

MASTER

**Prepaid water in Namibia
understanding the ongoing transition**

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Prepaid water in Namibia: Understanding the ongoing transition

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I. Preface and acknowledgements

To be included in final print version.

II. Executive summary

This research deals with water supply in Namibia and the specific innovation of prepaid water meters. It seeks to explain the socio-technical factors behind the choice for this innovation and what the actual application of prepaid water meters in a local case has meant for involved actors. Namibia is a sparsely populated, arid country in southern Africa with one of the most unequal societies in the world and more than half of the people living below the poverty line.

In Otjiwarongo, a town in the center-north of Namibia, the municipality is responsible for supplying water to households and communal standpipes. In recent years, Otjiwarongo and many other Namibian towns have started installing prepaid water meters to be able to collect payments for water by having people buy water credit before they consume the water. This innovation is not always working as intended due technical difficulties, resistance from users and other reasons. From Brabant Water, a Dutch water utility that has entered a cooperation with the municipality of Otjiwarongo, the request came to further examine prepaid water meters and their impact. This research aims to unravel how the innovation of prepaid water meters gained prominence as well as how it is functioning in the social reality of Otjiwarongo.

This has led to the following research question for this thesis:

How are sustainability visions of involved actors regarding Namibia's water supply transformed and concretized into local water supply innovations, and to what extent are these local water supply innovations successful?

Research approach

Systems such as water supply are more than just the technology and infrastructure, from an innovation sciences point of view it is useful to see them as socio-technical systems that have different dimensions (for example technology, user relations, market structures, policy and regulation, cultural meaning, etc.). Changes in one dimension affect other dimensions and trigger bigger shifts: transitions. The field of transitions studies helps understand these changes, where they come from and what their consequences are.

The theoretical framework of the Multi-Level Perspective (MLP) looks at interactions on different levels: landscape, regime and niche. Processes on landscape-level are broad processes that have impact on a range of fields (for example: shifts in thinking on development or water supply, natural processes like climate change or shocks like disasters or revolution). The regime level is the complex that consists of the existing rules and structures on how things are done in a certain field, water supply for example. Niches are the breeding place for innovation, where new socio-technical systems can be experimented with in protected spaces to develop them further so they eventually could take over or change the regime. Prepaid water meters are such a niche-innovation that is in development. A second framework can be used to better understand developments at niche-level: Strategic Niche Management (SNM) and evaluate local projects. SNM is focused on three internal niche-processes to evaluate the transition potential of niche-innovations. These three niche-processes are networking, expectations formation and learning. If these are aligned with each other, it enhances the chances of an innovation breaking through. In this case, there is however more need to understand what is happening within the prepaid water project in Otjiwarongo and why certain parts of the project are not proceeding as planned. A third theory, that of sociological translation

helps understand the extent to which the municipality has been able to ‘translate’ the local situation to one where prepaid water meters are used. It also helps understand where resistance is occurring and why. It does this by classifying interactions in different ‘moments of translation’: problematization, intersement, enrolment and mobilization.

Data collection

The research was conducted on-site in Otjiwarongo through in-depth interviews and observations. Furthermore, several interviews with actors from Namibian government, bulk water supply, NGOs, and other towns were conducted. These interviews were informed by the theoretical concepts above, charting the niche-processes as well as following the actors. Scholarly literature on broader trends in development, water provision and Southern Africa helps in placing the findings in their context and inform the analysis of the different levels.

Analysis and conclusions

From the MLP analysis, it was found how several landscape pressures have shaped the evolution of the Namibian water supply regime over the past decades, shifting the notion of what is a sustainable water supply. International trends of service commercialization and decentralization have influenced national policy so that a new bulk supplier was created to supply water to municipalities and ask them the full cost-reflective tariff. At the same time, the municipalities are responsible for supplying water to their inhabitants and paying the total water bill to the bulk supplier. This makes it crucial for municipalities to have their inhabitants pay for the water they use, something which is hard especially from the poorer parts of towns. This tension has led municipalities to look for solutions and prepaid water meters have been selected as promising innovation in many cases, also in Otjiwarongo.

A closer analysis of the local application of prepaid water meters through the SNM framework showed several things. The municipality of Otjiwarongo expected the innovation to work in three different applications: to collect payment from people in informal (slum) areas on standpipes, to collect payment and previous debts from poor people in regular households and to be able to offer people individual connections in informal areas. The municipality places these devices but has noticed that they do often do not work as planned: people do not understand how to use it, the meters do not work, people have smart ways of paying less than the municipality wants and the meters are sabotaged in order to get water. The municipality is learning from this and coming up with (technical) solution, but deeper learning is wanted to understand where resistance comes from and to reflect on the municipality’s assumptions on how the innovation would help towards a sustainable water supply.

The final analysis of interactions in the local project shows the limitations of the municipality’s agency. Even though it can unilaterally decide to place prepaid water meters, this does not guarantee that they succeed in their goals and it requires more efforts from the municipality to successfully translate the local situation in the situation as they intend it. Although individual users have more limited agency, they still are able to resist developments in such a way that the translation becomes a very costly process for the municipality, undermining the project.

The combination of SNM and translation has led to interesting, more general conclusions on how translation efforts can be compared with the niche-processes and how certain translation steps point to the need for different kinds of learning.

Policy implications

Recommendations that come out of the results of this research are aimed at the municipality of Otjiwarongo and Brabant Water. The first one is to develop a working definition of sustainability for themselves (and coordinate this with each other). This helps better understand the extent to which developments are sustainable or whether innovations work towards sustainability; it creates a useful benchmark. The second step would be to encourage and foster deep learning processes about the local prepaid water project: not only how certain operational issues can be resolved, but also to reflect on the impacts of such an innovation on the local community and the different aspects of sustainability (where social sustainability is strongly linked to the wellbeing of the community). To better channel this learning and decisions and actions in the project, a third recommendation is to analytically divide the project in sub-projects along the different purposes and target groups that the prepaid water meters are used for. This helps both actors compare and learn from the successes and failures of each sub-project. Finally, the municipality and Brabant Water could explore alternative/additional measures to replace or supplement prepaid water meters in some of its uses. Debt collection through personal communication is being experimented with, with promising results. Experience from South Africa suggests the possibility of free basic amounts of water to decrease the vulnerability of the poorest people.

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VI. List of abbreviations

ANT	–	Actor-network theory
DWA	–	Department of Water Affairs
GDP	–	Gross Domestic Product
IMF	–	International Monetary Fund
IWRM	–	Integrated water resource management
LA	–	Local Authority
MAWF	–	Ministry of Agriculture, Water and Forestry
MDG	–	Millenium Development Goal
MLP	–	Multi-level Perspective
NamWater	–	Namibia Water Corporation
N\$	–	Namibian Dollar (N\$1 ≈ €0,10 in February 2012)
OPP	–	Obligatory Passage Point
PPP	–	Purchasing Power Parity
RC	–	Regional Council
RED	–	Regional Energy Distributor
SE	–	Strategic Executive
SNM	–	Strategic Niche Management
SWAPO	–	South-West African People’s Organisation
UNDP	–	United Nations Development Program
WatSan	–	Water and Sanitation forum
WDM	–	Water demand management
WHO	–	World Health Organization

1. Introduction

This research deals with the provision of one of the basic necessities of human life: clean, potable water. It has been defined as a human right and one of the top priorities in global development efforts. Clean water is a key ingredient for direct human survival but also for food production and maintaining healthy living conditions. This thesis centers around the supply of drinking water in Namibia with a focus on the city of Otjiwarongo, situated in central-north Namibia. Here, the infrastructure to provide water is in place, but the challenge is to provide an increasing population with clean drinking water at affordable rates, while supporting the infrastructural and organizational structure to keep doing this in the future. Past developments have led the municipality of Otjiwarongo, the actor responsible for providing water to its residents, to install prepaid water meters in a number of its households and on the communal taps in poor, informal areas in town. The aim is to create a sustainable way of providing water to its residents. Through Dutch water utility Brabant Water NV, the request came to examine this project and evaluate its success. Brabant Water NV has engaged in capacity building and assistance in strategic planning with the municipality of Otjiwarongo. Prepaid water meters are envisioned to play a key role in water provision in Otjiwarongo, so a thorough and systematic evaluation of the options and the project so far is desired.

From an Innovation Sciences perspective, large socio-technical systems and the way they evolve are of special interest. The water supply complex including all its technical, social and economic aspects can be seen as such a system. This research analyses the changes and developments in this system from the perspective of transition studies. Different theoretical perspectives from this field of study have further informed its research questions.

These theoretical perspectives are the Multi-level Perspective (MLP) to explain the interactions of developments on different levels that lead to certain socio-technical innovations, and Strategic Niche Management (SNM) to understand the dynamics within local projects where these innovations are applied in a societal context and how to evaluate the success and chances of these experiments. Moreover, the research explores the possibility to augment the SNM theory with a third theoretical framework: that of translation-theory that focusses on the interactions between involved actors to explain dynamics of actor agency and resistance, in order to get a more complete picture of the prepaid water meter project. The combined potential of these theories is explored to learn more about the dynamics in the large socio-technical system of water supply and the role prepaid water meters might fulfill in general and in Otjiwarongo in particular.

This chapter will introduce the research objectives and questions and provide some background to Namibia, Otjiwarongo and the function of prepaid water meters within water supply.

1.1. Research objectives

The aim of this research is to comprehend what prepaid water meters do, why they are used and how well their application fits within the broader context of Namibia's water supply as well as in Otjiwarongo's local context. From the Innovation Sciences perspective on systems like these, there emerges an interest for the policy choices that lead to the implementation of prepaid water meters given the context and historical development of Namibia as a country and specifically Namibia's water supply. Structuring these through a transition perspective will help understand the ongoing

transition in Namibia to a more sustainable water supply. The multi-level perspective provides a framework in which one can make sense of simultaneous developments on different analytical levels and how they are shaping each other and the outcomes in terms of socio-technical developments on the local level.

One of the local level cases in which the prepaid meter was selected and installed as part of abovementioned transition is that of Otjiwarongo. Another objective of this research is to assess the performance of the prepaid water project undertaken there. To the end of evaluating such a real-world experiment, several approaches can be chosen. The Strategic Niche Management (SNM) approach is a developing field in which niche-experiments of novel socio-technological innovations can be systematically analyzed. Identifying crucial internal niche processes holds the promise of better understanding current projects as well as providing managerial suggestions for future development. Over the past years, application of the SNM framework has been gradually expanded from mainly energy-related innovations in western societies to other domains and other parts of the world. In this process, many issues have come to light to which the framework should provide more answers. One of these issues have been with agency of actors and the messiness and undirected character of projects in real life and the actor interactions steering these erratic project paths. To cope with this, additions to the SNM-perspective have been explored using the theory of 'sociological translation'. The efforts to implement the niche innovation of prepaid water in Otjiwarongo can also be analyzed through this perspective of sociological translation. Finding where the SNM framework and sociological translation are contradictory, complementary or overlapping will provide a broad assessment of the prepaid water project in Otjiwarongo so far and future possibilities.

1.2. Research question

Combining the research objectives with the theoretical suggestions above leads to the following main research question of this thesis:

How are sustainability visions of involved actors regarding Namibia's water supply transformed and concretized into local water supply innovations, and to what extent are these local water supply innovations successful?

The sub-questions that lead to the different part of the analysis:

- a. *In what ways are landscape factors and the evolution of the socio-technical regime shaping the transition to a sustainable water supply in Namibia and the currently chosen local water supply innovation of prepaid water meters?*

This sub-question is informed by the multi-level perspective that structures developments into three levels (landscape, regime, niche) to understand the interaction of societal, technological and policy processes at the different levels that lead to the implementation of novel socio-technical systems (Geels & Schot, 2007).

- b. *What is the transition potential of the local water supply innovation in Otjiwarongo when analyzed as a niche experiment?*

The application of the prepaid water technology can be regarded as a niche experiment. A Strategic Niche Management-approach (Kemp, Schot, & Hoogma, 1998) helps assessing the project in

Otjiwarongo by examining the three internal niche processes in the project (network formation, expectations management, learning processes) to provide more insight to its transition potential. Transition potential is the measure of success by evaluating to what extent a niche innovation contributes to a transition to sustainability.

- c. *What agencies are performed by the municipality of Otjiwarongo in the local experiment with prepaid water meters in Otjiwarongo when analyzed through a translation perspective?*

The third question helps expand the above analysis of the local experiment through the lens of sociological translation (Callon, 1986). By using this approach, more attention is given to the interactions back and forth between the involved actors in the local experiment with prepaid water meters. Through this lens, the agency of the involved actors can be understood. Their combined actions and reactions affect the course of the experiment and its sustainability. By selecting a focal actor in the translation analysis, one can understand the way in which it is performing agency. The municipality of Otjiwarongo is the actor initiating the prepaid water project and consequently will serve as a focal actor. Success is measured here by looking to what extent the translating actor succeeds in creating an actor-network, something which is necessary to reach its goals.

A second research question is formulated to derive recommendations from the analyses performed in the research. The questions above are analytical in character, but in the process of answering them, policy implications and recommendations will follow. Thus, the second question is as follows:

What policy recommendations follow from the analysis of developments in the socio-technical system of Namibian water supply and the combined analyses of the local prepaid water experiment in Otjiwarongo through the SNM perspective and the translation perspective?

1.3. Research justification

1.3.1. Societal relevance

As mentioned, access to clean drinking water is vital to human existence and development. Till today, this remains one of the top priorities on the international development agenda. In sub-Saharan Africa, where Namibia is situated, there are still millions of people that do not have access to safe water sources for their needs (United Nations, 2010). The question how to organize service provision and especially vital services such as water supply to the poor masses remains an issue of debate worldwide involving influential international institutes, see for example World Bank (2006) as well as drawing scholarly attention, see for example McDonald and Ruiters (2005).

Namibia's society is a highly unequal one with a large part of the population being very poor. Furthermore, Namibia is a very arid country with few perennial rivers and little and intermittent rainfall, which makes that people solely rely on the water that is supplied to them through the man-made water supply system. The upside of this is that people generally get clean and safe water fit for human consumption through this system. The potential downside is that decisions on price and organization of water provision can have very profound and existential implications on the quality of life of Namibia's poor population. Developments in Namibia's water supply are therefore of interest, especially their eventual concrete consequences on user-level.

The prepaid water meter produces such concrete consequences for water users at the local level. Its application in Otjiwarongo is the outcome of developments in Namibia's water supply having impact

on what and when users have to pay to have access to drinking water. In previous cases where prepaid water meters were installed, the consequences could be seen to affect quality of life, affordability of basic services and even whole socio-cultural structures like the nature of the relation between a state and its citizens (Dawson, 2010; McClune, 2004). This warrants deeper research into the effects of prepaid water meters and the dynamics of the prepaid water project in Otjiwarongo. It is important to see how different interests have been taken into account and to which extent all affected actors have been included in the decision and implementation process.

The central actor in the prepaid water meter project is the municipality of Otjiwarongo, which initiated the experiment as a result of many different developments and interests from their local community as well as the higher level governance context in Namibia in which they function. For them, it is useful to gain more insight in the dynamics of the local community, the extent of the effects of their own actions and how this all works towards accomplishing their goals. The actor that took the initiative for this research, Brabant Water, strives to contribute to development in their field of expertise – water supply – as a form of corporate social responsibility. Their interest was in gaining more knowledge about the context of Otjiwarongo's water supply and the prepaid water project in particular so they could make informed decisions on the way they make their contributions.

1.3.2. Scientific relevance

The developments in water supply in Namibia present an interesting field for transition studies to test the applicability of different frameworks and test their assumptions. The water supply system is an essential socio-technical system that is in transition. The transition involves processes at different levels and in different socio-technical dimensions that interact to produce outcomes that are ever changing. For example: outside technologies are adopted into the regime, triggering changes in other dimensions, and so on.

The multi-level perspective and strategic niche management frameworks will be used to understand this transition that is taking place in a new kind of socio-technical system (water supply) and in the context of a developing country in sub-Saharan Africa. Several students in the area of innovation sciences have applied an MLP and/or SNM approach to transitions in developing countries, which yielded results that were different from those found in contexts of developed, western countries (the main area in which these frameworks have been developed, tested and expanded). This research will add to that by introducing another application field – that of water supply. This makes it empirically novel.

Furthermore, recent efforts to supplement SNM with theory of sociological translation has been undertaken to give more prominence to the agency of actors in niche-experiments (see Raven et al. (2011)). This research further explores the added value of translation-theory to the SNM-framework and its analytical and managerial implications.

1.4. Introduction to Namibia

The Republic of Namibia is a country situated in south-western Africa (see Figure 1). It is very sparsely populated with only 2.2 million inhabitants on a surface of 825,418 km², which is roughly 20 times the land area of the Netherlands. Namibia is in many ways a country of extremes: climate, geography, but also in society and economy.



Figure 1: Map of Africa with location of Namibia highlighted (Adapted from Wikipedia).



Figure 2: Map of Namibia with Windhoek and Otjiwarongo indicated (adapted from d-maps.com).

1.4.1. Geography and demography

Located in the south-west of Africa, it borders South Africa in the south, Botswana to the east and Angola to the north. Along the west coast is the Atlantic ocean and a vast coastal desert. In the rest of the country, the landscape varies from deserts to savannah highlands and more mountainous regions. Its capital and biggest city Windhoek is located centrally and is home to a large share of Namibia's population with over 300,000 inhabitants. Apart from that, the majority of the population resides in the north of the country where the most populous ethnic group, the Oshivambo, come from.

Namibia is the most arid country south of the Sahara, with a rainfall of virtually zero in desert areas to 600mm per year in the northern areas of the country (in The Netherlands, average annual rainfall ranges from 690 mm to 900 mm). The only permanent rivers are the ones shared as border with Angola in the north and South Africa in the south. Within the country, there are mainly ephemeral rivers that have a seasonal flow dependent on the rainy season. Situated in the tropics with the tropic of Capricorn running through the country, it has 300+ days of sunshine per year and high temperatures in summer (September to May) and still warm in the winter. The biggest differences between the temperatures are between day and night, where the temperature range in some places can be 30° Celsius.

Namibia is a multi-ethnic country with the majority of people belonging to one of three main indigenous peoples: Ovambo, Herero and Damara. Also there is a sizeable white minority (7%) and people of mixed ethnic background ('coloreds' and 'basters', together 6.5%). The official language of Namibia is English (spoken by 75% of Namibia's population, mostly as secondary language). Various indigenous languages are spoken by the respective ethnic groups as well as German by Namibians of German descent and Afrikaans that serves as a lingua franca between the different ethnic groups (spoken by 85% of Namibian population, mostly as secondary language).

Currently, Namibia has 2.2 million inhabitants, a number which is expected to grow to 3 million in 2030 (UNDP, 2010, p. 186).

1.4.2. History

Namibia as a distinct geographical unit came into being with the colonization by the Germans in the late 19th century. Before that time, the area of Namibia was inhabited by different indigenous ethnic groups, groups that migrated from other parts of Africa and incidentally by European explorers and settlers since the 15th century. The Germans established German South-west Africa (*Deutsch-Südwestafrika*) in 1884 to halt further British colonization moving north from the cape colony in present day South Africa.

Early on in World War I in 1915 the Germans were defeated by South African armies and the South Africans subsequently occupied South West Africa. The occupation was mandated by the League of Nations (predecessor of the United Nations) in 1919 and South Africa would continue to rule South West Africa until 1990, when independence was won after a bloody domestic struggle and increasing international pressure. Before 1990, South West Africa was ruled in a similar way as South Africa by a white minority, and racial segregation and discrimination was institutionalized in the Apartheid system.

After independence, the Republic of Namibia was established as a parliamentary democracy. The name Namibia comes from the Namib-desert, which is the oldest desert in the world and makes up a large part of central and coastal Namibia.

1.4.3. Economy and society

Namibia's economy depends on mining of metals, gems and uranium, agriculture (mainly livestock) and to a lesser extent manufacturing and tourism. For a lot of products, Namibia depends on imports, mainly from South Africa. Unemployment is a large problem in Namibia, with an unemployment rate of 51.8% in 2008. The unemployment mainly affects the unskilled and low-skilled labor force.

Although Namibia officially falls within the lower-middle income group of countries, it has one of the most unequal distributions of wealth in the world. GDP per capita stood at US\$6,900 in 2010, corrected for purchasing power parity (PPP), which ranks it globally as 132nd out of 227 (CIA World Factbook, 2011). However, it has the highest Gini coefficient (0.74) of the world, which points to a highly uneven distribution of wealth.¹

In Namibia, 55.8% of the population falls below the poverty line.² This is reflected by a large number of people living in informal areas of cities and towns in self-built shacks. The Human Development Index (HDI) of Namibia stands at 0.606 (105th in the world). This is an index developed by the United Nations Development Program (UNDP) that takes into account income, health and education. In a new, inequality-adjusted HDI, Namibia does much worse and the index drops by 44% to 0.338. All three fields (income, health and education) see a decline in score due to inequality (UNDP, 2010, p. 154).

¹ The Gini coefficient ranges between 0 and 1 and indicates to what extent income is evenly distributed. If the number is 0, there is perfect equality: every member of a society has exactly the same income. If the number is 1, there is perfect inequality: one member of a population has all the income.

² The international poverty line was redefined in 2008 by the World Bank as living on less than US\$1.25/day at 2005 PPP (Ravallion, Chen, & Sangraula, 2009).

Literacy is well above the average of sub-Saharan Africa, with 88.2% compared to an average of 62.4%. Like other southern African countries, Namibia suffers from a HIV/Aids epidemic in which 15.3% of the adult population was infected in 2007 (UNDP, 2010, p. 199).

1.4.4. Politics and institutional structure

Since the abolition of the apartheid regime and independence of South Africa, Namibia has instated a parliamentary democracy along three administrative branches (executive, representative and judicial). There is a multi-party system, but in practice the Swapo party is the dominant party, gaining a vast majority of the votes in every election since independence. The Swapo party owes its continued popularity to the important role it played in the struggle for independence and the end of apartheid.³ Sam Nujoma, head of Swapo, was the first president of independent Namibia and served three terms until 2005. After that, his successor Hifikepunye Pohamba became president and was re-elected in 2009 for a second term until 2015.

Namibia has a decentralized government structure, where the country is carved up into thirteen regions. These regions have a regional council which is elected once every five years. In local politics, constituencies elect a town council – which in turn elects a mayor. Here again, SWAPO is the dominant party with a vast majority – It won 226 out of a total 327 local seats in the 2010 local elections (The Namibian, 2010b).

1.4.5. Otjiwarongo

Otjiwarongo is a city situated in the north of central Namibia, 250 kilometers north of Windhoek (see Figure 3). It is the capital of the region Otjozondjupa and one of the major transport hubs in the region, situated on the roads from Windhoek to the north and with roads branching to nearby Outjo and the popular national park Etosha.

Approximately 40,000 people live in Otjiwarongo, distributed over three main residential areas: the town center, the township Orwetoveni and the informal settlements on the edge of town. These areas can be seen in Figure 3. The town center is by far the largest area. This most prosperous part of the city has relatively large plots of land and homes and also houses most of Otjiwarongo's commercial activity. The informal areas house about 13,000 people. The rest lives in the town centre and township (about 27,000 people), the exact distribution between these two areas is not known.

The distinction between the town center and the township stems historically from the apartheid-segregation in 'white' living areas and 'black' living areas. Nowadays, the town center is also inhabited by black Namibians that have been moving up socially and economically. This area has expanded on the southern edge of town. The former black township is inhabited by lower-middle class residents, predominantly black Namibians. The third area is the informal area on the eastern edge of the township, home to the urban poor and newly arrived migrants from rural areas. People here can get a plot of land appointed to them, but they are not allowed to build any permanent structures on these. The result is a shantytown. These areas are expanding rapidly due to migration

³ SWAPO originally stood for 'South West Africa People's Organization', but because of its rejection of the name South West Africa and its insistence on replacing it with Namibia, the name of the organization's name was changed to 'Swapo party of Namibia'. The party is in a lot of ways very much comparable to its well-known South African counterpart, the African National Congress (ANC). Under the leadership of Nelson Mandela, it was the main proponent of abolishment of apartheid and is to this day the dominant party in post-apartheid South Africa.

towards Otjiwarongo. Otjiwarongo's population grows at an estimated 4.5% per annum [interview 6].⁴ While the informal areas grow, the municipality of Otjiwarongo is working on 'formalizing' these areas, making them eligible for more permanent construction and the full package of municipal services.

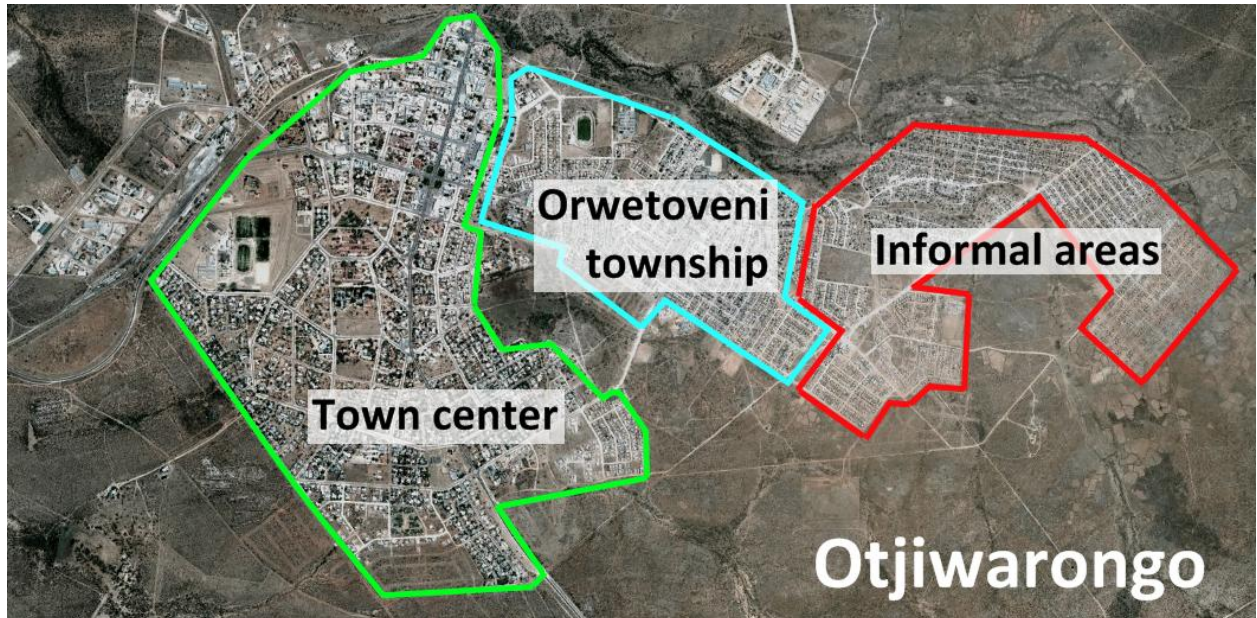


Figure 3: Map of Otjiwarongo with the three main residential areas indicated (adapted from Google Earth).

1.4.5.1. Administration and representation

The municipality is the executive branch for all municipal affairs, which include the provision of several services: the supply of water to its inhabitants, maintenance of streets and roads, sewerage and trash removal, providing public lighting, maintaining public spaces and more. It used to also include the supply of electricity, but this was changed a few years back.

The inhabitants of Otjiwarongo can vote for their representation in elections every five years. Out of those elections, the town council is formed and a mayor is chosen. As in most Namibian cities, the town council is Swapo-dominated and the present mayor, ms. Hilda Jesaja is a Swapo-representative. The town council decides on many issues that are then taken on by the municipality to implement.

1.4.5.2. Twinning relations with Dutch partners

The municipality of Otjiwarongo has had a twinning relationship with the Dutch municipality of Heusden since 2003. The cooperation focuses on local administration, but also on construction, schooling and health projects relating to the HIV/Aids-problems in Otjiwarongo (Municipality of Heusden, n.d.).

In addition to this cooperation, the Dutch water utility Brabant Water NV of which the municipality of Heusden is one of the shareholders, has entered into a cooperation with the municipality of Otjiwarongo in 2010. The focus of this cooperation is on "capacity building in the fields of market research and testing state of the art pre-paid water meters, operation and maintenance of pre-paid

⁴ Interviews will be referred to with a number between brackets. The list of interviews can be found in the appendix.

water meters and strategic planning of the pre-paid water project” (Otjiwarongo Municipality, 2010b).

1.5. Water Supply

In Sub-Saharan Africa, the number of people with access to improved water sources stood at 60% in 2008 and thus it remains a huge challenge to further expand water access (United Nations, 2010, p. 58). It is incorporated as part of the Millennium Development Goals (MDGs) by the United Nations, which are eight globally agreed upon goals to improve basic development on a global scale by 2015.

From a 2008 report on the progress of the MDGs in Namibia, Namibia seems to be well ahead of the rest of sub-Saharan Africa on water access: 97% of urban households and 80% of rural households in Namibia have access to safe drinking water (National Planning Commission, 2008, p. 42). It is important to note that access to water in this case means that people have a source of safe drinking water in the vicinity of their home. It does not tell about the extent to which these people are able to use the water services and what distance is close enough to qualify as access.

1.5.1. Prepaid water meters

So, what does a prepaid water meter do? A prepaid water meter is a device at the end of the water pipe, just before the tap. It is an electronic device that will open and shut the water supply automatically. For it to open, the user needs to present a tag that has water credit on it (see Figure 5). The tag carries a chip on which credit can be placed. People need to buy credit and at the vending point the tag can be topped up by the cashier with the amount of water that is purchased. The computer in the water meter reads this chip and meters the water it is dispensing, automatically deducting the amount of water supplied from the credit on the tag. When the tag is removed or when the credit runs out, the meter shuts automatically and water supply is blocked.

The meter is fitted with software that operates this and a small display shows the remaining credits and the amount used. Optionally and depending on the sophistication of the software, some extra functionality can be added like dispensing basic amounts of water for free or against reduced tariff.



Figure 6: A communal tap with conventional water meter on the right (Kastner, McHugh, St. Martin, & Youssef, 2005).



Figure 5: Prepaid water meter with tag inserted.



Figure 4: Opened up prepaid water meter with the electronics and battery unit.

Also, tag and meter can be coupled so that households have a personalized tag with a personalized tariff. The electronics in prepaid water meters are often powered by a battery that needs regular replacement (see Figure 4), but there are new type meters that get their power from electricity generated by the flowing water.

The prepaid water meter installation often replaces a 'conventional' meter. The conventional meter consists of merely a meter and no further electronics (see Figure 6). This requires the meter to be read by technicians on a regular basis, after which the used amount can be billed to the user(s) of the water. Thus, the conventional system is a post-paid system as opposed to the new prepaid system. This is the main innovation.

