



Innovations in the South African water sector

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Preface

This report is written to graduate at the Erasmus University of Rotterdam. This master thesis is the finalization of the study Public Administration with the specific master direction, Decision Making and Management for Complex Spatial Developments. This document is written in cooperation with DHV (department Water) and the Erasmus University Rotterdam. During the six months taking internship the organization has supported and guided me through the process of doing a research and writing a master thesis. To enquire the research data, an internship overseas was necessary. This research took place in South Africa in the province Gauteng.

This report is the bases of the international comparison written by DHV (Y. Deelstra) and Erasmus University Rotterdam (A. van Buuren) and three master students. The international comparison will be presented at the European Group of Public Administration (EGPA 2008) congress in Rotterdam in September 2008.

Proudly I present you this report. The research question which I have answered in this report is: “What constitutes the innovative capacity of the system of water use in South Africa? ”. I would like to thank the people in South Africa who were willing to attend me during the research. This research could not be accomplished if the following people in the Netherlands and South Africa did not assist me:

Ytsen Deelstra and Jos Peters from DHV and Arwin van Buuren from Erasmus University of Rotterdam. Special thanks goes to Sean Glynn and Francis Gibbons from SSI Johannesburg for their guidance and the opportunity to work at their office during this research.

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Wijnand Smulders

Executive summary

This research is about the innovative capacity of the water sector in South Africa. The goal of this research is to describe the participating organizations in the water and innovation system of South Africa. This specific research is based on the following research question:

“What constitutes the innovative capacity of the system of water use in South Africa?”

The organizational structure of the water sector is one of the factors that constitutes the innovative capacity. In South Africa the organizational structure consists of the water policy network, the innovation policy network, implementation organizations and the knowledge organizations.

- These clusters mentioned above individually constitute the innovative capacity, but through collaborations and relations between these clusters the innovative capacity of the water sector is also constituted. The presence of communication hubs and platforms are good examples of that collaboration and relations.
- The human capacity is another factor which constitutes the innovative capacity of the water sector. The human capacity is the overall education level and the amount of skilled people in the water sector. At the moment the education level and the amount of skilled people in the water sector is too low.
- The available financial resources also constitute the innovative capacity. The financial capacity are the present financial resources in the water sector. Many organizations do not have the financial resources to innovate individually.
- The policies established by the Department of Water Affairs and Forestry and the Department of Science and Technology also constitute the innovative capacity. The use of stimulating or repressive instruments influence the innovative capacity.

The “Free Basic Water”

The water sector and the provision of water in South Africa is a public task. For this organizational structure is chosen as water is seen as a basic need and a public good. The legislation “Free Basic Water” is a good example of that. The government has to secure the provision and the access to clean water for all the people in South Africa. Three public organizations are responsible for the provision of water (figure 5, page 41);

1. the national Department of Water Affairs and Forestry (DWAF),
2. the regional Water Boards and
3. the municipalities.

The South African water sector is divided into three different water divisions: drink -, sanitation – and storm water. The innovative capacity of these divisions differs highly. The last decade the Department of Water Affairs and Forestry has prioritized the drink - and sanitation water division above the storm water division.

The South African government is working on better water resources because water is scarce. This results in a better water infrastructure. That seems to be a fertile departing point for the development and diffusion of innovations in the water system.

The water innovation system

The most important organizations for the creation of innovations in the water innovation system are the knowledge institutions. In South Africa (Gauteng) these important knowledge institutions are the Water Research Commission, Council of Science and Industrial Research, the large water boards (Rand Water) and universities (Pretoria and Johannesburg). The Water Institute of Southern Africa (WISA) is the most important organization for the dissemination of knowledge. The universities are the organizations which create the most knowledge. The figure of the innovation system is given in § 4.6 page 53.

Communication

The three organizations in the water system interact on daily bases with each other. These communication lines are direct, formal and informal. The larger operators as Rand Water and metro municipalities have direct contact with the minister.

The organizations in the water innovation system communicate with each other but this is often project related. The bigger knowledge institutions as the Water Research Commission and the Council of Science and Industrial Research communicate directly with the department and the minister.

To organize decision-making and collaboration in the water and innovation system in the water sector, organizations established different platforms and other types of communication hubs. The task of these platforms is to share information, to communicate and to facilitate cooperation. The most important and well known communication hubs in South Africa are WISA and the Water Sector Leadership Group (WSLG).

Decreasing and increasing factors for the innovative capacity

In South Africa there are some general conditions which decrease or increase the innovative capacity of the water sector.

Capacity is decreasing

The innovative capacity is decreasing because :

- the water policy (established by DWAF) and the innovation policy (established by the department of Science and Technology) do not adjust the policies to each other. Both departments operate in a silo. The advantage of synergy effects and policies which can strengthen each other get lost.
- implementation organizations often are not capable of innovating internally, thus these organizations buy innovations from knowledge institutions. The consequence is that implementation organizations are able to steer the researches by demand. Innovations for the implementation organizations have to be directly implemental and are based on solving a problem (short term/conservative) instead of fundamental researches/innovations on the long term.
- in South Africa there is a shortage of skilled people. Many organizations need skilled personal to manage the daily activities. The shortage of skilled people influences the amount and quality of developments and researches towards innovations, because these activities get postponed, take more time or can not be realized at all.

Capacity is increasing

The innovative capacity increases when the knowledge institutions in the innovation system collaborate. Knowledge, financial resources and capacity are shared and synergy effects occur, institutions are able to create innovations based on more knowledge. In the near future the knowledge dissemination will be more efficiently because organizations are establishing more communication hubs and platforms. The organizations are establishing a network which increases collaboration, knowledge sharing and eventually the innovative capacity.

Recommendations

Recommendations for SSI and the South African government

At the moment the organizational structure of the water sector is not developed optimal, and an advantage could be achieved by :

- a good communication network. SSI has to be part of the new platforms and the communication hubs.
- sharing knowledge. It is crucial for an organization as SSI to be up to date about the latest developments, innovations, policies and regulations.

SSI has to focus on the development of systems or technical applications for the reuse of water. At the moment water is used once and is sent to the purification plants, but if water can be captured with a technical application or system it can be reused for other purposes.

Create access to clean water for all the citizens

In the future the demand for clean water will increase and the South African government has to supply this water. A solution for this demand are new techniques and resources and/or by using the available water optimally. Better use of storm water is an alternative. The last ten years this division has been neglected and by investing in this division more advantage of this water could be achieved. The storm water could be captured and used for agriculture or after direct purification as drink water. The use and creation of new techniques means a transformation of the short term (problem solving) research to the long term (fundamental) research methods.

Shortage of skilled people

The government has to attract more capacity (skilled people) to the water sector. This could be done by providing unskilled people with a learning job at public organizations within the water sector. Eventually these educated people will have an added value to the water sector. By solving the shortage of skilled people organizations are able to do more fundamental research instead of problem based research.

Awareness of direct communication: create one department

The innovation policy established by the innovation policy network is secondary to the water policy. The organizations in the water sector see the innovation policy more as a guideline than a legislation/policy. By integrating the innovation policy in the water policy innovation can be promoted and stimulated. Another alternative is one department which establishes both policies. In this way there can be created overlap and/or adjustment between the different policies. The advantage is that synergy effects can be achieved as well.

Recommendation for the Netherlands

The innovation agenda: stimulate fundamental research

Many challenges (for example pollution, climate change, the increasing sea level) will influence the drink, storm and waste water quality. By making an innovation agenda the Dutch government can face up to those challenges by stimulating fundamental (long term) research.

Stimulate organizations to innovate: by compliance to the goal setting

The Dutch government has to keep the legislation and the policy of the water sector dynamic. The goal setting established by the national government has to be challenging, organizations have to innovate or improve their processes to comply to the goal setting. In this way complacency can be prevented.

Stimulate organizations to innovate: by funding

Another alternative to stimulate organizations to innovate is by funding researches. By funding the organizations or specific researches the government is able to influence the amount of incremental (short term) and fundamental (long term) research as well.

Stimulate collaboration and the synergy effects: create innovation platforms

To stimulate collaboration and synergy effects organizations have to meet each other. The government has to create specific innovation platforms, communication hubs and networks where all the organizations in the water sector are invited to discuss water issues. The different departments involved or linked to the water sector also have to be invited. The water sector is linked with many other departments thus an integral approach is necessary.

Awareness of the limited resources of water

What important is for the Dutch national government is that organizations and also citizens are aware of the limited resources of water. To supply the increasing water demand the Dutch government could use other resources (sea and surface water) or technical applications. Therefore the processes to purify the water have to be intensified.

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Introduction

The climate is changing, this process started a long time ago but in the last fifty years the speed of this process is increasing. Climate change is one of the greatest social, economic and environmental threats of the planet.(ec.europa.eu ; 22 September 2008) The temperature and sea level are increasing because of that climate change.

In the Netherlands the “Deltacommissie 2008” (Delta Commission 2008) investigated the perspective of the Netherlands – when the government does not change the present policy - in comparison with the sea level over one hundred years. The sea level is increasing and the Netherlands is caving in, water will flood to the inlands and half of the country (cities and rural areas) in the Netherlands will flood.

When water is described like this, it is a threat for a country, but the opposite could be true. The Dutch use huge amounts of water for business (transport, drink water), recreation and domestic use.

The Dutch built most of their dams and dykes to keep the water from flooding in to the country. In South Africa these measures were taken to prevent water from flooding out the country because water in South Africa is scarce. In the near future both these countries will be confronted with an increasing water demand. (Rosegrant et al. 2002)

Water is a basic need for everyone and in South Africa the demand for water will increase by domestic use. (Rosegrant et al. 2002) Still over one million people in South Africa do not have access to clean water. The South African government set a goal with their Water Service Act and Free Basic Water to provide million citizens with water in the near future. To fulfill this demand by the people the government and/or other organizations have to provide cities and villages with enough water. Besides water production the South African government also has to distribute the water to the rural areas and cities.

Institutions in the water and innovation system are responsible for respectively the water provision and for innovations in the water sector. The capacity to create innovations in the national innovation system (NIS) is depending on these institutions. Are these institutions able to realize the water provision and be innovative at the same time? Do these institutions have the knowledge, financial resources and is there the right environment which stimulates innovations or is it because of the long time of “return on investment” or repressive legal and policy conditions that institutions do not innovate at all. (Thomas & Ford 2005)

The innovative capacity of the national innovation system depends on the national and regional interaction and collaboration between the different public and private organizations and knowledge institutions in the water sector. Are these institutions in the South African water sector present and in what kind of form, are they increasing or decreasing the innovative capacity of the water sector?

This research is done to inform and advice the Dutch ministry of Housing, Spatial Planning and the Environment and the ministry of Road and Waterworks about activities to increase the innovation capacity of the water sector in The Netherlands. These departments are establishing an innovation agenda for the Dutch water sector. With the insights given by this research the departments are able to indicate factors which are influential on the innovative capacity in a country.

1.2 Research question

A good underpinned research has a clear *research question*. The research question of a research is the goal setting – What must this research achieve? What is the goal?- and the *definition of a problem* - Which questions have to be answered to achieve the goal setting?- together. (Hakvoort 1998: 5)

A central aspect in this master thesis is innovation. What is innovation, how do innovations occur and what type of organizations are involved within the innovation system? This research is aimed on the water sector of South Africa and in particular on the three water divisions (drinking, waste and storm water). With the increasing demand for water the South African government has to create a positive innovative capacity for organizations to operate in. Without this innovative capacity the national and regional government may not succeed in providing the water amount necessary for the daily needs of 48 million people.

The first *goal* of this research is to acquire an insight in the organizational structure of the water and innovation system of South Africa. Which organizations are involved and what are the tasks of the participating organizations in the water and innovation system. The second *goal* is to acquire an insight in the innovative capacity of the (innovation system of the) water sector in South Africa. In particular the increasing and decreasing factors of the innovative capacity. In this research the water innovation system of South Africa is the central aspect and not the complete national innovation system of South Africa. In two other countries the same research is done and a comparison of these three different countries (Canada, Portugal and South Africa) is made, this comparison is added to the appendix.

In assistance with DHV and the Erasmus University of Rotterdam, the next research question has been formulated:

“What constitutes the innovative capacity of the system of water use in South Africa?”

This central research question is separated in several *sub questions*.

- How is the (governance) system regarding water use organized in South Africa, and what are the country specific features with regard to “the water sector” of South Africa?
- How is the innovation system in South Africa regarding the water sector organized?
- How is the interaction network (platforms and communication) in the South African water innovation system organized?
- What are drivers and barriers which hinder or increase the innovation capacity in this innovation system?

1.3 Chapter description

A master thesis is the report of a completed research This research has the subsequent arrangement.

In the second chapter the theoretical framework of this research is written. This framework is based on literature research and describes the terms innovation, innovation capacity and several theories about the design of the water system. Three different perspectives about the national innovation system will be given under which the Cluster, Triple Helix and the National Innovation System perspectives will be described. In chapter three the most valuable perspective will be given to describe the innovation system and capacity of South Africa. Also

the translation from theory to the National Innovation System Model and the concepts/dimensions used in this model will be mentioned in chapter three.

In chapter four the analysis of the water and innovation system is described. In this chapter the theory and empery come together and give an insight in the water system and a reflection of the innovativeness of the innovation system of South Africa.

The conclusions and recommendations of the research are presented in chapter five. Mainly the increasing and decreasing factors of the innovation capacity will be mentioned. Ideas for the “Innovation agenda” of the Dutch government and vanguards for DHV and SSI for the near future will be presented in this chapter as well.

A list of used literature for the theoretical framework and analysis and a list of abbreviations at the end completes the report.

The international comparison between the three different countries is added to the appendix.

Chapter 2 Theoretical framework

This chapter is the theoretical framework of the research, the theoretical approaches for this research will be mentioned and described. One specific theory about innovation has been chosen to use for this thesis and several perspectives on the water system are described in this chapter. These theoretical approaches about innovation and systems are used to develop a model as the basis for this research.

§ 2.1 will be used to describe the water system, this is of importance because the focus will be on a specific part of the water system in this research. In § 2.2 the definition of innovation will be given and the innovation sector will be explained. Four different perspectives (theories) to look at innovations within the water system will also be described. These four perspectives (Furman et al., Gibbons, Lundvall and Porter) will give a description of how innovations could work. In §2.3 network and interaction between organizations are the central aspects.

§ 2.1 Water system

The water system, in Dutch “waterketen”, is part of the water sector. The water sector involves all the water related activities. What is the water system then? According to the “Bestuurakkoord waterketen 2007” the water system is: “*All the services for households and companies that are involved with the use and discharge of water.*” The water system includes the discharge of waste water and supplying of drink water, the collecting of effluent waste water of it through the sewerage (including redundant storm water) and the transporting and purifying of the urban effluent. (Bestuurakkoord Waterketen, 2007) The water sector is a closed circle, as can be seen in the figure of Appendix A. The figure shows that the water sector is a process with an input, throughput (process) and an output. These three steps can be seen in three different levels; product, process and the system level. This will be further explained in the context of South Africa.

Product

The product is the output of the working process. The working process **consists of** the distribution from water to the purifying stations, purification and eventually the distribution from the purified water into the national water resources. In the water sector this means that the product is purified water. The use of water by companies and citizens pollutes it. There are three types of water: polluted (waste) water and purified (drink) water and the last one is storm water. (Bestuurakkoord Waterketen, 2007)

Process

The process scale involves the steps that are taken to purify water. “*The process innovation involves new or improved manufacturing processes or production means, which an organization implies to manufacture products or offer services.*” (de Leede, 1997, p.57) According to Hakvoort et al. (2004) process scale can be described as the transformation phase in which the relations between the means and the results is coordinated. The governance policy provides the instructions/rules on how to fill in the process. The governance policy gets translated in the organization policy, in this case the policy of the water sector. The policy can be divided into two parts, which is indicated as the efficiency concepts. Hakvoort et al. (2004) mention the technological efficiency (lowest costs) and the economical efficiency (connection with water demand) as the two efficiency concepts of the policy.

System

The system approach is when there is an integral approach on all the water activities in the complete water sector. This means that all the steps which have been taken in the water sector and the processes are part of a complete system. The system also includes water resources like rivers, channels and lakes (created by dams). (Duivenboden et al., 2000)

By innovating the processes, organizations are able to produce water quicker and more efficiently. Innovations also occur within a complete system, because water resources like dam formed lakes keep on developing to be able to supply the water demand. (Water Wheel, 2007)

§2.2 Innovation

Innovations in general often mean a technical, service or organizational structure change forward. Innovations are created by institution(s) to produce or improve new things. Institutions innovate to achieve more efficiency, process or product development or to stay ahead of the competitors. (Schumpeter, Porter, 1990) The water sector is often a public domain, because of that the goal setting for innovations is most of the time efficiency. There are numerous definitions of innovation, in this research the definition is demarcated to the perspective of Ketteringhame. *“Innovation is the process where the ideas, designs and applications will be created, collected, interpreted and implemented to products and services in practice.”* (Ketteringhame et al. 1986)

In this research the focus lies on the level where institutions interact, collaborate and share knowledge to create innovations. Through interaction, institutions are able to share knowledge and strengthen each other, innovations could be created quicker because more knowledge is available. (Morgan, 1997) Innovations on process level will be driven or hindered by the presence or absence of the next factors. (Porter, 1990)

- Availability of high quality input (money, knowledge employees);
- The nature of the question of the product by the customer (demand);
- The degree of competition between institutions and the degree of awarding successful innovations/innovators;
- The presence and density of the connection/interaction between institution and the spatial opportunities to make innovations happen. (Porter, 1990)

To understand how innovation works, the next four theories will give a perspective on the innovation structure of institutions or network. The four theories are written by Freeman, Gibbons, Lundvall and Porter and in these theories institutions and their roles are central aspects.

National Innovation System (NIS)

Innovations are an evolutionary and interactive process where organizations are involved in. (Morgan 1997: 492) Organizations have to collaborate with other organizations to use their internal knowledge optimally and by combining their own knowledge with the knowledge of other organizations they are able to create innovations. There is interactive knowledge development if actors interact/share knowledge together within the social, political, economic, and cultural context. (Muller and Zenker: 2001) Lundvall (1992) conceptualised the following definition on national level: *“A system of innovation is constituted by elements and relationships which interact in the production, diffusion and use of new, and economically*

useful, knowledge". (Muller and Zenker: 2001) This definition could be extended with Freeman's approaches (1987:1) to have a good perception on the national innovation system "...the network of institutions in the public and private sectors whose activities and interaction initiate, import, modify and diffuse new technologies". This long-term relationship and collaboration between institutions consists of power, trust and loyalty and has elements of non-price and market interactions (prices and quantities). Within these linkages arrangements(platforms), relations and interaction(communication) are available to strengthen each other. (Freeman, 1987) The institutional set-up has a large influence on the innovations. (Lundvall,1985/1992:10).

The government has a significant role in the water and innovation sector because the water sector is a public domain. The government enhances the knowledge, organizations and "authority" through policy making. (Gurbaxani et al. 1994: 148) The interaction is based on rules and roles are present between the different institutions to come to a clear understanding/relationship. Besides rules and regulations institutions are also motivated or obligated by governmental organizations through (water and innovation) policies to innovate. (Gurbaxani et al. 1994:147) These relations occur on different levels (national, provincial and local) and do not have to be the same at every level. The government is able to use different perspectives on governance in the water sector; supervision, steering, control, collaboration, responsibility, or can give autonomy. (Krahmann, 2003)

Clusters

Porter described a cluster as: A cluster is a geographic concentration of institutions and companies linked to each other by knowledge, trade or industry. This linkage is based on commonalities but also on complementary forces. (Porter 2000:16) The scope or range of these clusters are different, it can be national, state, region or city wide. The cluster is relating to the possibility of creating efficiency or affectivity, but it can also combine knowledge to be innovative. Within these clusters different entities occur. Entities are organizational structures, these can occur in different forms. Depending on the existing structure (different entities and goal setting) in the clusters competitiveness or collaboration occurs. All the participators are connected by skills, technology, or other common inputs. (Porter 2000)

The connection between clusters and the system of innovation is that the innovation which will be created often will be created by organizations in a cluster. Innovations often occur when different organizations have different goal settings but share the same interests. These organizations communicate and share information, knowledge or money and capacity to innovate. Competition on the other hand is also a good stimulator for innovations. Clusters are present in these kinds of environments and stimulate the innovation capacity of organizations by connecting institutions. (Porter 2000:34)

Clusters are important, but why are these clusters important and what is their influence on policy? Porter has written that clusters are important for organizations to come together. The advantage of the cluster is that organizations are capable to create a policy which is supported by all the organizations in the cluster. The main reason for the existence of clusters is that; "*clusters provide a vehicle to bring companies, government, and local institutions together in a constructive dialogue about upgrading, offering a new mechanism for business-government collaboration.*" (Porter 2000:30) Through this collaboration the partnership and dialogue between the private organizations, government and "knowledge" institutions (university) will take place at a more concrete level. (Porter 2000:30)

Triple Helix

Gibbons et al. (1994) mentioned that innovation is a fuzzy process and boundaries between institutions have to blur if scientific knowledge has to be produced. The Triple Helix is formed by the three institutions government, university and industry. This relationship is premised on the flow of knowledge. The flow of knowledge is no longer a linear process from the source of information to the application. The knowledge flows among these institutions make the creation of innovation and economic growth possible. During time the overlap by ties between the organizations was decreasing and the boundaries between the organizations were fading away. (Etzkowitz et al. 1998a.) "A triple Helix in which strand may relate to the other two can be expected to develop an emerging overlay of communications, networks, and organizations among the helices." (Etzkowitz & Leydesdorff 2000) The consequence of the elide of boundaries is that the institutions are able to assume the role of other institutes besides their traditional functions. For instance universities show entrepreneurship and firms show academic qualities (R&D centre and knowledge sharing). (Gibbons et al. 1994)

§ 2.3 Network organizations

Innovation and the network organization, set of actors which are or are not connected by ties, approach are narrowly connected. In a network perspective the context consists of organizations which are directly or indirectly connected to each other and exchange resources to create synergy effects. These connections create a network structure which is linked with the behaviour of the organizations. (Kenis and Oerlemans, 2007) In the network approach the organizations are embedded in a web of mutual relations which increases or decreases the possibilities of the behaviour. Thus a network exist of missing or present linkage between two organizations (dyads). This linkage is based on friendship, technological collaboration, information exchange and so on. (Kenis and Oerlemans, 2007) A vital factor of a network organization is communication and interaction, this can be done individually between organizations or group wise. Two good examples are communication hubs and platforms.

