation and transformative actions toward the creation of "blue cities," respectful of their river ecosystems and water resources. According to Roth and De Loë, the strength of the Ontario approach lies in the "inclusion of provincial government and conservation authority representations on Water Response Teams" (2015: 21).

Application of ANT to comprehensive water management in Guelph

Several key success factors in the co-management of Guelph's water resources were identified through the application of ANT. This method has the merit of bringing to the table different elements on an equal footing (humans and non-humans alike) in a pluralistic context, without any preconceived notions, to try to understand the forces that bring them closer in a common network. ANT has made it possible to analyze and understand the networking activities of actors by considering the multiple tensions inherent to innovations. The translation process is also used to understand how people cooperate within different contexts and the reasons for success or failure in organizations. By combining the technical and social dimensions, ANT offers an original interpretation of technological development and implementation (Missonier, 2008).

The research analyzes how the pan-Canadian network of water stakeholders contributed to define Guelph water policies aiming at sustainable water policies, and a healthier and more resilient watershed basin in face of climate variability. Based on the findings of the POLIS Project contributors at the University of Victoria presenting various cases of Canadian cities applying the water soft path approach, we were able to figure out the existence of communication channels united under this approach and including academics and interest groups from sites such as Salt Spring Island, Kitchener, Elora, and Guelph. Upon discovering the presence of links between the university-led

network and municipal spheres, the research line of inquiry about how this Canadian water connection influenced Guelph decision-makers began to take shape. This step revealed what appears to be a common goal for all parties concerned, as well as the existence of a human and physical network that allows the multi-scalar construction of knowledge between water stakeholders from provincial governments, research centres, conservation authorities, and municipalities. The physical parts of the system are represented by the new information and communication technologies, including web platforms, allowing for rapid flows and exchanges of information. In the wake of these collaborations, Guelph's municipal Water Service staff has forged its own path in applying water conservation knowledge shared among Canadian thinkers to prepare the Guelph Water Conservation and Efficiency Strategy Update (2009) (which will be called herein the Guelph Water Strategy) (City of Guelph Water Service employees, 2012: Interview). Despite the fact that water managers and planners in Guelph did not explicitly acknowledge that they were applying the water soft path (*Idem*), this approach in fact appears to have had a tangible impact on the design of the Guelph Water Strategy and there is no doubts that they knew of its existence (*Idem*; Binstock 2010). In the preamble of his report, Binstock explicitly said that Guelph is to be used as a "pilot project [...] to identify enabling conditions that have allowed Guelph to pursue measures that align with the soft path's core principles" (2010: i).

Since this network predates the research, unlike other experiments conducted in action-oriented research such as that of Akrich *et al.* (2006) on the sustainable reproduction of the St. James shells, it was necessary to work back up the thread of the "spiderweb" in order to understand the structure of the network in an ex-post process. The advantage of working after the fact is being able to observe the modes of knowledge appropriation favoured by citizens and their willingness to adopt water-wise practices. Several indicators, such as citizen participation in various activities organized by the City, the voluntary conversion of lawns, and the presence of rain barrels in private lots, have been useful for determining the degree of citizen involvement. It appears that over time, collective knowledge has been shaped and shared, thus forming the citizen base of the network that will ensure its continuity after the departure of elected officials and/or staff of the City.

Below are summarized the various stages in the process of forming the water conservation network in Guelph according to the principles of ANT as presented by Callon (1986).

Problematization

This first stage relates to the identification and formulation of problems as directly perceived in reality (observations, findings, needs, experiences), and federates a set of various stakeholders. For problematization to exist, there must be recognition of the problem by the actors and convergence of their interests in finding answers and solutions. This step is crucial for the actors. Problematization can only be assured by a recognized "translator" (see section on translation below) and accepted by the actors of the network, in this case the Guelph Water Conservation Project manager, who has collaborated with the POLIS Project in the study of ecological governance. During an interview, the director of this service said having received the backing of the City to hire creative water management experts to solve the problem of long-term water supply in Guelph (2012: Interview).