Technically the prepaid water meter is a lot more sophisticated than the regular meter. This causes the prepaid meter to be much costlier to purchase - roughly ten times more expensive in the case of Otjiwarongo: N\$2,500 (€250) per installation versus N\$250 (€25) for a regular meter [28]. The worldwide market for prepaid water meters is small compared to the whole of global water meter production and is not expanding significantly. Economies of scale, lowering the prices of prepaid water meters are therefore not expected [29].

There are different (international) manufacturers of these meters that produce prepaid water meters with different design and functionality. The prepaid meters are currently in use in several countries around the world, but South Africa is the place where it has been applied in greatest number. Across Namibia, several models have been used in different places and also in Otjiwarongo different models of prepaid water meters have been used.

Why is the prepaid water meter used? It ensures that people pay for their water, since people have to purchase credit and can only consume what they have already paid for. The non-payment in the post-paid system of billing after consumption was high and put municipalities in difficult payment positions themselves since they have to pay bulk supplier NamWater for the supply of water on a monthly basis.

The prepaid water system is thought to make sure that everyone pays for their water and to close the loop of financial sustainability, where the budget nowadays has to be balanced within the water system/ This will be discussed in more detail in the rest of this thesis.

1.6. Structure of the thesis

The thesis is roughly divided in an introductory part, a part with the different analyses and a concluding part (see Figure 7). After this first chapter, chapter 2 will go into the theoretical literature that will be used in the analysis of Namibia's water supply and the specific prepaid project in Otjiwarongo and it will explain the way data was collected. The analysis of Namibia's water supply from a multi-level perspective will make up chapter 3, further introducing the innovation of prepaid water meters and the way the technology is applied in the Namibian context. Chapter 4 then will go into the application of prepaid water technology in Otjiwarongo and provide some preliminary conclusions on success and sustainability of the local project through a Strategic Niche Management analysis. Chapter 5 will revisit the local project in Otjiwarongo through the lens of sociological translation to provide a different perspective of the project and its local consequences.

The goal of the concluding chapter 6 is threefold: (1) discussing the results from the analysis of the evolution of Namibian water supply system in the previous chapters, (2) combining the insights that have been gained from analyzing the local Otjiwarongo project to evaluate its success and sustainability outcomes and (3) discussing the theoretical insights that were gained from comparing and combining the SNM perspective with the approach of sociological translations. Chapter 7 closes the thesis by drawing out policy recommendation on the basis of the conclusions in chapter 6.

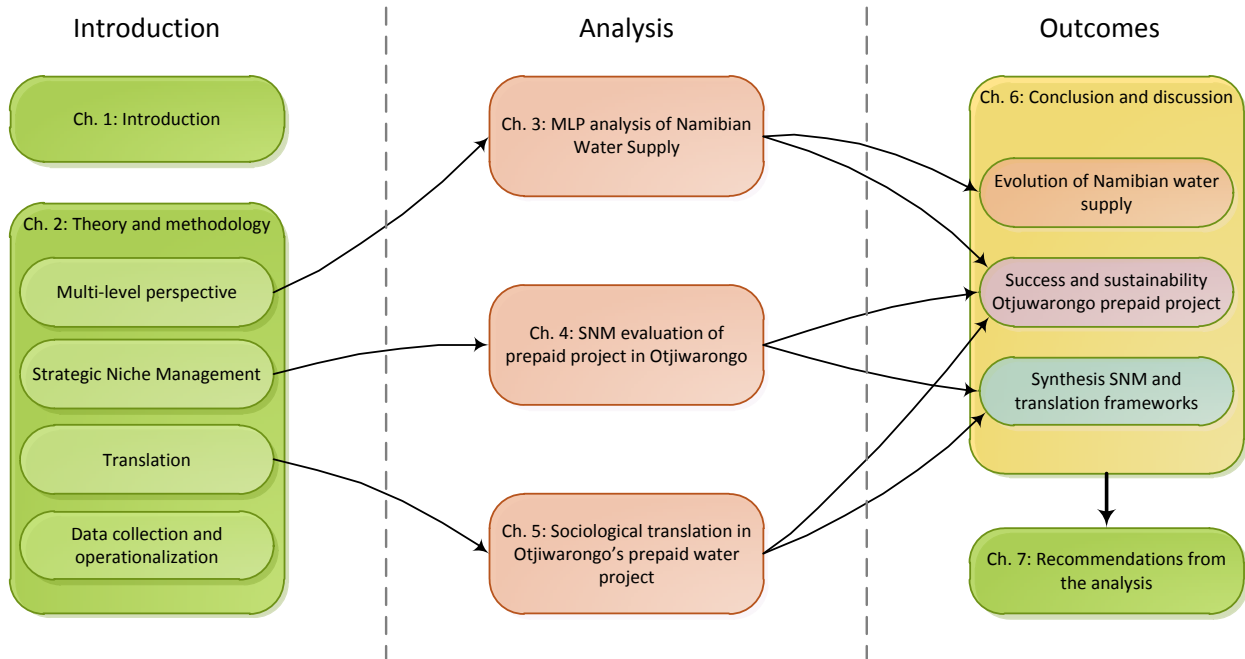


Figure 7: Structure of this thesis.

2. Concepts, theory and methodology

This chapter will further elaborate on the concepts of transitions, sustainability and success. Furthermore, it introduces the theoretical lenses used for the analysis: the Multi-Level Perspective to analyze transitions and the Strategic Niche Management-framework and the theory of sociological translation to analyze the local project. The chapter concludes with a section on the methodology of the research and how data was collected.

2.1.Socio-technical transitions to sustainable development

The analyses in this research are positioned in the field of transition studies. This field focusses on transitions, taking a systematic approach to big changes in socio-technical systems. Transitions are defined as shifts from one socio-technical system to another on the level of societal domains or functions, for example energy, transportation or – as in this research – water. These shifts involve multiple changes in the different dimensions of technology and its societal application, coming about through interactions between different (groups of) actors. Such shifts are radical in the scope of change, profoundly altering the way things are done in a societal domain or function. They are not necessarily radical in terms of time; transitions are often long term processes (Grin, Rotmans, & Schot, 2010, pp. 11-12).

Socio-technical is a classification that can be used to describe systems that contain heterogeneous elements. These elements have different dimensions that together form a system, summarized by Smith (2007, p. 429):

1. Guiding principles
2. Technologies and infrastructures
3. Industrial structure
4. User relations and markets
5. Policy and regulations
6. The knowledge base for the regime (a regime is the set of institutionalized rules that govern the way of doing things in a particular field)
7. Cultural and symbolic meanings underpinning practices

The socio-technical system central in this research is that of water supply in Namibia. The transition that has been unfolding over roughly the past 20 years has been framed as one towards a sustainable water system, This transition has triggered large shifts in all above dimensions of the water supply.

2.2.Multi-level perspective: Landscape, regime, niche

The Multi-level perspective (MLP) was conceived to understand how transitions come about. The MLP combines insights from evolutionary economics and sociology of science and technology (Grin, Rotmans, & Schot, 2010, p. 18).

It argues that transitions are driven by the interaction of processes at different levels: the socio-technical landscape, regime and niche. These levels contain configurations that reach across multiple dimensions and the levels are distinguished by increasing degrees of structuration and stability they give to practices. The MLP can be seen as a nested hierarchy, where niches are embedded in regimes and regimes are in turn embedded in the socio-technical landscape. Where the lowest level – the

niche – is not very structured at all and characterized by small networks and diffuse rules, the middle level of regimes has already formed stable structures of socio-technical elements. The highest level of the landscape involves very broad background structures that provide the environment in which systems evolve.

Regardless of the level of structuration, socio-technical systems consist of heterogeneous elements, like technology, regulation, infrastructures, markets, user practices, cultural meaning, et cetera.

When transitions are analysed, the MLP stresses the interactions between processes at the different levels to explain the dynamics of transitions. Figure 8 illustrates the three levels and how they might interact. Grin et al. rightly note that the MLP is a middle-range theory combining elements of different theories and working as an abstract analytical framework that identifies relations between these elements and other principles. To further specify interaction mechanisms on the different levels “the MLP needs to be complemented with more specific theories” (2010, p. 18). To this, I will turn in section 2.3.

Increasing structuration of activities in local practices

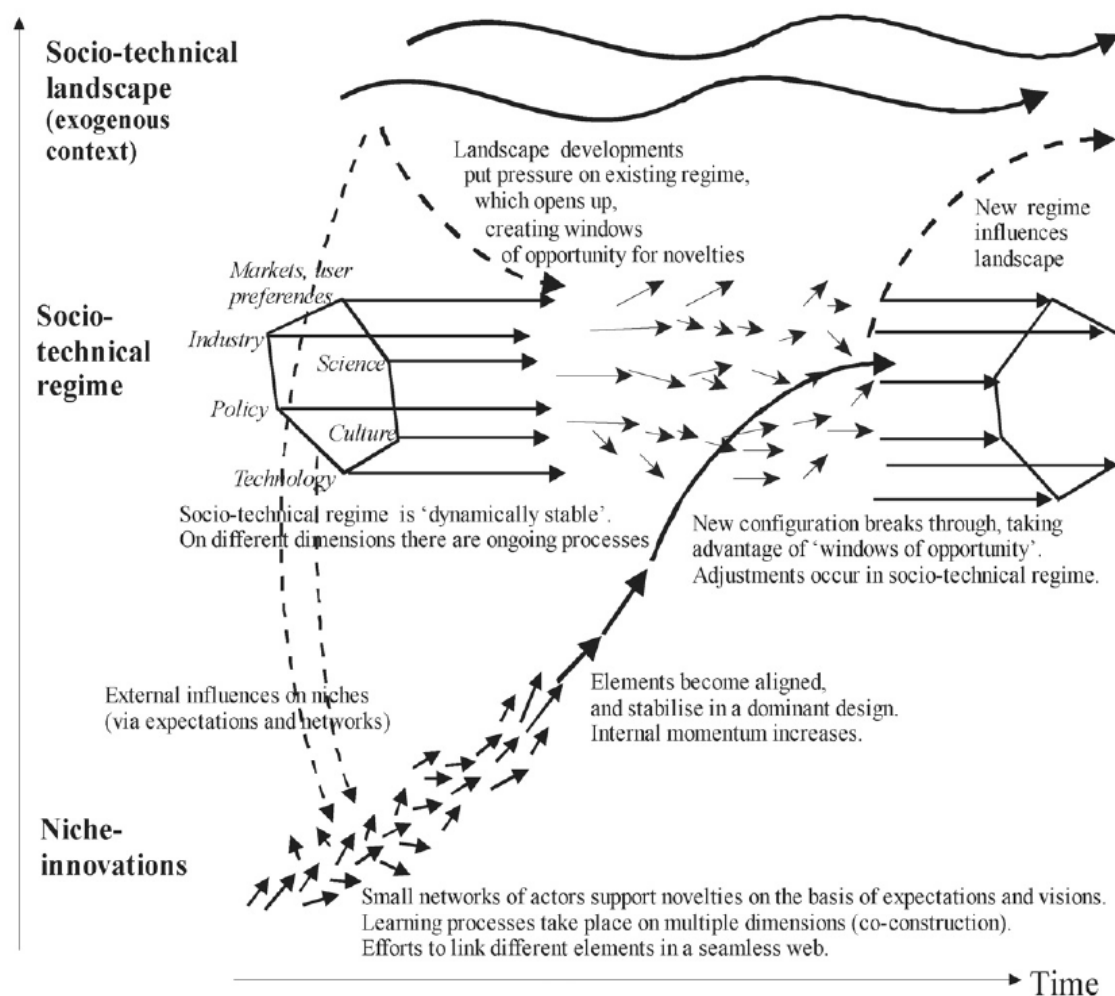


Figure 8: The three levels of the Multi-level Perspective (Geels & Schot, 2007, p. 401).

2.2.1. The socio-technical landscape

The level of the socio-technical landscape is used to categorize external factors that cannot be influenced by regime or niche actors in the short term. These factors can be long-term trends (e.g. industrialization), external shocks (e.g. natural disasters) and factors that do not change or very slowly (e.g. climate) (Grin, Rotmans, & Schot, 2010, p. 24). These factors can put pressure on socio-technical regimes and force them to open or reconfigure.

2.2.2. Socio-technical regimes

The central level in this theory, the socio-technical regime, is defined as a set of rules that are linked together. These rules pertain to the different dimensions of the sociotechnical system and can be categorized in three categories: cognitive rules, normative rules and formal rules.

Cognitive rules shape the way in which actors think in a field, be it the direction of certain technologies, the perception of user preferences and practices and the way a socio-technical system functions in any of its dimensions. Normative rules are about the roles and expectations of proper behaviour by actors, guiding interactions and actions performed by actors. Formal rules constitute the regulative environment in which a system operates.

Actors within a regime internalize and reproduce these rules and have a clear role prescribed by the regime rules. Because a regime is a set of interlinked rules, altering a rule affects other rules. Change does take place, but in an incremental way along the lines of the regime rules. This is referred to as 'dynamic stability'. Regimes are characterized by these lock-in mechanisms, the different dimensions of the regime all developing along predictable trajectories that are interlinked.

However, external pressures from the landscape might disrupt the stability of the interconnected rule-sets and create tensions. This makes a regime more fluid and opens it up for new configurations and elements, introducing radical change.

2.2.3. Niches

The MLP defines the niche-level as the locus for experimentation and innovation. A niche refers to specific space outside or on the fringe of a regime that offers (partial) protection from the selection environment of the regime, where the regime rules often completely accommodate existing mainstream technologies and thus form a huge barrier for innovation. These niches are carried by experimental projects that are protected through the dedication of resources by certain actors or networks (Grin, Rotmans, & Schot, 2010, p. 22).

For a socio-technical innovation to break through and reach mainstream application, timing is of the essence: when regime stability is under pressure due to landscape factors, a niche-technology should be available that is sufficiently developed and stable to be (potentially) able to resolve the regime tensions. The interaction of the different levels forms the basis for transitions.

2.2.4. Transition typology

Transitions can unfold in different ways depending on timing and the nature of interactions between the different levels. Taking this into account, Geels and Schot have expanded on different transition pathways. This results in four categories of transition as opposed to the baseline of no change and mere regime reproduction (Geels & Schot, 2007, pp. 406-413):

1. Transformation pathway

Moderate landscape pressures at a time when no sufficiently developed niche alternatives are available force a regime to change its own direction and innovation activities. Compatible niche-innovation can be added to the regime.

2. De-alignment and re-alignment pathway

Diverse, sudden and intense landscape pressures erode the regime while no sufficiently developed niche-innovation is available to replace the regime or its elements. For a time, several niche-innovations will develop in a competitive environment, eventually giving dominance to one of the niche-innovations. A new regime will form around the dominant innovation.

3. Technological substitution pathway

Diverse, sudden and intense landscape pressures occur while a niche-innovation is sufficiently developed. The innovation will replace the regime.

4. Reconfiguration pathway

Local problems in regimes lead to the adoption of developed niche-innovations that are compatible with the regime. Their incorporation triggers further socio-technical change.

These categorizations help understand the transitions a researcher might encounter and the ways in which it might develop. After an MLP-analysis, one is able to identify what kind of transition (or combination of transition types) is unfolding through this typology.

2.3.Niche Development

An objective of this research is to study a local case (prepaid water meters in Otjiwarongo, Namibia) and evaluate its success (see section 2.4 for the definition of success). The local case forms an experimental project on the niche-level that is connected to a global niche, which will be explained in the next section. As mentioned before, the MLP needs to be complemented with other theories to further analyze what is happening at different levels. To analyze how niche-innovation is proceeding and further stabilizing the rules of a niche, the framework of Strategic Niche Management is often used in tandem with the MLP. This will be the first way of looking at the case study in this thesis.

The case-study in this research revolves around a niche-innovation that is applied by a central actor to reach its goals in a local community, and the adoption is decided on by this central actor without a choice for the receiving users in the community. The central actor is trying to shape a project to fit its goals and the extent to which it succeeds depends on the agency this actor can perform: the capacity to act and exercise power and its limits.

Because MLP and SNM are very much about structure, a common criticism has been that SNM presents a framework that is about managing innovation processes in a linear way following the structure of the three internal niche-processes (Lovell, 2007).⁵ A promising theory to supplement SNM with more focus on agency is that of sociological translation, first formulated by Callon (1986). Therefore, this lens will be employed to re-assess the local case in a second analysis. Both the approaches of SNM and sociological translation are further explained below.

⁵ Although work has been done that specifically employs SNM to highlight the non-linear character of processes of socio-technical change (see Geels and Raven (2006)).

2.3.1. Global niche and local experiments

Looking at niche innovations and niche actors, it is useful to make the distinction between global niches and local experiments and practices. This helps distinguish the dynamics at different levels. Inspired by Law & Callon (1994), the local-global distinction in SNM focuses on how the local network and the global network function, what roles they play and how they interact.

Actors in the global network are involved in the niche, but at a distance from the individual projects. They provide support through resources: financial, political and technical. The local network consists of the actors setting up the project, developing it further and aligning actors and expectations with(in) the local context (Geels & Raven, 2006, pp. 377-378).

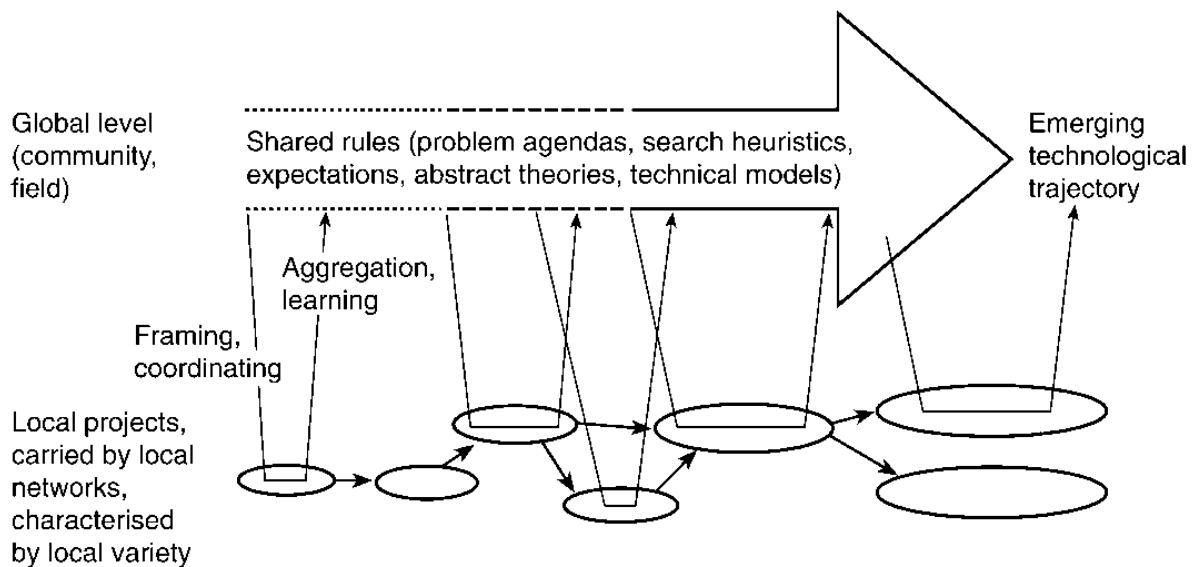


Figure 9: Visualization of the relation between a global niche and local experiments (Geels & Raven, 2006, p. 379).

Interaction between the local and global niche level goes both ways: the adaptation of generic concepts to a specific local context of local lessons feeding back into global rules. This is illustrated in Figure 9. Earlier research has observed these processes, but warns that these transfers/translations are difficult (Raven, Heiskanen, Lovio, Hodson, & Brohmann, 2008, p. 475).

2.3.2. Strategic Niche Management

Strategic Niche Management (SNM) is a field of study aimed at better understanding what happens at the lowest level: that of the niche. Closely related to the MLP, its core assumption is that sustainable innovation can be facilitated through the creation of technological niches (Grin, Rotmans, & Schot, 2010, p. 80). Creating such niches would allow an innovation to further develop by only gradually exposing it to market forces and actively creating protective spaces in which not only the technology evolves, but also the user practices and societal and regulatory structures in interaction with each other. When a project can develop in such a protected space, room is made for experimentation in a real-world setting. Central to the SNM-framework are three internal niche processes: (1) articulation of expectations and visions, (2) the building of networks and (3) learning processes.

2.3.2.1. *Actor Networks*

For niche-experiments it is considered to be important to have all the actors engaged that are involved in the innovation and its societal application. By having them on board, the experiment is more likely to resemble the real world context. A network should be both broad and deep: broad means including a wide range of actors that is involved and deep refers to the commitment of actors and ability to mobilize resources.

2.3.2.2. *Expectations*

Expectations fulfill an important role in niche-experiments: they provide direction to learning processes, attract attention and serve as legitimization for the protection that is given to the experiment. The expectations can be evaluated along three criteria: specificity, robustness and quality.

Specificity is important, because too general expectations do not provide enough guidance. Expectations can be on different levels: the macro-level of visions and promises that are the driving force behind certain efforts. Meso-levels tell more about the functionality of an innovation: what should it do, what functions can it fulfill. Micro-level expectations are specific and help formulate exact goals and requirements for an innovation (van Lente, 1993, pp. 181-183).

The **robustness** of expectations pertains to the fact whether the expectations are shared by the involved actors. The **quality** of expectations refers to whether expectation are in fact substantiated by earlier projects or experience (Grin, Rotmans, & Schot, 2010, p. 82).

2.3.2.3. *Learning processes*

For an experiment actually to contribute to the development and formation of a stable niche it is crucial to process the experience on the different dimensions of the innovation. There are several ways of learning that can be identified: (1) *learning by searching* is the research that might lead to new knowledge on a technology (know-why), (2) *learning by doing* takes place by actually producing artefacts of technology (know-how), (3) *learning by using* is done when a technology is actually used in its intended context and (4) *learning by interaction* happens by deliberate communication between different involved actors (e.g. producers and users) (Kamp, Smits, & Andriessse, 2004, pp. 1627-1628). Which ways of learning take places depends on the network of actors in the experiment and the formulated expectations.

Furthermore, there is a distinction between first-order learning and second-order learning. First-order learning is the direct feedback of technical and user experiences. Second-order learning is a reflection on the underlying assumptions about socio-technical systems (the niche as well as the involved regime). The last kind of learning helps reflect on the feasibility and desirability of a niche-innovation (Raven, 2006, p. 584).

2.3.2.4. *Application of the SNM-perspective*

SNM is useful both for analyzing global niches and their development as well as the individual niche-experiments. Furthermore, as the name Strategic Niche Management implies, it cannot only be used as an analytical tool but also as a managerial one, assisting in setting up and facilitating niche-experiments. A common misunderstanding implies that innovation always starts bottom-up and that niche development triggers transition is corrected by the different transition pathways that have been elaborated on in section 2.2.4.

By analyzing niche-experiments through SNM, the transition potential of a niche-innovation can be evaluated. When internal niche-processes are done in the ways described above, niche-experiments can add to the stability of the global niche and its trajectory, improving the chance of taking advantage of opportunity windows in the regime and increasing the transition potential of the niche-innovation.

SNM-analysis has been applied to a wide range of niche-experiments, mostly in western contexts and in systems of energy and mobility. A diversification to projects in developing countries has taken place as well as a diversification of the types of socio-technical systems in focus.⁶

In this research, an SNM analysis is conducted on a local experiment with prepaid water meters in the context of a developing country (Namibia) and an innovation for supplying a basic need for human existence and development (water) that is experimented with by one actor on the fringe of a regime (a local authority that is on the interface between the water supply regime and the local community of users).

2.3.3. Sociological translation

To shine more light on the dynamics of the local experiment a second analysis is conducted with more focus on the interactions between actors in the experiment and the agency the principal actor (the local authority) performs. The theory of sociological translation is a useful tool for this. It helps understand conflict better. Actors are wielding their agency to reach their own goals that might be (potentially) contradictory; the outcome thus depends on which actor managed to gain prominence by positioning itself as an obligatory passage point.

This theory of sociological translation (short: translation) originates from the sociological field of Actor-Network Theory. Translation is the process of forming a network, forging alliances and mobilizing actors in achieving a certain goal. Power and influence are key factors in forming of a heterogeneous network. This *heterogeneous* character is emphasized as actors engage as much in negotiation with intermediary technologies and pieces of the natural world as they do with other human actors. This process, dubbed 'translation' by Callon, is aimed at forming a network in which one actor represents the whole network by positioning itself as an *Obligatory Passage Point* in which it controls the outcome of certain interactions (Callon, 1986, p. 214). Actors that are translated can be either intermediaries or mediators. Intermediaries are actors that merely pass on 'meaning', while mediators are actors that transform their input (Latour, 2005, p. 39). This translation-process proceeds through the four steps of sociological translation:

2.3.3.1. Problematization

In the *problematization* step, the translating actor is to phrase its goal in such a way that it is a concrete problem for which other actors can be interested. By problematizing in such a way that the actor is an indispensable node in the network, it tries to establish itself as the *obligatory passage point* (OPP). Here, visions can be rephrased as more concrete expectations in which the translating actor plays an indispensable role.

⁶ See Grin et al. (2010, p. 83) and Raven et al. (2008, p. 465) for summaries of scholarly works on the applications of SNM. Also, several master theses have explored application of SNM in context of developing countries (e.g. Drinkwaard (2009) and Heijnen (2010)). Other research has assessed the potential of SNM for analyzing different kinds of innovation (e.g. Witkamp et al. (2011)).

2.3.3.2. *Interessement*

After this problem is phrased, the actors needed in the network have to be indeed interested to form the alliance with the translating actor. This is done through *devices of interessement*, which can be means of creating joint interests, interesting the other in the 'problem' or using instruments of power and force. Interessement is done with a vision of what the to-be enrolled actors want and also what competing actor-networks there might be; making clear the interest in joining the network and simultaneously blocking other associations that could prevent the establishment of the actor as OPP.

2.3.3.3. *Enrolment*

If the interessement succeeds, actors become enrolled in the network. This requires further negotiation and compromising, continuing the 'discussion' between the translating actor and the actors in its network and a continued deployment of the (refined) devices of interessement.

2.3.3.4. *Mobilization of allies*

This stage is about representation in which it will become clear whether the translating actor can really deal with their other actors as representatives of their respective backgrounds and whether the translating actor in turn can truly speak on their behalf. It shows whether it has indeed become the Obligatory Passage Point or that the translation has failed. By reducing a large population to spokespersons, the network can be more easily handled and translation can proceed. As Callon (1986, p. 209) puts it: "To mobilize, as the word indicates, is to render entities mobile which were not so beforehand. (...) Through the designation of successive spokesmen and the settlement of a series of equivalencies, all these actors are first displaced and then reassembled at a certain place at a particular time".

2.3.3.5. *Application of translation*

The translation is an on-going process: managing the actor-network, being able to represent actors and keeping dissidence in check is a task that requires permanent attention. This conceptualization of translation puts emphasis on the agency of actors and their (in)ability to establish themselves as an obligatory passage point and a single representative of a heterogeneous group of human and non-human (natural, technical) actors. This way, it provides insight *why* and *how* certain actors for a certain amount of time succeed in acting as representative of a big heterogeneous network and being an indispensable node in it.

So when translation is successful (at least for some time), the translating actor has convinced the actors in its network to accept the role the translating actor needs them to fulfil to reach its own goals.

2.4. Success/performance of the niche-experiment

The above two approaches (SNM and translation) help evaluate a local experiment with a niche-innovation in terms of its **transition potential** (SNM) and **successful translation** (whether a translating actor reaches its goals by successfully forming an actor-network). It is thus possible that successful translation occurs in a project, but that the innovation still has no transition potential. Together they provide a more complete picture on the status of the experimentation project.

A third way of defining success is in terms of **sustainability** because this is the explicitly mentioned vision on water supplied shared by regime actors, and also by the initiating actor of this niche-

experiment (local authorities in general, municipality of Otjiwarongo in particular). Therefore, it is useful to define the broadly – and often carelessly – used concept of sustainability and sustainable development.

2.4.1. Combining SNM and translation

An effort at combining SNM and translation is done by Raven et al. (2011). Their analysis helps see agency performed by the translating actor in terms of the internal niche-processes in SNM. The authors try to explicitly link the translation moments to niche-dynamics:

“Problematization translates previous experiences and perceived opportunities in the wider context into a new expectation. Intersement translates that expectation into networking activities. Enrolment means that actors truly accept their new position in the network and start a process of experimenting and learning. Mobilisation might translate the lessons into wider niche and or regime networks.” (Raven, Verbong, Schilpzand, & Witkamp, 2011, p. 1077)

Also, the research establishes that the translation-approach gives more attention to the specific interaction – who is the action aimed at, and who acts? – and identifies the mechanisms deployed in the several stages of translation. The authors argue that the translation perspective helped them establish how far the translating actor has come in creating its niche-experiments (halfway, in their case-study) and from the SNM perspective they take what future actions the actor could undertake.⁷

2.4.2. Sustainability as measure of success: sustainable development in water supply

Sustainable development was defined by the Brundtland-report (commissioned by the United Nations) in 1987 as to ‘meet present needs without compromising the ability of future generations to meet their needs’. Sustainability can be broadly divided in three categories: environmental, social and financial (Adams, 2006).

For the socio-technical system that is water supply, **environmental sustainability** means that water is won in quantities that do not exceed the natural repletion rate of water in rivers, lakes and aquifers (underground reservoirs). Also, the abstraction and processing (transport, purification, storage) of the water should not irreparably harm the natural environment and reduce the possibilities of producing safe drinking water in the future.

Financial sustainability means water is produced, purified and supplied to users in a way that is financially feasible. Whoever bears (part of) the costs of supplying water, should be able to do so in the future as well. Several strategies are possible to achieve financial sustainability, one of which is to make sure the end user of the water pays the costs that his water usage took to produce. This is an approach that has gained prominence.

A water supply that is **socially sustainable** should incorporate whether water is available to all people that need it. The fact that drinking water is a basic necessity for every human being brings forth that water should be distributed in such a way that anyone has the possibility to fulfill their basic needs for water. This includes physical proximity of a source of drinking water, but also the

⁷ It has often been a fine line between the analytical and managerial character of strategic niche management, they blend easily. This makes for confusion at times, but is also one of the attractive sides of the theory: providing insight as well as concrete suggestions for future policy.

ability to use the water (being affordable and having enough water at one's disposal for their daily use).