Institutions and interaction

Institutions have different roles in an innovation system, in this research the institutions can be divided in the development (capacity/role) and the implementing (capacity/role) institutions. The power of the innovation capacity depends on the institutions which are involved and the way institutions interact with each other. (Gurbaxani et al. 1994 and Lundvall 1988) Why are institutions and interaction patterns important for innovations and this research? Institutions and interaction patterns are important for this research because the "creation of an innovation is an interactive process, where institutions internally and externally learn interactively from each other". (Morgan 1997:492) Besides that Morgan writes that "*innovations are shaped by a variety of institutional routines and social conventions*" (Morgan 1997:493) Based on this perspective, institutions and interaction patterns have an influence on the innovative capacity and have to be discussed in this thesis.

The organizations in the innovation system interact with each other. Interaction is the founding of a system, where organizations collaborate. "*Interaction is used here to describe all types of direct and indirect, personal and non-personal interactions between organizations and/or individuals from the firm, university and the governmental side.*" (Schartinger et al. 2002 article) The degree of interaction and the completeness of the interaction (knowledge/information sharing) is able to influence (decrease or increase) the innovation capacity. (Schartinger et al. 2002 article)

Chapter 3 National Innovation System Model

This chapter is the analytical framework of the report. To be able to measure the innovation capacity of the water sector in South Africa a translation from the theory into the National Innovation System Model and practical indicators has been made. The theories given in the theoretical framework, together formulate the model in figure 1. Organizations which have a direct relation could share information and knowledge. Based on these relations and the national innovation system, indicators to measure the degree of the capacity of innovativeness are made. This framework enables to assess the innovations.

Innovation capacity is the capability of the innovation system to make innovations possible. (Furman, 2002) This report is about the water sector and its innovative capacity. The water sector will be described by four different individual “clusters”. These clusters interact and have linkages. The cluster organizations will be explained separately. The capacity of each cluster specific and the interaction patterns with other cluster organizations will be mentioned. The cluster perspective is based on the cluster theory by Porter, because Porter mentioned that organizations can be linked by trade, knowledge or industry. In this case the organizations are linked to each other, because all the organizations are involved in the provision of water.

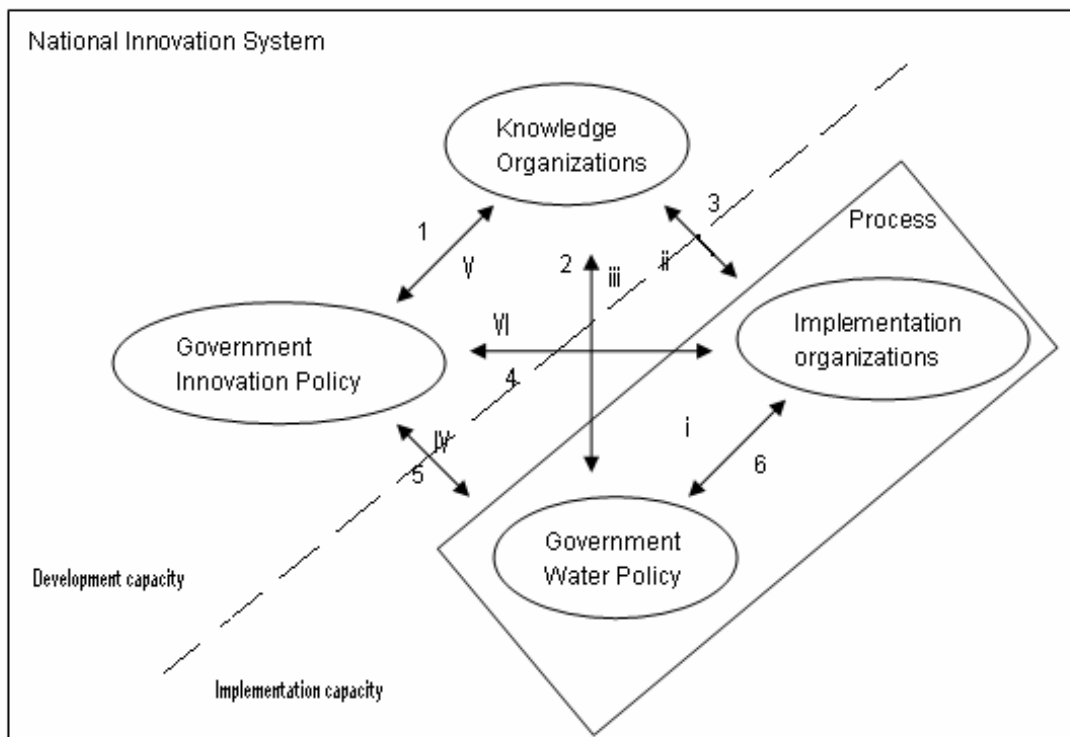


Figure 1: National Innovation System Model (NISM)

This model has the same approach as the National Innovation System (NIS) perspective written by Freeman. Institutions in the public and private sector modify and diffuse new technologies by working together. This collaboration is based on interaction, trust, power and loyalty between the institutions in the network. In this network different institutions are represented, namely universities, government and industry. In this network there is a relationship and interaction between government, university and industry based on the flow of knowledge. This is what Gibbons called a Triple Helix. Through knowledge dissemination

and sharing the creation of innovations in the NIS is possible. In this way institutions learn from each other and are able to combine the available knowledge. (Edquist 2005: 184 and Muller and Zenker, 2001) There are two types of innovation capacities in the network. The development capacity of the NIS, this are the Government Innovation Policy and Knowledge Organizations. The organizations of the development capacity stimulate or create the innovations. The other capacity is the implementation capacity. This are the Government Water Policy and the Implementation Organizations. The organizations of the implementation capacity buy and implement the new created innovations within their operational activities. The process level (Water Government Policy and Implementation Organizations) is where the product water is provided and distributed towards the customers in South Africa. The linkages in the model represent the interaction and relations between the organizations in the innovation system.

Innovative capacity

Innovative capacity is the capacity of an organization, cluster or network to create and implement innovations. These innovations occur with products or services. (Nayak & Ketteringame 1986) Innovation capacity can be defined as: “*The national innovative capacity is defined as country’s potential – as both an economic and political entity – to produce a stream of commercially relevant innovations.*” (Furman et al. 2002) The innovative capacity reflects the ability, of organizations and/or organizational structures within a country, to produce and commercialize new technologies over a long period in time. These technologies are new for one specific country but could also be new to the whole world. The innovative capacity is focused on the fundamental changes of the innovation process. (Furman et al. 2002)

The innovative capacity of the water sector in a country is influenced by economic and political., but also the sophistication of an economy and it’s labour force influences the innovative capacity. These are more dynamic factors, besides those also the investments and policy choices made by the government and private sector influences the innovative capacity. In countries the innovative capacity is different because the factors as economy, geography, innovation policy and political system are dynamic and not similar in every country. (Furman et al. 2002 and Freeman 2002) The similarity of the countries is that the innovative capacity of the water sector can be divided in two separate capacities; development and implementation capacity. Though these capacities do form the innovative capacity together there is a difference between the implementation capacity and the development capacity.

Development capacity

The development capacity is focused on new innovations and is a reflection of the degree that organizations are able to develop new technologies/innovations for the water sector. These organizations are not involved with the practical implementation of the innovations. The bases for innovations is that the organizations collaborate to share and exchange knowledge to innovate. (Camagni 1991, Morgan 1997) In this case these organizations are the knowledge and implementing organizations.

When the innovative capacity is relatively low, because of small financial investments, innovations are developed in a linear way instead of radical changes. (Porter and Stern 1999:6) Researches are demand driven and are focused on developing a specific outcome. This outcome will be in the most of the time a practical solution which can be implemented immediately. Little resources are used for fundamental research. (Water and Sanitation, 2008) When the innovation capacity is relatively high, organizations develop innovations before the

demand rises from implementing organizations. The knowledge organizations do unsolicited research instead of research to a specific problem-based outcome. (Porter and Stern 1999:12-13)

Implementation capacity

The implementation capacity is the capacity organizations have to implement established policy or innovations. The implementation capacity of the water sector is focused on the more practical innovations in the water sector which are directly implemental in the water sector. (Interviews 2008) The power to implement new technologies or innovations is depending on the type and size (capacity) of the organization. The influence of the implementation organizations on the water policy and innovation policy, results in a more implemental innovation or policy. The implementation capacity of organizations also depend on the amount of skilled people, financial resources, operational capacity and so on. (Porter and Stern 1999) The implementation capacity is of importance for the continuation of the activities of the development capacity, because when there is no demand for or innovations do not get implemented new innovations will not be created.

The innovative capacity consists of the implementation and the development capacity together. The total national innovation system of the water sector can be translated to a figure. This network figure shows the relation between the clusters and the public and private organizations. The degree of collaboration influences the creation of innovations. (Asheim and Isaksen 2002:85)

The types of interaction between the organizations have influence on the innovative capacity. The completeness of the interaction and linkage between the different organizations explain the type of relations between the organizations and are based on time, intensity, intimacy and the reciprocal services. The relation can be divided in a financial, knowledge sharing or more hierarchical relation which influences the innovative capacity. (Kenis and Oerlemans, 2007)

In the network theory different configurations are mentioned for the collaboration between the public and private organizations. This discerns different degrees of collaboration between government and private organizations concerning the implementation of policies. (Kenis and Oerlemans, 2007)

The innovation capacity of the government increases when there is more collaboration between different governmental and private organizations. Together these organizations have more money to invest, more knowledge to use for new innovations. The organizations also have more capacity to implement innovations or to create innovations by doing research. (Kenis and Oerlemans, 2007)

In the next paragraph the decreasing and increasing indicators for the innovative capacity of the water innovation system in South Africa are given.

§ 3.1 The relations and cluster organizations

A The Water Policy Network

The water policy organizations (also water policy network WPN) are part of the implementation capacity of the water sector, because these organizations are responsible for the water provision. The WPN is able to influence (decrease or increase) the innovative capacity of South Africa. The WPN coordinates the sector through the established water policy which has to be implemented by other (implementing) organizations. The degree of involvement in establishing the water policy by the implementing organizations (IO) influences the innovative capacity of the water sector in South Africa. Policies will not be

implemented optimally if the IO's are not fully supporting the adjusted policies. The degree of innovative capacity of the water sector depends on the structure and coordination on development and implementation by WPN. "*Policy includes the coordination of a certain development of the society*" (Bovens et al., 2001:82) Organizations (WPN) use repressive and/or stimulating instruments to achieve a goal, the types of instruments chosen decrease or increase the innovative capacity. (Herweijer and Hoogerwerf, 2003:242)

	Stimulating / Increasing instruments	Repressive / Decreasing instruments
Communicative	Informative	Propaganda
Economic	Subsidy	Tariff
Juridical	Covenant	Law, norm or ban

Table 1: Types of instruments to achieve goals (Herweijer and Hoogerwerf 2003:242)

The innovative capacity decreases when the policy is steered top-down, because there is limited discretionary space, while a bottom-up approach increases the innovative capacity. A top-down approach is when the policy is established by the WPN and is guided by the national government towards local government through direct supervision, rigid norms and prescribe standards. These are all restricted indicators for a decreasing innovative capacity. With a top-down approach the IO's use their capacity to comply to rules (standards and norms) and to achieve goal settings established by the WPN, instead of creating and focusing on suitable goal setting and new innovative techniques (innovations). The bottom-up approach is used when the organizations are able to establish their own policies and make decisions within the organizations. An implementation method is giving the implementation organizations discretionary space (degree of free interpretation of the policy) or not. (www.ew.govt.nz)

The indicators to measure the WPN (DWAF):

Indicators for decreasing innovative capacity:

Policy aims

- Discretionary space on policy; degree of prescribed technical applications, methods and or standards;

Policy instruments

- Use of repressive instruments (rigid norms, tariffs or rule-setting) by WPN.

The innovative capacity decreases because the implementing organizations have to comply to rigid norms and tariffs setting and IO's are not allowed to buy or demand for new technical applications (innovations) besides the prescribed by WPN. Innovative organizations will not create innovations when there is no demand and no market to sell it to.

Indicators for increasing innovative capacity:

Policy aims

- Free scope on policy; goal setting is aimed on outcomes and output..

Policy instruments

- Use of stimulating instruments, like subsidies, information or covenants.

The innovative capacity is increasing because organizations are allowed to implement technical applications, methods or standards suitable for their organization and the WPN stimulates this by using stimulating instruments. The implementation organizations will search and demand for the best matching methods and technical applications for their

operational activities, these will not be the same for every implementing organization. The demand for technical applications and methods increases the innovative capacity, because the innovative organizations are able to create innovations (researches) as the demand rises.

In the national innovation system there are six relations which influence the innovation system. Relations are important for the creation of innovations. (Stuarts, 2000) The relation between institutions get formed by the interaction these institutions have. (Morgan, 1997) Interaction is the direct and indirect communication between organizations and/or individuals. (Schartinger, 2002)

- I. relation between the Water Policy Network (WPN) and the Implementation Organizations (IO);
- II. relation between the Implementation Organizations and the Knowledge Organizations (KI);
- III. relation between the Water Policy Network and the Knowledge Organizations;
- IV. relation between the Innovation Policy Network (IPN) and the Water Policy Network;
- V. relation between the Innovation Policy Network and the Knowledge Organizations;
- VI. relation between the Innovation Policy Network and the Implementing Organizations.

Relations Water Policy Network

The relation between the Water Policy Network and the Knowledge Institutes, Implementing Organizations and the Innovation policy Network are described in the following paragraph. These linkages are in every single case bilateral, but are mentioned finite.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
I WPN – IO	Decision-making	Strict boundaries between policy making and implementation	Degree of decision-making by mutual adjustment
		Focus on conservation and problem solving	Focus on improvement and innovation
III WPN – KI	Knowledge transfer	Strong focus on technological knowledge and problem solving	Combination of technological and ‘administrative’ knowledge
		Strict principal-agent relation focused on problem solving	KI’s do unsolicited research and WPN is willing to use this knowledge
IV WPN – IPN	Policy adjustment	Both networks are working in silo	Mutual adjustment and policy integration occurs
		Demand steering from WPN to IPN	Mutual search towards useful knowledge and innovation policy

Table 2: Relations WPN

- I. In which way is the hierarchical structure formed, based on cooperation or is it an one way relation. The kind of decision making is influencing the innovative capacity. Is there a strict boundary between policy making by the national government and the implementation by the implementing organizations, or is this based on mutual adjustment. By combining the know how of the operational activities and attainability of goal setting by the IO's with the knowledge about general goal setting by the water policy network, the policies and the available technological knowledge could be implemented optimally. (Kenis and Oerlemans, 2007) The innovative capacity increases when the implementing organizations collaborate together and adjust their policies and provide each other with input concerning innovations or policies (synergy effects). (Meeus and Kenis, 2007) When the policy is established is this directed top down or is there a bottom up approach. Innovations occur to solve problems (conservative) or innovations strive for improvement on the long term (fundamental).

- III. Knowledge transfer is an element in this relationship. The innovation capacity depends on the degree of knowledge sharing. When knowledge could be and is shared easily the best practices and the best guidelines can be chosen to form and implement the water policy. (Meeus et al., 2004) With the transferred knowledge the water policy network is capable of developing better suitable water policies to the possibilities of the implementing organizations. By matching the policy to the capabilities of the water sector the innovation capacity increases, because innovations can be implemented more easily and therefore will be used and created more often.
The indicators for the decreasing capacity are the strong focus on technological knowledge and problem solving based on strict principal-agent relation. This is decreasing the innovative capacity because the organizations are constantly running behind and anticipating on problems which are already there instead of preventing problems by changing processes through new innovations. It is also decreasing the innovative capacity because organizations do not look outside the box for new "radical change" but focus on a specific process and/or area (solicited research) within the water sector to improve. The increasing factor is the unsolicited research done by the knowledge organizations which can or could be used by the water policy network, these types of researches are able to create more radical changes. (Meeus and Edquist, 2006) These researches are focused on both the technological as the administrative knowledge.

- IV. An element within this linkage is the policy adjustment of both organizations. A decreasing indicator is when organizations work in silos and when the innovation policy network is secondary to the water policy network. (Galbraith, 1973) This is decreasing the innovative capacity because there is no overlap with both policies and synergy effects will not be achieved. (Kenis and Oerlemans, 2007) An increasing indicator for the innovative capacity is when the policies from the WPN and the IPN integrate and when mutual adjustment is pursued. Both policies get optimized in this way and synergy effects can be achieved. (Meeus and Kenis, 2007) The advantage of mutual adjustment is that both networks will share and disseminate knowledge and perspectives will be combined to strength and complementary each other competences. (Meeus and Kenis, 2007 and Galbraith, 1973)

B Implementing Organizations

The implementation organizations are responsible for the implementation of the established policy by the Water Policy Network. The implementation organizations are the organizations which translate the policy into practice. If the operational activities by the IO's are focused on and minimized to translating the given policy by WPN to daily activities it is decreasing the innovative capacity. If this occurs the IO's do not use their capacity and resources to innovate but only to implement the given policy. The opposite of strict policy boundaries is discretionary space for the IO's. Discretionary space increases the innovative capacity of the water sector in South Africa, because organizations are allowed to choose own goal setting, standards, and/or technical applications. With this free scope of policy the implementation organizations can decide when innovations will be implemented and which type of innovations will be implemented. The IO's create innovations, for example to spend less money. The implementation organizations are organizations which can influence the implementation capacity of South Africa. These organizations can demand for innovations or create innovations within the own organization.

The knowledge transfer the IO's could have with the other three cluster organizations is threefold. Depending on the type of knowledge transfer the organizations could increase or decrease the innovative capacity. In table 3 the roles of IO's in the creation of innovations are described.

Relation	Content	Indicator for innovative capacity
Agent	These organizations create innovations for the principal, The agent has more knowledge available then the principal.	This is decreasing the innovative capacity, because the principal implement the innovations, but do not create an institutional "knowledge" memory.
Principal	Organizations buy innovations from the KI's. When autonomy increases the organization is able to judge what it needs by itself.	Decreasing, because the IO's do not create the innovations by itself and do not store an institutional memory. With more autonomy the organizations are able to adjust the demand to their needs.
Innovator	The organization is able to innovate by itself.	This is increasing innovative capacity, because organizations can innovate for their own organization but also create innovations for other organizations. (problems change in challenges)

Table 3: Types of knowledge transfer (Waterman, 1998)

The indicators to measure the IO (Water Boards and Municipalities)

Indicators for decreasing innovative capacity:

Discretionary space

- If the discretionary space is low the organizations are not able to innovate. The organizations use their capacity to implement the established policy by the WPN;
- Organizations are not able to determine the start of innovative projects by themselves.

Development of innovations

- Organizations have a low budget for investments in renewals;
- Organizations do not have own financial resources to invest in innovations;
- Organizations have a culture which is focused on short-term problem solving (conservation) and on incremental improvement;
- Innovativeness within the organization is not stimulated;
- There is a lack of competition and collaboration between the water providers.

The innovative capacity decreases when organizations do not have discretionary space, because their capacity will be used for implementing and adjusting the policy established by the WPN to their own standards instead of doing Research and Development for new innovations. (Jensen et al., 2005) When organizations do not have the financial resources to innovate, the organizations will not demand for radical innovations but demand for short term solutions for their problems. In this situation research must create an outcome which can be implemented immediately These solutions are mostly incremental changes instead of fundamental changes. (Jensen et al., 2005) When competition on the long term is missing, organizations do not have to be inventive or improving to be competitive (to survive) and organizations will not innovate because organizations are not driven enough, complacency will occur. (Lundvall et al., 2002)

Indicators for increasing innovative capacity:

Discretionary space

- Organizations have a large discretionary space. Organizations set their own goals and determine own output and outcomes;
- Organizations are able to determine the start of innovative projects and the implementation of these innovations.

Developments of innovations

- Organizations have a high budget for investments in renewals;
- Organizations have own financial resources to invest in innovations;
- Organizations have a culture which is focused on long-term problem solving (innovation) and on fundamental improvement;
- Innovativeness within the organization is stimulated;
- There is high competition and collaboration between the water providers.

The innovative capacity increases when the financial resources for research are available and when an organization is able to determine by itself to invest in proper and suitable Research and Development projects for their organization instead of implementing a standard technical application. Collaboration makes sure that the innovative capacity increases because organizations share financial resources and knowledge to strengthen and complementary each others competences and possibilities for the creation of innovation. (Kenis and Oerlemans, 2007)

Relations Implementing Organizations

The relation between the implementing Organizations and the Knowledge Institutes, Water Policy Network and the Innovation policy Network are described in the following paragraph. These linkages are in every single case bilateral, but are mentioned finite.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
II IO – KI	Knowledge transfer	Strict principal/agent relation between IO (as an principal) and KI as agent(s)	KI's do unsolicited research and IO's are willing to use this knowledge
		Demand steering from IO focused on problem solving	Collaborative communication (platforms and communication hubs) about possible improvements/innovations
VI IO – IPN	Development of innovations	No water sector specific innovation policy established by the department of Science & Technology	Financial flow from IPN to IO's for R&D purposes
		No user involvement in knowledge development	User involvement in knowledge development.

Table 4: Relations IO

II. Central aspect is the knowledge transfer from the KI's to the IO's. In general the IO's do not have the financial resources or the capacity to do own research or to create innovations. The relation is based on the transfer of "technological" knowledge to and the request for research to "new" technological developments by implementation organizations. (Water Sanitation, 2008) The degree of the relationship between the knowledge organizations and implementing organizations also influences the innovative capacity. (Meeus and Kenis, 2007 p. 42) The form of knowledge transfer influences the innovative capacity as well. If labour mobility, platforms and communication hubs are present it increases the innovative capacity, as knowledge is easy to disseminate and to obtain. On the other hand an absence of these platforms and communication hubs and the presence of a strict principal-agent relation between the IO's and KI's is decreasing the innovative capacity. The disadvantage of a principal-agent relation is that the information is divided asymmetric. (Spremann, 1987; Waterman, 1998)

VI. Innovation development is the central aspect in this relation. The question is how these organizations give form to the creation of innovations. If the innovation policy network has established a sector specific innovation policy, with a financial injection, to create innovations by IO's and the IO's are involved with the knowledge development it increases the innovative capacity. A specific innovation policy for the water sector is increasing the innovative capacity, because the innovation goal setting is adjust to the implementation organizations. Besides that the line of communication between the IP and the water sector is shorter and more direct then if it was a general innovation policy established by the IPN. Through an adjusted policy and financial support by the IPN the IO's are able to enlarge their capacity (skills, collaboration) to do research and it gives the IO's a degree of financial certainty. When implementation organizations are involved with the creation of knowledge/innovations, the IO's create and store

knowledge/innovation in their organizational memory. By remembering knowledge organizations are able to recognize behaviour and situations and can anticipate to it. (Prusak, 1997) When the specific innovation policy is missing, the IPN communicates the central goal setting with all the sectors and not one sector in specific. If the IO's are not involved with the creation of innovation or do not have a sector specific innovation policy it decreases the innovative capacity because these organization do not build and store an organizational memory to use in the near future and communication lines are long and indirect and policy adjustment takes more time.