Incentive

This stage is about building an alliance system able to impose and stabilize the identity of others, cutting off, if necessary, formerly established relations between stakeholders. The incentive is the interpretation of the issue given by those who establish the facts, and their interests as well as those of the residents they recruit in the construction of the network (Lamy, 2007). The goal of this stage is to strengthen the bonds and motivation of the actors vis-à-vis the issue. In the case at hand, the election of a City council open to conservationist ideas was a catalyst for action. Before that, the 1998 proposal of a water strategy was not approved by the Guelph City Council. Nonetheless, some programs such as Outside Water Use Program (2001) and Royal Flush Toilet Rebate (2003) were successfully implemented (Clean Air Partnership, 2012: 10). With this new City Council, priorities were identified along with corresponding actions. The shared objective was sustainable development of the hydric resource, a priority that resonated with the values of the citizens of Guelph.

Enrolment

Enrolment involves the definition and coordination of roles. Its success depends largely on the proper conduct of the incentive stage. It can be described as the alignment of stakeholders to convince others, influence their behaviour, collect resources and be able to disseminate the statement or object in the spatial and temporal dimensions. These are the multifaceted negotiations that accompany the enrolment phase and allow it to succeed.

According to observations made in Guelph, recruitment took place among two groups: First, among the elected council and the rest of the City staff, to persuade them to invest in better management of water resources despite the additional costs generated for the community (experts' salaries, construction of new drinking water treatment plants, repair and replacement of pipes); and second, among citizens, by raising awareness on the importance of getting involved in the water cause. Environmental awareness campaigns are still in place, targeting the younger generation and the more reluctant residents. We can observe the advocacy work accomplished during this stage by the City of Guelph staff in collaboration with researchers, local activists and regional conservation authorities, exposing residents to the same message about the need to conserve water resources. It is the homogeneity and consistency of the message that is striking in this case, even if it comes from multiple sources. This consistency probably accounts for the effectiveness of the actions taken by local governments in enrolling citizens.

Mobilization of allies

It is at this stage that the actors enrolled in a project assume a spokesperson role for the groups they represent, by becoming involved in the development of innovations. However, this mobilization does not guarantee the participation of the actors in embracing innovation and change. Two issues arise: the accuracy of the proposed solutions and the role of each individual involved. Individuals, behaving as active vectors, can adopt behaviours of abandonment or acceptance, which can have an impact on the modes of engagement or the statement of solutions itself, or they can even appropriate the cause by transferring it to totally different contexts.

A milestone in this mobilization was the acceptance of the water bill by Guelph residents and business owners. The water bill was presented in the following manner: Each water consumer pays two charges for water services, one for water usage, the other for the cost of treating wastewater. Each residence or business is equipped with a water meter showing daily consumption. For a family of three, the average annual fee per household amounts to $810 (in 2016). Tips are available on the City's website to help citizens reduce their water usage and identify leaks. This billing strategy is an incentive for citizens to cut down on their water consumption, but it has a dark side to it: Low-income households need to reduce water intake to a minimum if they want to be able to afford the service at all (*principle of symmetry* in ANT). Plans are under way at the City Council to review the water fee structure as of 2017 to accommodate special customer groups (Guelph Water Conservation Project manager, 2016: Interview). Also, the more members in the household, the more difficult it becomes to control overall consumption, especially with children who may forget to use water wisely.

With the 2006 Water Supply Master Plan, a 10% annual increase in billing was planned, to give the population time to adapt to the real cost of water services (City of Guelph, 2013). Water rates cover the following services: infrastructure renewal (present and future), increasing energy costs, administration costs (including reading the water meter), staff salaries, environmental disposal (e.g., solid waste), and equipment maintenance (*Idem*). Funds are set aside to repair and replace water infrastructure to avoid unpleasant surprises down the road.