2.4.2.1. Environmental sustainability of Namibian water supply

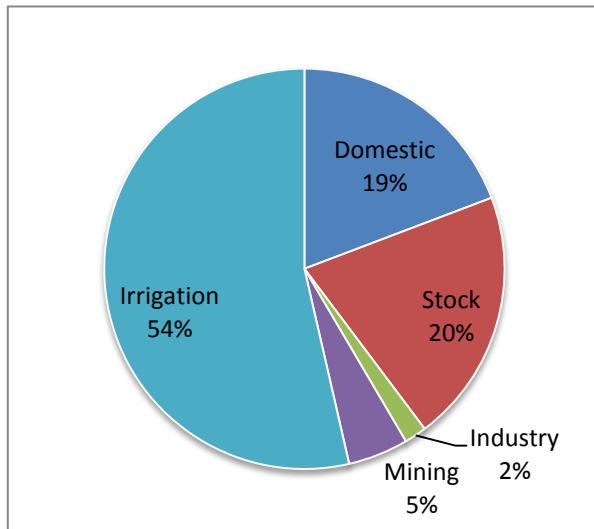


Figure 10: Water consumption in Namibia in 2005 per use (total: 390 million m³) (Heyns, 2005).

Since Namibia is a very arid country, water supply is an issue that receives a lot of attention. Water is available from the various sources that are short in Namibia. According to Heyns (2005, pp. 92-93) Namibia is in a state of absolute water scarcity, where the water availability per capita is less than the norm suggested to be able to achieve sustainable socio-economic growth.

Of the total amount of water in Namibia, the biggest part is used for (subsistence) agriculture since this is very irrigation-intensive in a country

with sparse and unpredictable precipitation. Domestic use, the focus of this research, counts for about a fifth of the total consumption (see Figure 10).

NamWater, the supplier of drinking water in bulk to municipalities and large private clients, reports no problems with supplying enough domestic water now or in the near future. NamWater has a policy of determining the maximum sustainable yield of different water sources to ensure that the resources are not consumed too fast. Furthermore, alternative sources of (drinking) water are examined, for example through water reclamation plants or sea water desalination.

Besides the existing natural circumstances and the growing pressure of population growth, climate change poses big uncertainties for the sustainability of Namibia's water supply. The consequences are hard to predict, but are likely to include longer and more frequent periods of drought as well as harder to predict and heavier rain seasons (Reid, Sahlén, Stage, & MacGregor, 2007).

Although environmental sustainability is definitely an important issue for long-term water supply in Namibia, it is not a main driver of change in this study of water supply. Water supply in most places is not hampered by the shortage of water sources. For Otjiwarongo, a NamWater official stated the water supply capacity to be enough in the foreseeable future, with the option of expanding the capacity when needed [7; 11]. In places where water is in short supply, it is because of the lack of infrastructure rather than the absence of water sources [17].

2.4.2.2. Financial sustainability of Namibian water supply

The issue of financial sustainability is one of great importance for Namibian policy and the changes to water supply that have been implemented such as the prepaid water meter. Providing water supply in Namibia is an expensive endeavour: according to Banerjee et al. (2008, p. 60) US\$80 per capita are spent annually on water supply and sanitation services, where no other countries in sub-Saharan Africa spends more than US\$10 per capita per year. Explanations for this can be found in the arid conditions of Namibia and its very sparse population: extensive infrastructure is needed to

serve small remote communities. Since independence, Namibia's policy makers have moved from a situation where financial loss of water was covered by the national government to a structure in which the water supply sector has to sustain itself without 'outside' subsidies. These developments have led to the establishment of NamWater as a publicly-owned but separate entity charged with supplying water in bulk. Subsequently, steep tariff increases were implemented to make the price of water more cost-reflective and reduce the need for subsidies by the government to NamWater. Responsibility to pay these bills was shifted to local authorities that had to collect these payments from their residents.

Thus, over time, the financial sustainability was no longer guaranteed through the national budget but by recovering the costs from the end users of water. This is a development that is of great importance to this research. The new central notion in service provision became 'full cost-recovery', which means that tariffs that end-users have to pay include the operation and maintenance costs of the infrastructure as well as organizational overhead and investments.

2.4.2.3. Social sustainability of Namibian water supply

Clean drinking water is of importance to a healthy society and its development. This is reflected by the fact that it is an important part of the aforementioned Millennium Development Goals (MDGs) and the undisputed position of water as a very basic need.⁸ Scholars have attempted to further substantiate the gains from clean water (or conversely, the losses due to lack of safe water supply). Hutton et al. (2007) for example have tried to calculate the gains of investments in water supply and sanitation in terms of health cost savings and other positive societal returns. Their different analyses have found that every US\$1 of investment has a return between US\$5 and US\$46.⁹

The figures of water access in Namibia mentioned earlier are hopeful in this light. However, the equitable distribution of water is as important to social stability as equitable distribution of wealth. The aforementioned economic inequality in Namibia has its impact on the access to water as well due to the cost-recovery paradigm in water supply. Because of the need to pay the full costs of every unit of water, availability of water is related to the availability of monetary resources to members of society. A rule-of-thumb used is the 5%-rule: water is considered affordable when households have to pay less than five percent of the household income for their water consumption. Although McPhail (1993) has tested this assumption and found that poor Moroccan households were willing to pay slightly more, it is clear that there is a limit to what poor households can spend on water.

For a socially sustainable water supply, it is important that people are able to consume water in sufficient amounts to sustain lives and livelihood. Literature on this differs on what amounts are sufficient. Howard and Bartram (2003) make a distinction between different levels of water service requirements. Their optimal level requires 100 liters per capita per day to enable full uses minimizing health concerns. The intermediate level is 50 l/c/d where all basic needs should be fulfilled and some additional washing and bathing is possible, qualifying total health risk as low. The other two levels of

⁸ For example in the well-known 'hierarchy of needs' by Maslow, which orders human needs in hierarchical order to show how more sophisticated needs rely on the fundamental ones, like access to sufficient amounts of food and water.

⁹ Depending on the calculation, the context (developing country or least developed country) and the chosen mode of intervention (protected water source, the presence of purification/disinfection, the access to water in households). Often, water supply and sanitation are being treated together, because they are two sides of the same coin. This research, however, focusses purely on water supply.

basic access (<20 l/c/d) and no access (<5 l/c/d) are seen as posing high risks for health and can be deemed unsustainable.

It is not exactly sure what criteria Namibia officially has at present, but in the second national development plan (2001-2006) it was set at 15 liters per capita per day (DRFN, 2005, p. 11).

Also, the way in which water is supplied differs for different strata of society. In Namibia, formal-sector households often have an individual household connection indoors. For the earlier mentioned informal-sector inhabitants of Namibian towns, communal standpipes are provided in public places. This means people have to share a tap with several other inhabitants of their neighborhood (in Otjiwarongo there is roughly one standpipe per 250 informal-sector residents).

The differences in access to water points and the extent to which people can actually get water from them are issues of great importance and points of contestation when discussing Namibian water supply and the prepaid water innovation.

2.5. Methodology

This research has a strongly qualitative character. A large part of the data was collected in Namibia and mainly in the town of Otjiwarongo, which is the focus of the case-study in this thesis. This was supplemented by documents providing further context to Namibia's water supply and the prepaid water experiment in Otjiwarongo.

2.5.1. Literature study

To provide context to Namibia and its water supply in particular, documents form an important source of data in this research. From the MLP perspective, the characterization of the landscape requires an overview and sense of historical background that was obtained from a diverse range of sources: both primary (official documents, correspondence, newspaper articles) and scholarly (on Namibia and Southern Africa, on water supply developments and the effects of prepaid water technology). Regime developments were traced partly through official documents providing insight on regulative regime rules and validating information obtained through interviews. Lastly, documents furnished some quantitative data for illustrative purposes and to provide background information.

2.5.2. Semi-structured interviews

The main part of the research conducted in Namibia consisted of interviews that were conducted in a semi-structured way. The MLP and SNM approaches have several theoretical concepts that guided part of the interviews. Additionally, interviewees were given a lot of space to elaborate and reflect on developments and ongoing processes. This proved to be useful for the ANT-approach of translation that prescribes 'following the actors' and refraining from applying any categorization beforehand.

The interviews were conducted with regime actors and niche actors as well as some outside experts. Many interviewees are associated with the municipality of Otjiwarongo that is both an actor within the water supply regime as well as the initiating actor for the local experiment with prepaid water meters. A list of interviews can be found in the appendix.

2.5.3. Observations

A third technique involved personal observation. This helped bring to the fore issues or practices that were not deemed important enough to mention by interviewees but do provide additional information or context to the research.

2.5.4. Limitations of the research

In qualitative research, the researcher him/herself is a key instrument: collecting data and applying a theoretical and interpretative lens, which cannot be seen separately from the researcher's background and interests (Creswell, 2009, p. 175). Also, the forms of data collection each have their advantages and drawbacks, the latter I tried to ameliorate through cross-checking interviews with written documents and observations. Furthermore, case-study research is hard to generalize and/or replicate exactly. This is however not the intention of this research, but rather to provide insight in the dynamics of the specific case in relation to a broader context and in that way try to add to the growing body of empirical work in transition studies as well as that of water supply issues.

3. Multi-level perspective on a transition to sustainable water supply

Action to achieve a sustainable water supply is not limited to Otjiwarongo or Namibia, but consists of multiple developments on different levels, colliding and concurring and together shaping the outcomes.

This chapter will help understand the developments leading to the choice for prepaid water meters as a means to deliver water to residents of Otjiwarongo, Namibia. Through the Multi-level Perspective (MLP) on transitions, developments are positioned in three main levels of the socio-technical system: the landscape, the regime and socio-technical niches. The chapter provides insight how landscape factors evoked a shift within the water supply regime in Namibia in moving towards a sustainable water supply. The evolution of the regime creates certain new tensions that stimulate actors to look for more effective ways of delivering water and retrieving costs which resulted in local experiments with the niche-technology of prepaid water meters. Through the lens of the MLP, these dynamics can be understood and seen in relation to each other. The chapter will establish to which extent the MLP framework explains the influence of the different levels on each other and how these lead to the adoption of the niche-innovation of prepaid water meters.

3.1. Landscape factors and developments

The socio-technical landscape is the metaphor for broad societal processes that exert influence on regimes and niches. The landscape is the set of institutions and processes at international and national level, which are too big in scope to be influenced by regime and niche-actors on short notice. Like a landscape, these are a given that actors have to deal with or in which they would have to invest huge amounts of resources to reshape.

The landscape sets the stage on which a regime operates. Discrepancies between landscape factors and regime rules lead to tension, which inform the need for change and create space and momentum for niche innovations. Landscape factors inform the prevailing or changing visions on the different dimensions of regimes such as water provision.

3.1.1. The political, social and economic background of Namibia

Namibia is one of the last countries in Africa to become independent, gaining independence in 1990 from South-African rule. Under South-African rule, Namibia was governed in a very centralist way and had to deal with the institutionalized discrimination and segregation of the apartheid-system. After armed struggle in the 1980s and international pressure and negotiations, a multi-party, multi-ethnic democracy was instated. Although independent, it still has a strong orientation towards South Africa.

Economic inequality: great diversity in people to service

As mentioned in the introduction, Namibia deals with high unemployment and a very uneven distribution of wealth in society. In interviews, Namibian government officials consequently state unemployment and poverty are as being among the main challenges for the country to address. In Otjiwarongo, this is also named as one of the main issues (The Namibian, 2010a). This means that authorities have to provide service to a people in greatly varying socio-economic conditions.

Physical ordering of cities in rich and poor, rooted in apartheid.

The physical legacy of apartheid is the separation between the city centre and peripheral townships in urban centers. The former was historically intended for the white elite and the latter for the

discriminated black majority. Since the abolition of apartheid, this racial segregation is no longer in effect, but the spatial division is still there. Nowadays, this divide is between middle and upper class in the city centre and the (large) lower-middle class and urban poor in the townships. On the outskirts of the townships there are ever growing informal settlements: due to rural-urban migration, low-skilled unemployed people arrive in towns and have to settle on land outside the town.

Political legacy of apartheid

The historical burden of apartheid is still very much present in Namibian politics. Interviewees stated that differences in service standards reminded them of apartheid. This is an important sentiment that politicians on different levels act on. The issues of inequality and lack of emancipation are invoked in statements like ‘using communal standpipes is humiliating for our people’ or that dry toilets remind people of apartheid-era sanitation facilities [12; 17]. An important issue in Namibian politics is the need for more empowerment and emancipation of the black majority. Although political emancipation has taken place, economic emancipation lags behind. The provision of employment and services is therefore an important point in Namibian politics and water service often plays a prominent part in elections and political campaigning.

Orientation towards South Africa

After independence, Namibia remained very much oriented towards South Africa. As Namibia’s biggest and richest neighbor, with a shared recent political history, it is often taken as an example by Namibia’s policy makers when looking for solutions. With Namibia being a small country population-wise with only limited domestic industrial and agricultural production, it imports many of its industrial and agricultural goods from South Africa, as well as a substantial share of its energy needs. Also, South African companies are very active in Namibia’s economy. In the context of water supply, it seems that the Namibian choice for prepaid water solutions has been inspired by South Africa, where prepayment of water is applied more than in any other country. Prepayment for services has been further developed and adopted to African needs in South Africa since the 1980s as an answer to public utilities’ non-payment problems (von Schnitzler, 2008, p. 910). Also, politicians and government officials in Namibia speak in the same terms as their South African counterparts: ‘culture of non-payment’ as a heritage of anti-apartheid resistance is an important argument for prepaid water meters and educating people on economic value of water.

3.1.2. Sustainable development and policy goals

Millennium Development Goals

The Millennium Development Goals (MDGs) are internationally agreed upon development targets. These are eight goals aiming at improving basic social and economic conditions on a global scale by 2015. The government of Namibia has declared itself to be committed to the MDGs and to use them as a “rallying point for development efforts and resource allocation for optimal outputs” (National Planning Commission, 2008, p. III).

Goal 7 includes the target to halve the number of people that do not have access to sustainable access to safe drinking water and sanitation.¹⁰ Namibia is likely to reach its targets for drinking

¹⁰ More information about the Millennium Development Goals can be found on the website of the United Nations Development Programme: <http://www.undp.org/>.

water, with a (formally statistically defined) coverage of almost 100% in urban areas and 80% in rural areas (National Planning Commission, 2008, p. 42). However, this does not take into account the extent to which people can really get water from the source in their neighborhood.

Sustainability and 'Vision 2030'

A leading document for Namibian government policy is the Vision 2030, formulated in 2004 to guide Namibia in the transition to a developed and industrialized nation in 2030. The document has as its core message to achieve by 2030 “a prosperous and industrialized Namibia, developed by her human resources, enjoying peace, harmony and political stability” (Republic of Namibia, 2004, p. 38). The document stresses the need for sustainable and equitable development and is cited by many officials and government documents to be an important guide for their policies.

The Vision 2030 mentions water in the contexts of health and sustainable development. Related to health and poverty reduction access to water for everyone is acknowledged to be of main importance. However, also cost-recovery is highlighted in statements like the following: “By 2030, equitable access to water should be supported by water pricing that reflects the cost of water supply, with subsidies being fully transparent and mainly restricted to lifeline amounts for low income users” (Republic of Namibia, 2004, p. 139).

It is not made clear how the goals to increase water access and to increase cost recovery are to be reconciled.

Water resource development and management

International streams of thinking that get imported into the southern African context are of great influence on water development policies. Thinking about the management of water resources is heavily influenced by growing attention for environmentally sustainable water abstraction in relation to the demand. Water demand management (WDM) has become the generally accepted paradigm on which policy is built. WDM's central point is pricing policy, driving towards establishing tariffs incorporating full cost-recovery.

These narratives are supported by the projection of environmental concerns onto southern Africa. Qualifications like ‘absolute water scarcity’ are imported into national policy to make the case for reforms along WDM –lines (McDonald & Ruiters, 2005, pp. 51-56).

3.1.3. Visions on service provision in Namibia

In general, Namibia has been moving away from service provision by the government since independence. This is in line with global developments and thinking about service provision. As part of the neo-liberal vision that has gained prominence, the task of the government is seen as regulator and facilitator, whereas actual service provision is better left to companies or company-like structures. The rationale is that market parties are better at providing services efficiently and effectively. Many important international institutions have promoted this view on governance, institutes that influence Namibian policy makers.

Several developments have come forth from this shift in thinking. These range from full privatization (selling off public assets to private sector parties) through commercialization/corporatization (establishing public entities as separate units, functioning as a commercial enterprise) to outsourcing (having certain parts of service provision done by private companies).

The World Bank, an important international financial institution and often leading on what constitutes the right way of providing public services, has committed several of its annual World Development Reports to infrastructure and the provision of services. In those, they promote the delivery of services through commercialized and financially sustainable enterprises. For example, the 1994 World Development Report by the World Bank presented an agenda for reform that relies heavily on market mechanisms like introducing competition, managing infrastructure like a business and supporting private involvement (World Bank, 1994, p. 2)

A link can therefore be seen between these international developments in thinking and Namibian developments since the 1990s. The traits of the neo-liberal thoughts together with the idea of demand management can be found in the rationale for the commercialization of water and electricity services in Namibia. Another example can be found in the yearly IMF's consultation with Namibia in which it welcomes Namibia's public enterprise reform and encourages a concrete privatization plan (IMF, 2002).

McDonald and Ruiters (2005, pp. 32-35) have identified five main types of driving actors behind privatization/commercialization of public services in southern Africa:

1. (International) firms

Companies that see chances in the privatization or the outsourcing of public services are actively promoting these processes. Also, consultants that are hired to investigate appropriate ways of service delivery often have a strong pro-privatization attitude.

2. Lenders and donors (International financial institutes and bilateral development agencies)

These actors, like the World Bank or USAID, promote such privatization/commercialization processes by adding conditions to their loans or aid. These conditions often relate to different forms of private sector involvement in public service provision.

3. Government at different levels

When tied to these conditions, governments themselves become propagators of the privatization/commercialization processes. These are enabled through legislation and public tenders for services and assets.

4. NGOs

Local and international NGOs have been promoting pro-privatization reform, sometimes through umbrella platforms like the World Water Council.

5. Media

From an inventory done by McDonald and Ruiters, media in southern Africa had a tendency to report favorably about private sector involvement and processes of privatization and commercialization. This influences public opinion as well as lawmakers.

Thus a wide array of actors have been active in promoting a new attitude towards service provision, championing a more market-based approach with either introducing private sector parties to service provision or market mechanisms to public entities.

Electricity services

An important landscape development is the institutional change in electricity distribution in Namibia. The distribution of electricity in Namibia used to be the responsibility of local and regional authorities. As an outcome of the new Electricity Act of 2000 and the wish to restructure the energy market, the supply of energy to customers was moved away from the local authorities to newly formed Regional Electricity Distributors (REDs). These REDs now supply energy to customers and bill them directly. A number of reasons were presented: including the financial viability of the new entities, the possibility for private sector participation and the perceived unsustainability of local authorities' practice of using electricity revenue to finance other services (Electricity Control Board, 2006, p. 2). Local authorities are shareholder of these newly formed entities and also receive some compensation for the loss of electricity revenue, this compensation is called the 'LA Surcharge' where LA stands for 'local authority' (Electricity Control Board, 2007).

This particular policy change is cited by municipality officials in Otjiwarongo as particularly important because the loss of revenue meant that they had to reconsider their income and expenditure. They receive the LA surcharge, but in real value this is a diminishing source of income. The first few years this 'softened the blow' but the surcharge will be increasingly insufficient to cover municipal expenses. Also the amount of the LA Surcharge is determined by the Electricity Control Board, so beyond the control of the LA. Furthermore, this surcharge is to disappear after a period of some years, to be replaced by dividend payments by the REDs, an even less dependable source of income for the LA (Electricity Control Board, 2006, pp. 14, 34). In interviews with various officials, the reallocation of electricity revenue is cited as one of the main reasons to closer examine water revenue and the possibility of cost recovery and recovering unpaid bills [1; 6; 8].

3.1.4. Decentralization

In many African countries, decentralization has gained prominence in many African nation. This was part of structural adjustment programs promoted by the World Bank (Ndegwa, 2002). Since independence in the 1990s the Namibian government has embarked on a course of decentralization: regional and local authorities are seen as the appropriate level of decision making and governance of services. This policy of decentralization is argued to lead to more democracy and development as well as efficiency. This is codified in the in the Regional Councils Act and the Local Authorities Act, both of 1992 and implemented over the course of the following years.

As part of decentralization policy, Namibian municipalities have to be financially self-sustaining, where they balance their expenses on 'non-income generating' services with revenue from rents, taxes and municipal services.

According to the category of local authority, the authority is responsible for certain services. The four types of local authority are (1) part 1 municipality, (2) part 2 municipality, (3) town and (4) village. The first three categories were initially assigned the responsibility for water and electricity distribution, refuse collection and street maintenance. Villages, the last category, are responsible for water distribution only (Pietilä, 2005). The decentralized responsibility for water is also explicitly stated in the Water Supply and Sanitation Sector policy of 2008 where "local authorities and regional

councils will be responsible for implementation of water supply and sanitation in the urbanized areas” (MAWF, 2008, p. 2).

Otjiwarongo classifies as a part 2 municipality and is thus responsible for its own water distribution as well as the other municipal services mentioned above. As mentioned in section 3.1.3, electricity distribution was moved from municipalities to the more centralized Regional Energy Distributors (REDs). This not only meant a reduction in work, but more important a decrease in income that was used to finance ‘non-income generating’ (i.e. loss-making) municipal services.

3.2. Water supply regime in Namibia

A socio-technical regime consists of rules embedded in institutions. These rules can be divided into three categories: cognitive, regulatory and normative. Together the rules constitute the established way of doing things, in this case: how water is supplied, by and through whom and who is paying what. This section will explore the water supply regime in Namibia. By discussing its history, linking to the aforementioned landscape factors and exploring the involved actors, the character and structure of the water supply regime become clear. The main observation is that the Namibian water supply regime has evolved since independence until the present day from a public service regime to a commercialized regime.

3.2.1. History of the Namibian water supply regime

Before Namibian independence, the South African Water Act of 1956 was in effect and the water affairs of South-West Africa were managed by the Department of Water Affairs (DWA). The act and the DWA have been guiding in the construction and management of water supply systems in the decades before independence.

After independence, the DWA was integrated in the newly formed Ministry of Agriculture, Water and Rural affairs (nowadays Ministry of Agriculture, Water and Forestry; MAWF) and new guidelines for water supply policy were put forward in the 1993 Water Policy. Parallel to this, the aforementioned decentralization of governance in Namibia (section 3.1.4) appointed the local authorities as responsible for urban water supply and regional authorities as responsible for rural water supply. Thus, a division between (centrally governed) bulk water supply and (decentralized) water provision to individual users was created. Consequently, the bulk water supply was deemed to be inefficient when operated by public institutions and the Namibian government chose to commercialize bulk water supply in the 1997 Namibia Water Corporation Act (Heyns, 2005). Through this act, the Namibia Water Corporation (in short: NamWater) was created to provide bulk water supply throughout the country. NamWater is fully owned by the Namibian government, but functions as a commercial company with the objective to supply sufficient quantities of water of suitable quality by cost-effective, environmentally-sound and sustainable means. To this end it can set tariffs on a basis of full-cost recovery (Republic of Namibia, 1997, pp. 6-8). NamWater’s customers are some (large) private customers and the local authorities that then have to distribute it to their residents. This means that the local authorities get presented a monthly bill based on full-cost recovery tariffs for the water consumption of their whole area of jurisdiction. The local authority can then choose how to bill their individual customers, as long as they pay their monthly NamWater bill. Cost-recovery is however emphasized in national policy and local authorities are expected to charge their residents cost-reflecting tariffs.

Further policy was developed, with the 2000 National Water Policy White Paper as a guideline for the drafting of the 2004 Water Resources Management Act. This act has been passed by parliament but has not yet commenced. A follow-up policy document was the 2008 Water Supply and Sanitation Service Policy (WSASP). Core concepts in these documents are 'sustainable water supply', 'equitable water distribution', 'decentralized governance' and 'full cost-recovery' (MAWF, 2000; MAWF, 2008; Republic of Namibia, 2004).

The tariffs that NamWater proposes have to be approved by the cabinet and then published. Regulation and legislation are the task of the government, bulk water production of NamWater and local distribution of the local authorities. Still until now some regulatory activities are not clearly allocated. They are more clearly defined and allocated in the 2004 Water Resources Management Act which is to replace the 1956 Water Act but at the time of the research (2011) has not commenced.

3.2.2. Water supply technology and infrastructure

The Namibian water supply infrastructure is comparable to that in most countries. Water is won mainly from ground water and catchment basins. These are operated by the national water corporation NamWater. They transport the water to urban areas, where it is stored in water towers or other reservoir. From here the local authority purchases the water that is required by the urban area (for residents, business, municipal watering, etc.). At this point it is metered and this is used to bill the local authority on a regular basis. The infrastructure in the urban area is property of the local authority that operates, maintains and expands it. It is responsible for transporting the water to all its residents, who have a connection in their households in the formal areas and standpipes in the informal areas.¹¹

Before (or without) the introduction of prepaid water meters, the connections are fitted with water meters that have to be read periodically by technicians of the local authority which then bills the amount used to the customer. In the case of communal standpipes, people pay a fixed amount per month, since individual use is not measured. This is schematically represented in Figure 11.

¹¹ This was the case in Otjiwarongo. In interviews with officials from smaller settlements and responsible ministries, it became clear that situation differs greatly between urban and rural areas. These places are so small that they fall under regional authorities and face more hardship due to lack of resources and political priority. They were facing lack of supplied water and a very limited number of connections. The water supply to rural areas and settlements faces a lot of challenges: some similar to urban areas, others different, in general more problematic [17; 24]. Rural water supply would warrant a research of its own.

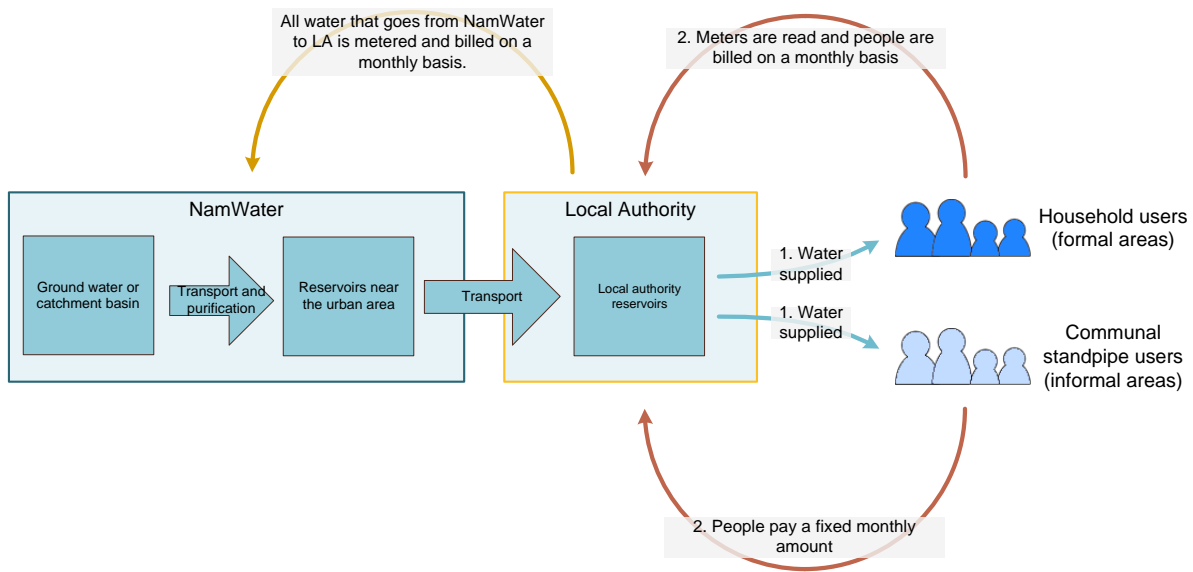


Figure 11: Production and supply of water in Namibian Water Supply Regime (without prepayment of water).

NamWater wins the water and purifies water along certain guidelines. The goal is to produce sufficient amounts of water that is safe for human consumption [7]. Municipalities do not have to further purify or test water, and Otjiwarongo does not find this necessary. It does add a chemical to reduce the hardness of the water, to reduce discomfort and scaling of equipment [9]. Water quality tests are taken on a regular basis by NamWater. In time, the quality guidelines will be replaced by standards that accord to WHO-standards when the Water Resources Act will be effectuated.

The infrastructure within many urban areas in Namibia is old and therefore water losses in the system are sometimes very high, due to leakages or faulty metering. In Otjiwarongo, the losses are below 10% most of the time, which is a good performance compared to other Namibian towns and cities (sometimes loss is up to 80%) [9].

The meters that are installed in households are regular water meters as used around the world. The meters used in Otjiwarongo cost around N\$250 (€25) per meter [26]. Most conventional meters in Otjiwarongo were quite old and required a lot of maintenance. However, the main problem is not the technical functioning of this type of meter, but the work to do the readings and the difficulty of collecting payment. This is attributed by officials to both the poor socio-economic situation of a majority of the people and what officials describe as a ‘culture of non-payment’, both landscape factors discussed in section 3.1.1.

For the great number of people living in the informal areas of urban centers, the amount they had to pay was not linked to the used amount of water: no incentive is given to use water sparingly. This did not mean that there was unlimited water: for example, in Windhoek whole neighborhoods in informal areas got cut off when the community as a whole did not pay enough or when the representatives that collected the money kept it for themselves [11]. In a large number of Namibian towns and cities, prepaid water meters were primarily applied in the informal areas of the town or city.

3.2.3. Institutionalized rules

The institutionalized rules can be categorized under the regulative and normative rules that prescribe how water should be supplied and how responsibilities are distributed.

- Water supply is a responsibility of municipalities

The general policy of decentralization in Namibia as a landscape factor has resulted in municipalities being fully responsible for providing and sustaining water services. No structural financial support is given to municipalities from a national level, but rather municipalities are supposed to be able to sustain themselves and the water supply to their residents.

- Water has to be cost effective and subject to cost recovery

A rule that is greatly emphasized in the regime is the fact that water service provision has to be financially sustainable. Through the establishment of NamWater as a public water company, this is institutionalized. NamWater is obliged to incorporate all costs in their bulk water tariffs. This automatically impacts the local authorities that get their water in bulk from NamWater. The second part of it is that in the official policy, services should be financially self-sufficient and cross-subsidization *between* water supply and other services is deemed undesirable. All services are ought to be charged in full to the users (MAWF, 2008, pp. 8-9). Important to note is that this is contradictory to the decentralization logic that local authorities are themselves responsible for delivering services and organizing this in the way they seem fit.