C Knowledge Organizations

This group exist of three organizations: private companies, knowledge institutes and universities. Although these organizations differ in the purpose to create knowledge these organizations will compete each other and are complementary ('cooperation'). The first indicator to measure the innovative capacity is about the cooperation, competition and market structure. The second indicator is about internal coordination to decide which goal has to be achieved. The third indicator is about creating possibilities to innovate. The fourth indicator is about dissipation of knowledge.

The presence of competition and collaboration has an advantage, because the organizations have to be improving and/or inventive to compete and/or organizations can strengthen each other by competence and knowledge sharing which results in synergy. The knowledge organizations have innovation development capacity. (Lennon and Sahota 2003)

The indicators to measure the innovativeness of the KI:

Indicators for decreasing innovative capacity

Market structure

- There is a lack of competition and collaboration between the knowledge organizations;
- Knowledge organizations are depending on established innovation policy or demand by implementing organizations;
- There is no autonomous organization which stimulates organizations to innovate and creates a central demand for innovations.

Type of research

- Strong focus on problem solving (regional outcome) and applied science and research and development;
- Strong focus on specific divisions (drinking, waste and/or storm water) of the water sector.

Stimulator and knowledge sharing

- The absence of platforms and/or communication hubs to share knowledge;
- There is limited knowledge dissemination between organizations;
- The education level of employees is of high standards but it is not kept up to date/that way;
- Labour mobility of the employees is low;
- Innovations (by individuals) within the organizations are not rewarded or do not get stimulated.

The innovative capacity is decreasing when collaboration and competition is not present, because organizations do not strengthen each other by sharing knowledge, competences will not be enlarged and synergy effects will not be achieved. (Kenis and Oerlemans, 2007) When the demand for innovations is not present, the innovative capacity will decrease because knowledge organizations can not sell the created innovation or knowledge or will not do research by demand. Knowledge and/or implementation organizations could postpone that specific (most of the time fundamental) research because it is not profitable in the short term.

Indicators for increasing innovative capacity

Market structure

- There is high competition and collaboration between the knowledge organizations;
- Knowledge organizations are autonomous and these organizations are market based;
- There is an autonomous organizations which stimulates (instruments as subsidy) organizations to innovate and creates a central demand for innovations.

Type of research

- The knowledge organizations are not only focused on problem solving (regional outcome) but also focused on fundamental research and applied science;
- All the specific divisions (drinking, waste and/or storm water) of the water sector are part of the research focus.

Stimulator and knowledge sharing

- Many platforms and/or communication hubs are present to share knowledge;
- The knowledge dissemination between knowledge organizations is unlimited;
- The education level of employees is of high standards and is kept up to date by refresh courses and further intensification;
- Labour mobility of the employees is high;
- Innovations (by individuals) within the organizations are rewarded and stimulated;

By stimulating research projects (through subsidies) the innovative capacities increases, because more “knowledge” organizations are able to do (fundamental) research. The organizations are able to use more human and research capacity during the research, which could enlarge the research outcome. By sharing knowledge, organizations are able to complementary and strengthen each others competences. Innovations can occur more quickly in this way. (Sakakibara, 2003) The presence of platforms, communication hubs and labour mobility are factors which increases the knowledge dissemination and the innovative capacity because organizations have more knowledge to do research with. (Meeus and Kenis, 2007)

Relations of the Knowledge Organizations

The relation between the implementing Knowledge Organizations and the Implementing Organizations, Water Policy Network and the Innovation policy Network are described in the following paragraph. These linkages are in every single case bilateral, but are mentioned finite.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
II IO – KI	Knowledge transfer	Demand steering from IO focused on problem solving	KI's do unsolicited research and IO's are willing to use this knowledge

III WPN – KI	Knowledge transfer	Strict principal-agent relation focused on problem solving.	KI's do unsolicited research and WPN is willing to use this knowledge.
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Table 5: Relations KI

V KI - IPN	Knowledge development	Strict demand steering from IPN to KI	Communication between KI and IPN about appropriate knowledge questions
		Principal – agent relation under strict conditions	Broad conditions for knowledge development with autonomy for KI

Table 5: Relations KI

- II. Knowledge transfer is an element in this relation and it is decreasing when the IO's steer the demand for innovations based on problem solving. In this way the organizations are constantly running behind and anticipating on problems which are already there instead of preventing problems by changing processes through new innovations. The innovative capacity is increasing when the KI's are able to do unsolicited (fundamental) research, the outcomes can change complete processes and are focused on the long term. These types of research get stimulated by IO's when these organizations have autonomy to decide what kind of (innovation) policy the organization uses. Implementation organizations also have the responsibility over the investment of financial resources in technical applications, (fundamental or incremental) researches and/or methods.
- III. Knowledge transfer is an element in this relation. The innovative capacity is increasing when KI's have the resources to do research on the long term and search for more fundamental and/or incremental innovations. The innovative capacity increases even more when the WPN is willing to use the innovations created by the KI's, because the KI's have to adjust innovations to the characteristics of the WPN. The KI's get more stimulated when the innovations get implemented.
- V. The policy to coordinate the innovations in the water sector is made by the innovation policy organization. This is decreasing the innovative capacity when it is strictly demand steered by the innovation policy network, because the risk is that the demand/innovations are steered on present problems and not on fundamental change. With discretionary space or autonomy for the KI's this problem could be tackled in advance, because these organizations are allowed to decide what type of research the organizations do, fundamental and/or incremental research. When the demand is based on communication about appropriate knowledge questions the innovative capacity increases, as the organizations formulate and adjusts both policies to one research goal based on the demand from the IPN and the KI's.

D Innovation Policy Network

The innovation policy network (Department of Science and Technology) establishes the policy which has to stimulate the knowledge and implementation organizations to innovate. The goal set by the department is to tackle issues of the future in advance, this is called fundamental research. The department also tries to tackle present issues by incremental (problem-solved) improvements and applied science. Stimulating can be done by pushing innovations (subsidy and fiscal benefits) or by pulling innovations (norm proposition or by increasing demand). (see also table 1) The department is able to decrease or increase the innovative capacity by policy aims, policy instruments or decision making.

The indicators to measure the IPN:

Indicator for decreasing innovative capacity

Policy aims

- The Department of Science and technology formulates general innovation goals. Organizations are not stimulated individually to achieve innovations;
- There is no overlap between the established policy by the innovation policy network and the water policy network (silos).

Policy instruments

- The Department of Science and Technology prioritizes innovation (solicited-incremental) projects.

Decision making

- The Department of Science and Technology decides top-down.

The innovative capacity is decreasing when the general policy established (steered top-down) by the IPN or WPN has to be adjusted by the organizations which have to implement it in their specific situation. This takes time, money effort and capacity, which otherwise could be used for other purposes like research. When the department of Science and Technology prioritizes problem solving above incremental innovations it decreases the innovative capacity, because problem solving does not strive for renewal or progress (on the long term) in the water sector.

Indicator for increasing innovative capacity

Policy aims

- The Department of Science and technology formulates general innovation goals and establishes a policy for sector support specific;
- There is an adjustment between the established policy by the innovation policy network and the water policy network.

Policy instruments

- The Department of Science and Technology finances knowledge institutes ;
- The Department of Science and Technology does not prioritize (unsolicited-fundamental) innovation projects.

Decision making

- The Department of Science and Technology establishes a policy adjusted to knowledge and/or implementing organizations.

The innovative capacity increases when knowledge is shared and the policies established by the WPN and IPN are adjusted to each other. In this way these policies can strengthen and complement each other where necessary. (Sakakibara, 2003; Kenis and Oerlemans, 2007)

By adjusting the innovation policy to the specific sector, the implementation by the implementation organization is matches better and is more easily to comply to. Organizations need less financial resources and capacity to implement the policy. This capacity could be used for innovations or research. By financing researches the department of Science and Technology is increasing the innovative capacity, because organizations are able to enlarge the amount or degree of skilled capacity. A condition is that the financial resources must be used efficiently by the receiving organization.

Relations Innovation Policy Network

The relation between the implementing Innovation Policy Network and the Implementing Organizations, Knowledge Organizations and the Water Policy Network are described in the following paragraph. These linkages are in every single case bilateral, but are mentioned finite.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
IV WPN – IPN	Policy adjustment	Both networks are working in silo	Mutual search towards useful knowledge and innovation policy
V IPN - KI	Knowledge development	Strict demand steering from IPN to KI	Communication between KI and IPN about appropriate knowledge questions
		Principal – agent relation under strict conditions	Broad conditions for knowledge development with autonomy for KI

Table 6: Relations IPN

- IV. The central aspect in the relation between the water policy and innovation policy network is policy adjustment. When both networks work in silos and do not adjust their policies to each other the innovative capacity decreases, because synergy effects will not be stimulated and policies will not be optimized. The innovation approach from both networks also influences the innovative capacity, if the networks search mutually to useful knowledge instead of innovation “policies” which get steered by demand by WPN, increases the innovative capacity.

- V. The central aspect is the knowledge development. When the IPN and KI have a principal-agent relation under strict conditions then the innovative capacity decreases because the principal needs a lot of time, effort, capacity and money to control the agent. This could be invested in research instead of this control mechanism. The innovative capacity increases when the IPN and KI communicate about appropriate knowledge questions and financial flows from the IPN towards KI’s also increases the innovative capacity.

§ 3.2 General relation flows

This paragraph is added to this thesis, because it gives an insight about the relations between the different organizations in the innovation system of South Africa. The general relation flows between organizations are different. The classification has been made into four different type of flows; financial, advice, steering, knowledge and education flow. In practice these flows are measured differently. Most of the flows are described in the analysis of the organizations but the knowledge, education and collaboration flow will be described separately, because of the importance of these flows for the innovation system.

Financial flow

In this context the financial flows are the financial resources which are freed for research. These financial resources can be seen as funding or subsidies, from one organization to another to do research. (Berglof et al., 2002)

Indicators for financial flows

- Transition of financial resources (subsidy or funding);
- Transition of financial resources to educate (internships or complete studies);
- The amount of projects and the financial resources involved.

Knowledge and education flow

In this context the knowledge and education flows are the transition of knowledge and the possibility, created by organizations, to educate employees or students. Knowledge sharing/transition are the “*activities of transferring or disseminating knowledge from one person, group or organization to another*” (Lee, 2001 p324) Transition of knowledge and education flows get stimulated in network organizations. Organizations share knowledge and information to achieve synergy effects. (Kenis and Oerlemans, 2007)

Indicators for educational flows

- The possibility to follow internships and extra training within organizations;
- Lectures given by universities for other organizations or conferences.

Indicators for knowledge flows

- The amount of congresses, symposia or conferences;
- The amount of knowledge networks, communication hubs and platforms;
- Lectures given by universities for other organizations.

§ 3.3 Factors of influence on the National Innovation System

The organizations in the model are part of a national innovation system, there are several context factors influencing the outcome of an innovation in the national innovation system. Freeman and Furman et al. described the factors which are present in every single country, but depending of the form each factor is influencing the innovative capacity in an individual country differently. This research is not able to focus on all these factors, because the subject would be too broad then. Because these factors do influence the innovative capacity the factors will be given below and will be described briefly. The influencing factors on the innovative capacity are geography, politics, economy and the policy established by the government (Freeman 2002; Furman et al. 2002; Porter et al. 1999:20). Freeman also added the education level of the employees and the cultural and historical aspects of a country to the other factors.

- 1) **Geographic country specifics** A huge categorical system can be made to describe these specifics, but for this research a plain description will function. This description will include; the climate, the geographic structure and the size of the country.
- 2) **Cultural aspects** Because culture is a very broad definition we will only use it when necessary to explain relations between organizations. A basic description of the culture in how people cooperate with each other can give an insight in a country. A “claim-culture” or a “polder-culture” will have great influence on results of organizations.
- 3) **Historical aspects** Path dependency plays in this factor a great important role. A chosen way cannot easy be changed and therefore is history a part of the prediction of tomorrow. A small description of the large historical facts of the country like the abolishing of the apartheid in South Africa will be sufficient.
- 4) **Political aspects:** The political system is partly created by the juridical system and partly by political parties. The juridical system can be described as Anglosaxican (common law) or a more European Continental law were more is written down. Organizations are created in the boundaries of the law and therefore this factor is of great influence. But the political system decides how the organizations function. The political system as defined here needs to scope the level of the government, the way of voting (one vote-one man, or representative), the way of governing one party or collective cabinets and the size off the administration
- 5) **Economic situation and human development** The economic situation of a country says something about the possibilities of the companies to innovate on it’s own. Hereby is the human part important like the percentage of de different categories of work indicates the level of economic development in a country (agricultural, technological or services). But also the financial economic situation, the competition, the possibilities to have a monopoly. An important part is the labor market this has everything to do with human development. Within a population development can be found. Human development uses indications as population size and growth, average population age, percentage of immigrants and emigrants, urbanization, individual economic situation.
- 6) **Education level** The education level of a population has great influence on the capability to become innovative. Indicators of the education levels can be found in the organizations and in the individuals. For individuals are statistic numbers an indication of the education level (literacy rate, years of education, percentage of total population per sector)The more organizational factors of education and the function of the knowledge institutions will be described later in the paragraph of the Knowledge organizations.

§ 3.4 Research design

The research design consists of four different aspects; type of research, research method mythological responsibility and research instruments. These aspects will be described.

Type of research

This research is based on facts with the intention to increase knowledge. This is an empirical-analytical research.(Huisman, 2004) Because the focus of this research is set on Public Administration it is hard to put the research in one specific causal model. This research approach strives for a high degree of validity and significance/reliability.

Reliability stands for the consistency of measurements, also the degree in which an instrument measures the same way each time it is used under the same conditions with the same subjects. For this research it is of importance to secure reliability by internal consistency. The internal consistency of the instrument interview will be done by making use of one questionnaire. Not only can the use of a questionnaire guarantee the reliability of the instrument but also the style of the questionnaire. The style of the questionnaire is determinable by grouping the questions into concepts. In each concept there are at least three questions present, which measures the same concept. At the point that the results of the questionnaire is analyzed it is important to see if the questions per concept are parallel. This analysis also request that the outcomes per concept will be compared by class participation. This means that the results of on questionnaire will be compared to another questionnaire, to see if the participants of the different organizations share the same or different images of the current situation. (<http://www.socialresearchmethods.net>, 03/04/2008)

Validity stands for the degree of accuracy of the measurement. Validity is also seen as the value that is given to the conclusions of the research. The validity in this research will be focused on the external validity. The external validity determines the degree in which the results of the individual researches are generalizable to the other researches. To generalize this research on other cases the outcomes of other researches have to be predictable and match with this case. (Robson, 2002: 106) Because of the several factors which have not been part of this research, but could have an influence on the outcome it is not possible to generalize this research. But the outcome concerning the drivers and barriers could be of value for other cases and research processes. (<http://www.socialresearchmethods.net>, 03/04/2008 and Robson 2002) This also means that the uses of the following instrument are of importance:

- The conceptualization of the theoretical framework into a conceptual model makes the research measurable. By the use of the same concepts there has been created an opportunity to give the same shape to the different country specific research. Hereby the creation of a higher degree of comparability of the different country specific researches.

A dangerous aspect of a research by interview are the biases. There is a respondent biases, the respondent does not give the interviewer all the information or does not mention what the respondent thinks, because of the negative outcome a research could have in the future. Besides a respondent bias there is also a researcher bias, this is when the researcher is searching for certain outcomes because of the researcher subjective view about the topic. (Robson 2002, 171) To make sure these biases do not occur, and when it occurs that it will be solved during the research, data triangulation is used. In this case it is desk research, interviews and documentation (internal and external) by the organizations which have to give the researcher a complete oversight of the situation in South Africa and decreases the influence of one specific “incomplete” data.

Research method

Because of the amount of time available for this master thesis this research is a singular case-study. In this research is chosen to in-depth and examine a specific instance/situation of the water sector and innovation system in South Africa for over six months. Additional to the present situation of the water sector and the innovation system are the increasing and decreasing factors of the innovative capacity.

Research instruments

To collect data, research instruments are used. The use of documents (literature research) is the first instrument that has been used. This instrument is used for the theoretical- and

analytical framework and took place before the water sector was described. This instrument focused on the documents with theories about innovation, innovative capacity, institutions and interactions to write the theoretical framework as bases for the NISM. Several theories are described to give a better perspective on innovations and innovation systems. The second instrument is the secondary literature, this literature consists of magazines, books, websites, folders etcetera about (individual) organizations participating in the water sector. This literature is used to describe the type (public, private), role and funding of the organizations. Also the task of the organizations in the water sector and innovation system of South Africa is determinant through this instrument. Besides the secondary literature interviews are used to collect data. The interviews ground the collected secondary literature and give a better insight in the water sector and innovation system. By interviewing organizations more detailed information about the organizations and the structure of the innovation system is obtained. Different organizations involved in the water sector and innovation system have given their vision on the present situation through interviews.

Methodological responsibility

The methodological responsibility can be divided in several steps. (Hakvoort 1998)

1. Determine an object of public administration. In this case it is the innovative capacity of the water sector in South Africa. South African public and private organizations are involved in this object for study.
2. There has to be a problem within this object of study, if a research wants to take place. The first problem is the lack of oversight on the water and innovation system in South Africa. The second problem is the lack of oversight on factors which can increase or decrease the innovative capacity of the water system in South Africa. This research can be classified as studying, describing and explaining research.
3. With the use of the goal setting and the research questions the problem definition can be intensified and made specific for the province Gauteng in South Africa. (see previous chapter)
4. The research approach is the next step. This consists of a theoretical and empirical framework. The *theoretical framework* of the research is used to formulate a model of analysis. This model is used to analyze the innovative capacity of the water innovation network in a systematic and structural way. The theoretical framework is based on secondary literature (literature research) research. The *empirical framework* is based on the active institutions in the water sector and the innovation system, but also the contacts of SSI Johannesburg were part of the empirical scope. The information comes from secondary literature but also through interviews.
5. Collecting information. Putting theory into practice, determination of the amount of research and the method of collecting the data.

The research instruments are literature research (secondary) and several interviews. In total 25 interviews have taken place in the province Gauteng, these are public and private organizations involved in the water sector (water - and innovation system) in South Africa. These contacts were able to give information about the formed networks for knowledge dissemination, relations between organizations (based on policy or not), the role and task description of the specific organizations and the organizations gave information about the drivers and barriers in the innovation system. The organizations also gave a good and clear vision about the water sector and innovation system in general. (Appendix VII Interview list ; Appendix VII List of contacts) To make sure this research is representative for South Africa, all the clusters and types of

organizations involved in the water and innovation system were interviewed. Information given by organizations is most of the time coloured and has to be compared with images/reflections given by other organizations.

The collected data is presented in a way that the source is anonymous.

6. Eventually conclusions and recommendations will be given to DHV (SSI Johannesburg) and the Dutch ministry of Housing, Spatial Planning and the Environment and the ministry of Road and Waterworks.

Focus of the research

To keep the focus of the research limited, to realize the requisite depth, several factors of South Africa have been placed outside the research focus. These factors are economy, geography, demography, culture, politics and education, these factors are shortly described at the end of the third chapter.

During the research the temptation was present to focus more on the political environment in the water sector, but because of the complexity and the period of time which was available this factor was left beside. This could be a good focus for a continuation research.

Another curtailment is the exclusively focus on the networks of the water and innovation system. Especially the innovative capacity of the South African innovation system is a focus of this research, because this subject is worth a complete research.

The field of research is the province Gauteng. The research is focussed on this province because of practical reasons. Firstly SSI is stationed in Johannesburg (Gauteng) and secondly South Africa is too big to use it as field of research. In this province live 12 million people and this province is almost the half of the Netherlands. In this area all the institutions are represented and willing to participate in the research. For the international comparison is the size (inhabitants) of the province similar with Portugal and the area Ontario (Canada).

Relevance of the research

The scientific relevance of this research lies in the explanation of what the innovation capacity of the South African water innovation system constitutes, this is based on scientific theories. This analysis makes it possible to make a statement about the pretending value.

This research also has its social relevance, because through obtaining this understanding there is a contribution to the always current discussion about water issues in South Africa and elsewhere. Institutions get an overview of the factors which decrease or increase the innovation capacity of the innovation system in South Africa. These organizations could use this in their advantage.

Chapter 4 The water sector of South Africa

§ 4.1 Country specific features of the Republic of South Africa

South Africa is the most southern country on the continent Africa. Its borders are connected to Botswana, Namibia, Mozambique, Swaziland, Zimbabwe and the last country lies in and is surrounded by South Africa this is the enclave Lesotho. The Eastern and Western borders are the Indian and the Atlantic Ocean.

Geography

The country is 12,149,470 km² and is the 25th-largest country in the world. 48 million people live in the country. The administrative capital is Pretoria, Cape Town is the legislative capital and Bloemfontein is the juridical capital of South Africa.

In South Africa there are different kinds of climates. In general South Africa has a temperate climate. Every climate has its consequences for the use of the land and the possibilities for water use and transportation. The different climates can be seen in figure 2.

