WDM, 'NATURAL RESOURCE RECONSTRUCTION' AND 'ADAPTIVE CAPACITY': A SYNOPSIS OF SOME KEY FINDINGS

by

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Paper presented at the
3rd WATERNET/WARFSA Symposium
"Water Demand Management for Sustainable Use of Water Resources IWRM"
University of Dar es Salaam, Tanzania
30-31 October 2002

Introduction

One of the fundamental guiding forces for the normative basis of the water sector that currently exist at the global level is what has become known as the Dublin Principles[1]. Stated briefly, these are:

- Fresh water is a finite and valuable resource, essential to sustain life, development and the environment.
- Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels.
- Women play a central role in the provision, management and safeguarding of water resources.
- Water has an economic value in all its competing uses and should be recognized as an economic good.

These Dublin Principles form the foundation of this research, which seeks as a primary objective, a deeper understanding of the functioning of key variables at work in the social sphere of developing countries within the Southern African Development Community (SADC) region.

Purpose of the Study

The study sought to develop a deeper understanding of the various social components of what is known as 'adaptive capacity' in order that this knowledge can be incorporated into Water Demand Management (WDM) strategies currently under consideration within the SADC Region.

[1] For more details on this aspect, consult Lundqvist & Gleick (1997:28).

Research Team

The research team remained unchanged[2] for most of the project and consisted of the following:

- **Principal Researcher** (PR): Anthony Turton (Head of the African Water Issues Research Unit - AWIRU)(University of Pretoria).

- **Botswana Local Research Partner** (LRP): Mr. John Khupe (Retired Principle Water Engineer at the Gaborone Town Council and now a private consultant).

- **Botswana Enumerators**:
  - Mr. Maoto Khudu
  - Mr. Walter Moilwa
  - Mr. Baosentse Mangope
  - Ms. Phone Itshekeng

- **Zambian Local Research Partner** (LRP): Mr. Chitaku Mucheleng'anga (National Institute for Scientific and Industrial Research – NISIR).

- **Zambian Enumerators**:
  - Ms. Margaret Ng'oma
  - Ms. Esther Mbao
  - Mr. William Musonda
  - Ms. Liswaniso Mukubesa

Research Questions

There are three research questions and hypotheses that form the focal point of the research project. These are as follows:

The first research question seeks to develop an understanding of the role that legitimacy plays in WDM policies. In this regard the specific objective is to develop an understanding of the interaction between the policies made by technocratic elites on the one hand, and the way that the broad public supports these policies on the other hand. The central assumption in this regard is that polices which are perceived by the affected public to be both fair and reasonable will receive the support needed to sustain them and can therefore be considered to be legitimate. Legitimacy and sustainability are therefore linked in terms of this assumption.

[2] There were small changes in the composition of the Zambian team as the result of the marriage of one member and the transfer of another to a new job. These changes had no material impact on the final outcome as they occurred towards the end of the project.

Research Question # 1

What social factors can be identified in Southern Africa that result in support for, or hostility towards, local government attempts to manage water demand?

Hypothesis # 1

There are a number of social factors, known generically as 'adaptive capacity', that either act in support or in mitigation of, efforts made by government in the form of WDM policies.

The second research question seeks to develop a deeper understanding of the respective components of any sustainable WDM policy within the cultural, political and economic context of Southern Africa. The central assumption in this regard is that WDM policies that are imported from other geographic settings will not necessarily be culturally, socially or politically viable within SADC.

Research Question # 2

How can one best disaggregate the various aspects that are relevant to any profound understanding of WDM in a Southern African cultural setting?

Hypothesis # 2

There are three distinct aspects relevant to any profound understanding of WDM.
(A) The 'institutional component' comprises financial and intellectual capital working in tandem with the decision-making processes to produce a range of alternative solutions by technocratic elites.
(B) The 'social component' comprises the normative elements of society acting in tandem with other social factors that result in the willingness and ability of the social entity to accept these technocratic solutions as being both reasonable and legitimate.
(C) The 'communication component' comprises various elements such as consultation, feedback and support (or opposition) between the institutional and social component that functions in a dynamic fashion.

The third research question seeks to further develop, and if possible to operationalize, the intuitively useful but as yet largely untested concept of ‘adaptive capacity’. This concept has been accepted by the International Development Research Centre (IDRC) as a potentially useful tool with which to guide their future research funding efforts (Brooks *et al.,* 2002:11) and lies at the heart of other research currently underway in the SADC

Region (Turton, 2002a; 2002b; Turton & Warner, 2002). Allan (2000:xvi; 322-323) supports this concept as a useful tool for hydropolitical analysis.