Cross-subsidization *within* the water sector between users is possible through rising block tariffs. This is done in several cities and towns, though not in Otjiwarongo: people pay different tariffs depending on their usage. This way, the water use for basic sustenance and quality of life is offered cheaper (so more affordable also for poorer users). Above certain thresholds of usage, people have to pay more per unit of water, so 'luxury' usage (watering gardens, washing cars, swimming pools) is more expensive than the quantity associated with basic usage. This luxury usage can then subsidize poor people's usage.

- There is one bulk supplier (NamWater)

By law, NamWater is determined to be the nation-wide supplier of bulk water. It is a company that is fully owned by the Namibian government. They are appointed to supply water to local authorities, industries and the directorate of rural water supply (part of the MAWF) that supplies water to rural communities (NamWater, 2006).

Exceptions to this are certain municipalities that have water production facilities themselves (e.g. when the sources are located within municipal territory and the facilities are owned by the municipality). This results in a bigger municipal organization, but no organizational overhead of NamWater is then included in tariffs. In general, tariffs in these towns are much lower. Another important consequence is that there is no monthly bulk water bill to be paid to NamWater. This takes away one of the main tensions that exists within the Namibian water supply regime and de-facto gives local authorities much more leeway: cross-subsidization is possible, as well as more flexibility with respect to the cost-recovery rule.

3.2.4. Other rules

Certain regime rules follow from the social, economic and cultural context of Namibia and/or water supply. These can be classified as cognitive rules, where the context shapes the way in which solutions are conceived and considered.

- Prevailing non-payment for water services

It has proven hard to collect payments for water use from all users through a post-paid billing system. This can mainly be attributed to the poor economic situation of many Namibians. Water payments have not been enforced in the past and given the small budget of many residents, payment of water bills is not a priority. A second factor is the way of thinking that water is a basic human right that should be freely available to all Namibians. Public debate is still going on about this and politicians heat up the debate during election campaigns, at times urging people to refuse payments ([8; 22]; (The Namibian, 2009)).

This practice has put local authorities in a predicament: they are subject to the regime rules that stress their full payment of bulk water but are also dealing with this non-payment on the side of their residents. Many LAs have a hard time balancing expenses and revenues and often there is a substantial amount of unpaid arrears from residents to the LAs.

- The nature of water: from merit good to commodity.

Contrary to the previous point, economists and policy makers have shifted their perception of water in the past decades. Following economic theory, water can be understood as a 'merit good', in between a public good and a private good. Public goods would normally not be provided by the market because of their non-exclusive and non-rival character, while merit goods would normally be underprovided by the market and therefore the public sector has to ensure these goods to be provided in sufficient quantities and to everyone.¹²

In recent years, the view of water as a merit good has been attacked and arguments made that water provision should be viewed as a private good, that fully responds to market forces and is to be supplied most effectively by the private sector (McDonald & Ruiters, 2005, pp. 20-21). Although, no full scale privatization has taken place in Namibia's water supply, the perception of water as a commodity has gained ground. This cognitive rule is behind the treatment of water under the rules of cost-recovery.

3.2.5. Regime actors

Local Authorities

Local Authorities (municipalities and smaller town and village administrations) are responsible for supplying water to their residents. That makes them ultimately responsible for the delivery of the water to people's taps, but also for making the water regime financially sustainable. Within the

¹² Non-rivalry means that someone enjoying a good or service would not diminish the next person's possibility to enjoy it. Non-exclusivity means that people cannot be excluded from using it. Famous examples of public goods are clean air, public lighting or national defense. Water is not entirely non-rival or non-exclusive, but if provided by the market it would almost certainly lead to private sector supplying these services to customers who can afford it, but not to a socially optimal level.

regime, costs that are made by the bulk water supplier are passed on to the local authorities in the water tariffs and the municipality is responsible for charging their residents cost-covering tariffs.

NamWater

NamWater (Namibia Water Corporation in full) was established to supply bulk water on a commercialized basis as a result of Namibia Water Corporation act of 1997. By commercializing bulk water supply, expenditure and income would have to become more balanced and accountable. The price at which water is supplied would have to reflect the costs made to abstract it from natural sources and make it fit for human consumption. NamWater's main objective is formulated as to "to provide water of an appropriate quality in sufficient and sustainable quantities, in the most cost-effective way" (NamWater, 2006).

NamWater is the main actor responsible for guarding the environmental sustainability of water supply in Namibia. They are obliged to determine the maximum sustainable yields of water sources and make sure these are not exceeded.

When supplying water to local authorities, NamWater bills them on a monthly basis and has instruments to enforce this payment. In the past, NamWater could limit water supply to whole towns and cities when payments were not met. This is not happening anymore, but in case of payment problems, NamWater has the mandate to take over municipal water supply and restructure a municipal organization through an 'intervention agreement' [7]. NamWater can set new tariffs for bulk water on an annual basis. NamWater is bound to certain regulation with respect how much tariffs are allowed to increase and the increases have to be approved by the national cabinet. NamWater is however mandated to make tariffs cost-reflective, which in practice has led to sharp increases in tariffs.

Ministry of Agriculture, Water and Forestry (MAWF)

This ministry is in charge of water affairs. They are directly responsible for rural water supply and the overall management and regulation of the water cycle and water resources in Namibia (MAWF, 2008, p. 2). The Department of Water Affairs, integrated in the ministry, used to be responsible for providing bulk water. This task was transferred to NamWater. The DWA is still responsible for water supply to rural communities [15]. Also planning and regulation fall under the DWA (Heyns, 2005, p. 92).

National Cabinet and parliament

The national cabinet of Namibia is the actor that can propose new laws that affect the regime. These laws have to be passed by vote in parliament. Also, the cabinet has to annually approve the water tariffs proposed by NamWater. Since independence, the national government has changed the water supply regime substantially, introducing many of the regime rules mentioned above. This often happened under influence of landscape developments. The parliament is the entity that passes laws. In this function, it has passed laws that changed the water supply regime in a profound way.

3.2.6. Regime evolution and emerging tensions

Since Namibian independence in 1990, the water regime has evolved under the influence of the landscape developments mentioned in section 3.1. This has led to altered and different regime rules and the creation of new actors (NamWater). This has altered the dynamics of the regime, creating

tensions along the way. Table 1 on the next page shows how the regime rules have changed compared between the water supply regime as it was shortly after independence and the present day water supply regime. This comparison is made along the seven socio-technical dimensions as suggested by Smith (2007). The changes are highlighted and reflect the aforementioned landscape factors and developments in the regime.

The main tension arising from this evolution in the Namibian water supply regime is the one between the commercialized operation of utilities in which every unit within the regime must be financially self-sustaining and the reality of the Namibian society in which it is hard to recover the costs from poor users. With the local authorities being the interface between the network of regime actors and individual members of society, it is the actor that needs to absorb these tensions. This way, municipalities are often confronted with the difficulties of collecting all the payments and at the same time fulfilling its own payments to NamWater. This tension is the main cause that municipalities have started looking for solutions that make it easier to collect the outstanding payments from residents.

Dimensions socio-technical systems	Namibian Water Supply Regime (around 1990)	Namibian Water Supply Regime (at present)
1. Guiding principles	Water as 'merit good'	Stress economic value of water Save scarce resources. Water as private good
2. Technologies and infrastructures	Post-paid water through conventional meters	Post-paid water through conventional meters
3. Industrial structure	All public entities, unclear cost structures, no commercial principles of operation; soft budget constraints Integrated planning and operation	Commercialization: Every actor financially self-sustaining Smaller entities all responsible for own financial sustainability (financial and managerial ring-fencing) Separate bulk supplier for water, responsible for environmental sustainability
4. User relations and markets	Dichotomy formal-informal users Separate billing of water, service charges, taxes (formal households) Flat fee for informal households including water costs Action by LA: meter reading, billing, (dis)connection, debt recovery activities, repairs Action by user: report failure, payment	Dichotomy formal-informal users Separate billing of water, service charges, taxes (formal households) Flat fee for informal households including water costs Action by LA: meter reading, billing, (dis)connection, debt recovery activities, repairs Action by user: report failure, payment
5. Policy and legislation	State as provider of services	State as regulator, facilitator Decentralized: local authorities responsible for water supply Cost-reflective tariffs mandated
6. Knowledge base for regime	Public service provision Dominant ethical base: water as basic human right	Neo-liberal vision on service provision Dominant ethical base: Water as commodity
7. Cultural and symbolic meanings underpinning practices	Resistance to apartheid: non-payment	Post-apartheid: emancipation through water access User perspective: non-payment, water as a right

Table 1: Evolution of the regime since independence until present, split along the seven dimensions of the socio-technical system as proposed by Smith (2007). Changed regime rules are highlighted in red.

3.3. Prepaid water as a niche innovation

3.3.1. Niche-technology

The prepaid water meter technology has only small implications for the technical system, but impacts the whole socio-technical system of water supply. An overview can be seen in Figure 12 (compare with Figure 11 on page 32).

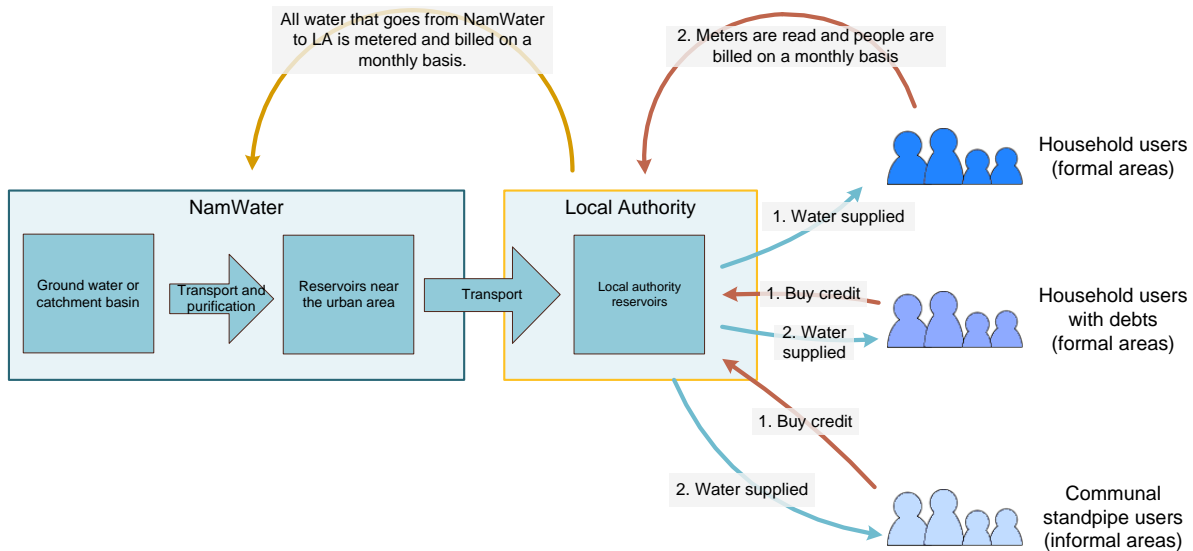


Figure 12: The regime with prepaid niche-technology incorporated (as applied in Otjiwarongo).

A fundamental change is the order of actions for the user: conventionally, a user would get water from the tap and at the end of each month the user is billed for his/her water use. Either the bill is made up on the basis of the used amount of water every month, or a fixed monthly amount had to be paid for users of the communal standpipes. For the prepaid meter the user has to buy credit that is charged onto an electronic tag. To get water from the tap, the user first has to present the tag and when there is credit on the tag, the user gets water and the cost of the water is deducted from the credit. Now, the user has to pay before he/she can use water. The availability of water is directly linked to the amount of cash the user has available for water credit at the moment, thus reducing budgeting flexibility of users.

This reversed order of action is only applicable to the designated groups of users: in most towns these are standpipe users that will now have to pay for their personal usage of water. In Otjiwarongo household users that have a bad payment record are also targeted with the prepaid water meter technology.

When all works well, the municipality is ensured payment from these users that were normally hard to persuade to pay.

The changes in practices and relations can be observed by comparing the 'conventional' water supply regime with the one where the prepaid water meter technology is adopted. Again, the seven dimensions of the socio-technical system as suggested by Smith (2007) help make a structured comparison, summed up in Table 2.

The introduction of prepaid water meters changed or added rules in five of the seven dimensions of the water supply regime. However, some of the regime dimensions are the reasons for the tensions that triggered local authorities to look for solutions like the prepaid water meter and change the dimensions that they were able to influence.

The changes in rules reflect some of the relations within the socio-technical regime: local authorities are the interface between the regime actors and the users that are affected by changes and the supplier of the financial means to support the regime through their water payments that are based on full cost-recovery. The rules that are intentionally changed are meant to resolve the tension. They reflect the dimensions in which a local authority has the power to change or add rules. Because some of the dimensions are beyond the influence of LAs, a solution is sought within the power of the local authority. The power of the municipality over the different dimensions greatly influences which innovations are feasible for them and which are not.

A short elaboration on Table 2:

1. Guiding principles

Although cost-recovery for every unit of water is present in the regime, it becomes a more salient feature when prepaid water meters are applied: recovery of the costs of every unit is enforced through the innovation.

2. Technologies and infrastructures

The materialization of the innovation is in the more complex meter that enables the prepayment of water. These meters have to be purchased and installed. When functioning as intended, it takes over certain functions otherwise performed by municipal employees: collecting payments (including debts) and (dis)connecting when appropriate.

3. Industrial structure

The innovation brings the manufacturers and suppliers of the more sophisticated technology into the network. The local authority introducing the technology has to deal with them to obtain the meters themselves and to keep them functioning, establishing a link to the global niche of manufacturers (see next section).

4. User relations and markets

Relations between the LA and the inhabitants are profoundly changed with the introduction of the prepaid water innovation. To start with, residents are qualified in categories of either eligible for prepaid water meters or not. In Otjiwarongo, a new category was created for poorer people (only people living in the low-middle income township Orwetoveni) with debt that also qualified for the prepaid water meters. Second, people that receive the prepaid water meters are subjected to other water tariffs that enable the municipality to include service charges and debt recollection in the tariff.

For the people that have to use the prepaid water meters, the different order of actions applies (pay before consumption instead of afterwards) and also the tasks in the system are distributed in a new

way: some shift from LA to the user, others are done automatically through the meter instead of by LA personnel.

This change in practices brings along extra tasks for the users, a main one being budgeting. This includes the active monitoring of the credit they have left, going to municipal offices for new credit in time and on times that the office is opened. Also, in the case that there is no money available to buy credit, they will have to find alternative ways: for example investing in social relations to be able to borrow water from neighbors. These are all returning tasks that require time and effort from the users.

5. Policy and legislation

6. Knowledge base for the regime

In these two categories, no changes are brought about by the introduction of the innovation. It is rather the evolution of the regime that happened before that triggered the search for the innovation (as described in the water supply regime analysis in section 3.2). These two dimensions are beyond the influence of the LA as a regime actor.

7. Cultural and symbolic meanings underpinning practices

Changes here are no intended effects of the innovation but rather observed in practice and subject of academic literature. The 'rules' are closely related to the changes in the dimension of user relations and markets. The actions of automated cost-recovery and debt recovery through the prepaid meters evokes user resistance, either caused by the inability of people to comply (no money for prepaid water credit) or the unwillingness by the perception of injustice and stigmatization of the poorest by creating a clear division (this is referred by some dismayed users as 'disrespect' in a petition handed to the municipality, see Community Members (2010)).

Whereas the regime suffered user resistance in the form of non-payment before, the resistance takes on more active forms when prepaid water meters are installed. Because the option of non-payment is made impossible by the prepaid water meter (that shuts off when payment is not done), users resort to material resistance, resulting in sabotage in different ways.

Overall, the profound changes in order and distribution of actions lead to a different relation between (local) government and citizens, summarized by scholars like von Schnitzler (2008) and Dawson (2010) as 'prepaid citizenship'. Dawson (2010) argues eloquently how access to water is part of social citizenship and how prepaid technology transforms this into relationship that has to be renewed on a regular basis (p. 387). Also, it deflects the frustration users might experience away from the authorities but onto a piece of technology and onto the user's direct environment (p. 392-393). In this context, it is that McClune (2004, p. 18) speaks of self-disconnecting devices: authorities no longer have to go to users themselves and risk confrontations. Simultaneously, questions of access to service are recast as administrative issues instead of a political struggle and claims to citizenship (von Schnitzler, 2008, p. 908).

Prepaid water meters are installed only in poorer urban areas; the townships that were historically designated as black living areas under apartheid-rule and the shantytowns that have formed in informal areas. This fact inevitably leads to comparison with the apartheid era, saying that two service standards (post-paid billing vs. prepaid metering) are a new form of segregation along old

racial-spatial lines. McClune calls it 'the new apartheid'. Von Schnitzler (2008, p. 910) points out how the concept of prepayment technologies was revived in South Africa in the 1980s as a response to apartheid-era problems of non-payment from discriminated communities. Through its history, the technology is tied to modes of governance that try to structure infrastructure shielded from political struggle.

Dimensions of socio-technical systems	Namibian Water Supply Regime (at present)	Namibian Water Supply Regime with prepaid technology
1. Guiding principles	Stress economic value of water Save scarce resources	Stress economic value of water Save scarce resources; Water as private good Recover costs for every unit of water
2. Technologies and infrastructures	Post-paid water through conventional meters	More complex meters that allow prepayment Automatic payment, disconnection
3. Industrial structure	Commercialization: Every actor financially self-sustaining Smaller entities all responsible for own financial sustainability (financial and managerial ring-fencing) Separate bulk supplier for water, responsible for environmental sustainability	Commercialization: Every actor financially self-sustaining Smaller entities all responsible for own financial sustainability (financial and managerial ring-fencing) Separate bulk supplier for water, responsible for environmental sustainability High-tech foreign meter producers Namibian suppliers for parts, replacements
4. User relations and markets	Dichotomy formal-informal users Separate billing of water, service charges, taxes Flat fee for informal households including water costs Action by LA: meter reading, billing, (dis)connection, debt recovery activities, repairs Action by user: report failure, payment	Refining selection target groups: people with bad payment records Prepaid water tariffs to collect taxes, service payments, debts Informal users also subjected to prepayment of water. Action by LA: repairs Action by user: buy credit at office, report failure, budgeting Automated action: payment (deduct from credit), (dis)connection
5. Policy and legislation	State as regulator, facilitator Decentralized: local authorities responsible for water supply Cost-reflective tariffs mandated	State as regulator, facilitator Decentralized: local authorities responsible for water supply Cost-recovery mandated
6. Knowledge base for regime	Neo-liberal vision on service provision Dominant ethical base: Water as commodity	Neo-liberal vision on service provision Dominant ethical base: Water as commodity
7. Cultural and symbolic meanings	Post-apartheid: emancipation through water	Post-apartheid: emancipation through water access

underpinning practices	access User perspective: non-payment, water as a right	User perspective: water as a right, resistance to debt/cost recovery "Prepaid citizenship"
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Table 2: Comparison of the 'conventional' water supply regime in Namibia and a regime with the prepaid water niche-technology incorporated on seven dimensions of the socio-technical (based on Smith (2007)). New or altered rules highlighted in red.

3.3.2. The global niche

Prepaid metering has had a long history for gas and later electricity, with British patents for coin-operated gas meters going back to the late 19th century. Prepaid water metering is from a significantly later date, being applied in different countries around the globe, but mainly in the global south.

In the 1980s and 1990s prepaid water meters were also used in the UK to target certain urban areas, following privatization of water services in the 1980s (McDonald & Ruiters, 2005, p. 14). However, they were declared illegal in 1998 because of the negative public health impact. Prepaid water meters are being used a lot in South Africa, a country to which Namibia is very much oriented due to geographical proximity, economic intertwinement and colonial history.

Estimates are that of the 8 million prepaid water meters deployed worldwide, 6 million are installed in South Africa (von Schnitzler, 2008, p. 900). Prepaid water meters in South Africa have been installed in huge projects, for example when all the households in Soweto were provided with a prepaid water meter during “Operation Gcin’amanzi” (Zulu for ‘Save Water’).¹³

There are several manufacturers of prepaid water meters, a number of them South African, but also from the UK and the Netherlands who in turn have their components manufactured in other places. They are responsible for technical development of the prepaid water meters. The other dimensions of the socio-technical system of prepaid water are however not aggregated to a global level: there is no clarity within the global niche how to apply the prepaid water meters and in what context and how to combine with other organizational or technical measures. A reason might be the importance of the associated regime and local context that the rule, as illustrated by Table 1 and Table 2 above.

3.3.2.1. *Namibian experiences: local experiments*

More Namibian local authorities have been looking for ways to resolve this tension in the regime. To this end, a large number of Namibian municipalities, towns and villages have adopted the niche-innovation of prepaid water meters as an element into their regime configuration. They have adopted the innovation in different ways. A common element that is observed a lot is the installation of prepaid meters on standpipes in the informal settlements that are present in (virtually) every urban center in Namibia. A point on which the municipality of Otjiwarongo stands out is in the implementation of the prepaid water meters in households, something that is not that common in Namibia. One of the reasons the prepaid meter is not used for households in other places is that debt and cost recovery are pursued through other means, which seem to consist of much attention for debt and payment collection through human capacity (extra personnel charged with this). This points to the differences in chosen solutions: technical versus organizational. Although prepaid water meters are a popular solution, there are (non-technical) alternatives.

There is an exchange of experiences between different municipalities (e.g. Otjiwarongo with Windhoek, Outjo, Omaruru and others) about different types of meters and the manufacturers and suppliers

¹³ Soweto is a township located near Johannesburg, South Africa and has approximately 1.3 million inhabitants (Wikipedia, 2011).

associated with those. This is however also mainly about the technology and not so much the other dimensions of the innovation.

In general, the application of prepaid water technology in Namibia can be interpreted as a collection of local experiments. These are not coordinated or connected on a higher level and experiment with different aspects of the system. In niche theory, successful niche-technologies aggregate to a higher level of niche rules leading to more homogeneity and over time an emerging technological trajectory. This can happen in various ways, for example through actors that are involved in multiple local experiments and thus carry knowledge back and forth, leading to aggregation of experience and knowledge. Some attempts to create this have been undertaken in Namibia, for example by awarding contracts for installing the prepaid technology in more towns at the same time to one supplier.¹⁴ So far, this has been unsuccessful and in practice, local experiments are not connected except for in incidental and superficial ways.

3.3.3. Local-global aggregation of learning

In these local prepaid water experiments we can see that the technology is derived from a global community of technology manufacturers including some basic rules on how to use and install the meters, but that other rules come or are adapted from the water supply regime in Namibia as described in section 3.2. Also, local learning about these other, non-technical dimensions of the socio-technical niche is fed back into the regime rules and not so much to a global niche.

Technical experiences are to a certain effect fed back into the global niche. Some of the social-economic learning is incorporated into the regime: taken up by regime actors and incorporated into new experiments. The latter is happening to a mixed extent: some experiences are shared, others are lost or not communicated. There is communication between municipalities on an incidental basis, but no organized platform. A MAWF-official expressed the expectation that local authorities and ministry officials would start communicating on a more structural basis when a Water and Sanitation (WatSan) forum would be established (which is due in the near future) [22]. It would be mainly intended for sanitation issues, but could also be a platform for sharing knowledge on water related affairs including prepaid water experiences.

Drinkwaard (2009, p. 86) suggested about global-local aggregation in developing countries that a third, intermediate level should be established because local niche-actors do not have access to the global niche and also their lessons are not fed back into an emerging global niche (hampering the development of a more stable trajectory). In the case of prepaid water meters in Namibia, especially the latter seems to be true. To enable local projects to learn from each other, an intermediary level would be wanted. This could be a platform for the exchange of experiences and would foster deeper, second-order learning (see next chapter for more on second-order learning or lack thereof in the local project of Otjiwarongo).

¹⁴ In the past, a tender has been awarded to one company (Nossob River Systems Ltd.) to install prepaid meters in 18 towns. This project is generally considered to have failed and resulted in thousands of defunct meters and a N\$11M claim from the government to recover some of the expenses made (McClune, 2004; The Namibian, 2005).

3.4. Conclusion and discussion

In this chapter, I have attempted to analyze the transition in Namibia's water supply through the Multi-Level Perspective (MLP) and how it leads to implementation of prepaid meters in local contexts. The MLP helps understand how the developments are products of interactions between processes at different levels. It provides insight on how landscape factors and the evolution of the socio-technical regime have led to tensions and how prepaid water meters came to be involved as a local water supply innovation to address these tensions.

MLP-analysis

By looking at the landscape developments in Namibia as well as the structure of the water supply regime, it is easier to understand under what circumstances and for what reasons municipalities choose to set up an experiment with the niche-technology of prepaid water meters. The transition in Namibia proves to be one of the reconfigurational kind, as described by Geels and Schot (Geels & Schot, 2007, pp. 411-413). In this transition, regime actors look to take up niche-innovations as a solution to certain tensions in the regime, these tensions emerging from regime evolution over the past twenty years. This evolution can be seen as part of the reconfiguration going on. Subsequent developments that are influenced by the landscape factors and niche-innovation which trigger new changes together form a chain of events leading to a profound reconfiguration of socio-technical systems – the transition.

Several developments at landscape level shaped this regime evolution that created tensions that mainly affected the local authorities (LAs) and led them to look for solutions. First, the landscape development of service rationalization and commercialization had its effect on the rules of the water supply regime which led to emphasis on financial sustainability of the regime actors. Parallel to that the electricity regime was also reconfigured in a way so that electricity revenue would no longer be collected by LAs and they could not set the tariffs anymore, limiting the possibilities of cross-subsidizing non-income generating municipal services. From the Namibian decentralization strategy (also a landscape factor) it followed that responsibility for water service provision was allocated to local authorities and also that these LAs need to be financially self-sustaining. While electricity income disappeared from LA budgets, there was increased pressure to balance the budgets. At the same time, the cost recovery-rationale in the water supply regime meant that bulk suppliers were given the mandate to ask cost-reflective tariffs from LAs and emphasize timely payment by LAs. The socio-economic situation of many Namibian citizens - another landscape factor - makes it hard for municipalities to retrieve the costs of supplying water from their residents. Thus the last step in the cost-recovery chain is a troublesome one, the main source of tension within the water supply regime.

The above factors combined made local authorities look for an innovation to resolve the tension in the water supply regime. Given the constraints by regulatory and normative rules plus the landscape factors, the attention of LAs turned to retrieving the costs of water from their residents. Although it is not quite clear who first brought the prepaid water meter to Namibia, it is plausible to retrace this to South African influence, the country to which Namibia is most oriented economically and politically for historical and geographic reasons. Different LAs started experimenting with prepaid water meters to reconfigure the regime in such a way that their insecurity of payment and thus the tension within the regime would be resolved.

Local authorities like the municipality of Otjiwarongo have decided to react by installing prepaid meters and recover payments and past debts this way. The innovation has its own set of rules that are still unstable: the municipality is replacing or adding rules in the process. With its dedication to installing prepaid water meters and to support these out of its own budget for some time, local authorities created a protective space for the innovation to develop and hope to move further along in a transition towards sustainable water supply in Namibia.¹⁵

In terms of the MLP this can be seen as a local niche innovation in an effort by a regime actor to reconfigure the regime to a more stable configuration.

An issue that is salient throughout the analysis of the three levels is that of power relations/hierarchy, especially in the regime level. While many of the landscape developments are outside the power of the regime to change (per definition of the landscape), there are inequalities within the regime as to who can alter regime rules and who cannot. The evolution we have seen is one where the responsibility of closing the budget of water supply was shifted from the national government to the local authorities. The LAs have had very little influence on this process and mainly just have to comply with the changed regime rules, which created the earlier mentioned tension within the regime. The extent to which LAs can or cannot influence dimensions of the water supply regime also shapes the solutions they arrive at, like the prepaid water meter.

Most of the rules that are changed when introducing the prepaid water innovation are means to reach the goals of local authorities. The changes in the dimension of markets and user relations are implemented intentionally. However, it has become clear that these changed practices have a profound social and cultural impact, shaped by the landscape context of Namibia. The landscape factors of Namibia's historical background of a not-so-distant apartheid past and the marks this has left on Namibian society and communities play an important role in how the prepaid meter innovation is embedded and what meaning it has for Namibian society. The notion of 'prepaid citizenship' combined with Namibia's history of segregation is not necessarily one intentionally evoked by the local authorities, but it is still a very real outcome and will have impact on the local projects where prepaid water meters are being implemented.

¹⁵ The resources are incidentally supplemented with governmental subsidies in the range of several millions of Namibian dollars. These have to be applied for and cannot be taken for granted. In general, local authorities take the initiative of creating the protective space.

4. Local experiment: Otjiwarongo, Namibia

In Otjiwarongo the municipality has decided to start experimenting with prepaid meters after the non-payment of water bills became a salient issue. This happened around 2004 when the electricity revenue stopped flowing through municipalities and started being collected by separate Regional Electricity Distributors instead. Combined with the changed rules and structure of the water supply regime as discussed in the previous chapter, the municipality found itself in a tough position: on one hand squeezed by the water supply regime to ensure full cost recovery, on the other hand dealing with a community that did not pay for water on a regular basis and the loss of a assured stream of income from electricity revenue to cushion this tension. This led the municipality to endeavor to improve the reliability of revenue collection from water services in two ways: (1) by replacing conventional water meters in selected households in Orwetoveni township by prepaid water meters (around 2100 households as of June 2011) and (2) by replacing troublesome earlier prepaid meters on standpipes in the informal areas of Otjiwarongo by a new type of prepaid meters and installing new standpipes that were fitted with prepaid meters.¹⁶ This will be referred to as the prepaid water experiment¹⁷ and got underway in 2007 when the tender for the first meters was awarded to a manufacturer (an actor from the global niche) and the first prepaid water meters were installed [2].

A third, separate decision was made later in 2010 to (3) install individual connections for households in the informal areas of Otjiwarongo fitted with prepaid meters (which was a *sine qua non* for these type of connections). This can also be regarded as part of the prepaid water experiment.

In this section, a niche analysis will be performed which leads to a number of findings and conclusions about the prepaid-water project in Otjiwarongo. For this, the niche-processes proposed by Strategic Niche Management (SNM) are examined (networking, formulation and concretization of expectations, and learning processes). This will answer the second sub-question of this research about the transition potential of the local water supply innovation of prepaid water meters when analyzed from the perspective of a niche experiment. In other words: to what extent does the prepaid water experiment contribute to a transition in water supply towards a more sustainable water supply regime.

The municipality is a regime actor that has started experimenting with the niche-innovation of pre-paid water meters and accompanying practices as a new way of providing water to its inhabitants. The analysis of the three internal niche processes therefore logically starts from the municipality, because it is the actor that initiated most actions and challenged the status quo of water supply in Otjiwarongo.