(www.info.gov.za and www.statssa.gov.za)

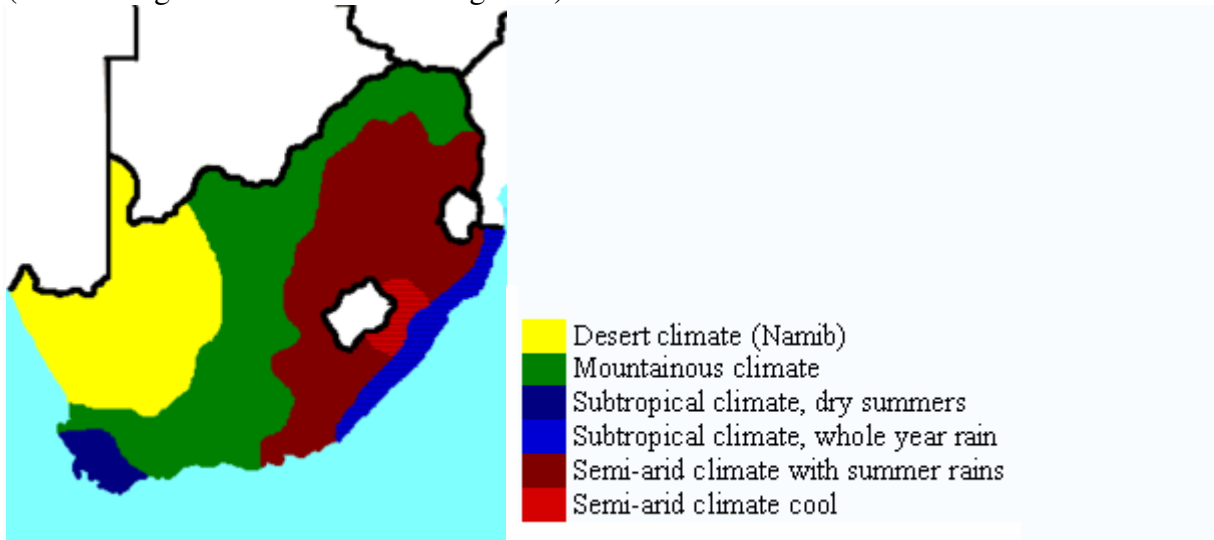


Figure 2: South Africa

Demographic and culture

The population of South Africa is heterogeneous, different ethnic groups and nationalities live in the country. That is why eleven official different languages are spoken in the country. South Africa is also called the Rainbow Nation and demography and cultures take an important place in the daily activities. The country is divided in four main groups the whites (9%), African (79%), colored (9%) and Indians (3%). The population has not widespread over the country. The provinces in the east are more populated than provinces in the west. There are a lot of cultural organizations which fight for the different cultures in the country. (www.info.gov.za)

History

European encounter

The Portuguese were the first encounters of South Africa. The Portuguese used the country and in particular Cape of Good Hope as a place to rest and to unload their goods. In 1652 the Dutch (Jan van Riebeeck) established the real first station in Cape of Good Hope on behalf of the East India Company. This was also the start of the slavery.

War characterizes the period in time between 1795 and 1902 the best. The presence of gold and diamonds in the ground encouraged people to start these wars. In 1934 attempts have been made to combine the cultures and the Afrikaans and English speaking population. This so called United Party lasted for five years until 1939, this is also the year that World War II started. In 1948 the “Whites” National Party was elected and once again had the power over South Africa. The first thing the National Party did was presenting a set of laws which was the start of the apartheid. The blacks were most of the time poor and the whites were rich and enjoyed the industrialization in the 1950s until the ‘70s. In 1961 South Africa became a Republic. (www.info.gov.za)

The Apartheid

The apartheid made sure that South Africa got ostracized from the outside world. Other countries found the apartheid controversial and not tolerable. There was also a lot of resistance within the own country borders. The most well known and internal supported organization was the Africa National Congress(ANC).

The first elections which were enjoyed by all the racial groups were held in 1994, the ANC won and is still the party with the majority. The end of apartheid does not mean everything is settled in the country. Still millions of people, mostly black people, live in poverty. The criminal ratings and the differences in wealth and economic growth between the different social groups did not go as fast as hoped for. (www.info.gov.za)

Until today the in heritages of the apartheid can be seen, people are confronted with the past every day.

The national political structure

The latest constitution of The Republic of South Africa has been signed in 1996 by, at that time, President Mandela. The national government of the Republic of South Africa consists of a Parliament, Cabinet and various Departments, which all carry out different functions.

The cabinet

In the Republic of South Africa there is a cabinet which consists of the President (Mr. Thabo Mbeki), the Deputy President (Ms. Phumzile Mlambo-Ngcuka) and several Ministers of the different departments. The different Ministers have all different portfolios were the ministers are responsible for. The cabinet in South Africa is individually and in a collective way responsible/accountable to the Parliament.

The Parliament

The Parliament is responsible for establishing legislature and law for the whole country, as long as it is in accordance with the Constitution of 1996. The Parliament can be divided in two different parts; the National Assembly and the National Council of Provinces (NCOP).

The National Assembly consists of 350 until 400 representatives members chosen for five years by the South African people. The task of the National Assembly is to achieve descend legislature and monitoring the actions of the administration.

The National Council of Provinces (NCOP) is a council that consists of permanent members (54) and special delegates (36) from the provinces. The task of the NCOP is to represent the interests of the provinces in the national sphere of government. (www.capegateway.gov.za and www.info.gov.za)

The national government departments

In total there are 24 departments in The Republic of South Africa. The Departments are responsible for their own tasks and implementation of legislation and establishing goal setting concerning their portfolio. The departments have to provide the public with services. For this research the Departments of Water Affairs and Forestry (DWAF) and Science and technology (S&T) are of importance. (www.capegateway.gov.za and www.info.gov.za)

Economy

The economy of South Africa is one of the best of the African continent and the rating is the twentieth of the world. South Africa has a well-developed economy market. To support the economy the South African people have created a modern infrastructure to all the major and urban cities in the country. (www.info.gov.za)

By far the most important areas are Johannesburg, Cape Town, Durban, Port Elizabeth and Pretoria. These cities are the economic centers of South Africa and the smaller urban cities are better known for the poverty and unemployment figures. Despite of the hard labor from the government the most of the African people are poor and there is an income gap between the rich and poor (dual economy). Inequality not only exists in the income of households but also in the earnings of the black and white, the white earned average four times the money a black man did. Other major problems are the criminal rate/activities and the consequences of the AIDS/HIV pandemic for the next several decades. (www.info.gov.za)

A huge problem in South Africa contains electricity, because the electricity and water infrastructure is not good enough organized to supply the present and future demand. At the moment rolling blackouts are the solution to this problem. (www.info.gov.za)

Education

The national Department of Education is responsible for the (higher) education level in South Africa. The department provides the country with a national framework for school policy. No child may be excluded from studying in South Africa. Other tasks are delegated by the department to the nine provinces in South Africa, the Department of Education is responsible for the administrative task and the devolving of the power to the elected school governing bodies.

At the moment South Africa has 12.3 million learners and these are divided over the three bands of education. The first one is General Education and Training, the second one is Further Education and Training and the last one is Higher Education and Training. 2.1 million people above the age of 25 years had completed some level of tertiary education (included degree or diploma) in 2003. This amount is the same as 6% of the entire people of South Africa. (DWAF, monitoring and evaluation report. 2006:65)

At the moment the amount of skilled/educated people is too low to be able to answer to the demand of the private and public organizations in the water and other sectors. This hinders the innovation capacity of the water sector.

§ 4.2 Conclusion

South Africa is a country with possibilities, but it is facing many problems at the moment. The country is recovering from the Apartheid and through many organizational restructures it uses a lot of capacity to create the best organizational setting, this is decreasing the innovative capacity. This is also an example of the political context there is in South Africa.

The economy in South Africa is one of the strongest of the continent and the government is willing to invest in research and development, this is increasing the innovative capacity. At the moment South Africa has power and water infrastructure problems, especially a lack of power is decreasing the innovative capacity. There is an overall shortage of skilled people. Since the end of the Apartheid the amount of students is increasing drastically, because everybody is allowed to go to school now. The national government is faced with shortage of skilled people and is stimulating the South African people to follow education.

§ 4.3 The water system of South Africa

The water sector of South Africa is divided in three different water divisions. This is the drink, waste and storm water division. The government is responsible for the water sector because the government has defined water as a public good. For the three divisions different systems are developed to distribute and to purify the water. In this chapter the description of the three separate divisions and the participation of the different organizations in the divisions are given.

§ 4.3.1 Drink water

There are three different governmental organizations involved in the drink water division. The first and most important is the national government in the form of the Department of Water Affairs and Forestry. DWAF is the legislature of the water sector, this is in all the three divisions, and DWAF is responsible for the water resources. The water resources are the rivers, reservoirs, the water in the lakes and so on. DWAF mandates other public organizations (private organizations are not involved) to take care of the purification of water (water boards) and the distribution (municipalities) of water to the households. (Interview April 2008)

Two examples of water boards in Gauteng are Rand Water and Magalies Water. These organizations are public organizations and have the mandate of the national government to take care of the bulk water supply (huge amount of purified water). Rand Water buys water directly from the national government. This water comes from the resources, which are managed by DWAF. The task of the water boards is to draw the water out of the water resources from the national government and distribute it to the purification plants which the water boards have installed. These water boards purify the water and sell it to the municipalities. (Interview May 2008, www.randwater.co.za)

The municipalities also named local councils buy the water from the water boards, every year the Water Boards set a price for the water. The local councils sell the water to the households, the households have to pay for the water after the free basic water amount is reached. (60 liters per person a day) This is a climbing tariff to make sure the free basic water will be paid by the more wealthier people. At the moment the most local councils are running on loss. The costs to buy and distribute the water are much higher then the incomes received from the citizens.

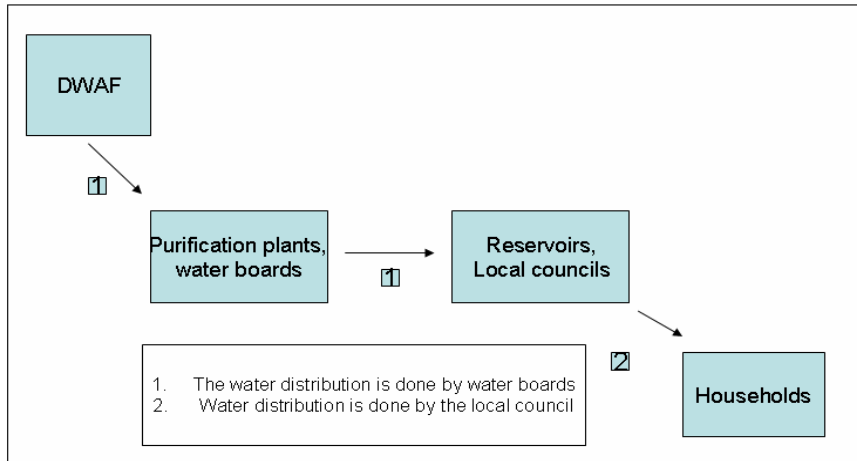


Figure 3: Drink water process

§ 4.3.2 Waste and sanitation water

The municipalities take care of the purification of the waste and sanitation water, after receiving it back from the households. The Department of Water Affairs and Forestry mandated this responsibility to the municipalities because these organizations have the best oversight of the area. DWAF establishes laws and standards where the water quality and the purification process have to apply to.

The municipalities have installed big purification stations to purify the water that returns from the households (domestic) and the industry. The polluted water will be purified and the municipality have to put it back into the system. The system can be described as the rivers and the reservoirs of DWAF. There are also examples of organizations that purify their own water and put it back into the system or sell it to local councils for re-use, an example is the mining industry in the Eastern Cape. In Gauteng the used water has to be purified before it returns into the system. There is a special waste and sanitation “program” at the purification plants to purify the water. (Interview April and May 2008, www.joburg.co.za)

Purification of the waste and sanitation water is the responsibility of the municipalities. (WRC, 2006) The municipalities are the only organizations involved with the purification of the waste and sanitation water in South Africa. The municipality of Pretoria outsources the purification of the waste/sanitation water to East Rand Water Care Company (ERWAT) and Johannesburg to Joburg Water. These are public autonomous bodies owned by the municipalities in Pretoria and Johannesburg. The cost for purification for the domestic user is based on tax and for the industry it is also based on tax but this amount depends of the degree of pollution of the water. If the water is highly polluted an organization has to pay more for the purification process then when the water is a little bit polluted. In the next figure the process will be described. (Interviews May 2008)

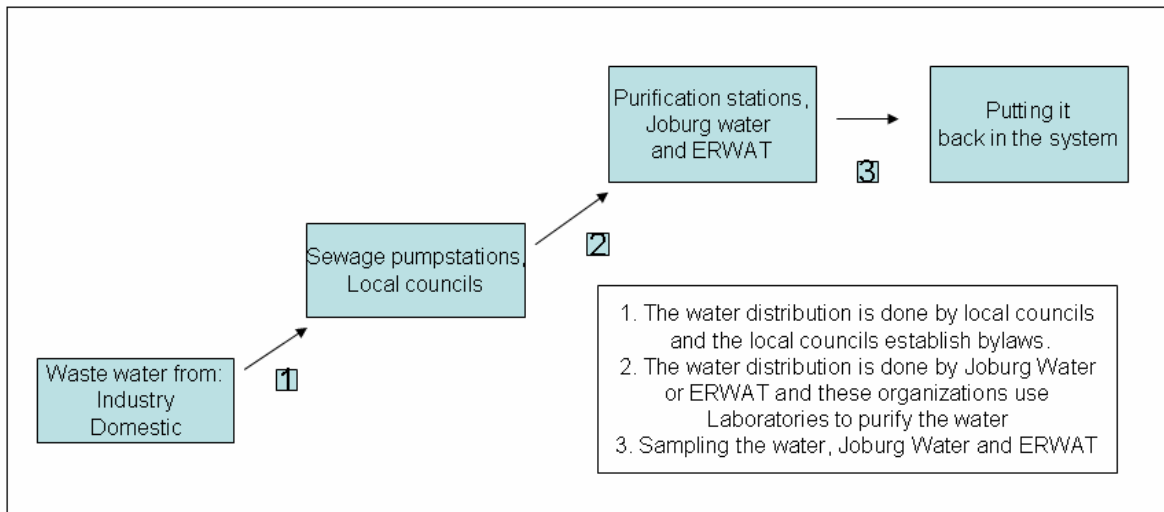


Figure 4: Waste and sanitation process

§4.3.3 Storm water

The distribution of storm water into the system is arranged by the Road Department. In Johannesburg is this Johannesburg Road Agency. This water will not be purified by the purification plants that is why the Department of Roads is responsible for this task. The Department of Roads is responsible for this task because storm water flows towards the streets and this is the responsibility of the Department of Roads as well. The assumption is made that storm water is clean enough to be directly distributed from the roads to the water system. Department of Roads is a distributor of water. This is also the reason for the national government to keep the storm water separated from the waste water and the drinking water, because these types of water have to be purified before it will be put back in the water system. The Department of Roads is responsible for the quality of the water pipelines the capacity of distribution and the final distribution of the water towards the rivers. (www.jra.org.za and Interview June 2008, July 2008)

In figure 5 the organizations involved in the storm, drinking and waste water divisions are mentioned. In the storm water division the Transport department is responsible for the distribution of the water. The linkages between the different organizations represent the structure of the water policy established by the department of Transport. In this division the local municipalities (Road Agencies) establish the policy for the storm water and not the department of Water Affairs.

With the waste and drink water the department of Water Affairs and Forestry is responsible for the water policy. This policy is established and structured top-down. Organizations have to comply to the standards and goals set by the department, but the organizations are able to design the organizational and operational structure by themselves. (White paper on national water policy in South Africa 2002)

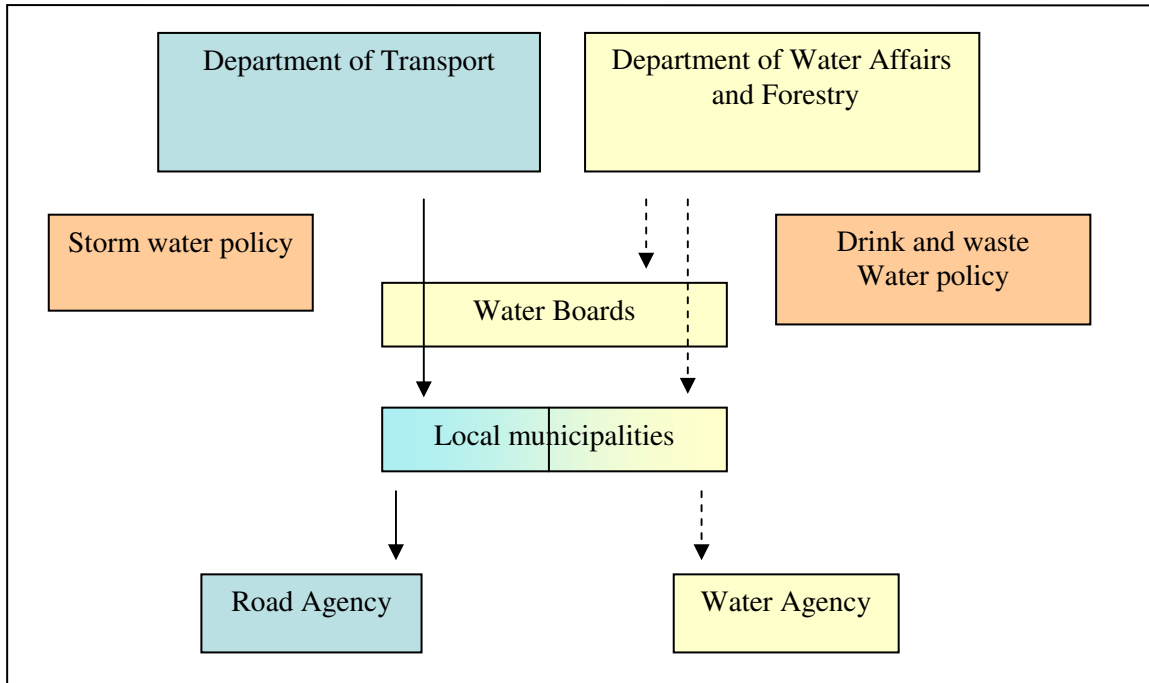


Figure 5: Storm water and drink and waste water division

§ 4.4 Description of all the actors involved in the water sector

§ 4.4.1 National level

To have water in South Africa is not as normal as in Europe. Still a million people do not have the presence of good sanitation and drink water. The South African government is working hard to change these figures. Since 1994 South Africa has a national water supply and sanitation legislation for the people. The big advantage of this legislation is that the government gives the people access to clean water and safe sanitation; these are the basis every person in the world needs. The government wants to reduce the poverty and improve the national health in the country by providing the water services. The Department of Water Affairs and Forestry (DWAF) makes sure that all areas in the country have access to clean water and are provided with good water services.

The government has chosen for free basic water for every person every day. This is 60 liters a day for a household of 8 persons. This is accomplished by the National Water Act (1998) and the Water Service Act (1997). The consequence of free basic water is that the government has to organize the water sector (policy and financial form) of South Africa. These acts will both be explained separately. First the government and in particular the Department of Water Affairs and Forestry (DWAF) will be described.

Department of Water Affairs and Forestry (DWAF)

The national government has divided its tasks over several levels in the country. The organization on the national level is the Department of Water Affairs and Forestry. DWAF is responsible for the task *water matters*. This consists of addressing water service provision and water resource management. This department ensures that the next four important areas will be managed and arranged. (EVD, 2005)

First of all DWAF has to make sure that information stays maintain and developed. Information has to be accurate and up to date, besides that the department always has to be able to inform the other organizations involved in the water sector. The information is necessary for the purpose of regulation, support, management and monitoring.

Secondly the department has to regulate procedures. This has to be done by establishing national standards and procedures, the department even has to monitor sector performances and the department has to take care of making regulatory interventions. These procedures are water related and are a reflection of what the different governmental organizations have to do to provide the households with the water, but also how often to communicate with the department. (EVD, 2005)

Thirdly the department has to establish the water policy. This means that the department sets the goals in the water sector and the department has to promote good practice. The department establishes an oversight of all the legislation within the water sector. DWAF is even responsible for the establishment of the developed strategies to achieve the water sector goals.

The fourth and last main area for DWAF is support. DWAF has to support other government and water institutions and is responsible if it is not done right. DWAF has to provide capacity, give practical advice combined with new developed guidelines and the department has to give technical support. (EVD, 2005)

This department cooperates with the departments housing, health and education to make sure the national water and sanitation goals will be achieved.

The government and especially DWAF have established different kind of acts to make sure the people in the whole country have the access to drinking water and safe sanitation. These acts will be discussed the next paragraphs. These acts are of importance because of the content of these acts the water sector is organized in this way. (www.info.gov.za)

National water act (1998)

Responsible for this act is the national government (the Minister at the moment Mrs. Lindiwe Benedicta Hendricks). The minister has to make sure that these fundamental principles will be achieved and these principles have to be realized in accordance with the Constitutional mandate for water reform. The Minister has the obligation to achieve a right use, protection, access and allocation of the water resources.

The most fundamental principles in the act are sustainability and equity. These terms are the bases or “*central guiding principles in the protection, use, development, conservation, management and control of water resources*” (National Water act no 36 1998). To fulfill in the basic needs (water) of the people living in South Africa the act has been accomplished. The principles are established to make sure these basic needs will be available for the present and following generations, protection of water resources, the need to share water resources with other regions in several countries, the need to develop socially and economically by the use of water and the need to realize fitting (suitable) institutions to achieve the purpose of the act. (National water Act no 36, 1998)

The purpose of the act is to ensure that the water resources of the nation are used, conserved, protected, developed, managed and controlled in such a way that these resources can and will be used on the long term.

Water Service Act (1997)

The main reason for this act is to make sure that every citizen of South Africa has the right to have access to basic water supply and basic sanitation, it even makes sure that the water services institutions have a duty to realize this. Water services are water supply and sanitation services, and includes all levels of services. (DWAF, an introduction to the water service act 1998). Water has to be provided in a certain quality. By this act the water service developments plans and norms and standards for tariffs are provided. This act is a commitment that the government will provide a regulatory and legislature framework for water services institutions and intermediaries. Even the powers and duties from the different water boards and water services in the system are described in this act and the possibilities for interfering and monitoring by the Minister or Province is mentioned in this act. Basically it defines the roles of the government and the responsibility of the different spheres which come with it. This act is established consistent with the Constitution. (DWAF Water service act 1997)

In a later phase the South African government introduced “Free basic water”.

