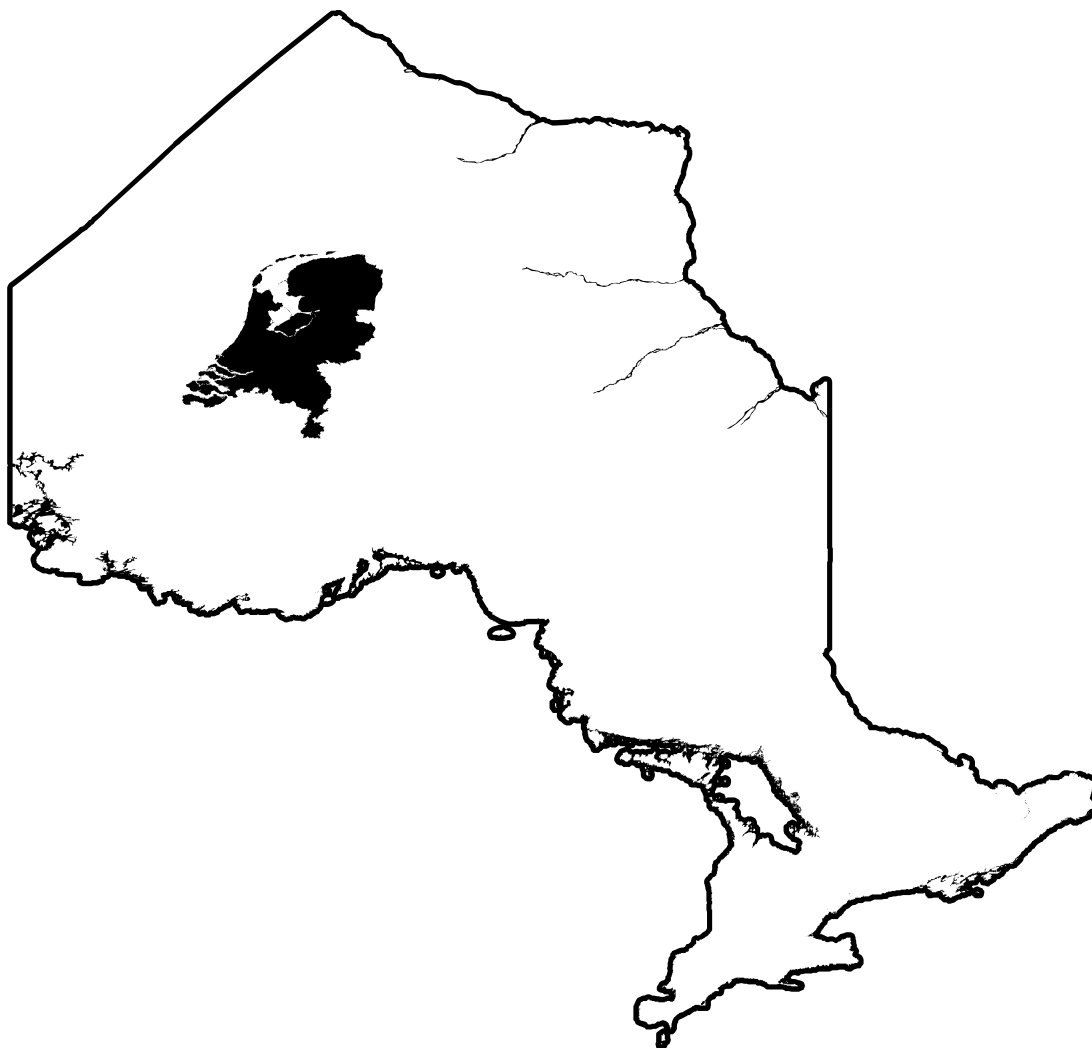


Innovation capacity in the Ontarian system of water use
Creating knowledge about knowledge



Dhr. J.T.M. van Nistelrooij BSc.
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First reader
Dr. M.W. van Buuren

Second reader:
Prof. dr. ing. G.R. Teisman

Master thesis for the master besluitvorming en management van complexe ruimtelijke vraagstukken

Preamble

Every Dutchman thinks that he knows “everything” about water. Why search for innovation in the system of water use in Ontario when you come from the Netherlands? This master thesis isn't written to find innovations but to understand the elements that contribute to create innovations. This thesis has got to create knowledge about the process of creating knowledge. With this thesis I'm finishing my master Public Administration at the Erasmus University Rotterdam. This master is specialized in decision making and management in complex spatial planning questions, Innovation is definitely complex and the water system is of course part of spatial planning. I hope to give meaning to the multiple interpretable words and show with this paper that the two systems in Ontario are one complex unity.

This thesis is part of a larger research done by DHV and the Erasmus University. In that research a comparison is made between four countries: Portugal, the Netherlands, South Africa and Canada. I would like to thank both organizations for the possibility I received to go to Toronto and participate in this research. Although some parts are influenced by the comparative study I hope you can also see my own influence and my own perspective on the reality. My perception of the reality as shown in this thesis is influenced by many participants of interviews, employees of Delcan and DHV. I would like to thank them all for their participation. More specific I would like to thank; Gerard van Houwelingen for the guidance and good conversations in Canada; Ytsen Deelstra and Jos Peters for the supervision of the project and guidance in the Netherlands; Wijnand Smulders and Angela Gomes for their being as fine colleague and cooperation; Tim Hoopman for linguistic suggestions; Arwin van Buuren for the guidance from the Erasmus University; my family for their support to go to Canada and Janet for all her patience and support, and lonely hours waiting for me. I hope you can enjoy reading this thesis.

Amersfoort, September 2008

Jos van Nistelrooij

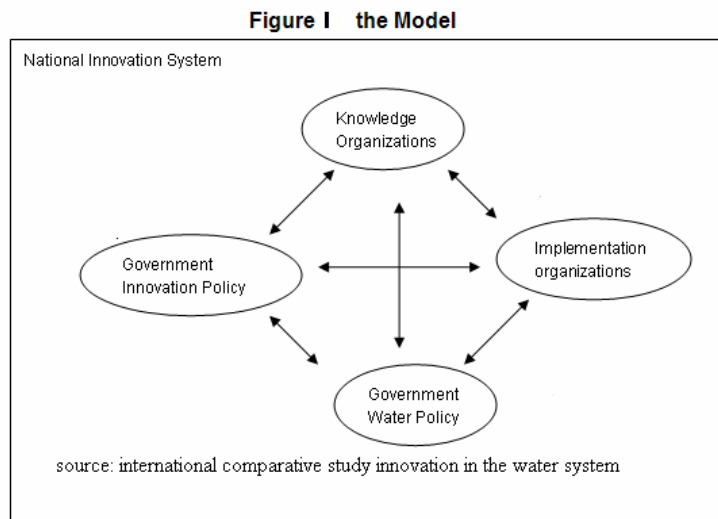
Summary

This research is done for a master thesis in public administration and a comparative international study of DHV. It describes the innovative capacity in the system of water use in Ontario and gives some recommendations for the Ontarian and Dutch governments. The innovative capacity in a normal system can be explained by elements of innovation theory. A company innovates to create a temporary monopoly on the market. In a governmental organized sector the drive to find innovations is less apparent because the organizations already have a monopoly. Political pressure or other elements can be of influence on a governmental controlled sector and thus also on its innovative capacity. Besides scientific relevance knowledge about the elements that explain the innovative capacity the research also is relevant for the society. The Dutch ministry of Housing, Spatial Planning and Environment and the ministry of Roads and Waterworks are working on a long-term innovation vision for the Dutch system of water use. This research can be used to identify elements for this long-term innovation vision. The main question of this research is: *What explains the innovative capacity in the system of water use in Ontario?*

The four sub questions of this research are:

1. *How is the system of water use organized in Ontario?*
2. *In what way is the innovation system in Ontario organized?*
3. *What constitutes the innovative capacity in Ontario?*
4. *What are the barriers and drivers in the innovative process in the system of water use in Ontario and how can the government influences these barriers and drivers to increase the innovative capacity?*

In the innovation literature is there no model that describes the innovative capacity in a governmental organized sector. The model in Figure 1 is created for the comparative research based on different theories. The most important theories that were used for the model are the National Innovation System, the diamond of Porter, the triple helix model and the model for national innovative capacity by Furman, Porter and Stern. The model is build on three components: the country specific elements, the organizations and the clusters of organizations. These components are related to the innovative capacity with the use of the definition. The definition of innovative capacity as used in this research is **the ability of institutions and their relations in the system of water use to create, collect, interpret and implant new ideas, designs and application to products and services in practice over the long term.**



For this research three analyses are done: a context analysis, an actor analysis and a network analysis. The outcome of the three analyses are used to create one statement on the innovative capacity of the system of water use in Ontario. Empirical data is collected by a document analysis and several interviews.

The three context elements that explain something about the innovative capacity of the system of water use in Ontario are: the Education, the economic and human development and the geographic aspects. The system of water use in Ontario is decentralised, the municipalities have implementing powers to produce drinking, waste and storm water. The provincial ministry of Environment regulates the system. The municipalities are free to choose the operator private or public. For storm and wastewater there is cooperation with the Conservation authorities. The conservation authorities

operate between the local and provincial level. The municipalities can use some fund from the provincial ministry of Public infrastructure renewal for the replacements or creation of water facilities. The knowledge organizations in Ontario are characterised by the divers mix of companies, universities and public research institutes. The knowledge organizations have due to this diverse mix also a diverse mix of knowledge. The innovation policy organizations are federal and provincial organized to stimulate the knowledge organizations. Only the Awwa Research Foundation (AwwaRF) and the Water Environment Research Foundation (WERF) are demanding specific knowledge from the knowledge organizations. The network organizations play a large role in Ontario for connecting organizations to each other.

The innovative capacity of the system can be explained by the innovations created at the implementing organizations or the knowledge organizations and the stimulation of the water and innovation policy organizations of these innovations. The innovative capacity of the implementing organizations is relatively low because of its position. The implementing organizations are autonomous but have to meet regulation criteria. Innovative solutions have to prove that they meet the quality norms by delivering controlling data to the Ontarian Ministry of Environment (MOE). The smaller and medium municipalities don't have financial resources or enough staff to do the research. This is the result of the water tax and the local political conservative influence. The two barriers identified in this system are related to this problem; the demand for innovations is low and the local political interference is high. This lacking demand is also the result of provincial policy, because of secotarialisation there is no provincial specific innovation policy for the system of water use. The positive influence on the innovative capacity comes from the larger and growing municipalities because they have more relations with knowledge organizations and are better able to allocate resources for innovation. Like the companies and universities are individuals important for the creation of the innovations. They sell their innovations to other organizations. This entrepreneurial spirit is the first driver. The large networks are recognized as second driver because they stimulate the exchange of knowledge. These networks are facilitated by the Innovation policy organizations and the network organizations. The large networks in Ontario relate organizations to each other and provide a basis for cooperation. An important aspect that is essential for all the organizations is the institutional infrastructure, the high developed education system provides a high develop workforce. This workforce makes it possible to be innovative.

This research is based on qualitative research and giving a degree to the amount of innovative capacity is for that reason dangerous. Giving a summation of quantitative elements doesn't make it a qualitative study. Without giving a number on a scale, the innovative capacity in the system of water use is described by the degree of innovative capacity. The degree of innovative capacity is medium to high. The knowledge stock, the knowledge infrastructure and the available knowledge organizations can facilitate a system with a high innovative capacity but the implementing organizations aren't using the possibilities to it's maximum. The reason that the municipalities aren't as innovative as they could be lies in the local political conservatism, the water taxation and the lack of steering on innovations from the provincial government.

The most important recommendations for the Ontarian government are to change the financial system and raise the implementing level to regional or above regional level. This will decrease the local political conservatism and increase the demand for innovations. The Dutch government can stimulate innovation in the system of water use by creation knowledge exchange between parts of the system, stimulating partnerships for research and prevent policies of implementing organizations that focus too much on price.

Abbreviations

AMO	Association of Municipalities Ontario
AWWA	American Water Works Association
AwwaRF	Awwa Research Foundation
CFI	Canadian Foundation for Innovation
CFM	Canadian Federation of Municipalities
CIHRC	Canadian Institute of Health Research Council
CWN	Canadian Water Network
CWWA	Canadian Water Wastewater Association
IRAP	Industrial Research Assistance Program
MOE	Ministry Of the Environment
MMA&H	Ontario Ministry Municipal Affairs & Housing
NAFTA	North Atlantic Free Trade Agreement
NCE	Network Centres of Excellence
NRC	National Research Council also known as Canadian National Research Council
NSERC	National Science Engineering Research Council
OCE	Ontario Centres of Excellence
OCWA	Ontario Clean Water Agency
ODWAC	Ontario Drinking Water Advisory Council
OECD	Organization for Economic Co-operation and Development
OMWA	Ontario Municipal Water Association
OMAFRA	Ontario Ministry of Agriculture, Food, and Rural Affairs
ORF	Ontario Research Foundation
ORIC	Ontario Research and Innovation Council
OSPE	Ontario Society of Professional Engineers
OWWA	Ontario Water Works Association
OWWEA	Ontario Water Works Equipment Association
PEO	Professional Engineers Organizations
PIR	Ontario Ministry of Public Infrastructure Renewal
RIN	Regional Innovation Network
R&D	Research and Development
TRCA	Toronto Regional Conservation Agency
SR&ED	Scientific Research and Experimental Development
SSHRC	Social Science and Humanities Research Council
STEP	Sustainable Technology Evaluation Program
SWAMP	Storm Water Assessment Monitoring Program
WEAO	Water Environment Association Ontario
WEF	Water Environment Federation
WERF	Water Environment Research Foundation

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1. Introduction

The production and distribution of water are recognized as two of the basic tasks of the government. The government has to safeguard availability and quality, because water is a basic need and contaminated water forms a health risk. How the government organizes the water sector differs per country but the importance of safe drinking water is always acknowledged. The production of drinking water and the treatment of sewage can be done by a public or a private organization and can be regulated in several ways. To prevent disasters the government has to ensure the quality of the water. Stimulation of innovation and implementation in the water sector is important to prevent future disasters. As result of the high costs and the risk of failure and thus the loss of tax money innovation is, in a government-controlled sector, a political issue.

In innovation literature there are several elements that stimulate innovation in a society. The innovation literature is part of the economic studies, because innovations originate as an aspect of the market. A company has to be competitive, for instance with an innovative solution, or it will lose its market share. There are several elements that support the creation of innovations in a country. When all those elements in a country are brought together one can speak of a degree of competitiveness for a country, or the capacity of a country to be innovative. The differences between countries can be explained by a difference in elements. The difference of innovative capacity between countries can for instance depend on the level of education of the workforce. These elements of the economic studies can be used to describe innovation in governmental controlled organizations. It is likely that those organizations are also influenced in other ways. This could give some insight how these elements influence the innovative capacity in a sector dominated by the government. When the general innovative capacity of a country is large this doesn't have to influence a specific sector. Therefore it is important to understand to what extent the government should motivate innovations or implementations in a sector that they control. To put shortly the goal of this research is; which elements explains innovative capacity in a governmental controlled sector?

Innovation is as simple and as complex as the society. You can describe it in many ways; how it functions or how parts of the society interact to create innovation. It is a wonderful unity build of elements that influence the process. This research tries to find some of these parts to explain the innovation capacity in a governmental controlled sector. According to Simon (1996 p.1) it is the task of science to show that complexity, correctly viewed, is only a mask for simplicity, to find patterns hidden in apparent chaos. This goal of finding patterns in apparent chaos fits with the reason of writing this thesis, it is written for the writer's graduation for his master Public Administration direction Decision Making and Management of Complex Spatial Questions at the Erasmus University Rotterdam. The goal to explain the elements of the innovative capacity fits with the scientific relevance of the study but is also relevant for society. Both companies and government need knowledge about this system to be able to steer the sector and make decisions that will benefit the innovative capacity.

The Dutch company DHV is as engineering and consultancy firm an expert in combining technical solutions with complex spatial questions in society. As an international company DHV finds it interesting to know what the differences between countries are and what kind of effects these differences have on the implementation of technical solutions. An international comparison of innovative capacity in the water sector can explain more about the sector specific elements. For this reason is this thesis part of a larger international comparison between three countries: Canada, Portugal and South Africa.

The Dutch ministry of Housing Spatial Planning and Environment and the ministry of Roads and Waterworks are working on a long-term innovation vision for the Dutch system of water use. The two ministries have the same interest in finding the specific elements of innovative capacity in the system of water use, to be able to steer innovation in the system of water use. The complete water sector would be too large for this long-term innovation vision but focusing of the system of water use is doable. In the agreement between the ministries and the water producing organizations (het

Bestuursakkoord, 2007 p1-10) is the system of water use specified as; "*the production of drinking water, and treatment of sewage and storm water.*" DHV has functioned as principal for this research and in cooperation with the Erasmus University Rotterdam was DHV the supervisor of this thesis.

The goal of this research is to find the elements of innovative capacity in the system of water use in Ontario and not in Canada. Canada has a size of 9,984,670 km² and is 240 times larger than the Netherlands. (Britannica encyclopaedia online 2008) The financial resources and the availability of time didn't allow to do research in all ten provinces and three territories of Canada. The office of Delcan, the strategic partner of DHV in Canada, is positioned in Markham near Toronto. The provincial government of Ontario is seated in Toronto and for the convenience of this research the scope of this research is the province of Ontario. This research hopes to show that the complexity of innovation in the system of water use in Ontario is build on a pattern hidden the apparent chaos. It is interesting to find, in this hidden pattern of innovative elements in organizations and their relations, which these elements influence the innovative capacity in the water system of water use.

1.1 The questions for this research

The main research questions of all the three master theses are identical but the focus of this research, the country, is different. To be able to include all the Ontarian specific elements of the system of water use a basic, simple and short research question is used. The simplicity will bring the power to include as many as relevant elements in the research.

The main question: *What explains the innovative capacity in the system of water use in Ontario?*

This main question doesn't include a prescriptive element on how the Ontarian government positively can influence the innovative capacity in the system of water use because the purpose of the research is a descriptive analysis to find elements that increase or decrease innovative capacity. When the focus of a research has a prescriptive character, the risk to look only for elements that can be influenced by governments is high. Of course a public administrative paper should contribute to both science and society, the element of prescription shall be used in the last sub question to help the system improve, based on this research and the international comparison.

To answer the main question in logic steps the first thing that needs to be described is the organization of the system of water use in Ontario. The unique organization of system of water use in Ontario is depending on the country specific governance and institutions, which influence the innovative capacity. This description functions also to see organizational problems or solutions. The need to understand a specific sector is important, because sector specific features can influence innovation positively or negatively, because these elements have different functions in the sector. Organizational questions need to be answered to understand how they depend on each other. Therefore the first sub question will be:

1. How is the system of water use organized in Ontario?

In the system of water use there are organizations that contribute to the innovative capacity by being innovative. Related to these organizations are organizations, which are specialized in innovative solutions and institutions to support innovation in general. These organizations and institutions form an innovation system in a country that is larger than only the water sector. They have an indirect influence on the system of water use but a direct influence on the innovative capacity. The second sub question will describe these organizations and their functioning:

2. In what way is the innovation system in Ontario organized?

The relations between these two questions can help to explain how the innovations arise in the system of water use in Ontario. Patterns of interaction, allocation of resources for innovation and other elements can show patterns of innovation. These patterns show the process to come to innovations. This process is important to understand because it explains which of the elements contribute to

innovative capacity. This innovative capacity has to be seen as a process between the two systems that constitutes innovations. For this reason the third question shall be:

3. What constitutes the innovative capacity in Ontario?

To be able to use this research as a contribution to the Ontarian society, it is interesting to know what the barriers and drivers are in the process of being innovative. Especially the Ontarian government needs to find how the innovative capacity can be enlarged. Furthermore is information on how to influence innovative capacity relevant for other governments. The fourth sub question shall be:

4. What are the barriers and drivers in the innovative process in the system of water use in Ontario and how can the government influences these barriers and drivers to increase the innovative capacity?

1.2 Chapter description

To find the answers on the research questions a model is created, based on innovation theories and public administration concepts. These theories and model are presented in chapter two. The concepts of public administration can sometimes be vague. In chapter three is showed how these concepts can be found in organizations and which methods are used to do the research. In chapter four the country specific elements are presented, these elements are found in the institutional context of the society and explain why certain organizational elements are as they are. All the organizations in the water and innovation system are presented in chapter five. The roles and structure of the relations become visible in chapter six. In chapter seven are the country specific element, the organizations and the relations used to constitute the elements of the innovative capacity in the system of water use in Ontario. Following from these elements is it possible to identify drivers and barriers. Chapter eight shall conclude this thesis with the answer on the research questions and some recommendations for governments and further research.

1.3 Summary

The innovative capacity of a sector consists of several elements that support the creation of innovations. In a market innovations arise as result of competition, but the system of water use is innovation regulated by the government. This results in the question: what explains innovative capacity in the system of water use? This research is done for a master thesis in public administration and a comparative international study of DHV. It tries to describe the innovative capacity in the system of water use and to give some recommendations for governments.

The main question of this research is:

Which elements explain the innovative capacity in the system of water use in Ontario?

The sub questions of this research are:

1. How is the system of water use organized in Ontario?

2. In what way is the innovation system in Ontario organized?

3. What constitutes the innovative capacity in Ontario?

4. What are the barriers and drivers in the innovative process in the system of water use in Ontario and how can the government influences these barriers and drivers to increase the innovative capacity?

2. Theoretical framework

Innovative capacity is a very simple and complex term. Simple because innovative capacity refers to the ability to produce innovations. But innovative capacity is also complex since the interactions of the many indicators that explain the ability to innovate, are ambiguous, double, multi-interpretable and hard to quantify.

Economic studies have developed a list of indicators that positively influence the capacity of a country to innovate. These are based on quantitative studies and statistically they are overall right but can't explain some of the cases. The focus of economic studies is based on competition because in the market a company is only able to survive if it outperforms the competition, for example by being innovative. Without competition economic studies aren't able to explain innovation. This makes the water sector very interesting; due to several governmental tasks there is no direct competition. The government will have to stimulate the sector to be innovative or it will, according to the economic studies, lack innovation. A public administration study is necessary to explain how the government stimulates this innovation and what the drivers of innovation in this system of water use are.

The indicators given by economic theories are useful, but the incentives to innovate can be different in the public sector. Paragraph 2.1 will introduce the economic approach to innovation. It explains the start of innovative thoughts from a company's perspective and works slowly to a full national innovation system. Paragraph 2.2 shall introduce the special character of the water sector and will introduce the difference between the bureaucratic, market and network model of governing. These steering methods shall be of importance for the ability of governments to stimulate innovations or to innovate themselves. The innovation literature and the specific elements of the water sector and the governance structures shall be combined in one model in paragraph 2.3. This paragraph will also define innovative capacity.

2.1 Innovation theory

The theory of innovation finds its origin in the study of business economy. If a company isn't able to innovate and his competitors do, he will lose his market share. With this in mind it's not strange that the first thoughts about innovation came from a competition point of view. The development of innovation theory will be presented with the different perspectives on innovation. Where in the beginning years of the innovation theory the perspective was centralized around the company, and its competitive benefit, the innovation theory changed to a more governmental perspective with innovation as leading point for economic development. This paragraph will try to show this development and introduce the important aspects of innovation that can be used in the model in paragraphs 2.3.

The definition of innovation and the start with Schumpeter

Being innovative for a long time was considered an aspect of competition. Many historical economists like Adams and Ricardo describe competition. Schumpeter was in 1912 the first to introduce the entrepreneur as a driving force of the economy and competition. (Katzky 2005 p.5) He introduces the radical innovation ("creative destruction") as a way to eliminate competition. Schumpeter also introduces the aspect of incremental innovations, improving and adjusting others techniques ("routine capitalism"). In his model innovation comes in waves and there is always one driving force, an entrepreneur or a research facility. His approach of innovation is based on a linear model, a longer theoretical description of Schumpeter can be read in appendix 1.

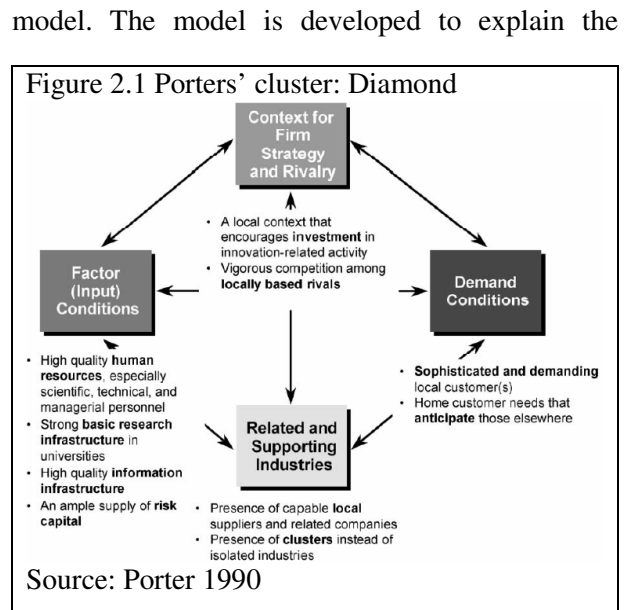
Innovation as used in this thesis is the ability to create, collect, interpret and implement new ideas, designs and application to products and services in practice (Nayak and Ketteringham 1986) and this process can be viewed at several levels. This is a very wide definition of innovation, because the focus of this research is not on innovation but on the factors that stimulate the creation of innovations. For this reason the whole process of creation and implementation is included and all kinds of innovations are acknowledged. The use of the linear model of Schumpeter ended with the rise of the cluster. Empirical and theoretical prove showed that being innovative was more of a process of interactions than a linear occurrence of inventions.

Japan and the rise of the cluster

The rise of the Japanese industries in the eighties can be seen as the starting point for a paradigm change, since innovations in cluster became as a result of cooperation. Both in theory and in practise was, not a single company, but a cluster of companies the focus for innovation. The reason for a cluster as a starting point for innovation originates from the fact that more companies together are better able to share the risks and have more knowledge normative and empirical. Cooperation needs communication and knowledge exchange; a short distance to each other makes this possible, which is available in a cluster. More explanation of the rise of the clusters can be read in appendix 1. The common used definition for a cluster is: "Clusters are geographical concentration of interdependent firms with similar or closely related capabilities". (Porter 1990)

Porters' model of the cluster

Porter used the definition of a cluster in his model. The model is developed to explain the characteristics of the environment that shapes the rate of private sector innovations in a nation's industrial clusters. He recognizes the dynamics of innovations and the dynamics of interactions, between clusters and specific institutions. For this interaction he created four key drivers as shown in figure 2.1. Central for this interaction is the group of companies in a sector. Competition and the local context are drivers for a company to invest in economic solutions, otherwise the competitor shall be more innovative and the company will go bankrupt. The demand conditions are the costumers, when they have special demands and are willing to pay for new solutions than they drive innovations. When supporting industries in different sectors are innovative these ideas can spillover. This spillover can result in innovation in the sector of the company. The input factors are basic conditions and those underwrite the importance of education and other resources.



The problem with the model of Porter is that water producing organizations have a monopoly, as will be explained in paragraph 2.2. The context for firm strategy and rivalry would be zero and as a result there would be no innovation in the water sector. The demand conditions are also special because of the monopoly. The model is usable for knowledge companies, who sell innovations to the water producing organizations, because the knowledge companies have a demand. This model can't be used for the water producing organizations because the demand of their consumers is different organized. In the model that will be explained in paragraph 2.3 this split between knowledge producing organizations and water producing organizations is essential.

The different government roles aren't visible in this model. In this model the government can influence the input factors, by stimulation education and scientific research and in the system of water use it is also able to stimulate the demand. The relation between the stimulation of research and the stimulation of demand is important, this interaction will be mentioned in paragraph 2.3 because it gives an extra possibility for the government to stimulate innovation.

Triple helix model

The triple helix model uses, like the cluster theory, close relations as driver for innovation. But it is more based on public and private interactions. Where Porter identifies governmental influence as one driver, the triple helix theory is separating state and academia. Although the triple helix model is closely linked to the national innovation theory, which will be explained later, it deserves special attention. The cluster theory centralises cooperation around a company but the triple helix theory gives

a central role to the universities. Etzkowits and Leydesdorff describe the triple helix relation between the state, academia and companies in three modes (2000 p. 111).

In the first mode the state includes the academia and the private corporation. The second mode recognises the independence of the academia versus the state and the bounds with the industry. This second mode is mostly developed by Giddons (1994). The communications and negotiations are more bottom-up while the first mode uses more a top-down approach. In the third mode trilateral networks and hybrid organizations are used to interconnect the academia, state and industry. This last mode is the most interconnected one where interdependence between the three actors is very important. In a society the three different kinds of modes can be seen. Gibbons et al. (1994) argued that a “new mode of production of scientific knowledge“ has become manifest. But it doesn’t explain how the dynamics between those modes are arranged. (Etzkowits and Leydesdorff 2000 p. 115)

The triple helix model identifies two actors or institutions with a public task the government and the academia. The interaction and three different modes of governance between those actors can be of use for the model in paragraph 2.3. But the water sector has more kinds of institutions, for the identification of those institutions the theory on National Innovation Systems (NIS) shall be used.

National and local innovation system theory

The National Innovation Systems (NIS) uses innovation not from a company, or cooperative view but as an important aspect of the national economy. According to Freeman, a national innovation system (NIS) is “the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.” (1987) Although Freeman and Lundvall were the first contributors, they both point out that Friedrich List is the first thinker on this matter as he describes "the national system of Political Economy" in 1841 (Freeman 1995). System in national innovation systems refers to a historically dynamic context and not to a deterministic context. List was the first to identify parts of this production system, he wasn’t able to see the picture made by Lundvall and Freeman. The structures of the production system at national level and the institutional set-up depend on this historically dynamic context. Institutions in this context are the roles organizations play or identify themselves with. The number of institutions identified in a national innovation system can differ per country as result of historical differences. The institutions and the elements of these institutions can be of crucial importance or may be a hindrance to innovative capacity. A basic list of the institutions is given by Miozzo and Walsh (2006 p.145).

1 *Business firms*; firms are the institutions that have to invent the innovation, through R&D or through cooperation. The private investment in R&D is higher than investment from the government in most of the developed countries. Depending on the sector are firms more willing to invest in basic research or in direct applied development. The importance of this institution lies in the commercialisation of the innovation. Without implementation the discovery of an innovation is worthless. The balance between small firms and large firms says something about the level of development. Small firms have behavioural advantages (creativity, flexibility, propensity to take risk and good internal communication) large firms on the other hand have resources advantage (finance for investment, range of staff with different skills and experience, size of R&D, and range of products). They can play a complementary role with inter-organizational relationships. (Miozzo and Walsh 2006 p.148)

2 *Educational institutions*, these institutions are important because only an educated workforce is able to create or to adapt to innovations. The specialization of firms in a national economy is the result of different competencies in the education. All the levels of educations are important, because only an elite group of innovators will not be able to implement innovations. (Miozzo and Walsh 2006 p.149-150)

3 *Public sector research establishment*; The public sector research establishment can be financed by the public and private sector and has as goal the creation of knowledge. Depending on the country this role is fulfilled by universities or governmental research institutes. The value of these research institutes lies in their basic research and their links with the private sector.

4 *Public policy*, several governmental bodies at local regional and national level have adopted policies to promote and regulate innovations. Within these policies five different roles can be identified. The first role for the government is as user of innovation. Providing a growing and reliable level of market demand, this leads to investments from the private sector. In the water sector the government is the only actor to create a demand for knowledge. The second role for the government is to support the science and technology by investment in education and R&D. The educational institutions have already mentioned the importance of education. The investment in technology also is a role of public policy. Funding technology can be based on the funding of fundamental science, mostly done at universities and public research institutes or funding can be used for applied science. Stimulation of companies to become innovative, the funding of applied science, can also come through tax incentives or subsidy. But also providing loans to be able to invest in risky technology is a governmental role. This third role will be further explained with the description of the financial institutions. The fourth role of policy is to stimulate cooperation between organizations. These stimulants have to result in closer linkages between both private and public organizations and a mix of applied and fundamental science. The fifth role lies in the power to regulate and create standards, by prescribing a higher level of standards the demand for innovations will rise. The regulation of intellectual knowledge is also part of this fifth role. (Miozzo and Walsh 2006 p.151-153)

5 *Financial institutions*, the financial institutions can play a crucial role in the innovative process because the private sector in some stages depends on foreign capital. Being innovative means taking the risk of failure. The way in which foreign capital is attracted can differ from the stock exchange, loans from the banking sector or financial support from the government. More possibilities to get financial support will result in more research, the risk of failure will stay the same but the abilities to do high-risk research will grow. The government can take some of the risk with governmental programs.

6 *Legal institutions*; legal institutions are important to secure the intellectual property rights. Companies are only willing to invest in the development of innovations when they have benefits of these investments. By giving patents to firms, the government is creating a temporary monopoly on a technique, to create a possible financial return. The disadvantage of this stimulation is the lack of possibilities to use techniques of others because this means that a firm has to pay for the usage. Assigning patents in networks is also very difficult because the creation is a joint production, contracts can arrange some cooperation but not all.

7 *Trade unions and political organizations*; political actors can behave as a barrier or driver to innovations. Their role is indirect because innovation isn't necessary their purpose. A union can be a barrier when new techniques would replace jobs but a driver when there is need for techniques to secure health. (Miozzo and Walsh 2007 p.145, de Bruijn, P. van Oort, P. Raspe, O. 2004, p43-44)

The appearance of these institutions in a system only predicts that some tasks are done by organization. Because innovation is a process only mentioning organizations doesn't give a complete picture of the capacity of the system. For innovative capacity the focus should be more on the interactions between the institutions. Resulting from the interaction in the system is the allocation of resources by the institutions. This allocation should lead to an optimal configuration of the functions of the institutions. Since every country is different there isn't an optimal configuration known. Although the indicators for the institutions in the economic theory are quantitative the optimal configuration is a qualitative statement. Therefore the same optimal configuration should be following from the model in 2.3. Summarizing from the different tasks from the list of institutions mentioned above has the optimal configurations to include:

- A working demand structure
- A high educated workforce
- A financial system to support risk taking of the firms
- The development of fundamental science and applied science
- Access to science and technology
- The ability of firms to incorporate several elements (innovation as part of the business culture)
- The creation of collaborations, through networks
- A good working business environment and legal system

(Miozzo Walsh 2006 p.145-153)

These elements are also identified by the OECD (2005 p 234-236) as possible determinants of the innovation performance. The problem with an optimal configuration is the dependence on each other and the local situation. The basis of these indicators is that they don't work on alone. When Economic studies are made to measure the capacity on the system, they are only statistically measuring the several loose indicators and the statistic influence on each other. They don't include the interactions between the institutions. The allocation of resources isn't just a decision, it is a political game. Only referring to the local context doesn't make it valid to underestimate the interactions. The elements of this theory, both the institutions and the optimal configurations, are very valuable for the model. The institutions can be used to identify the roles of that the actors play in the system of water use to create innovation. The optimal configuration can show some barriers or drivers when there are problems with the realization of this configuration.