4.1. Networking

In the development of niche-innovations, the communication and coordination of actors is crucial for the success of experiments. A balanced, inclusive and interconnected network of actors enables the

¹⁶ By installing more standpipes, the pressure on the existing standpipes was decreased. The number was expanded from 30 to 53 meters, improving coverage to one standpipe per 250 inhabitants as compared to one standpipe per 400 inhabitants previously [9].

¹⁷ Here, the term 'experiment' flows from the SNM-discourse where the niche-innovation is constituted by various experiments in a real-life socio-technical environment (elaborated on in chapter 2). The terms project and experiment are used interchangeably throughout this thesis.

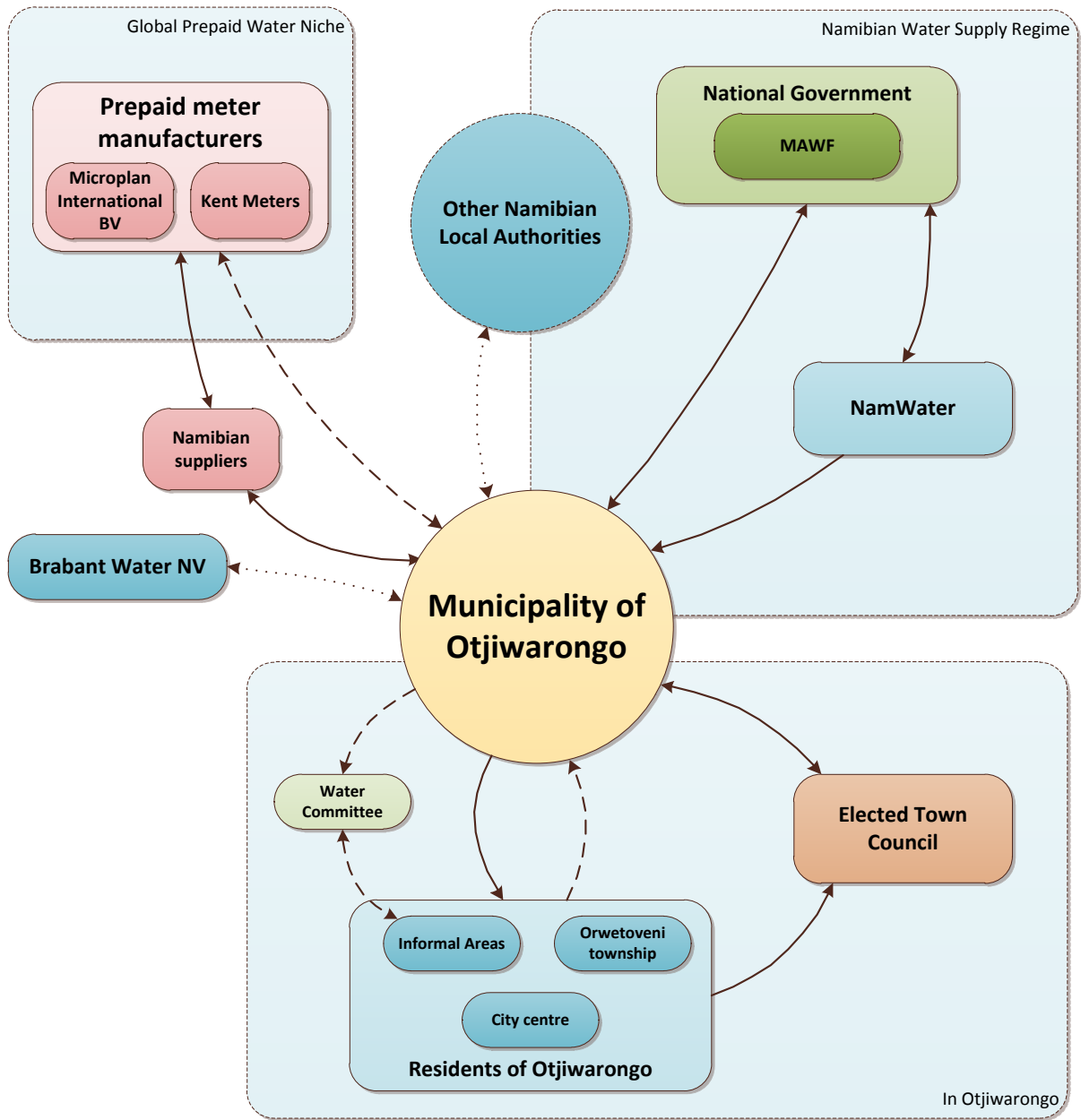
other two niche processes (expectations formation and alignment; learning processes) and promotes the stability of the niche: expectations can be aligned throughout the network and experiences by all involved actors can be incorporated into learning processes.

Figure 13 shows the connections that are of relevance to the niche-experiment with prepaid water meters in Otjiwarongo. There are two important characteristics in this case. First is the centrality of the municipality as an actor in this network. They took the initiative for the prepaid water project and involved other actors in it. This is related to the second important characteristic: the municipality being part of the water supply regime. Before the installation of prepaid water meters, the municipality was already responsible for water distribution in Otjiwarongo. A large part of the other actors and their relations in Figure 13 were already in place before the niche-experiment and some were part of the water supply regime. The regime is under pressure due to landscape developments and the mismatch between regime rules and reality. The niche innovation of prepaid water meters is embraced by the municipality as a possible solution to these tensions and touted as such to the other regime actors. This is the character of the reconfigurational pathway as identified in chapter 3, where local problems lead to a search for sufficiently developed niche-innovations that are compatible with the regime and help solve the problems. In turn, existing relation in the regime are transformed due to the effects of the niche-innovation. Also new actors and connections have appeared. The distinction regime-niche is a fuzzy one in this case. In some of the dimensions of the water supply system the regime rules are applicable in the niche or slightly altered, while in others they are radically different as has been illustrated above in section 3.3.

Municipality of Otjiwarongo

The municipality is the central actor that took the initiative to start installing the prepaid water meters to resolve the regime tensions. As a regime actor, it is linked to national level government actors through regime rules like regulation and institutional set-up. In search for an answer to the tensions within the water supply regime, the municipality looked for innovations that could resolve or ease these tensions. Within the national regime, the municipality is restricted in its agency but within in Otjiwarongo they have the power to initiate a niche experiment like the prepaid water meter project. For the prepaid water meters they work with the manufacturers, actors from the global niche. These are all foreign companies for which a Namibian partner is needed to ensure a fast and reliable supply of parts and spares.

The main actors the municipality deals with are their residents and the political representation in the form of the town council. The residents are a heterogeneous actor that is affected by the installation of the prepaid water meters.



Legend connections:

- > Frequent/binding
- - -> Infrequent/unclear
-> Non-committal/advisory

Figure 13: Actor overview for the local prepaid water niche in Otjiwarongo, connections to the regime and the global niche

National Government of Namibia

The national government as a regime-actor was described in chapter 3. It shapes the environment in which the municipality delivers its services. More specifically, the ministry of Agriculture, Water and Forest (MAWF) is the department that determines policy with regard to water, resulting in a large share of the regime rules. They are not specifically involved in the prepaid water niche, but put much emphasis on cost recovery and the reduction of debts which created regime tension and led the municipality to look for solutions. MAWF officials have so far not expressed any particular enthusiasm for prepaid water meters [15; 22].

NamWater

As bulk water supplier, NamWater achieves full cost recovery from local authorities through its tariffs. This regime rule is a major contributor to the need and urgency the municipality feels to receive timely payments for water use from its inhabitants. As a regime actor, NamWater officially has expressed a willing attitude towards prepaid water meters for informal areas, but also warned for the (technical) problems that often occur with prepaid water meters [7]. NamWater and the municipality of Otjiwarongo communicate through personal connections, but plans are to formalize this in a general agreement about terms of service and an annual forum to discuss matters. As part of the water supply regime, NamWater is affected by the results of the prepaid water experiment, but they are not directly involved.

Residents of Otjiwarongo

The residents of Otjiwarongo are the ones directly influenced by the installation of prepaid water meters. It is useful to distinguish between different groups of Otjiwarongo, along the lines of the three areas in which the town can be divided: (1) the rich city center, (2) the poorer townships and (3) the informal areas.

The city centre

This richer part of town is the area with a relatively small amount of debts and is therefore not affected by the prepaid water project: these will not be installed in this part of town. When people are behind on their payments, they are treated by 'regular' debt control and their water connection will be manually disconnected by municipality technicians and reconnected after payment of (part of) the debts and a reconnection fee.

Township 'Orwetoveni'

Orwetoveni is the poorer formal part of Otjiwarongo, the former black township. In this area, payment of monthly bills is a big issue and debts are generally high. The households with the worst payment record were the initial target group for prepaid water meters. Their conventional water meters were replaced (free of charge) by a prepaid water meter and a tag which people could charge with credit and use on a meter to get water. Households with some debts (no clear threshold) can choose to participate in the prepaid water meter and have to pay a reduced fee for installation of the prepaid water meter [8]. Households and their tags are assigned a personalized tariff, in which repayment of previous debts is a large part of the tariff. By default, the ratio is 80-20: 80% of the tariff is basic chargers, miscellaneous services and debt repayment, 20% is credit for actual new water. This ratio or the amount of debt to

repay per month can be adjusted after a consultation with a municipality official. The municipality also runs an office in this area of town, where people can purchase credit, report malfunctions and file complaints [4].

This office is the main method of communication both ways between the municipality and inhabitants of Orwetoveni (especially the prepaid water users).

Informal areas

The informal areas of Otjiwarongo house mostly people who recently migrated to Otjiwarongo or who are in a very poor social-economic condition (no income/employment, families that could no longer afford to live in Orwetoveni Township). All inhabitants of the informal areas are affected by prepaid water meters: the majority has to use communal standpipes that are operated on a prepaid basis and recently a small minority has had the chance to obtain a prepaid water connection in their households. In this area, no debts are run up because prepaid water has been in effect for a longer time and before that there were no records of payment kept on an individual basis. All people are paying the same tariff that also includes some charges for refuse removal and plot lease.¹⁸

In the informal areas there is a municipal office as well, mainly for selling the prepaid water credit and not so much for feedback or complaints. When the municipality wants to communicate to inhabitants of the informal areas, community meetings are organized and announced [6]. Also, a water committee was formed out of several inhabitants of the informal areas on the initiative of the municipality to assist people when new prepaid water meters were installed to educate and assist people. This water committee was not permanently 'employed' (the members are volunteers). Inhabitants however regularly turn to these water committee members to report problems. Furthermore, the municipality technicians have written their phone number on standpipes to enable people to contact them (see Figure 14).



Figure 14: A standpipe (no. 13) in the informal settlements, fitted with a prepaid meter (not visible) and the phone number of one of the municipal technicians written on the side.

Elected Town Council

On top of the different communication channels between the municipality and its inhabitants, there is the political system that allows people to influence a range of issues in Otjiwarongo. The Town Council is elected once every five years and is a representation of Otjiwarongo's inhabitants. In elections access to water is a big issue and one of the outcomes of this has been the decision to offer individual water connections to households in the informal areas. This idea was pushed by the town council and has to be executed by the municipality, even though municipality officials have doubted the feasibility of this

¹⁸ From personal communication with Burgert Liebenberg, Strategic Executive Finances, Otjiwarongo municipality.

[2]. This example shows that through their electoral influence, inhabitants also influence municipality policy.

Municipal or other government officials however complain about the dubious role politicians sometimes play by campaigning for free water and water as right to gain votes and then leaving it to the authorities to execute these projects [2; 22] or politicians promoting non-payment [8]. Other examples from Namibia support this impression, where political pressure led to water and sanitation solutions that are not sustainable [12; 17].

In Otjiwarongo, there are regular meetings between town councilors and municipality executives which deal with many more municipal issues beyond water supply [13]. This interaction is regular and extensive, but the town council does not seem to be a much-used intermediary in communication between residents and the municipality on a regular basis.

Prepaid water meter manufacturers and Namibian suppliers

Essential niche actors that have been involved are the manufacturers and suppliers of prepaid water meters and their spare parts. They are the suppliers of the technology that largely determines what the technology can and cannot accomplish. There are several manufacturers that operate from other countries and are part of the global niche. The municipality has experience with several manufacturers and types of meters. The presence of a Namibian supplier is essential for the municipality since they have to be able to get spares and repairs on short notice to be able to ensure service provision [2]. However, working with the suppliers has been troublesome in the past and this has influenced parts of the project evolution (see learning in section 4.3).

Brabant Water NV

A new partner for the municipality of Otjiwarongo is Brabant Water NV, a Dutch water company that has engaged in a cooperation with Otjiwarongo through an existing twinning relation between Otjiwarongo and the Dutch municipality of Heusden¹⁹. The cooperation focusses on capacity building and operational assistance [29]. Brabant Water NV has no experience with prepaid water meters, but does have a lot of knowledge and experience in supplying water in the Netherlands. They are in regular contact with the municipality of Otjiwarongo, but regarding prepaid water meters, content of the cooperation still has to be determined. It is interesting to note that in communication to on their website, the municipality of Otjiwarongo has placed more emphasis on the prepaid water meter in the cooperation than Brabant Water says there is.

4.2.Expectations formation and alignment

Expectations are evaluated on the basis of their specificity, robustness and quality as suggested by Grin et al. (2010, p. 41). The specificity is seen in the formulation of expectations at macro-level in the form of scenarios, at the meso-level in the form of functions and the micro-level in the form of specifications. The robustness shows in the extent to which expectations are shared by the various actors and the quality in the extent to which expectations are substantiated by actual results from experiments.

¹⁹ Heusden is a shareholder of Brabant Water NV, a publicly-owned company of which all shares are held by the municipalities of the province of Noord Brabant, the Netherlands.

The direct cause of the large-scale experiment with prepaid water meters is the abovementioned loss of electricity revenue as a main source of income for the municipality of Otjiwarongo. The disappearance or diminishing of this source of income endangers the provision of other municipal services that do not generate net income and cannot be sustained on their own. This caused the municipality to examine their other sources of income, the main ones being water revenue, rents and taxes, which includes lease of plots, some real-estate related tax and service charges for refuse removal and sewerage. All of these charges were billed together on a monthly basis, but a large number of households in Otjiwarongo have non-payment histories which have accumulated into debts.

The municipality thus went looking for a solution to the uncertainty of their monthly income and the possibility to sustain and expand the services they provided. The prepaid water meter is seen as an innovation that is part of this solution. The scenario of a municipality where the long-term provision of services is sustained and where the reach of these services is steadily expanded is regularly invoked when prepaid water meters are discussed. This is the overarching macro expectation in the case of Otjiwarongo. This expectation is **robust**, but not very **specific**. How this macro-level expectation is further specified is discussed below. A short overview of the expectations at different levels can be seen in Table 3. From the macro-expectation, several meso-level (functional) expectations come forth. Some of these are then further specified, whereas others are not. This is an indication of how specific the expectation is. Less specific expectations might be easier to agree upon, but this ‘false robustness’ conceals the fact that actors might have quite different views on the concrete requirements and functionality of the innovation.

Macro	Long-term sustenance and expansion of municipal services			
Meso	Payment and debt collection	Educating about value and use of water	Granting and sustaining access	
			No cut-offs	New connections possible
Micro	Credit vending at municipal office		PP meter cuts itself off	Reuse PP meters possible
	Basic charges and debt-payoff included in tariff			Subsidy possible
	More possibilities for debt control			Robust installation

Table 3: Hierarchy in specificity of initial expectations.

Payment and debt collection

After the loss of electricity, the municipality depends on a smaller number of sources of income. This combined with the non-reliability of the actual collection of these payments caused serious concerns about the **financial sustainability** of the municipality in its current form. The meso-level expectation that the installation of prepaid water meters would help collect previous debt and ensure the timely payment of water, taxes and services in the present and future was the first and foremost cause for action. This expectation about functionality thus was crucial in choosing the prepaid water meter as the technology to be applied.

The **quality** of this expectation is ambiguous: although there were more experiments with prepaid water meters in Namibia and even in Otjiwarongo (on the standpipes in the informal settlements), the use of

prepaid water meters for recovering costs and debts from households had not yet been tested. In formulating the expectation there was an implicit referral to other experiments through contacts with other municipalities and manufacturers of prepaid water meters as proof of effectiveness, but these experiments do not map 1-to-1 to the envisioned application in Otjiwarongo.

To this end of cost and debt recovery, a number of specifications for the technology itself were formulated to increase the **specificity** of expectations: mainly technical, but also the surrounding service system (credit vending, the functioning of debt control, technical support). The initial micro-level expectations were that the prepaid meter would collect the basic charges for a water connection and debt repayments on top of the tariff per unit of water used in the Orwetoveni households where they were installed. The vending of credit can be done at the municipality office in Orwetoveni and in the satellite office in the informal areas. Also, the inclusion of debt repayment in the tariff was expected to stimulate residents to come into the office and arrange a personalized debt repayment plan. Furthermore, people that had a choice to participate in the prepaid water experiment and chose not to do so would be more suited for other debt control measures.

Important to note is that other micro-expectations developed throughout the project and evolved with the experience and feedback from the prepaid water project in Otjiwarongo. These developments are part of the learning processes that will be discussed in section 4.3.

Educating people on value and use of water

Another expectation that the municipality internally has about the prepaid meter is its educational function: by having people pay for water credit, it will teach them about the value of water and make people use water more sparingly. This belief is shared within the water supply regime, with national water policy referring to the conserving effect it will have when users actually pay for the water they use along the principles of Water Demand Management (landscape factor in chapter 3). Non-payment served as a method of quiet resistance during the apartheid-era and is still regularly invoked in political campaigns where politicians garner support by stating that people have the right to free water [8]. This contradicts the views of the municipality and current Namibian policy when it comes to services in general and water provision specifically (see chapter 3). Furthermore, the municipality of Otjiwarongo feels that Namibian people do not have the right priorities when it comes to their budget and expenses and that paying for municipal service should be higher up on peoples list of priorities [8]. Municipality officials see the prepaid water meters as an effective way of unambiguously teaching people that they have to pay for water on a timely and regular basis.

This expectation's **robustness** in the regime is high: the expectation of educational value is widely shared by officials at national government and NamWater. It is not further specified how this would work exactly. Among non-regime actors, the residents and political representatives of Otjiwarongo, this is not as much seen as a promise of prepaid water meters.

Granting and sustaining access to water

Another functional (meso-level) expectation that is linked to the prepaid meter is that of **granting and sustaining access**. This happens in two ways. The first is the expectation that people will no longer be

cut-off from water when they have a bad payment record. Previously, people would be disconnected after a certain time and amount of non-payment for their services. This required municipality technicians to go to the household and physically disconnect them. Reconnection required a (partial) payment of due payments plus a reconnection fee (of N\$110, around €11) at the municipal office before municipal technicians would again visit the household and physically reconnect the water. The prepaid water meter makes these actions obsolete. This kind of connection only gives water when it has already been paid for: running up debt is impossible and dis- and reconnection are no longer applicable.

The second way in which the prepaid meter grants and sustains access is of more recent nature and focusses on **granting individual access** in informal areas. In 2010 the decision was taken in response to the elected town council that demanded individual connections for everyone in Otjiwarongo.²⁰ By installing new connections fitted with a prepaid meter, the municipality expects to be able to connect more households that previously did not qualify for a household connection. These households are located in the informal areas of Otjiwarongo. These are registered by the municipality and the land is demarcated, but these household do not have a formal address or status. Combined with the uncertain economic status of these households, they were deemed not to be suitable for household connections on a post-paid basis (receiving monthly bills). The municipality has responded to the political call for individual connections for all by attaching the prepaid water meter to it. These connections are provided at a subsidized rate²¹. This meso-expectation is one that is shared by the municipality and the town council and partly by the residents, who have indicated to welcome the possibility of individual connections but see the costs of N\$1,000 for a connection as prohibitively high and thus not as truly providing connections for all [14]. This expectation can be thus seen as moderately **robust**. The **quality** of this expectation is not substantiated by other experiments: connecting individual informal households in this way has not been done before. There are other towns where efforts have been undertaken to connect every inhabitant through a prepaid connection, but this was in a different context and unsuccessful.²²

Regarding the **specificity** of this expectation, this has been further elaborated on in several micro-level expectations in which specifications are laid out. For the individual connections in informal households, meters of the Microplan-type can be re-used that were used previously in Orwetoveni households but that were replaced with newer meters [8]. Funding for the realization of the individual connections could possibly be applied for with the national government (this application was still pending in September 2011). The meters are to be installed in protective concrete shelters near the edge of the plot as to make inspection possible, tampering less probable and have a standard for installation [3].

²⁰ At present, residents in Otjiwarongo's informal areas depend on the communal standpipes (also fitted with prepaid water meters). Estimates are that around 13,000 people inhabit these areas (Otjiwarongo Municipality, 2010a).

²¹ The first 50 individual prepaid connections in informal areas were installed in 2011 at the cost of N\$500. After these first 50 connections, the costs were raised to N\$1,000. The total costs for the meters are around N\$3,000, so the lion's share of the costs is still subsidized.

²² This is from the mining town of Arandis, which had all the houses fitted with prepaid water meters in 2003, only to have these removed again in 2005 because non-functional prepaid water meters had worsened non-payment (van der Merwe, 2010).

4.3.Learning

The third internal niche-process is that of learning. As the niche-experiment develops and events unfold, experience is gained about the functioning and the effectiveness of the niche-innovation. These can be related to the initial expectations and the extent to which they correspond with real-life outcomes. Successful learning occurs when the experiences are fed back into the network and expectations are adjusted or further refined in such a way that they better resemble the observed practice and help manage the project more effectively.

Learning takes place in several stages of niche-innovation and is often divided into four categories: learning by searching, learning by doing, learning by using and learning by interaction. The first two categories pertain more to the development and production of the technological artifact, which are not part of the experiment in Otjiwarongo since the artifact is bought ready-made. The latter two are of interest from the perspective of Otjiwarongo: the experiences gained by installing and using the prepaid water meters and the sharing of experiences between users and producers (where the municipality is seen as the producer of the prepaid water system in Otjiwarongo).

Within the Otjiwarongo-experiment

In the beginning of the project, a specific prepaid water meter was selected from among the available manufacturers. For this, the technical expectations of the municipality were used, together with the municipality's experiences with a previous, generally unsuccessful prepaid standpipe experiment and the experiences of other towns and cities. The Microplan Tagmeter, made by the Dutch company Microplan International BV, was selected as appropriate for the municipality's purposes of providing households with prepaid connections to replace their conventional meter and fitting the communal standpipes in the informal settlements with prepaid meters.

Since the start of the prepaid water meter experiment in 2007, many lessons have been learnt and (are being) processed. These can be mainly categorized as *Learning by using*. Some of the main points are:

1. Technical difficulties

A big part of the experiences related to the functioning of the prepaid water meters themselves. The users and the municipality encountered many unforeseen technical difficulties, which were an important point of learning in the first years of the prepaid water experiment. Some of the encountered difficulties were due to the device itself (faulty batteries, malfunctioning electronics) or the wear and tear that comes with usage (valves that wear when opened frequently, meter display damaged by direct sunlight) [3]. Some of these problems were solved with simple additions or modifications (e.g. installing a cover that protects the display from direct sunlight). Other problems have been taken into account when ordering new types of meters. In most cases, the municipality takes the responsibility for repairs and replacements, except when there are visible signs of sabotage. So far, the municipality has encountered a lot more technical difficulties than it anticipated, resulting in more broken meters (more than 500 out of around 2150 meters malfunctioned, where they expected no significant number) [2]. From this, the municipality has learned to put more emphasis on the availability of a local supplier and the importance of testing new meters extensively, which they have done for the new kind of prepaid

water meters they are planning to install as of 2011 in Orwetoveni households. With the Microplan prepaid meter they have been using since the beginning of the project, it became very hard to get spares and repairs from 2009 onwards because the Namibian supplier (Tagmeter Namibia) proved to be unreliable [2]. They are now dealing with Microplan International BV directly to look for a solution, but no new local supplier has been found as of yet. As for the meter the municipality decided to further explore meters manufactured by Kent Meters, there now is a Namibian supplier which was not there in 2007 when the first tender was awarded. Learning about the technical aspects has led to the specific and more substantiated expectations that the Microplan Tagmeter can be managed better and used on standpipes and new informal household connections and that the new Kent prepaid water meter can serve as the new meter for Orwetoveni households (that also require debt collection).

2. Public discontent and vandalism

The decision to start replacing people's conventional meters by prepaid water meters is an invasive one. The worst debtors do not have a choice and are forced to adopt the new innovation and all its consequences: paying a higher tariff that includes charges and debt repayments, the extra effort of having to go to the municipality office to purchase credit and dealing with a new and relatively vulnerable device.

Also, the newly placed emphasis on debt collection was experienced as an extra burden by inhabitants. In the past, the municipality was lenient towards non-payment and building up of debt. Now, people are confronted with debt they have built up in the past and this has led to incomprehension and anger. One of the ways in which the dissent was expressed was through demonstrations that took place in September 2010 and the petition that accompanied it. In the petition, several issues regarding the prepaid water meters are touched upon: debt repayment, repair costs for faulty meters, tariff increases and the general affordability of the services plus the debt repayment. The members that handed in this petition felt they were treated unfairly and there was no clear communication by the municipality (Community Members, 2010). The content of several of the complaints were misinformed or contrary to the actual policy of the municipality, which also points to miscommunication between municipality and its inhabitants.

In Orwetoveni, the disconnection of people has not ceased, contrary to expectation. People choose to share prepaid water accounts and not to use their own account for the prepaid water, which leads to them not paying the basic charges and the debt-repayments included in the tariff. This has led the municipality to shut off connections that are provided with a prepaid water meter, even though the prepaid water meter was expected to make this unnecessary. This in turn leads to people not paying anything anymore and unknowingly running up even more debts: although they use no water, some basic charges do get added to the account every month. Also prepaid water connections are physically being bypassed, by people tapping off the pipe before the meter. In this case, the connection to the plot is closed down as well [19].

In informal settlements, standpipes with prepaid water meters break down regularly, sometimes due to sabotage by some of the users. People's main points of discontent are with the speed at which repairs of

the standpipes are performed by municipality technicians. A broken standpipe means that people have to walk to the next standpipe, which might be twice the usual distance²³. The municipality insists that repairs are made as soon as possible and often within a day. However, some inhabitants of informal settlements speak of standpipes that have not been working for months. Somewhere there must be a miscommunication in which informal area residents do not succeed in reaching the municipality and the municipality is under the impression that all standpipes are in working order. Some informal settlement residents have expressed their preference for the system that was in place before prepaid standpipes were installed: people had to pay a monthly fixed amount of N\$12 regardless of the quantities they used [28]. Now, prepaid tariffs are N\$30/m³, where the water price includes other municipal charges as well (Saes, 2012).

The public misunderstanding and discontent with (parts of) the system have led the municipality to search for new ways of communication. Community meetings and water committees have been organized to reach inhabitants. Water committees are also used to make the municipality easier to reach for inhabitants. The posting of telephone numbers on the prepaid water meters was meant to increase the municipality's accessibility. However, the tensions between residents and municipality are not all resolved at present, so sabotage and protest keep occurring.

Notwithstanding the above troubles and complaints, inhabitants of both the informal settlements and Orwetoveni have on other occasions expressed their happiness with prepaid water connections. Also, households that have not yet been provided a prepaid water connection sometimes ask for one. Furthermore, the possibility to have individual prepaid water connections in the informal areas has been welcomed as a desirable option.

3. Improvement of cash flow

One of the aims was to improve the timely payment of water that is being used. Municipal officials are satisfied about this [8]. This is partly canceled out because some of the technical malfunctions make a lot of water go to waste. However, for the municipality this is an important development which ensures that the municipality in its turn can pay the monthly bills to NamWater for the water use of the whole town. Over the years 2009-2011 there has been a steady collection of water payments with a surplus for the municipality (Saes, 2012). This however gives no indication about the situation before the prepaid water meters or to what extent every liter of water is paid for. The surplus is caused by the higher tariff the municipality calculates than just the NamWater tariff (it adds basic charges and other service fees). So, at present there is no sign that more people are paying, but officials do have faith in the system that it is encouraging timely payment.

4. Debts still running up

²³ A standpipe in Otjiwarongo is mostly found within a 200 meter radius of people's homes. One has to keep in mind that people that fetch water from these standpipes would have to carry 20 kg per person per day when one keeps 20 liters per person per day in mind as an amount people use per day (Saes, 2012).

The first years of the experiment have not yet led to the debt reduction that was expected by the municipality. On the contrary: debts are hardly recovered. Currently (2011) the total debt of inhabitants to the municipality stands at almost N\$25 million, a record high. As partly explained above, people are circumventing debt repayments through using other people's accounts that have less debt to repay and therefore a lower water tariff. This way, people have learned that they could pay less to access water.

For the municipality this is an undesirable development. They had to reassert their initial expectation that the prepaid water meter would help collect debts. It responded in two ways: First, it went looking for a technical solution by selecting a different type of prepaid meter that allows a meter to be coupled to a specific account so people can only use their own account where their debts and due service payments are included in the tariff. This technical solution is called 'zoning' and seen as the single most important feature that prepaid water meters should have in the future. The second way is to not solely rely on prepaid water meters for debt collection, but also to assign extra staff to the financial department to personally approach inhabitants to discuss their debts and repayments. This latter method is a shift away from the prepaid water meter as the panacea to the municipality's financial concerns.

5. Purposes

The use of prepaid water meters on standpipes was one that was known and experimented with before, also within Otjiwarongo. The first experiences with thirty prepaid standpipe meters from a South African manufacturer (Water Master) were problematic; they got damaged easily by wrong use (intentionally or not). This helped better formulate requirements for the new type of standpipe meter. The use in households with debts was one that led to mixed experiences, the most important ones named above. For this, no other experience in or outside of Otjiwarongo were available, so many of the issues were hard to foresee. Still, the purposes of debt recovery and prevention and cost recovery currently are the most prominent ones.

When the idea of installing individual prepaid connections in the informal settlements was put forth, the previous experiences led the municipality to decide to reuse the Microplan prepaid water meters for this. Some of its functional shortcomings did not apply for the use in informal settlements households (that have not built up debts in the past that had to be recovered, so 'zoning' is not required). Some of the technical problems are countered by placing it in a protective shelter on the plot of users. The problems with sabotage are thought to be countered by placing meter and tap near the edge of the plot, in good sight from the road in the hope that the visibility would prevent or complicate acts of sabotage or bypassing. So some of the lessons learned during the past few years with the prepaid meters in formal households are being applied to the new purpose of informal household connections.