Free basic water

In the year 2000 DWAF under supervision of President Mbeki investigated if a free basic water policy was possible. In the year 2001 the majority of the municipal Councilors supported this initiative. The main reason to supply the citizens with a free basic water is because of the thought that no one can be denied access to water because citizens can not afford it. The amount will be 60 liters per person a day and it is written in the Water Services Act of 1997. Local authorities are mandated to change the amount of free water to the citizen; this depends if an area is water stressed or not. These organizations choose the kind of technology used for it (Free basic water, 2001)

Free basic water is supposed to be for the poor. This group consists of citizens which do not have a safe water supply. This water will be provided by the municipalities, those municipalities are also responsible for providing the service and set the price of the water. The municipalities will be assisted by the national and provincial government because of the co-operative governance system. However those governmental organizations invest a lot of money and capacity in the realization of free basic water for everyone, the government still does not manage to realize it for everybody. Many households do not have any water supply at all, even the basic level of needed water is not available. (Free basic water, 2001)

Department of transport

The department of transport is responsible for the roads in South Africa. This department is also responsible for the storm water division. For instance in Johannesburg the Johannesburg Road Agency (JRA) is responsible for the storm water in that region. The reason to make the road agency responsible is more a practical solution. The most sewage is lying beneath the main road. Their task is to distribute the storm water from the roads to the main river system, after that the water is the responsibility of the national government because the river system is part of the water resources. (www.transport.gov.za)

Next the description of the province Gauteng and the task for this governmental organization within the water government is written. The research field is the province Gauteng and especially the two main cities Pretoria (capital) and Johannesburg.

§ 4.4.2 Provincial level

The tasks of the province are established by the national government. This is based on the policy framework and legislation and it strives for a co-operative development of South Africa. The province has to translate the national policy to a goal setting which fits the perspective of the province the best. After that the province has to design a fitting implementation strategy and appropriate policy measures. The province is a part of the Department of Provincial and Local Government (DPLG). The province has no direct influence on the water sector. But through the DPLG the province has to ensure legislation, policy and make sure there is enough capacity building arrangements. Regulation has an overlap between the local a provincial level. (EVD, 2005)

Gauteng is one of the 21 one provinces in South Africa. It has over 12 million residents and lies in the middle of the country. The province is divided in three big metros (Johannesburg, Pretoria and Ekurhuleni) and other small local councils. From origin the province Gauteng is a gold province and the mining industry is well represented here. The province Gauteng is a business province and compared to the others one of the richest provinces in the country. Water is scarce and the water boards (Rand Water and Magalies Water) buy and distributes the water from other areas (Lesotho highlands over 300 km. and Vaal river) towards the province.

Water boards

The role of the water boards, mandated by DWAF, is recently renewed. The establishment of this renewal has been introduced by the new Water Services Act in 1997. The main idea is that the water boards provide the local governments with bulk water. In this way these government bodies only have to focus on the constitutional obligations concerning water services. In South Africa there are 15 water boards which provide bulk water for different councils. Sometimes the water boards provide bulk water for several councils. If water boards do not provide areas with bulk water the government (local councils) are responsible for the supply of bulk water. In the province Gauteng the water boards, Rand Water and Magalies Water, are responsible for supplying the bulk water to the local councils. Rand Water supplies the complete province with bulk water. The task is to buy the water from the government (reservoirs as rivers and dams) and deliver the water to the local councils. During this process Rand Water has to purify the water, Rand Water has built several purification stations all over Gauteng for that. The water boards are autonomous public organizations and earn money by the purification of waste water and selling it to local councils. (Interview May, 2008 and EVD, 2005)

§ 4.4.3 Local government

By local government, municipalities are mend. These municipalities are mandated by the government (DWAF) to provide the citizens with water. These organizations are allowed to design the organizational and operational structure by themselves as long as these organizations provide the citizens with water. The government monitors these governmental organizations. The organizations operate by the tax income received from the citizens of their municipality. In South Africa there are three different kinds of municipalities local and district and if the municipalities are very big these municipalities are called metro municipalities. South Africa is divided in several metropolitan area's (6), 92 districts and 231 local municipalities. A district municipality consists of different smaller (local) municipalities.

Local and district municipalities have different kinds of tasks (legislative and executive function).

District municipalities

These kinds of district councils have to make sure that the development in the area will be continued during a specific amount of time. These municipalities have to make sure that the local municipalities (councils) harmonize their policy to each other. The district municipalities have to create the capacity and divide these sources equally over the municipalities, so the local municipalities are able to carry out their tasks and functions. (www.paralegaladvice.org.za 18-04-2008)

Local municipalities

The main goal is to make sure that all citizens in their area are provided with services to fulfill their basic needs. The most important services are water supply, sewage collection and disposal and electricity and gas supply. These municipalities are Water Service Authorities, these authorities have the constitutional and primarily responsibility in their area to realize the water service provision. (DPLG, 2008)

The local municipalities in some occasions unite to provide the water supply for the households in the area. In the province Gauteng Johannesburg is a good example of that. Johannesburg water is an entity of all the local councils involved in Johannesburg, this body has taken over the responsibility for the purification and supply of the water for the households in Johannesburg. All the local councils are involved and Johannesburg Water operates as an autonomous body owned by the municipality of Johannesburg. (www.johannesburgwater.co.za)

The municipality of Pretoria has chosen for another approach concerning purification of waste and sanitation water and has a public organization which purifies and distributes the water for them. This organization is East Rand Water Company (ERWAT) and makes sure that the water is properly distributed from the municipality water pipes to the purification stations and afterwards to the water system once again. (www.erwat.co.za)

Water Services Authorities (W.S.A.)

These authorities have the constitutional and primarily responsibility in their area to realize the water service provision. Each water service authority may choose individually to provide the water services their selves or the WSA can choose for the alternative and contract an external water service provider who arranges everything on their behalf, this is called Municipal Service Partnership. The most important responsibilities of the water Services Authorities are;

- The organization has to provide the right of access to basic water services, (sanitation, drink water);
- The organization has to provide education and information to and communicate with the consumer;
- The organization has to select, contract, regulate and procurer the water services providers;
- The organization has to ensure that water is accessible (economically, efficiently, sustainable);
- The organization has to make preparations and plans for the development programs of the water services.

(EVD 2005, Draft white paper on water services 2002) In every province the Water Service Authority can be arranged differently. In Gauteng the three metros (Johannesburg, Pretoria and Erkuhuleni) together with the local councils are the WSA.

Water Service Providers (W.S.P.)

It is important to describe what a water service supplier is, because these organizations are responsible for the water provision. The South African definition is the following; “a water services supplier is an organization (municipal government, public, private or a mixture of both entities) who has a contract with another water services provider to sell water to, or accept wastewater for the purposes of treatment from, that provider bulk water services provider). “ (Draft white paper on the water services 2002)

The most important thing of the water services providers is that these organizations have to provide water services in a way (quality) which is written in the Constitution, Water Service Act and in accordance with the water services authority (contract). The consumer must be informed by the water services providers about the payment conditions and the standards of the water services supply.

There are several forms of water services providers. The most common in South Africa will be mentioned.

- Municipalities, can be water services provider as water services authority;
- Municipal entities; these entities are set up by a company act or by law and are controlled and owned by public providers;
- Water boards, these institutions are organized to provide other water services institutions with water services;
- Private operators, are organizations who differ in size (large and small) and ownership (local and national). (DWA Draft white paper on the water services 2002)

The difference between the Water Service Providers and the Water Services Authority is that the Water Services Providers are responsible for the water provision. The Water Services Authority are responsible for the realization (pre conditions) of the water service provision.

For this research important Water Services Providers will be Rand Water and Magalies Water. To clarify the differences between the different types of Water Services Providers there is added a figure in appendix IV, this is table 7.

If municipalities want to outsource the water services (sanitation and water supply), the municipalities have to make sure that another public or private organization will ensure the maintenance of the water services in an area. The local government must always defend the public interest. (EVD, 2005)

§ 4.4.4 Other types of organizations

There are several other organizations involved in the water sector but these organizations do not influence the water provision directly. These organizations are the Southern Africa Local Government Association (SALGA) and Catchment Management Agencies (C.M.A.).

Southern Africa Local Government Association (SALGA)

The reason for the Southern African Local Government Association to exist is that this organization helped with the transformation of the local government in South Africa. The focus of this organization lies on the development of services delivery. This transformation took place from pre-1994 regime until the first democratically elected government. SALGA is a national representative from all the local government organizations in South Africa and the core role of the organization lies in different areas related to local government. The main task

is to represent, promote and protect the interest of the local government. SALGA together with nine other provinces represents the local government in the National Council of Province (NCOP) in the national parliament and further in the Finance and Fiscal Commission (FFC). SALGA has the possibility to influence the national and provincial policy and by doing so also the local legislation. (www.salga.net 22 April 2008)

Catchment Management Agencies (C.M.A.)

CMA's are statutory bodies which have a jurisdiction in a water management area (W.M.A.). The task is to manage the water resources (licensing water use, monitoring water quality etc.) and this organization has to coordinate the other operating institutions involved in that area concerning water issues. There are 19 catchment management agencies and areas, only not all of the them are already operational. (www.dwaf.gov.za/cm 21 April 2008)

§ 4.5 The national innovation system of South Africa

Innovations in the water sector in South Africa are very common. (www.wisa.org) Of course there are different kinds of innovations which are implemented by organizations. There is the system, process and product innovation, but besides these innovations organizations innovate also institutional. An institutional innovation could be the restructure of an organizational setting. This can be divided in an internal organizational restructures or external restructures. The external restructures of organizations have an overlap with the system innovation. Because the organizational restructures made by the government (water boards in 1997) have influence on the national innovation system and the "policy" for innovation.

The national government of South Africa has different departments which influence the innovation system. The Department of Water Affairs and Forestry (drink and waste water), Department of Science and Technology and the Department of Transport (storm water) are examples of departments which are important for the innovation system. (www.dwaf.gov.za) These departments are responsible for the establishment of the water policy and the innovation policy.

Innovations in South Africa concerning water are not only directly steered by the government with an innovation policy but more by legislation. Different respondents from the bigger private and the public organizations mentioned that the innovation policy is also built in this legislation. The government sets the water policy and legislation bar high so organizations have to innovate or restructure their organization to comply to the goal setting. A good example of that is in the Water Service Act 1997 and the water policy where is written that organizations have to investigate and to develop to achieve the established goals set by the government. (DWAF, Water Service Act: 1997 ; DWAF, Water policy, 2005)

The national government is the establisher of the water and innovation policy. With these policies the government stimulates organizations to innovate in the water sector. These tasks are divided in three different departments. The innovation policy is the responsibility of the Department of Science and Technology and the water policy is the responsibility of the Department of water Affairs and Forestry and the Department of transport.

In this chapter the most important organizations in the national innovation system will be described and additional information is added to Appendix IV. Firstly the governmental organizations (water and innovation policy establishers) which are involved will be mentioned, secondly the knowledge organizations, thirdly the implementation organizations. After that the relations between organizations will be described and the interaction/linkages

these organizations within these relations have. Organizations do not always interact individually, platforms are also used by organizations to operate in. After that the most important drivers and barriers for innovations will briefly be presented.

§ 4.5.1 Water Policy Network

Department of Water Affairs and Forestry

This department is responsible for the establishment of the general drink and waste water policy. DWAF established in cooperation with the other departments the water service act, national water act and free basic water. These acts are established to give every citizen in South Africa the right to have access to clean water. The policies established by the government are translated into goal settings by the water boards and the municipalities. These organizations have discretionary space to implement the policy optimal in their region, but DWAF uses repressive instruments (rigid norms) to keep this discretionary space within boundaries. Together with the water boards and the municipalities DWAF is responsible for the water provision in whole South Africa.

Water Boards

The water boards are autonomous organizations mandated by DWAF and their task is to supply the local municipalities with bulk water. The water boards buy the water from the national government and distribute the water from the national resources towards purification plants. After purification the water boards distribute the water to the local municipalities. There are fifteen water boards in South Africa, if a municipality does not have a water board to provide them with water the municipality has to supply the water by itself. The province Gauteng has two water boards Rand Water and Magalies Water. (Interviews April, May and June 2008)

Local municipalities

The local municipalities are mandated by DWAF for the water provision to the citizens in the municipality. The task of the municipality is to distribute the water to the households and to distribute waste water to purification plants and purify it. Afterwards the municipalities have to put the water back system. These organizations receive discretionary space from DWAF to implement the policy in the municipality. Eventually the organizations have to comply to the goals set by DWAF.

§ 4.5.2 Innovation Policy Network

Department of Science and Technology

This department is focused on innovations and establishes an innovation policy for the organizations in the water innovation system. This innovation policy prioritizes projects in South Africa. The department of Science and Technology does not have the financial resources to subsidize many organizations or projects. This innovation policy is not optimally adjusted to the water policy and policies from the knowledge institutes. Another responsibility for the department of Science and Technology is the sustainability of the national innovation system. The department also has to inform the government with advice over problems and opportunities for South Africa. By law a council is established (National Advisory Council on Innovation) with 22 individuals. The task of the department is to do researches, enquiries, studies and consultants over the national innovation system manor of functioning. A minimal of 50% of the invested money is directly allocated to the populations (research) which have a disadvantage. (Science and Technology, White paper, 4 September 1996)

Department of Water Affairs and Forestry

DWAF stimulates and promotes innovations in the water sector through the WRC. The government receives the funding from the taxpayer and funds it to the WRC. Besides a stimulator DWAF is also a participator in researches and innovations in the country, because the national government is the custodian of the water resources and the water sector the government (DWAF) wants to be involved in many projects. The role of the department can be different in the researches from supervisor until an organization that wants to be informed about the new developments. The department is not an organization which constantly tries to do research within the organization. The core business of the department is to provide the households with water and to establish the water policy. The knowledge and the know how about researches and innovations the department has is compared to other institutions as universities and CSIR minimal. This the reason for the department to be involved with innovations but do not create the innovations internally. (Interview April 2008)

The national government has a lot of influence in the different organizations which are involved, within Rand Water and municipalities it is very political. This influences also has consequences for the internal innovation policy. (www.dwaf.gov.za and Interview April 2008)

Department of Transport

The department of Transport does not have an own innovation policy and uses the same innovation policy network as the other water related organizations. The last years the innovations in the storm water division was neglected because of the other priorities (drink and waste water) the national government had established. (Interview June 2008)

Municipalities

The local municipalities do not have an own innovation policy to stimulate innovations within there region. The local municipalities do not have the financial resources and capacity to realize their own research centers, many of the municipalities in the province Gauteng are running on costs each year. (www.dwaf.gov.za / Interview May 2008) The consequence of this is that the municipalities have to buy their new innovations or researches for innovations from other organizations.

The metro municipalities like Pretoria are doing research internally, because this is a larger operator. Because water is scarce and the demand will increase the organizations have to come up with better ways to realize water supply more efficiently. (Rosegrant et al. 2002 and Interview May 2008 , www.tshwane.org.za)

Municipalities are involved with researches and innovations. As a shadow group in the researches of the WRC next to the research group the local municipalities give feedback and steer the directions concerning the research outcomes. The only input the municipalities have consists of giving feedback and informing their own local municipalities about the developments to make sure that there is not too much resistance when the implementation phase arrives. (www.wrc.org.za / Interview May 2008)

SALGA

SALGA is of importance in the innovation policy network because this organization organizes platforms where organizations involved in the water sector come together. These organizations discuss and talk about developments (innovations) and researches for instance innovations in the water sector. SALGA is also the organization that connects the local municipalities with the innovation suppliers. SALGA is responsible for the needs of the regional councils on national level, but besides that SALGA also advices the 283 councils (if

necessary individually) about the best innovations (technologies) and in which researches local councils should invest. Eventually the local councils are freely to make choice by themselves. SALGA does not have the capacity, knowledge or the expertise to do research or create innovations within the own organization. SALGA gets funded by grants and levies of the local municipalities which SALGA represents and SALGA receives donor money from for instance the European Union through DWAF. (Interviews May and June, 2008, www.salga.net)

§ 4.5.3 Knowledge organizations

The Water research Commission (WRC)

The Water Research Commission is an autonomous public organization established, structured and completely funded by the Department of Water Affairs and Forestry since 1971. The taxpayer pays a small amount (€ 0,003) to the national government per liter water that the user buys. The national government funds this money to the Water Research Commission for research and development programs. This is on yearly bases € 3,8 million. (Annual report WRC 2007) The WRC has a central role in the innovation system. Research organizations often receive financial resources and guidance from WRC for the researches. In return for the funding the WRC gets the patents of the innovations, inventions or new technologies. The financial amount is different per research and the importance of the research. At the moment the WRC focuses the financial resources on the drink and sanitation water division, because there are many challenges in these divisions. This focus is also determinant by the departments because the water and innovation policies are focused on these divisions. (Interview 2008)

The role of the WRC over the last thirty year was to increase and develop the capacity (supply and demand) of the water sector and to broad the South African water centered Research and Development base. The WRC has also the task to realize research on critical issues. This could be solicited or unsolicited research which WRC stimulates by funding. Solicited researches are researches where the funding is committed to boundaries. In this way the WRC is able to steer the research direction of the organizations. Unsolicited researches are proposals delivered by organizations which could be funded by the WRC, when the WRC sees potential in an interesting research direction. In this way the WRC has a big influence on the research directions in South Africa, because the organization has the financial resources and the choice to fund the research directions that WRC wants to fund. (www.wrc.org.za and Interviews May and June, 2008)

The most important mandated roles of the WRC are:

- Stimulating capacity and knowledge building and funding direct water research in the water sector.
- Realizing co-operation, co-ordination and communication between different organizations in water research and development. Make sure the research and priorities within the water needs are available. (www.wrc.org.za)
- Advising DWAF about the purchase of new technologies or the implementation of new policies.

WRC is the provider of applied knowledge concerning water-related innovation, by providing the water sector with new knowledge and technology through research.

The Water Institute of Southern Africa (WISA)

WISA is an institute which provides a platform. Here the different kinds of organizations come together to exchange knowledge, experience and information to improve and develop the water (services) resources management in the country. WISA is an intermediary between public, private, industry, suppliers, development and research organizations of the water services in the country. WISA makes interaction and communication (by WISA's channels) between different organizations possible. WISA is also responsible for workshops, education and training courses for organizations and dissemination of knowledge. WISA is a private organization and gets funded by operational activities (conferences, member fees, implementing activities for the government). (www.wisa.org.za 21 April 2008, Interviews May and June, 2008)

Universities

Universities are the organizations which produce the new knowledge, this could be on demand by other external organizations or for own purposes. Universities have the expertise, capacity and the knowledge to generate technologies and knowledge within the own organization. Universities support other (private and public) organizations with researches to create innovations. Besides practicing research, universities are also the organizations which teach and guide organizations with their researches. Universities guide other organizations by giving workshops, sharing information and assist with establishing the research models. The most important research organization of the universities in Gauteng is the University of Pretoria. This university has its own Water Institute where a lot of knowledge has been created the last couple of years. The other important universities in the province Gauteng are Johannesburg and Witwatersrand University. The research money collected by the universities consists of donor (national government), project, patents and support money from organizations as WRC and water boards. It depends on the university how much the organizations have to spend but the Water Institute of Pretoria has the most money to invest in water research in the province Gauteng. (Interviews April and May, 2008)

Council of Science and Industrial Research (CSIR)

The Council of Science and Industrial Research is a private-public organization that exists for more than fifty years. CSIR was constituted by the Act of Parliament in 1945 and has the mandate to create knowledge and innovations for South Africa. This organization has to improve the South African quality of life and has to make sure that innovations occur on national and even international level. CSIR also advises the department (DWA) about the purchase of new technologies or the implementation of new policies. This organization is part of the innovative capacity of the water sector, because CSIR cooperates with WRC, universities, national government, water boards and private organizations. CSIR used to be 100% funded by the national government but since 1985 the government is cutting back in their funding. At the moment CSIR receives 40% (€ 37,5 million) of its funding from the government (free to invest), private sector 15% (€ 14 million), international all around 10% (€ 9 million), projects for the national government 25% (€ 23,4 million) (within boundaries) and the rest of it CSIR receives from all kind of operational activities. The funded money gets allocated over the different divisions and locations in whole South Africa. (www.csir.co.za and Interviews May 2008)

Private organizations

Private organizations have the role to share and create knowledge and to assist organizations with creating innovations and knowledge (most of the time manufacturing). The private organizations for example Anglo American (mining house) have own research centers where new innovations are created. The big private organizations create knowledge for internal use. (Interviews May 2008) Another important role for private organizations is to build partnerships with public organizations to create innovations and develop new technologies. The mining houses are a good example of that. Those organizations have started a public private partnership (province Mpumalanga) to purify waste water and reuse it for other purposes. Different organizations mentioned that private organizations have an important role in the implementation phase because those organizations are able to produce and install the innovations at the implementation organizations. Private organizations are funding research by themselves and use the opportunity of WRC for funding as well. It depends on the size of the organization how much the research and innovation budget is. Private organizations are able to fund internal researches because their main goal setting is gaining profit out of their delivered services/retail. (Interviews May, 2008)

§ 4.5.4 Implementation organizations

Johannesburg water and East Rand Water Company (ERWAT)

The municipalities are responsible for the water supply to the households. The municipalities demand for knowledge and innovations to achieve their goal setting as efficient as possible. Besides demanding for innovations and knowledge the municipalities are also responsible for the implementation of knowledge. The local municipalities do not have the expertise and know how to do research internally. Those organizations have to outsource the researches or buy the knowledge or innovations. Most of the time the local municipalities do not have an own innovation policy but comply to the innovation policy of the department of Science and Technology. (Interviews May and June, 2008)

The large municipalities named metros like Johannesburg and Pretoria have established autonomous organizations for the distribution and purification of the drink and waste water. These organizations like Johannesburg Water and ERWAT (East Rand Water Care Company) are public organizations that are separate bodies from the municipalities. These organizations are also participants of the innovation network in South Africa. ERWAT and Johannesburg Water often collaborate with the universities in Johannesburg and in Pretoria. ERWAT is funded by the municipality but is autonomous; Johannesburg is self sustainable but is still a public organization. (www.erwat.co.za and www.joburgwater.co.za, Interviews May and June, 2008)

Water Boards (Rand Water and Magalies Water)

The role of *Rand Water and Magalies Water* as an implementation public organization is bigger than the role of the local municipality. Compared to the municipalities the water boards have more influence on the innovation network. The role of Rand Water is double because this organization demands for knowledge and innovations but it also supplies knowledge and innovations internally. Rand Water has its own research center to achieve innovations for their operational activities. This water board has the financial resources and knowledge to innovate internally and to underwrite this approach this water board also has its own (long term) innovation policy. Rand Water and bigger water boards in general collaborate with universities, consultants and private organizations (mining) to create new innovations. At the moment the challenge for Rand Water is to enter the private market to gain more profit. (www.randwater.co.za and Interview May 2008)

§ 4.6 Relations within the innovation system

Organizations in an innovation system have different kind of relations with each other, these could be (highly) developed and be based on knowledge and/or financial flows, labor mobility or hierarchical structure. Based on these relations the national innovation system is given in figure 6. All the organizations and relations between organizations are described in the paragraph above. Two important relationships are not mentioned, these are the education and knowledge flow and collaboration between organizations. These are given in this paragraph.