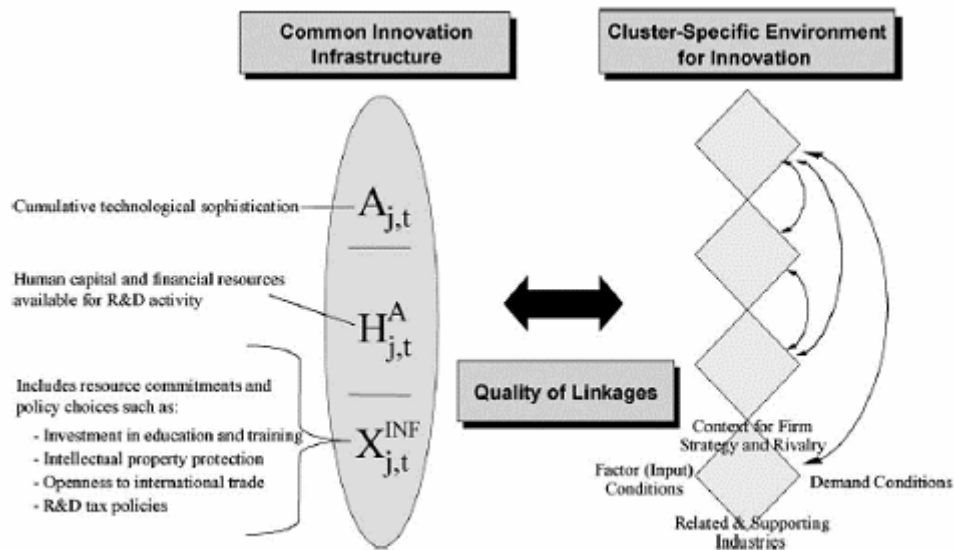
National innovative capacity used by Economists

The only theory that brings the cluster theory and the national innovation systems together is the theory of national innovative capacity. Furman, Porter and Stern made a combination of those theories to be able to calculate the innovative capacity of a country. They defined the national innovative capacity as: the ability of a country to produce and commercialise a flow of innovative technology over the long term. (Furman, Porter, Stern 2002 p.899) The strength of the national innovation capacity depends on the nation's common innovation infrastructure (based on the innovation system theory), the environment for innovation in a nation's industrial cluster (based on the cluster theory of Porter) and the strength of linkages between these two. (Furman et a 2002 p. 899-933)

The common innovation infrastructure is build on three drivers: the stock of knowledge, the talent pool and the national investments and policy choices. The stock of knowledge is the availability of a basis of fundamental and applied knowledge, which can be a starting point for innovations. The talent pool is the workforce needed to create and implement innovations. The National investments and policy choices is the influence of the government. The several government roles are here mentioned as one driver. (Furman 2006 p.20) These three drivers are the combination of the several indicators given by Nelson to create a National Innovation System.

Cluster specific environment for innovation is based on the earlier mentioned cluster diamond of Porter. To describe the relation between the indicators from the National Innovations system and the indicators from the model of Porter this model calculates the quality of the linkages. This calculation is based on two statistical indicators.

Figure 2.2 Model of Nation innovation capacity



Source: Furman, Porter and Stern, 2002 p.906

The model shown in figure 2.2 is made by Furman, Porter and Stern and used for quantitative economic analysis. It is also relevant to this study, because it gives a definition of innovative capacity and it makes the linkage between the institutional factors and cluster specific factors. The problems with this model are that the water sector isn't correctly measurable with the cluster model of Porter. Water producing organizations have a monopoly, as will be explained in paragraph 2.2. The context for firm strategy and rivalry would be zero and according to Porter as a result there would be no innovation in the water sector.

The model counts the number of platforms and the combined investment in research as basis to describe the quality of the linkages. As a result the quality of the linkages between the cluster and the institutional indicators is very statistic. In the social theory there are other ways to interpret the quality of linkages. The elements, which are used to describe the common innovation infrastructure, are part of organizations. A quantitative statement can be made on the innovative capacity when these organizations are related to the system of water use. If it is possible to combine this idea with cluster specific features and the social measurement of interactions, than we are able to make a real statement on the innovative capacity of the system of water use.

2.2 The water system and governance

In ancient times the Romans were able to supply the city of Rome with a good working water system. However the governmental influence in the water sector was recognized even before the rise of the Roman Empire, Archimedes (287BC -212BC) stated that; *"Men should judge it's municipal board on the hand of the care for it's drinking water supply"*(de Moel, Verberk van Dijk 2005 p.48)

2.2.1 The natural monopoly and health concerns

The first water company in the Netherlands was NV Duinwater-Maatschappij in 1853 and it was for 0,8 million Euro financed mostly by foreign investors. Mostly with English money, who knew the system of water use was a profitable market. The company took water from the dunes in Haarlem and transported it to Amsterdam through a distribution network. Before 1853 water was brought to the city by boat. Although the company was bringing more water every year, the public was complaining about high rates and the unfulfilled needs. The company wasn't able to meet the growing needs of the growing city and the rates where considered too high as result of the lack of competition. In 1896 the company was taken over by the city of Amsterdam (de Moel, et al 2005 p.49). Comparing to Toronto the people of Amsterdam were late in setting up a distribution network for the city. In Toronto a private gas, light and water company started in 1843, to distribute water through a small-scale network

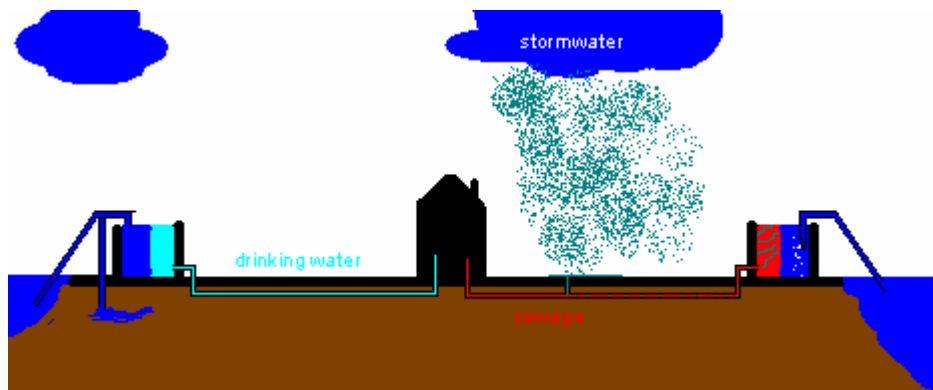
of wooden pipes to private houses in York. The municipality of York also bought, for the same reasons as in Amsterdam, the drinking water company. (Source: website city of Toronto)

The natural monopoly on the distribution network and the health risks when water is contaminated, make drinking water and sewage treatment a public good. The water source is a public good, not a common good because it can be rivalrous and people can be excluded from the use. When one person drinks purified water there is less “clean” water for others. The resource, water, is a common pool but the treated water isn’t. Due to the distribution system it is possible to be excluded from the water. The market is able to deliver this good but it wouldn’t supply water in less populated areas because the investment of the distribution system would cost too much. And the risk of the misuse of the monopoly is too high. The importance of drinking water for the public health makes it a governmental task, the creation of this positive externality requires at least regulations.

Van Ast (2000) recognizes five stages of water management and governmental influence in the water sector. The first stage is based on safety (flood protection), the second on land use, the third on human use like drinking water and the treatment of sewage. The fourth stage is integral water governance where the first three single stages are managed together. The fifth stage is interactive water management, this stage is based on interaction between water management and the society. Although these stages are made on the historical process in the Netherlands, they can also be relevant for this research. The perspective on water management and the society on the water sector can have influence on the size of the sector and the connectivity to sub-sectors. In the model of Porter as mentioned in paragraph 2.1 the connectivity to sub-sectors, related industries, would be seen as a positive element for innovation. The definition of the system of water use shall for this research be a bit smaller than all the aspects of the five stages.

“The system of water use can be defined as the services for the household and companies that are involved with the use and discharging of water. The system of water use includes the wasting and supplying of drinking water, the collecting of effluent wasting of it through the sewerage and the transporting and purifying of the urban effluent. “(Bestuursakkoord waterketen, 2007, p. 2)

Figure 2.3 Water system



Source: made for this research

As the picture showed the three products, drinking water, sewage and storm water can be seen as one system. The five stages made by van Ast showed that the object for water management changed per stage. With the change of water management also the role and aim of the government changed. Resulting for the different roles are there different organizational structures to manage the different aims. This aspect of different roles have to be used in the model and can be used besides the roles of the national innovation system theory.

The model that will be presented in paragraph 2.3 uses the roles of institutions as mentioned by the innovation literature and the roles of the governmental institutions to describe the innovation system in the system of water use. To be able to provide a meaning to the role and functioning of the organizations in the model it should describe some of the institutional elements of the organizations. These elements are only relevant for the innovative capacity in relation to other organizations. The innovation process is the result of interaction between organizations. Elements of organizations have to be viewed in relation to each other and as basis for the innovation process.

2.2.2. Government organization and types of steering

The paragraphs above mentioned different roles for the government. One organization can have different roles therefore the role alone is not useful for a description of an organization. The way the government plays these combined roles can be seen in the different types of relations. Governmental organization shall use different instruments to play the roles and to steer the sector. This steering of the government is also called governance. For this research three different types of governance are introduced. The traditional bureaucracy, the market and the network structure, each have their own strengths to stimulate innovation. These steering mechanisms can be used to understand which element of the organization explains the innovative capacity. The same instrument of an organization can function totally different in a different governance model. Strict rules on standards can be a positive element in a hierarchy and a negative element in a network situation.

Bureaucracy

Bureaucracy is based on the power of the legal decision monopoly. As a central actor the government decides how the society should be run. (Hughes 2003 p.21-22) As a result of the procedures, the hierarchical bureaucratic organizations are accountable and every case will be equal for the law. The flexibility to change the policy for independent cases is very low. In the context of this research this can be a negative aspect of the bureaucratic organization, as Huges mentioned; “it breeds timeservers instead of innovators” (Huges 2002 p.34). It encourages being risk averse and for innovations you need to take the risk of failure to become successful. A bureaucracy is a decreasing factor for innovative capacity when it is too rigid and too centralised. The two aspects that can be recognised to declare that a bureaucracy is too rigid are: sectoralisation of departmental policies (in Dutch “verkokering”) and implementing problems as result of the lack of implementing freedom. (Kickert 1998)

Market

The market has not one central organization but many independent actors and the functioning of the market isn't based on regulations but on the pricing mechanism. The pricing mechanism is based on a system of a demand and supply of a product. As result of competition the lowest price will arise from the market. The actors in the market are suspicious to each other because working together has the risk of losing a benefit to competitors. The agency theory, created by Jensen & Meckling (1976), explains the risk of the principal who lacks the knowledge and possibility to control the agent. The agent is able to trick the principal and use more resources than necessary. Niskanen (1973 p.23) has used this agency theory to explain the same problem in governmental organizations. Monitoring programs and evaluations have to control the agent and his result. The rise of New Public management started the implementation of more market mechanism in governmental organizations, to create a more effective and efficient government. These market mechanisms resulted in more independency for implementing organizations, this independence is contributing to the innovative capacity. But also introduced the same mistrust in relations as described by the agency theory.

Network

The creation of a network society as result of the change to an information age is described by Manuel Castells. The basis of this perception is that neither the state nor the market could govern the system. It is a joint process resulting in the new network society, with new social meanings of space and time. (Castell 2000 p. 407-459; 500-509)

Networks are changing patterns of relations between mutual dependent actors, who are formatting around policy problems or clusters of resources. (Teisman 1992, 1995 p. 63) Decision-making in

networks is a joint interactive process, from actors who come together in a policy arena. Depending on a topic or issue actors play an interactive role. The government has to adjust to this new society. Goldsmith and Eggers (2004 p.3-24) argue that the government will change from a hierarchical model, through a more privatised government (outsourced government) or a mode of more cooperation between several governmental organizations (joined-up government), to a situation of cooperation between both private and public organizations to reach a goal (networked government).

Due to complexity steering in networks is more difficult than in a single relation between actors. Actors are able to steer in the arena through interaction and the use of resources but have to acknowledge the dependence on other actors. The creation of a joint focus, sharing goals and visions can result in joint decision-making. Mutual dependence forces actors in a network to decide which goals are feasible, which resources are usable and which selection criteria are useful. (Teisman 1992, 1995 p 224) The use of resources can be linked to the level of trust in interactions as described by Nootboom (2000 p. 916-928) This level of trust would allow the researcher to make a better statement about the mutual dependence and the strength of the relation. For this research this level of trust isn't used because this would complicate the research too much. The thought of Nootboom nonetheless played an important role in the description of relations because the ability of organizations to stimulate other organizations to allocate resources finds its basis in trust.

Tabel 2.1 elements

	bureaucracy	Market	Network
Structure	Hierarchical relation	Agent-principal	Mutual dependence
Steering instrument	Rules, regulations	Financial incentives	Interdependence and relation
Degree of flexibility	low	high	Med-high
Tone of relation	Formal, bureaucratic	Suspicion	Mutual benefit, trust

(based on above mentioned theories)

Elements of governance models

The above mentioned governance models can be identified on four basic elements; structure, steering instrument, degree of flexibility and tone of relation. The four elements describe the differences between the three governance models. The classification of relations in governance structures is necessary to understand the way organizations play a role of the organization. The way how they play the role explains how instruments are used and why an element is contributing or decreasing the innovative capacity of the whole system. The four elements and the description per governance model are described in table 2.1. The element "Steering instrument" is simplified in the table. The governance structure, which is used by the organization to play the role, has to fit with the right steering instruments to influence the innovative capacity. Every role in the innovation system of water use has its own specific instruments. In the model these specific instruments shall be explained. The instruments, identified by Koppenjan and Klijn (2004) as resources, are used to give a small list of instruments. The five types of instruments (resources) are financial resources, production resources, competencies, knowledge and legitimacy.

The five resources used for this research are; financial resources, production resources, competencies, knowledge and legitimacy, as identified by Koppenjan and Klijn (2004 p. 144).

- Financial resource is often necessary to realize the solutions and to cover organizational cost.
- Production resources are the ability to produce water or the ownership of the water treatment facility. The actor who owns the treatment facility needs to be included in the process to innovate his equipment. Educated staff can also be a production resource. In the theory of Koppenjan and Klijn the production resources can also be the ownership of a new innovation, the know-how. In this research this element isn't used in this definition of resources but this is included in the knowledge resource. Because otherwise two different elements could mean the same
- Competencies relates to the formal/juridical authority to make decisions. This can relate to contractual power (in a market system) or hierarchical power (in a bureaucratic system). Both

contracts and the authority to regulate or to make public decisions can have huge formal influences on decision-making.

- Knowledge is an important resource for the development of solutions. Innovation is a search for knowledge, for this research knowledge is an important resource. Different kinds of knowledge can be identified per organization like applied knowledge or fundamental science. Actors depend on each other for other kinds of knowledge, a university can lack some practical knowledge from a water company.
- Legitimacy this is a little bit vague but it refers to the ability to support or to withdraw support from a process. A good example are the environmental organizations, they have a lot of legitimacy when they try to influence decision-making. With help of the media they can show problems in source water and bring a lot of political influence in decision-making.

2.3 From theory to model

The previous mentioned theories shall be used in this chapter to create the model and the definition of innovation capacity. The definition of innovative capacity is necessary to understand why different elements in the country specific elements, organization or relations can contribute to innovative capacity. The concept of the model is also used for the international comparison but some of the elements are used in this thesis more in detail. Paragraph 2.3.1 presents the definition and paragraph 2.3.2 presents the model.

2.3.1 From governance capacity to innovative capacity

The model that shall be presented in the next paragraph uses relations between the innovative organizations and organizations in the system of water use to provide a description of the innovative capacity. It can be seen in the organizations and the relations. The definition of innovative capacity has to be clear to identify indicators, which interprets the innovative capacity of the system of water use. There isn't a definition specialised for this use but definitions of economic and public administration can be used to create a new one.

The economic definition of innovative capacity as used by Furman, Porter and Stern (2002 p. 899) is: "the ability of a country to produce and commercialise a flow of innovative technology over the long term." There are two problems with this definition, the focus on innovation and the economic scope. Important in this research is the process to come to innovation but in the definition by Furman, Porter and Stern this is related to the end product, the innovative solution. Therefore it is useful to include the broader definition of innovation by Nayak and Ketteringham¹ as used in this paper.

The definition of Furman, Porter and Stern focuses on the economic aspects of innovation, but as mentioned before the system of water use is a special case. The use of governance capacity is logical when the definition has to include processes where governmental organizations have influence in a network perspective. In their paper Gonzalez and Healey (2005 p. 56) use governance capacity, in the urban context, to explain social innovation. Their definition of governance capacity is: *the ability of institutional relations in a social milieu to operate as a collective actor.* (Gonzalez and Healey 2005 p.56) Like their paper, this thesis uses the governance capacity to explain the interactions between institutions to stimulate, to promote and to create innovations. The social milieu can be specified for this research to the system of water use. The combinations of the several definitions above gave the following definition of innovative capacity: **the ability of institutions and their relations in the system of water use to create, collect, interpret and implant new ideas, designs and application to products and services in practice over the long term.**

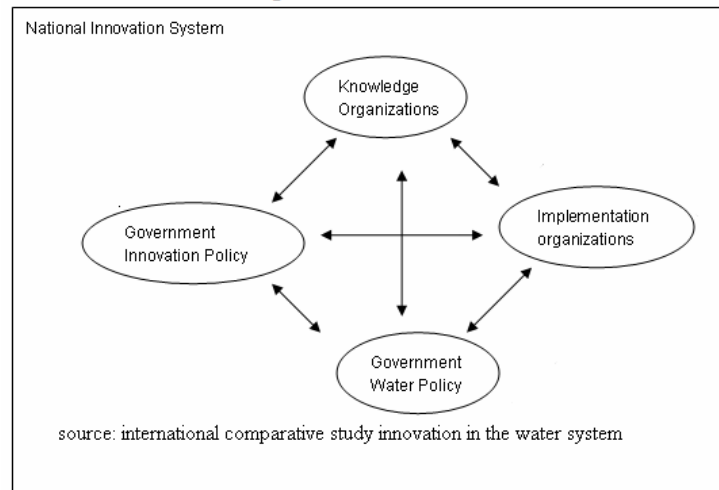
In the following paragraph this definition can be used in the model to present indicators for the innovative capacity in the system of water use in Ontario. It provides possibilities to quantify the elements of the model as increasing and decreasing to the innovative capacity.

¹ Innovation is the ability to create, collect, interpret and implant new ideas, designs and application to products and services in practice (Nayak & Ketteringham 1986)

2.3.2 The model

The model that is created for this thesis is based on the different innovative theories and influenced by elements of public administration theory. The model has three components that need to be described separately. The first component explains the country specific elements. These elements are necessary to describe the Ontario specific institutional context. The second component of the model is the description of the four clusters. The four clusters of organizations are based on the four different tasks in the system of water use. The last component is the relation between those four clusters. Innovation is a process between organizations, therefore this part is the most important part. Individual elements of the organizations shall be mentioned in the description of the four clusters. Some of the elements explain the innovative capacity of the cluster and some explain the innovative capacity in relation to other organizations. Figure 2.5 shows the complete model with the clusters represented by the circles, the arrows represent the relations and the square around the circles and the arrows represents the national innovation system. Country specific elements are within this system but outside the clusters or the relations.

Figure 2.5 the Model



The country specific elements

The country specific elements are elements that influence the system, but are external to the organizations in the system. These country specific elements are necessary to understand the influence on the institutional context. The elements are based on the National Innovation System Theory and the cluster model of Porter. Both models use external influences on the innovative capacity of organizations. A long list of elements can be made but the most important six are used to understand the context in which organization have to operate. The six elements that are described can only change over the long run. The following six elements shall be explained:

- Education, is important not only as knowledge base for innovation, the implementation will have problems when the workforce isn't educated.
- Economic situation and human development are important for the whole society, the water sector is part of a larger development. Whole societies can become innovative as result of economic changes or human development. The ageing workforce in some western societies can result in the need for new workforce or innovative solutions.
- Political aspects, the water sector is part of the political discussion and this can result in political influence in the sector. This can drive innovation with extra pressure. It can also prevent innovation through the lack of investment as result of low political priority.
- Historical aspects, the path dependence of the water sector will tell something about the ability to implement innovations. When there is almost no working water system a lot of innovations can be implemented. Historical disasters can also prevent innovation because the negative name from the past will prevent successful implementation.
- Cultural aspects, as work mentality and other cultural aspects can result in a drive for more innovation or in a more conservative mode.
- Geographic country specific aspects are important for the water system. In a water system there is more drive for innovation when there is not enough water, or when it is polluted than when there is enough clean water.

Three of these elements influence directly the innovative capacity of organizations in the system, these are: the education, economic situation and human development. The political, historical and cultural aspects can explain path dependencies of certain organizational forms in the system. The geographic features are important to understand operational choices in the water systems.

The organizations

In the innovation theory different institutions are mentioned, based on the national innovation theory different roles of institutions can be identified. Four main tasks become apparent when the different roles of institutions in the national innovation theory are combined with the roles a government has to play in the system of water use. Those four tasks are executed by different organizations. The four clusters of these organizations together form the innovation system in the system of water use.

The first cluster contains organizations, which are directly involved in the producing process, the implementing organizations. The second cluster is arranged around the organizations that create water policy. Companies, universities and public research institutes are three different institutions as mentioned in the national innovation system but used in this model as one cluster; the knowledge organizations. The last cluster contains the organizations that stimulate the innovation in the society. The innovation policy organizations are a different cluster than the water policy organizations because the focus of the policy results in different goals and roles and structures for organizations. The four clusters can be described by their organizational elements and by their roles. The roles are necessary to understand what the goals of the organization in the clusters are. The organizational elements are necessary to understand the functioning of the organization, how the goals can be reached.

Implementing organizations

The implementation organizations are the producers in the system of water use. The role as producer or operator is the first role of the implementation organization. The implementation organizations have to operate the facility with the aim to treat water, wastewater or sewage. This task is the main goal of the organizations of this cluster. The internal functioning of these organizations can be described with the following elements; the structure, the organizational culture, the types of products, the type of competition and the resources.

The structure of the organization can be public or private and central or decentralised. The internal organizational culture can be qualified in many ways, for this research the simple difference between a political organised culture or a professional culture, as identified by Mintzberg(1998 p. 289-299) is used. Professionals are better able to judge what kind of technological innovation is necessary. There are three products in the used definition of the system of water use. The implementing organizations don't have to produce all these types of products, it is possible that they specialise in, for example, storm water treatment. Competition between implementing organizations can be on price or quality. The two important resources available in implementing organizations are: their staff and their financial situation. The availability of internal applied knowledge depends on how many engineers and operators work in the organization. The implementation organizations have more control over the financial situation when they have a tax system than when they are paid per output. These single elements as presented in table 2.2 can't directly be used to qualify increasing or decreasing innovative capacity. Both private and public implementing organizations can be innovative. What can be stated is that decentralised organizations are better able to adapt to the local context and that there is more change on diffusion when there are more products in one organization. These elements are selected because in combination they can be used to make a statement on the internal innovative capacity of the organizations.

Table 2.2 Description of the implementing organizations

	Combined positive	Combined negative
Structure	Private	Public
	Decentralised	Centralised
Internal organization culture	Professional	Political
Number of products	More products	One product
Competition	Competition on quality	Competition on price
Financial resources	Tax system	Depending on output
Staff (production resources)	Engineers and operators	Only operators

When the implementation organization is also the owner of the facility they have two other roles. Implementation organizations have, besides the operation of existing facilities, the task to build new facilities and replace old ones. This gives two possible roles; costumer and innovator of innovations. Both these two roles can be used to influence the innovative capacity of the whole system. When implementing organizations buy already known techniques it will result in a negative influence on the innovative capacity. The influence on the innovative capacity is positive when implementing organizations demand an innovative solution or become innovative themselves. The ability to create innovation themselves relies on the resources implementation organization have and the regulations of the water policy organizations.

When implementing organizations are more autonomous they will be able to adapt to the local context and therefore it will result in more innovative solutions. The autonomy of the organization is for all the three the roles the indicator to qualify the implementation organizations a contribution or a barrier to innovation. The more autonomous the implementation organizations are the better they are able to make local decisions and play the three roles. The functioning of the three roles can be judged in perspective of the relation.

The water policy organizations

The second cluster of organizations has the role to steer the system of water use. The water policy organizations are more centralized organizations that function hierarchical above the implementing organizations. Three roles can be identified for the water policy organizations: the regulator of the water system, the financier of the water system and stimulator of water specific innovations. In the context of the national innovation system theory the organizations are public policy, financial and legal institutions. (Miozzo & Walsh 2006) It is likely that one central organization has more roles but it is also possible that the roles are spread over organizations. Like the implementation organizations the structure is relevant to describe the organizations. Because of the different roles it is very important that the different organizations communicate with each other to adjust the policies in the cluster. The internal adjustment can be a decreasing influence for the innovative capacity of the cluster when the cluster is sectoralized. The other important aspects for the internal functioning can be included in the functioning of the roles. In table 2.3 are the different roles and their resources combined as one element.

Water has to be regulated by policy organization, to prevent misuse of the monopoly and create the externalities. The role or regulator can be described with elements like in hierarchy, rules and laws and controlling mechanism. The more autonomous the implementing organization is the better it is able to bring the policy in the local context but the greater the risk of disasters. The influence of the regulator on innovative capacity depends on the steering influence. The functioning of the regulator can be qualified as rigid or open. When a regulator uses the norms and standards to drive implementing organizations to a higher quality level this increases the innovative capacity. When it prescribes techniques it will not result in new innovations.

Not in all the country own the implementing organizations the facilities and when they do it is likely that they don't have sufficient funds to invest in new facilities. The second role as financier of the system is larger in developing systems, in developed systems the role as financier is more based on financing replacements. Although the role originally isn't organised around stimulating innovation it

can be played in that way. Giving implementation organizations the ability to buy innovations increases a diverse demand for innovation. This instrument is a technology pull instrument², with financial possibilities it creates a demand that pulls diverse innovative solutions to the sector. When request of implementation organizations are judged on innovativeness and extra subsidy for trials is given this is an increase for the innovative capacity. The innovative capacity decreases when the financial support is based on economic elements and current or future expected output.

The third role as stimulator of innovations is closely related to the way the role of the financier can stimulate innovations. By subsidizing innovative ideas the stimulator increases the demand for innovations. The difference is that now there is a more specific demand for knowledge and that besides implementing organizations also knowledge organizations can contribute. The role of stimulator is necessary in the system of water use because of the monopoly. The theory of Schumpeter described that being innovative is driven by the creation of a temporary monopoly. (Katz 2005 p.5) But the system of water use is already a monopoly and in the public sector isn't there always an incentive to invest for future financial benefit. It is cheaper to "lend" innovative ideas from neighbour implementing organizations without taking a risk. By creating a demand for knowledge, applied and fundamental the stimulator solves this prisoners dilemma. All the implementing organizations can use this knowledge and when they are innovative the financial support prevents the risk of failure. Important aspects that can be used to make a statement on the increasing or decreasing innovative capacity is the sort of demanded knowledge and the openness for research questions. Both applied and fundamental knowledge is necessary and innovators should be free to choose how the research should be done.

Table 2.3 elements of the water policy organizations

Element	Decreasing innovative capacity	Increasing innovative capacity
Internal policy adjustment	Sectoralised	Joint decisions
Hierarchical resources	Regulations based on techniques	Regulations based on norms, standards or goals
Financial resources	Financial support for IO strict, budget based on output	Financial support for IO based on output steering with subsidy for innovative trials
	Demand KO based on applied solutions and closed research questions	Demand KO for applied and fundamental solutions and possibility to have open research questions

Knowledge organizations

The cluster of the knowledge organizations contains organizations that create knowledge for the system of water use. Based on the National Innovation System theory three types of institutions can create knowledge; firms, educational institutions and public research establishment. (Miozzo & Walsh 2006) In this model those organizations are called the companies, the universities and public research institutions. These organizations differ in the type of knowledge that they produce and the roles they play in the innovation system of water use.

Companies deliver applied knowledge to the implementation organizations by selling instruments and techniques. The role of companies is based on developing and selling knowledge. Universities educate applied and fundamental knowledge to their students and develop more fundamental knowledge. The role of universities is more based on spreading knowledge. The public research institutions are close related to water policy organizations; mostly they are used when companies or universities aren't able to deliver specific knowledge. These institutions are common used for evaluation of techniques or developing knowledge for policy of water policy organizations.

This cluster has as innovator the role to create as diverse as possible innovations. The available knowledge in a country is called the knowledge stock. The larger the knowledge stock is the better the

² More explanation on push and pull instruments is given at the description of the innovation policy organizations.

system of water use is able to adapt to new circumstances. This cluster has besides the role as innovator of new ideas also important for the spread of these ideas. Fundamental knowledge from universities has to be combined with applied knowledge from the companies to create applied solutions. The spillover between knowledge organizations is important for the diffusion of knowledge. Ideas for a specific part of the system of water use can also be used for different parts. Cooptition in the cluster results in more ideas and diverse innovations. Description of the innovative capacity of the cluster should be based on the combination of functions of these organizations. The mix of both public and private organizations increases the kind of knowledge that is created. When the knowledge organizations operate at federal, provincial and local level they spread new knowledge on all the levels. Individual organizations are more innovative when they specialise in a specific topic but for the whole sector all the aspects of the system of water use need innovations. The resources, which the organizations need for their role, are based on there capacity to develop knowledge. When there is more money for research and all the three types of knowledge organizations have research facilities the knowledge stock becomes more diverse. Essential for the knowledge organizations is good educated employees as production factor are the employees: the innovators.

Table 2.5

	Indicator for decreasing capacity	Indicator for increasing capacity
Structure	Only public or private organizations	A mix of organizations
Level	Only at one (local) level	Available at all levels
Competition & Cooptition	No competition between the same sorts of KO and no cooptition between different types.	Cooptition between the same sort and different sorts of KO. And the existence of platforms for interaction.
Financial resources	Companies have no risk capital	Companies have risk capital
Production resources	No own R&D centres, organization around only one specific topic or low educated staff	R&D centres, different departments and experts. High educated staff.
Knowledge	Field of expertise is specialised and not on all the topics in the water system. As result not enough products and no possible spillover.	Broad mix of expertise on all topics in the water system specialised organizations. More types of products through cooptition resulting in spillovers

Innovation policy organization

The water policy organizations are making specific policy for the water sector. This can include some innovation policy but in most cases this will be done by other organizations; the innovation policy organizations. These organizations stand the farthest away from the process of producing water but are relevant because they facilitate the innovative infrastructure. The roles for the government to increase innovation, as used in this model, are based on the five functions for the governments as mentioned by Miozzo and Walsh (2006):

- Creating demand
- Supporting education and governmental R&D
- Financial support to companies
- Supporting cooperation
- Creation of networks and the regulations for competition.

Not all those roles are roles of the innovation policy organizations. As mentioned water policy organizations are able to stimulate a demand through implementation organizations or by direct demand from knowledge organizations. This sort of demand results in specific innovations for the system of water use. Innovation policy has a broader goal than stimulation of innovation in the system of water use. Innovation is an important aspect of the economic development and therefore innovation policy organizations stimulate more than one sector.

There are two different goals for innovation policy recognized by Faber (2005 p. 272), selection and diversity. Selection will result in one, the best, solution for a certain problem that will be the best in the world and diversity will result in several innovative solutions that will compete between each other

but will all exist. A benefit of diversity is that a different innovation can influence others and lead to a more advanced innovation (spillovers). Two types of policy instruments can be identified to stimulate innovation, technology push instruments and technology pull instruments. Technology push instrument stimulates direct the development of knowledge and there for influences the knowledge organizations. Technology pull instruments will influence the demand for innovations and thus have more impact on the implementing organizations.

Table 2.6 Instruments for innovation policy

Policy type	Specific	Generic
Goal	Selection	Diversity
Policy instrument concerning technology push	1. Research programmes, subsidising	2. Fiscal benefits, knowledge building and knowledge sharing
Policy instrument concerning technology pull	3. Normproposition / collection	4. Increase of the demand

Source: Faber 2005 p 272

The role to support education, governmental R&D and financial support for companies is a specific technology push instrument. The idea is that by financial support the risk of failure decreases for the knowledge organizations. The knowledge organizations will start to do specific research. The role to support cooperation and the creation of networks is a technology push instrument based on the idea that cooperation leads to spillovers. The diffusion of knowledge increases when platforms are used to exchange knowledge. As seen in table 2.6 the innovation policy organizations are mostly using technology push instruments. Water policy organizations are using technology pull instruments by the creation of regulations and the specific subsidy for implementation organizations.

The elements in table 2.7 describe the innovative capacity of this cluster. The main aim of innovation policy organizations is to stimulate innovation, but this doesn't mean that this is always resulting in innovations in the system of water use. The policy goal has to include specific elements for the water sector and general elements for the stimulation of the whole innovation system. The stimulation of other sectors is important for the spillover effect. Innovation policy based on input from experts is better able to meet the demand in the sector. Politicians can misuse their political influence to create innovation policy. As result the aim of innovation policy isn't only innovation, for instance economic development instead of innovative development. The different instruments have to be used for open research possibilities and stimulate both applied and fundamental knowledge. The creation of networks is essential for the diffusion of knowledge.

Table 2.7 The innovative capacity of this cluster can be explained by the ability

	Decreasing for innovative capacity	Increasing innovative capacity
Policy goal	Support for only general or only specific sectors	Both general and specific support.
Policy making	Political decision or compartmentalization	The use of expert committee's and open research possibilities
Financial resources	Stimulation of only applied knowledge	Stimulation for both applied and fundamental knowledge
Production resources	No supporting networks	The creation of networks to support the spread of knowledge

All the four the clusters are described by their specific elements and their roles. The specific elements are already able to give a description of the innovative capacity of the cluster. The influence of the roles of the clusters is included in some elements but not in all. The functioning of the roles can better be judged in the relations. In the next paragraph the relations are related to the governance system, which shall result in a better picture of the influence of the roles of the organizations on the innovative capacity.

Interactions and relations

The four clusters of different organizations as mentioned above are all part of a larger society, communication exist between all of those clusters and between organizations inside of the clusters. According to the network theory is interaction the basis for joint decision-making. In innovation literature several writers point to the fact that creating innovation is a joint process. Interaction and communication in this model is very important because it helps innovation arise in groups and spread it over the sector. Knowledge organizations can have world-class research but this can only result in implemented innovations when the knowledge organizations have contact with implementing organizations. The exchange of resources and knowledge is an important element to create innovations. Based on the role of the organizations shall allocate their resources and have a specific behaviour. The governance models can identify types of relations. This can be done based on the four elements as mentioned in paragraph 2.2.2. Different types of relations explain different behaviour in for the same role resulting in different innovative capacity in relations.