Research Question # 3

How can Ohlsson's (1999) concept of 'adaptive capacity' be operationalized in a Southern African context?

Hypothesis # 3

Ohlsson's (1999) concept of 'adaptive capacity' can be operationalized as being the way that a decision-making entity incorporates social norms, aspirations and support (or opposition) into WDM policies.

Literature Review

Turton (1999a; 2002a) suggests a model linking 'natural resource reconstruction' via 'WDM' to the 'adaptive capacity' of a social entity. This is presented schematically in Figure 1. As can be seen, the author visualizes an interconnection between ‘adaptive capacity’ and ‘natural resource reconstruction’. In fact, both of these are the flip side of the same coin. The former is regarded as a type of social foundation upon which the series of strategies are subsequently built. This can be likened to the construction of a major monument for example. If the foundations are solid (sufficient ‘adaptive capacity’) then the construction can proceed upwards. Two pillars take the weight of the superstructure, which consists of two distinct components. The bottom portion, forming a sound lintel (to continue with the construction metaphor), consists of WDM strategies and policies. The end stage of the construction consists of placing the apex of the roof onto this lintel. The apex is ‘natural resource reconstruction’ which is the final phase of the process. Once this has been reached, it can be said that the social entity is stable and balanced, with sustainability of water use being the prevailing condition.

In order to reach this point of completion, careful consideration needs to be given to the design of the pillars that will ultimately hold the superstructure up. These pillars can be likened to the two components of ‘adaptive capacity’. In the illustration, each pillar is constructed differently. In the final analysis, each pillar is vitally important if the construction is to be sound. Let us examine these in greater detail.

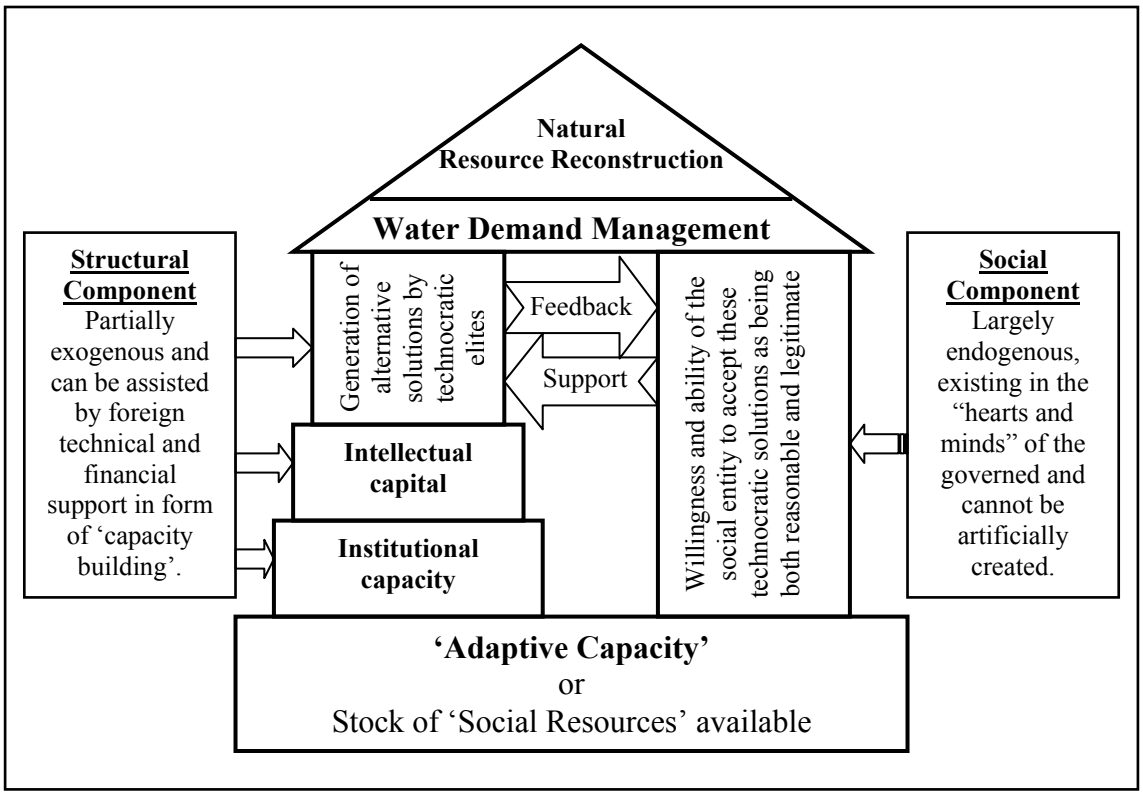

Figure 1. Model linking 'natural resource reconstruction' via 'WDM' to the 'adaptive capacity' of a social entity (Turton, 1999a; 2002a; 2002c:15).