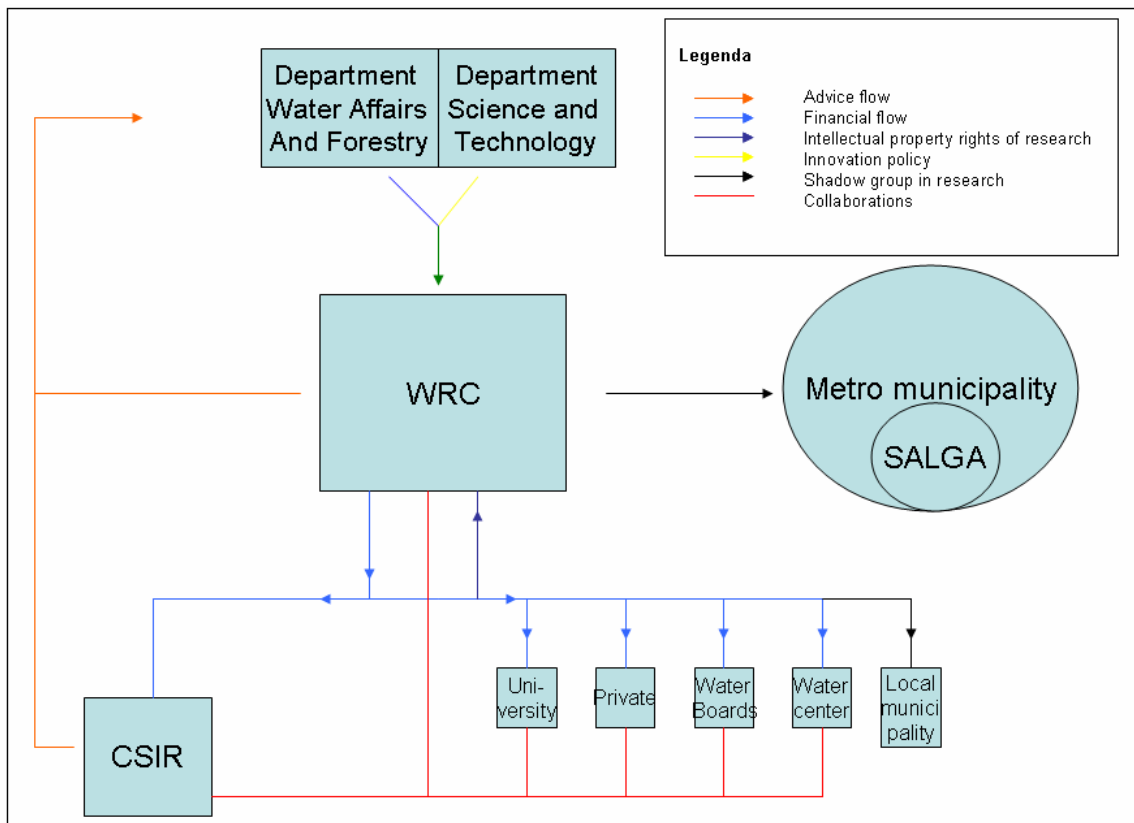


Figure 6: National innovation system

§ 4.6.1 Knowledge and education flows in the innovation system

An important relation between the organizations are the knowledge and education flows. The most important organization in the innovation system for the knowledge flow is WISA. The core business from this private organization is the knowledge dissemination through conferences, symposia, meetings etc. WISA has the ability to inform all the participating organizations in the innovation system in one time, other organizations/communication hubs are not able to do that as well. (www.wisa.org.za, Interviews May and June, 2008)

The WRC also disseminates knowledge, the purpose is to educate “people within” organizations. This is done during the projects/researches which WRC has with other organizations. Knowledge dissemination does not only occur through organizations. Employees or individuals within the organizations are also important for the knowledge dissemination. The WRC, CSIR and the universities have many employees with double functions or employees which have worked or still work for two organizations (in the innovation system) or more. The labor mobility among these organizations is high. (Interviews April, May and June, 2008)

The water boards in the province Gauteng and in particular Rand Water have an educational role in the innovation system. The water boards educate and pay for scholarships from students. The students have to work for and learn from the water boards in return. In this way the water boards educate and disseminate knowledge through the innovation system and within their own organization.

§ 4.6.2 Collaboration

In the innovation system there is no competition between the participating organizations. This is decreasing the innovation capacity but it is good for the knowledge dissemination between the organizations.

The universities often work together with the Water Boards (student exchange, internships) for specific research topics. A good example of this collaboration is during the water tap research. This research is done by several knowledge organizations (University of Johannesburg and Rand Water) to find out if people in the rural areas had easy and physically good access to water. Other collaborations are those between the CSIR, Water Boards and WRC. All the knowledge organizations (private and public) collaborate to achieve improvement in the problematical water cases. Another example is in Limpopo, where the mining industry collaborated with the local municipalities to purify water up to a level which made it possible to reuse it for agriculture.

The organizations in the innovation system and water system come together to discuss researches, projects or policies established by the government. These meetings take place at platforms, these platforms are almost always established by governmental organizations.

Organizations in this innovation system collaborate, but competition between organizations is missing. The advantages of the collaboration is not compensating the absence of competition optimally.

As a result of interaction relationships come into existence. It is important to describe which organizations interact in the innovation system to understand what kind of relationship these organizations have. Organizations interact on personal, non-personal, organizational, group or on individual level. (Schartinger, 2002) The sort and amount of interaction explains the linkage between the organizations, is it formal or informal, daily or once a year and face to face or is it done by letter/report.

§ 4.7 Interaction within the innovation system

The Department of Science and Technology is responsible for the innovation policy, but this department does not have direct contact with the organizations in the water innovation system, which have to achieve the goal setting by the department. The Department of Science and Technology monitors if organizations as WRC have achieved the established goals. (Interview May, 2008)

All the organizations communicate with each other, this could be done individually or by platform or group wise. This interaction occurs in a formal and in an informal way. The most organizations communicate informal during collaborations (researches and/or projects) and official meetings are done formally. A lot of organizations (Rand Water, CSIR, Johannesburg Water, WRC, government) managed to have employees in boards of universities or platforms, a better relation is created in this way. It would make this report very unclear if all the communication lines in the innovation system would be described, that is the reason for the description of the most important communication lines between organizations. (Interviews 2008) The total description is added to Appendix V.

§ 4.7.1 Governmental organizations

DWAF ↔ Water Boards	Communication is project related and communication lines are always open. The communication is focused on water provision not on new innovations. Innovations will be created by the Water Boards (Rand Water), DWAF does not cooperate with the Water Boards to create new innovations. The Water Boards have the knowledge and capacity to innovate, DWAF also stimulates the water boards to innovate by demand. (Interviews May and June 2008)
DWAF ↔ Local municipalities	Communication is daily during the operational activities (water provision). Innovations are not created by these organizations. Both organizations do not have the knowledge and capacity within the organization to innovate, this knowledge has to be bought from other organizations. (Interview May 2008)
DWAF ↔ Department of Science and technology	Communication between these organizations is present before the organizations individually establish their policy. Afterwards these organizations do not often communicate or compare their policies to one another. Compartmentalization does occur with these departments and the policies are not adjust to each other. (Interview May and June, 2008)
DWAF ↔ WRC	These organizations often interact. The WRC has to present DWAF an annual report and DWAF monitors WRC quarterly. Every two months DWAF and WRC have a formal meeting. Every month these organizations have an informal contact moment. (Interviews May, 2008)

Table 8: Interaction governmental organizations

The communication between the governmental organizations is most of the time based on the operational activities and not on the creation of innovations. This is because the governmental organizations do not have the knowledge and financial resources to do research themselves, except for the Water Boards and in particular Rand Water. When governmental organizations are participating researches these organizations most of the time pay for the outcome and are not involved in the research process. If these organizations are involved often an principal-agent relationship is created. (Interview May 2008)

§4.7.2 Knowledge organizations

The Water Research Commission communicates with all the organizations in the innovation system. Many organizations see the WRC is a key player in the innovation system, because this organizations funds and assists organizations during researches. The communication is project based and formal and informal. The WRC is also the producer of the magazine Water Wheel, through this magazine the WRC communicates with all the organizations monthly about new developments. This magazine also tries to educate organizations. (www.wrc.org.za 3rd of July and Interview May 2008)

CSIR ↔ Universities	The communication between these institutions is often quick and informal, because of the overlap from employees. Many employees work for both organizations. The collaboration between these institutions is embedded in the culture. These institutions already collaborate over 50 years.
Water Boards ↔ Universities	Communication between these institutions are direct, formal and informal and is research based. Interaction takes place easily because employees of Water Boards are also represented in the chairs of universities. The relation is based on projects, financial flows (funding) and there are educational flows (internships at water boards). (Interviews April and May 2008 www.randwater.co.za 17 May 2008)
Knowledge organization ↔ Local municipalities	The relation between the knowledge organization and local municipalities is a reflection of many organizations which have to buy innovations (knowledge depending). The communication is project based and the knowledge organization has more information than the local municipalities (principal-agent), local municipalities are always running behind. Bigger municipalities are able to steer research directions by demand as long as these organizations have the financial resources for it.
WISA	WISA communicates with all the organizations in the innovation system. WISA communicates directly through member letters but also indirect through symposia and conferences. This organization is the communication hub with the most members (almost every organization is member or present at the conferences) and is able to disseminate knowledge in the best way. (Interviews 2008)

Table 9: Interaction knowledge organizations

§ 4.7.3. Networks

As mentioned in the theoretical framework organizations do not only communicate individually but also group wise in a network. In these network organizations, the organizations are connected by their behaviour. Organizations share/exchange financial resources, knowledge and or capacity through platforms and communication hubs within these networks. The most important national platforms for the water sector and water innovation system in South Africa are the following.

Platform	Type and funding	Goal setting
Water Southern Africa (WISA) Institute Africa	Private, payment for services	Meeting point for organizations (network function) and knowledge dissemination amongst those organizations.
Water Network Information	Public, funding by DWAF	Knowledge dissemination.
Water Leadership Group (WSLG) Sector Group	Public, funding by DWAF	Discussion group where all the organizations involved in the water and innovation system are participating.
Masibambame (third)	Public	Coordinating comity of developments in the water and innovation system.

Table 10: Platforms in the innovation and water sector

Platform	Type and funding	Goal setting
<i>Coaltech 2020</i>	Private-Public partnership, funding by private mining organizations	Solution for water issue, reuse of water for agriculture benefits.
<i>One Stop Shop</i>	Public, funding by DWAF	Opportunity for citizens to give or receive feedback (questions, complaints etc.) about the water provision process.
<i>Water Network</i>	Public, funding will be done by public organizations	Discussion group about the water sector in particular the organizational setting.
<i>SALGA</i>	Public, funding by local government	Representative of and advice organizations for the local governments (local and national level).

Table 10: Platforms in the innovation and water sector

The **Water Institute of Southern Africa** is the most important platform in the South African water sector. All the important public and private organizations in the water system and water innovation system are invited to join the conferences. This platform shares knowledge and discusses developments in the water sector. These conferences are four to five times a year and for many organizations it is the start for collaboration with other organizations because of its informal atmosphere.

E-WISA is an electronic platform. This platform is part of WISA, that is responsible for the digital information assimilation. E-WISA provides the organizations with the tools to innovate.

The **Water Information Network** (WIN) is another communication hub for the organizations in the water sector. The main goal setting for this organization is to communicate and to inform organizations with detailed information about specific topics in the water sector. Through this organization other organizations can come in touch with each other and collaborations might occur. All the organizations connected to the water sector are able to use this communication hub.

SALGA is for the local municipalities a communication hub and/or a platform. SALGA organizes official meeting for municipalities four times a year. The municipalities discuss achievements and set priorities for the near future. Besides that SALGA also informs the local municipalities about new innovations and advices them about new developments concerning technologies in the water system.

The national government has a platform where DWAF and the local municipalities and SALGA come together. During these meetings the organizations are debating about water issues. These meetings occur once a quarter. The government takes the lead and is head of these meetings. There is also another public platform that is organized by the peer header of this platform, the department of Science and Technology. The department of Science and Technology discusses and debates about the innovations in the water sector. Another role of this platform is to simplify what the technological advances in the water sector are. In May 2008 the platform had the first trial meeting and the participating organizations want to have a structural formal meeting twice a year headed by the department of Science and Technology.

The following organizations are involved in this platform WRC, SALGA and the ministry of DWAF. There is contact with the CSIR to participate as well.

The platform **Water Network** is a platform where different public organizations are involved in. The organizations which are involved are the ministry of DWAF, the three metro municipalities, SALGA and the water providers. In this platform the organizations discuss about the role which private organizations can fulfill in the water sector. Because of the present legislature (free basic water and so on) it is hard for the private sector to participate in the water provision and innovation system. The meetings are on structural bases, once in the five months. A key player in these meetings is the government because eventually the Department of Water Affairs and Forestry has to change the policy and has to give some space for private intervention in the water (innovation) sector.

A less influencing platform in the South African water sector is called **Masibambame**. This platform is a coordinating comity and is organized by one of the participating organizations every quarter. This platform is designed to keep all the organizations in the water sector informed about the developments in the water sector. This is a platform that is established every single year. This year is the third cycle, this platform is funded with European money. (Interview June and July 2008)

The far most important platform is the **Water Sector Leadership Group** (WSLG). This is a group that has a meeting every six months (two times a year). The goal is to debate about present issues or urgent topics, besides that the platform looks at the long term strategy of the water sector (policy) and the organizations discuss guidance and leadership by the ministry of DWAF. Every single organization brings in one of the strategic key players from their organizations. The following organizations are represented civil ministry of DWAF, SALGA, municipalities, member of the private organizations and the civil society. Before these meetings every organization has its own device mechanism (meetings) to be well prepared for this meeting.

The ministry of DWAF has also established a platform which is called “One stop shop”. This platform is designed for the citizens to have direct contact with the department of Water Affairs about specific water topics. When citizens have a request or complain the department has to make sure that this request or complain will be investigated. (Interview July 2008 and www.dwaf.gov.za)

An example of a **private-public partnership** is the collaboration of Coaltech 2020 (mining houses) and the local municipalities and ministry of DWAF. This platform is established to debate and discuss developments concerning the reuse of the water in the area Limpopo in the province Mpumalanga. The goal of this collaboration was to purify the polluted mine water and reuse it for agricultural benefits in the rural areas. This platform is established for a longer term because the issues are urgent and stay urgent because of the water scarcity. These organizations meet four a five times a year and the leading organization is the mining house. (Interview May 2008)

The platform **NEPAD** is an international platform for different African countries to develop the continent Africa. This platform also has a division which is responsible for the environmental aspect. NEPAD stands for The New Partnership for African Development. The major task of NEPAD is to deduct the challenges of the African continent. This association

has to develop a vision for the African continent so the African leaders can renew the African continent. (www.nepad.org)

Chapter 5 Analysis of the innovation system

Contingency factors

The extra factors which are involved in the innovation model, are the factors which have an obvious influence on the innovation system but do not have a linkage with one specific cluster or organization. Well educated employees are the bases of innovations. These employees can be educated by scholarships but also by working on the job (experience). A network is also an important factor with influence on innovations. The interaction patterns per specific cluster are already mentioned but the capacity of the whole network is linked to specific nodes in the network. These nodes may not be organized too strong because those could influence the innovative capacity in a bad way. (Kenis and Oerlemans, 2007) It is important that organizations are autonomous, because those organizations are able to steer their own network parts.

In the analytical framework the decreasing and increasing indicators for the innovative capacity of South Africa are given. This will give a reflection on the capacity of the different clusters and the relations between the clusters. In appendix V the table used for analysis is given. This table and the table for analysis of South Africa are also used in the paper for EGPA conference 2008. (Van Buuren et al., 2008)

§ 5.1 Analysis of the clusters in the innovation system

The clusters in the innovation system are able to increase or decrease the innovative capacity. In this paragraph the indicators for the innovative capacity are given and explained.

Cluster	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
Water policy network	Policy aims		The large discretionary space for the local municipalities given by the national government.
	Policy instruments	Absence of collaboration and competition.	

Table 11: Water Policy Network

The water policy (goal setting) is established by DWAF (Water Policy Network table 11), this policy (goal setting) provides a direction for the regional and local organizations, the IO's have discretionary space and have to establish their own policy (within boundaries of the department). This increases the innovative capacity because the organizations are able to set the goals to their own standards, technical applications and capacity. In this case capacity will not be used to implement the restricted policy by the national government, but can be used for other purposes.

At the moment the water policy network uses repressive instruments in the water sector. Tariffs for the water provision are set by implementing organizations after approval by national government. Organizations communicate and interact with each other to optimize the operational activities. The innovative capacity is decreasing because the national government is setting the water tariffs. Competition based on pricing and the need for efficiency are absent by this measure.

Cluster	Element	Indicator for decreasing capacity	Indicator for increasing capacity
Implementation organizations	Discretionary space		The IO's have large discretionary space.
	Development of innovations	Smaller operators do not have the capacity (human and financial) to create innovations.	Large operators have more capacity (human and financial) to innovate.
		Municipalities are forced to use incremental innovations instead of fundamental.	Water boards strive for development and innovations within the water sector.
		There is no direct competition between operators.	

Table 12: Implementation organizations

The *implementation organizations* (table 12) are able to establish their own policy and choose their own standards, technical applications and methods as long as these organizations stay within the restricted boundaries given by the department (concerning goal setting). This is increasing the innovative capacity because organizations are able to adjust the goal setting to their capacity or even do their own (fundamental) research.

A good example of this discretionary space are the larger operators (water boards) which have their own innovation policy. These organizations are able to do research within the own organizations as long as the organizations have sufficient financial resources and their own research centre for innovations. Allocation of financial resources between water boards is missing, the consequence is that capacity (financial, human) differences between water boards. The development and the financial health of the water boards is not the same in whole South Africa.

When the implementing organizations are **smaller**, for example the municipalities (local and district), the organizations do not have the financial resources and human capacity to develop innovations or financially provide for a research centre. These organizations buy their innovations from other “private” or knowledge organizations. Municipalities are focusing on incremental improvements and extension of the system based on existing techniques, because organizations have to supply water to a bigger amount of domestic water users and these technical applications have proven their qualities. This is decreasing the innovative capacity, because there is no demand for new innovations and knowledge organizations will not create innovations if there is no market for it.

On the other hand is the **culture** of the water boards increasing the innovative capacity, because these organizations want to be progressive and involved with new developments in the water sector. A good example of that is the scholarships and educational possibilities within the organizations.

Cluster	Element	Indicator for decreasing capacity	Indicator for increasing capacity
Knowledge institutes	Type of research	Researches are focused on problem-solving.	CSIR and WRC stimulate (un)solicited research by funding and assistance.
	Competition	Lack of competition in the water and innovation system.	Good collaboration between organizations.
	Structure	KI dependent on policy or implementation organizations	The innovation policy is not the stimulator of research, but demand and issues are.

Table13: Knowledge Institutes

The most knowledge institutions (table 13) are focused on research for specific (regional issues) outcomes, which can be implemented immediately. The bigger knowledge institutions as CSIR and the WRC are also doing or stimulating fundamental research. The advantage of fundamental research is that the innovations are focused on the long term and not issue specific. This increases the innovative capacity, because fundamental research is also a stimulator for more research. Organizations within the innovation system collaborate to innovate, this is also increasing the innovative capacity, as organizations have more knowledge, financial resource and capacity to create innovations. A disadvantage is that the overall knowledge infrastructure is not fully developed, this has consequence for the availability of knowledge during researches.

The absence of competition between the knowledge organizations is decreasing the innovative capacity, because organizations do not have to innovate or optimise the operational activities, technical applications, efficiency and/or methods to be competitive with other organizations. The most organizations are autonomous, except for the WRC and the CSIR, these organizations get financial support from the national government (DWAF). Autonomy has a positive influence on the innovative capacity, because organizations establish their own innovation policy and are self sustainable.

Cluster	Element	Indicator for decreasing capacity	Indicator for increasing capacity
Innovation policy network	Policy aims	Lack of direct funding, direct communication and a specific innovation policy.	Creation of network facilities.
	Decision-making	Top-down steered innovation policy by the department of Science and Technology.	

Table 14: Innovation Policy Network

The innovation policy (table 14) is established by a separate department (Science and Technology), this department is not personally (through financial support) **involved** with the researches in the water and innovation system in South Africa. The financial support for the innovation system comes from DWAF and goes to WRC. The department of Science and Technology also establishes the innovation policies for the other departments in South Africa.

The consequence of the **absence** of a department which establishes the innovation policy for one specific sector is that the policy does not fit optimally to the specific expectations and demands of the organizations in the water innovation system and other sectors.

The innovative capacity is decreasing because the innovation policy network does not personally fund, and prioritises researches in this way, and does not establish a specific innovation policy for the water innovation system. The innovative capacity also decreases as the knowledge institutes have to comply to the top-down steered innovation policy established by the department.

The innovative capacity is increasing as the sector is creating network facilities to innovate.

§ 5.2 Analysis of the relations in the innovation system

The relations between the organizations in the innovation system are able to increase or decrease the innovative capacity. In this paragraph the indicators for the innovative capacity are given and explained.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
I WPN – IO	Decision-making	Separation of the policy network and implementation organizations.	
		Focus lies on problem solving instead of process development.	

Table 15: Relation WPN-IO

The relation between the WPN and IO (table 15) can be characterized by the water and innovation policy making national government (DWAF). These policies are established separately by the departments and there is a **strict separation** between establishing the policy and the implementation process. The policies are steered top-down with a large discretionary space by the operators (water boards and municipalities). This is decreasing the innovative capacity because the know how and expertise from the different organizations does not get combined to improve the policies.

Decision making is focused on **problem solving**, as many areas in South Africa do not have the intended water quality or access to water. Organizations have to use their capacity to reach the acquired level of water quality instead of progressing their present operational activities. The absence of progress is decreasing the innovativeness of South Africa.