Relation between Implementation organizations and water policy organizations

The relation between water policy organizations and implantation organizations is originally based on a hierarchical governance structure. For the role as regulator the control over the implementing organisations is the highest in the hierarchical governance model but it doesn't result in the best configuration for innovation. For the development of water policy the water policy organization can decide on its own but this is negative for the innovative capacity. Influence on the water policy from the implementation organizations results in better policy because the water policy organizations aren't able to see all the problems in the system. The role of the water policy organization as financier of constructions and the development of innovations is best played with the focus on improvement. The more autonomous the implementation organization is the better it is able to adjust to the local situation. A principal-agent relation with steering mechanism based on economic indicators can result in a lack of innovative investment. When the relation is based on mutual dependence the commitment to innovation from both parties is larger.

Table 2.8

	Indicator for decreasing capacity	Indicator for increasing capacity
The development and enforcement of water policy	Hierarchical steering mechanism for strict hierarchical relations will result strict policy	A more market or based approach with production contracts and steering gives more possibilities to create autonomy and influence.
The development and implementation of innovations	Role as agent can prevent the use of all the resources when the principal wants too much control.	Participation for innovation on partner basis results in more commitment and allocation of resources.

Relation between implementing organizations and knowledge organizations

The two roles of the implementation organization, creation of innovations or buyer of innovations, both need the network governance as relation. Because the roles of the knowledge organizations can only increase the innovative capacity when there is a more or less equal relation. The developer of innovations by knowledge organizations and the spread of knowledge can be used for the local context of the implementation organizations. This is only possible when both the organizations are open to advice and work in partnership.

Table 2.9

	Indicator for decreasing capacity	Indicator for increasing capacity
Developing innovations	With market based relations shall the principal (the implementing organization) use the demanded knowledge to become innovative without real cooperation.	In a network relation use both the organizations their specific knowledge to deliver jointly an innovative product
Buying / selling innovations	When this relation is based on market relation shall the principal (the Implementing organizations) only demanding for known technology no adjustment from the agent (the knowledge organizations) is possible.	An equal partnership shall result in innovative knowledge organizations because they shall have to adjustment to the local context of the implementation organizations.

Relation between implementing organization and innovation policy organization

The relation between the implementation organizations and the innovation policy organizations is based on the indirect stimulation of innovation because the creation of the demand for innovations is mostly arranged through the water policy organizations. There isn't a real governance structure that can be qualified for the relation between the implementation organizations and the innovation policy organization. Most of the instruments of the innovation policy organizations are used for knowledge organizations. The only two possible relations are through creation of networks and the specific financial support. The creation of networks can be used by implementation organizations to receive knowledge and provide use input. When implementation organizations play the role as innovator the use of specific policy money can be of support overcome the financial risk.

Table 2.10

	Indicator for decreasing capacity	Indicator for increasing capacity
Financial support	No specific innovation policy resulting in no financial support for Implementation organizations and no relation.	Specific innovation policy with subsidies for innovators can be used by innovative implementation organizations.
Networks	Networks created for academics and companies	Networks created with users participation result in influence for implementation organizations on knowledge organization

Relation between water policy organizations and knowledge organizations

The water policy organizations and the knowledge organizations both depend on each other. For the approvals of new techniques companies need to influence the policy and for updated policy water policy organizations knowledge from the knowledge organizations. The best governance structure for this relation is the network based relation, because interaction between each other is based on the mutual dependence. New policy based on only in-house knowledge has the risk to be outdated. Influence from knowledge organizations increases the innovative capacity of the policy. The role as stimulator of the system of water use also provides a relation for the organizations. Stimulation of the sector is the largest when knowledge organizations are asked to provide fundamental and applied knowledge with the possibility of unsolicited research.

Table 2.11

	Indicator for decreasing capacity	Indicator for increasing capacity
Demand of knowledge for policy	In a principal-agent relation uses the water policy organization only advice when they think they need it.	A relation more on network basis results in periodically a possibility to advise asked or unasked from the knowledge organizations to the water policy organizations.
Stimulation of innovations for knowledge stock	Demand for specific knowledge based on a market relation can result in only an applied knowledge stock and doesn't allow a lot of freedom for the agent (knowledge organization)	The network based relation results in A network based relation with the possibility of unsolicited research increases the innovative capacity

Relation between water policy organizations and innovative policy organizations

For the stimulation of innovations in the system of water use communication between the water policy organizations and the innovative policy organizations is important. The water policy organizations need specific knowledge for the system of water use. This specific support can be given by both the organizations. Cooperation on network bases increases the innovative capacity because the mutual goal is the stimulation of innovation.

Table 2.12

	Indicator for decreasing capacity	Indicator for increasing capacity
Policy adjustment	No relation, both organizations create sectoralised policies.	Joint network based stimulation results in mutual agreed policies to stimulate the system of water use.

Relation between innovation policy organizations and knowledge organizations

All the roles of the innovation policy organizations can be used to increase the innovative capacity of the knowledge organizations. Still the governance structure is important to understand to which degree this support is increasing the innovative capacity. If the governance structure is based on a market the result is that the principal (the knowledge organization) is lesser able to create innovations. With a more network-based relation the knowledge organization is able to develop the research questions and better able to steer the policy to the highest support for the innovative capacity.

Table 2.13

	Indicator for decreasing capacity	Indicator for increasing capacity
Creation of policy	A hierarchical based political policy.	A network based expert committee to create innovation policy
Demand of knowledge	Market based steering, trying to have influence on research questions. Only influencing applied science	A network based relation with the possibility of unsolicited research

2.4 Summary

This chapter showed the theory and the model that is necessary to understand the innovative capacity in the system of water use. Important theories to explain development of the model are the National system of Innovations, the triple helix model and the cluster theory of Porter. Like the National innovative capacity theory of Furman, Porter and Stern the model of this research tries to relate the innovations in a system to the innovation infrastructure. To be able to do this the model uses the organizations and their relations to find the elements of the organizations that contribute to the innovation. The organizations are clustered in the model in four clusters; the water policy organizations, the implementing organizations, the knowledge organizations and the innovation policy organizations. The definition of innovative capacity as used in this research is **the ability of institutions and their relations in the system of water use to create, collect, interpret and implant new ideas, designs and application to products and services in practice over the long term.** Based on the definition of innovative capacity is it possible to identify elements that can be used to describe the innovative capacity.

3. Research design

The model that was presented in the last chapter is completely based on theory. This model only makes sense when it can be used to analyse a sector in the real world. Chapter 3.1 shall complete the model by giving it elements to measure innovative capacity in a province. To collect empirical data this research has chosen to use the province of Ontario as a case study. Chapter 3.2 shall explain the used type of research, method and instruments.

3.1 Making the model from literature to part of the reality

The model is based on theory, to make it useful for research the different elements have to get a meaning in real life. To be able to use the elements that contribute to the innovative capacity they should be made determinable in observable elements. The definition of innovative capacity can be used for the determination of these aspects. For every element of the model at least two configurations should be made to explain to which extent they contribute to the innovative capacity of system of water use. The different components in the model have to be analysed and described by different methods. Because the analysing methods provide specific tools for identifying parts of the model, the methods will be explained first. After this is done the different elements in this research will be specified. Following after the identification of those specific parts, the relation with the presented theory in chapter 2 can be made and the innovative capacity of the specific parts can be clarified.

Different analysing methods to answer the sub questions

The model has got to be used to give answers to all the sub questions and the main question. The different elements of the model make it possible to use parts of the model for three types of analysis. Together these analyses will result in one combination of innovative capacity of the whole sector. Because several elements can both increase or decrease innovative capacity, the description of the element as used in the sector shall explain the increasing or decreasing degree.

The background elements are part of a background analysis (or an institutional analysis) and six factors are identified. Basic features of the country and its system are necessary to understand the development of society and basic assumptions of participants. Doing research in other countries implies the need of this knowledge and for the understanding of the reader it can also be used as a description. The determination of the actors is a logical step after the background elements of the country are known. A group of actors together form the clusters, as identified in the model. The actors need a separate description of the actors because the internal interaction in a cluster also influences the innovative capacity. The description of the actors defines the different structures, goals, roles and resources of both the water specific and innovation specific organizations. The description of these actors is based on an actor analysis. The elements from the background and actor analysis are necessary to answer the first two sub questions. Both sub questions require the descriptive part of the actor analysis. The structure, the goals and the resources will be used as indicators for the innovative capacity of the specific clusters. The relations can, based on the roles and the governing styles, explain the innovative capacity of the relations with the use of a network analysis. Interactions between organizations create the network and are a visible aspect of the process to innovation. When this process is known statements can be made on how the innovative capacity is constituted. For the third sub question this process level is important. Besides the institutional description the third sub question needs the interaction of the different elements on each other.

Bringing the different elements together to make a statement on the process of the innovative capacity. In this process some elements will function as a driver or a barrier for innovation. By highlighting these elements this research can create recommendations to increase the innovative capacity. To answer the fourth sub question the innovative process is reviewed by participants and compared to the configuration of innovative theory some barriers and drivers can be given.

3.1.1 Background analysis (analysis of institutional context)

The background analysis is necessary to understand the assumptions in the society based on the country specific elements. Certain aspects of a society are common for native residents, but due to path dependency might seem strange to foreigners. These elements are not odd but different and can influence the rise of an institutional system. As mentioned before these elements are based on the theory of the National Innovation Systems and some on the model of Porter. Two of the six elements are direct drivers of innovative capacity, the education and the economic situation. The geographical aspects have an indirect influence on innovative capacity but are also seen as a driver or barrier for innovation. The following three elements influence the creation of institutions and path dependency in the water sector; political, cultural and historical factors. These elements are only necessary to understand the system. An indication for their influence on innovative capacity can't be made because of its indirect influence.

The level of education in a country explains the innovative capacity of the workforce, the better it is educated, the better it is able to innovate and implement innovation. To measure the degree of education several indicators can be used; the percentage of primary, secondary and tertiary education (OECD) 2005, the availability of on the job education and the existence of criteria to work in the water sector. The economic situation and human development are socio-economic indicators of the society. When a society is in a recession, it's not likely that governments have extra the money for innovation. The size of the workforce is also a very relevant socio-economic aspect. Indicators can be the economic situation (depending on GDP compared to other years), arrangement of workforce (depending on age, population size and population growth, education and immigration). The better the economic situation and the higher the available workforce, the better it can support the innovative capacity. The geographic aspects can simply be described by a country's climate and its geographic features and what this means for the demand of techniques. Companies will be triggered to create innovations, if society demands more techniques.

Table 3.1 Background indicators

	Decreasing innovative capacity	Increasing innovative capacity
Education	Low educated workforce	High educated workforce
Economic situation and human development	Problems with economy or size of the workforce	No problems with socio economic factors
Geographic aspects	Enough clean water	Lack of clean water for geographic or climatically reasons.

The other three aspects are necessary for their description of the system. The political aspects, as the type of political system, the description of the law (common law or more European tradition), the organization of political parties and the influence of unions are all of influence on the way the organizations in a country function and how the water system is governed. Historical aspects have the same importance as political aspects, some political aspects are due to historical aspects. Also the path dependencies of choices of techniques are important for the innovation in the system of water use. Cultural aspects are relevant for the mentality of the workforce and the openness to innovations. A plain description of important aspects is enough to understand the context of a society, an extensive description is not within the scope of this research.

3.1.2 Cluster and actor analysis

The start of description of the model needs an analysis of all the actors that are available in the sector. The model has clustered them in four kinds of institutions but actors can operate solitary. In this paragraph some elements will be identified that contribute or decrease the innovative capacity. It doesn't matter if one organization lacks this element when there are other actors in the same group that make up for this organization. After the description of the individual actors a statement can be made for the whole cluster. Therefore this analysis shall be done in two steps, first on actor level and second on the level of the cluster.

The actor analysis as done in this thesis is based on the analysis method by Koppenjan and Klijn (2004 p. 135-147). This analysis method has four steps. The first step is the identification of the problem, but in the description of the model the cooperation isn't just based on one problem therefore the first step will not be used in this thesis. The problem that could be identified for this research is the lacking innovation in the system of water use, but this only makes sense when actors in the network also identify this problem, which is not the case. As a result this step will not be used. But when necessary for the other steps the identification of problem is linked to a problem that supports or hinders the innovative capacity in the water sector.

Step 2 inventory of actors is of more use. To describe the model there is a need for an individual description of the actors. This second step as identified by Koppenjan and Klijn (2004 p. 138) analyses which actors need to be taken into account. Several questions can be answered to include actors. Because of the dual character of the model, this will result in two types of questions; are the actors linked to the water sector and / or are they linked to the creation of innovations. The model can be used as basis to identify the type of organizations but the model can be incomplete. To prevent the loss of actors of importance in the Ontario society there will be searched for different kinds of resources. Which actors possess hindrance or realization power for innovations in the water sector, which poses knowledge insights and ideas to contribute to innovations or are participating in the water sector and can become innovative? The description of the actors will result in a description of a type of organization. It will be described by its legal structure (public, private and hybrid), its level of operation (local, provincial or federal) and when possible linked with the role to a place in the model. To explain the innovative capacity of the structure it has to be connected to the specific elements of the organization.

Step 3 inventory of problem perceptions is meant in the analysis to differentiate the actors. In the model there is already some differentiation between the groups, but this step is also of importance for a better understanding of the organizations. In a cluster the roles are divided over the organizations. The perceptions of the system and the identification of the role, interests, and goals of organizations can result in a good description of the organizations themselves and the current situation of the sector. The roles, perceptions, interests and goals can be seen as a motivation to participate in the model. The goals are the specific objectives of an organization, the reason that they exist. The goals don't have to be directly linked to the system of water use of being innovative. The role is executed to reach the goals. The roles make clear why the organization operates in the system of water use. The perceptions and interests of the actors are relevant when they explain more of these roles. These perceptions shall result in behaviour that is visible in relations. In this actor analysis the relation between organisations shall only be described from the individual elements of a role, the remaining elements of the relations will be described in the network analysis.

Step 4 positions of actors: The resources an actor has, explain its position in the network. The more resources it needs the more dependant it is on other actors. The availability and the dependence on resources is necessary for the network analysis to explain the sort and strength of relations. In the theoretical framework five resources were identified; financial resources, production resources, competencies, knowledge and legitimacy (Koppenjan and Klijn, 2004 p 144). In the model these resources were related to the innovative capacity. Here is stated how they can be recognised:

- Financial resources can be identified by the budget of the organization and the regulations on freedom to allocate this budget for other means.
- Production resources are recognized as objects the actors own and use to produce its goods. For an implementing organization this can be the ground of the treatment plant, the treatment plant itself but also its employees (operators and engineers). For knowledge organizations this is its laboratory and researchers, differentiated to their education level and their speciality. For water policy organizations the production resources are the different departments and their special role their employees.
- Competencies resources can be found in juridical statements of the organization, this formal power has to have a legal background.

- Knowledge resources are part of every organization, implicit knowledge (experience), applied science and fundamental science can be identified. The kind of knowledge of an organization can be identified with the use of its reputation.
- Legitimacy is difficult to identify, but can be found in support of political persons, media or civil groups.

Possible innovative capacity in the groups

Per group is in the model identified what kind of elements actors can have when they belong to a certain group. These elements have a decreasing or an increasing influence on the innovative capacity. Based on table 3.2 an overview is made of the elements for innovative capacity per cluster. Some element of organizations are directly observable in the society like the operational level (local provincial or federal) but some elements need more description how this research has observed them.

Table 3.2 Actor or cluster description

Element	Description
Organization description	Cluster specific elements to describe the organization
Organization functioning	The goals, roles and perceptions of the organization
Resources	Type of resources the organization has

Based on Koppenjan and Klijn 2004 p 135-147

The four groups are Water Policy Organizations (WPO), Implementing Organizations (IO), Knowledge Organizations (KO) and Innovation Policy Organizations (IPO).

Table 3.3 Implementation Organizations (IO)

Element	Description															
Organization description	<p>The descriptions of the elements that describe the implementing organizations are completely based on definitions which can directly be used in the society. For clarity are internal culture and the sort competition described.</p> <p>The internal culture is qualified as professional when decisions for long-term development are made by engineers and political when these are made by politicians.</p> <p>The sort of competition between implementing organizations is visible in benchmarks.</p> <table border="1"> <thead> <tr> <th>Structure</th> <th>Public</th> <th>Private (or hybrid)</th> </tr> </thead> <tbody> <tr> <td></td> <td>Centralised (provincial or federal)</td> <td>Decentralised (local)</td> </tr> <tr> <td>Internal decision culture</td> <td>Political</td> <td>Professional</td> </tr> <tr> <td>Number of products</td> <td>One product</td> <td>Diverse products</td> </tr> <tr> <td>Competition</td> <td>Competition on price</td> <td>Competition on quality</td> </tr> </tbody> </table>	Structure	Public	Private (or hybrid)		Centralised (provincial or federal)	Decentralised (local)	Internal decision culture	Political	Professional	Number of products	One product	Diverse products	Competition	Competition on price	Competition on quality
Structure	Public	Private (or hybrid)														
	Centralised (provincial or federal)	Decentralised (local)														
Internal decision culture	Political	Professional														
Number of products	One product	Diverse products														
Competition	Competition on price	Competition on quality														
Organization functioning	<p>The goal of implementation organizations is to produce the products in the system of water use. The roles that the implementation organizations can play are the operator, the costumer or the innovator. The innovative capacity, following form the roles of the implementation organizations, depends on the ability of the organizations to make autonomous decisions. The perception on this degree of independence is high and thus increasing for innovative capacity when implementing organizations are autonomous in using the resources.</p>															
Resources	<table border="1"> <thead> <tr> <th></th> <th>Indicator for decreasing capacity</th> <th>Indicator for increasing capacity</th> </tr> </thead> <tbody> <tr> <td>Financial Resources</td> <td>Depending on output</td> <td>Tax system</td> </tr> <tr> <td>Production Resources</td> <td>Not owning the treatment facilities, no available educated employees or only operators.</td> <td>Owning the treatment facilities and have a good educated employees, engineers and operators.</td> </tr> </tbody> </table>		Indicator for decreasing capacity	Indicator for increasing capacity	Financial Resources	Depending on output	Tax system	Production Resources	Not owning the treatment facilities, no available educated employees or only operators.	Owning the treatment facilities and have a good educated employees, engineers and operators.						
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Financial Resources	Depending on output	Tax system														
Production Resources	Not owning the treatment facilities, no available educated employees or only operators.	Owning the treatment facilities and have a good educated employees, engineers and operators.														

Table 3.4 Water policy organizations (WPO)

Element	Description		
Organization description	The WPO are public organizations as result of their goals. It is more likely that this group of organizations is hierarchical and more central (at provincial or federal level) as result of its regulatory function. For the innovative capacity of the cluster is not the structure or the level of operation and indicator but the degree of internal adjustment in the cluster.		
		Decreasing innovative capacity	Increasing innovative capacity
	Internal policy adjustment	Sectoralised	Joint decisions
	The internal policy adjustment can be qualified as sectoralised when there is no policy adjustment, communication between organizations takes place at high hierarchical level and there are no interdepartmental work groups.		
Organization functioning	Its goal is to safeguard the water supply and to regulate the implementing organizations. To be able to full fill this task the WPO play three roles. The regulator is the controlling organizations with regulative powers. The financier and the stimulator are both more guiding roles to stimulate the IO and KO. Based on the National innovation system the institutions can be qualified as governmental policy, financial and / or legal institution.		
Resources		Decreasing innovative capacity	Increasing innovative capacity
	Competencies (hierarchical)	Regulations based on techniques	Regulations based on norms, standards or goals
	Financial resources	Financial support for IO strict, budget based on output	Financial support for IO based on output steering with subsidy for innovative trials
		Demand KO based on applied solutions and closed research questions	Demand KO for applied and fundamental solutions and possibility to have open research questions

Table 3.5 Knowledge organizations (KO)

Element	Description		
Organization description	The universities and research institutes can be public, hybrid or private. Important elements to describe the internal innovative capacity of the KO are the resources and following elements.		
		Indicator for decreasing capacity	Indicator for increasing capacity
	Structure	Only public or private organizations	A mix of organizations
	Level	Only at one (local) level	Available at all levels
	Competition & Cooptition	No competition between the same sorts of KO and no cooptition between different types.	Cooptation between the same sort and different sorts of KO. And the existence of platforms for interaction.
	The competition and cooptation is relative difficult to observe in this research participants are asked to describe their competitors in competition or cooptition.		
Organization functioning	There are different kinds of research, and every organization has its own goal. The different kinds of organizations are necessary to create different kinds of knowledge. Universities are able to create more basic knowledge, research institutes more technical knowledge for specific elements and evaluation of techniques (that the market will not provide) and the market will deliver innovative techniques and direct solutions for the IO. The roles of the KO are innovator and carrier of knowledge. By developing and selling the knowledge the system of water use becomes more innovative.		
Resources		Indicator for decreasing capacity	Indicator for increasing capacity
	Financial resources	Companies have no risk capital	Companies have risk capital
	Production resources	No own R&D centres, organization around only one specific topic and low educated staff	R&D centres, different departments and experts. High educated staff.
	Knowledge	Field of expertise is specialised and not on all the topics in the water system. As result not enough products and no possible spillover.	Broad mix of expertise on all topics in the water system specialised organizations. More types of products through cooptition resulting in spillovers

Table 3.6 Innovation policy organizations (IPO)

Element	Description		
Organization description	The organizations are public or hybrid organizations at a more levels at the same time. The goal of specific organizations is visible in policy documents and the type of policy making is visible in the internal structure.		
		Decreasing for innovative capacity	Increasing innovative capacity
	Policy goal	Support for only general or only specific sectors	Both general and specific support.
	Policy making	Political decision or compartmentalization	The use of expert committee's and open research possibilities
Organization functioning	The goals of the different organizations can be described as stimulating the economic development of the country and safeguarding the innovative capacity. The different roles as identified by Miozo and Walsh were; creating demand, supporting education and governmental R&D, finance support companies, supporting cooperation and the creation of networks and regulations for competition. The organizations are only trying to stimulate innovation, the interest of organizations lies only in serving, not in taking the lead. The perception of this group is that the KO should be innovative and competitive.		
Resources		Indicator for decreasing capacity	Indicator for increasing capacity
	Financial Resources	Only financial support to parts of the system or to specific types of science.	A mix of policy instruments financial possibilities for KI and IO for applied science, this can be a mix of subsidizing and lending or other financial support. And support to KI for fundamental science. The financial support for the creation of innovation platforms
	Production resources	No support for cooperation or no regulations for competitions, resulting in no intellectual property.	Besides financing the IPO can also create sector specific platforms to share knowledge and stimulation of cooperation. Regulations for creating patents.

The combination of the individual analysis of the four clusters can give a first impression in the innovative capacity. Some elements already include the functioning of the roles of the organizations. For a stronger analysis the functioning and classification of a relation shall be used to explicate the innovative capacity of the relation. The frequency of relation patterns and the perception of participants explain the strengths of the relations. This will result in the strength of the innovative capacity of the specific relation. The network analysis can show how often resources are used and how often this results in innovations because without this interaction the ability to innovative is useless.

3.1.3 Network analysis

The network analysis is used to describe the interaction process. This interaction process between organizations is part of their roles and shows the use of the resources. Normally a game analysis would be done before the network analysis. This isn't performed, because in game analysis the focus is on one problem or case. The description of one case or problem wouldn't include the indirect influence of other elements that are necessary for the description of innovation capacity. This network analysis has two components; the inventory of interaction patterns and inventory of perceptions on interactions by actors. These components are based on the roles of the model and the resources of Koppenjan and Klijn (2004 p151-159) as described in the theoretical framework. Based on the found interaction patterns, several stages can be identified to explain how the process of being innovative works. Interaction patterns give meaning to the allocation of resources. This gives the possibility to explain the relation of different element of innovative capacity on each other. In a normal network analysis there also is a component that analyses the institutional context of the network. Because the model already has identified six elements, the component for the institutional context isn't part of this network analysis.

Inventory of relation patterns of actors

By mapping the diversity of relations of actors and their individual network, relations in the whole system can be identified. More central actors can be identified and modes can visualize driver organizations who function as link to other networks. The frequency in which actors interact is not directly useful, because the number of interactions does not explain the innovative capacity but the type of interaction does. Linked to the use of resources or type relation it becomes more valuable.

The perception on interaction by roles and governance structures

A statement based on the roles and types of relations can describe the innovative capacity of the relation. To identify different relations three different governance structures are used. As mentioned before shall show, in the actor analysis, the use of resources by an actor which roles are played by that actor. The positive or negative influence of the roles in different types or relations is described in paragraph 2.3.2. It didn't describe how the elements of a governance structure can be identified. In table 2.1 (paragraph 2.2.2) relative vague definitions are used to make a difference between bureaucracy, market and network relations. The structure of the relation and the steering instruments can be observed in interactions but the degree of flexibility and the tone of the relation is subjective. Participants are asked to describe relations and their perception is the basis for the classification. The flexibility to influence other organizations and the trust in these organizations are for this reason only guiding indicators.

From three component to an innovative configuration of the system

The three analyses show the innovative capacity of the three components. To receive an overview of the influences of the loose components one table could be made with increasing and decreasing elements. The problem is that the components aren't independent elements but they interact. Country specific elements have influence on the organizations and on the relations. To be able to use this interrelation one could create the barriers and drivers of the system. This has to be made on the combination of the three elements and therefore it needs criteria that are the basis of the model. In the National innovation systems literature there are several lists with elements to create an optimal configuration. Based on the list of the OECD (2005) and Miozzo and Walsh (2006) was the following list presented in the theoretical framework:

- A working demand structure
- A high educated workforce
- A financial system to support risk taking of the firms
- The development of fundamental science and applied science
- Access to science and technology
- The ability of firms to incorporate several elements (innovation as part of the business culture)
- The creation of collaborations, through networks
- A good working business environment and legal system

(Miozzo Walsh 2006 p.145-153)

The use of this list makes it possible to identify problems (barriers) or drivers of innovation. Besides the use of this list all the participants were asked to identify barriers and drivers. This was done to make sure that the barriers and drivers weren't the result of a theoretical game.

3.2 Research type, methods and instruments

This research uses the historical hermeneutic perspective on science. In this type of scientific research is communication (interaction and language) an indication of facts. According to Habermas is giving a meaning (*Sinnverstehen*) to communication possible based on a reference framework of the social cultural context. (1997 de Jong p. 283) The complexity of the society and the dynamics in the water sector make it impossible to have a positivistic empirical analytic research. It's not possible to make deductive statements or have complete predictions of other systems in other countries. This is caused by the fact that there are too many variables that can influence innovative capacity. Nevertheless, the goal of this research is to make statements on empirical, significant, as objective as possible and systematic observations.

The research strategy and instruments

The research strategy (or method) to find empirical prove for the model is based on a multiple case-study. Being part of a comparative analysis the selection of the country and the country specific elements in this water sector are the boundaries of the case. The choice to perform a case study fits the historical hermeneutic perspective. In a classical experiment it isn't possible to include all the complex variables. The use of a case gives the possibility to explain why certain indicators influences innovative capacity more than other factors. A different strategy could have been a survey. In this research the choice is made not to use surveys because some basic assumptions of the scientist are probably different than the participant. The water system is run by engineers and they have a different perspective on innovation than social science students. Apart from this a case study also enables the researcher to conduct several small interviews or a small survey. A case study gives the possibility to use multiple instruments. These multiple instruments were used in a flexible design. The boundaries of the case study where made by the objective by DHV and by the time available for this research. The reason for the selection of the system of water use was result of the comparative study. The "bestuursakkoord" made the boundary to use only organizations in the system of water use and or organizations that where connected to the innovation system. A more practical boundary was the size of the province (it was not possible to take Canada as one sector) and due to the time the number of participants was limited. The boundaries combined resulted in the water sector in Ontario as main case. In this sector several small innovations where selected to highlight elements of the innovative system. A flexible design was chosen because a process like innovation isn't predictable and although the theories give some elements, the theory on innovation also stated that every country can differ. For this research the instruments that were used, were interviews and document analysis.

As starting point for the collection of empirical data the experts at the local office of DHV, in Ontario this was DELCAN, gave a direction for the search. Besides the model, the theory and the documents found before leaving to the Netherlands / Canada this was the basis of the first interviews. Snowball sampling (2002 Robson p.142) was used with as result that the participants in the interviews identified more individuals that were of interest for this research. For the comparable character of this research an open-ended interview was not possible. The need for a partly structured interview resulted in a basic list of questions that had to be asked. Besides that the participant was free to provide information. The description of the type of interview is better to be called a "focused interview". (2002 Robson p 159) The interview was guided by specifying key topics but the order wasn't fixed. There will be two stages in the interviews, the first level is needed to get the basic ideas about the system and its organizations. The second stage is more case specific where some case will be chosen to look more in-depth in the barriers and drivers. At the end of the interview all the participants were asked to describe their network, by drawing it on a paper. And when possible identifying others by linking them to resources.

Because the process of innovation takes place in interaction between actors it is very difficult to make a good observation process. This would require following almost all the interactions (formal and informal) of a large group of people and that was the reason not to use the instrument of observation. But because innovation is an ongoing process and conferences can be part of this process to innovate I was participant at one conference and one symposium. This does not qualify observation as a used instrument with empirical results for analysing, but it gave a good impression of how interactions work.

During the interviews the reputation method (Woerdman 1999 p.246) will be used. The use of the reputation method makes it possible to understand perceptions of actors and perceptions of an actor on others. The reputation method simply asks actors to give a description of the reputation of other actors. The participants are also used as experts to make a judgement on being innovative. My technical expertise makes it necessary to rely on the participants, it can be interesting to see when there are disputes on being innovative. If this occurs it also explains something about the relations. The basis for the actor analysis, the network analysis and the game analysis were the interviews with a basis from the documents. The background analysis (institutional context analysis) can completely be based on literature of the country and written documents.

The focus

The focus of this research is the innovation capacity in Ontario regarding the water sector. Deriving from the definition of innovative capacity as created for this research, this is the process of interactions between the organizations and individuals within those organizations to become innovative in a changing society. Besides the knowledge about the organizations, interactions can tell how the innovation is created. Canada is 240 times larger than the Netherlands (see also paragraph 4.1). Besides the size difference it is not possible to conduct the research in the whole of Canada because of its constitutional structure. Based on the constitution every province has the right to design what the institutional structure of the water sector should look like. As a result there are huge differences between provinces in Canada. This makes it impossible to do research in the whole of Canada due to the lack of time and the size of this master thesis. The choice to research the water system in Ontario is a practical one, the office of Delcan was there. Delcan was able to support my research and this made it a good province because I was close to the provincial government. Ontario is still 25 times larger than the Netherlands. The northern part is low populated and for this research of lesser interest, when the focus of this research is only at the southern part, it is a good scope because it is almost similar in size and population to the Netherlands. The influence of the federal government will be taken into account, but only when it involves the innovation or water sector in Ontario, like the international competition of companies can have huge influences on the sector these can be important but are not the main focus of this research. The main focus is around the water producers and the other actors in the model.

Validity and reliability

This research is a qualitative research with as weakest point for validity and accuracy that is based on perceptions. Validity refers to the accuracy of a result (Robson 2002 p. 100). Important in that sense is how accurate the used definitions are and how accurate the collected data will be. The construct or face validity identifies whether a concept is the right indicator for an outcome. It is simply not possible to prove if the definitions are good enough but by using more than one theory to identify factors this problem was solved.

It is also important to verify whether the collected data is reliable. According to Robson (2002) there lies a threat in the description and interpretation of an event or interview. Because a description of an interview can be inaccurate, incomplete, or misinterpreted, this research will try to use a recording. This provides the scientist the possibility to replay the interview and write down the exact words said. Of course there is a risk of researcher biases or respondent biases (Robson 2002 p 172). The researcher bias is the effect that the researcher is subjective to the topic and therefore only looks for certain outcomes. The respondent bias refers to the problem that the respondent not tells what he thinks or withholds information because the possible negative outcomes of the research. Both these problems are tried to be solved by using triangulation. Triangulation is the use of more than one method (Robson 2002 p 371). The use of data triangulation gives more objective data. The use of documents and interviews will work to improve the data. Theory triangulation is used to make the model, this is done together with the other students and helps to see the same fact from different perspective. The interviews and possible barriers are also prepared by the group, this reduces the researcher bias.

The generalization is the possibility to project the outcomes of this research on other cases and the ability to predict the new outcomes. (Robson, 2002, p 106) This is also called external validity and is very difficult with a flexible design. Because the selection of a specific case and the historical setting makes it very difficult to predict even within the country a new outcome. Nevertheless the description of the process is more important because this gives the possibility to understand the barriers and drivers of innovation.

3.3 Summary

This research will use the case study of the Ontarian system of water use. Empirical data is collected by a document analysis and several interviews. The analysis is based on three methods of analysing. The context analysis describes the six country specific elements. The actor analysis is used to describe the system of water use and the innovation organizations. Based on the roles that are identified in the actor analysis and the governance structure a statement can be made on the innovative capacity of the relations. To give the analysis for innovative capacity more strength the network analysis is used to bring the description from an institutional level to the process level.

4. Empirical description of context

Chinese is a very simple language, a Chinese child of three years old can speak it fluently.
(Dutch joke)

To understand a complex system you either have to be born in that system or learn it step by step. This chapter shall describe the basic component of the model, the background elements. The next chapter shall describe the organizations. These two are essential to understand the first picture of the system of water use and the organizations in the innovative system. The basis for the two descriptions is based on the background analysis and the actor analysis. In the background analysis the specific elements shall be mentioned that are important to understand the path dependency of the country. The country specific elements are in this thesis considered not to change or only to change over a long time. Organizations are more likely to change and therefore are mentioned in a next chapter.

This chapter will describe the basic element by the size and the number of citizen in Ontario, the geographical elements, the political and historical elements, the cultural elements, the economic situation and human development and the education.