6. Service requirements

Currently, credit can be bought at the municipal offices in Orwetoveni and the informal settlements on working days and at the Orwetoveni office also on Saturday mornings [4]. Interviews with inhabitants have shown the wish for more vending points (closer by) and longer opening hours. Municipal officials have also recognized this wish and are looking into the possibilities. The option that is currently

considered is that of enabling third-party vendors to be able to sell credit. This is something that is possible with Kent Meters [11]. This could be one of the extra requirements formulated for new or upgraded systems.

Meanwhile, the users have found ways to respond to their new situation. An exploratory survey amongst users and user interviews showed that people would get water from their neighbors when they run out of credit and they have no money to buy new credit or the office is closed. Still, they indicate that they would rather have extended opening times of municipal offices or return of the flat fee for water (that was used for standpipe users before).

First and second order learning.

Most of the learning that is described above and has taken place can be classified as first order learning: concrete experiences with the niche-technology and the socio-technical system are used to improve or change certain aspects or to formulate new or more specific requirements. In this case, a lot of the learning experiences are processed into new technical specifications. The municipality hopes to improve on a large part of issues with the prepaid meter and unfulfilled expectations by choosing a new meter that corresponds with the new (technical) requirements. It is currently in the phase of switching away from the prepaid meters manufactured by Microplan and moving towards prepaid meters made by Kent Meter. The municipality has undertaken an internal test with the new Kent prepaid meters to make sure they function as expected.

Within the new local niche, most learning processes are within the municipality coordinating and executing the experiment. User experiences have a harder time reaching the responsible officials at the municipality and thus learning proceeds in a more difficult way, and particular user experiences do not reach the municipality or in the form of more general dissent. Therefore, there are few specific user experiences that are processed through first order learning into new functional requirements. The general public and political call for more connections has been internalized into the project through provision of these connections fitted with a prepaid meter. However, in general, the *learning by interacting*, is not taking place. The drawback of this is that learning by users takes place without interaction with the municipality and takes the form of learning how to bypass water payment or debt repayments through sabotage which is costly and undesirable for the municipality and no lasting solution for users.

Second order learning, where the basic assumptions underlying the prepaid water system are challenged and rules are rejected or (re)formulated, has taken place to a very limited extent only. The unsuccessful recovery of debts so far has led to first order learning in the form of the new 'zoning'-requirement where the prepaid meter forces people to use their own account, but also to second order learning that changed the assumption that the prepaid meter would be the sole solution to recover these debts leading to the appointment of more municipality personnel to collect debts.

On a more fundamental level, doubts have arisen that debt recovery is at all fully possible in Otjiwarongo given the socio-economic situation of many of the targeted inhabitants. Officials have pointed in interviews to the impossibility for many people to repay debts on a regular basis and at the

same time pay for current services and support their general costs of living [6; 19]. They feel reluctance to pursue debt recovery at every cost, which would ultimately result in legal actions and possibly expropriation of possessions or eviction from their properties. Officials find this very undesirable. This points to a challenge to the feasibility and desirability of debt recovery, but has not yet resulted in concrete reformulation of this rule.

Concrete second-order learning in this case would be to further explore what the affordability of water really means for the population of Otjiwarongo. Currently, the possibility to buy small amounts of credit at a time is seen as enough to make water affordable (several officials stating how people can buy water for just N\$10 or even just N\$1 at the office). Taking into account what amounts of water people need to sustain their lives and livelihoods and how big a percentage of their household's income this consumes, would give a richer conception of affordability and the potential of the prepaid water meter to ever supply affordable water and accomplish cost and debt recovery for the municipality.

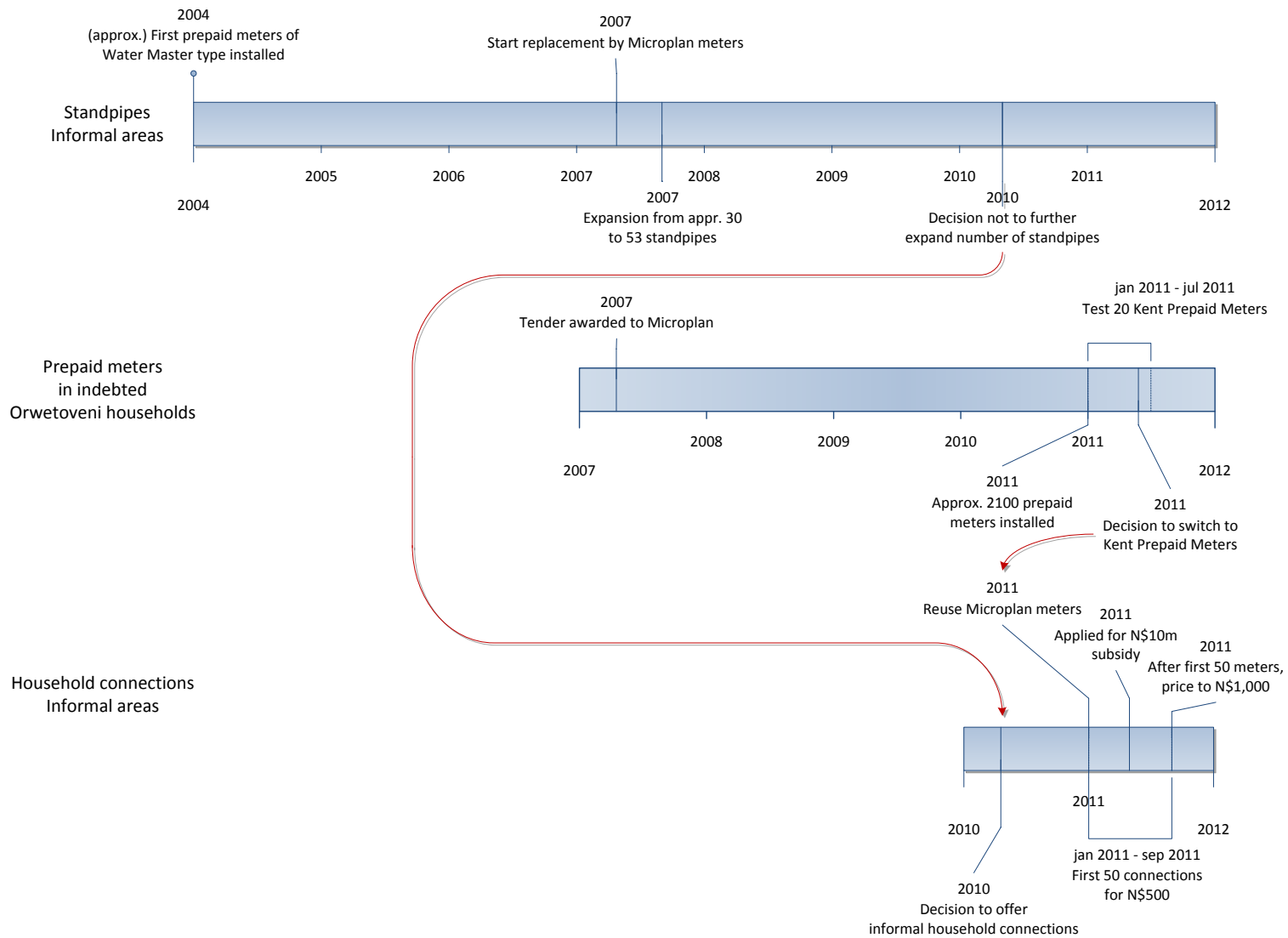


Figure 15: Developments in the Otjiwarongo prepaid niche-experiment, sorted by different application and including the main connection between the two original applications and the later adopted third application of informal household connections.

4.4. Conclusion SNM-analysis of the local experiment

The main developments in the Otjiwarongo prepaid water experiment can be seen in Figure 15. This figure shows a chronological order of decisions and actions and helps better place some of the above learning as well as some of the following conclusions.

The local experiment can be evaluated through the Strategic Niche Management-framework with a focus on the three internal niche-processes: set-up of actor networks, formulation and alignment of expectations and the handling of learning processes. SNM helps answer the question whether the niche technology has transition potential by evaluating the local experiment. It can help evaluate whether it has a place within a wider transition to sustainable water supply in Namibia through analyzing the niche.

4.4.1. Actor network

The actor network in this case is one that partly consists of regime actors and partly of (global) niche actors and the users and their (political) representation. From analyzing the network, the central role of the municipality becomes clear as the initiator of the project and the one that engages in combining regime and global niche rules in an experiment in Otjiwarongo's local context.

A special relation to consider is between the municipality of Otjiwarongo and the inhabitants affected by the prepaid water technology. Because the adoption of the prepaid water meters was not decided by its users but forced by the municipality, this presents an interesting case for a niche experiment. Normally, in SNM experiments users have to be convinced through expectation alignment and kept onboard through the right handling and feedback of learning processes. Here, it is not possible for users to directly influence (un)adoption of the innovation. They do however determine the success of the experiment and the municipality through public feedback, political preference, resistance or cooperation.

We can see that the municipality is at the center of the network, connecting the different parts: the involved regime actors, the local users and the global niche actors. Although it is quite caught up in the regime relations with little possibility of changing it, the municipality is for a large part in charge of its network in Otjiwarongo with the affected users. The municipality also has quite some bargaining power towards global niche actors, since these are the manufacturers of the technology and there are several of them. The actor network suggests that the municipality is the actor that can set the pace and tone in the network. Because of its central position, this brings the responsibility of sharing information with and between other actors. It is the central actor in the alignment of expectations and the processing of learning.

4.4.2. Expectations

The expectations that accompanied the niche innovation were high and differed in their specificity, quality and robustness. Quality and specificity were low when it comes to one of the main uses of the prepaid water meters, that of installing it in township households to the end of *financial sustainability* by increasing cost and debt recovery. The main cause is that this is a relatively new and untested application in Namibia. Combined with the high expectations that the prepaid water meters would solve

this important issue, we can see that some disappointment had set in about the initial expectations. Debt has so far not effectively been recovered, but on the side of cost recovery there have been hopeful cash flow improvements. The expectations of what meters are needed in the future to further enable cost and debt recovery have been refined by further specifying which meter the municipality needs. Not much attention has been given so far how they will work out in practice, so except for technical functionality expectations there are no new or refined expectations for the application in the households itself.

It is hard to measure to what extent the expectation of educating people on the value of water and importance of paying bills has come true. Since this would be an outcome not measured in monetary or technical terms, it is a less pressing expectation which is vaguely believed and formulated but has no concrete follow-up. It is sometimes evoked to motivate the municipality's decision process, but it is not in any way measured or used to evaluate the success of the niche experiment.

The third main expectation that the prepaid water meters would increase the municipality's capacity to provide and sustain access to water is a very concrete one. Not all the associated micro-level expectations have completely come true and the municipality is confronted with the harsh reality in which prepaid water meters had to be disconnected and the supply of water could not be sustained. However, more connections have been provided to people previously not eligible for individual connections and this does fulfill one of the (newer) micro-expectations. Even more, this promise of providing more individual connections through prepaid water meters in the informal settlements has been boosted to one of the main expectations for the project.

4.4.3. Learning processes

Learning that has taken place has fed back into the local niche in the form of technical and service adjustments and new, more specified expectations. Most learning is first order learning pertaining to aspects of the prepaid water system. There is limited reflection on the assumptions underlying the system. These assumptions are mainly regime rules and landscape factors applied to Otjiwarongo and/or water supply.

Niche stability can be seen as dependent on the three internal niche processes explored above. However, the complex relation between municipal government and the residents makes this hard to assess. While there is a network including all involved parties, this relation is a hard one to analyze: the targeted residents of Otjiwarongo are the users of the technology but the municipality is the actor that decides to adopt the innovation or not. So the success of the experiment is judged by the municipality on basis of its own criteria and expectations and its own experiences. User experience, especially negative, is only fed back in indirect ways. User dissidence or resistance following from discontent affects the municipality's experiences and learning through the seeming non-cooperation of residents or the political pressure through elections and then the town council. The municipality's learning will then be focused on reducing or dealing with resistance and dissidence, instead of directly dealing with the causes of these.

The expectation of educational value of technology is not assessed against reality. At present no learning has taken place that tells to which extent the municipality is really dealing with reluctant users that have to be taught how to value water, budget and pay their bills and to what extent people are really unable to afford full-cost reflective water tariffs. Evaluation of this expectation would tell the municipality more about whether they are targeting the right people in the right way in the prepaid water project.

Also, municipality learning and formulation and adjustment of expectations can be happening in a structured way and 'by the book', but still makes it hard to say whether this is a successful niche experiment because the abovementioned division of user role and the decision maker. At present, the municipality has expressed its intent to go forward on the chosen path and continue the application of prepaid water meters. It also expressed that the project is still experiencing 'growing pains' but feels it has come a long way in addressing those [2]. In SNM-terms, the municipality has decided to sustain and expand the protective space for the niche technology: although it is not yet yielding all the financial and social returns that are hoped for, the belief is still strong that the technology will be able to in the future.

4.4.4. Transition potential and sustainability outcomes

So, what is the transition potential of the prepaid water technology in a transition towards sustainable water supply?

The municipality of Otjiwarongo (as are most other LAs) is not responsible for the environmental sustainability of water supply, as this is a task of NamWater as the actor that abstracts water from natural resources and makes it fit for consumption. This leaves financial sustainability and social sustainability as the important goals for the municipal water supply system. Is the prepaid niche technology achieving this or promising to achieve this in the future?

4.4.4.1. Transition potential towards financial sustainability

Financially, the prepaid water meter is expected to generate a steady stream of revenue to achieve cost recovery and in the case of many households also to achieve debt recovery. For this, the municipality has made (and is making) investments in the meters and the required infrastructure. From the regime-analysis in chapter 3 we have found the premise that the tariff for every amount of water should cover the costs of its production and provision is the foundation of the water supply regime. Is the prepaid water meter going to achieve this?

In parallel research by Lisanne Saes, her cost-benefit analysis of the needed investments versus the income it can generate shows that cost recovery of water through the prepaid water meter would imply tariffs that are far above what is feasible and desirable for the low income groups that are targeted (Saes, 2012).²⁴ Debt recovery would be added on top of the water tariff, raising it further. This is only feasible when households have enough disposable income. Most of the targeted indebted households

²⁴ For this computation, Lisanne Saes combined financial data from the municipality (cost to install prepaid water meters, operation cost, estimated life span of the meters) with income survey data of the Namibian bottom 25% and the 25-50% bracket and the maximum desirable amount of income to be spent on water from scholarly literature.

are part of the lower middle-income group and cannot be assumed to have enough money to feasibly pay full cost-recovery tariffs and debt repayments.

The prepaid water meters can still help in generating a more stable cash flow from water payments, but is unlikely to yield full cost recovery. As long as financial sustainability is supposed to be achieved through full cost recovery, the transition potential of the prepaid water meter is low. If this underlying assumption would be challenged, the prepaid water technology can assist in guaranteeing a certain cash flow and have some transition potential towards financial sustainability. For financial sustainability in the regime's current conception to become attainable, either the investments should become much cheaper so that cost-recovery leads to lower tariffs or there should be a sharp decline in poverty which would make the affordability on the user side much higher.

4.4.4.2. Transition potential towards social sustainability

It is much harder to assess social sustainability and the extent to which it is being achieved. Accessible, equitable and affordable water supply is constitutive of a socially sustainable water supply: people are able to get the full amount of water needed for sustenance regardless of their socio-economic status. This can be at odds with the full cost-recovery rule of the regime.

Access is an element of the expectations formulated around the water supply: through the prepaid water meters, individual household connection in the informal area became feasible for the municipality and disconnections are supposed not to occur anymore when prepaid water meters are used. These both would improve the extent to which people have access to water. Also, individual connections for poorer households would reduce inequality and the burden of getting water, although in the current set-up individual connections are only attainable for the people that can afford the (subsidized) price of getting the connection.

The above way of providing access to individual households in the informal area brings the level of service closer to that of the formal areas of town (compared with getting water at the communal standpipe). However, for the households in Orwetoveni township, a new divide is created in service standard between those that receive a prepaid meter and those that keep their old connection, where the latter retain the flexibility associated with a post-paid connection and the former have to deal with the new order of actions that requires them to purchase credit at a municipal office and to budget appropriately for them to be able to access water. Thus, both in Orwetoveni two service standards now exist (prepaid and post-paid) as well as in the informal areas (individual and standpipe connections, both prepaid). Whether this degrades social stability is hard to answer, but an issue worth considering and possible topic of further research.

Social sustainability can partially be assessed by looking at whether people are able to access the quantities of water needed for daily sustenance. This is not taken into account by the municipality in their expectations nor has this become a salient learning point, so from the SNM-analysis this is hard to assess. The prepaid water meter experiment does not take into account any desirable minimum amount of water people should have access to per day or what the maximum share of household income can sustainably be spent on water. Whether people are able to have enough water for a not too big part of

their income is not part of the formulated expectations or a concrete issue in feedback and subsequently not present in learning processes. Research by Saes (2012) has shown that users of prepaid water meters in Orwetoveni are in general consuming much less water than conventional, post-paid water users (55 liter/capita/day versus 183 l/c/d). Users in the informal settlements that use either prepaid standpipes or prepaid household connections have even lower water usage (both around 28 l/c/d).²⁵ Especially the latter figure is reason for concern given the 50-100 l/c/d amounts that are deemed desirable by Howard and Bartram (2003). Also, the big discrepancy between prepaid and conventional use in Orwetoveni is an issue of interest. These issues are at present not part of learning processes by the actors in the prepaid water experiment.

Furthermore, application has led to some complaints and resistance from users, but the exact causes of this are not identified easily for the municipality. Communication on these issues is often troublesome between users and the municipality, which hampers effective learning. The municipality itself thinks technical improvements will help take away some of the annoyances (new meters with better functionality, optimization of installation). This is mostly connected to the expectations the municipality has. The SNM-analysis lets one evaluate along the lines of the expectations in the niche process and the learning involved, which in this project does not touch on all dimensions of the socio-technical system. The more general rule alterations have been discussed in chapter 3, amongst which the profound cultural meaning of changing practices. These have a strong socio-cultural impact which is to be taken into account when assessing the impact on social sustainability. They are not articulated in the niche experiment, so would be easy to overlook. However, the radical change in order of actions which affects the poorer part of Otjiwarongo's population undoubtedly has an impact on the transition potential towards a socially sustainable water supply.

Concluding, the transition potential of the prepaid water meters towards social sustainability is a mixed bag and hard to assess overall. This warrants further attention in the project to assess whether the niche innovation can be part of the sustainability transition in water supply.

4.4.4.3. Niche experiment stability and protective space

The municipality is the actor that has created the protective space for this project: investing and allowing time before it has to yield results. It realizes that it is a pioneer in areas of the prepaid water meter application. At present, it is satisfied with the progress it has made, learning about the technology and the issues that come from everyday use in the context of Otjiwarongo's households and informal areas. The intention is to continue the project and further expand. The municipality is actively looking for national subsidies to expand and sustain the protective space for a longer time.

From the above, however, it can be said that certain aspects of the system and/or the underlying assumptions in the regime limit the transition potential of the prepaid water meter towards a sustainable water supply. The innovation is not fully able to resolve the regime tension that comes down on the municipality, although it might come some way in resolving it. Furthermore, the innovation affects sustainability in other ways than captured in the expectations, actor interactions and learning

²⁵ This data was gathered through an exploratory survey in Otjiwarongo by Lisanne Saes. It should be treated as a useful indicator of issues of importance in water use.

mechanisms in place now. Second order learning is crucial, in which certain key foundations of the niche technology and the regime will be re-evaluated and the experiment, the regime and societal impact can be reconciled. In the future, this can lead to adjusted focus and expectations in prepaid water experiments.

4.4.5. Results and limitations of the SNM-analysis

The SNM-analysis has been useful in a descriptive way in further understanding the developments, the actions of involved actors and on which expectations and learning mechanisms they act and react. It however also makes that in assessing this project the analysis automatically focuses on the dominant actor of the municipality as the central actor in the project creating the protective space and most articulated in its expectations and goals. The evaluation then follows the lines of the articulated expectations. Aspects of the project that fall outside these lines of thought (and sight?) are neglected, while the impact on the users and the transition potential is affected by them. Also, experiences by the users - the actor group that is most affected by the prepaid water project and plays a large role in successful embedding the technology in the real world - are not clearly visible because their feedback is not specified in word and not taken up explicitly in the observed learning processes. Other ways are therefore needed to get a more complete picture of the role the users play and the progress of embedding the prepaid water innovation.

5. Translation towards sustainable water supply in Otjiwarongo, Namibia

This chapter is an attempt at adding more insight to the dynamics of the Otjiwarongo niche-experiment through the perspective of sociological translation. The character of the project is such that a bigger focus on interactions and the agency of the municipality are useful. Given the fact that the municipality is the actor that took the initiative in changing the status quo and introducing the (niche-)technology of prepaid water meters, it is interesting to take them as the ‘translating’ actor: trying to shape the local actor-world to fit their visions and goals through the four steps of sociological translation.

The question to be answered in this is how successful the ongoing translation has been, performed by the municipality, in the local prepaid water meter project. The translation analysis will bring new and different insights from those offered in the previous chapter, in an attempt to further evaluate the local project. This exercise will highlight the similarities and differences that arise from the SNM-analysis in the previous chapter and the translation-analysis from this chapter. It will proceed by analyzing how the municipality is moving through the four moments of translation.

5.1. Translating actor: Municipality of Otjiwarongo

The municipality of Otjiwarongo and its goals in the prepaid water meter project have received considerable attention in the previous chapter, of which a small recap will be given here. Namibia’s socio-economic and historic background, changing visions of service provision, development goals regarding water access and decentralization of responsibilities to local authority level are the landscape factors that have steered the evolution of the Namibian water supply regime. Regime rules have shifted to one where the water regime has to be financially self-sustaining, preferably also the separate actors. The local authorities (LAs) are part of the water supply regime on the interface of the regime and the residents that receive the water. In the current regime, the revenue supporting the regime has to come from the full cost recovery of the water services through the tariffs that people pay for water. The LAs have been given the responsibility to collect these payments and to funnel these to the other actors in the regime to support their activities.

This evolution has put considerable tension on the LAs because payment collection is a troublesome endeavor in Namibia’s highly unequal society where a lot of people have problems earning a regular income and budgeting in a way that allows them to pay monthly bills.

Several local authorities thus went looking for solutions to ensure payment. The municipality of Otjiwarongo has chosen to experiment with prepaid water meters that oblige the user to first buy credit before they can obtain water through the meter. This socio-technical innovation is expected to resolve the tension between the socio-technical regime’s rules and the local social context.

In this local social context, the municipality of Otjiwarongo interacts with other actors to facilitate the introduction of the innovation. The diffusion of the innovation is forced by municipal decision, but to ensure the desired effectiveness a constant effort is needed to make sure it is embedded in the local context in a way that the innovation functions as expected. This can be regarded as the translation that the municipality performs: creating a reality in which the newly introduced innovation of prepaid water

meters resolves the tension and helps to work towards the vision of supplying water in a way that is sustainable for the municipality.

5.2. The actor-network

The theory of sociological translation stems from the branch of sociology called Actor-Network Theory (ANT). ANT sees the distinction between social and natural world as an artificial one and argues that the world should rather be viewed as a network consisting of heterogeneous entities. These entities themselves are a representative or 'spokesperson' of a collection of people, knowledge, routines, technology or elements of the natural world. In this view, these entities are all actors that can be a person, a group of people, an institution or a device inscribed with practices and structures, and so on. All these actors have to be 'convinced' to cooperate in order for the translating actor to reach its goals. Whether the translation succeeds can tell us something about the extent of an actor's agency. Actors can be intermediaries or mediators. The former do not have the ability to change outcomes in 'unpredicted' ways, they are a passing station. Mediators do wield agency over outcomes so the product of interactions is unpredictable.

The municipality of Otjiwarongo can be seen interacting with a range of actors, both mediators and intermediaries, translating the vision of sustainable water supply in a way that these actors relate to them and the municipality's actions as being in their interest. Simultaneously, it tries to cut these actors off from alternatives or bypasses them to become an indispensable node in the network, what Callon (1986) calls an obligatory passage point.

The actor network overlaps for a large part with the niche-network as described in section 4.1., treating differently the distinction between the levels (regime, (global) niche, local context). However, I also made some choices that in my view are useful for this analysis and I think correspond with the perception of the municipality as translating actor.

A first choice is to include the regime as one actor in the network, even though it consists of multiple actors. It can be represented as one actor as it represents a set of rules and relations with which the municipality has to deal. The municipality, as has been noted before, is part of the water supply regime but the tension in the regime is actually between the municipality and the rest of the regime. Therefore, the municipality is acting to resolve this tension in a way that works within the regime and the rest of the regime can be seen as an actor that has to be engaged in the way of working of the municipality. This

The actors that are not included in the translation analysis are the ones that do not have to be engaged in the translation process. They might still be 'suppliers' of technology, rules, visions, etc., but no relevant actors in this local project.

An actor that has been added is the prepaid water meter itself. In this analysis, it has to work as the municipality envisions. To be applied effectively, the meters have to be embedded such that they function in a way that corresponds with the envisioned functionality. This also captures the translation of design characteristics of the technology and the required infrastructure behind the prepaid water meters. In the end, the specific devices have an impact on the practices and interactions of other actors

with the prepaid water meters and with the municipality. Because the municipality is not involved in the design and manufacturing of the meters, the municipality is not so much associated with the manufacturers of the meter as it is with the meter as such. The relation between the municipality and the prepaid water meter is a defining one for the success of the translation.

What follows is how the municipality performs translation to reach its goals. This is not a one-time procedure, but a continuous process. The four steps of the process might be performed simultaneously and the distinction is not always clear, but an attempt at categorization will already help understand the observed interactions and success of the project.

When translation is performed successfully, the principal actor – the municipality of Otjiwarongo – can be said to have at least momentarily formed an actor-network for water supply, representing all the actors it has enrolled.

5.3. The four steps of translation

5.3.1. Problematization

The first step of translation is that of problematization. In this step, the municipality as the translating actor tries to frame their goal as a problem that concerns all the involved actors. Actors need to be convinced that their goals coincide with those of the municipality and that the way to reach their goals is through the municipality and the prepaid water meter project. Figure 16 is a graphical representation of the networks, their goals and the obstacles they encounter. The municipality of Otjiwarongo wants to frame its goal as an obligatory passage point (OPP) for the other actors to circumvent their obstacles and reach their own goals.

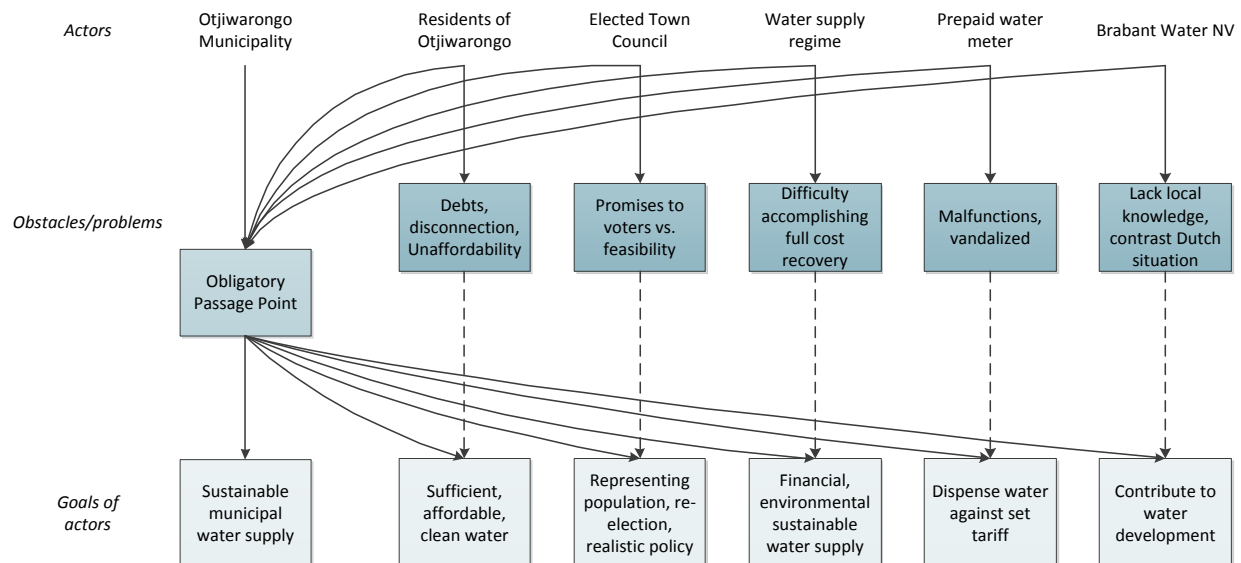


Figure 16: How the municipality of Otjiwarongo tries to establish itself as the Obligatory Passage Point (OPP) for the different actors it is dealing with (following Callon (1986), lay-out inspired by Baan Hofman (2011)).

The goals in figure 1 are derived from several sources: official statements, previous analyses and general knowledge. These are the goals of the actors concerning water, the overall prominence of the goals differs per actor. The water supply regime and the prepaid water meter are geared towards supplying water and thus these goals are important for them. For the municipality, town council and Brabant Water, the supply of water in Otjiwarongo are one of many issues and for residents, obtaining water is only one of the many goals towards sustaining their everyday lives.

The goal for **Otjiwarongo municipality** is to achieve a sustainable municipal water supply that serves the whole community of Otjiwarongo.²⁶

A sustainable municipal water supply that serves the whole community of Otjiwarongo is further specified as one where costs as well as outstanding debts are recovered in order for the municipality to be able to support and expand the water supply system in the future to be able to serve the whole population of Otjiwarongo.²⁷

The others actors each have their own goals and they have to be convinced that these can be achieved through the municipality as OPP:

The **Residents of Otjiwarongo** want to have access to sufficient amounts of clean drinking water at an affordable rate. For them, this is of course not their only goal in daily life. It is however of great importance, especially relating to the importance of water in everyday life. This group has been suffering however from disconnections that can be related to the affordability of water and the debts that people ran up by not paying for water in the past.

Elected town council want to serve their constituency, ensure re-election and come up with feasible policies for Otjiwarongo among others when it comes to providing more water connections to Otjiwarongo's residents. Individual members and their political parties want to be (re)elected. They are on one hand dealing with the residents that have their goals and on the other hand with the municipality that has to execute policy in Otjiwarongo. This actor is perceived as representative of the political side of the prepaid water experiment and also representing (part of) Otjiwarongo's residents.