Through SALGA the municipalities want to participate in the establishment of the water policy. The **participation** of SALGA in the water policy is increasing the innovative capacity as organizations can combine their know how and capacities with those of the WPN.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
II WPN – KI	Knowledge transfer	Research focus is problem solving as WRC is funding this type of research.	WRC stimulates research by funding for only the patent rights in return.
			KI do unsolicited research but the Water policy network is not always able or capable to use the outcomes.

Table 16: Relation WPN-KI

The relation between the WPN and KI (table 16) can be described as a relation based on the creation of knowledge. Knowledge institutes focuses on **problem solving** and on the creation of technical knowledge, the reason for this is that the WRC is **funding** 50% of their financial resources to these types of researches. This is decreasing the innovative capacity because organizations do not innovate on the long run but on the short term and issues will come back in the near future.

The innovativeness of South Africa increases when organizations create innovations on the **long term**. These innovations are not **issue driven** as most of the short term innovations. The fundamental and unsolicited researches done by the knowledge organizations are also stimulated by WRC, but the outcomes of these researches can not always be implemented by the water policy network or/and the implementation organizations.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
III WPN – IPN	Policy adjustment	Innovation policy is secondary to the water policy and compartmentalization occurs.	

Table 17: Relation WPN-IPN

The relation between the WPN and IPN (table 17) can be characterized by the poor policy adjustment between both organizations. Policy adjustment does not occur and the water policy is considered more important than the innovation policy. This is decreasing the innovative capacity, as **compartmentalization** between both departments occurs and the policies do not get optimised and completed by each other. The consequence is the loss of synergy effects.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
IV IO – KI	Knowledge transfer	Operators have to buy innovations, because these organizations can not innovate within their own organization.	The bigger operators are able to do their own research to improve the services quality.
		Small operators with small financial resources are not able to steer research directions.	

Table 18: Relation IO-KI

The relation between the IO and KI (table 18) can be described as one based on knowledge creation and implementation. The smaller implementation organizations can not steer the specific research direction necessary for their operational activities. These organizations have to **buy the innovations** from knowledge institutions, because the implementation organizations do not have the financial resources, knowledge and capacity to innovate within the own organization.

The innovative capacity decreases when the knowledge institutes and implementation organizations collaboration is based on a **principal-agent relation**, as the knowledge created will not be memorized by the principal or the organization that buys the innovation. The advantages of an institutional memory gets lost.

The innovative capacity increases when organizations as Rand Water and metro municipalities are able to **innovate within their own organization**. These organizations have the human capacity and the financial resources to do the researches. These researches are adjust to the specific needs of the researcher and are more easily **implemented and adjust** to the operational activities of the organization. If organizations are willing to use innovations created by other organizations, the innovative capacity increases because researches are profitable for the KI's and will be done more often.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
V IO – IPN	Development of innovations	The innovation policy is not specific enough to stimulate the water innovation system.	There are no financial flows from the department of science and technology.
		Users were not involved for counselling or to adjust this policy.	

Table 19: Relation IO-IPN

The relation between the IO and the IPN (table 19) can be characterized by the stimulating instruments of the IPN to create innovations. The innovation policy established by the IPN is not adjusted to the specific needs of the organizations in the water innovation system. The consequence of a general statute of this policy is that the policy is **not specific enough** to stimulate the implementation organizations to innovate. Many organizations see the innovation policy as a vision or guideline instead of a policy where to comply to. This is decreasing the innovative capacity of the water innovation system.

The department of Science and Technology does not **communicate directly** with the implementation organizations. This is the consequence of a general innovation policy, which is secondary to the water policy, and accommodating the subsidies with another department. This poor communication does not stimulate the integration of the innovation policy in the water innovation system.

Relation	Element	Indicator for <i>decreasing</i> capacity	Indicator for <i>increasing</i> capacity
VI KI - IPN	Knowledge development	General goal setting costs capacity for the knowledge institutes.	
		Lack of collaboration between IPN and KI (principal-agent relation).	The IPN established an innovation policy.

Table 20: Relation KI-IPN

The relation between the KI and IPN (table 20) can be described as a relation to create knowledge and innovations. The knowledge institutes (especially the government organizations) have to **comply to** the goals set by the innovation policy, financial support is not present and monitoring happens afterwards. All these indicators are decreasing the innovative capacity. The capacity needed by the organizations to comply to this goal setting can not be used for more specific “fundamental” research.

The creation of knowledge could be optimised by a **collaboration** between the KI and IPN. In this way the IPN is able to establish an innovation policy adjusted to the specific needs and operational activities of the knowledge institutes.

Chapter 6 Conclusion and recommendations

§ 6.1 Conclusion

This research is focused on the innovative capacity of the water sector in South Africa. It is impossible to rate the innovative capacity of the water sector based on this research, because there is no other country or situation in time to compare it with. Based on this research the constitution of the innovative capacity of the water sector in South Africa will be given. Many factors have influence on the innovative capacity, in this research the focus lies on the general conditions because the more detailed factors of influence need more time to be researched.

Water in South Africa is scarce, that is the reason for the national government to interfere and secure the provision of drink, cleaning of waste and storm water. Three public organizations are responsible for the provision and purification of water.

4. the national Department of Water Affairs and Forestry (DWAF),
5. the regional Water Boards and
6. the municipalities.

The organizational structure of the water sector is one of the factors that constitutes the innovative capacity. In South Africa the innovative capacity is constituted by the implementation capacity and the development capacity and there are other general conditions.

The implementation capacity of the innovative capacity

1. The water policy network: Water is a valuable good because it is scarce. But water is also a basic need, thus the decision maker (water policy) is risk averse. The water policy network is reticent concerning the implementation of new technologies because of the impact on the public health if the water quality standards are not achieved.
2. The implementation organizations: The size of the operators influences the capacity to implement innovations, if the operators are small the organizations do not have the financial resources and capacity to afford researches and/or new technologies. The larger organizations have the financial and human resources to innovate and collaborate with other organizations.

The development capacity of the innovative capacity

3. The innovation policy network: The goal setting is to stimulate the knowledge - and implementation organizations to innovate. At the moment the direct communication between the innovation policy network and the organizations in the water innovation system is undeveloped. The innovation policy is secondary to the water policy and because of that it is not functioning optimally.
4. The knowledge institutes: In the water innovation system of South Africa competition is missing and the researches are too much focused on problem solving, but the collaboration between the knowledge institutions is well developed.

General conditions which constitute the innovative capacity

- The bilateral collaborations between these clusters also constitute the innovative capacity of the water innovation system.
- The overall education level is another factor which constitutes the innovative capacity of the water sector. At the moment the education level and the amount of skilled people in the water sector is too low.

- The available financial resources also constitute the innovative capacity. Many organizations do not have the financial resources to create innovations internally.
- The policies established by the Department of Water Affairs and Forestry and the Department of Science and Technology also constitute the innovative capacity. The use of stimulating or repressive instruments influence the innovative capacity.

Decreasing and increasing factors for the innovative capacity

In South Africa there are some general conditions which decrease or increase the innovative capacity of the water sector.

Capacity is decreasing

The innovative capacity is decreasing because :

- the organizational structure of the water sector is still developing, because of that the infrastructure for the knowledge dissemination is still developing as well.
- the water policy (established by DWAF) and the innovation policy (established by the department of Science and Technology) do not adjust the policies to each other. Both departments operate in a silo. The advantage of synergy effects and policies which can strengthen each other get lost.
- implementation organizations often are not capable of innovating internally, thus these organizations buy innovations from knowledge institutions. The consequence is that implementation organizations are able to steer the researches by demand. Innovations for the implementation organizations have to be directly implemental and are based on solving a problem (short term/conservative) instead of fundamental researches/innovations on the long term.
- in South Africa there is a shortage of skilled people. Many organizations need skilled personal to manage the daily activities. The shortage of skilled people influences the amount and quality of developments and researches towards innovations, because these activities get postponed, take more time or can not be realized at all.

Capacity is increasing

The innovative capacity increases when the knowledge institutions in the innovation system collaborate. Knowledge, financial resources and capacity are shared and synergy effects occur, institutions are able to create innovations based on more knowledge. In the near future the knowledge dissemination will be more efficiently because organizations are establishing more communication hubs and platforms. The organizations are establishing a network which increases collaboration, knowledge sharing and eventually the innovative capacity.

§ 6.2 Recommendations

In this paragraph recommendations will be made. This chapter has been split in two parts; in the first part the recommendation is made for Stewart Scott International (SSI) and the South African government about topics to improve. After that there are some recommendations for the Dutch water sector and in particular the ministry of Housing, Spatial Planning and the Environment and the ministry of Road and Waterworks Road by learning from the situation in South Africa.

§ 6.2.1 Recommendations for SSI and the South African government

At the moment the organizational structure of the water sector is not developed optimal, and an advantage could be achieved by :

- a good communication network. SSI has to be part of the new platforms and the communication hubs.
- sharing knowledge. It is crucial for an organization as SSI to be up to date about the latest developments, innovations, policies and regulations.

SSI has to focus on the development of systems or technical applications for the reuse of water. At the moment water is used once and is sent to the purification plants, but if water can be captured with a technical application or system it can be reused for other purposes.

Create access to clean water for all the citizens

In the future the demand for clean water will increase and the South African government has to supply this water. A solution for this demand are new techniques and resources and/or by using the available water optimally. Better use of storm water is an alternative. The last ten years this division has been neglected and by investing in this division more advantage of this water could be achieved. The storm water could be captured and used for agriculture or after direct purification as drink water. The use and creation of new techniques means a transformation of the short term (problem solving) research to the long term (fundamental) research methods.

Shortage of skilled people

The government has to attract more capacity (skilled people) to the water sector. This could be done by providing unskilled people with a learning job at public organizations within the water sector. Eventually these educated people will have an added value to the water sector. By solving the shortage of skilled people organizations are able to do more fundamental research instead of problem based research.

Awareness of direct communication: create one department

The innovation policy established by the innovation policy network is secondary to the water policy. The organizations in the water sector see the innovation policy more as a guideline then a legislation/policy. By integrating the innovation policy in the water policy innovation can be promoted and stimulated. Another alternative is one department which establishes both policies. In this way there can be created overlap and/or adjustment between the different policies. The advantage is that synergy effects can be achieved as well.

§ 6.2.2 Recommendation for the Netherlands

The innovation agenda: stimulate fundamental research

Many challenges (for example pollution, climate change, the increasing sea level) will influence the drink, storm and waste water quality. By making an innovation agenda the Dutch government can face up to those challenges by stimulating fundamental (long term) research.

Stimulate organizations to innovate: by compliance to the goal setting

The Dutch government has to keep the legislation and the policy of the water sector dynamic. The goal setting established by the national government has to be challenging, organizations have to innovate or improve their processes to comply to the goal setting. In this way complacency can be prevented.

Stimulate organizations to innovate: by funding

Another alternative to stimulate organizations to innovate is by funding researches. By funding the organizations or specific researches the government is able to influence the amount of incremental (short term) and fundamental (long term) research as well.

Stimulate collaboration and the synergy effects: create innovation platforms

To stimulate collaboration and synergy effects organizations have to meet each other. The government has to create specific innovation platforms, communication hubs and networks where all the organizations in the water sector are invited to discuss water issues. The different departments involved or linked to the water sector also have to be invited. The water sector is linked with many other departments thus an integral approach is necessary.

Awareness of the limited resources of water

What important is for the Dutch national government is that organizations and also citizens are aware of the limited resources of water. To supply the increasing water demand the Dutch government could use other resources (sea and surface water) or technical applications. Therefore the processes to purify the water have to be intensified.

§ 6.3 Possible continuation researches

In this research the influence of the political context/arena is not included, for DHV it is interesting to do a continuation research to the political influence, on decision making on regional and local level, and context of South Africa. Many organizations (WRC, ESKOM, water boards, municipalities) are depending on the decisions made by the national government. These decisions influence the daily operational activities of these organizations, it is interesting to know which person and or department has the most influence and how an organization as DHV (daughter company SSI) can participate in this arena.

An opportunity for a research for DHV is to see what the consequences of the dependency is from The Netherlands to other countries as Germany and Belgium are where our water resources come from. What is the influence of pollution on the water quality and what can they do to improve the water quality.

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Department of Transport:

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Department of Water Affairs and Forestry:

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Organizations

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www.dhv.com

Company EVD

www.evd.nl

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www.ssi-dhv.com

Council of Science and Industrial Research:

www.csir.co.za

East Rand Water Company

www.erwat.co.za

ESKOM South African national utility

www.eskom.org.za

Johannesburg Water

www.johannesburgwater.co.za

Johannesburg Road Agency:

www.jra.org.za

Metro municipality Johannesburg

www.johannesburg.co.za

Metro municipality Pretoria (Tschwane)

www.tschwane.co.za

The New Partnership for African Development

www.nepad.org

Rand Water

www.randwater.co.za

The Southern Africa Local Government Association

www.salga.net

Southern Africa – Netherlands – Chamber of Commerce

www.sanec.nl

Water Institute of Southern Africa

www.wisa.org.za

Water Research Commission

www.wrc.org.za

Research methods

Social Research

www.socialresearchmethods.net

Regional council , Environment Waikato

www.ew.govt.nz

Abbreviations

ACT	Arts and Culture Trust
AIDS	Acquired Immune Deficiency Syndrome
ANC	African National Congress
CMA	Catchment Management Agencies
CSIR	Council of Science and Industrial Research
DHV	Company name DHV
DoE	The Department of Education
DPLG	The Department of Provincial and Local Government
DWAF	The Department of Water Affairs and Forestry
E-WISA	Electronical- Water Institute of Southern Africa
ERWAT	East Rand Water Company
ESKOM	South African national utility
FFC	Financial and Fiscal Commission
HIV	Humane Immune Deficiency
IPN	Innovation Policy Network / innovation Policy Organizations
IO	Implementing Organizations
JRA	Johannesburg Road Agency
KI	Knowledge Institutes / knowledge Organizations
NCOP	The National Council of Provinces
NEPAD	The New Partnership for African Development
NISM	National Innovation System Model
NWA	National Water Act 1998
R&D	Research and Development
SA	South Africa
SALGA	The Southern Africa Local Government Association
S&T	The Department of Science and Technology
SSI	Stewart Scott International
WIN	Water Information Network
WISA	Water Institute of Southern Africa
WMA`	Water Management Area
WPN	Water Policy Network / Water Policy Organizations
WRC	Water research Commission
WSa	Water Service Act 1997
WSA	Water Service Authorities
WSLG	Water Sector Leadership Group
WSP	Water Service Providers

Appendix

This document is the appendix of the research “ Innovations in the water sector of South Africa”. This document is written to ground the chapters written in the main report.

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Preface

The text in this appendix is complementary to the texts in the main report. These texts give the reader additional information about subjects described in the main report.

The added figure in chapter II is from the theoretical framework, it is added because not every country organizes the water system in the same way. This figure shows how the water system is organized in South Africa. This is the starting point of this research and therefore it has to be clear how the water system of South Africa is formed. This figure gives an overview of the three types of water in the water system and the several steps in the cycle of the water system.

In chapter IV the water service providers in the water system of South Africa are described in a figure. This chapter also has a table with the organizations of the water innovation system. The interactions between the organizations in this table and in the innovation system of South Africa are described. These subjects are mentioned in chapter four of the main report. This text is allocated to the appendix because it is a large text and it is too specific for the main report. This text is complementary to the text in the main report. The barriers and drivers of the innovation system are also described in this appendix.

A table is added to chapter V. This table is the analytical framework of this research and is allocated from chapter five to this appendix. In this table the indicators for the innovative capacity of the clusters and relations are given. Based on these indicators the collected information about the innovation system is analyzed.

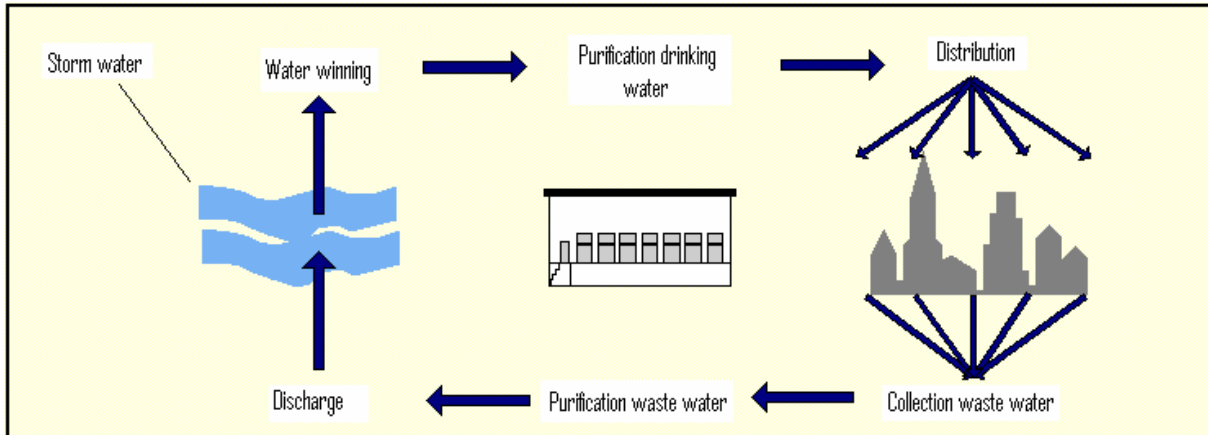
Chapter VII is added to the appendix, because it explains how information during the research with the interviews is collected. First of all the interview list is added. This gives an insight in the questions which are asked during the conversations with the participators of the research. This interview list is an assembly of all the questions asked to the different types of organizations. In the second part of this appendix the participators are given. The added value of this list is that the dispersal of the different types of organizations can be verified.

In the last chapter (VIII) the international comparison with Canada and Portugal is given. Through this document an insight is given in the differences in the three countries, concerning the innovation system, water sector and the innovative capacity. But also the similarities are mentioned.

Chapter II Theoretical framework

Figure of the water system as used in this research

The water system does not have to be organized the same in every country. This figure shows how the water system is organized in South Africa. This is the starting point of this research and therefore it has to be clear how the water system of South Africa is formed. This figure gives an overview of the three types of water in the water system and the several steps in the water system to purify the water.



Source: IDEA Consult

Chapter IV The water system

This table shows the types of water service providers in the water sector of South Africa.

EXAMPLES OF WATER SERVICES PROVIDERS		
Type	Services provided	Example
Bulk water WSP	Sale of bulk water to another WSP by contract.	Rand Water
Bulk wastewater WSP	Treatment of wastewater received from another WSP by contract.	ERWAT, WSSA contract to run Zandvliet Treatment Works in Cape Town
Retail water WSP	Only provides retail water services and takes risk on income from water sales (even though income is collected by the municipality on its behalf).	Johannesburg Water
Retail water and sanitation WSP	Takes full responsibility for provision of services and accepts risk on the income from water and sanitation services.	Durban Water and Waste (Note: Also provides some of its own bulk services)
Bulk water WSP and retail water and sanitation WSP	Provides bulk water services to other water services providers as well as retail water and sanitation services in its own area.	City of Cape Town

Source: D.W.A.F. Draft white paper on the water services 2002

Table 7: Water Services Providers in the South African water sector

The water innovation system

This table gives an impression of the organizations involved in the water sector.

Type of organization	Organizations	Type and finance	Goal setting
<i>Water policy network</i>	Department of Water Affairs and Forestry (DWAF)	Public organization National taxes	Establishment water policy and financing WRC
<i>Innovation policy network</i>	Department Arts, Culture, Science and Technology	Public organization National taxes	National innovation policy for all the departments
<i>Implementing organization</i>	Water Boards	Public organizations Selling water to the local municipalities	Bulk water supplier, these organizations provide the municipalities with a huge amount of purified water
	Municipalities (local, district and metro)	Public organization Local taxes and DWAF	Responsible for the water provision to the households and businesses
<i>Knowledge (innovation) organizations</i>	Water Research Commission (WRC)	Public organization, owned (100%) by DWAF Funded by DWAF	Stimulating research and innovations in water chain.
	Council of Science and Industrial Research (CSIR)	Semi-public organization 30% funded by D.W.A.F. the other 70% by selling the knowledge and the services(researches) of the organization	National research institute. They are responsible for the national strategic topics concerning international collaborations and networks settings. This organization is also responsible for the research on national level for D.W.A.F. because of the 30% funding
	Universities (the most important: Witwatersrand, Johannesburg and Pretoria)	Public organizations Funded by the Department of Education and college money	Teaching and producing of knowledge
	Water Institute Southern Africa (WISA)	Private organization	Knowledge dissemination by arranging workshops, conferences, symposia for her members

The innovation system

The ministry of D.W.A.F. as legislature communicates with all the organizations in the innovation network. These communication lines do not always have to do with innovations it self but could also be interaction about the implemented policy (monitoring) or benchmarking. The department communicates on informal and on formal bases, in most of the occasions it is informal communication.

Rand Water has a good and intensive collaboration with the ministry of D.W.A.F. and the local councils. The interaction with the ministry of D.W.A.F. is about projects and about compacts. The ministry of D.W.A.F. has to report to the Parliament and Rand Water (water boards) has to assist the ministry. Before this meeting a lot of interaction and communication is present between the organizations. Besides this *“in terms of informal communication the lines of communication are always open”*. (Rand Water 23rd of May 2008) The formal communication takes place each quarter in the form of report that Rand Water has to deliver to the ministry and each year there is an annual meeting. The formal meetings only take place when the department thinks it is required.

The communication with the local councils and Johannesburg Water and ERWAT are almost daily because of the drinking water provision. As these organizations are customers the organizations do have also a customer service desk for local councils, That is the most important platform of interaction for these organizations. Besides this formal platform the organizations also meet on annual bases to set the tariffs that the local government has to pay for the bulk water. Just as with the national government the informal communication lines are open every day.