4.1 Size, demographic, climate and geographic factors

Ontario is the second largest province. It has a size of 1.076.395 km² and 12 million citizens (2006). It is still 25 times larger than the Netherlands but has almost the same amount of citizens, because the Netherlands has 41,500 km² and 16 million citizens. (Britannica encyclopaedia 2008) The focus of this research is based on the southern part and specific the Greater Goldenhorseshoe. This area is comparable in size with the Netherlands because it is 31,562 km² and has 8 million citizens. The southern part of Ontario has a humid continental climate, which is a bit like the climate in the Netherlands, but is a bit warmer in the summer and colder in the winter, as can be seen in Table 1. The colder temperatures have a big influence because minus 6 and 7 result in a deep frozen ground. (As a result the pipes can brake in the winter frost). The geographic situation in Ontario is quite different than in the Netherlands. The inhabited surface is sloping with differences from around 100 to 200 meters. This of course has influence on the way the water system is designed; however in engineering terms it is still pretty flat. The uninhabited parts have a more mountainous terrain. An also special geographic feature is the Niagara Escarpment with a height difference of approximately 100 meters within 50 meters! (Source: website <http://www.escarpment.org/About/overview.htm>)

Table 4.1 Climate in Netherlands and Toronto

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average highest temp °C	5.2 -1	6.1 -.2	9.6 5	12.9 11	17.6 19	19.8 24	22.1 26	22.3 25	18.7 21	14.2 14	9.1 7	6.4 2
Average lowest temp °C	0.0 -7	-.1 -6	2.0 -2	3.5 4	7.5 10	10.2 15	12.5 18	12.0 17	9.6 13	6.5 7	3.2 2	1.3 -4
Mean °C	2.8 -4	3.0 -3	5.8 1	8.3 8	12.7 14	15.2 19	17.4 22	17.2 21	12.2 17	10.3 11	6.2 5	4.0 -1
Precipitation mm	67 61	48 51	65 66	45 70	62 73	72 72	70 68	58 80	72 83	77 65	81 76	77 71

Source: Based on data by the Environment Canada and KNMI

There is enough water in Ontario, Canada contains seven percent of all the renewable freshwater in the world. This can also be seen in the consumption Canadians use about 1650 cubic metres of freshwater per capita more than double the average European rate. (Source: website NWRI 1)

4.2 Historical and political aspects

Archaeological research proves that Canada was inhabited by humans for 26,500 years. By Europeans it was first discovered about 1000 AD by the Vikings. The real colonization began around 1600 by the French and the British. As a result of this colonization Canada is still bilingual. The description of the total history of the federation of Canada is too long but important acts for the creation of Canada are; the constitution act in 1867 with the creation of the confederation; the statute of Westminster in 1931 where it is stated as independent and the Canada act or constitution act 1982 where it became independent of the British parliament. Queen Elisabeth is the official head of state but represented by the governor general. The house of commons has 308 elected seats and the senate has 105 appointed members. The elections are based on the British system with electoral districts and single-member plurality. A candidate can choose to be independent or sign up as member of a party. In 2006 there were fifteen parties but the cabinets were always liberal or conservatives. (Source: website elections Canada and Britannica encyclopaedia 2008)

The legislative and executive authority is divided between the federal government and the provinces. The provinces like the federal level have an appointed leader, the lieutenant governor. The provinces have powers on local or private concerns. The municipal government, education and for example water management are part of their powers. As result the ten provinces have their own system of local government with as result different names and power on municipal level. In Ontario there are municipalities which work together in a region, counties that combine region and municipal level and the metropolitan areas around the big cities like Toronto. Important to know is that the municipal act 2001 regulates which powers are granted to municipalities, but there are also separate acts for larger municipalities. Like the Toronto act 2006, or the city of Hamilton act 1999. Important is to know that if the province wishes to change a municipality it can do so. These easy changes have huge influences fore example in the water sector the change from public utilities commissions to more municipal governance had a lot of impact and makes more provincial ministries indirect influential. Another impact of the provinces laws is that they have their own jurisdiction and this means that the national and the provincial legislators can differ over aspects of the same matter. (Britannica encyclopaedia 2008)

In Canada one of the most important aspects of a politician is to show leadership. As a result new politicians have to show new political policy otherwise the politician can't be seen as a leader. As a result can you see in both the water and the innovation policy field that there are a lot of new start ups but that there is no long term plan. It is good for a politician to build a new sewer-plant but even better when he is able to cut on the cost of it. As a result of the fact that the system doesn't collapse directly if you cut on the maintenance, that's where you will start to cut. As a result the ageing infrastructure hasn't had the maintenance that it needed. An example of leadership in the innovation policy field is the large amount of organizations and projects that new governments will announce. As a direct result old programs (even if they are successful) are cut and everything has to be started up from scratch. This picture is not true for all the programs, the National Research Council and the NSERC are already around for quite a time. An explanation could be that these organizations are more on arm length of the government. Interesting to see is that the political leadership also makes it possible to handle relatively fast after a disaster. To understand the current situation in the water sector in Ontario you need to understand the effects of the Walkerton disaster. The disaster and the result of the disaster is explained in textbox 1. It is essential to understand because some long living problems that were recognized by professionals were political addressed.

Textbox 1 The Walkerton tragedy as starting point for innovation

A sad historical moment that was important for the water sector in Ontario was the Walkerton tragedy. In May 2000, Walkerton's drinking water system became contaminated with deadly bacteria, primarily *Escherichia coli* O157:H7. Seven people died, and more than 2,300 became ill. The community was devastated and there were widespread feelings of frustration, anger, and insecurity. How could this have happened? The Ontario government established a public inquiry led by honourable D. O'Connor to find this out. (Website: Walkerton Commission Inquiry (2002a))

The disaster

The contamination of well five came from a farm near the well, due to a heavily rainfall on May the 6h 2000 the primary source of the well became contaminated. The outbreak would have been prevented when with continuous use of chlorine residual and turbidity monitors. The continuous monitors at well five failed because of shortcoming in the approvals and inspections program of the MOE, the lack of training and expertise of the operators from the Walkerton public utilities commission. The outbreak would likely have been substantially reduced if the operators had measured chlorine residuals daily at well five but there were false entries about residuals in daily operating records and the practice were unacceptable and contrary to MOE guidelines and instructions, operators knew this but the PUC commissioner did not know that. A MOE inspection report had significant concerns about the water quality in 1998 but there was no response at that moment. Because the well 5 was not tested at the right time and the operators concealed the test for a time to the health unit, it was possible to get this huge outbreak. The reduction in provincial government budget made it less likely that the MOE would have identified the need for contentious monitoring the well and the improper operating practice at Walkerton PUC. According to the O'Connor inquiry the MOE had short fallings in it's approval program, the inspection program, the preference for voluntary rather than mandatory abatement and the water operator certifications program.

(Website: Walkerton Commission Inquiry (2002a))

The recommendations

The O'Connor inquiry made two rapports, the first part reported on the events in Walkerton and the causes of the tragedy. The second rapport made recommendations to change the policy and improve the components of the Ontario's water system. To make good recommendations the enquiry consulted a lot of water professionals. The recommendations were divided in five areas and together they make a multiple barrier system.

- | | |
|-----------------------------|-------------------------------------------------------------------|
| 1 source protection | (MOE and conservation authorities) |
| 2 Standards and Technology | (updating and adapting the system and creating an advice counsel) |
| 3 municipal water providers | (quality management approach, and training) |
| 4 provincial oversight | (Save drinking water act and change in MOE) |
| 5 Special cases | (small water systems and first nations) |

(Website: Walkerton Commission Inquiry (2002b))

These five steps resulted in not only the implementation of technical product innovations but also in organizational change and a paradigm change. The water managers where already for a long time using water as one system. Political thinking on source water as the basis of drinking water was a paradigm change. The source protection resulted in the identification of risks for the source water. The conservation authorities played a large role in the development of the plan to identify the local risks in their watershed. In perspective of the five steps of van Ast (2000) was the first step of the program a change from the third to the fourth stage, integral water governance. This is very rare to occur that fast. The second change was an organizational change in the MOE, the guidelines for water quality became laws and influence from experts in the system of water use was ensured by the creation of the ODWAC. The influence of the network organizations OWWA and WEAO was also ensured true frequently meetings. The third advice had to increase the municipal performance. The advice was to focus on training for operators by the creation of a Walkerton Centre. With the start of quality management should replacements and innovations be ensured and the advice was to investigate the financial system because the current system wasn't able to meet the financial requirements for replacements. The fourth step was an organizational change at the MOE and the adoption of a law (the safe drinking water act). This resulted in a tighter controlling because now drinking water inspectors were able to use pressure on municipalities. The special cases where the native territories and some other places up North.

On 5 September 2007 the MOE reported that all the recommendations were implemented. This is according to participants a rare case that the politicians implement all the recommendations of an enquiry.

4.3 Cultural aspects

The Canadian Culture is one of the largest multicultural countries as result of the diversity in the origin of the Canadian citizen. Besides the French and the English occupation immigration from Europe and Asia is the carrier of the different cultures to Canada. Canada is still a country based on immigration in 2005 the foreign born population was 19.1 percent. This will affect the culture for a long time. (Source website OECD)

The Canadian culture is influenced by its economic contacts to the United States. Already in 1951 the Royal commission on national development in art, letters and science warned that the Canadian culture had become invisible from the neighbour's. It spoke of an American invasion by film and radio. Canada depends heavily on their neighbours for trade and expertise. In the system of water use the dependence on the US is most visible at the international (American) network associations. Important cultural aspects for innovations are some findings of Atkinson and Coleman. They say that due to the Anglo-protestant heritage the ideal of individualism, independence and competitiveness is high valued and that governmental intervention is thought to be suspicious. (Creutzberg, 2006 p.27) This can also be seen in the water sector where it is acknowledged that governmental intervention is necessary but also costing too much. The influence of the "claim" culture is also visible in the society. This results in conservatism because implementing problems with innovations can lead to a claim. Besides the strong relation to the US there are also influences from Europe. These are coming from Quebec, the France speaking province. (Britannica Online 2008)

4.4 Economic situation and human development

As past colony of the British throne Canada is part of the Common-wealth however the biggest trade partners can't be found in this group. The biggest trade partner is the United States for 76% of its export. As result of the North American Free Trade Agreement (NAFTA), which was signed in 1994, and its previous US-Canada Free Trade Agreement (1989) the US is able to use Canadian energy (Oil, gas, uranium and electricity). The United Kingdom was the second trade partner with 3% and Japan the third with 2% of the export in 2007. (Source: website Statcan)

Besides its natural resources Canada has a high skilled labour force and modern industrial plants. The high Canadian dollar price compared to the US dollar together with the high oil price is a threat to the Canadian economy. The American tourist isn't coming as they are used to do and on 4th of June GM announced a closer of a large Canadian plant. (Toronto star of June 5th and website World fact book CIA)

But the Canadians don't need to worry because their human development is still one of the best in the world. Canada ranks 4th in the Human Development index 2007/2008 of the UN (HDI is an index number with the life expectancy, education and GDP per Capita as variables) (Source: website UNHDP 1) Only Iceland Norway and Australia present better in this social economic index. The high HDI index number can be explained by the high GDP per Capita in 2005 was this 33.375 (PPP US\$), high life expectancy 80.3 years and high education rate 99,2% (Source: website UNHDP 2)

4.5 Education level

To be innovative education is one of the most important factors. The literacy rate in Canada is 99 and according to the OECD Canada ranks 1st in the share of population with tertiary education. Education is a joint responsibility of the Federal, provincial en municipal government. As a result of its high level of education the workforce is also relatively high educated. In 2004 the enrolment of the Ontarian university students in engineering was 16 percent of the total student population. (for the other sectors see appendix 1 (Industry Canada 2007 p 30 and the website Ontario) But only a high degree of students finishing the university doesn't directly mean a high educated workforce. In Ontario (and the rest of Canada) an engineer is only able to wear the title "professional engineer" when they have demonstrated that they possess the necessary qualifications and when they are licensed by Professional Engineers Organization (PEO). This is arranged in the Professional Engineers Act and as defined under section on a professional engineering an Professional Engineer is needed when: 1. Any act of designing, composing, evaluating, advising, reporting, directing or supervising; 2. where in the safeguarding of life, health, property or the public welfare 3. that requires the application of engineering principles, but does not include practising as a natural scientist. If what you do meets all three tests, you are practising professional engineering and must be licensed by the association. In Ontario there are 65.000 engineers and those are all registered by the PEO. The PEO is an organizations run by professionals to keep the ethics and practice standards high. All the work done by a professional engineer can be stamped with a seal and public engineers can be recognized by a small ring. Basically the qualifications include a minimum of a bachelors degree at a Canadian (or similar quality) engineering university, some years of experience and pass the exam. (Source website PEO)

After the engineer or consultant engineer gets the title the continual education goes through the OSPE (the Organization Society of Professional Engineers), education for the water sector is given through the network organizations (Ontario Water Works Association, Water Environment Association Ontario) The operators also need a license to operate. The certification for the operators goes through the OWWA and the WEAO. Education can be followed at the Walkerton centre. After an operator has its title he needs to keep his knowledge level high with a credit system. Credits can be earned by attending conferences and symposia. (Source: website OSPE)

4.6 Concluding

This paragraph showed that the southern part of Canada is still a bit larger than the Netherlands but that it is comparable, even though it is colder in the winter and hotter in the summer. For the innovative capacity it is interesting that there is a lot of water used. A large demand of water can influence the demand for innovations in the system of water use. But as a result of the large supply of water this demand can be fulfilled without creation of the need of innovations. The history, political system and culture are of large influence on the institutions in three ways. First the constitution has resulted in the separation of powers between the federal and provincial level. Second the influence of the American culture has resulted in a more claim culture driven society, it's not shown that this is positive or negative to the innovative capacity. But it is a recognized influence. The third large influence on the institutions in Ontario is the Walkerton disaster. Organizations are reviewed and reorganized without judging, at this moment, it can be stated that it influenced the institutions in Ontario.

Increasing for the innovative capacity is the high educated workforce, which is still growing as a result of migration. The economic situation is not perfect as a result of the current financial crisis in the United States but can still be qualified as increasing for the innovative capacity. The ownership of natural resources will contribute to the prosperity of Canada because public infrastructure can be financed with the revenue.

Table 4.2 innovative capacity of background indicators

	Decreasing innovative capacity	Increasing innovative capacity
Education	-	High educated workforce which is able to innovate and implement innovations.
Economic situation and human development	-	There are some economic problems as a result of the current situation in the United States but the revenues on natural resources make the economic situation a contribution to innovative Capacity.
Geographic aspects	Although it is used a lot there is enough clean water. Which result in a decrease because companies aren't challenged.	-

5. Empirical description of the clusters

This chapter describes the organizations per cluster as recognized in the Ontarian innovation system of water use. The model as showed in the theoretical chapter is build on four clusters; the water policy organizations, the implementation organizations, the knowledge organizations and the innovation policy organizations. These four clusters are the basis of the sub paragraphs 4.2.1 to 4.2.4. There are more organizations in Ontario than the model is able to explain. In Ontario a number of network organizations function as intermediary, inside and between the clusters. Those network organizations will be mentioned in subparagraph 4.4.5. The explanation of the different organizations in this chapter shall be the used in later chapters to understand relations and interaction and the innovative capacity of the four clusters. The description creates the possibility to make a statement on the innovative capacity of the cluster, based on the types of organization and the resources. The goals, the roles can function as elements to explain the position and relation in the network.

5.1 The water policy organizations

The different policy fields in Canada are divided between the federal and the provincial level by the constitution act of 1867. The main consequences for the water sector is that; the federal level has the responsibility for the national security, the sea and coasts, first nation parks, (public health) (Website department of Justice Canada, constitution act line 91). The provinces have the regulatory powers of the municipal institutions, local works, natural resources and hospitals. (Website department of Justice Canada, constitution act line 92) As result the province has the regulatory function over the water sector, with the Ministry of Environment (MOE) as most important provincial ministry. The central function of the water sector, connect policy from more federal and provincial ministries to the water sector. A short list with the most important policy organizations shall be given. The description is based on the organization type and goal, the relation to the water sector and other actors in the model and the resources these organizations have. Characterizing is that the federal ministries have knowledge as resources and lack regulative competence. The main competence resource lies within the provincial ministry of MOE. The only resource the MOE lacks is the financial resource, this lies within the provincial ministry of Public Infrastructural Renewal (PIR)

The Canadian ministry of Environment and the Canadian ministry of Fisheries and Oceans

The federal ministry of environment is responsible for the preservation of the Canadian environment. To manage the water resources it has defined two main goals: protecting and enhancing the quality of the water resource and the promotion of wise and efficient use of water. The Canadian water act regulates the preservation of the surface water. (website Ontario Ministry of Environment 1) As competence resources ministry is able to influence the policy when it applies to international waters (rivers with the US) or the environment of the surface water. Its other resources are the federal research institutes. The National Water Research Institute and the St. Lawrence centre are both used for research on surface water. Surface water is part of the system of water use as source or as discarding area for the output of sewage and storm water facilities. Like the ministry of Environment the ministry of Fisheries and Oceans has indirect influence on the system of water use by control over the source. The goal of the federal ministry of Fisheries and Oceans is to protect the fish, by the protection of rivers. The regulative power of the ministry of Fisheries and Oceans is larger as result of more regulated norms to protect fish. The financial and knowledge resources of both ministries are used in relation to support municipalities or other local public actors when those need information in relation to their jurisdiction.

The Canadian ministry of Health

The Canadian ministry of Health is the federal department, which is responsible for the national health. It produces drink water guidelines, based on scientific research and consultation of the provinces. The provinces are not obligated to follow these guidelines but will most likely do so. The health officer is the national representative in case of drinking water contamination to give support to federal agencies and provinces. The ministry of Health has as resources its knowledge and lacks real competence resources until a province isn't able to stop an outbreak. The relations of the ministry of Health are as federal ministry based on advising lower level governmental bodies.

The Ontario Ministry of Environment (MOE)

The responsibility for the water system lies in Canada at the provincial level and in Ontario the Ministry of Environment (MOE) is the regulator. It is responsible for “ensuring that acceptable standards were maintained with respect to the air, water and land quality of the province.” The MOE has to steer the municipalities, which have the delegated mandate to treat drinking, sewage and storm water.

The MOE is created in 1972 with the merger of the department of environment and the Ontario Water Resource Commission. In those days the MOE had a larger task, as it was also responsible for the provision of sewage and water facilities and operation of laboratories for environmental research. In 1993 the MOE was merged with Ministry of Energy in a ministry of Environment and Energy, at the same time agencies like Ontario Clean Water Association (OCWA) were created to put operations on arm length of the ministry. In 1997 the two ministries were separated again resulting in again the MOE and the ministry of Energy, Science and Technology. (Website Ontario Ministry of Environment 2) Interesting is that almost all the participants, including MOE employees, tell me that the power of the MOE has shrunk over the years and that the capacity to be an initiator of innovation went away. The loss of innovation capacity started with the creation of the MOE as described in textbox 2. In the last couple of years the possibility to stimulate innovation decreased because financial resources for new plants went first to the OCWA and then to the ministry of Public Infrastructural Renewal (PIR) and financial resources for innovations went to the provincial ministry of Research and Innovation. The only function for the MOE left was to regulate the sector, in terms of institutions as described by Miozzo and Walsh the MOE is a policy organization with legal functions. The loss of the financial resources and internal knowledge as result of the reallocation to other ministries explains the logical need for the MOE to focus more on competencies as resources to steer the sector. The loss of financial resources and knowledge has decreased the capacity of the MOE to be innovative on its own, now the system has to be innovative. The MOE is only able to steer with regulations. This has increased the importance of relations because it has increased the dependence of the MOE on other actors.

The structure of the MOE can still be described as hierarchical, in relation with the municipalities it has some principal-agent aspects. The municipalities are autonomous as a unit but the province is able to change all the powers, which qualifies it as a more hierarchical relation. The province is able to control the system of water use with the creation of norms and standards. Before Walkerton there were guidelines and the ministry influenced the municipals through the individual approvals for constructions, as a result there were huge differences in the quality between municipalities. After Walkerton, guidelines were put into laws with a result that the ministry can take action if municipalities don't apply to these standards. The MOE has more steering power and is more able to control new treatment plants, but this doesn't have to lead to more innovation when it decreases the willingness of municipalities to implement innovations. The focus on too much control for new possibilities is definitely an element of a principal-agent relation.

The relation with the association of municipalities has become more important, the municipalities have to be innovative. After Walkerton the relation between the MOE and representative or network organizations has increased. The MOE has changed its attitude, and is more open to those organizations, especially to the Ontario Water Works Association (OWWA), Ontario Municipal Water Organizations (OMWA) and Water Environment Association Ontario (WEAO). The direct relations with experts in the knowledge organizations and implementing organizations are improved since Walkerton with thanks to the Ontario Drinking Water Advisory Council. This council is a result of the Walkerton recommendations and is officially called the advisory Council on Drinking Water Quality and Testing Standard The council answers directly to the minister of MOE and can give advise (requested or on own initiative), review standards and hold stakeholder consultations. The members from the council are a diverse representation of the drinking water work field. (Source: website ODWAC)

The only research that is funded through the MOE comes from the standards and development branch. This research is or specified by the needs of the ministry or in the best of research program. The best in research selects university research in the environment sector that can get some provincial support. But this can't be seen as innovation support. Innovation policy is made by the ministry of Research and innovation the MOE isn't allowed to have innovation policy. This support can be seen as

development that is necessary to develop standards. The only official role for the MOE in supporting innovation is the support to the ministry of Research and Innovation in advice on the technical possibility of the applications for funds. This relation and more direct and indirect links to other organizations, and the influence of these on innovation capacity, will be mentioned later in the network analysis.

Textbox 2 The rise and loss of innovation capacity 1956 to 1974

The private drinking water companies, who were the first in the sector, were in the later years of the nineteenth century almost all taken over by the municipalities. During the first part of the twentieth century the important innovation chlorination improved the water system. The depression and the great wars prohibited good financial support to improve the whole water use system. After the Second World War the provincial government took the leadership and created in 1956 the Ontario Water Resources Commission (OWRC). The OWRC had the mandate to finance, build, own, operate, and regulate water and sewer systems all over the province. The knowledge necessary to build water and sewer systems, had to be researched. The OWRC had several funds that were applicable for universities, municipalities, consultants or companies. The commission became in a couple of years world ranking and its annual conference attracted many scientists all over the world. However it also became arrogant and unresponsive to local development planning. In 1974 the OWRC was disestablished, due to budget cuts and parts of the staff and its functions were transferred to the new Ministry of Environment. Parts of the research departments were cut down good researchers switched from the public to the private sector. In the years following 1974 more and more of the MOE was cut down and the reputation as world leader was lost.

(Source: Ministry of Public Infrastructural Renewal 2005 and interview with D. Langley)

The ministry of Public Infrastructure Renewal (PIR)

The Ontario provincial Ministry of PIR was created in 2003 to function as partner inside and outside the government to modernize public infrastructure. Its goal is to modernize public infrastructure, create a plan for economic growth and take care for the environment in ways that enhance the quality of life and contribute to economic success. To reach its goals the ministry cooperates with public and private partners. (Website ministry of PIR 1) Until 1993 the MOE was responsible for the grants for smaller municipalities to build or improve the water treatment utilities. With the creation of the Ontario Clean Water Association (OCWA) this financial responsibility was put at a distance but due to a conflict of interest the OCWA had to stop with these tasks. PIR has taken the role to invest in the water infrastructure (and other public infrastructure), besides that role it also governs some agencies and crown corporations. PIR has a depending relation with the MOE for technical advice on applications for funds. Like the dependence on the MOE is PIR also depending on more provincial ministries for technical advice in other fields. PIR is described more as an economic affairs ministry, where request for funding are scored. Economic possibilities of those requests are as important as technical innovative solutions. The relation of PIR with municipalities can be described as functional. Based on specific funds municipalities can lend money or apply for funding. This can be described as principal-agency relation, based on economic factors. Within knowledge organizations the PIR was not known, this is part due to its new identity and because the funds are only applicable for municipalities or private organizations with a public task (like hospitals). The identified resources of PIR are the financial power and the steering power (competencies) over the agencies under its control. Steering of crown corporations responsible for liquor and gambling and other agencies wasn't part of the research because of the missing link with the water sector. The financial allocation to municipalities can be qualified as a decreasing factor of innovation capacity. In the application of municipalities the innovative aspect is taken into account but economic factors are as important as innovation solutions. One participant pointed out that some innovative solutions fail because the economic risk of the project.

The Ministry of Municipal Affairs and Housing (MMA&H) and other provincial ministries

The MMA&H is not directly involved in the water sector, still it has a huge influence. Its function is to govern the municipalities. Almost all the ownership of the water systems is in the hands of the municipalities. In 1995 the savings and restructuring act amalgamated many municipalities. As a result the number of municipalities decreased, it fell from 815 to 445, this gave the possibilities to merge municipal water organizations. The two main resources of the ministry is financial or competencies.

But the resource competency is only able to influence the water sector by the size of the municipalities. Other ministries have the same indirect influence.

The Energy Competition Act in 1998 made an end to the public utilities commission. In a number of municipalities these commission were responsible for all the public utilities. The public utilities commissions were privatised to energy companies but the water and wastewater functions were re-integrated in the municipal structure. According to a participant a lot of municipalities thought they found a cash cow to raise taxes. Making water part of the public engineer department, resulted in a municipal tax. Instead of a financial gain the municipalities found that it was a cost, the public utilities commissions had financed the cost of the water facilities with the profit made on the energy. (Ministry of PIR 2005 p.14)

More provincial ministries can be mentioned but all have indirect influence, this is the result of the central role the governance of the water treatment has in the society. Examples are the provincial ministry of Health, the health-officer is also responsible for outbreak of waterborne disease, or OMAFRA the agricultural ministry that has to regulate the farms, which use water and are a threat to source water. For the water sector their resources are fully based on competencies and based on the legislation a contribution or a decrease for the innovative capacity.

5.2 The water implementing organizations

The production of water is delegated from the provincial to the municipal level. Municipalities are the owner of the drinking water, sewage and storm water facilities. Municipalities can receive support from the conservation authorities for storm water and public or private operators can support the operation of the facilities. Besides municipalities those organizations are also recognised as implementing organizations. The organizations shall be described by: the organization type, the level of operating and its perceptions. The different implementing organizations have different resources, this is part of their ability to stimulate innovative capacity. Important is the degree of freedom to create their own policy and how they allocate the resources to do so, culture can be part of this decision-making in allowing risk of failure.

Municipalities

The municipality has a delegated responsibility to supply drinking water and treat sewage and storm water to the citizens. Depending on the area, municipalities can work together within a region or county. The 445 municipalities own all the treatment plants and the distribution network.

The municipalities were not always the owner of the system, first water firms were private but in the first decade of the 20th century those were taken over by the municipalities. The larger municipalities are owner for centuries and have a comparable ageing problem as the Netherlands. In some older cities the collection of sewage and storm water is still combined. The smaller water facilities were build after the WWII with support, and ownership of the province. The water and wastewater facilities are often part of the engineering department within the local administration. In smaller municipalities this results in a responsibility of one engineer for the drink water plant, the sewer, the road and the other municipal facilities. Of course he has to have some certificates for operations but the water sector isn't always his specialization. For the operation some smaller municipalities contract it out to Ontario Clean Water Association (OCWA) or private organizations. Another possibility is that small municipalities are joined in a region that produces the water and than the municipalities only have the responsibility for the distribution. The regulations from the MOE are put in norms and standards equal for all the municipalities and certificates, which are more detailed and specified per facility. There are guidelines from the MOE that can be used as a manual to design a new facility. Municipalities are free to make own designs but they have to be approved by the MOE. Being innovative and thus not follow the guidelines result in more monitoring because not all the specifications are known to the MOE. This, for municipalities, sometimes is the reason not to be innovative because the cost of proving a system increases.

Being the owner gives municipalities also the possibility to raise tax for water. The problem with the current financial system is that the users only pay for the direct cost. The tax for water is one of the lowest in the world and there is not enough saving for reinvestment (0.4% is the average rate of reinvestment in Canada). From 1974 to 1992 the Direct Grants Program financed 85% of the system,

this fund was covered with federal and provincial money (and up north if financed close to 100 % of the systems). (Ministry of Public Infrastructural Renewal, 2005, p.54) The current problem is an ageing system and a political dispute about the financial solution between the province and the municipalities. The municipalities have to increase the tax on water (a very unpopular solution) or use other taxes to allocate for the water system or the province has to help. The ministry of PIR is able to give some small grants or give loans but has not got enough money for maintaining the system. The fact that the water facilities are part of the local administration makes it compete for finance with replacement of roads and parks. These are more visible and local politicians are more interested in building visible infrastructure because voters will see the improvement. This influences the culture at the municipalities, resulting in a decreasing factor for innovative capacity.

In relation to the model the municipalities are the users of the innovations, but as result of the financial situation as mentioned above this demand for innovation isn't optimal. As resources the municipalities have the ability to use their own financial resources, their operational expertise and the support of their citizens. Being innovative, as municipality, isn't rewarded because there is no financial drive. Being conservative and copying form neighbours gives a larger reward because you can't be blamed for doing wrong and it is not as expensive. What can be seen is that only growing medium municipalities and large municipalities are able to allocate money and knowledge to become innovative. The drive for those municipalities is their reputation and leaders role. A good example of a growing innovative municipality is Richmond Hill as described in textbox 3.

Textbox 3 Richmond Hill

Richmond Hill, a growing municipality above the city of Toronto, needed a replacement of an old snow storage facility. This replacement resulted in a technical innovation. A innovative snow storage was build in a park, to use the asphalt in the summer as play ground and in the winter as snow storage. Instead of allowing melt water to drain into the ground water it went to a storm captor unit (to separate oil and grid) and than in a storm water pond. The storm water pond was discharging the melt water as cleaner water in the rouge river. The municipality funded the innovation on its own, because there were at that time no funds available for this innovation. The municipality worked together with Environment Canada to do some research. Environment Canada did a pollution reduction study. As result there was found that only the salt in the water was higher than normal surface water. The innovation was awarded with Ontario Public Works Association technical innovation award 2007. Besides the attention of associations also the media spread the new technology, discovery channel made a documentary about this storage.

(Source: website municipality of Richmond Hill and the interview Richmond Hill)

The Ontario Clean Water Association (OCWA)

The Ontario Clean Water Association (OCWA) is an operational provincial enterprise agency, created in 1993 with The Capital Investment Plan Act. The goal of the OCWA is to support municipalities by operating drinking and wastewater plants, and help municipalities designing new plants. As enterprise agency it has a hybrid structure, it has to make at least financial break-even like a normal company but is not allowed to refuse help to a municipality as result of the mandate of the MOE. The functioning of the OCWA can be understood by its creation and short history.

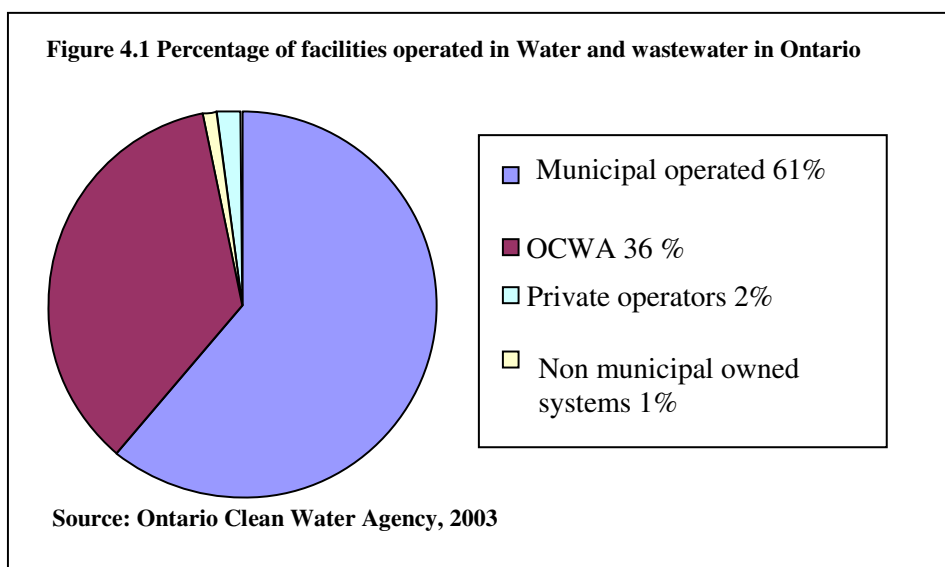
The reason for the creation of this hybrid status was that it was not wishful to have a regulatory ministry that also produces and owns a water system. Besides the classical controlling problem that you can't control yourselves, there was also a problem in the financial structure. The system was changing from a central subsidizing system to a more decentralized owned system. The OCWA became the owner and operator of all the provincial plants (mostly the smaller plants up north) and it became responsible for the loans to municipalities (who owned plants). After the complete portfolio of the provincial assets was made all the ownership transferred into municipal hands in 1997. The OCWA was still able to bundle loans from municipalities and make profit on the loans. The rise of competition on the operator field from Veolia and American Waterworks made it impossible for the OCWA to have the financing possibilities, this was conflict of interest. And in 2003 the responsibility of the financing went to the ministry of PIR. Although the OCWA is left with only the responsibility of the operation and facilitation to municipalities it still has a lot of operational knowledge. This gives

the OCWA a large benefit in the competition with private operators. At the same time some municipalities accuse the OCWA of arrogant behaviour.

The most recent figures (2003) are shown in figure 4.1 and it shows that the OCWA operates 36% of the water systems. The resources of the OCWA are based on operating resources and legitimacy resources. The knowledge about operating and their specialized system to give support to isolated places is the bases of the operating resources. The reputation in the past as knowledgeable organization and their special duty from the MOE to handle in problem scenario's also gives them legitimacy resources. The relation with the province can be described in two ways, officially their relation is based on a principal-agent relation but the informal relation that still exists between individuals results in an informal network that mentioned OCWA as a partner. The official relation is shown in their business approaches and than they have to report like an agent. But informally the OCWA handles more on a partner basis.

The relation with municipalities is also more complicated the larger and medium municipalities are more able to work on their own and have called the OCWA arrogant in the past. The larger municipalities are not depending on the OCWA, the smaller municipalities would mention the OCWA more as a partner than as an agent. The relations can be described more as partners because there is a mutual dependence.

(source website of OCWA and the contribution of Jim Meritt en J. Thomson)



Private operators

There are a number of private operators who like OCWA can operate water treatment plants on behalf of a municipality. The private operators have a financial goal this is linked to the goal of the municipality to operate cost effective. The two largest private operators that can be recognized are American Water Services Canada Inc. and Veolia (formerly U.S. Filter). An important example to understand the common opinion on privatisation is the city of Hamilton. The large privatisation in the city of Hamilton was turned back, after serving out the contracts the investments in the plants were neglected and the only thing the company had to do was cut employees to make profit. This hasn't improved the reputation of privatisation. The relation of private operators and a municipality can be compared to the kind of relation of the OCWA with the difference that the OCWA isn't allowed to refuse to help municipalities.

Conservation authorities

The conservation authorities are public organizations functioning between the municipal level and provincial level. The conservation authorities are governed by a group of representatives of local municipalities. The goal of conservation authorities is to protect natural resources and manage land

usages. The management of ground and surface water links conservation authorities to the system of water use. The conservation authorities were created after hurricane Hazel for the conservation, restoration and Ontario water land and natural habits management. The Conservation Authorities Act of 1946, gave municipalities the possibility to form a conservation authority on a watershed basis. Therefore the conservation authorities are crossing municipal borders and have more municipalities under its guidance.