The **water supply regime** aims to supply water in an environmentally sound and financially sustainable way, which means that all the costs they make for abstracting, transporting and purifying water and their overhead has to be recovered through the water tariff that is set for the municipality. This way of working is central to the regime rules that have set the stage for these kind of local experiments (as discussed in chapter 3). A main obstacle would be when municipalities do not succeed in accomplishing the financial sustainability through cost-recovery. The water supply regime is perceived representative of the regime actors and rules and all the individual entities these actors represent in turn. Although the

²⁶ Compare with the macro-expectation/vision in the SNM-analysis of the prepaid project in Otjiwarongo from chapter 4 formulated as 'long-term sustenance and expansion of municipal services'. The goal and vision correspond with each other, although the goal here is formulated slightly narrower for the clarity of the translation analysis.

²⁷ This is basically a specification along the lines of macro/meso/micro-structure of expectations in the SNM analysis (chapter 4).

regime is an analytical construct, it corresponds to how the municipality deals with them in this project at this moment. The main efforts in the project are directed 'downwards' to the actors in the local context and what they need from the regime is for them to agree with the space the municipality is creating for itself to act. At present, the regime acts as an intermediary, not modifying actions in this project. It does have the latent agency to do so. Also, would the municipality decide to change its focus of the project and start working 'upwards' trying to change regime rules or interactions with the regime actors, a new dynamic would emerge where the water supply regime cannot be seen as one actor-network represented by regime rules. Also it would not simply act as an intermediary but become a mediator by wielding its agency.

The goal of the **Prepaid water meter** is to dispense the amount of water corresponding to the credit on the tag that is presented to it, the end to which it was designed. The prepaid water meter is perceived as representative of the technological and design choices it is inscribed with as well as the infrastructure of which it is the end-point.

Brabant Water NV has expressed the wish to contribute to development projects from their expertise in managing water infrastructure and supplying drinking water to end users. They do not have much local knowledge and therefore find it hard to give concrete assistance. They have, just as the water supply regime, latent agency which is not used at the moment. Would they however decide to change their opinions about crucial aspects of the water supply system, they could start to exercise some influence and act as mediator, transforming outcomes.

5.3.2. *Interessement*

To seduce the other actors to make an alliance with the municipality, the municipality engages in interessement. This can be done through 'seduction', through coercion or a combination of both, depending on the relation between the actors. Some of the actors have to be disentangled from other relations. The municipality chooses a different approach per actor based on the balance in the relationship and the means – the devices of interessement – it has at its disposal. Therefore, a structured overview of the interessement is given below:

5.3.2.1. *Residents of Otjiwarongo*

First and foremost, the residents of Otjiwarongo are distributed in several groups that determine in what way they are dealt with by the municipality when supplying water: formal households, formal households with debts in service payment and informal households. The two latter groups were selected that had to be enrolled (more firmly) in the network where the municipality is the obligatory passage point (OPP). By not paying bills, these groups of residents had an association with municipal services while bypassing the municipality that wants payment for these services.

The most important device of interessement that is introduced is the prepaid water meter (also an actor itself) which is installed in the households with debt and the communal standpipes when the municipality deems it necessary. The residents are not given a choice, so here the municipality uses coercion for the interessement. The prepaid water meter is installed and the user has to work with the

device, the intention being that the user will not avoid payment now that the meter ensures this automatically.

Additionally, the municipality has used several devices of interestment to convince the targeted users to align themselves with the municipality. The municipality organized information meetings and formed a water committee consisting of residents of the informal settlements to be of assistance when the new meters were placed at the standpipes. The information meetings and water committee were used to explain how to work with the prepaid water meters, but also to inform about the importance of paying for water and services and to repay debts (when applicable).

Furthermore, the municipality had to facilitate the system to make it possible for the residents to enroll in the network and to convince them to use the system as intended. The measures the municipality took can also be classified as devices of interestment, which were the opening of vending points for the credit and the hiring of extra personnel trained in installing and repairing prepaid water meters.

Finally, the town council as political body and Brabant Water as outside expert can be deployed as devices of interestment. When they support the policy and actions of the municipality, it can help further convince the residents of Otjiwarongo.

5.3.2.2. Elected town council

The town council, chosen in elections once every five years by the inhabitants of Otjiwarongo, is essential in decision making. It decides on a wide range of issues in consultation with municipality officials. It has a responsibility towards its voters and to the general interest of Otjiwarongo. For the municipality, the town council is the main political actor they have to deal with.

Because a lot of municipal decisions are made in close cooperation between the municipality and the town council, the association is there, but the municipality has not established itself as obligatory passage point towards achieving the goals of the town council yet. This is illustrated by the fact that politicians (in general, not just of the town council of Otjiwarongo) are giving out mixed messages to their electorate, in election times promising free water and objecting payment for these services [2; 8; 22]. Also, when in office, the town council acts on different interests than the municipality does, which results in councilors asking the municipality to go easy on debt recovery in election times [19]. This can be seen as a relation between the town councilors and the residents of Otjiwarongo that surpasses the municipality.

Thus, the municipality tries to disentangle the town council from this association and get them to align themselves with the municipal policy on recovering costs and debts through prepaid water meters.

The municipality has as its main device of interestment the close contact and cooperation it maintains with the town council. Discussing with them the situation of the municipal water supply and the tension in the water regime is the device of interestment the municipality can employ in order to convince the town council that the municipality project is the best way to reach their goals.

5.3.2.3. *Water supply regime*

The regime is perhaps the easiest actor to perform the interessement on. As the whole of bulk water supply, regulatory and legal framework along the regime rules it is already associated with the municipality of Otjiwarongo. The municipality buys all the water the town needs in bulk from NamWater and then distributes it, something that is documented in Namibian legislation and the cornerstone of water supply regime. The municipality is already the obligatory passage point for water from bulk supplier to households, physically and through the rules of the water regime.

A (distant) threat is that when municipalities mismanage their water supply in such a way that they in no way can fulfill their payments to NamWater, NamWater has the mandate to (temporarily) take over water supply in a town to get everything back in order [7]. In such a case, the water supply regime would disentangle itself from the association with the municipality and directly associate with the users of water. Also, the regime can ration bulk water supply to a certain limited amount of time or volume of water per day to towns when they feel they need to, when the municipality would start operating outside or against the regime rules of cost recovery.

The main device of interessement the municipality employs to keep their association with the water supply regime intact is the operation within the regime rules, most tangibly in the monthly payment of the bill for water to NamWater. Additionally, it is in close contact with the local branch of NamWater and different departments of national government to talk through all matters pertaining to water supply in Otjiwarongo and keeping the association between the actors in place.

5.3.2.4. *Prepaid water meter*

The prepaid water meters are a crucial actor in the actor-network that is to be formed. They are a principal actor in achieving the sustainable water supply as the municipality envisions it. The prepaid meters should therefore associate with the municipality in a way so that they supply the amount of water corresponding to the tariff and the credit the user gives up (not more but also not less).

To enroll the prepaid water meter in this actor network, the municipality employs several devices of interessement: the resources to obtain the actual prepaid water meters, technicians able to install correctly and carry out repairs, the credit vending facilities, the tag that stores the credit. Through these devices of interessement, the municipality is also disentangling or preventing direct associations between the users and the prepaid water meter, where the user is using the prepaid water meter in such a way that it is dispensing water without subtracting credit.

Another device of interessement the municipality can employ is the choice of different types and brands of meters, replacing meters that do not function in such a way that the municipality reaches its goal.

5.3.2.5. *Brabant Water NV*

Brabant Water is a relatively new actor in the network. It became involved through a twinning relation between Otjiwarongo and the Dutch municipality of Heusden. It was interested in supporting water supply development in Otjiwarongo and the municipality of Otjiwarongo was interested in its expertise, also to come to “capacity building in the fields of market research and testing state-of-the-art pre-paid

water meters, operation and maintenance of pre-paid water meters and strategic planning of the pre-paid water project” (Otjiwarongo Municipality, 2010b).

The device of intersement that is used to associate the actors is a Memorandum of Understanding signed in 2010 in which the cooperation was made official. Regular contact and visits from Brabant Water officials to Otjiwarongo are also ways of aligning goals and interests.

Associating with Brabant Water is of main interest because of their expertise. It might also be interesting because having such a high-status party as ally will help give leverage to promoting your project in political and government circles. This would mean that the relation with Brabant Water would be used as device of intersement.

5.3.3. Enrolment

In the previous stage – intersement – the municipality of Otjiwarongo has tried to interest each other actor to accept the role the municipality has envisioned for them in order to reach the goal of a sustainable water supply that serves the whole community of Otjiwarongo.

When the intersement succeeds, actors align themselves in the actor-network by accepting the role envisioned for them. Often, however, more negotiation is needed to accomplish this. That is what the enrolment stage is about: a test for the initial intersement and following actions that are performed when necessary to turn the intersement into actual enrolment.

5.3.3.1. Residents of Otjiwarongo

The initial performance of intersement has only partially enrolled the residents of Otjiwarongo. The prepaid water meter that was installed in all indebted households and on all the communal standpipes has not succeeded in fully enrolling all users. From the beginning of the project, there has been dissidence where Otjiwarongo’s residents have not accepted the role of user that follows the prepaid water protocol of buying credit at the municipal office and then using this credit to partly pay for water and partly pay for other services and debt reduction. Although the prepaid water meters are used daily, it is not uncommon that they are tampered with in such a way that the municipality is bypassed (e.g. punching the valve of the meter so that water runs without the meter having to switch the valve) or both the municipality and the meter are bypassed (e.g. when people tap the water by piercing the pipeline before the meter). Further negotiation done by the municipality is by tweaking the prepaid water meter in such a way that this kind of dissidence is harder to perform: more robust housing (concrete casings in new installations) for the meters or the disconnection of users [3; 19].²⁸

Another way in which enrolment initially did not occur is in the field of debt recovery through water tariffs. Indebted households all got personalized tariffs based on the amount of debt they had to repay and which could be discussed with the municipality (standard water tariff for this group of users: 80% to service payments and debt repayment, 20% to water credit). Users however chose to use the tag of

²⁸ Even though the initial promise of the prepaid water meters was that disconnections would be a thing of the past, the municipality has in some cases resorted to disconnection of users that had prepaid water meters because they refused to take part in debt collection or were tapping the pipeline on their own plot of land and this was impossible to control.

neighbors with less or no debts and this way avoiding their higher personal tariff. The municipality is negotiating the enrolment in two main ways: by (1) in the near future replacing the current prepaid water meters with another type or prepaid water meter that allows to couple one tag to one meter ('zoning'), making this form of dissidence impossible through the functionality of the prepaid water meter and (2) by appointing personnel charged with the collection of debts, not solely relying on the prepaid water meters and tariffs to recover debt.

So as we can see from the above, people are to a certain extent forced to accept the devices of intersement but nevertheless find ways of resisting enrolment. The disapproval and resistance evoked by the efforts of the municipality to form the actor-network and to get the residents into the role envisioned for them, is voiced in other ways. The petition that residents of Otjiwarongo have presented to the municipality is one of the most explicitly formulated documentations of the dissent that exist (Community Members, 2010). Many of the issues brought forward showcase misunderstanding or miscommunication that exists – for example about the reasons for the new system, about the structure of the tariffs, about the extent to which the municipality respects and understands the issues of the community. Thus, it is not clear for the residents why the municipality's actor network helps them reach their own goal of access to sufficient safe and affordable water. The municipality continues with employing its devices of intersement (information meetings and the water committees). But enrolment is still not performed completely.

Furthermore, the connections that are being offered to households in the informal areas since 2010 are employed by the municipality as a way of showing that they are able to expand their services in the new actor-network and this is a development that residents overall have welcomed as a move in the right direction [14].

In general, the municipality is considering more ways of negotiating through extending services which might be implemented in the future (e.g. expanding vending possibilities for credit) [2]. These can be deployed in the future to further perform enrolment, but it's hard to say whether they will be enough to accomplish full enrolment since these negotiations seem not very substantial compared to the impact of the forced devices of intersement and the absence of negotiation about these.

5.3.3.2. Elected Town Council

Although the town council does acknowledge the municipality policy as the right one and they align themselves with it, there is still the feeling that politicians are publicly making different points to please the electorate. The close cooperation between municipality and town council thus has proven not enough to have local politicians publicly align themselves with the municipality's policy on water supply.

A further negotiation was therefore carried out by the municipality. It honored the long-standing wish of the town council to offer individual connections to households in the informal settlements (normally only eligible for the communal standpipes). However, they attached the application of prepaid water meters as a prerequisite for these connections to be realized [2]. This way, it has been able to further enroll the town council in the actor-network where the municipal water supply policy is the OPP for all actors to achieve their goals. The goals of the town council are in this way further reconciled with the

goals of the municipality: it is serving its constituency with improved connections, but these come with a prepaid water meter. For now, the town council is also promoting the municipality policy on water supply and prepaid water meters [13]. However, this might again change in the future (election times for example).

5.3.3.3. *Water supply regime*

The enrolment of the water supply regime is successful. The role that the regime fulfills is one of passive support. The interessement performed by the municipality by acting along the lines of the regime rules is successful as long as it keeps doing this. The cash flow to the municipality improved due to prepaid water meters, so it is currently even better possible to make the monthly payments to maintain the enrolment.

The municipality is trying to broaden their translation towards the water supply regime, for example by in recent past applying for subsidy to support the project, turning the passive support into active support. This can be seen as a negotiation not to consolidate the interessement, but to stretch it further. A resource like a subsidy could then be used as devices of interessement in the rest of the actor-network.

5.3.3.4. *Prepaid Water Meters*

The interessement was aimed at facilitating the smooth implementation of the prepaid water meters to perform the enrolment of the prepaid water meters in the actor-network as intended by the municipality. However, when the project got underway, complications occurred and the enrolment did not fully succeed. Further negotiation to more fully enroll the prepaid water meter was needed with three main points:

First, the meter itself broke down more often than expected (500 out of around 2150 meters needed repair or replacement in past years [2]). Some of these malfunctionings seemed to be due to the environment and conditions in which the meters were installed: damage due to exposure to sunlight and temperature differences, a lot of wear and tear due to extensive usage, easily damaged because of position and sensitivity to incorrect usage. By several technical negotiations, the municipality technicians tried to protect the meters from this and thus improving their enrolment in the role that was designated for them. These negotiations were hampered by the problems the municipality has had with the Namibian supplier of spare parts and replacements, leading to more negotiations of the municipality with the actor-network the prepaid water meter is thought to represent including manufacturers and local suppliers.

Secondly, because the prepaid meter is also used as an imposed device of interessement in the association between the municipality and the residents of Otjiwarongo, it is influenced by the dissidence of (part of) Otjiwarongo's residents (as discussed above). The tampering with the meter can be seen as an association between the users and the meters and simultaneously breaking the association between municipality and meter. This is thus the other side of the negotiations with the residents discussed in the enrolment-paragraph above: better protecting the meters or disconnecting the meters of which the enrolment has failed.

Thirdly, as the project developed, the role of the meter was further defined in ways that could not be fulfilled by the current prepaid meter even when it functions the way it was intended. For the newly required functionality of ‘zoning’ (which is hoped to facilitate debt recovery), the negotiation by the municipality will consist of the complete replacement of the current types of meters by meter of another brand. This means effectively filling in this position in the actor-network from the beginning.

5.3.3.5. *Brabant Water NV*

The interestment of Brabant Water was performed and enrolment followed. This has so far resulted in the supporting role the municipality had envisioned for Brabant Water, although the specific knowledge of Brabant Water on the prepaid water technology proved to be limited. Brabant Water has been able to provide advice on other water supply subjects (maintenance, strategic planning) and procedures of structured testing of new water meters. Through hosting Brabant Water officials twice yearly, the enrolment is continued.

5.3.4. Mobilization

The mobilization stage has to point out whether the municipality has really established its actor-network and can act and speak on behalf of it. Also, this stage of the translation process proves whether the actors it has been enrolling in the network are in turn representing the entities that the municipality assumed they would represent. When actors are single entities, this is quite easy to establish. However, in cases of large groups being represented by spokespersons, the spokespersons can be enrolled in the network but if dissidence occurs amongst the group it ought to represent, mobilization has failed. When groups are more diverse, dissidence is more probable. Another important point is the agency of the actors that are associated with: if these have a lot of agency outside of the network – whether actors are able to reach their goal outside of the actor-network – the association within the network is more fragile and needs constant attention.

5.3.4.1. *Residents of Otjiwarongo*

The residents of Otjiwarongo are a crucial actor, one consisting of a heterogeneous set of individuals in wide-ranging personal circumstances. The sub-group targeted with prepaid water meters is generally the poorer part of Otjiwarongo’s population. They were all reached by the main device of interestment: the actual prepaid water meter. The other devices of interestment (information meetings, facilities, water committee) were intended to reach all members of the community as well, but it is hard to see to which extent this happened. The described dissidence points to unsuccessful interestment. In the enrolment stage, the negotiations are not enough to realize full enrolment. Although a large part of community members are working with the system and are satisfied with it, there is also a considerable number of community members that is unhappy and not willing or able to accept the role the municipality envisions for them (members using water through the prepaid water meter system in the intended way). Full mobilization is hard to accomplish in such a heterogeneous community and the municipality’s methods of engaging the whole set of entities that form the actor have not been fully successful. There is not much agency for the residents outside the network in terms of getting sufficient, affordable, clean water in any other way due to the absence of local water sources and only little and intermittent rain that can be harvested. Inside the actor-network, there can be dissidence in the ways described above (bypassing the prepaid meter or tampering with it). These

actions force the municipality to perform the translation again or in a different way on these individuals or smaller sub-groups of Otjiwarongo residents, for example by repairing new meters, engaging in informing them and trying to convince them.

5.3.4.2. Elected town council

The town council is assumed to represent the political scene of Otjiwarongo as well as the voters that elected them. Therefore, enrolling the town council in the network enables the municipality to execute their policy and performing the translation to other politicians and the residents of Otjiwarongo. Whether these are mobilized by enrolling the town council is questionable. The town council itself is at present engaged in the network, but only future actions (for example around the next elections) will prove whether Otjiwarongo's politicians have aligned themselves with the municipality policy and whether the residents are represented by the town council's position (through voting).

The agency of the town council outside the actor-network is limited: although they can reach their goal of political representation and (re)election by dissociating themselves from this actor-network and the municipality project, there are few ways for the town council to reach their goal of more water connections that supply water to Otjiwarongo's residents without involving the municipality.

5.3.4.3. Water supply regime

The water supply regime represents the entities discussed in section 3.2 (NamWater, National Government, Ministries). The definition of a socio-technical regime already indicates that they are harmonized with each other through the regime rules. Translating this actor into the network has been possible by operating within these regime rules and problematizing the municipality goal in a way that corresponds with the regime rules. Treating the water supply regime as a representative actor has been effective in this translation.

The agency of the water supply regime outside the translated actor-network is present, making it possible for the regime to bypass the municipality when needed. This makes the association between municipality and the regime potentially fragile, but the regime rules and inclusion of local authorities in the regime makes it unlikely that the regime will bypass the municipality of Otjiwarongo unless absolutely necessary.

As mentioned before, the water supply regime is an actor in the background. At present barely visible when one merely analyses the translation in the local prepaid water experiment. The prior MLP analysis has however shown how influential they have been and potentially are. For example, when the municipality would shift the emphasis in its translation efforts away from the local actors and towards the regional and national actors in the regime, this particular interaction between municipality and water supply regime would 'heat up' and translation would take place in very different ways.

5.3.4.4. Prepaid water meters

The prepaid water meters are representative of a very diverse set of entities: of the municipal water supply infrastructure right up to the user functioning as one of the interfaces between the municipality and the residents, of the manufacturers and local suppliers behind the prepaid water meters. Furthermore, the population of prepaid water meter consists of more than 2100 meters in the whole of

Otjiwarongo, most applied in formal township households, some on communal standpipes and some (since recently) in informal households.

The mobilization is affected by several issues that have presented themselves: the tampering of the users with the meters is an example of the users directly associating with the prepaid water meter, the bypassing of meters is a challenge to whether the prepaid water meter is really the interface between the water infrastructure and the user. Furthermore, the fixing of technical malfunctions and the problems the municipality has encountered was hampered by the dissidence of the local supplier that was behind the prepaid water meters.

Finally, the problems occur with one meter at a time - in total a substantial share of the total number of meters has experienced dissidence over the course of the project so far. The municipality can translate for the prepaid water meters in Otjiwarongo, but the dissidence that occurs one meter at a time, requires retranslation per individual meter (something that is costly).

5.3.4.5. *Brabant Water NV*

Brabant Water has in general oriented itself in such a way that they want to assist with municipal efforts of reaching their goal for water supply. The individual employees of Brabant Water the municipality deals with are representative for the part of Brabant Water that is involved in this cooperation with Otjiwarongo. At present, translating Brabant Water has been proceeding almost automatically. They are a sleeping actor

Brabant Water has the possibility to also act outside the actor-network, by choosing to cooperate with other actors. However, as long as their goal is specifically to assist in Otjiwarongo, cooperation with the municipality is most likely and they will not disentangle themselves any time soon. Furthermore, Brabant Water can evolve as it learns more about water supply in Namibia and prepaid water meters, further specifying their stance on issues. Their reactions to the municipality's efforts could then change and ask for a more

5.4. Conclusion: successful translation?

On the basis of this analysis we can see whether translation was performed successfully or only partially. The moments of translation are being passed through by the actors, often repeatedly. What has been described in these moments are different kinds of interaction, which fits with the ANT-background that entities are always in some relation to each other. Actors in themselves are networks of entities and perpetually seek to form new networks to reach their goals.

In this case, the municipality of Otjiwarongo has been trying to translate the other actors that play a role in reaching the goals of the municipality (a sustainable municipal water supply). The problematization-stage is about identifying the actors involved and recasting the municipality goals and the municipality itself in such a way that it they form an indispensable node in achieving the other actors goals – they become the obligatory passage point (OPP). Through the stage of interessement, the formulation of the OPP and the identification of collection entities as actors are tested. The interessement is the stage in which mechanisms are deployed to get the actors in a place where they accept the municipality's problematization and associations with alternative practices are disrupted, setting the stage to make the

OPP truly obligatory (in this case, accepting the organization of water supply as proposed by the municipality as the way to reach the actors' goals). At this stage we have seen the municipality employing various devices of interestement, some of them at high costs (prepaid water meters, the physical and organizational infrastructure).

Where interestement is about identifying which other associations need to be broken to form the desired associations, the third stage of enrolment shows the test in real life: is the interestement put in practice as was envisioned? Here, by looking at the interactions that followed the commencing of the project, we can see where associations have been formed and where additional negotiation is needed. Following this, observing the additional negotiations helps to understand where contestation arises: for instance, the residents have not accepted the initial interestement by finding ways to evade payment and debt recollection. The additional negotiations by the municipality towards its residents proceeded through different channels: through the technical artefacts, through communication in various bodies (meetings, writing, personal communication at the office and with technicians). This negotiations are performed or in the process of taking place at the moment of research (September 2011) with unclear or yet unknown outcomes. Furthermore, interestement performed on the prepaid water meters was not fully successful: there was more malfunctioning and direct association with other actors (the residents) was not fully prevented. Certain negotiations helped improve interestement (the politics done with the town council) to establish enrolment – that is, until the next test. Other interestement with the water supply regime and Brabant Water immediately succeeded and needed no further negotiation.

Then the final stage: mobilization. This stage is all about representation, but in fact, the whole process and many of the observed actions are shot through with issues of representation. The crux of the project here has been for the municipality to get every resident to use the changed water supply system with all its socio-technical dimensions. For this, every individual member of the actor group residents (thousands) were confronted involuntarily with a new system they had to work with. For the accompanying devices of interestement (assistance, information, consultation) that are meant to mobilize the residents in the project, not every individual can be reached. The municipality seeks to find individual members of groups that are representative of (a part of) the community and to reach them or to set up bodies that will help diffusion of the devices of interestement, but these are troublesome endeavors: 100% of the community members are never reached. Thus, there is always a part of the community that is only confronted with the forced-upon device of the prepaid water meter, not accompanied with any information. The municipality tries to compensate this by enrolling other actors that ought to be representative of the community as well: those of the Town Council, the political representation of Otjiwarongo's residents. The town council members and their political organization do serve these goals, but are also involved in many other projects and have their own stakes.

Even if all devices of interestement reach individual community members, there is still the question whether residents accept the translation. Their limited agency outside this network (little no other ways of obtaining water) and towards the municipality as a whole leads them to perform the agency they do have in their physical vicinity: towards the prepaid water meter as a representative of the municipality's water supply actor-network. Individual residents form their associations with the prepaid water meters

or with other residents (for instance in avoiding the debt repayment). This leaves the municipality no option but to retry translation beginning again at problematization and interessement. Deploying the devices of interessement (again) brings high costs with it for the municipality.

Furthermore, the prepaid water meters are a population of thousands of individual entities as well and – following ANT – each meter represents a network of its own. Translating them into the network yields similar problems as translating the community of residents. Representation is limited: some general devices of interessement can be deployed to facilitate enrolment but each individual member can show dissidence and not be translated. This is again at high costs for the municipality to attempt translation once more.

Although it uses sometimes fragmentary observation, this translation-analysis helps get an impression of the dynamics of the local project and especially about the extent of the municipality's agency. Although the municipality is in the position to steer developments in Otjiwarongo's water supply and to set the rules of such a system, this 'power' does not automatically lead to compliance of its residents and elements of the system. While the municipality can perform the agency of putting a system in place, individual users have the agency to resist the system or change the rules for their individual case. The costs for the municipality to wield its agency all the way down to the individual level of each of its residents is very high and presents clear limitations for the municipality. Other ways that are less costly involve more compromise and fail to reach 100% of the community. In the above analysis, we see the municipality performing agency on both ways is a search for successful translation that as of yet has not been performed. It is difficult to say how far translation has proceeded, for example how many of the residents are successfully translated and how many are not. It however is clear that there is dissidence on such a scale that the municipality is substantially hindered in reaching its goals, an observation that helps contemplate future actions and their feasibility.

5.5. Translation and SNM

Having looked at the local experiment through two different lenses, it is possible to see the differences in focus and findings, but also the common ground they cover.

The Strategic Niche Management approach offers a very structured way of analyzing the experiment through the three internal niche processes (networking, expectation formation, learning). Translation focusses on interactions in the experiment and places these in different steps of translation (problematization, interessement, enrolment, mobilization).

5.5.1. Principal actors and agency

In SNM, the expectations that have been explicitly formulated are very guiding in evaluating the learning that is taking place: are all expectations by actors being reflected on and adjusted when necessary on different levels? In this experiment, one actor (the municipality) is the principal actor that initiates action in the three niche processes. It has formulated expectations in a far more coherent, explicit way than any of the other actors²⁹. This makes the municipality's one-sided expectations

²⁹ Due to varying reasons: lack of knowledge about the niche-innovation (users), lack of involvement/interest (regime actors), lack of knowledge/interest in the local project (global niche actors).

prominent and in guiding the further evaluation of learning processes, giving less prominence to other actor's experiences and learning. However, these lessons are of importance as well. In this case, user experiences are crucial for the shaping of the niche-innovation as one that solves the tension experienced by the municipality of Otjiwarongo.

The translation perspective places less emphasis on the formulation of expectations, but more on the actions that follow to 'convince' other actors that these expectations also solve their problems if they cooperate. It focusses on the different ways the principal actor (the municipality) deploys its devices of interestment and follows these up with further negotiation to ensure enrolment. These actions provoke reactions - and thus become interactions. So when the principal actor acts, the researcher is automatically focused on the reaction by the targeted actors.

Concluding, in cases where there is such a principal actor, the translation perspective helps give a 'voice' to the other - less vocal or articulated – actors.³⁰ It helps take into account actions that do not always classify as learning in SNM because they do not directly relate to a concrete actor or expectation. These actions do influence projects to a great extent as we have seen in the above analysis and show how actors react to the agencies performed by the principal actor. It helps understand the scope of the principal actor's agency.

5.5.2. Translation and transition potential

In the previous chapter, SNM has also been used to judge the transition potential of the prepaid water experiment in a transition towards sustainable water regime by comparing what is known about (1) what entails financial and social sustainability in water supply, (2) the perceptions of financial and social sustainability in the regime and niche and (3) the internal niche-processes through the SNM analysis.

It was found that in both areas of sustainability (financial and social) the expectations and learning in the local project did not fully cover all aspects of social and financial sustainability. The translation analysis in this chapter can add to translation potential towards social sustainability the 'conflict' that was observed in the experiment between mainly the municipality of Otjiwarongo, its residents and the political representation in the form of the town council. The conflict that is observed points to deep rooted resistance and can be said to be detrimental to the transition potential. Furthermore the observed costliness of translation is an additional hindrance for the transition potential towards financial sustainability.

Thus, some of the observations from the translation analysis add to what we know about the project's transition potential, but still the explicitly formulated expectations and the categorized learning processes from the SNM analysis offer more guidance for this analysis. The translation analysis does offer the insight that the agency in niche-processes is limited by local social complexities, it helps mark

³⁰ By vocal, one could understand that the reactions by actors might be relatively small compared in scope or impact compared to those of the principal actor (telling something about power relations). By articulate, one could understand that reactions by actors might not always seem like a coherent or logical response (telling something about miscommunication or misrepresentation).

the reach of actor's agency which from a managerial point of view is useful to assess the feasibility of policy.

6. Conclusion and discussion

In this concluding chapter, I will recap the conclusions from the three analyses (MLP, SNM and translation) and combine them to answer the main research question:

How are sustainability visions of involved actors regarding Namibia's water supply transformed and concretized into local water supply innovations, and to what extent are these local water supply innovations successful?

For this, I will also refer back to the different aspects of sustainability that are useful as background to the transition and thus to judge the transition potential of the niche innovation of prepaid water meters. From the analysis through the multi-level perspective we see how various large-scale processes on the landscape level have over time shaped the vision on sustainability for the water supply regime, of which mainly the view on financial sustainability is of big importance for the local authorities. The task of implementing these visions in local context leads them to adopt prepaid water meters. A closer analysis of a local prepaid water meter project shows that the local implementation shows incongruence between the proposed innovation and the complex social reality. Conflict arises from its application and resistance at individual level hinders successful operation of the system. The incomplete visions on sustainability informing the choice for the niche innovation of prepaid water meters makes that pressing local issues have not been taken into account in the concrete project.

This is elaborated on below. Furthermore, I will reflect on the different analyses and how they work together and give suggestions for further scientific research. Policy recommendation for the involved actors follow in the next and final chapter, chapter 7.

6.1.Sustainability

Sustainability in water supply is divided into three categories: environmental, financial and social sustainability. Environmental sustainability requires that water is only produced from sources in quantities that are naturally replenished and that production and transportation do no irreversible damage to the natural environment. Financial sustainability refers to producing water in such a way that in the future the infrastructure and services can be upheld, therefore budgets need to be balanced. Finally, social sustainability refers to whether the water supply is organized in such a way that the basic needs of the whole society are met and that the water supply functions in such a way that society is able to maintain a certain standard of living.