WISA is an important organization for the ministry of D.W.A.F. Through WISA the ministry wants to be integrated in the network of private organizations, because at the moment the department is not integrated in the business world. This is why the ministry is a member of WISA and also communicates with this organization. These communication lines are not often and are more formal, like the membership. WISA and DWAF do not communicate on informal bases both organizations mentioned that. (Interview WISA and D.W.A.F. May 2008)

DWAF and private organizations do not often communicate. When the ministry and private organizations work together it is often an initiative from the bigger private organization (multinationals, mining houses) because those organizations are confronted with an issue. The collaboration is then project (crises) based. The duration is most of the time a couple of years, two until four years that depends on the project. The communication is then formal with the national government and often more informal with the local councils. The platform is named Coaltech 2020. The role of the national government is as a supplier of resources and advice instead of technological input. The local councils have a big role in these types of collaboration. This is because the issues are on local level and these organizations are more involved. That is also why the informal communication is less developed with the national government compared to the local councils. (Interview DWAF and Anglo American Call May 2008)

The CSIR has direct communication lines with D.W.A.F. Employees of CSIR even report directly to the minister and the director-general to inform them with new information. *“This is a quite close and complicated relationship”* (CSIR, May 2008), because the relationship is this close the policy established by the government is easily influenced by CSIR. The communication lines are formal during the meetings and these organization have two

meetings a year. Besides these meetings the CSIR also has to report to the government every year. CSIR tries to be as formal as possible and the informal communication lines are more projects related. (CSIR May 2008 and www.csir.co.za)

The WRC has a complicated structure, because the organization reports to the ministry of D.W.A.F. concerning the water policy and implementation of it. But for the innovation policy the WRC looks at the Department of Science and Technology and the operational activities of the WRC have to be complied to the water service act which is managed by the ministry of D.W.A.F. The WRC has different relationships with the ministry of D.W.A.F., DWAF is stakeholder and monitors the WRC therefore the WRC reports to DWAF. The ministry could also be a customer and then DWAF communicates in a different way (also formal but with a different message).

The local municipalities collaborate a lot with the ministry of D.W.A.F. because DWAF sets the water policy where the local councils are involved in. The ministry of D.W.A.F. monitors the local municipalities and the local municipalities have to report to the ministry. These are many reports a year and the formal structure is a meeting every quarter. Besides these formal structures there is a lot of informal communication, "*we just have to pick up the phone*" (Interview Tswane and Johannesburg May 2008)

SALGA has formal structures with the national and local government to debate issues. These meetings are once a quarter and SALGA tries to communicate with the national government in behalf of the local municipalities. Besides direct communication with the national government SALGA also communicates with the national government in other types of platforms.

SALGA also has individual informal contact with the national and especially with the local government. SALGA is starting to create a new network with interaction patterns because SALGA's opinion is that these networks are not arranged good enough to stimulate the innovations optimally in South Africa. (www.salga.net and Interview SALGA May 2008)

Knowledge organizations

WISA has a good formal and informal communication network with WRC. This is because there is a lot of labour mobility and personal overlap between these organizations. Employees of WRC are often involved with WISA or used to be. WISA is also the organization which disseminates the knowledge from WRC and other (private) organizations. WISA has a huge network where different types of organizations are involved in, CSIR also uses WISA's network to keep in touch (formal and informal) with other organizations.

WRC and the CSIR often collaborate during researches. The WRC funds CSIR to do research and WRC receive knowledge in return. These communication lines are formal during the researches and informal with the research leader. Besides that the WRC has a lot of informal contacts with the CSIR because these organizations collaborate and support (advice) each other.

The universities have a lot of contact with WISA, WRC and CSIR. The universities and in particular the University of Pretoria with the CSIR have a lot of personal overlap in the organizations. A lot of employees of CSIR teach at this university or do research for this organization. That is why the communication is quick and informal. But during the researches all the organizations try to keep the communication lines as formal as possible, because of the

needs. The universities have the advantage that those organizations can communicate individually with organizations because often universities get funded for a specific research. The other connection between universities and public and private organizations is that many students follow internships at private or public organizations to learn and do research about a specific topic in the water sector.

Rand Water works together with the WRC and universities for research. In most of the time Rand Water does unsolicited research and get funded by the WRC, but Rand Water also stimulates universities (Pretoria, Witwatersrand, and Johannesburg) to do research by funding them. Rand Water has established and funds a chair with participators from the universities and Rand Water to arrange specific topics for research. Rand Water communicates when it is acquired and this could be formal and informal structured. After one year the organizations in the chair and Rand Water individually look back on what the achievements are. (Rand Water May 2008)

Johannesburg Water and ERWAT work both together with WRC and universities. These water centers also fund organizations to do research. The communication is most of the time formal and depends on the research how often it is. These organizations do not have a high labour mobility or personal overlap as other knowledge organizations have.

Implementing organizations

The communication between Rand Water and Johannesburg Water and ERWAT is the same as with local municipalities. These organizations also communicate through the boards of the organizations, to arrange contracts and to arrange an agreement over specific topics. (Rand Water March 2008 and www.randwater.co.za)

Barriers and drivers in the innovation system

Barriers for the innovation capacity for the public organizations

The public organizations all together have a couple of big barriers which influence the innovation capacity. The first and most important barrier for innovativeness in the public organizations is the shortage of skilled people in the sector. In the water sector is a present capacity of 10% of the supposed 100% available. In Johannesburg they have 3 active engineers on 100,000 citizens. It supposed to be 30 active engineers on the 100,000 citizens, so the capacity could have a working range of 10%. (DWA education report September 2006, Interview University 2008) The shortage of skilled people is because of the amount of educated people and the private sector pays more.

Secondly the respondents of ministry of D.W.A.F. and local municipalities mentioned that the public organizations also loose a lot of capacity during the implementation of the new legislations. Since 1994 the organizational structure of South Africa is reformed. The legislation is an important aspect of that and organizations are still working on the implementation of the legislations and defining their role. This capacity can not and will no be used for innovations or other development goal settings. (Interview May Tshwane and DWA)

The third barrier has to do with the design of the communication hubs between the different public organizations. The ministry of D.W.A.F., local municipalities and SALGA mentioned that the communication and the knowledge hubs are not used efficiently. Because not all the organizations do participate, for example some important private organizations are not involved and the meetings could be arranged more often. An optimizing of the communication hubs is not an unnecessary luxury.

Fourthly the organizational structure of the South African government is in most of the cases designed in departments. That is why organizations internally do not always operate as one and silos do occur within governmental organizations. A disadvantage of that is that departments do not strengthen each others thought, knowledge, financial resources and eventually also do not strengthen each others innovation capacity. The best example of that is the dividing of the storm water and waste and drinking water. In the waste and drinking water the departments are very inventive and that department kept on doing research the last decade, but the Johannesburg Road Agency and the Water Research Commission both mentioned that the research for storm water restarted just one year ago. The reason was that the priorities of the Johannesburg Road Agency and Water Research Commission were set differently and this is also a consequence of the separation of the (drinking and waste) water divisions. The policies and legislation by the national government do not stimulate (political pressure) innovation in the storm water division at all. These innovations are crises and cost driven. Besides that the money invested has to reach outcome to implement in the water division.

Another national barrier is that implementing organizations are supplying not only the rich areas with water but also the poor areas. This is because of the free basic water “act”. The consequence of that is that the local municipalities run on loss, because not all the water receiving people are able to pay their water bills. These organizations have to add money for the provision and distribution of water, instead of reaching a break even point or making a small profit for research. These organizations are not able to invest a lot of money in new innovations because of the lack of financial resources. (Interview WRC and Tshwane and Johannesburg Water 2008)

The last barrier is the social context. Public organizations can implement the newest technology in the sewage and purification stations but the consequence will be a loss of jobs and unemployment. At the moment a lot of South African people are unemployed. The need to create jobs is far more important than to implement new innovations. (Interview WRC and Johannesburg Water 2008)

Barriers for the innovation capacity for the private organizations

The private organizations all together have a couple of barriers which influence the innovation capacity in the water sector.

Anglo American Call mentioned that the Water Service Act the best legislation established by any government in the world concerning water is. But the firm also mentioned that the passages have been implemented very poorly. This is why the end result is not what it supposed to be. (Interview Anglo American Call 2008)

All the private organizations mentioned that the legislation established by the government could be more innovations driven. At the moment the government steers the private organizations towards innovations but the private organizations have a relative small input and impact in the water sector (public organizations only). That is why the need to be innovative and participating in the water sector is relatively small. This has a negative influence on the innovation system of the water sector.

For semi-public organizations as CSIR (60% private) is the politically imperative transformation a huge barrier for the innovativeness. Since the national government decreased the funding from 100% until 40%, the innovativeness decreased with almost the same digits (www.csir.co.za and Interviews CSIR 2008). The political transformation is also a reason for employees to immigrate to overseas countries. The innovative capacity of CSIR has decreased the last years and because it has to strengthen the innovations of the complete country, the innovation capacity of the complete country decreased

Elements which are important for both the public and private organizations

It is important for public and private organizations and for the citizens to realize that water is scarce in South Africa and in particular in Gauteng. People and organizations are not aware of the scarcity of water. This is because of the fact that water is relatively cheap and easily to receive by twisting the tap.

A barrier for public and private organizations is complacency and continuity. Especially the last one is a huge problem for the public organizations. The most organizations do not have an institutional memory, which means that the organizations constantly lose knowledge because employees leave the institution.

Drivers for the innovation capacity for the public organizations

The first important stimulating factor for innovation is that water provision, distribution, and sanitation is a task for organizations with the same goal setting, in this case governmental organizations. These organizations have a good communication and relationship between the different organizations downstream and upstream in the water sector.

Challenging legislation is mentioned as a driver for the innovations in the water sector, several public organizations mentioned this. Organizations have to innovate/developed

(institutionally or efficiently) the own organization to comply to the legislation established by the government, otherwise these organizations could be sanctioned.

For the public organizations on local level public pressure is also an important driver to innovate and to be as sufficient and effective as possible. Also because citizens are able to complaint directly to the national government through the “One stop shop”.

Drivers for the innovation capacity for the private organizations

Private organizations look at one thing to innovate and that is what is in it for them. The business case is the main goal setting of private organizations and public organizations look to aspects as more efficiency, quality of processes and structures or reaching a bigger group of citizens. Legislation from the government used to be a driver for the water innovation by private organizations. But since the scarcity of water it became a business case. To give an overview of the differences between public and private organizations there have been quoted two organizations; a private and a public organization.

Local municipality Tswane, May 2008:

“We try to create better quality and processes of structure in the water sector”

Anglo American Call, May 2008:

“It starts with innovation(s) and it creates opportunities for more profit!”

An important driver for the private organizations is that there has been created a lot of knowledge about water in the last few years. A lot of private organizations have to implement new technologies or have absorbed a lot of knowledge about water. These organizations are able to innovate themselves the next years. A driver is the quick knowledge production and demand for knowledge.

Elements which are important for both the public and private organizations

Drivers for innovations are crises, like power, and the fact that water is scarce in South Africa. This drives the innovation for public and private organizations. Besides this push factor the South African country has also the pull factor funding. This is an important factor for private and public organizations to stimulate the innovations. It does not only make innovations possible, but it makes sure that organizations can realize the capacity building for innovations.

Another important driver for innovations mentioned by all the organizations is an individual characteristic of employees. People want and have to improve themselves, because of that innovations occur and organizations are able to improve themselves as well. Innovations are depending on the passion of individual persons.

Huge drivers for innovations in the complete water sector are the platforms like WISA and WIN. Those organizations take care of the dissemination of knowledge and information in South Africa and she is also responsible for the interaction between different types of organizations.

Chapter V Analysis of South Africa
Table analytical framework for analysis clusters

Cluster	Element	Indicator for decreasing capacity	Indicator for increasing capacity
Water policy network	Policy aims	Degree of prescribed standards, technical applications and methods	Degree of general goal setting on output and outcomes
	Policy instruments	Only repressive instruments, i.e. strict norms, rule-setting and tariffs	Combination of repressive and stimulating instruments
Implementation organizations	Discretionary space	Small space	Large space
	Development of innovations	Low investment budgets for renewals. No own financial resources	High investment budgets for renewals. Autonomous financial resources.
		Organizational culture focused on conservation and incremental improvement	Organizational culture focused on innovation and radical improvement
		No competition between water providers.	High competition.
Knowledge institutes	Type of research	Strong focus on applied science and R&D	Combination of fundamental research and applied science
	Competition	No competition between KI	High competition between KI
	Structure	KI dependent on policy or implementation organizations	Autonomous, market based knowledge institutes
Innovation policy network	Policy aims	General innovation goals and financing of KI	Both general innovation goals and support of sectoral innovation
	Decision-making	Degree of top-down decision-making	Degree of decision making by mutual adjustment

Table analytical framework for analysis relations

Relation	Element	Indicator for decreasing capacity	Indicator for increasing capacity
I WPN – IO	Decision-making	Strict boundaries between policy making and implementation	Degree of decision-making by mutual adjustment
		Focus on conservation and problem solving	Focus on improvement and innovation
II WPN – KI	Knowledge transfer	Strong focus on technological knowledge and problem solving	Combination of technological and ‘administrative’ knowledge
		Strict principal-agent relation focused on problem solving	KI’s do unsolicited research and WPN is willing to use this knowledge
III WPN – IPN	Policy adjustment	Both networks are working in silos	Mutual adjustment and policy integration occurs
		Demand steering from WPN to IPN	Mutual search towards useful knowledge and innovation policy
IV IO – KI	Knowledge transfer	Strict principal/agent relation between IO (as an principal) and KI as agent(s)	KI’s do unsolicited research and IO’s are willing to use this knowledge
		Demand steering from IO focused on problem solving	Collaborative communication about possible improvements/innovations
V IO – IPN	Development of innovations	No sector specific Innovation policy	Financial flow from IPN to IO’s for R&D purposes
		No user involvement in knowledge development	User involvement in knowledge development.
VI KI - IPN	Knowledge development	Strict demand steering from IPN to KI	Communication between KI and IPN about appropriate knowledge questions
		Principal – agent relation under strict conditions	Broad conditions for knowledge development with autonomy for KI

Chapter VII Research

Question form

Introduction

1. Students Erasmus University, master thesis public management
2. Assignment DHV Netherlands
3. Short description of the international comparative research innovation system in the water chain (four countries: Canada, Netherlands, Portugal and South-Africa)
4. Indicate how long the interview will take and what topics will be discussed
 - Ask the interviewed what is his / her function and how he / she is connected to the innovation system and / or water chain, how long he works there (what did he do before) / is the person member of a network association? And why??

The organization

- 1) What does the organization do?
- 2) What is the vision and mission of the organization?
- 3) Which parts in your organization are responsible for innovation and innovation policy?
- 4) What is the role of your organization in the national innovation system [concerning the water chain] or water system? What is the added value of your organization to the innovative capacity of the water system? Are you able to explain it to me and can you give me an example?
- 5) What is the definition of the water system according to your organization?

Innovation

1. What do you think of the present innovation and the innovation capacity of your organization and network? Is there any innovation at the moment? Are you positive or negative about the present innovations and why? How have these innovations been achieved?
2. What explains the innovativeness of the water sector? Or what explains that the water sector is falling behind concerning innovations compared to other sectors?
3. What do you think is the most important positive or negative factor/barriers for innovations?
4. How is innovation in your organization designed? (is there a specific innovation policy? Does this include networks or platforms? How is it initiated and funded). (Can not be asked to every cluster so be cluster specific)
5. How would you describe innovation on the national, provincial, regional and municipal level? (In which level does your organization try to participate in realizing innovations? How is the policy of that government's level you try to participate with? Does this include networks or platforms and is it innovation stimulating? How is it funded)
6. What are the threats for the future are there possibilities for innovations? Is the economy and the market open for new innovations or are they slowing it down?

Case specific

- 1) Can you give a clear and good representative example of a case in which innovation in the water system has taken place? I like to have an overview how the system works! (describe the case, what were the significant parties, how was it funded?)
- 2) What was the organizations role your own role in this innovation?
- 3) What was driving the organization(s) to make sure this innovation was created? (legislation, emergency, improvement etc..) Who has the leading role in this case?
- 4) Was there any form of cooperation and what was the kind of relation between the different organizations?
- 5) Do the citizens influence the outcome or the process, if so how and why? Is it a factor of influence?

- 6) How was the innovation created, was there a platform involved or was it just one organization?
- 7) What kind of communication was used to spread the innovation and the knowledge?
- 8) Was there any form of diffusion (labour mobility, knowledge, money) to realize the innovation? Which factors do stimulate or slow down the diffusion? Do these organizations or legislations influence the diffusion?

Innovation policy and water policy

1. What is the established water policy by the government?
2. Who established this water policy within the government?
3. Has she also established an innovation policy?
4. Who established this innovation policy within the government?
5. What is the result of that? Are these water and innovation policy stimulating or slowing down the innovations in the water sector? Can you give me an example of that? (could you answer one policy at the time)
6. Is this policy binding or are organizations free to do what they like as long as it stays between boundaries, concerning water and innovation?
7. What role does the water / innovation policy play in your organization?
8. How is the water / innovation policy constructed? Which parties were involved?
9. Which factors and actors have influence on the water / innovation policy and how?

Connections Knowledge organizations

- 1) What role does communication / interaction play in the innovation system and the spread of innovations in the water chain?
- 2) Is your organization member of a network in the national innovation system?
- 3) Who is asking/demanding for new knowledge? How does this knowledge demands rise? What is your role in giving it to them and why are you able to produce it? Why is this type of knowledge or innovation produced? How do these knowledge questions occur, been created?
- 4) (Does your organization get commissions / assignments from the other institutions, if yes what type of commissions / assignments are they?)
- 5) What type of research does your organization perform and which parties are involved
- 6) Is there a matter of a competition or cooperation between the knowledge organizations, if yes why / how / with what effect?
- 7) What is your view about the other organizations in the network Is the cooperation between the different organizations going smoothly or has it its difficulties? What kind of difficulties are you facing right now?
- 8) How is the production of knowledge within the water chain getting steered by subsidy giving organizations? Do they stimulate/influence/steer a specific kind of knowledge or every kind of knowledge production (research)? How are questions about knowledge created? Which organizations create these questions?
- 9) How do you connect knowledge producing organizations with the water chain? (intermediary, platforms, knowledge infrastructure etc.): knowledge dissemination.

Connection implementing organizations

1. What role does implementing organizations play in the innovation system and / or water chain? Are you going to workshops and network meeting and so on.
2. What are the motives to innovate or not to innovate?
3. Is there a relation with innovation policy organizations in the water sector?
4. How do implementing organizations try to influence the water policy and how do the policy establishers try to influence the implementing organizations?
5. How do you describe the cooperation with other organizations? Where do you find the most difficulties and what goes very smooth?

Connection Government

- 1) Is there official contact with all the players in the network to influence the policy process. I mean departments, knowledge organizations and implementing organizations. Are there structures for this contact and how do they organize these moments of contact to create innovation?
- 2) How does the government try to influence the innovation in the water chain and what kind of policy do they use (let them some individual space or has it boundaries). (law and legislation, finance (punishment or subsidy etc.)
- 3) Is there within the governmental organization a know compartmentalization? How do they try to prevent this? Does this influence the innovation capacity or the water policy?
- 4) Is there a kind of overlap or interlocking at the implementing or policy making role of the government? Or are these roles more and more disconnected in the years?
- 5) Is there a relation between the established water policy and innovation policy? Is there harmonization and connection between it? (interlocked or overlapping each other)
- 6) Is there a relation between the water and innovation policy and the producer and deliverer of knowledge?

Expectations and improvements (do's and don'ts)

1. What could be done differently in the network in order to improve its innovative capacity? Who should do this?
2. What should other organizations change in order to improve the functioning of the network?
3. What changes should be made by your own organization in order to improve the functioning of the network?
4. What expectations do you have concerning the innovation system and / or water chain and what part does your organization play in these expectations

Network

- 1) Can you draw your network of connections to give me an insight in your network? If it is possible can you be more specific and give me a good insight of the most important parties in your network concerning the innovation capacity?
- 2) How are the relations between the organizations in this cluster/network? (Cooperation or are they depending on each other, how do they steer the cluster/network and what is the importance of trust?)
- 3) Which organizations has the money, knowledge, power to steer the policy or is most innovative? (draw it as well in the network)
- 4) Is the organization member of a platform? What kind of platforms and what is its function and the meaning of this platform for the innovation capacity? What do you think is the most important platform for the innovation capacity in the water system? How come (example)? What is the role of the platform then?
- 5) Is the network able to stimulate innovations (between) in organizations?

List of participants

The next organizations and individuals have participated in the research.

P.J. Ashton , PhD Pr. Sci. Nat.	Council of Science and industrial research Divisional Fellow – aquatic Ecologist	4 th of June 2008
J. Berg van den ,	Municipality of Johannesburg and Tshwane Manager water division	19 th of May 2008
M. Claassen , Dr.	Council of Science and Industrial Research Manager: Water Resources	4 th of June 2008
S. Glynn , PrCPM	Stewart Scott International (SSI) Principal Associate	28 th of May 2008
J. Haarhoff , PhD Pr.Eng.	University of Johannesburg	25 th of April 2008
K. Langwenya	Rand Water Manager Water Resources	10 th of June 2008
P. Lincoln	Stewart Scott International (SSI) Operations Water Sector	13 th of May 2008
T. Matabane	Department of Water Affairs and Forestry Junior manager water division	6 th of May 2008
W. Mayne . MSc, MBA, Pr. Eng	WISA Chief executive	9 th of May 2008
G. McConkey	Jantech – H2Oasis Director	25 th of June 2008
J. Mnisi	Johannesburg Water Divisional Manager: operation Support	5 th of June 2008
W. Moraka	South African Local Government Association Manager Water Services	30 th of May 2008
L. Naude , PrEng	Stewart Scott International (SSI) Principal Associate	2 nd of July 2008
K. Nthethe , B.Sc (Ch.Eng.)	ERWAT Process Designer	29 th of May 2008
T. Nyandoro	Rand Water Financial and Economic Planner	23 rd of May 2008
D. Salmon , Dr.	Anglo American Call Anglo Technical Division	19 th of May 2008
K. Sinnema , MSc	Water Board Zwolle Manager International Affairs	7 th of April 2008
H. G. Snyman , Ph.D., Pr. Sci.Nat.	Water Research Commission Director: Water-Centred Knowledge	13 th of May 2008
A. Turton , Dr.	Council of Science and Industrial Research Strategic research Leadership (Natural Resources)	

	and the Environment)	16 th May 2008
D. Weston	Department of Water Affairs and Forestry Manager water division	6 th of May 2008
J.E.K. Zuyl van, PhD (Exeter) Pr. Eng	University of Johannesburg	25 th of April 2008

Stewart Scott international participants:

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A. Richardson	Engineer
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Anonymous informants:

ESKOM Holding	Water division	1 st of July 2008
Johannesburg Municipality	Water division	22 nd of May 2008
Cape Town Municipality	Water division	25 th of June 2008
Department of Science and Technology		14 th of May 2008
Johannesburg Road Agency		5 th of June 2008

VIII International comparison