The conservation authorities have some regulative competencies as resources. After Walkerton the conservation authorities were used to make source protection plans. To support municipalities are the conservation authorities able to see all the building permits and will give an advice on the “green” function of the new building. Problems with climate change and a larger focus on source water control, after Walkerton, gave possibilities for regional conservation authorities to become more influential. To raise awareness and to become innovative there were (and are) several initiatives to educate the people and to find better solutions to handle problems with storm water. The research the conservation authorities conduct is contributing to the knowledge over the systems and thus contributing to the innovative capacity. A good example of research done by conservation authorities is the analyses of the quality of current water ponds done by Toronto Regional Conservation Authority (TRCA). This contribution of the TRCA resulted in adjustment of the standards of the MOE. In textbox 4 are the two programs STEP and SWAMP explained and their relation to their partners.

Textbox 4 Local innovation in storm water

The Toronto Region Conservation Authority plays an important role in the Toronto area for researching storm water and environmental solutions. TRCA has conducted two researches in cooperation with partners. The Storm Water Assessment Monitoring and Performance (SWAMP) program was created in 1995 to evaluate the effectiveness of storm water technologies. The MOE, the TRCA and the municipal engineers association along with host municipalities funded the program. As a result of the 10 studies the technical standards set by the MOE, were changed.

The following program was the Sustainable Technology Evaluation Program (STEP) with more private partners. The STEP tested new sustainable technologies, like permeable pavement and green roofs, on affects for the clean water and air. Besides monitoring and evaluating these technologies, the development of solutions to implementation barriers and the creation of tools, guidelines was an important part. The results were used to promote effective techniques. The website www.sustainabletechnologies.ca and presentations at several conferences (of network organizations) supported this sharing of knowledge.

The STEP program was able to be more self sufficient in financial terms, private partners like Walmart contributed on parts of the program.

The relation between the conservation authorities and the Federal ministry of the Environment (Environment Canada) is based on sharing knowledge and the financial contribution to research. The conservation authorities and the MOE have a special relation because the conservation authorities are sometimes implementing MOE policy but the conservation authorities aren't under direct control of the MOE. As a result the relation is based on a sort of network relation. The same kind of explanation can be given for the relation between the conservation authorities and the municipalities. Municipalities govern the conservation authorities but at the same time they receive advice from the conservation authorities. This can be explained by the dependence of the conservation authorities on other organizations for finance. The small competence resources have to be confirmed by the municipalities to rule the basis of the relation for this reason is the competence of the employees (production resource) and the specific knowledge, which is lacking at municipalities. (Website TRCA and Website conservation Ontario)

5.3 Knowledge organizations

The knowledge level in Ontario is highly developed, which can be explained by the high rate of tertiary education and the mix of different kinds of knowledge organizations. The three types of knowledge organizations as identified by the model are; universities, research institutes and companies. The difference between universities and research institutes on one side and companies on the other side lies in the non-profit character of universities and research institutes. The governmental support for those organizations is higher and essential for their survival. In this paragraph the organizations and their goals will be mentioned per group. The different kinds of knowledge

organizations are necessary to create both fundamental as applied knowledge. Based on the different resources each type is able to create a kind of knowledge. Relations between the different types of knowledge organizations are important because the spread of knowledge leads to innovation. Cooperation and competition between knowledge organizations stimulate and improve innovation and spillover effects.

Universities

In Canada there are 90 universities, 21 of them are located in Ontario. Universities have a goal to educate their students and deliver independent research. The importance of universities is underwritten in both goals, good educated engineers are necessary to be innovative and fundamental and applied research is necessary to find innovations. The universities are private organizations but are depending on public money to survive. Universities are funded for 47% by federal money, 20% by provinces and the industry funds 17%. The federal support is directed through the granting councils, the National Science Engineering Research Council (NSERC) is the most important council for the more technical studies. The NSERC and the other granting councils shall be explained next paragraph as innovation policy organizations. Not all the twenty-one universities are providing courses linked to the water sector. The most important three universities for the water sector in Ontario are the Waterloo University, Toronto University and Guelph University because they have a NSERC industry research chair. (Robitaille, J.P. Gingras Y. (1999) The level of funding for university research in Canada and the United States: Comparative study association of universities and colleges Canada found on website:http://www.aucc.ca/_pdf/english/publications/researchfile/1999/vol3n1_e.pdf)

Important for the innovative capacity of universities is the independence to develop the research questions. Universities are better able to use all of its resources when it is able to allocate this to research questions on its own. Steering has to come from a whole sector, not from one funding organization. Interesting in the Ontarian context is the financing method of the NSERC research chairs. The NSERC research chairs have to be supported by partners, for the water sector these are municipalities, operators and companies. The companies and municipalities supporting the NSERC chairs at the university are able to give advice on the topics of research. The partners also provide support with equipment, a pilot plant or financial resources. The NSERC doubles the research money and the input of material of partners only as the university becomes the owner. The university doesn't have to become the owner of the patents. Importance of the creation of the NSERC research chairs lies in the possibility for municipalities to start a pilot plant. This gave municipalities to possibility to start local research. A more in-depth description about the research chairs and the relations with municipal pilot plants is described in textbox 5. The influence of the private partners can sometimes be used strategic; the researcher from the large companies may already know the outcome of their own research before they ask a university to conduct a research. Companies need independent research to prove their own product. Still the research of universities is important, because universities operate and judge independent of their partners. If a professor isn't independent he will lose his credibility, which shall result in lesser partners in the future.

The resources for the university are their scientific equipment, their students and their reputation of their research. To do research enough equipment and high educated and differentiated personnel is necessary. Besides NSERC research money and the direct partners financial support specific for equipment of universities is given from organizations like the Ontario Research Foundation and the Canadian Foundation for Innovation. Research equipment isn't a problem in Ontario this is contributing to the innovative capacity.

The students are an important resource for universities because they can participate in research and will link the university in the future to partners. What can be seen is that individual professors keep contact with their students and that universities organize alumni activities. This results in a tight informal network around professors. This network is contributing to the innovative capacity because it leads to the spread of knowledge. Besides the spread of knowledge the network is also used to create new partners. The professor has to find new partners because they have to finance parts of his research. The professor has to run his chair as a company because he has to sell his research at conferences. Besides the reputation of former research the professor has to have some entrepreneurial

spirit to stay innovative and find new solutions. The most contributing element to innovative capacity is the central position of the professor. A professor, with an NSERC chair, is the central actor between the different partners. For both companies and municipalities the professor is a knowledge beacon. Relations between universities, municipalities and companies are based on mutual dependence. Small questions based on applied knowledge, is informal and direct given from the professor to his contacts. Larger projects are more formal for financial reasons but the contact stays informal. The direct link to the water policy organization is arranged through the ODWAC for financial support there is no large

Textbox 5 the NSERC Industry chairs for water and the first pilot plants

The first NSERC Industry chair for drinking water was created at the university of Waterloo. At the moment the NSERC industry chair started for its 7th period of 5 years. Over this period of time different partners have contributed to the research chair. Important in this aspect is that large companies and municipalities were both stimulating this research. One of the reasons to start the research chair was that the analytical ability to measure grew so fast in the late eighties and people started to see bacteria and cryptosporidium. As a result there grew a public strong push to lower those risks. To be able to measure methods and facilities a larger scale research was necessary.

Under leadership of Professor Huck started three partner cities; the city of Ottawa, the city of Brantford and the city of Winsor, to build a pilot plant. The three city's had different kind of surface water and were selected to build the first pilot plants. The choice for the three municipalities was based on the difference of their water. Ottawa has a huge river that is for the largest part uninhabited, Brantford has an urban river that is very intensive used and Winsor uses water of the great lakes. In 1992 the pilot plants were build, financed roughly for 1/3 by the MOE, 1/3 by the NSERC and 1/3 by the municipality.

A pilot plant has the benefit that it is larger than in a laboratory and this implies that both chemistry and physical characters can be tested. Besides the water isn't used as drinking water and this is an advantage above a normal drinking water plant because it gives the possibility to sabotage the process to see what the critical factors are. You can try everything in a safe way. The university had the possibility to do research and the municipality was able to test their system changes before put into practice on the normal facilities. Once companies knew of the pilot plants, they started to offer equipment and several tests were conducted.

Due to the more evaluative character some of the participants consider pilot plants not as a way for innovation. Pilot plants don't invent new techniques. Still is this kind of research important for the innovative capacity because new techniques need to be accepted and fundamental knowledge to understand the functioning of the techniques needs to be developed. The drinking water sector is especially conservative because a change in system can lead to a disaster. As seen in the previous paragraph, are municipalities risk-averse because possible disaster (financial or outbreaks) will be blamed on the municipality. The pilot plants prevent this risk.

A pilot plant allows a new technique to be tested before used on large scale. Descriptions of manufactures are always within boundaries; the possibility to test even the high risk makes it interesting. To test safety procedures or crazy ideas is necessary for innovation, according to Ian Douglas of the city of Ottawa where some accepted ideas not true and worked some "impossible" solutions. The input of operators of the normal plants could also be tested and resulted in improvements.

direct link to water policy organizations. The link to research foundations is direct and formal. This includes funds allocated to a specific problem in the water sector and projects that are done with partners. Projects for AwwaRF and WERF are also conducted by the universities but compared to the federal money this is not in the same order. (the private organization Awwa Research Foundation (AwwaRF) and Water Environment Research Foundation (WERF)

Research Institutions

Research institution in Ontario can be linked to the federal or the provincial level. As in house research institute some federal ministries have institutes on arm length of the organizations. In the system of water use the federal research institutes are the National Research CC (NRCC) and the National Water Research Institute (NWRI). Financially depending on federal support but independent in doing research and advice beacon for their ministries and other organizations. After the Walkerton disaster the province created the Walkerton centre with the task to educate and to stimulate research at provincial level.

NRCC

The national research council steers several institutes on behalf of the Canadian ministry of Industry. For the water sector the Sustainable infrastructure research centre in Regina is the most important centre. The Regina Sustainable Urban Infrastructure cluster does research for roads, highways bridges drinking water, storm water and waste water systems. This cluster is based in Regina (province Saskatchewan) and falls out of the scope of this research to mention them in-depth because to join the research one of the local actors in Regina have to be included. (website NRC 1) When the participants in this research mentioned this centre it was only about the research for concrete pipes. (website NRC 2)

NWRI

The ministry of Environment Canada funds the National Water Research Institute (NWRI). The NWRI has the largest fresh water research facility with over 300 staff members and is linking water science to environmental policy. It has two main centres one of inland water in Burlington (Ontario). Together with partners it conducts research, in the water system as defined in this research it is participating and funding some wastewater and storm water research. On behalf of Environment Canada it support municipal research as mentioned in textbox 3. The NWRI has a very high reputation and its research is used for setting standards at both federal and provincial level. (Website NWRI 2)

Walkerton research centre

One of Judge O'Connors recommendations after the Walkerton disaster was to create a research centre in Ontario that could provide scientific basis for policy decisions. The Walkerton centre erected to stimulate research and to educate operators. One opinion of a participant is that the Walkerton centre is just a political statement; according to this participant it doesn't really conduct innovative research. What can be seen is that they finance and conduct some research but the most important task of the Walkerton centre is the training facility.

Corporations

Although there can be found huge differences in possibilities to innovate between the large companies, the medium and small companies there is one similarity and that is the dependence on the demand of the sector. The demand in the system of water use comes from the governmental actors. A water treatment facility is very expensive equipment and in Canada there is a relatively small market. The entry cost for companies to develop a full new system is too large and government support looks necessary. The goal of companies is to make profit with the supply of fundamental or applied knowledge. The available resources are their knowledge and financial situation (to take a risk by doing research). The current large companies are less depending on local governments than small companies and therefore they are treated separate.

Private research in large companies

The two best-known international corporations in Ontario are Zenon (GE water) and TrojanUV. Only corporations with this size can afford to have research facilities. The research that is done is linked directly to applications and not for its scientific basis. Within the research department the largest group of employees is working on the existing products, product development, and there is a small group that tries to work with out of the box ideas. This last group can have a result in a radical innovation. The development of research is guided by a policy document. This policy document is based on the goal to develop new techniques or use known techniques in niches of the market. The policy documents are living document based on the latest research. An example of a technique known in one niche of the sector and used in another part is the development of Zeeweed. First membranes were used for wastewater and later the technique was used for drinking water. In textbox 6 is shown how a radical innovation became quickly implemented after the discovery at Zenon and an outbreak of scyphosporidium required this solution.

The large corporations have a budget, ten times higher than NSERC Chairs. According to my interviews an NSERC chair cost about 1 million dollar and those corporations have a research budget around 10 million dollars. This gives the international corporations the benefit to use the best equipment and high-qualified researchers. The availability of the international corporations can be

seen as a benefit to innovative capacity. The innovative capacity increases even more through the contribution of the corporations to the NSERC research chairs at universities. The relation of

Textbox 6 Collingwood

In March of 1996 the Toronto Star mentioned rumors of an pandemic outbreak in Collingwood. (the Toronto star) Reports of people suffering form cryptosporidic symptoms began to come to the local Simcoe County District Health Unit. A water boil advice was given even though sampling didn't prove there were some cryptosporidium. Collingwood depends heavily on tourism and bad press would mean no tourist. The Collingwood PUC tried to find a solution together with consulting engineer, Ainley and Associates because cryptosporidium is resistant to chlorine and other common disinfectants. The solution for the short time was a Zenon Mobile Reverse Osmosis unit, which was operational in 60 hours. But a more innovative solution was needed for the long run, the first ZeeWeed Membrane pilot plant for drinking water in Ontario.

Interesting to know is that because of the first time to build it, there was no known certificate of approval, normally this would take a long time because the technology was new and the MOE had to approve this specially. There was academic prove that ZeeWeed was able to clean cryptosporidium, because Zenon had used it for waste water treatment, for drinking water it was still building an pilot plant in British Columbia which was not yet operational. A pilot project status was approved by the MOE and this pilot project would include a larger amount of water supply than in British Columbia and a more energy friendly approach.

The municipality didn't come up with the solution; this was an idea of Zenon. But it shows how a radical innovation needs to have the stars aligned for implementation. The technology was available it only needed a problem to become implemented. More interesting is to know why municipalities didn't implement or participate in the development of the innovation before the outbreak. Participants point out that implementation would have been slower if there wasn't a direct threat. (source: website Innovaris, issue 3, 2000 and interview OCWA, ZENON)

international corporations and universities (or clients in the system of water use) is important for them to develop and sell the products.

Both Zenon and TrojanUV have many patents, they are for this reason a very valuable partner to the NSERC chairs because they can give knowledge. They are both careful about sharing new information because this could cost them a strategic benefit. The relation can be described as a network partnership with mutual dependence. The reason for participation of corporations in the network is three fold. They need independent research, it is cheaper to do research at a university and they need new researchers (recruitment).

University research is considered unbiased and the companies need this prove the technology. Regulators will trust a new technology only when an independent researcher has tested the technology. The second reason is that it is sometimes necessary for companies to understand the general principles of a technology, this will not directly lead to a new application and can be done by a university. The third reason lies in the possibility to give advice to universities (through NSERC chairs or through AwwaRF or WERF). This can give a benefit because new technologies that are researched by universities spread the knowledge and the confidence in these techniques. The basics for innovations are talented people, both the large companies recruit people form all over the world and connections to universities will help this recruitment.

Private research in smaller companies

The medium and smaller companies are also doing research but have more problems with financing. They depend more on financial support from innovation policy organizations. The basis of these companies is an engineer who likes to solve problems and apparently is very good at it. Clarifica is an example where there is one founder that is a good engineer but what can be seen is that they do not know exactly how the informal networks work. They have enough work of their current clients and rely to much on mouth to mouth marketing. Interesting is that they acknowledge the importance of marketing, participating at a conference even gave too much work. Slowly growing and commercialization still is difficult because the engineers like to find solutions. The programs that exist already on provincial level can help those companies but the companies have a lack of time to search for those programs, which can result in not using them.

At some larger consultancy firms are also some innovative departments, the main focus of these departments isn't being innovative but customer support. It is compared to the international corporations more a marketing strategic action than a research facility. Consultancy firms have more applied solutions and have more implemental experience to increase the capacity of the facilities.

The relation of both kind of corporations with water policy organizations and implementing organizations should be considered as principal agent relation. Specific demands from municipalities are structured around applied solutions. The relation with the MOE is more formal and based on the request of companies for the approval of techniques. Informal are the more network-based relations, where companies inform civil servants about possible solutions.

Although international companies aren't depending on financial support from innovation policy organization any more they still use tax credits. The importance for small companies to receive financial support lies in the fact that the first ten years both mentioned international companies relied on financial support. In those starting years Trojan didn't sell a lot of products but the federal support and personal investment allowed it to survive and to grow into the company it is today. Zenon was also heavily supported but according to its founder governmental support is not the only way to success, because if an innovation can't sell, it is not an innovation. Some participants stated that there is less money to support companies at the moment in the way that Zenon and Trojan have had. This could become a problem for the current starting companies and might result in a loss of innovative capacity in the future.

5.4 Innovation policy organizations

In Canada two percent of the GDP (27 billion) is spent on R&D. Canada is ranked number twenty-first in the OECD list of private partner spending. The knowledge organizations in Canada are for fifty-four percent depending on public finance. This makes stimulation of innovation an important role for the government. In Canada can be seen that stimulation of innovation comes from different levels. The most budget has the Federal government, the second contribution (for the system of water use) is given by the member organizations, Awwa Research Foundation and the Water Environment Research Foundation, and the smallest budget to stimulate research is the province. Each level shall be mentioned and the most important organization per level shall be described with their resources to stimulate innovation. (OECD (2007), Industry Canada 2007)

5.4.1 Federal government

The ministry of Industry is at federal level responsible for coordinating the innovation policy. Several other ministries have their own innovation policy for their specialism but this has to comply with the policy of the ministry of Industry. For instance the federal Ministry of Environment has the NWRI as institute. Within the ministry of industry the National Research Council advises on the direction for innovation. The National Research Council (NRC) was created in 1916 as organization on an arm-length of the minister and governed by a council of experts appointed for three years. In the early years mainly as an advisory body but during the Second World War it grew rapidly as it performed R&D for the allied forces. The NRC still advises the minister of industry but it also includes twenty research institutes and some technology centres and several programs. For the water sector this is the Regina Sustainable Urban Infrastructure the only one. (Industry Canada, 2007 and website NRC 3)

The goals and the resources to support the federal government are written down. In November 2006 the ministry of Industry of the Canadian Government released a plan to make Canada a world leader for current and future generations. The goals were written in this plan called *Advantage Canada*. The implementing part was written in the science and technology strategy *Mobilizing Science and Technology to Canada's Advantage*. There were three needs identified; the need for a stronger private-sector commitment to Science and Technology; the need for Canada to strengthen their knowledge base and the need to be a magnet for talent. Some of the long-time existing federal institutions were included in this "new" initiative. Although the initiatives aren't new the structure or their rapport includes all federal initiatives in a comprehensive way. The instruments the policy uses are based on a generic type with diversity as goal. It uses technology push instruments as predicted in the theoretical paragraph by Faber.

The three needs identified in *Mobilizing Science and technology to Canada's Advantage* are based on the stimulation of three groups firms, universities and individuals. The entrepreneurial advantages describes the programs to support the firms; Science Research & Experimental development (Fiscal benefit), Industrial Research Assistance Program (subsidizing) and National Centres of Excellence (sharing knowledge). For the stimulation of universities the basis lies at creating a knowledge advantage to focus research on four topics where Canada is strong. The NRC uses technology push instruments for both selection and diversity. The research councils and the Canadian Foundation for Innovation (CFI) will be mentioned here both focusing at financial stimulation of universities. The third need of intellectual individuals has the smallest direct link to the water sector. The different programs shall be mentioned with their purpose and goal.

SR&ED

SR&ED program is one of the examples of a tax credit. Particularly for small companies is the Scientific Research and Experimental Development program important, it gives private corporations a possibility to earn an investment tax credit of 35% up to the first 2 million, and 20% on any excess amount. The subsidy is open to almost all the research questions, the company has to show the time/money invested and the results of the research, almost all technical research is allowed as long as there is a risk of failure. Without risk, when the outcomes are known the government will not finance the program, the SR&ED program is monitored by the ministry of Finance. (Source: interview Clarifica and website Canadian Revenue Agency)

IRAP

The Industrial Research Assistance Program (IRAP) is an assistance program for small and medium Canadian firms. It helps understand technology issues and opportunities, here for it uses industrial technology advisors and provides network links to other companies. IRAP provides innovation assistance to 12.000 firms each year and shares some of the financial risks of R&D projects. In the interview with Clarifica was mentioned that the IRAP support is considered important but time-consuming. A request for financial support would take a lot of work, at least seven workday's full work and as a result a request takes months of preparing. Clarifica used IRAP funding once (four years ago) and is preparing a proposal at the moment. IRAP is part of the national research Council and IRAP and its predecessors have been helping Canadian firms innovate for close to sixty years. (Source: interview Clarifica en website IRAP)

Research Councils and research industry chairs

Federal funding for research at universities in Canada goes through the research councils, the Natural Science and Engineering Research Council (NSERC), the Canadian Institutes of Health Research (CIHR) and the Social Science and Humanities Research Council (SSHRC). The three research councils have the same tasks but a different research subject. The two important research councils are the NSERC and CHIR, because the SSHRC doesn't spend any money in the water sector. The CIHR is monitored by the ministry of Health and only involved when research involves public health. The NSERC funds the most research for the system of water use. The NSERC was erected by NRC but the NSERC reports directly to the minister of Industry. A council governs the NSERC; the council consist of members from private and public sectors. The three councils support research through scholarships, research chairs, funding indirectly the cost of research and stimulates networks through the National Centres of Excellence.

In Ontario there are three NSERC chairs at Waterloo University, University of Toronto and Guelph University. The basic structure of an NSERC industry chair is a University with partners. Funding of industry chair is based on the input of the partners. Federal money doubles the resources of the public or private partners. Besides the specific Research chairs where private partners are necessary there are also Canadian Research Chairs where partners aren't necessary. Universities can also apply to Canadian Research Chairs. (Source: website NSERC)

CFI

The Canada Foundation for Innovation (CFI) is created by the government of Canada as an independent organization to fund research infrastructure in public or non-profit sector. The CFI funds

to 40% of a research project infrastructure and the rest has to come from funding partners (public or private).(Source: website CFI)

NCE and CWN

The Networks of Centres of Excellence (NCE) program creates partnerships among, industry, universities and government to develop the economy and improve the quality of live. These networks are nationwide and are administered by NSERC, SSHRC and CIHRC (the three granting councils) in partnership with Industry Canada. The centres of excellence are created for a period of seven years.

The Canadian Water Network (CWN) is one of the four Networks established in 2001. This year the CWN started for its second period after these seven years there will be no federal support and the network has to be self-sufficient. Although companies should participate with government partners and research organizations to become more innovative, the most funding comes, at the moment, from the federal funds. The board of the CWN has fifteen members from the very large companies, research institutes and governmental organizations. The University of Waterloo hosts the CWN. Within CWN there are three programs that have a national focus; protecting watersheds and ecosystems, protecting Public Health and ensuring Sustainable Water Infrastructure. The last two are the most relevant for this research; universities can solicit for research together with partners. Besides some financial resources to support research the main resource is it's network. This network stimulates cooperation and interaction.

A relation between an organization and the CWN is, as a network should be, based on individual activity. A social network analysis done by the CWN showed that the most participants in the CWN are academics, have a longer work experience and have a well established network compared to the water network in general. Members of CWN have different needs but the basis is that they need the network for collaboration, partnership or to stay up-to date. Besides the different needs there are several groups with their own sector. The study proved that there is a low connection between academics and practitioners even though they know each other. The reason for this is the diversity of interests and priorities. The cooperation that exists is between small groups of people sometimes cross-sector but these groups don't interact that often. It is the goal of CWN to create more of those interactions in the fragmented community.

To support a larger relation between municipalities and academics the CWN shall start in cooperation with the Ontario Centres of Excellence a national research consortium. The National research Consortium has got to research: innovative management and Treatment options for Municipal water Systems and provide a start point for this relation between academics and practitioners. After three consulting rounds, the resulting ideas for research areas are: appropriate drivers for decisions, Innovative technologies and management strategies, effective communication of Issues to secure Support for Decisions. The consortium hasn't started yet but is expected to launch soon. (Source: Website Canadian Water Network, online document of the research consortium and interviews)

Table 5.1 federal innovation programs

Name program	SR&ED	IRAP	Research councils (NSERC)	CFI	NCE-CWN
Sort program	Tax credit	Subsidizing	Creation of knowledge	Subsidizing	Network
Goal	Stimulating investment in R&D	Subsidizing and assist small and medium firms	Financing universities and programs	Support for research equipment	To stimulate triple helix cooperation
Design for	Companies	Small and medium firms	Universities	Public institutions	Universities and partners
Governed by	Ministry of Finance	NRC	Independent (NRC)	Industry Canada	NRC and three councils
Freedom of research questions	Total free (as long as it qualifies as research)	Total free	Depending on expertise field	Total free depending on percent of financing by partners	On topic solicited and unsolicited

Diversity of the federal innovation policy

What can be seen in table 5.1 is that the Canadian federal government has a very diverse innovation policy with special accents for all the kind of knowledge organizations. The only missing type of program is the creation of demand for innovative products. One can argue that this isn't part of a central strategy but that independent ministries are responsible for this stimulation. The problem in the system of water use is that the federal ministry of environment only stimulates research and protection and hasn't the competencies to steer direct the sector.

5.4.2 International Research organizations

Even though the American water works association Research Foundation (AwwaRF) and the Water Environment Research Foundation (WERF) aren't governmental organizations they both make policy for innovation. Because these organizations fund public R&D for the water sector not inside their own organization. Universities, profit and non-profit organizations can compete to get this funding. The organizations are built on the membership of water utilities, international firms and manufacturing companies and consultancy firms. In return for the contribution members of those organizations receive the results of all the research and are able to suggest research questions.

AwwaRF

The American water works association Research Foundation (AwwaRF) is a non-profit organization dedicated to advancing the science of drinking water, together with it's members it support international research in the drink water sector. In 2006 the AWWARF funded for \$15.3 million dollar in research programs, for \$ 1,3 million in Research management and for \$ 1 million in technology transfers. (Source website AwwaRF) AwwaRF was established in 1996 and it has about 900 water utilities and 50 consultancy firms and manufacturing companies as members. Besides the financing trough the subscribers the AwwaRF also gets money from governments. (in 2006 it received one million from the American government.) There are three ways to get financial support from AwwaRF for research; solicited research programs, unsolicited research program and tailored collaboration programs. The research questions of all the researches are judged by a expert committee. Based on peer reviews the quality of the research is tested before funding is given. Besides the funding of research the spread of knowledge is also one of it goals. Besides a printed version uses the AwwaRF the conferences of the American Water Works Association to spread results. (Source: website Awwarf)

WERF

The Water Environment Research Foundation is a non-profit organization that fund & manage water quality research trough diverse public-private partnerships. It was founded in 1989 and it works together with municipal utilities, corporations, academia, industries & federal government (in USA, UK, CA and New Zealand). It is more focused on the waste and storm water site of the water system. It funds close to \$7 million a year for research. It has the same ways of funding as AwwaRF (Source website WERF) And tries to support its members in the same way.

According to participants it is very bureaucratic to get funding from AwwaRF or WERF, you will only ask for funding if the federal government can't support you. Interesting is that the funding partners can be the same as for the NSERC chair, as result you can use a partner twice. Universities are also involved in peer review for those organizations. Peer review is necessary before a research grant is given. Relations with the AwwaRF and WERF, are very formal. Relations with participants from other organizations known through AwwaRF or WERF are informal. Both the organizations function as a platform for universities to interact, this is on the international level.

5.4.3 The Ontario Ministry of Research and Innovation

The Ontario government also has innovation high on its agenda, therefore there is one ministry that's trying to create "a culture of innovation in Ontario " mostly by allocating money for research and development. In 2004 it invested \$489 million in R&D. (S&T strategy report) The ministry of Research and Innovation tries to create this culture of innovation by guidance of innovation trough

policies and programs. Like the federal government there are both organizations and programs to stimulate innovation. There can be made a difference between sector organizations, that try to steer the research, and commercialisations and funding organizations, that only supply money but don't give sector direction. In this paragraph only the organizations and programs are mentioned that can be linked to the system of water use. (Source: website Ministry of Research and Innovation 1)

The innovation agenda, as presented in April this year, focuses mostly on the commercialisation of innovations. Besides the ongoing support on excellence in research, there are four research opportunities chosen, bio – economy and clean technologies is one of them. Research in this field receives more support but again commercialisation seems to be the biggest support. (innovation agenda and innovation strategy plan)

The ministry was advised by a board of experts through the Ontario Research and Innovation Council (ORIC), but after a strategic plan was developed to point out the strength and weakness of the innovation in Ontario the ORIC was dismantled. At this moment there is no council where innovation experts are asked to give an opinion on the innovation policy of the province. (Source: website of ORIC) This is a decrease in innovative capacity because the minister of research and innovation is making policy on its own.

Commercialisation

The Ontario Research Commercialisation program, the Ontario Commercialisation investment fund, the International Strategic Opportunities Program and the innovation and demonstration Fund are all based on the thought that the weakest link in the innovation isn't the research for the new idea but the possibility to put it in the market. The premiers discovery awards and early research awards are a good example for the spread of best practices. To provide the link between education and innovation is supported through the Youth Science and Technology Outreach program and the Teachers Science and Technology Outreach program. (Source website ministry of Research and Innovation 2)

ORF

The Ontario Research Fund (ORF) supports funding for research in non-profit organizations. Over four years \$624 million is spent in the research excellence and the research infrastructure program. The ORF Research Excellence program funds research for clean technologies, creative industries or health and bioscience industries. Ontario research institutions can get this support for infrastructure when they want to apply for the Canada foundation for innovation (these request also other partners). Applications are reviewed by a ministry staff, expert peer review and a peer review panel that gives advice to the ORF Advisory board. The ORF advisory board has expert members and they review the advice but the final decision is made by the minister of Research and Innovation. The early research awards for promising Ontario researchers is also funded out of this fund. (Ministry of Research and Innovation 3)

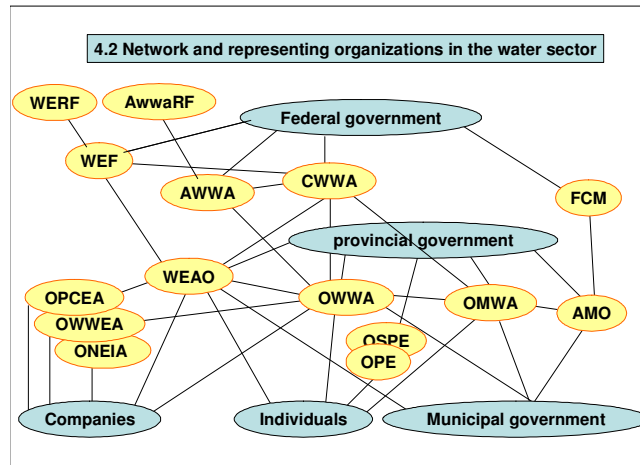
OCE and RIN

Some programs in Ontario are running for a long time, the Ontario Centres of Excellence (OCE) were created in 1987. The OCE tries to commercialise research in several sectors there for it has five centres, for the water sector there is there the Ontario Centres of excellence for Earth and environmental technologies. Commercialisation of in clean air, water and land and smart infrastructure is its purpose. To support this research there were local networks created between industries to solve different kind of problems. The main aim is commercialisation, education and directing research. (Creutzberg 2006 and website Ministry of Research and Innovation 4) Besides the OCE the Regional Innovation Network program also tries to create links between business and research. Regional Innovation Network Program (RIN) contains twelve multi stakeholder regional development organizations. Were several governmental, industry and innovative organizations come together to support clients that needs them like; research, small firms and investors. This Regional innovation network approach is promising but in a different sector; the life science and technology. (Ministry of Research and Innovation 5)

5.5 Network organizations a group not known in the model

In the model that was created for this research four different groups are identified, during the research it appeared that the Ontarian context had some organizations that could be put in one group; the network organizations.

This group of organizations is based on membership of individuals or organizations and plays as non-profit organizations several roles that support relations in the network. Because a lot of the roles are similar the organizations will not be mentioned separate, for the separate description you can use table A1 in appendix two. The network organizations as shown in figure 4.2 operate on different levels and as seen work together to play their roles. For the system of water use network organization are member organization (for individuals and organizations), represent to different government level and stimulate the communication of knowledge by the organization of conference and magazine.



operate on different levels and as seen work together to play their roles. For the system of water use network organization are member organization (for individuals and organizations), represent to different government level and stimulate the communication of knowledge by the organization of conference and magazine.

The roles of the organizations

There are two central organizations on provincial level the Ontario Water Works Organization (OWWA) and the Water Environment Association Ontario (WEAO). The OWWA is as a unit of the American Water Works Association the central actor for drinking water. The OWWA organises together with the Ontario Municipal Water Association (OMWA) and the Ontario Water Works Equipment Association (OWWEA) their annual conference. The central organization for waste and storm water is the WEAO as unit of Water Environment Federation, the annual conference of the WEAO is organized in cooperation with Ontario Pollution control equipment association (OPECEA). On federal level is the Canadian Water and Wastewater Association (CWWA) the representing organization for the units of AWWA and WEF and the municipalities in Canada. The international organizations AWWA and WEF are both situated in the United States and for the influence to the federal government it was wishful to have a Canadian organization. The WEAO and the OWWA have a coordination function in the network as local organization in the province.

Influence on provincial water policy

The WEAO, the OWWA and the OMWA are recognised as partners of the MOE. The policy influence of the organizations has increased after Walkerton as result of their support to judge O'Connor. There are official meetings with these organizations and the policy department of the MOE to deliver input or critic on new legislation. There is informal influence on policy makers through the membership of civil servants. And the network organizations give official response to new laws; the input option is open to anyone for forty days. The organizations give also the possibility to MOE civil servants to educate new laws through the conferences. During the conferences the informal contact creates the support

Support for innovation by spread of knowledge and creating an informal network

Network organizations are a platform for discussion, several issues can be united between organizations and new insights can be shared. For this reason the network organizations are a contribution to the innovative capacity of the system of water use. The ability to link people within a sector and to find organizations in the complex society is done more easily within those organizations. Because of the special role the network organization play they are also central between the innovation and the water sector. The AwwaRF, WERF and their innovation will be explained in the next paragraph. But the real role of the network organizations lies in their basic function the network. The

capacity to innovate due to this network will be described after the explanation of the relations in the system.