6.2.MLP view on transition

Through the Multi-Level Perspective on transitions, the interactions between processes at three levels (socio-technical landscape, regime, and niche) are investigated to see what kind of transition is going on and how this is proceeding. The MLP analysis has enabled me to discern the processes at different levels and offers an explanation on what sustainability visions there are and how these in turn are shaping the transition the water supply regime is undergoing.

In the years since Namibia's independence in 1990, we have seen an evolution of the water supply regime (the rule-set on how to supply water, embedded in institutions and infrastructure). This has been

happening under the influence of multiple landscape factors: the different streams of thought on (1) sustainable development of water sources and on (2) development in Namibia in general combined with (3) new ideas on service provision, promoted by a set of powerful actors on the landscape level. These have shifted rules in the regime to those focused on cost-recovery of water and the financial sustainability of all regime actors. Furthermore, the landscape factor of (4) decentralization had influenced regime rules in such a way that local authorities are completely responsible for water supply. Two final landscape factors, (5) moving electricity supply away from municipalities to separate entities and (6) the social, political and economic context of Namibia as a highly unequal, southern African country made that this evolution of the water supply regime created considerable tensions for local authorities. Local authorities are the actors responsible for distributing water to a diverse population of which a large part is impoverished and is not able and/or willing to pay water bills.

The evolution of the regime changed the rules in many of its socio-technical dimensions. From this changed regime, the main visions on sustainability were that the bulk water supplier (NamWater) is responsible for guarding environmental sustainability and that financial sustainability was a responsibility of each regime actor to recover their expenses from the tariff that they calculate. Social sustainability is not very explicitly specified in these rules.

This latter vision is of impact on local authorities that now had to look for ways to actually collect the payments for water that were based on the cost-reflective tariff. So the transition at hand in the water supply system is one of the reconfigurational kind where local problems are solved through incorporating a niche-innovation into the regime, which in turn triggers new changes across the dimensions of the socio-technical system.

This financial sustainability vision in combination with the poor situation of many Namibians leads to the fact that non-payment of bills (sent on regular basis after consumption) puts local authorities in a tough position. The search for niche-innovation is in order to be able to fulfill this sustainability vision of financially independent regime actors.

A niche-innovation that has been developed sufficiently to be used is that of prepaid water meters, of which the main feature is that people have to buy credit at a vending point which is stored on a chip that has to be presented to a water point *before* they can access the water. This way the (cost-reflective) payments should be collected more easily. This innovation has been widely applied in South Africa, to which – another landscape factor – Namibia is very much oriented. The prepaid water meters themselves are produced by different firms from several countries.

Thus a number of Namibian local authorities are attempting to reconfigure the water supply regime by experimenting in their town to incorporate the niche-innovation of prepaid water meters. A look at the changes this triggers in the different dimension of the socio-technical system of water supply shows that the intended changes are in the dimensions in which the local authorities actually have enough agency (as dictated by regime rules and local context). These dimensions comprise more than mere technologies and infrastructures and affect the relations between the users and local authorities and the

practices of involved actors, but it also brings about changes that were not intended by the reconfiguring actor.

6.3. Local niche-experiment

The research focused on the local experiment in Otjiwarongo, a Namibian town that started implementing prepaid water technology in 2007. This experiment is analyzed in two ways: (1) by evaluating the experiment as a whole and assessing its transition potential and (2) by gaining more insights in how the municipality of Otjiwarongo (the local authority in this case) performed its agency to shape the experiment and reach their initial goals. For the first, the approach of Strategic Niche Management has been used and for the second one the perspective of sociological translation. Both analyses evaluate in different ways how successful the experiment has been.

6.3.1. SNM analysis of the prepaid water experiment in Otjiwarongo

A successful niche-experiment can contribute to the transition potential of an innovation, increasing the stability and maturity of the niche innovation. For this to happen, the SNM framework suggests that three internal-niche processes should be taking place in such a way that they lead to more stable rules (assuming that this only happens when the project runs smoothly or goes as planned).

These internal niche processes are (1) networking, (2) expectation formation, and (3) learning.

In the prepaid water case in Otjiwarongo, we can see the network being one with the municipality very central between the water supply regime, the residents of Otjiwarongo and their representation and the manufacturers and suppliers of technology in the global niche.³¹

The municipality expanded on the initial sustainability visions from the regime by formulating more specific expectations for the project. The prepaid meter was initially envisioned for two applications: in households with debts and on communal standpipes. The formation of expectation went on as the project started, in the form of technical tweaking and specification, and small service additions. Also, a third purpose for the prepaid water meter was thought up: the use of the innovation to be able to give informal households an individual water connection on their own plot of land.

These developments all point to learning that has been going on and feeding back into expectations. Other experiences in the project were related with the resistance of inhabitants that emerged in the course of the project, the sabotage that emerged from it and the general frailty of the prepaid water meters. The municipality sees the solution to these issues in new kinds of meters and functionality. Much of the learning by the municipality is technology-oriented. Other learning that has taken place was about communication and reaching people, which was enhanced by setting up various communication channels. In general, the learning in the project is geared towards solutions to the encountered problems. This qualifies as first order learning. Learning that has taken place in other actors can be observed for example in the ways the users are dealing with the prepaid water innovation that has been placed in their neighborhoods and/or homes.

³¹ The global niche is the level where the general innovation is developed through resources and knowledge. Global niche are constituted by local experiments where the innovation is actually applied.

Also, new insights and thinking arose on the wider societal context of the system: the affordability of the whole system and the ways of working between the municipality and users (for example: automating actions through prepaid water meters versus appointing more employees to approach residents in person for issues of payment and debt collection). This is a promising start of second order learning processes, but as of yet they have not been fully developed and whether the assumptions (visions) behind the prepaid water experiment and the expectations are reflected upon remains to be seen. It does already show that there is a possibility of alternatives to either the old situation or the prepaid water meters.

6.3.2. Translation

Throughout the above, it has become clear that the municipality (and local authorities in general) is (are) a principal actor in this local experiment, initiating projects and having the most power. This is reflected in the above review of internal niche processes that automatically focusses most on actions by the municipality of Otjiwarongo. In sociological translation, these efforts by a principal actor are seen as the construction of an actor-network with the principal actor as indispensable node. This process is called translation, where the principal actor translates goals and actors to place them on the desired position in the envisioned actor-network. Translation that proceeds in four stages (problematization, interessement, enrolment, mobilization) shows the interactions between the translating actors and the other actors that are meant to be engaged in the network.

The main conclusions in this stage were that engaging Otjiwarongo's residents is only partially possible through forms of representation (political, representative water committee, forms of general communication) and that the most important part consists of translation at an individual basis: by installing an individual prepaid water meter for each residential household, negotiating with them to use it as intended, etc. Although the municipality has the agency to do this, it comes with a high price. When we see the prepaid meter as an actor, we also observe that translating the meter so that it works as intended by the municipality is harder than expected and is also costly. In a way, it is comparable to translating the residents: it often requires translation on an individual basis.

It proved very useful to situate the local project and translation analysis in the broader context of Namibia's water supply regime and landscape factors that was established through the prior MLP analysis. It enriches the translation analysis in the sense that it helps understand why the project got underway, define 'background' actors that might gain more prominence depending on how translation proceeds and understand why certain agencies are performed the way they are.

6.3.3. Translation and niche-processes

The extent to which translation is successfully being performed tells us something about the general character of the niche processes in the experiment. From my empirical findings, I will expand on first suggestions done by Raven et al.. They studied an actor that was translating from a (global) niche to several experiments and came to the following insight:

"Problematization translates previous experiences and perceived opportunities in the wider context into a new expectation. Interessement translates that expectation into networking activities. Enrolment

means that actors truly accept their new position in the network and start a process of experimenting and learning. Mobilisation might translate the lessons into wider niche and or regime networks.” (Raven, Verbong, Schilpzand, & Witkamp, 2011, p. 1077)

This can be further specified in a couple of ways. When these moments of translation are followed through in this order (all the way down to mobilization), there is a successful translation going on. More often, however, we see that translation is not fully performed on all actors or in this exact order of the four steps. It is a more messy process in which translation of the different actors is in different moments of translation on a given moment of time. We also see that the principal actor has to go back and forth between the moments of translation. I propose to specify these iterative steps as (elements of) niche processes as well. This can be seen in Figure 17.

Taking the relations mentioned by Raven et al., the mapping of SNM processes to moments of translation can be expanded with several types of learning. The enrollment stage is suggested as the place where experimenting and learning starts. First-order learning about aspects of the system can be seen as happening while in this stage, going back to the interessement stage to deploy new or altered devices of interessement to enroll actors. So learning takes place within the expectations about the use, reception, and effects of the niche innovation. When translation is in the moment of mobilization and it turns out that the actors are not the spokespersons they were perceived to be, the translating actor can return to the interessement stage to deploy new/other devices of interessement in a different way in the network, which signals that learning about the network is taking place (about inclusion, representation and effectiveness of interaction). When the translation proves to have failed more thoroughly, the actor can be seen to return to the complete beginning where it can rethink its assumptions on how to reshape the problem or which actor-network it wants to translate. This can be seen as deeper learning or second-order learning where initial assumptions are challenged within the project. These learning processes have been identified as crucial for valuing alternative trajectories and reflecting on feasibility and desirability of niche-innovations (Raven, 2006, p. 584).

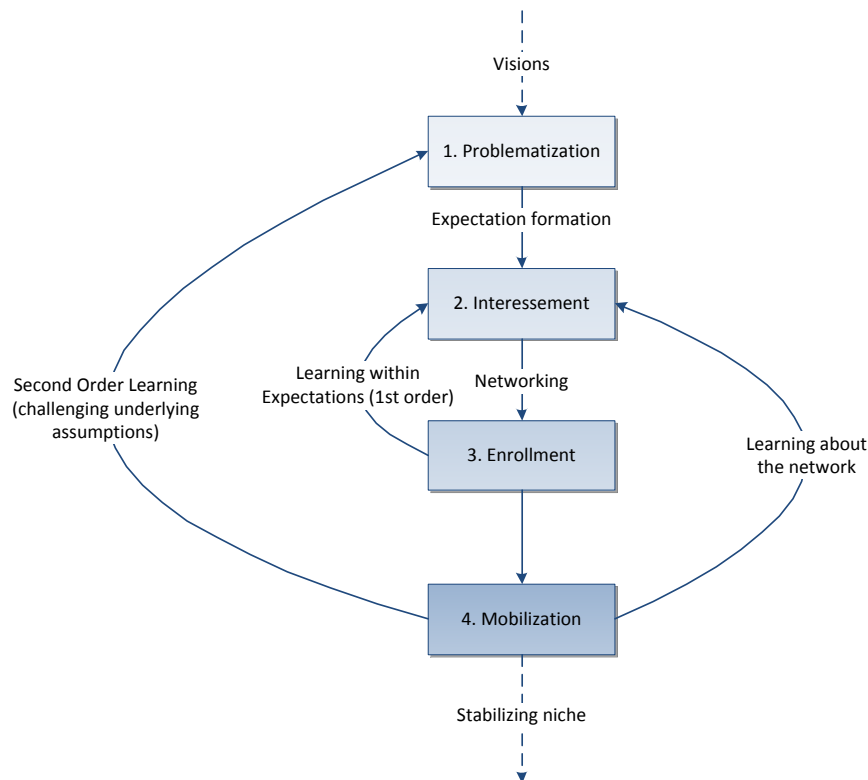


Figure 17: Mapping elements of niche-processes to the iterative process of translation.

Also, we can see the external links to global niche and/or regime level: before the process the guidance by visions from a higher level and at the end the lessons of successfully performed translation that help stabilize the niche.

In summary, the theory of sociological translation can further elucidate the character of the niche-processes in an experiment. In particular, it helps to further specify types of learning.

However, because in translation theory it is a choice of the researcher how to define actors (that represent a network themselves) they become somewhat of a black box. For example, in this research, the internal specification of expectations in the municipality (the principal actor) is lost in the translation analysis because this analysis only takes into account the interactions *between* actors.

6.4.Success

All in all, we can try to establish the success of the project seen from the different viewpoints of SNM and translation, and try to say something about the sustainability performance.

6.4.1. Transition potential

When we relate the project from an SNM perspective to a transition to a sustainable water supply, we see currently that the notions of sustainability in the regime and how they are transformed to local niche-expectations do not include all aspects of sustainability. For a local authority social and financial sustainability are of importance. The latter is directed by the regime visions on financial sustainability,

which are concretized in the niche-experiment. Social sustainability is not defined from regime rules but is affected by the niche-innovation in various ways. The learning that is taking place partially reflects on the sustainability impacts, but there are also aspects (especially of social sustainability) that are not covered at the moment. Also, there is not much second order learning to reflect on the extent to which certain aspects of sustainability are reconcilable with each other (e.g. demanding payment for every unit of water vs. the accessibility by all inhabitants) or how feasible these are (e.g. full cost and debt recovery).

Thus, in certain aspects, the niche-experiment is working towards being compatible with the transition towards (the regime's notion of) sustainability. Other aspects of sustainability are not reflected upon or addressed by the niche-experiment. Transition potential is thus hard to assess without more thorough tests of the niche-innovation on all sustainability aspects; when aspects are not taken into account in the niche-experiment it is likely to be detrimental to transition potential.

6.4.2. Successful translation

From the translation perspective, we can establish how and to what extent the actor-network is formed as the municipality intends. As mentioned, the translation is a constant, iterative process and performing translation (multiple times) on individuals is a costly affair.

In the analysis, dissidence of the actors was observed: they did not become enrolled in the network after devices of interessement were deployed nor after additional negotiation. Often, it also occurred that translation on certain actors (especially residents and prepaid water meters, but also the town council) did not prove to work for the whole group it was thought to represent and dissidence was seen in entities in the network that make up those actors.

Relating this to the potential of a sustainable transition, the analysis has brought to light issues mostly relating to social sustainability. The conflict that is found in different moments of translation, especially with the residents of Otjiwarongo, shows that the prepaid water meter is causing societal upheaval. The municipality has been responding to this with certain measures, but it has not solved new tensions in such a way that translation is now fully performed.

6.5. Discussion

In this research, I have applied two increasingly well-known transitions frameworks and combined them with a different approach. The MLP and SNM frameworks are relatively young but have been used in a substantial body of research on a wide variety of cases – this body is ever expanding. The case of Namibia's water supply and local experiment with prepaid water meters present a new field with idiosyncrasies. The case is one that is mainly in the public policy domain, even more so than cases from previous research on energy systems. Although we have seen the diffusion of more business- and market-like principles in the socio-technical system of water supply, this remains a difference to be reckoned with.

A second salient idiosyncrasy is the character of forced adoption of the niche-innovation of prepaid water meters. This leads to a network where certain actors are not given a voice in decisions and merely confronted with their consequences, leading to other forms of reaction and resistance. Normally, in

SNM analyses of niche-innovations, the alignment of actors is one of the main points of interest. Here, there is a profound asymmetry in the network, where certain actors can force things upon other actors (through political power and 'monopoly' power). Transition potential is usually seen as whether an innovation is adopted and diffusing, so whether the user is convinced of the innovation. Here, the adoption and diffusion decisions are in hands of the local authorities which are not the end-users of the innovation but have other goals with them. This leads to different niche-dynamics. Here, the introduction of the third theory of sociological translation is of value. In the moments of translation that have been defined, there is explicit space for these kinds of unequal relations.

What has been named earlier as important characteristic of this study is the fact that there is such a principal actor initiating experiments. This brought up the question of agency, a factor for which the translation perspective is also very suited to analyze it. Not only by the above mentioned room it offers for unequal relations of power, but also because it makes no predetermined distinction between which actions are important and which are not. Therefore it helps give focus to small but meaningful actions of adoption, adaption or resistance by users with seemingly little agency.

Furthermore, when applying the translation perspective, this can be done in many ways where it is up to the researcher to determine which actor to take as a starting point. Because of the background of translation in actor-network theory, every system is regarded as an actor-network in which the actors are again actor-networks of themselves. The choice for the level on which the researcher focusses is of importance for the outcomes (basically, the researcher gets to decide how much to zoom in or out). Parallel analyses can also be carried out, looking at the same case on the same level from the departing point of different actors.³² In this research my choice for the level and departure point of the research was determined by how this analysis was to be compared with the earlier SNM-analysis and their joint embedding in the MLP-analysis of the wider Namibian water supply system. It was informed by the interest for the agency performed by the municipality as principal actor and the impression of conflict, resistance and uncertainty on how to proceed in supply water. In general, within MLP, interfaces and moments can be discerned where interactions 'heat up': in stable regimes or niches, there is agreement on the general trajectory of the system and how to proceed. When external or internal factors create uncertainty (landscape pressure, internal regime tensions, unstable niche processes where learning suggests different directions) conflicts arise and actors try to bring different ideas to the fore. It is in these cases that translation analysis can be used to understand how actors try to shape the outcomes by observing how they perform translation and thus their agency.

For my research, the concept of sustainability needed specification, because it can be used in a lot of different ways and is only specified in limited ways in the regime rules. To have a benchmark to compare the sustainability visions and their concrete expectations with, this was needed. It pointed me to the fact that in many of the transition cases in earlier research, there is already an implicit idea of sustainability that is not changed or challenged anymore. This research however suggests the necessity of challenging existing visions/assumptions on sustainability. However, the benchmark I conceptualized is not a definitive one either.

³² As done by Baan Hofman (2011) for example.

A limitation of my research was the kind of data used to substantiate findings. The case-study in Otjiwarongo consisted mainly of interviews and observations. There were some numbers at my disposal but these were not enough to underpin all my findings.³³ Also going back into recent (policy history was not always easy as there is a considerable turnover of personnel in many positions and past decisions have often not been fully or systematically documented. I do think that the rich qualitative data from a variety of sources in Otjiwarongo and Namibia provide a representative view on the case and have been enough to provide interesting insights through the different analyses performed.

A final issue pertains to the supply of clean water for human use and consumption. The essence of water to human existence is probably clear to most people and has also been explicitly mentioned and implicitly visible throughout this thesis. One could ask whether such an essential service, often referred to as a basic human right, is fit to the commercial principles of the market. What is the bottom line, how far should one go to make sure that water is always available to all people? Is a device like the prepaid water meter per definition immoral because it can place an insurmountable barrier to water in times of emergency or great need? Throughout the research I have kept a certain distance from questions like this and the moral issues that come with the governance of water supply, but they do need to be a part of every discussion of water supply to people, no matter how poor or 'unwilling to pay' they are. However, a regular reflection on such issues and the prominence they should have in any policy are just as well part of the deeper learning and reflection on any project of policy in this field.

6.6. Further research

Further research building on this thesis could focus on several issues. First, the exploration of the added value of sociological translation in the analysis of a niche-experiment needs more work. Where Smith (2007) did a very broad comparison between regimes and niches and how they translated certain of each other actors into their own domain and Raven et al. (2011) focused on the translation mechanisms from an actor bringing global niche visions to local experiments, this research focused on the translation efforts of an actor in one specific experiment focusing on the interactions that take place in this process. In fact, translation holds promise to give more clarity in many stages of the MLP- and SNM-processes. A translation analysis can be used for each interaction or actor that warrants further investigation in the different levels of the MLP. This is particularly interesting when situations 'heat up' and conflict on how to proceed arises on one of the levels. In my research, I have tried to map certain steps possible in the translation-process to niche-processes. This is a mere suggestion on how to use translation. All in all, it can be said to hold promise for elucidating many relations that are yet to be unraveled at the different levels of the MLP.

Second, transitions in water supply are of interest for further research. Because of the very profound implications for basic human life, water supply is a socio-technical system that is always moving in order to improve access or quality (or both). Much of the literature found when conducting this research treat only certain aspects of water supply, or to stay in Innovation Sciences jargon, they only treat one or a few dimensions of the socio-technical system. A system-view on this complex of relations,

³³ My colleague Lisanne Saes has put considerably more effort in collecting this kind of data and work in making them fit for calculations like cost-benefit analyses. Or her results please refer to Saes (2012).

infrastructure, users, etc. can be very useful to understand and guide future water supply developments, especially in developing countries.

As a third suggestion, related to the previous one, the notion of sustainability in water supply warrants further research to give a sense of direction to the transition in water supply systems. This requires a synthesis of the aspects of social, financial and environmental sustainability regarding water, their trade-offs and how they can be united. In existing literature, social sustainability is often the least elaborated one, subordinate to either environmental and/or financial sustainability (these two are often combined). As a counterweight to this tendency, studies have been focused on the impact of certain water supply developments and innovations – like prepaid water – on the social sustainability. These however tend to see issues of financial and environmental sustainability as exogenous and fail to relate these to each other and to reflect on their interrelatedness.

7. Policy implications and recommendations

From the scientific analysis performed in this thesis, there are some policy implications that can be derived. These are mainly aimed at the municipality of Otjiwarongo and Brabant Water, two main actors that have been closely involved in this research and in the Otjiwarongo prepaid water meter project.

7.1.(Re)defining sustainability

For involved actors, it is useful to have a clear understanding of what they see as sustainable water supply. Using the distinction between social, financial and environmental sustainability is a good start to identify certain conflicting issues and to measure the impact of interventions like the prepaid water meter.

For the municipality of Otjiwarongo, they can supplement the sustainability visions given to them from higher (regime) level with their own notions of sustainability that apply to Otjiwarongo. For example, assessing the impacts of changes in water supply on the social situation in Otjiwarongo provides different guidance for projects than following the suggestions on financial sustainability from regime level.

For Brabant Water, defining what financial, environmental and social sustainability mean to them in the context of water supply, can help them further define the cooperation with the municipality of Otjiwarongo and how Brabant Water can contribute to sustainable development in Otjiwarongo.

This research has put forth some suggestions for what aspects of sustainability are (see chapter 2 for the elaboration on the concept of sustainability in water supply) and these can serve as a starting point.

7.2.Fostering learning

Throughout the research, learning has been a central point, as an internal process of the niche-experiment as well as a way to explain certain steps in the translation analysis. Furthermore, the processing of these lessons to other levels is a crucial process for the wider transition of the water supply regime in Namibia. Certain recommendation on how to stimulate and foster a broad range of different types of learning can therefore be made.

For the municipality of Otjiwarongo, the analysis in this research of their own agency and position in the networks can help them reflect on this. What are they able to do and how does this affect the actors they work with, with special emphasis on their own residents. Also, how do their actions trigger reactions and will this help them get further (e.g. when they counter ways of payment evasion through more sophisticated technical solutions, will this solve the problem or will it evoke more resistance and sabotage?). Reflection on their position in the network combined with the different aspects of sustainable water supply systems, will lead to more and deeper insights on their policy options.

Brabant Water can also play a role in fostering learning processes. Since they have committed to contributing to development in Namibia, they are also engaging in network building on national level and with knowledge institutes. This way they can provide an excellent platform for learning between experiments and on the water supply regime level. Parts of their development efforts could be focused on enabling the sharing of expertise and creating conducive environments for second-order learning to

reflect on the aspects of Namibian water supply systems on the different levels (regime, niche, local experiments). Concrete measures could be the organization of seminars on this issue, of creating clear evaluation guidelines to trigger different types of learning.

Learning can be a painful process, especially when it means reconsidering previous choices and perhaps changing your views on them. Fears of public accountability and cultural factors can be a hindrance for learning processes. It is therefore of important to approach learning as a positive process. Brabant Water can be of support in such processes or in finding others to coach this process.

7.3.Specifying water supply projects and their scope

In my analyses of the local experiment in Otjiwarongo, a diffuse view arose on the different purposes for the innovation. Regarding these as parallel projects might improve understanding and make policy decisions easier.

A first sub-project is the application of prepaid water meters on standpipes in the informal areas of Otjiwarongo. This project has been underway for a long time. After the installation of new prepaid water meters on an expanded number of standpipes in 2007, this project has been subject to mainly first order learning on technical difficulties and administrative issues. The amounts people pay for water include all kinds of other charges, raising the tariff to a level that is higher than the bare tariff for water in other parts of town that still get their water supplied post-paid. Affordability is an issue of interest, as well as communication and technical problems that arise. These deserve much attention in this case.

The second sub-part of the prepaid water case is the application of prepaid water meters in indebted formal households to enable payment and debt collection from them. This is a very complicated part of the project that got underway in 2007 and where a lot of issues have arose. It is the biggest sub-project (2100 prepaid water meters installed) and works with personalized tariff structures, including personal debt repayment and service payments. Experience has been that users find ways to just pay the lowest possible tariff by not paying their own personalized tariff but someone else's tariff that is lower. Also incomprehension and resistance occur. So far, payment and debt collection have not been realized to the degree that was expected. The municipality is planning to counter this with technical solutions: new prepaid meters that force users to use their own personalized chip with their own tariff. Whether this will work and what reactions this will evoke is the question that should be asked. For the function of debt recovery, the municipality has also started a debt collection program in which employees are charged with discussing these debts and their repayment on a personal basis. For example in this sub-project, reflection on the best ways of collecting debt and possibly de-coupling this from payment collection might be useful, just as to whether certain mismatches of expectation and reality will be solved by the new meters.

Finally, a relatively new application is that of installing individual taps on the plot of households in the informal areas for a subsidized tariff. This project has started on a relatively small scale. The aspect that stands out the most here is that it offers the prepaid water meter as an option to users, instead of the forced installation in above parts of the project. This brings with it a whole different dynamic between municipality and user. Lessons from this project on communication and cooperation can point to the

importance of (the perception of) agency for the users of the prepaid water system. Also, the social impact of this application is of interest: e.g. are people better off when they obtain this individual connection, how does it impact their water usage, or were these people already better off because they are able to afford themselves more than other residents (such as the investment in a prepaid water meter).

By looking at the sub-projects separately, the different lessons for them can be used in the project as a whole or in the other parts of the project. Also, per sub-project, the issues of importance can more clearly be defined as well as how the different forms of sustainability are affected in the sub-projects. It will help as an analytical tool to understand what is happening and to whom policy measures should be directed and what they should aim at.

7.4. Prepaid water and alternative/additional measures

Some final recommendations pertain to the system of prepaid water meters in itself. From the research, pros and cons of this innovation have become clear. It is useful to put these in perspective and also consider certain alternatives or additional measures.

Using prepaid water meters for debt collection has so far been troublesome. The debt repayments make the tariffs people pay for water higher. Evasion of debt repayment by using other people's prepaid water accounts is common practice and this way, people are not using their own prepaid accounts altogether, in fact leading to even bigger debts because their service charges or not paid either. The municipality of Otjiwarongo has already been trying out an alternative approach through the appointment of extra personnel that is charged with debt collection through agreements and monthly payments. Although this requires more commitment and time, it has some major advantages: (1) it enables the collection of debt repayments throughout the whole town and not only in the households that have been given a prepaid meter, (2) the first period that it has been applied has seen a decrease of debts in Otjiwarongo, so it seems to be effective and (3) the water tariff is not raised further through the inclusion of debt repayment, keeping water more affordable and preventing the evasive behavior described above.

General affordability of water is an issue of importance. The prepaid water meter is a strict enforcer of payment recovery, through its technology demanding payment before use. This can have the effect that the poorest of users are not able to access water in quantities needed. To alleviate the impact on the poorest part of the population, several options are available. One that is applied, tested and refined in South Africa is the free lifeline of water (currently set at 6,000 liters per household per month, based on a per capita use of 25 l/day and family size of eight) that supplies a free amount of water. This amount is below the amount deemed to be sufficient, but can help absorb the impact of water cost-recovery and thus benefit social sustainability. The free amount can be seen as the first block in a rising block-tariff system, where water tariffs increase progressively as more water is consumed per household. Prepaid water meters are capable to administer these amount. However, an unwanted effect of this system that has been observed in South Africa is that in practice households are cutting down on their consumption until it is within the free amount, rationing their consumption to below sustainable levels. This is something to take into account, but the free lifeline water amount is still worth considering.

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Appendix: list of interviewees

No.	Interviewee(s)	Details	Date
1	Naudé Slabbert	Strategic executive (SE) Infrastructure, Otjiwarongo Municipality	1-6-2011
2	Naudé Slabbert	SE Infrastructure, Otjiwarongo Municipality	3-6-2011
3	Chris, Jackson	Prepaid meter technicians, Otjiwarongo Municipality	6-6-2011
4	Ingrid de Klerk	Orwetoveni front-office, Otjiwarongo Municipality	8-6-2011
5	DRFN	Research institute on water affairs, based in Windhoek	10-6-2011
6	Agatha Mweti	SE Community services and Economic development, Otjiwarongo Municipality	13-6-2011
7	George Diergaardt	NamWater	14-6-2011
8	Burgert Liebenberg	SE Finance, Otjiwarongo Municipality	17-6-2011
9	Naudé Slabbert	SE Infrastructure, Otjiwarongo Municipality	17-6-2011
10	Peter Arndt	Clayhouse Project (NGO), Otjiwarongo	29-6-2011
11	Ferdi Brinkman	Head Engineer waste and bulk water, Windhoek Municipality	1-7-2011
12	Sjaak de Boer	EU Delegation Namibia, Windhoek	1-7-2011
13	Hilda Jesaja	Mayor of Otjiwarongo	5-7-2011
14	Water Committee	Inhabitants informal areas Otjiwarongo	12-7-2011
15	Erick Tsaeb	Ministry of Agriculture, Water and Forestry, Otjiwarongo office	19-7-2011
16	Employees Hospital	Orwetoveni Hospital, Otjiwarongo	20-7-2011
17	Ms. D. Endjala	Regional Council Otjozondjupa, office Kalkfeld	20-7-2011
18	Jephta Kasuto	Otjiwarongo Municipality	3-8-2011
19	Hoko	Finance dep., Otjiwarongo Municipality	3-8-2011
20	Naudé Slabbert	SE Infrastructure, Otjiwarongo Municipality	5-8-2011
21	Jaco Labuschagne	Outjo Municipality	11-8-2011
22	Johan van der Colf	Planning officer, Ministry of Agriculture, Water and Forestry, head office Windhoek	12-8-2011
23	Deon	Finance department, Otjiwarongo Municipality	2-9-2011
24	Laudia	Finance department, Otjiwarongo Municipality	2-9-2011
25	Reception	Otjiwarongo Municipality	2-9-2011
26	Naudé Slabbert	SE Infrastructure, Otjiwarongo Municipality	2-9-2011
27	Jephta Kasuto	Otjiwarongo Municipality	5-9-2011
28	Users prepaid water meters	Several interviews with inhabitants of Otjiwarongo	2011
29	Adri van Iersel	Brabant Water official, involved in cooperation Otjiwarongo. Several meetings at Brabant Water	2011-2012