The community's efforts at managing this collective resource can best be summed up by the fact that "Despite the addition of about 20,000 households, Guelph's water use has decreased twenty percent over the past ten years" *(Idem)*. According to the interviews made with the City of Guelph Water Services employees (2016), "water conservation is also saving customers money due to the ability to delay major water infrastructure projects that would be needed to supply the City with more water". By doing so, "water rates are kept low and affordable as the City does not need to build more supply" *(Idem)*. Although the Guelph Water Services staff has not chosen to take the water soft path approach per se, opting rather for a sustainable water management policy (2012: Interview), the reduction in overall water consumption, in spite of population growth, shows that the community is aligned with water saving strategies endorsed by the soft path. Guelph is therefore well under its way to becoming a smart water community.

The possibilities offered by ANT

Let us first recall that if ANT absolutely refuses to decide *a priori* on issues of scientific relevance, it has nevertheless provided opportunities for the development of analysis tools in the technical, scientific, social, economic and political spheres (Lamy, 2007). ANT provides a foothold into complex terrain and a variety of fields (sociology, science, geography, politics, economics, etc.). According to Latour (2006), the social world is something of a construction site. ANT offers opportunities to observe the operation of the site, the work carried out, and the equipment, tools and devices that are developed there, rather than limiting the analysis to the completed project as if it had always existed, disregarding the building process that led to the final result.

As noted by Cazal (2007), in a context of action research, ANT provides support for participatory development planning at the community level. The tools it offers help external stakeholders and interest groups work together to: 1) identify the key success factors of development; 2) understand the participation strategies of different entities in a network; and 3) build consensus on development priorities. Furthermore, it provides a series of toolkits designed to support the participatory process, which begins with an analysis of the present situation and ends with planning for the future and confidence building between the different actors. Qualitative and quantitative data used jointly allow for a better understanding of the situation as a whole (FAO, 2002). Furthermore, by including both human and non-human elements in its approach, ANT can provide sound information for analyzing a situation in its entirety.

In the case of water management in Guelph, ANT has helped to understand the interrelationships in a system that grows through differentiated contributions from its stakeholders over a given period of time. It provides an external cross-cutting look at the process of creating a multi-scalar network of knowledge-holders on water management. Studying the context of development of the network provides insight on how ideas spread (websites, e-newsletters, conferences, workshops, newspapers, studies, etc.), are endorsed by influential players and accepted by interest groups who appropriate the cause (enrolment) through various administrative bodies, and at different times.

Conclusion

ANT has proved useful to examine the building processes of the pan-Canadian water network and of shared knowledge about water management, rather than looking only at the results or history of the policies. It is necessary to study the processes behind the construction of scientific knowledge and the contribution of each elements of a network to identify the next steps towards making blue cities. The use of ANT has revealed the existence of a wide pan-Canadian water experts network whose interactions have been influencing decisions at various geographical scales, as far down as the city councils. The study of the pan-Canadian water network explains the accumulation of know-how on water conservation and sustainability in a number of different Guelph-based institutions, which contribute to make the city of Guelph a municipal leader in water conservation in Canada. It has also added some insights on the Ontario water governance model stressing the role of conservation authorities in coordinating and monitoring water management strategies and establishing an enduring communication with the Grand River watershed interest groups and residents, through time. The coming together of various water experts on the Guelph territory suggests the presence of a nexus favourable to water innovations. Such nexus is found in geographical studies explaining why some regions win and others lose (Benko and Lipietz, 1992). The attraction of the Guelph/Grand River Watershed territory and the readiness of its actors to embrace collaborative watershed management practices have opened up possibilities to put in practice water soft path principles and think about sustainable water management for the future. The sustained influence of the GRCA cannot be overlooked in the process, as we must recognize the importance of the territorial embeddedness of Guelph in its region and watershed basin. The territory and water themselves are part of the physical elements of the systems and do create a pole for converging interests. The shared alignment of conservationist ideas among local and regional stakeholders has propelled innovation in municipal water management

in the City of Guelph. As such, Guelph could very well be used as a “pilot project” as suggested by Binstock (2010) in the application of the water soft path for other Canadian cities. Nonetheless, the territorial attraction of water intelligentsia may not always be present on distinctive territories and results may therefore differ.

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