5.6 Summary

The different actors in the cluster each have their own resources. Summarizing the previous paragraphs a statement can be made per cluster. The water policy organizations have a large difference in resources. At a provincial level the MOE is responsible for the regulation and the ministry of PIR for financial support. The federal organizations have less regulative possibilities but are better able to allocate financial or knowledge resources. The implementation organizations are centralised around the municipality. As owner the municipality is free to chose the operator. The conservation authorities function between the provincial and the local level to stimulate the preservation of environment. The knowledge organizations in Ontario are characterised by the divers mix of companies, universities and public research institutes. The knowledge organizations have due to this diverse mix also a diverse mix of knowledge. The innovation policy organizations are federal and provincial organized to stimulate the knowledge organizations. Only the AwwaRF and WERF are demanding specific knowledge from the knowledge organizations. The network organizations play a large role in Ontario for connecting organizations to each other.

6. Description of relations and interactions

Interaction in the water sector are comprehensibly based on issues in the water sector and not specific on innovation. Only when water issues have a certain need for innovation these interaction will be mentioned as interaction for innovation. The basic interaction is the basis for cooperation and part of the innovative process but participants shall not identify these interactions as part of the innovative process because the goal of these interactions is based on other problems. The interaction between the actors can be formatted in patterns and these patterns can be linked to a basic game for innovation. Every innovation has its own process but several processes shall have some of the same patterns. The network analysis can show this pattern and the perceptions of actors on this pattern.

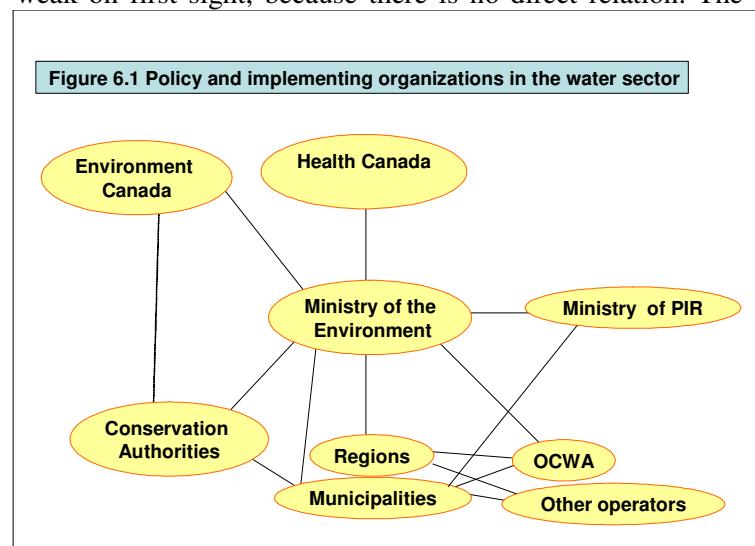
Based on the relations, the use of resources and the perceptions of actors on these relations the use a statement can be given about the relations. These relations can show the use of contributing or negative elements to innovative capacity. Per relation in the model the a statement can be given about the sort relation and its influence on innovative capacity

6.1 Relation between implementing and water policy organizations

The relations between water policy organizations and implementing organizations in Ontario is based on mutual dependence but originated from two different needs. Figure 6.1 shows the most important relations between and inside these clusters. Figure 6.1 doesn't show the reason for interaction only that there is interaction. The central position of the MOE and the municipalities is one of the first things that are visible. The relation between implementing organizations and federal organizations and implementing organizations looks very weak on first sight, because there is no direct relation. The jurisdiction and the sort of relations

can explain the strong position of the MOE and the relative small number of interactions from implementing organization to federal water policy organizations. When interactions are grouped at least four reasons for interaction between water policy organizations can be identified:

- The development of water policy
- The development of innovation
- The construction of water facilities
- The enforcement on the use of water facilities.



Development of water policy a network based relation

The MOE is responsible for the development of water policy, it has contact with the other water policy organizations like health Canada and Environment for the creation of standards. Through network organizations the municipalities are also able to influence the MOE. Since Walkerton is the MOE more open to influence of implementing organizations, still is this influence relative small. The influence of implementing organizations is the largest when they use knowledge as resources. The example as given in textbox 4 shows that implementing organizations as the TRCA can influence norms and standards with scientific prove. Environment Canada and Health Canada influence the MOE also with knowledge and federal guidelines. The MOE is able to use its hierarchical power to ignore this influence; in practice it values the federal influences because the scientific support is a good basis for regulation. Relations between the organizations are based on network basis and the trust level is relatively high. The MOE trust in the research capacities of the implementing organizations, or the federal level. The implementing organizations have some problems with the trust in intentions of the MOE in the past the MOE has been arrogant, for this reason they bundle their powers in network

organizations to be able to make a larger statement. The relations to develop water policy can be seen as a network relation, which is a positive element for innovative capacity.

The development of innovation a market based relation with network elements

The only direct relation from federal water policy organizations to implementing organizations is by support for research in the system of water use. This can be financial support or technical support for research. The federal organizations have more possibilities than the MOE, because the MOE has only some financial resources for standards development. The ministry of research and innovation has possibilities to stimulate innovation but this ministry isn't a water policy organization. As result of the smaller role the province plays, the relation between water policy organizations and implementing organizations is based on a network relation. When water policy and implementing organizations work together for innovation than it is based on a mutual dependence and results will be shared. The case in textbox 4 showed that research resulted in the change of standards but the original goal was just the research. Like the case with the new snow storage, in textbox 5, the innovation was stimulated with support from federal level. The trust in this relation is high and mostly judged on each other's capacities to input financial, production or knowledge resources.

The construction of facilities a hierarchical relation with market elements

The municipalities are the owners of the water systems and are free to buy technology and equipment. The MOE regulates with the use of certificates of approval new drinking water treatment facilities and storm/sewage treatment facilities. In these certificates is stated what the requirements are to operate the facility and the frequency of monitoring. After Walkerton the standards and regulations are also put into law to give the MOE more steering power. Municipalities can use guidelines to design new water facilities. In the guidelines are examples given with best practices how certain standards can be met. The relation between the MOE and the municipalities is both formal and informal, the official request to receive a certificate of approval is formal but during the design the municipality can get informal advise on innovative input. Consultants or the OCWA can also facilitate the communication from the municipality to the MOE. The problem that some municipalities have with the guidelines is; that not following the guidelines results in extra controlling requirements, which makes it more expensive. The relation can be qualified as a hierarchical relation where the MOE uses its hierarchical power to steer the sector. It isn't a principal-agent relation because negotiation between the MOE and the municipalities is too unequal and the power of the municipalities is too low. The use of all the regulations shows that the trust in municipalities has decreased after Walkerton. The relation is more complicated because the MOE has only regulations to steer the sector. The ministry of PIR is able to financially support the implementation of innovations. The relation between the ministry of PIR and municipalities can be seen as a principal agent relation where economic indicators are used to allocate the money. The relation between municipalities and PIR isn't very tight but as result of the relative new status PIR was not well known under the participants of this research.

Enforcement of water policy a hierarchical relation

The enforcement of the water policy is central from the MOE to the regions or municipalities, where there is more focus on drinking water topics than other topics of enforcement. Through extra controlling elements the enforcement of water policy is increased since Walkerton. This resulted clearly in a more hierarchical relation. For the production of drinking water are the regulations the tightest. Drinking water inspectors are able to test everything at the water facilities and municipalities have to report their own test to the MOE. The number of civil servants in the MOE working on drinking water is at least five times higher than the number working on storm or wastewater.

The influence of the MOE on the operators through the OCWA is decreasing, OCWA is more seen as a private operators. Still the informal contact of engineers of the OCWA to the MOE is larger than the contact of municipalities. The relation between the MOE and the OCWA can be described as a principal agent relation because the OCWA is able to negotiate some of the task to be done and at the same time depending on the MOE on its competence.

The freest are the conservation authorities, which implement some of the policy or the MOE for storm water. There is no large enforcement of storm water issues and the conservation authorities are relative independent, they are able to steer the storm water issues. The high level of trust in the relations to the

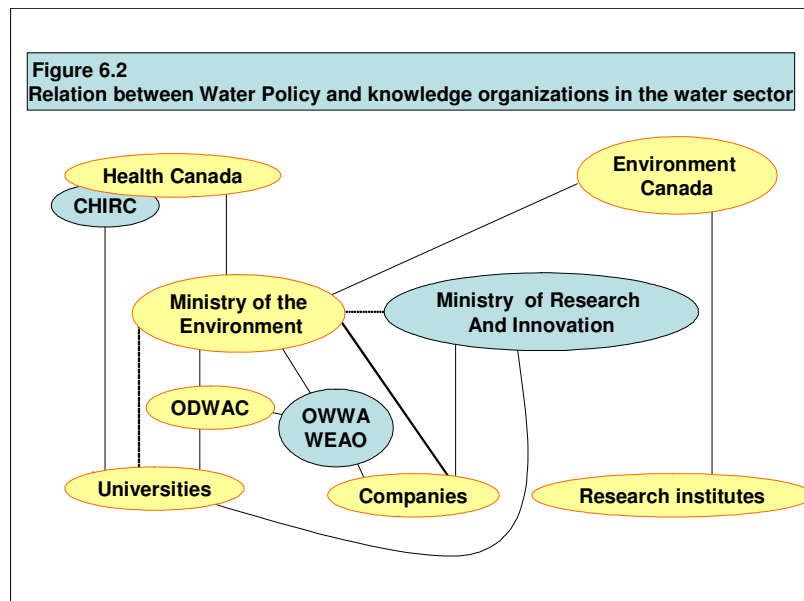
conservation authorities are based on the operational knowledge of the conservation authorities and the relatively high influence from other actors in the policy of the conservation authorities. As mediator between the local and provincial level they completely qualify as network relation.

6.2 Relations between water policy organizations and Knowledge organizations

The interaction between water policy organizations and knowledge organization is as shown in figure 6.2 both direct and indirect. The indirect relation to knowledge is guided through water policy organizations or the network organizations. The number of indirect relations is high because the identification of the goals for interaction shows four reasons for interaction:

- Influence on water policy
- Approvals of techniques.
- Simulation of innovation
- Sharing knowledge

Typical is that not all the knowledge organizations have the same reasons to interact but as resource they all use their knowledge to influence the policy or receive financial support. The trust level is higher for universities and research institutes is higher than for companies because the trust in intentions is different. The intention to make profit results in a more hesitated approach from water policy organizations.



Influence on water policy a network based relation

The direct influence on water policy of knowledge organization is only direct through the already mentioned Ontario Drinking Water Advise Council (ODWAC). This influence is of large importance because it is direct advise of the sector to the provincial Minister of Environment. The relation to civil servants of the MOE is more indirect and personal. Indirect influence is arranged through the network organizations. The informal contact between universities, companies and research institutes also has influence for the innovative capacity. It can be made visible because this interaction is based on personal contact. The relation is based on requests of civil servants and isn't often used to influence water policy. The direct influence of knowledge organizations on water policy is a one sided relation of comment form knowledge organizations to the MOE when organizations use the possibility of influence in the open period of thirty days to comment on new laws. The network organizations ask their members to give knowledge input when this is necessary.

Approval of techniques to much hierarchical steering

A specific type of influence for companies, is the approval of new techniques, companies need their new techniques approved to be able to let municipalities implement those. After research of universities a company can jointly with a municipality request a certificate of approval. The input of research in other countries can be used to support statistics of the application. When the MOE thinks there isn't enough data a pilot status for two years can be given. In those two years enough data can be gathered to receive a certificate of approval. A pilot status shall be given within 45 days to support the implementation of innovative solutions. For companies this relation is very formal to meet the criteria, informal is there intensive contact with civil servants to prevent a pilot status because this status gives a risk that a two-year-old system doesn't get the certificate of approval and becomes worthless. The formal character and the uneven power balance result in kind of hierarchical relation.

Market based stimulation of Innovation

Stimulation of innovation by water policy organizations is mostly done by the federal water policy organizations. Environment Canada stimulates research through their research institute (NWRI), Health Canada has also inside research facilities, but for the system of water use it influences indirect, through the innovation policy organization CHIRC, to universities. The MOE has the smallest support for innovation with their support through the best in research. At provincial level the Ministry of Research and Innovation is the most important organization and through this organization should the MOE have some influence on the Innovation. In practice this indirect influence isn't really functioning as result of the sectoralisation between those ministries. To describe the relation it can be qualified as a market based relation because when the federal or provincial organizations need knowledge than they will support the knowledge organizations.

Sharing knowledge a relation on network basis

The need for knowledge and the sharing of knowledge is very important for the innovative capacity of the network. In this context the sharing of different kinds of knowledge show a contribution to innovative capacity. What can be seen is that the MOE as regulator has a certain degree of knowledge, but for specialized knowledge it trusts on universities and the research institutes. For more practical knowledge the MOE relies on the network organizations or direct on companies. Federal organizations work on a less applied level and use as result a bit more fundamental knowledge.

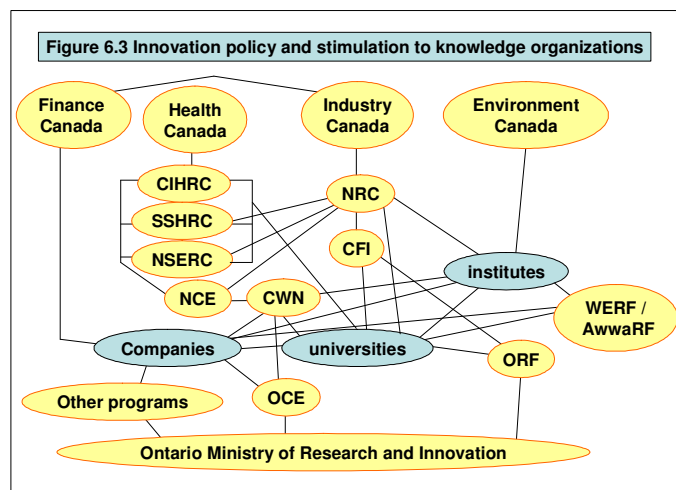
6.3 Relation between Water policy organizations & Innovation policy organizations

The relation between water policy organizations and innovation policy organizations is manifest on two levels; provincial and federal. On provincial level the relation can be described as sectoralised, on high bureaucratic level there is influence on each other's policies. There is no visible policy influence of lower civil servants of the MOE on the ministry of Research and Innovation. The civil servants of the MOE are used as technical advisors for the judgement of some applications but in these cases are there more ministries involved and is the technical advice just one of the requirements.

On federal level there is more cooperation between ministries and policies. The central responsibility of the ministry of industry is to stimulate innovation results in a centralized policy but ministries are able to develop extra innovation policy. The NRC and the research councils under the ministry of industry are able to steer universities in a broader objective. As result different ministries can have influence in the policy. The national centres of excellence are able to steer in different sectors, with influence from federal water policy organizations. The different internal research institutes are also an ability to steer a sector.

6.4 Relation between Innovation policy and knowledge organizations

The relations between innovation policy and knowledge organization are based on hierarchical and financial differences. Depending on the sort of innovation policy organization and the use of resources is the relation more rigid or open. The central position of the National Research Council (NRC) is visible in figure 6.3 as federal coordinator. The central role to different programs results in a broad mix of instruments to influence innovation. There is no need to influence the result of the research but only guiding the different types of research. The role of the NRC is formal. As result of the governance structure has the NRC many links to both industry and academics. In almost all the relations there is a kind of principal-agent relation because financial support for research is difficult to control. The creation of networks is more discursive because the creation of formal and informal meetings is a non-visible



process. The most formal relations come from the WERF and AwwaRF because the allocation is strict and application requires a number of controlling measures. When the communication patterns are combined there are four reasons for interaction:

- Financial support of Innovation
- Demand of knowledge
- Creation of Networks
- Influence on innovation policy

Financial support on principal agent basis

Financial support for knowledge organizations is based on specified and common subsidies or loans. All the different financial programs have elements of a principal agent relation, which is logical because the outcome of financial support is sometimes difficult to measure. This results in a lower trust level and more formal regulations for evaluation and progress report. Common subsidies are for companies given through tax credits and can be used for a broad purpose. The communication between Finance Canada and companies is formal. The specified subsidies are more intended for universities, this support is aimed at sectors or equipment. There is only formal communication around these topics. The support for a specific sector is not only for the development of knowledge but also for the development of the whole sector.

Demand for innovation based on partnership

The demand for specific innovations or research questions is defined by expert panels and comes from WERF, AwwaRF and the CWN. The relation with universities and companies is more network based because there can be influence on the research question. Especially with unsolicited research almost everything is possible. Although there is a large informal network around those organizations, applying for research objectives is a formal process. Participants point out that research done for WERF and AwwaRF results in more formal procedures for evaluation and progress than research done for the NSERC. More specified research questions are found in the research institutes because they have a closer relation with the mother department.

Networks

The networks that are created by governmental organizations are the CWN and the OCE. They are important for the diffusion of innovation, like the network organizations. The CWN seems to be a more university network with contacts at companies and some municipalities. The OCE appears to be a network for companies with contacts at universities and few contacts at municipalities. Together they are working to create a new organization to bring the demand of the smaller municipality to the academics because now only the larger municipalities are able to communicate with academia. The NSERC research chair functions as communication platform for large municipalities and the university. The NSERC industry chair is based on the funding for research and support for the creation of networks. Although being partner of a NSERC Industry chair is formal, it results in an informal network around the professor of the chair. The trust level in the NSERC industry chairs is higher than in the CWN because the NSERC industry chair has a more personal relation and for municipalities and companies connects the NSERC research chair better to their demand. Being organization member of the AwwaRF or WERF results also in an excess to an informal network. During the conferences of the AwwaRF or WERF knowledge is shared and new research partners are found. Due to relative high contribution this option is only open to the richer municipalities or companies.

Influence on innovation policy by experts

Influence from knowledge organizations to innovation policy organizations is important because innovation can't be supported from only a policy objective. The practitioners see problems and possibilities to invest for the government. At federal level participation of experts from universities and companies is arranged with several boards. The NRC board and the NSERC board are both filled by the scientist, from universities and companies. Those experts try to choose the best research for funding. As independent councils they are able to choose without political motive and advise the minister of Industry. At the AwwaRF and WERF expert advice is used for peer review, this is a quality

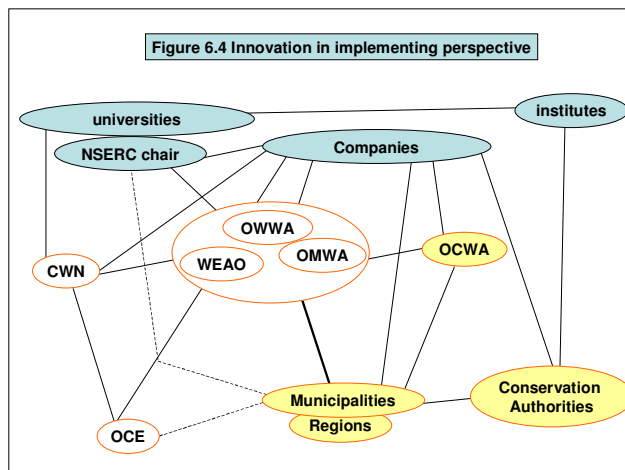
measure. The use of experts is also a risk for innovation because unknown “innovative” solutions will not be support by experts because it is unknown but still those experts are better able to judge on new techniques than a policy department. The only innovation policy organization that doesn’t uses experts any more is the Ontarian ministry of Research and Innovation because it stopped the Ontario Research and Innovation Council after its last advice.

6.5 Relation between Knowledge and implementing organizations

Relations between municipalities and knowledge organizations are based on a more applied need for knowledge. The demand driven character of these relations can be seen in the contact municipalities have with knowledge organizations. Most of the contact with companies is for direct questions and solutions. For more fundamental knowledge smaller and medium municipalities use intermediary organizations to contact universities or research institutes. Only the large municipalities have direct contact with universities. This can be explained by the different role the municipalities or implementing organizations play:

- Buyer of innovation
- Inventor of innovations.

As result of the relative weak financial situation the municipalities aren’t able to steer the demand in the sector. The network organizations are able to make a clear voice and therefore have a strong position in finding innovations.



Municipalities as buyer, direct or indirect applied demand

The central position of the companies, as seen in figure 6.4, can be explained by pattern that a large group of municipalities only buy innovations. For these municipalities there is a certain need, as result of a problem, to buy the technology from a company. In these relations the municipality is the principal and the companies are the agent. Companies try to work on a more network-based relation because a long relation can result in future purchases of the municipality. The municipalities see the relation on a more on a principal agent basis and try to gather more information by using consultants, the OCWA or through the Network organizations. The development of individual solutions is possible but as result of the financial restrictions and conservatism not very common. Municipalities are buying known techniques and using the same systems as their neighbours, which is a decreasing factor for innovative capacity. The real applied demand for knowledge to universities has to come from the network organization or companies and will only start when there is at least some demand from municipalities.

Larger municipalities as innovator on network basis

The growing medium municipalities and the larger municipalities have a larger budget to be innovative on their own and have the possibilities to support the NSERC or AwwaRF and WERF. As a result the contacts of those organizations are more diverse and the use of intermediates is smaller. This can also be seen in the trust level, where smaller municipalities have a more principal agent relation with companies are larger municipalities able to have a network relation. The knowledge level in larger municipalities is higher and as a result those are better able to judge on innovative solutions. Innovations in larger municipalities are almost all accompanied by university support for fundamental advise and company support for technical advice. The interesting role of the conservation authorities who is, on its own, able to play as network between different kinds of organizations, resulting in innovative solutions.

6.6 Relation between implementing and innovation policy organizations

There is no direct relation between implementing organizations and innovation policy organizations. As already mentioned the larger municipalities are participating in programs of the innovation policy organizations. Participation in NSERC industry chairs, CWN or OCE results in networks and in research. This participation is very important for the knowledge diffusion. Larger municipalities are able to spread the knowledge from the networks to the smaller municipalities. The relation with the policy organizations is only indirect, there is no direct communication or influence on each other. The most direct influence of Industry Canada is through the Canadian Federation of Municipalities (CFM). In the past an important program was the sharing best practice program, which was financially supported by industry Canada. This program ended as result of budget cuts. The only remaining direct fund for municipalities is the green municipal fund, which is financed by Industry Canada and also hosted by CFM. The weak relation between implementing and innovation policy hasn't got to be a direct threat to innovative capacity because indirect demand steering and indirect influence can also function. What is seen in the last paragraph is that there a small demand from municipalities and thus more intervention of innovation policy organizations would be wishful for the innovative capacity.

6.7 Summary

The large number of organizations is related to each other in the network, what is found is that the different roles of the organizations are visible in the relations. The water policy organizations and the implementing organizations have a hierarchical relation for the construction of facilities and the enforcement of water policy as result of the health risks with contaminated water. For the creation of innovations municipalities are more autonomous, this relation is based on a market relation and the influence on the water policy is more based on a network relation. The Relation between the knowledge organizations and water policy organizations is based on a network relation for the sharing of knowledge and resulting in influence from knowledge organizations on water policy. The stimulation of innovations is more market driven and the approvals of techniques are based on hierarchical elements.

The relation between water policy organizations and the innovation policy organizations is a sectoralised relation or can be described as a not working network relation. The relation between innovation policy and knowledge organizations for financial support is based on a principal agent relation, the same counts for the steering of the networks. The networks itself are based on network relations, the same is the influence on the innovation policy. The relation between knowledge organizations and implementing organizations is based on network relations for the creation of innovations and on a principal agent relation for the sell and buying of knowledge. Relations between implementing and innovation policy organizations are based on stimulation of municipalities. This is an indirect relation. How these relations contribute to the innovative capacity is depending on the organizations, shall be shown in the next chapter.

7. The innovative capacity

In the previous chapters the organizations are presented in their clusters and is the relation between the different organizations presented. Based on these findings the model as used in this research gives the possibility to make a statement about the innovative capacity. The empirical findings on institutional level are used to make statements about the process level. Every process is different but a general statement can be made on critical points, barriers and drivers. To ensure the quality of the statements about barriers and drivers they are compared with process statements and observations of participants and the theoretical configurations. The first paragraph 7.1 shall introduce the innovative capacity per clusters based on their actor specific elements and relations. The relations are included in the description per cluster with the use of the roles and governance structures. The second paragraph 7.2 shall based on the finding in the first paragraph present the drivers and barriers for innovative capacity in the water sector.

7.1 Innovative capacity of the system described per cluster

The four clusters of organizations as presented here are as already mentioned earlier not the complete picture for Ontario. The network organizations also play an important role, the strength of the network organizations lies in the relations between organizations. The network organizations are for this reason mentioned in relation to the four clusters. In the next sub paragraphs first the innovative capacity of the elements in the cluster are described and than the relations per cluster. The background indicators explain some of the institutional background of these elements. In chapter 4 was concluded that the high education and de economic situation and human development are contributing to the innovative capacity. The geographic aspects are a decreasing influence on the innovative capacity in the system of water use because they don't create a demand for innovative solutions.

7.1.1 Innovative capacity of implementing organizations

The implementation organizations could, according to the model, be of large importance for the innovative capacity by creating a demand for innovation. But in Ontario the implementation at the municipal level gives some negative influences on the innovative capacity. This is partly the result of the elements of the cluster itself, part of the relations and the current still functioning infrastructure.

Municipal implementation and innovative capacity

What can be seen in table 7.1 is that the municipalities are the centralised organization in the implementation cluster. The municipalities have as owner full control over the facilities. The larger municipalities the larger the engineering department and the larger engineering staff to develop innovations. Smaller municipalities have more problems due to the lack of operational resources. Only larger and growing municipalities are able to allocate financial resources for innovation. Investments of smaller municipalities in radical (already known) innovations occur when the problems are visible as is mentioned in textbox 6. In the current financial system the cost of replacements are not enough ensured. As a result municipalities have to contribute themselves for replacement. The financial system results in a lack investment and municipalities don't use the policy freedom to innovate, because they want to avoid the risk of failure. The decision culture in implementing organizations is political oriented. The local politicians have other goals than innovation in the water system. Local political conservatism and the lack of competition on quality are resulting in lower investments for innovations. The investments in innovations in the system of water use have to compete in the budget of municipalities with sport facilities or replacements of the road. The decentralised system, which was mentioned as a positive element in the model turns out to be of negative for innovative capacity as result of this political interference. A positive element for innovative capacity in the organizations is responsibility of the municipalities for all the products in the system of water use because this result in more knowledge diffusion. The positive element of the OCWA is that the management of water facilities up north would be more expensive when municipalities would operate itself. The competition between private operators and the OCWA doesn't lead to quality improvement. According to participants results the competition of operators only in lower prices. The worst case was the underbid of OCWA in some of the contracts to keep a strong position. (Ministry of PIR, 2005, p.69). This can't

result in better quality and innovation. The lacking resources for innovation are, also in the functioning of the roles in the relations, a problem for the innovative capacity.

Table 7.1 elements of implementation organizations

Organization	Municipalities	Conservation Authorities	OCWA	Private operators	Effect on innovative capacity	
Type / level	Public / municipal	Public / regional	Hybrid / provincial	Private / international	Too much decentralised system (-)	
Sort institution / roles	Public policy / Owner and distributor (innovations)	Public policy / support municipalities in conservation plans	- / Operators and advisor	- / Operator	Number of municipalities that develop innovations is low (-)	
Internal culture	Political	Political/professional	Professional	Professional	Municipality political steered (-)	
Number of products	Drinking, sewage and storm water	environmental conservation and issues with sewage and storm water	Drinking, sewage and storm water	Drinking, sewage and storm water	Organizations are involved in whole system (+)	
Competition	No competition, focus of benchmarks on price	No competition	Competition with other operators on price	Competition with other operators on price	No real Competition, comparison on price (-)	
Resources	<i>Financial</i>	Able to raise tax but current system not sufficient for replacement	Based on partners	Working price reluctant for municipality	Working price reluctant for municipality	Tax system for water isn't sufficient for replacement (-)
	<i>Production</i>	Municipalities are owner. only large municipalities have large engineering department	Knowledgeable staff with applied knowledge	Staff with implementing / applied knowledge	Staff with applied / implementing knowledge	Staff is high educated and municipalities are free to adjust their own facilities (+)

Roles of the implementation organisations

The municipalities are responsible for the production of the products in the system of water use and play the role as operator, costumer and innovator in the model. Using the roles as perspective to the relations the following interesting findings can be presented: a negative contribution to the innovative capacity in relation to the water policy organizations, a more positive contribution as result of the relation with the knowledge organizations and hardly any influence on the innovative capacity as result of the relation with the innovation policy organizations.

In relation with the water policy organizations the different roles of the implementation organizations are in conflict with each other. For the role as operator are controlling measures necessary but for innovator is an autonomous position important. The role as operator is regulated by the MOE to ensure the water quality. In this hierarchical relation the autonomous power of the municipality is very low, which is a decrease in the innovative capacity. The implementing organizations don't very often use the freedom given by the MOE. When municipalities use different techniques to reach the norms requires the MOE more controlling efforts. Influence on water policy has increased since Walkerton through the network organizations. The influence of the implementing organizations has increased because now there are official contact moments. The MOE sees the OWWA, WEAO and OMWA as useful partners for the creation of water policy.

For the role as developer or buyer of innovation the influence of the water policy organizations is divided. The water policy organizations from the federal level are contributions to the innovative capacity of the implementing organizations but the provincial organizations aren't giving enough resources. The financial support from the federal level is a contribution to the innovative capacity because this results in a network based relation with mutual dependence to develop knowledge. The ministry of PIR isn't able to deliver this support, the relation with the ministry of PIR can better be described as a principal-agent relation as result of the economic steering. The result of this relation is, that municipalities have to use their own financial resources to develop or buy innovations. The current tax system on water isn't supporting the innovative capacity. The current tax on water is based on direct cost, with no financial reserves for replacements. The province originally financed replacements but stopped subsidising the system. The tax system has to change because it is a decreasing influence on the innovative capacity. Only large and growing municipalities are able to allocate parts of their budget for the finance of innovation. The autonomous role of municipalities is useless when there aren't enough financial possibilities to develop or buy innovations. Innovative municipalities can use some support of the federal water policy organizations. Municipalities innovate and the results are analysed by the federal organization. In some cases small financial support is also possible, as seen in text box 3 is this relation based on partnership and a positive influence for the innovative capacity.

Table 7.2 IO <=>WPO

IO <=>WPO	Decreasing influence	Increasing influence	Total effect on innovative capacity
Developing policy / enforcement	Enforcement is hierarchical as result of the importance of the water quality. The possibilities to reach the norms with different techniques aren't used frequent because of the controlling requirements (-)	Through the network organizations is there direct and indirect influence on policy (+)	Although there is indirect and direct influence on the water policy is the enforcement too hierarchical and strict for innovation. (-)
Developing or buying innovations	The municipalities are autonomous to buy or develop innovations but the financial support from the province is small. The tax system on water isn't sufficient to provide financial resources for replacements. Resulting in only larger municipalities with possibilities to allocate their own budget. Without financial possibilities are the controlling requirements too expensive. (-)	From federal level there is a strong support. On network basis participate federal organizations with support for innovation. (+)	Municipalities are autonomous for development, with financial resources from the federal level some innovations can occur. The result of the enforcement of water policy can be seen in the lower development of new techniques because of the controlling efforts (-)

The relation between the implementation organizations and the knowledge organizations is based on the development of new innovations for the growing and larger municipalities a contribution to the innovative capacity. As result of the financial system larger municipalities have more resources to develop innovations. The larger staff and financial resources result in direct contact with companies and universities to develop innovations themselves. The municipalities with a pilot plant are also attractive for companies because this results in lesser controlling cost. The conservation authorities play a special role in developing knowledge with financial support from the water policy organizations are they able to evaluate techniques of companies with research support of universities. This is completely based on network relations and result in a high exchange of knowledge, which is a high contribution to the innovative capacity.

Smaller and medium municipalities buy more known technology, they use intermediary organizations and have a more applied demand. This is a decrease in innovative capacity because the exchange of knowledge is lower. The local political conservatism is the explanation that a relative high number of municipalities only buy already known technology. It is safe to use already known technology because you don't have a financial risk. This local political influence is with the financial situation the largest

explanation for the lack of innovations in municipalities. A less apparent factor is the high quality of the surface water resulting in lesser needs for high-developed innovations. When there are problems with the water quality the demand for radical innovations rises as seen in text box 6. This is more a positive contribution of knowledge organizations than a contribution of implementing organizations because these disasters are rare. Besides result the implementation of these radical innovations not in innovative municipalities.

Table 7.3 IO <=>KO

IO <=>KO	Decreasing influence	Increasing influence	Effect on innovative capacity
Developing innovations	The small and medium municipalities aren't really developing innovations (-)	The larger municipalities are working in a network relation with KO to develop innovations. The role of the conservation authorities in the development of knowledge is also on network basis contribution to the innovative capacity (+)	(-/+)
Buying innovations	The smaller and medium municipalities behave like a principal in their demand for innovations. The conservative local political influence results in a demand for already known applied techniques. This results in lesser innovation from the KO. (-)	When municipalities demand radical innovations the drive is as shown in textbox 6 probably a disaster. The participation is based on network basis and there is a high exchange of knowledge but these occasions are rare.	(-)

The participation of the large municipalities in the CWN or the networks of the WERF and AwwaRF is important for the innovative capacity of the implementation cluster. The spread of knowledge through these networks from the academia and companies to the implementing organizations results in a large understanding of new possibilities. Although the networks are more organized around the universities and companies the participation of the large municipalities is important, because they will spread the knowledge over the system. The larger municipalities will use these innovative ideas and share them with their neighbours. The same importance has the network organizations. During conferences universities and companies are able to inform the municipalities. This facilitation of user participation is not a contact with innovation policy organizations. Participation of municipalities in the CWN or NSERC industry chairs is important but doesn't result in a direct relation with innovation policy organizations. The CWN or the NSERC industry chairs both are programs of the innovation policy organizations. The closest relation with the innovation policy organizations is through the Canadian Federation of Municipalities (CFM). On behalf of Industry Canada divides the FCM financial support of the green municipal fund. The sharing best practises program was a very contributing program to innovative capacity but unfortunately it has stopped because of budget cuts. Indirect influence of municipalities on federal innovation policy is arranged through the Canadian Water Wastewater Association. The ministry of research and innovation has no special attention for municipalities, as result municipalities don't know a lot about the possibilities of the programs. The Ontario centres of excellence are trying to change the participation of municipalities by starting a research consortium in cooperation with the CWN.

Table 7.4 IO <=>IPO

IO<=>IPO	Decreasing influence	Increasing influence on innovative capacity	Effect
Financial support	No special attention on provincial possibilities (-) A point for sharing best practises could be restarted	Specific federal innovation policy is arranged through the green municipal fund. (+) Influence on innovation policy is arranged through the network organizations	(-/+)
Networks created by IPO	Participation of municipalities in OCE relative low. (-)	Although the networks are created around academia is the participation of companies and large municipalities a huge contribution to the innovative capacity.	(+)

The innovative capacity of the implementing organizations can be explained by the difficult position to innovate or buy innovations. The implementing organizations are autonomous but have to meet regulation criteria. Innovative solutions have to prove that they meet the quality norms by delivering controlling data to the MOE. The smaller and medium municipalities don't have financial resources or enough staff to do the research. This is the result of the water tax and the local political conservative influence. The positive influence on the innovative capacity comes from the larger and growing municipalities because they have more relations with knowledge organizations and are better able to allocate resources for innovation. The network organizations are important for the delivery of knowledge to the implementing organizations and influence on the other clusters.

7.1.2 Innovative capacity of water policy organizations

The innovative capacity of the Water policy organizations isn't based on being innovative as organization but on the contribution of their task and role to innovation of other organizations. The task of water policy organizations is to safeguard the quality and distribution of the drinking water and the environment. Treatment of drinking, waste and storm water is for that reason regulated. As the model points out the resources for a water policy organization can be used for the following roles: to regulate, finance and stimulate other clusters to be innovative. Table 7.5 shows that the several resources as identified in the model are spread over the different organizations and hierarchical levels. These different organizations play the different roles of the water policy organizations.

Innovative capacity organizations and resources

The separation of powers between federal and provincial level resulted in federal organizations with a focus on knowledge creation and the province with more financial and regulations powers. All the different roles the water policy organizations have to play are institutionalised in organizations. The fact that all the roles are institutionalised would contribute to the innovative capacity when there would be enough adjustment between the organizations. The adjustment at federal level seems to be available but the relation federal-provincial and provincial-provincial is less clear. Only at high hierarchical level (between deputy ministers) there is interaction and organisations aren't using interdepartmental organizations for policy making. A whole research can be made about this sectoralisation because the organizations need each other for good policy. This sectoralisation is a decrease for the innovative capacity because without policy adjustment the steering from policy organizations isn't optimal. A perfect example is the judgement of applications, this requires each other's expertise. Judgement of applications are now based on a check-list with mostly economic indicators, technical innovations with lesser attention to these indicators receive lesser funding.

The innovative capacity of individual organizations lies in the use of their resources for their specific roles. The innovative capacity of federal ministries lies in the support for research. They need research for creation of knowledge and to be able to give advise on provincial policy and create federal policy. This demand for innovation can be qualified as a technical push instrument for a specific innovation. This results in a contribution to the innovative capacity because the subsidy enables local initiatives. The subsidies and own research at federal level can be explained by the lack of regulative possibilities on this topic.

The province has more possibilities to regulate the system of water use. The regulation possibilities of the MOE can be used as a technological pull instrument by creating norms resulting in a selection of technology. The more central structure attitude of the MOE in the past and the usage of regulations support a rigid hierarchical description. Despite the fact that the regulations are based on norms is it not an increasing element for innovative capacity because municipalities don't use the possibilities. The reason here fore is the controlling efforts to maintain the quality and ensure that the implementation organizations reach the norms.

The internal elements of the ministry of PIR are not a contribution to innovative capacity because funds are allocated on economic basis because the funding possibilities aren't related to innovative pressure or high technical requirements. The communication between MOE and PIR isn't supporting the financial support because it can be qualified as high sectoralisation. This relation is resulting in an

allocation of financial support by PIR, which is a decreasing factor of innovative capacity. The effect of this financial support is a lack of specific steering to increase the demand for innovations, this technological pull instrument isn't used in the right way.

Table 7.5 elements of the water policy organizations

Organization		Health Canada	Environment Canada	MOE	PIR	Effect on innovative capacity
Type / level		Public / Federal	Public / Federal	Public / provincial	Public / provincial	All the kinds of institutions can be identified. (0) No influence
Sort of institution		Public policy institution	Public policy institution	Public policy / legal institution	Financial institution	
Policy adjustment		Federal on some topics	Federal on some topics	Sectoralised	Sectoralised	Sectoralised (-)
All the tasks and roles		Health (Stimulating innovations / demanding knowledge)	Preservation of environment (Stimulating innovations / demanding knowledge)	Preservation water and environment (Regulator)	System of water use is part of public infrastructure (Financer)	All tasks of WPO are done, no conflict of interest (+)
Resources	Financial	For policy research subsidy available (+)	For policy research subsidy available (+)	-	Funds and loans available but on economic basis (-)	Subsidy for research (+) subsidy for development (-)
	Competencies	During disasters regulative power	Only regulative steering to NWRI	Regulative power based on norms and enforcement by procedures	Not for system of water use.	Regulations based on norms (+) but enforcement (-)

Innovative capacity in relations of the water policy organizations

The most remarkable results in table 7.5 are the difference in roles between the organizations and the fact that water policy organizations aren't innovative themselves. Where provincial ministries focus on the local water system, federal organizations are more focused on an issue that is related to the system of water use. Both health and environment depend on the system of water use for good policy. The relation between the innovation policy organizations and the implementing organizations is already described in table 7.2. The described relation is two sided and the impact on the innovative capacity is the same because the innovative capacity of the water policy organizations is depending on the innovativeness of the implementation organization. Still the behaviour of the water policy organizations can be explained because it has large influence on the innovative capacity.

The current hierarchical relations from the MOE to the implementing organizations can be explained by the disaster of Walkerton. After the disaster of Walkerton it appeared that municipalities didn't follow norms because the MOE wasn't commanding. Norms and standards were put into the drinking water act, as was mentioned in textbox 1, and the MOE became more a controlling ministry. The problems with too tight regulations are known within the ministry but their goal isn't innovation but safeguarding the quality of water. The possibilities to use unknown techniques for this reason is also regulated with safety checks. At the same time the MOE became more open to influence from other organizations. It had to accept that for good standards in the regulations it needed the experts from the field and universities. The creation of the ODWAC has also increased the influence of the municipalities.

The relation between the MOE and the ministry of PIR as already described is high sectoralised. This doesn't give the MOE the possibility to steer on technical improvements by supplying municipalities with financial funds. The ministry of PIR has tried to change the tax system after rapport watertight was finished but due to provincial election this was stopped. The politicians didn't want a large

conflict between the province and the municipalities about the water tax. Relations with implementing organizations results for federal ministries in a network relation as described in at the description of the implementation organizations. The federal organizations need the knowledge for their policy and the municipalities need some research support. This mutual dependence results in constructive cooperation and is for this reason a contribution to the innovative capacity.

The relations with the knowledge organization can also be explained with the roles of the water policy organizations. The demand of knowledge from the MOE to create water policy is, as already mentioned, increased after Walkerton and based on a network relation. The ODWAC is a group of experts that gives comments new policy and standards. The experts come from universities, the NWRI, municipalities or the network organizations. The ODWAC has also the possibility to give unsolicited advice and is therefore of huge influence. A demand for applied solutions for a problem is lesser known. There is money available but the MOE isn't allowed to support innovations. This is the responsibility of the ministry of Research and Innovation. As result of the sectoralisation at provincial level this results in a lack of demand steering from the provincial level. In this relation are the federal organizations also of larger positive influence to the innovative capacity.

7.6 WPO <=> KO

WPO <=> KO	Negative influence	Positive influence	Effect on innovative capacity
Demand of knowledge for water policy	The MOE doesn't demand innovations from the knowledge organizations there is a small amount of money to receive advise for new policy. (--)	The demand of knowledge from the MOE to create water policy is based on a network relation. This relation is arranged in the ODWAC and the consultations of the network organizations. It started as result of Walkerton to increase contact with the experts in the field. (+)	The consultation of the experts is positive but the demand from the MOE is lacking (-/+)
Stimulation of innovations for knowledge stock	Demand for specific knowledge at provincial level is lacking because the support for innovations is the responsibility of the Ontarian ministry of Research and Innovation.	Support from the federal organizations is based on a network relation. Health Canada and Environment Canada use the results of the research for their policy. With the possibility to do solicited and unsolicited research they increase the stock of knowledge. (+)	Federal (+) Provincial (-)

The relation between the innovation policy organizations and the water policy organizations can be described in the same way as the internal relation between the water policy organizations. The relation of federal water policy organizations to federal innovation policy organizations is characterised by policy sharing, resulting in combined and independent policy. The relation between the provincial water policy organizations and the federal or provincial innovation policy organizations wasn't visible. There is a relation between the MOE and the ministry of Research and Innovation but this relation isn't a support for innovation. The MOE has no visible influence on the policy of the ministry of Research and innovation. The MOE isn't allowed to create an innovation policy on it's own, only for the development of standards, and it is only contributing with technical advise to the programs of the ministry of Research and innovation. This is a serious problem for the innovation in the system of water use because the MOE can only steer with laws and guidelines. It isn't able to stimulate financially the demand at the implementation level or by demanding innovations itself. A joint policy would result in a higher innovative capacity now the province (especially the MOE) isn't able to steer the innovations in the sector.

7.7 WPO <=> IPO

WPO<=>IPO	Negative influence	Positive influence	Effect on innovative capacity
Policy adjustment	At provincial level high sectoralisation resulting in no specific innovation policy for the system of water use	The federal development of innovation policies is more or less harmonised.	The lack of provincial harmonization is the important influence because the province should as regulator stimulate innovations (-)

Concluding can be stated that the separation of powers between the provincial ministries leads to a decreasing influence on the innovative capacity. There is not central steering organization and none of the organizations feels responsible for the innovation in the system of water use. When the MOE tries to steer the sector it is bounded by its resources because it can only steer with regulations. The financial system was build with financial support from the province but the ministry of PIR hasn't changed the tax system jet. The sectoralisation between the provincial ministries is a problem because now none is steering on innovation in the system of water use.

7.1.3 Innovative capacity of Knowledge organizations

The development of the knowledge organizations in Ontario is very advanced, because there is a good mix between universities, companies and research institutes. The mixed results in both applied and fundamental research as can be seen in table 7.8 is contributing to innovative capacity. The basis of the strong knowledge organizations is created by the high education level in Ontario and the stimulating policies of innovation policy organizations.

The elements of innovative capacity in the cluster

The diverse mix of both public and private organizations result in a diverse stock of knowledge. What can be seen in table 7.8 is that the availability of small companies and medium and international companies, universities is arranged at all the different levels. This results in a good connection to the different kinds of knowledge, which is positive for the innovative capacity. The internal knowledge exchange is higher than expected because it is more based on cooperation instead of competition or cooptition. The availability of risk capital is one of the reasons for the large diversity in knowledge organization. Innovation policy organizations point out that the investment in research and development with public money is relative large. The last years the financial possibilities are shrinking, participants have mentioned that this could become a problem for the current small companies. A lot of capital is necessary to survive the first couple of years. The production resources are a positive influence for the innovative capacity of the cluster because the employees are high educated and there are more sorts of research facilities. As result different kinds or research is done, not even in a more competitive setting. The different products and knowledge for the whole system of water use is available in the high-developed cluster with a large degree of innovative capacity.

Table 7.8

Organization	Universities	Internationals	Medium and small firms	NWRI	Walkerton centre	Effect on innovative capacity	
Type / level	Private provincial/ international	Private International	Private / provincial or local	Public Federal	Public Provincial	A good mix of different kinds of organizations (+) which are at all levels present (+)	
Sort institution and roles	Education and research institution (spreading knowledge)	Firm (providing products and selling knowledge)	Firm (Providing products and selling knowledge)	Research institute (providing knowledge for policy)	Education centre (providing knowledge to prevent outbreaks)		
Competition	Cooptition with universities and other KO	Competition with large and medium companies. Cooptition with small companies and cooperation with other KO	Competition with small and medium companies cooptition with rest of KO	Cooperation no competition because financial position isn't linked to a market	Cooperation with other KO	Competition and cooptition (+), better is the large amount of cooperation (+)	
Resources	Financial	Able to allocate money themselves	Have own budget for R&D and tries to use governmental support	Ability to allocate money for research depending on grants	Have federal money for support of local research	Support for research	Both private and public capital available for research (+)
	Production	Have research facilities	Have own R&D department	Depending on quality of staff (mostly high educated)	Have own research centre	-	There is high educated staff and more research facilities (+)
	Knowledge	Fundamental and applied knowledge	Applied knowledge sold in own machines	Applied knowledge based on local situation	Have fundamental and more applied knowledge	Practical Knowledge	There is a broad mix of expertise and products for all the topics in the water system. (+)

Creation of innovations

Already mentioned is the problematic demand for innovation. The demand from municipalities is largely based on known techniques. This could be explained with elements of the municipalities; the local conservative political influence and the tax on water. The relative clean surface water was a country specific explanation for a lack of demand. Interesting is that in a system with a lack of demand there is a large availability of knowledge. This can't be explained with the occurrence of a disaster because the international companies already discovered the radical innovations before the disasters occurred in these cases. An explanation can be the large availability of resources.

The resources of the different kinds of knowledge organizations give a central position to the knowledge organizations for the creation of innovations. As shown in table 7.3 the international firms have the largest ability to use financial resources and have a large possibility to develop techniques. Universities and the NWRI have as production factor also large research facilities but their research is more based on fundamental knowledge or evaluation of known technology. The combination of both kinds of research facilities and possibilities increases the innovative capacity because research isn't depending on one kind of research organization.

The stimulation for independent research comes from a diverse mix of innovation policies, which is an increasing influence for innovative capacity. The relations between knowledge organizations and

innovation policy organizations are sometimes more market based with principal-agent aspects. This is not a direct problem for the innovative capacity, because knowledge organizations are free to formulate research questions. The influence on innovation policy from the knowledge organizations is relative high because of the different experts committee's.

Table 7.9 KO <=> IPO

KO < = > IPO	Negative influence	Positive influence	Effect on innovative capacity
Creation of policy		The network based influence through the experts committees is a increasing influence on the innovative capacity	(+)
Demand of knowledge		Although there is a market based relation results the possibility of unsolicited research in a increase in innovative capacity	(+)

Sharing and implementing innovations

The networks around the universities function as platform for knowledge sharing to the other clusters. Universities and research institutes have a network-based relation with water policy and implementing organizations, companies have a more agent-principal relation. The type of knowledge that is shared or implemented explains the difference in type of relation. Universities and research institutes share more fundamental or evaluative knowledge and don't have the risk that the sharing of knowledge damages themselves. Companies are less willing to share knowledge that brings their profit in danger. Relations between companies and implementing or water policy organizations is more based on sharing applied knowledge. The functioning of network organizations make it possible for companies to share more knowledge and prevent the risk of losing a benefit this results for all parties in an increasing innovative capacity. The influence on the other clusters is for the knowledge organizations more important than for the other clusters. Without the sharing of knowledge decreases the financial position of companies, universities and public research institutions. They need to "sell" their knowledge during conferences or during participation in projects. This results in a more partner like behaviour for the knowledge organizations to the implementing or the water policy organizations.

7.1.4 innovative capacity of innovation policy organizations

The different innovation policy organizations together stimulate a broad mix of instruments for all the three kinds of knowledge organizations and implementing organizations. The mix of tax credits, technical advice, knowledge sharing and the stimulation of networks creates a positive innovative environment. The innovative capacity is increasing because the separate instruments have a positive influence on each other, a sort of synergy effect. Important for good innovation policy is that it focuses on specific and general support. In table 7.10 can be seen that the federal ministry of Industry (Industry Canada) and the Ontarian ministry of research and innovation have general policies. This results mostly in stimulation of education or research facilities at universities and commercialisation support for companies. Specific innovation policy is seen at the AwwaRF and WERF and some of the projects of Industry Canada. These specific innovation policies demand specific knowledge (solicited or unsolicited) from universities, companies in partnership with municipalities. The creation of the CWN as centre of excellence can also be seen as specific innovation policy.

For the creation of innovation policy the relation with the knowledge organizations is important. Federal policy is influenced by the large supported by experts; experts represent the sector in several councils to influence the policy. The same support of experts is found in the AwwaRF and WERF. This is an increasing indicator for innovative capacity because political programs tend not to stimulate the “right” aspects of the system. The possibility to share goals and visions will lead to uniting of visions. The experts advise on the scientific level and the broad direction for innovation policy. At the same time there are also programs with unsolicited options, not depending on experts. These are also increasing for the innovative capacity because some innovations aren’t jet accepted as innovation. As a result both directed and free research is conducted by the knowledge organizations. Only the Ontario ministry of Research and Innovation has stopped its cooperation with experts (the ORIC), they are for this reason lesser contributing to the innovative capacity.

Table 7.10

Organization	Industry Canada	AwwaRF / WERF	Ministry of Research & Innovation	Effect on innovative capacity	
Type / level	Federal / national	International	Provincial	The availability of steering at more levels (+)	
Sort institution	Policy organization	Non-profit member organization	Policy organization		
Creation of policy	Advice from NRC (experts)	Field expert judgement	Political decision (in past ORIC)	Advise of experts (+)	
Goal of the policy	System of water use is indirect important for economic development (General and specific policy)	Linked to the system of water use by the goals and therefore specific policy	The general importance of innovation results in general policy	A mix of both specific and general innovation policy (+)	
Resources	Financial	Divided over the different programs. Meant for a mix of instruments	Allocated to specific research demands	Allocated over several programs mostly for stimulating commercialisation	A mix of support programs to stimulate KO and IO (+)
	Production	Economic experts and the network function of CWN and NSERC	Network function of the organization self to create relations between organizations	The OCE at the moment changing to support system of water use	Cooperation support by creation of networks (+)
	Knowledge	Knowledge about functioning of commercialisation and sharing knowledge through CWN and Research Institutes	A lot of water related knowledge, spread through several resources.	Knowledge about commercialisation, not about water specific interest	Although not mentioned in the model as resources is support for commercialisation and sharing best practises important (+)

The relation with the water policy organizations, the implementing organizations or the knowledge organizations can be made visible through the use of resources. The resources are more used to produce the programs and isn’t a resource for the innovation policy organizations to be innovative.

The stimulation of the innovative capacity by demanding specific knowledge with financial support and the creation of specific networks is the role of innovation policy organizations because no water policy organization is able to centralise all these aspects. The MOE isn’t able to play this role because it lacks financial possibilities to facilitate the research. Environment Canada and Health Canada only provide knowledge related to their subject. The role of the specified stimulation is found in the CWN and the WERF and AwwaRF. The networks around those organizations are important for supporting the creation of relations. Sharing knowledge and cooperative research is done based on these relations.

The interaction to water policy organizations from the Ontarian Ministry of research and Innovation is provided at high hierarchical level but doesn’t result in policy adjustment. There is no cooperation for

the creation of innovation policy for the system of water use. Interaction between lower level civil servants is only done when a governmental technical judgement is necessary. The reason for the lack of cooperation lies in the fact that the innovation policy is created for a different purpose than sector policy. At provincial level the MOE is not allowed to have an innovation policy. This is in large contrast to the past, after the Second World War it was the predecessor of the MOE who developed the water system with specified innovation policy. The loss of this capacity to stimulate innovations decreased over the years as result of budget cuts as can be seen in textbox 2.

At federal level there is cooperation between the ministry of Industry and the different ministries. Common innovation policy is done at the ministry of Industry, sector specific actions are done in more or less cooperation. Environment Canada has own research policy for instance the research institute NWRI. Individual policy of the ministry of Industry; the CWN is influenced through a board member out of the NWRI.

7.2 Barriers and drives in the process to create innovations

The definition of innovative capacity as used in this thesis³ is based on the aspect of the system of water use to operate as a collective actor. In the previous paragraph the innovative capacity in the system of water use is described. Some strong and some weak points are made clear following from the Model. To be able to advise the Ontarian and other governments, the analysis of these strong and weak points has to be deeper. This can be done on the innovation theories in the theoretical chapter. In the theoretical framework is spoken of a configuration, which was necessary to create a more optimal innovation configuration.

The aspects were:

- a working demand structure for innovations
- a high educated workforce
- a financial system to support risk taking of the firms
- the development of fundamental science and applied science
- access to science and technology
- the ability of firms to incorporate several elements (creating innovation as part of the business culture)
- the creation of collaborations, through networks
- a good working business environment and legal system

(Miozzo Walsh 2006 p.145-153)

Three drivers and barriers can be identified, when the aspects are compared to the decreasing and increasing elements found in the previous paragraph.

Drivers

The first driver is the entrepreneurial spirit and government support to be innovative. Based on the strong position of the knowledge organizations and the divers support of the innovation policy organizations, can be stated that these are a huge driver for innovation. Based on the aspects of configuration this is logical. The water policy organizations stimulate the development of both fundamental and applied science. The knowledge organizations are a stimulating factor, because they are able to incorporate these elements and have a financial system that supports the risk taking.

The second driver, the existence of the networks, is also supporting the first driver. The networks are mentioned by several participants and are an important aspect of Miozzo and Walsh. They are a driver to more innovation, because they stimulate the access to science and technology and to other organizations. The last driver, education, is an important aspect because it is the basis for every innovation.

³ The ability of institutions and their relations in the system of water use to create, collect, interpret and implant new ideas, designs and application to products and services in practice over the long term.

Barriers

The two barriers are both found in the relation and the functioning of the implementing and the water policy organizations. The demand structure is one of the elements of the configuration of a good functioning innovative system, but in Ontario this certainly is a problem. The demand structure for innovation is a barrier for innovations in Ontario. The reason for this barrier can be found in the quality of the surface water and the financial structure for implementing innovations.

The second barrier is the lack of the creation of innovations at implementing level. The reason can be found in the driver for the local politicians, who have to support the implementing organization to be innovative. The local politicians are more risk averse, and MOE regulations stimulate to be conservative.

Driver 1 entrepreneurial spirit and government support

Innovations have to originate from somewhere, it always comes with the idea that something can be done better. The spirit to find a solution has to be stronger than only see the problem, because a radical innovation can be a solution for a problem that isn't agreed on. This doesn't make the problem a driver but the one, the entrepreneur, who recognizes it and solves it. The best way to be innovative is through an entrepreneur because if you're not able to sell it than probably there isn't "jet" a problem or it isn't a innovation.

An entrepreneur doesn't need to be an owner of a firm, because personal gain doesn't always mean financial gain. A city manager or city engineer and a professor can also be identified as entrepreneur. The personal drive of a city engineer or a professor can be as strong and original as an entrepreneur and with the same passion they solve problems. Although they aren't entrepreneurs they can have the same drive to solve problems. What is visible in Ontario, is that the innovative municipalities have strong city managers. They are able to sell the need of the innovation to the city council. The driver for those city engineers is some kind of credit or reputation. The problem with their solutions is the spreading of innovation. City managers don't have to sell the innovation, as benefit can be seen that they are more likely to work with partners. A professor at a university can also be seen as an entrepreneur, because his goal is to do the best research in the world. A NSERC research chair has a budget of around one million a year. To be able to operate for a longer time a research has to be run like a business. The money that is necessary also needs to come from private partners. Like an owner of a company professors need conferences to selling their product, their research.

The city engineer, a professor and the owner of a company all rely on their network, their knowledge and the physical research infrastructure to be able to find the solution. When they find an innovation they will use it different, but they are all three a driver for finding innovations.

The important aspect of financial support for research is important for all the three kind of entrepreneurs. The mix, of different programs to stimulate research, are a contribution to this aspect of innovative capacity. What can be seen is that there is more support for universities and companies than for municipalities to do research. This is logical because the original goal of the municipality is not to do research. But what can be seen in Ontario, is that municipalities with financial support from the city council and a good educated staff become innovative. Still companies and universities are better organizations to find risk capital to do research. The best example to underwrite the importance of financial support can be found in the international companies in Ontario.

Ontario has some specialized international companies that hold patents of radical innovations. Those patents are based on research done by a university and a long company internal research. Those ideas are partly funded with money from innovation policy organizations. A good example is Zenon, the founder was a professor but his research wasn't financed any more. He believed in his solution and with private capital he started a company. With a lot of government support he was able to survive the first ten years, before his idea became profitable. He needed a lot of financial support from the federal and provincial government to be able to conduct research and development but know his company is a world player.

Because there is a broad support for different kinds of knowledge organizations, those different organisations are able to produce different kinds of knowledge. Based on those different kinds of knowledge are the different organizations able to support each other in being innovative. The strong mix of different kinds of entrepreneurs and the broad financial support are certainly a driver of innovations.

Barrier 1 Demand for innovations and financial possibilities

When there would be a large demand for innovations, this would stimulate companies to deliver more innovations. For a long time there was no need for municipalities to demand innovations. The large amount of water available in Ontario, which functions as a relative clean water source didn't cause a problem to meet norms and criteria of the MOE. The demand for innovative solutions is higher when there is a problem or when future problems need to be prevented. A new technique can be very innovative but if it's not demanded it will never be implemented. The first technical innovation wave in the Ontarian water sector can be seen after the Second World War when all the systems were made for the smaller towns. This system is ageing and in the older systems is replacement already a problem. The need for good treatment and source protection is understood since disasters like Walkerton.

But with the current techniques municipalities are able to meet the criteria of the MOE. The second reason why municipalities don't create a demand for innovative solutions is that municipalities don't have the money to invest. The water price in Ontario is one of the lowest in the world (rapport watertight) and the users only pay the direct cost. Solutions to change the price system as recommended by the rapport watertight aren't implemented. As result there is a political discussion between the province and the municipality who should pay for the replacement. The most implementation of innovations are visible at growing or large municipalities who have money for a complete new system.

Driver 2 The existence of large formal and informal Networks

The networks that exist in Ontario are large and are connecting the different organizations. There are two different kinds of networks; those created by the innovation policy organizations and those around the network (representative) organizations.

The networks are important for three reasons; the triple helix function, the spread of knowledge and the relation function.

Working together

The triple helix function is the possibility created by the networks to participate in research and development of other organizations. Every actor can contribute to the research. The NSERC industry chair is a good example with a triple helix function. But also the CWN or the cooperation around projects of AwwaRF and WERF result in cooperation between universities, companies and municipalities to do research. Innovation isn't a process that is done by one organization. What can be seen is that universities play a central roll. The research done by a university isn't direct product development. But understanding the general principals of a product is one of the first steps. The contact between the professor and the partners result in sharing innovative thoughts. Municipalities or the operators will tell what there practical problems are and if they think they have a solution, they will consult the university. The developing companies also have the same kind of contact resulting in new products. Also for the testing of products companies need universities. The research of a university is always considered more objective than in-house research. This contact is both formal, with meetings, an informal contact, where it is common to phone a professor or just mail a question. The interesting thing is that all the participants in the NSERC chair say that the informal discussions on the topics are more a mutual agreement. This discussion is the first start of the spread of knowledge. But the spread of knowledge is more done by the network organizations.

Spread of knowledge

Working together for research leads to spread of knowledge but also congresses and symposia from network organizations have this function. In this way organizations are educated and is there a spread of best practices. The role of awards is also important; it gives media attention and gives the possibility to highlight innovative solutions. Knowledge is a powerful resource to influence federal and provincial policy used by the network organizations. Stimulating adoption of new techniques in standards and regulation is an important strategy to safeguard the water quality. The network organizations are able to address new threats to the MOE and are able to address new technologies. Of course companies and universities try to do the same but for the OWWA and the OMWA there are special meetings.

Knowing each other

The last function of the networks is the creation of informal networks. These are also created by the network organizations. For innovation it is very important to know each other in the field, if you have a problem you need to know whom you can call. The Collingwood case in text box 5 was a perfect example where there was a problem and within a couple of hours Zenon was there. More participants have said that being in the neighbourhood is one of the most important things.

Barrier 2 Local political interference and conservatism

At the implementing level there is a second barrier for the system of water use. The lack of motivation to innovate is a second problem next to the lack of demand. It isn't rewarding for municipalities to be innovative because there is no incentive for the local politicians. Besides the lack of reward conservatism is also a problem of local political interference. Politicians are rewarded by re-election when they are able to save tax money or by doing visible infrastructure renewal. As a result it is more rewarding for the local politician to finance a new park or playground than an innovative water solution. It is cheaper to let other municipalities do the research and only copying their ideas. Depending on the city manager or city engineer is the municipality more or less innovative. What can be stated is that larger or developing municipalities are more innovative than others. Because those city engineers are better able to "sell" the innovation to the city council. Larger and developing municipalities are the municipalities with a better financial system and a larger engineering team resulting in resources to be innovative. This is a small group of municipalities the rest isn't able to spend money on innovations.

Driver 3 Education

Although none of the participants has mentioned the high level of education it is definitely a driver for innovation in Ontario. The high-educated workforce is part of the innovative organizations and the networks. People drive innovations, with their education they are the access to science and technology and they are able to develop fundamental and applied science.

There are at the moment some problems with the ageing workforce. With support of the network organizations are student chapters created to prevent a future problem. According to T. Buer are good educated people more important than financial support. With less money it is still possible to do research but without talent it becomes impossible. The innovator or the entrepreneur has to identify a problem and to solve it. The governmental role in education is for innovation an important task.

7.3 Summary

The innovative capacity of the system can be explained by the innovations created at the implementing organizations or the knowledge organizations and the stimulation of the water and innovation policy organizations of these innovations. The innovative capacity of the implementing organizations is relatively low because of its position. The implementing organizations are autonomous, but have to meet regulation criteria. Innovative solutions have to prove that they meet the quality norms by delivering controlling data to the MOE. The smaller and medium municipalities don't have financial resources or enough staff to do the research. This is the result of the water tax and the local political conservative influence. The two barriers identified in this system are related to this problem. The demand for innovations is low and the local political interference is high. This lacking demand is also the result of provincial policy, because of sectoralisation there is no provincial specific innovation policy for the system of water use. The positive influence on the innovative capacity comes from the larger and growing municipalities because they have more relations with knowledge organizations and are better able to allocate resources for innovation. Like the companies and universities individuals are important for the creation of the innovations. They sell their innovations to other organizations. This entrepreneurial spirit is the first driver. The second driver is found in the large networks because they stimulate the exchange of knowledge. These networks are facilitated by the Innovation policy organizations and the network organizations. The large networks in Ontario relate organizations to each other and provide a basis for cooperation. An important aspect that is essential for all the organizations is the institutional infrastructure, the high developed education system provides a high develop workforce. This workforce makes it possible to be innovative.

8. Conclusions

The innovative capacity of the system of water use in Ontario is a very complex matter. As seen in the previous chapters there are a lot of influences from and within different organizations and their mutual relations that increase or decrease the innovative capacity. The analysis of innovative capacity, which was based on the model as presented in the theoretical framework has shown that the system of water use is a government dominated sector, if this also requires a large governmental role to stimulate the implementation of innovations shall be seen in the answer of the main question. Before the main research question “*What explains the innovative capacity in the system of water use in Ontario?*” is answered there shall first be an answer to the four sub questions. These are necessary to support the answer of the main question but also to explain some of the recommendations.

Which elements explain the innovative capacity in the system of water use in Ontario?

The sub questions of this research were:

1. *How is the system of water use organized in Ontario?*
2. *In what way is the innovation system in Ontario organized?*
3. *What constitutes the innovative capacity in Ontario?*
4. *What are the barriers and drivers in the innovative process in the system of water use in Ontario and how can the government influences these barriers and drivers to increase the innovative capacity?*

8.1 The answer to the sub questions

The sector that is investigated by this research is the system of water use, which includes the production of drinking water and the treatment of sewage and storm water. For the answer on the first sub question a description of the system is given based on organizational and institutional elements.

Sub question 1 How is the system of water use organized in Ontario?

The provinces in Canada have more constitutional power than the municipalities, because the local government is not arranged by the constitution. The province can create or abolish municipalities, therefore they are also called the creatures of the province. This gives the province more hierarchical possibilities. For this reason can the Ontarian system of water use can be qualified as regulated, centralised from the provincial level. The provincial Ministry Of Environment has the hierarchical capacity to regulate the system. As central ministry it steers the municipalities, who are the owners of the treatment facilities. The municipal engineering department or the regional engineering department arranges the operation of the facilities. The municipalities can also choose private operators or the OCWA, a provincial agency. On behalf of the MOE, conservation authorities can operate on a watershed bases. The conservation authorities operate between the provincial and the municipal level. The relation of the MOE to the municipalities is focussed on the safeguarding of the water quality. A outbreak of scriptosporidium in Walkerton resulted in more attention to the sector. The relation became more controlled and regulation more tight. The relation between the municipalities and the MOE can be described as hierarchical and bureaucratic. The MOE hasn't got the ability to stimulate municipalities by financial resources because this is arranged through the ministry of Public Infrastructural Renewal and research money is allocated by the ministry of Research and Innovation. The relations between the ministries as provincial level can be qualified as sectoralised.

The federal ministries that influence the system of water use are: Environment Canada and Health Canada. Those federal ministries only have small regulating authority, as result they influence the sector through the spread of knowledge. Both federal ministries have own research money and Environment Canada has the NWRI as research institute. When municipalities want to innovate they have got to finance this and the federal ministries can give support with technical research assistance. Relations with the federal organizations are based on mutual dependence; both organizations want the knowledge of possible innovations.

The relation between the implementing organizations is direct and informal. This direct relation results in the sharing of applied knowledge between the municipalities, the conservation authorities and operators. The sharing of knowledge in informal and formal networks is supported by the network organizations. An Ontario specific feature is the strong position of the network organizations. These member organizations represent individuals and organizations and function as large networks. The two most important network organizations are the OWWA and the WEAO. In relation to the MOE these organizations are respected for their expertise. Two other important aspect of the Ontarian water system is the large availability of relative clean surface water and the pricing mechanism of water. The tax on water is only based on the direct cost of water, as result there is not enough money for the replacement of the system. Ontario has an ageing infrastructure and between the municipalities and the province there is a discussion where this money has to come from.

Sub question 2 In what way is the innovation system in Ontario organized?

In Ontario the water policy organizations do not make a special innovation policy for the system of water use. The federal and provincial innovation policy is created by the innovation policy organizations to support the whole economy. This common goal is visible in the broad mix of different programs and organizations that are created to stimulate innovation.

The organization of the innovation system is characterised by the large number of innovation policy and high-developed knowledge organizations. Ontario has developed medium and small companies and high-developed large international known companies. The universities and research institutes are a central partner in the networks and the development of knowledge. Networks around the universities are partly due to the innovation policy organizations and partly due to the networks organizations. Those networks stimulate the contact and the spread of knowledge to the municipalities and other organizations in the system of water use. The high development of the knowledge organizations can be explained by the background elements. The high educational level and high economic circumstances are a basis for a high-developed society. In the past the province has invested in the development of the system of water use and in those years Ontario belonged to the leading innovators in the world (see textbox 2). Interesting to see is the relative weak position of the current municipalities to be innovative and the large role for the knowledge organizations to introduce developments.

The easiest relation to explain the high-developed knowledge organizations is the high expenditure of the innovation policy organizations. The knowledge organizations are the strong financial support from the federal level. The Canadian ministry of Industry is the central actor at the federal level with the guidance of the National Research Council. The NRC functions as an advice body of experts, members from companies and universities. Different programs under the NRC are supporting universities, companies and research institutes. The innovation specific organizations for the system of water use are NCE-CWN and the NSERC industry chairs. The CWN has as function to create a network between academia and practitioners. The NSERC industry chair financially supports fifty percent of the research of universities and their partners. For companies the general support is more important. The province supports mostly commercialisation for small and medium companies. The only public research support from the water policy organizations comes from the federal level. The innovation support from the water policy organizations comes from federal level. Environment Canada supports some research but this is focussed on waste and storm water quality and doesn't result in support for the whole system of water use. The largest specialised innovation policy for water comes from the non-profit research foundations AwwaRF and WERF. These organizations are the research foundations of the network organizations and have specialised requests for research in the system of water use. They also play an important role in the diffusion of knowledge, during conferences new techniques are spread and discussed. Through the AwwaRF and the WERF are also informal relations between knowledge organizations and innovative implementing organizations created.

The second sub question showed that the innovations in Ontario occur as result of the high-developed knowledge organizations, which are supported by the different innovation policy organizations. In relation to the system of water use can these answers the third sub question.

Sub question 3 What constitutes the innovative capacity in Ontario?

For the constitution of the innovative capacity in Ontario the focus should be on the knowledge organizations and the implementation organizations. Together they have to create and implement the innovations in the system. In the system of water use the development of innovations is a product of cooperation between the companies, the universities and the large municipalities. The process is influenced by the policy organizations, but those aren't innovative themselves. The knowledge and implementing organizations are able to create innovations, because they have the resources to be innovative.

A basis for these organizations is the functioning knowledge infrastructure, which is the result of the policy of the innovation policy organizations. The policy is created with interaction and influence from the knowledge organizations. The role of the innovation policy organizations is well organized because there is expert influence for the policy through counsels. To prevent a rigid innovation policy there are possibilities for open research questions. The general policy focuses on the good education, commercialisation and the creation of different kinds of knowledge. The specific policies for the system of water use are related to the partnerships to ensure the spread of specific knowledge. This makes the infrastructure as a pillar of the innovative capacity in Ontario.

On top of this innovative infrastructure comes the financial position and resources of the knowledge organizations. The large international companies are able to provide their own research facilities. Smaller and medium companies lack the financial possibilities, but are able to do research in relation with universities and federal financial support. The support of the NSERC industry chairs and the Canadian Fund for Innovation results in developed research infrastructure at universities. The cooperation between universities, companies and municipalities to be innovative is based on mutual dependence. The municipalities that participate in this cooperation and thus which are innovative are larger or growing municipalities. Those have financial possibilities, a knowledgeable staff and sometimes special resources like a pilot plant. What can be seen is that those municipalities are the example for other municipalities. Smaller municipalities implement innovative solutions when problems arise, for instance during a disaster. This isn't stimulating the innovative capacity but only supporting the implementation of known products.

Smaller municipalities lack the financial resources as result of the tax system on water and don't buy innovations as result of local political conservatism. The high-developed system of water use hasn't got large problems and therefore there naturally is a lower demand than its lesser-developed system. The municipality is as owner responsible for the replacement and investment in the system. The tax on water is based on direct cost, which isn't sufficient for the maintenance of the system. Smaller and medium municipalities have internal political discussions where the local tax should be invested. Innovations in the water system have to compete with other important local facilities like sport accommodations for financial support. The risk of failure of an innovation results in the loss of tax money, it is cheaper to "lend" working innovative ideas from neighbours. The relative strong regulation in the system of water use doesn't support the innovative capacity. The MOE requires several controlling mechanism, which are expensive but logical because of the risk for the human health. Since Walkerton is the enforcement of the rules and regulations increased and became the relation of the MOE with the municipalities more hierarchical. The hierarchical relation result in less autonomous decisions of the municipalities. The sectoralised relation between the MOE, the ministry of Research and the ministry of PIR prevent a provincial innovative policy. As result each ministry steers the sector with a different purpose.

As simple answer to this sub question can be stated; that the innovative capacity is constituted by the cooperative development of innovation by the companies, universities and large municipalities. This development is possible because of the available innovation infrastructure and the support of the

innovation policy. The innovative capacity isn't optimal because the smaller and medium municipalities don't create or have a demand for innovations. This can be explained by local political conservatism and lacking financial possibilities. The water policy organizations can increase this by policy adjustment.

Sub question 4

What are the barriers and drivers in the innovative process in the system of water use in Ontario and how can the government influences these barriers and drivers to increase the innovative capacity?

The drivers are the elements that carry innovation and support the existing of the innovative capacity in the system of water use in Ontario. The first driver is the entrepreneurial spirit. Being innovative, means try to find solutions, individuals in organization have this entrepreneurial spirit. This doesn't mean that one person creates innovation, but these persons are the central force for innovation. The positive support from the innovation policy organizations is of large importance. The infrastructure, which is largely financed by the federal government, makes it possible to maintain the large developed knowledge organizations. These developed knowledge organizations are connected to each other through the different networks. These networks are the second driver because they stimulate cooperation, the spread of knowledge and create informal contact. This cooperation, the triple helix function of the networks is the strongest at the NSERC research chair. A professor of an NSERC research chair does innovative research together with his partners. The CWN also gives he ability to work together. The spread of knowledge is mostly carried by the network organizations. Network organizations create personal bonds between people and those are important to find solutions. The informal networks are essential for finding solutions. This is seen the strongest by the OWWA and the WEAO. The third driver is education, without good educated people there are no good entrepreneurs to find solutions. The education level is high in Canada but with an ageing society immigration plays also an important role. The network organizations are using student chapters to stimulate student to start a career in the system of water use. Important to maintain the high-developed knowledge organizations is the stimulation from the federal government. The current international companies in Ontario have needed in their beginning years the governments support. This remains important for starting companies because the development of new facilities takes years of good research.

The barriers for innovation are found in the system of water use, not at the innovative organizations. The already high-developed system doesn't require direct innovations when the aim of policy is not to increase the water level. To maintain the current quality level of the water replacement is satisfactory. When the policy aim would be to increase the quality level it would lead stimulate the replacement of the ageing infrastructure as a driver of innovation. Due to the lack of demand this isn't the case. The lack of demand is the result of the financial position and the political conservatism at the municipal level prevents innovations. Only growing or large municipalities are able to do research for innovations. The risk of failure and local political influence doesn't support an innovative culture.

The provincial government can create more financial possibilities for municipalities to replace the ageing infrastructure. The way of financing hasn't got to be arranged through subsidies because a better functioning tax system for water would be sufficient. This would turn the resources of implementing organizations from a barrier to innovation to a driver for innovation. A better financial system would increase the demand for replacement and innovation. A subsidy system for the scientific aspect of the innovations from the ministry of PIR could prevent conservatism at municipal level. This would create a driver to be innovative instead of a risk.

8.2 The main conclusion

The introduction of this thesis started with the problem that innovations arise in the private sector as part of competition. But due to the lack of competition in the regulated system of water use there was no need for innovation. The elements of innovative capacity could be different than in a normal innovative system. Therefore this research has searched for the elements of the system of water use that influence the innovative capacity in the system of water use. Based on the theory are different elements identified, with the answers of the sub questions it is now possible to answer the main question:

What explains the innovative capacity in the system of water use in Ontario?

The innovative capacity of Ontario is constructed on both elements of the innovation system and elements of the governmental organization of the system of water use. The high developed knowledge system and the high-developed system of water use influences each other and each other's innovative capacity. Based on the third sub question can be stated that the companies, universities and large municipalities create the innovations in the system. This capacity to create innovations is based on their resources and those of the international companies and universities are the largest. The resources to create innovations find its foundation in the innovative infrastructure of Ontario. The high percentage of tertiary education students indicates a high-educated workforce. These are the innovators in the system, they have got to develop the innovations. Individuals within the organizations invent and carry innovations. The federal support to create network based cooperation through the NSERC research chair and the Canadian Water Network results in a high diffusion of knowledge. More specific demands for the water sector are created by the Awwarf and the WERF and have the same result; sharing of innovations trough cooptition and cooperation.

The combination of both general and specific policy goals results in both applied and fundemental knowledge. The large knowledge stock is used by companies to develop products, but also by the MOE to create standards and norms for regulations. The influence from the knowledge organizations on the innovation policy organizations through the expert's councils is a contribution to this general level of knowledge. The possibility to do unsolicited research ensures the autonomous position of researchers to find specific innovations. The creation of innovation policy for the Ontarian system of water use is prevented by the sectoralisation at provincial level. At federal level there is more cooperation and policy adjustment because each ministry has more own financial resources. At provincial level the relation between the ministry of Research and Innovation and the MOE is not contributing to the innovative capacity. Because of the lack of policy adjustment there is no specific innovation policy for the system of water use.

Historically the governmental influence on innovation was larger. During the developing years of the system had the government a large role in financing the system. This resulted in the development of implementing organizations and the knowledge organizations. At that time the provincial demand was to implement and develop the system the driver for innovation. The current demand for innovations is very low. Only the larger and developing municipalities are demanding or creating innovations because they have the financial possibilities to invest and the enough educated staff to create or monitor innovations. Smaller and medium municipalities lack the financial possibilities as result of the taxation of the water. The citizens only pay direct cost as results. There is no money left for the investment of the system. In the past this wasn't a problem because the Ministry of Environment financed development. The "new" ministry of Public Infrastructure Renewal hasn't got the same subsidies and there isn't a new taxation system. This financial problem of the municipalities has got to be combined with the local culture of political conservatism. Municipalities have to choose how to spend their money, and water facilities have to compete for finance with sport facilities. It is cheaper for a municipality to look at ideas of neighbours than to invest in innovations. When disasters happen the municipality will buy radical innovations but only innovations that the companies had already developed. As result the smaller and medium municipalities are not innovative.

The problem for the larger and growing municipalities are the relative rigid regulations in the system of water use. The Ministry of Environment has increased the regulations after Walkerton to ensure the

quality of the water. This also introduced a better interaction on standards and norms because the ministry of environment acknowledged that it needed the sector to know what right standards should be. Through the ODWAC have some of the experts direct influence on the minister. The OWWA and the WEAO are the knowledge organizations that periodically meet with the MOE. This influence has resulted in better norms and standards and the implementing organizations are autonomous to decide how the system should be run but using innovative techniques requires more controlling effort. The MOE isn't able to financially support the municipalities because as result of the provincial sectoralisation the MOE only has regulation to steer the sector.

The implementation and innovation in the larger municipalities function as example for neighbours, the importance for network organizations to spread innovations is seen at conferences. When innovations are tested and known to the ministry of Environment are municipalities less risk averse and conservative because they know what they buy.

This research is based on qualitative research and giving a degree to the amount of innovative capacity is for that reason dangerous. Giving a summation of quantitative elements doesn't make it a qualitative study. Without giving a number on a scale the innovative capacity of the system of water use is described by giving a degree of innovative capacity. The degree of innovative capacity is according to my observations medium to high. The knowledge stock, the knowledge infrastructure and the available knowledge organizations can facilitate a system with a high innovative capacity but the implementing organizations aren't using the possibilities to it's maximum. The reason that the municipalities aren't as innovative as they could be lies in the local political conservatism, the water taxation and the lack of steering on innovations from the provincial government.

8.3 Recommendations

The results of this research are not only a scientific approach of the innovative capacity in the system of water use in Ontario. There are some problems and some solutions found that can be used to help governments. Direct problems are used as recommendation to the Ontarian government. More general findings are used to make recommendations for the Dutch government. Participants were also asked what they would change in the system if they had the possibility to do so. Some of these thoughts are also very good recommendation, because they point to important problems in the sector. During this research there were also some problems with the model and for further research there are some new starting points where more attention is necessary.

1 Recommendations for the province of Ontario

The innovative capacity in Ontario in general is higher than in the innovative capacity in the system of water use. To increase the innovative capacity in the system of water use some governmental organizations can make some changes. Creating a new tax system for water use could increase the financial position of implementing organizations. The influence of the provincial ministries could be increased by better cooperation. This gives possibilities to use more resources for the same goals. The MOE could participate in research resulting in more flexibility and lesser controlling requirements. By creating producing organizations above the local political level the problem can be driven and conservative behaviour at municipalities can be prevented.

Recommendation 1.1

As the rapport watertight showed the current tax system for water is insufficient to maintain the water system. Investments have to be made to restructure the ageing infrastructure. With the creation of a financial system that pays for the full cost of water, the implementing organizations can create a larger demand for replacements. This could be arranged at provincial or local level as long as the tax for full cost is completely allocated to the system of water use. When local politicians aren't able to relocate the money that is paid for replacements, than the replacements become a new driver for innovation. In my opinion it is better to pay more for water and deliver higher quality of water. It is cheaper to invest in maintenance and replacement than to wait for failures of the system, what is occurring right now through the lack of investment.

Recommendation 1.2

The influence of the provincial ministries could be increased by better cooperation between provincial ministries. The MOE is able to steer the system of water use with regulations. To steer the financial support for the creation of facilities or the subsidies on innovations is the MOE depending on the ministry of PIR and the ministry of Research and Innovation. At the moment there is some cooperation but for better stimulation this cooperation should be more intense. The sectoralisation can be prevented by more interdepartmental workgroups. These interdepartmental workgroups should be arranged around specific problems in the system of water use. Examples are the ageing infrastructure, the ageing workforce or a more technical problems pharmaceuticals in water. These workgroups should give advise how the current programs should address these issues. The problems aren't the current programs, but the criteria to apply to these programs. By choosing shared goals at a high hierarchical level and creating criteria to meet these goals at lower level can a joint policy be created.

Recommendation 1.3

The strict regulation, which is necessary to assure the quality of the water, results in reactive behaviour of municipalities. There is no need to be innovative, because to ensure quality a municipality only has to follow the MOE changes in the norms or standards. Being innovative is more difficult than follow reactive the changes. To make is easier for municipalities to be innovative the MOE can start a sub division of the standards and norms branch that cooperates with the municipalities. This shall result in a more network-based relation with more flexibility to bow rules. The second benefit is that it creates a backdoor for the MOE to create innovation policy. They have no innovation policy because they are only stimulating innovations to create better norms. At the same time it rewards proactive behaviour because it can finance innovative municipalities.

Recommendation 1.4

Conservatism and local political influence is definitely a decreasing influence on innovative capacity. Restructuring the financial situation can already decrease the local political influence. But a second option is the merger of regions. By up-scaling the cooperation to a regional or above regional level becomes the local political influence smaller. A board of directors can run the daily business and all the municipalities have one vote as a shareholder. Local political decisions to allocate resources to water or a different purpose can be prevented by enabling full cost water tax to the new regional organizations. The cooperation also decreases the financial risk of failure because many pay one innovation. When the innovation works, it can be implemented in the whole region. The organizations shall be run more professional as can be seen in the larger municipalities.

This recommendation can only succeed when the province obligates it. Municipalities will probably not accept this recommendation because it would result in lesser power for municipalities.

2 Recommendations for the Dutch government

The research can also be of importance to other governments. The lesson that can be learned from this research is that the government is also responsible for the innovation in a sector that it controls. This doesn't have to mean that the regulator has to become the innovator but they have to create an environment where the implementation organizations are encouraged to become innovative or use innovations. This creation of an environment has some basic elements like a functioning demand system or creation of cooperation moments for diffusion of knowledge. The Dutch government can increase the innovative capacity of their system by using the following recommendations.

Recommendation 2.1

The market can provide the solutions therefore network cooperation is important. When subsidies are supplied to the Waterschappen or the drinking water companies, the network cooperation should be included. Like the NSERC industry chair subsidy should be based on a certain percentage from the partners and a certain percentage funded by the government. This would stimulate the cooperation between implementing organizations and companies or universities. This cooperation is one of the most important elements in the innovative process because it gives organizations the ability to learn from each other.

Recommendation 2.2

Try to combine the Kiwa and Stowa networks like the CWN, this shouldn't in a new organization but it can result in sharing knowledge between networks. For the focus of innovation cross infection is important. Kiwa and Stowa are both well-known international organizations and comparable with AwwaRF and WERF. The Kiwa and Stowa are important for the international name of the Netherlands in the system of water use. The organization of joint meetings of operators or engineers to develop innovative solutions to common problems can result in new ideas. The start of sharing knowledge between the different parts of the system can already start during education and taken forward during meetings inside the professional groups. Other ideas for cross infection of each other knowledge are giving the possibility to do research at universities or in other organizations during sabbaticals. Important for the organization of Kiwa and Stowa is that they remain independent, but try to use more possibilities to share knowledge. Don't cut a good working system by creating a new organisation, but try to increase its possibilities to cooperate. In Ontario a good functioning system was cut and the results were mentioned in textbox 2.

Recommendation 2.3

The Dutch governments should focus on its tasks, the national government has got to improve the level of tertiary education, stimulate the market and create a functioning demand for innovations. The market will deliver as long as it is stimulated. An innovation policy for the Dutch system of water use should involve what the current or future problems are, but not how these problems are solved. By giving too much direction, the output of innovation is already known. Radical innovations occur through new thoughts not through a directed path. The government can increase the educational level by supporting good education and stimulation of studying technical science. It can become more rewarding when more facilities of financial possibilities are offered to technical science students.

Offering commercialisation support to starting companies can increase the functioning of the market. When students are offered support to start companies it will become more attracting to use developed ideas from universities.

Recommendation 2.4

The discussion in the Netherlands to create one organization for the production of all the products in the system of water use is interesting for innovative capacity. The discussion in the Netherlands is based on more efficiency, but one organization can also have the result that there is more diffusion of knowledge. In Ontario municipalities are responsible for all the products. What can be seen is that it isn't important for the innovative capacity that operators are in the same organization or in two different organizations. It is important that there is contact between individuals. For both the efficiency and the innovative capacity of the system can be seen that in larger municipalities engineering departments are working separately. The production of drinking water and the purification of sewage in Ontario are run by the same department but the employees operate in their own specialism. Creating knowledge diffusion by cooperation or by combining conferences of the member organizations has shown in Ontario to function for the creation of informal contacts.

Recommendation 2.5

Competition between drinking water companies should be on quality not on price. The focus should remain on the highest quality for an acceptable price. Too much benchmarking on price will result in lower prices but also in lower quality standards. In the Netherlands there is a long tradition of highly innovative drinking water companies. As result of the fusions of drinking water companies is the competition between the remaining ten drinking water companies increased. The first benchmarks on water price are seen with more focus on functioning cost effective. It can be cost effective on the long run to meet the norms but not to invest in innovations when there isn't a direct threat. This would mean a loss of innovative capacity.

3 Recommendation for further research

During this research some very interesting other topics were found where further research is necessary. The model as used in this research doesn't include all the organizations that are known in the system of water use, also the political elements can be enlarged in future research because this has a large impact. There can also be more research on the relations between the water policy and innovation policy organizations. The cases as presented in the textboxes above can also be used to classify municipalities in different categories this need further research to make these categories scientific.

Recommendation 3.1

The model that is created for this research didn't include the network organizations. In Ontario those play an important role. These could be made visible in the model by creation of an extra cluster between the implementing and the knowledge organizations, but with separate relations to the water policy and innovation policy organizations.

The political aspect of decision-making in this model was represented in the organizations and mentioned as context variable. This political influence is relative high and has impact on the innovative capacity. In future research the relation between the political decisions and the implementation of the same organizations can be included. Also for cooperation between organizations political steering is a serious element.

Recommendation 3.2

There is more research needed to explain the relations between the water policy organizations and the innovation policy organizations. I was able to make some conclusions but was relative difficult to get statements from governmental participants on this topic. Participants from other organizations were willing to explain the sectoralisation of the government, governmental officials had some difficulty on this topic. I have the impression that there is a huge amount of sectoralisation and that communications between those organizations aren't as easy as they could be. A broader in-depth study on specific this topic could be very interesting.

Recommendation 3.3

During the research some cases were analysed, those are mentioned in the textboxes. For the purpose of this thesis the game analyses per case weren't usable, because due to the lack of time not the whole game necessary for a game analyses was reproduced. What was found in those analyses is that there could be made three categories for municipalities. The three categories were; frontrunners who are able to implement and develop innovations, mediate innovators who basically evaluate innovations before they are implemented and last; followers who don't innovate until they are forced by a huge disaster. These categories were made on the drive of municipalities to be innovative and based on the sort of decision making, incremental or more radical. The problem during this research was that there wasn't enough time to find which percentages of the municipalities belongs to which category. And not all the cases had a straight story. Further research can try to find the relation between the sort of decision-making and the sort of innovations that are implemented. There can also be further research to find the size of the three kinds of municipalities and how these are influenced by the ability to allocate resources. In the cases of this research the larger and growing municipalities were the most innovative ones and they had the largest staff and the most financial funds for research and development.

Recommendation 3.4

The theoretical framework as used in this thesis tries to combine the innovation policy theory and the public administration theory. The country specific elements are too broad, because they had to explain both institutional elements that explain the existing of organizations in their context and parts of the innovation infrastructure. A whole study on only country specific institutional elements and their relation with organizations could be made. The model as used isn't able to combine enough public administration elements with the latest thoughts of innovation as a process. As result the process level is now based on the relations. This could be larger when there was time to follow innovations for a longer time. The process of development of innovations and the actual first implementations can take years. Interesting decision moments of public organizations are difficult to measure years later. A suggestion for further research could be that a group of innovative engineers at innovative municipalities is followed and that they are asked periodically how they try to be innovative. This gives the possibility to enter in innovative moments before decisions are made to start the innovative process.

Recommendation 3.5

The comparative character of this research has influenced the findings of this research. The positive influence of the comparative character is the ability to understand the development of a water system. This results in the understanding that innovative capacity isn't based on one innovation policy, but that it takes years of development. The comparative character also had a negative influence because compared to South Africa and Portugal Canada was more developed, it had a larger network and it is not always true that a more developed society has a more developed innovation system. Developing countries have the benefit of the catch up effect and can for this reason have a larger innovative capacity. A simple assumption that a larger network stands for a better and easier spread of knowledge is only true until the network becomes too large. It is difficult to find the exact state of a system because the system itself is also part of a dynamic changing process. The view of participants is always based on the history and the expectation of tomorrow.

Recommendation 3.7

The system of water use is part of the political system, in the local political conservatism as barriers this is acknowledged. The political influence has in the findings of this research a relative small influence on the innovative capacity. The including of Unions or environmental NGO's could have been interesting because their pressure is in the network society also very important. The role of individual ministers isn't included because at the moment they didn't influence direct the system of water use. Participants where during interviews comparing different ministers and different policies, this can also be used as starting point for further research.

9. Postscript

I thank my second reader professor Geert Teisman. He pointed me, in his response, some white spots in my text and as result is this postscript. I'm able to rewrite my whole thesis or make a second one only on his four questions. But for the love of my girlfriend I will, at this moment, not do such thing. But for you as reader who has made it to the end, I would like to comment and clarify some of the statements I made previous.

Originally the textboxes were meant as individual cases, which could be used to analyse the relation between the system of water use and the innovative organisations in the development of several innovations. I have more data on those specific cases but in a later stadium of the writing process it appeared that this would broaden the thesis too much. I decided to take it out of the scope because this thesis focuses more on the organizational character. This also fitted with the international comparison. What appeared in the cases (now textboxes) is that there are two explanations for the innovation process (or implementation of innovations); mutual dependence and personal ties.

In the cases where innovations are necessary, to prevent disasters but not meant to create the best product the mutual dependence of organizations is more market based. Public entrepreneurial spirit isn't visible in these cases on the municipal side because innovations are bought from companies without (much) risk taking for the municipalities. In most of the cases an old solution will be sufficient, only in rare cases are innovations bought. Most of the municipalities don't try to be innovative. The influence of academia in these cases was also before the implementation of the innovations.

Much more interesting are the cases where this entrepreneurial spirit can be found in behaviour of civil servants and the (few) innovative public organization. The reason why these organizations seem to invest in innovations is two sided. The first reason is the same; of course there is some need, and the reason to cooperate result in a mutual dependence of organizations. But the stage of development of the innovation is different. The implementation of these innovations still includes some risks. Because the second reason to be innovative lies in a more technical thought that it is possible to make a quality improvement, it isn't just a financial benefit. What is visible during conversations with these civil servants is a certain passion to create a good solution. As result of their passion, these persons have a larger informal network with other persons who share the same passion. In this network they share success and failures. It isn't, in the light of innovation capacity, directly interesting if all the innovations are a success. Because in the in innovative process some steps of the process can be seen as failure before the idea is fully complete. Therefore is it better to focus on successfully developed innovations. Professors and private entrepreneurs have as result of the high innovative infrastructure enough facilities to become innovative. But civil servants at municipal level in Ontario have lesser possibilities. This is the level where public entrepreneurial behaviour is expected. But the lacking demand for products results in no political attention. The need to "sell" as civil servant the innovation to the city board, before investments can be made, is essential for the innovative capacity on this level.

The problem is that selling innovations to a city board, demands different capacities than the technical passion of a civil servant. Only civil servants with a build reputation (based on knowledge, seniority, reputation, formal and informal network) and a high developed political feeling are able to sell the innovations. Uniting the political world and the innovative world seems to be the "job" of the civil servant. Local politicians can only "score" when they take leadership. This has got to be related to a (known) problem or an almost certain success. The problem is that local politicians aren't connected to the innovative networks because the system of water use is only one of the tasks of the municipalities. This makes the role for the civil servant more important from an innovative capacity point of view.

The reason that I propose a more regional approach to implementing organizations is the lower political influence. A slightly larger organization is more able to give (the small group of) civil servants with this passion a larger possibility without taking huge (financial) risks. More regional organizations with complete (and shared) public ownership can work more efficient because of scale benefits and lesser political influence.

The question that is remaining is why I haven't included in the conclusion the focus on the more personal level to find the more personal union between the two worlds and with the explanation why some innovations succeed and other fail. This research tries to explain the innovative capacity as found in the system of water use in Ontario. In most of the municipalities, innovations are only bought without a lot of influence from the municipal side on the development. Only larger and growing municipalities play an active role. The union between the world of innovations and the world of public administration is stronger for municipalities with a civil servant with this passion and more entrepreneurial spirit. Labour mobility from Ottawa, an innovative municipality, to the other parts of Ontario is in this context interesting because they take their informal networks with them. But for the innovative capacity in Ontario the number of civil servants with this passion and their influence is a relative small part. The influence of education and development of universities and the whole society is of larger influence to the innovative capacity.

In line with the role of the passionate (entrepreneurial) civil servant the question could be asked whether municipalities should have a role in developing innovations. The role of municipalities is, in the original context, not to develop innovations but to produce water. Isn't it better that universities, public research institutions and companies jointly develop innovations? And when municipalities are only involved in the implementation of these innovations, they could be providing comments on the innovations to improve the developments. In the model used in this research they can play an active role but this requires more of the municipalities and its civil servants. My recommendations fit with the answer that municipalities should innovate themselves but to conclude for now I think I can use the subtitle of this thesis they probably do need more knowledge about creating knowledge.

Participants in Research

- Informant Ministry of the Environment in Environmental assessment and approvals branch, Ontario Ministry of Environment
- D. G. Langley Shirlas Enterprises
Former Division Vice President & Board Director Delcan
- Derek Smith Sustainable Technologies Monitoring Coordinator for Toronto Region Conservation Agency
- F. Lazar Professor economics Schulich school of Business York University
Member water strategy expert panel (expert panel watertight for ministry of PIR)
- M.J. Allen (ret) Awwa Research Foundation
- J. van Den Oever water treatment specialist VDO Consulting
- J.P. Mc Nally General Manager and City Engineer, city of London
- M. DeVries President TorjanUV
- E.J.Bowering Manager Policy and Program development Water Infrastructure Management City of Toronto
- W. Y. Liang senior Engineer Stormwater Management Water Infrastructure Management City of Toronto
- J. C. Nemeth Manager of Water Resources, Town of Richmond Hill
- Informant ministry of environment environmental innovations & emerging Sciences Branch
- S. Atlin Senior engineer Operations efficiency City of Toronto
- A. D. Tadwalker manager Operations efficiency, water treatment & supply City of Toronto
- J.F. Thompson Director of Engineering Services Ontario Clean Water Agency
- J. Klaus General manger Waterworks Department town of Markham (board member OMWA)
- R. Hoffman Assistant Professor, Drinking water research group University of Toronto
- J. Merrit Chair Advisory Council on Drinking Water Quality and Testing Standards
- B. Conant Director of Programs Canadian Water Network
- Prof. P. M. Huck NSCERC Chairholder in water treatment at University Waterloo
- Informant in environment Industry Office environmental innovations & emerging Sciences Branch in Ontario Ministry of Environment

- Informant in ministry of Research and Innovation
- C. Stebbing associate Clarifica
- Andrew Fata manager Clarifica
- Edward Graham President Clarifa water resources and environmental consulting
- T. Buer vice president global product development ZENON Membrane Solutions (GE water)
- I. Douglas Water Quality Engineer City of Ottawa
- T.D. Ellison Executive director Canadian Water and Wastewater Association
- Rector G. Patry president of the University of Ottawa
member National Research Council
Member Ontario Centres of Excellence
Former member Ontario Research Innovation Council
Founder of Hydromantis inc.

Delcan employee participants

- G. van Houwelingen Senior Water specialist Water Division
- A. Proux Division Vice president Water
- C. Marianayagam Vice president water division Toronto
- H. Tracy Director Engineering
- K. Hodges Vice president water division London

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WERF

www.epa.gov/awi/collaboration.html

Appendix 1 More innovation theory

This appendix is meant for readers who like to know more about innovative thought, all these theories are used for the creation of the model.

The start with Schumpeter

Schumpeter was a professor in Economics and Politics, and he created several concepts to explain economic growth. The entrepreneur could be seen as the start of the business cycle. Others would follow the first idea of the entrepreneur until there is no profit in copying or adjusting the same idea. At that point a new equilibrium was set and the cycle could start all over again. Two important concepts, identified by Schumpeter in this cycle are “creative destruction” and “routine capitalism”. “Creative destruction” is the fact that new innovations replace the old product, also known as the result of a radical innovation. The monopolist is periodically replaced by a successful challenger. Every innovator is “standing on the shoulders of giants” but has destructed the other company. “Routine capitalism” is the copying and adjusting of the new innovation, this will not replace the former product but will build on the same aspect of the product, this is also known as an incremental innovation.

In the water sector the water producing companies are monopolies, as a result radical innovation are according to Schumpeter not likely to occur because there is no need to replace an other entrepreneur. It is more likely that only the incremental approach of adjusting will be used without taking a risk.

Due to the fast growing companies in the first half of the 20th century Schumpeter changes his view from the entrepreneur as innovator to the larger companies with an R&D department. In innovation literature there is still a debate what is necessary a creative brain of an entrepreneur or sufficient recourses in a large R&D department. (Verspagen 2007 p.42-63, Miozzo & Walsh 2006 p 8-10, Katzy 2005) To prevent the risk of copying innovations governments play an important role in safeguarding copyrights. The use of a patent system is important for the competitive benefit, otherwise companies wouldn't innovate. The government prevents here a market failure but takes also the positive spillover effect (sharing or knowledge) away. For the model this part introduced two important aspects, the entrepreneur or the R&D department are the place of the creation of innovations and second there are radical and incremental innovations. The first governmental role in innovation policy is to secure patent rights otherwise there is no drive for innovation.

From a linear model to a cluster

In the eighties the linear thought ended, the rise of Japanese industries proved that it was wrong to think that one company was able to create more successful innovations on its own.

The rise of the Japanese industries in the eighties can be seen as the starting point for a paradigm change, since innovations became a result of cooperation. Until the rise of the cluster theory companies were doing a lot of R&D by themselves. It was even prohibited to collaborate in research and development, for instance in the USA cooperation could result in serious penalties until 1984. (Gibson and Rogers 1994 p. 80)

The success of the Japanese industries could be explained by there organization form; the Keiretsu. The Keiretsu are networks were contractors are closely related to subcontractor, and the networks are more formalized than normal networks. (Besanko and others. 2003 p.163). This is a kind of vertical integration where suppliers and buyers are working together because the competition isn't directly coming from the same cluster. (Besanko and others 2003 p.137). It also gave the rise of collaboration between companies to start up strategic alliances for R&D. These strategic alliances have the benefits of sharing the assets and reducing the risk. This is a more horizontal collaboration where competitors work together. One of the best examples for vertical and horizontal integration outside Japan is Sillicon Valley. Because this kind of cooperation needs communication and knowledge exchange a short distance to each other is important.

Appendix 2 Network organizations

Table A1

Abbrevia- tion	Name	Level	Representation of	Goals	Instruments
CWWA	Canadian Water and Wastewater Association	Federal	Municipalities AWWA and WEF; whole system of water use	To represent the water sector	Representation at federal level
FCM	Federation of Canadian Municipalities	Federal	All Canadian municipalities	Representation of all Canadian municipalities	Representation and some financial allocation of federal money
OWWA	Ontario Water Works Association	Provincial	Organization for drinking water professionals	Interaction platform for drinking water sector	Conference Symposia Education Magazine Lobby to province
WEAO	Water Environment Association Ontario	Provincial	Organization for environment professionals (Waste and storm water)	Interaction platform for professionals	Conference Symposia Education Magazine Lobby to province
OMWA	Ontario Municipal Water Association	Provincial	Municipalities (politicians and operators)	Representation of Municipalities and operators	Conference meetings and lobby to province
OWWEA	Ontario Water Works Equipment Association	Provincial	Companies	Representation of manufactures in drinking water	Conference and meetings
OPCEA	Ontario Pollution control equipment association	Provincial	Companies	Representation of manufactures in storm and waste water	Conference and meetings
OSPE	Ontario Society of Professional Engineers	Provincial	Professional engineers	Representation of all professional engineers	Meetings, magazine, education and lobby
OPE	Ontario Professional Engineers	Provincial	Obligated member organization for professional engineers	Maintaining the high quality of the name of professional engineers	
ONEIA	Ontario Environment Industry Association	Provincial	Environment industry	Representing the interest of the industry in Environment	Lobby
AMO	Association of Municipalities Ontario	Provincial	Municipalities of Ontario	Representation for municipalities in broad sense	
AWWA	American Water Works Association	International	All the 57.000 members (professionals and organizations in 130		Financial resources, knowledge and the organization for representation, the

			countries)		organization of conferences and
WEF	Water Environment Federation	International	The members in several countries		
AwwaRF	Awwa Research Foundation	International	-	Research foundation drinking water	See 4.2.3
WERF	Water Environment Research Foundation	International	-	Research foundation environment	See 4.2.3

(source interviews, <http://www.owwa.com/hm/inside.php?id=15>, <http://www.owwa.com/hm/inside.php?id=56>, <http://www.omwa.org/index.php?id=18>, <http://www.owwea.ca/en/hm/inside.php?sid=1>, <http://www.ospe.on.ca/>, <http://www.weao.org/aboutweao/about.htm>, <http://www.opcea.com/>)

Appendix 3 International comparison waterchain