The left-hand pillar represents the structural component[3] of 'adaptive capacity' and it can be engineered to a certain extent. External role-players such as donor agencies or non-governmental organizations (NGOs) can play an active role in creating the capacity that is needed in developing countries. In this sense they could advise on institutional arrangements, information technology (IT) systems, data flow and processing, training of skilled personnel, etc. The following are unique aspects about this component:

- This can largely be constructed as part of a conscious effort. It can even be regarded as an exogenous element in the sense that each of the major constituent parts can be sourced from outside of the social entity concerned.

- The basis of this component is an institutional setting of sorts[4]. It is imperative that such an institutional arrangement is effective, which in turn assumes that it is rationally constructed with a sound financial position. There may be more than one institutional arrangement, but the important thing is that they must all be effective. In this sense they need to have free communication with one another, so data generation

[3] Brooks *et al.,* (2002:11) support this overall conceptualisation, but modify it slightly by including the lack of technical and research capacity within the structural component.

[4] Homer-Dixon's concept of 'social ingenuity' is highly relevant here (Homer-Dixon, 1994:16-17; 2000:22), as this form of ingenuity is needed to negotiate rules and develop appropriate institutions.

and sharing becomes critical. Data generation, capture and processing become one of the critical variables of the 'sustainability levels of social resources' in this model.

- Housed within this institutional setting is the intellectual capital that is needed to interpret the data in order to generate viable strategies or policy options. This intellectual capital should be regarded as a critical element as it represents one of the variables of the 'sustainability levels of social resources'. Significantly, this intellectual capital will have to be multidisciplinary due to the increased complexity of their domain of interest[5].

- Whatever the arrangement, whether staffed by locals or foreigners, the main output of this structural component is a range of strategies or policy options. In other words, these technocratic elites[6] design the WDM policies by integrating data and knowledge of both foreign and local conditions.

The right-hand pillar is the difficult one to come to terms with however. Unlike the other pillar, this one cannot be engineered to any significant extent. This represents the social component of 'adaptive capacity'. The social component of 'adaptive capacity' is important to the overall success of the WDM strategies because it contains two unique elements:

- The willingness and ability of the people who are being governed to accept the WDM measures.

- The ability of the regime to generate WDM strategies that are perceived as being both reasonable and legitimate by those people being governed.

The first variable - the willingness of the people to accept the WDM strategies - in turn depends on the legitimacy of the political regime. If a government is popular, and if the prevailing policies are perceived to be reasonably fair, then WDM can be implemented without too many social disruptions. If large scale 'resource capture' exists which has led to structural scarcity and 'ecological marginalization', then WDM policies would be viewed with skepticism and would thus be undermined by the people being governed.

The second variable - the ability of the regime to generate WDM strategies - in turn depends on the quality and makeup of the structural component. These two components cannot be developed in isolation from one another. If the structural component is developed largely with foreign support, then it needs to pay close attention to the development of a mechanism to adapt foreign strategies to local conditions. A WDM policy that has been successful in Britain or Sweden for example may be wholly inappropriate in Southern Africa, but elements may be valuable. For this reason there is a need for feedback to take place between the structural and social component. This is in

[5] The section on 'discursive elites' in Figure 9 of Turton (1999a:28) illustrates how the composition of the technocratic elite shifts with time in response to changes in the level of management complexity.

[6] Homer-Dixon's concept of 'technical ingenuity' is highly relevant here (Homer-Dixon, 1994:16; 2000:22).

the form of consultation with special interest groups[7] which is designed to make them part of the process and to bring them on board. Support is either given or withheld as the result of this feedback in a dynamic manner. This can be understood as being a process whereby the government gains legitimacy for its intended actions, and is thus a vital component in the overall WDM chain. This is poorly understood at present, and no literature is available on this particular aspect of WDM.

Perceptions are therefore very important, especially given the fact that the support aspect is dynamic. What those being governed today support may be opposed tomorrow. These perceptions constitute one of those intangible aspects that the social sciences try to come to grips with in the field of WDM. For this reason perspectives on water need to be understood and where appropriate, to be changed. Heyns (1997:83) notes for example that the "inhabitants of [Namibia] have traditionally viewed rainfall and water supplies as a gift from God. In the past authorities have supplied water without charge as a social good. People are now resisting paying for water". The introduction of pre-paid water meters in Zwelithle (Hermanus) was viewed with suspicion and the meters were smashed (Turton, 1999b), even though this political demonstration of frustration or outrage disadvantaged the community as a result. Prior to the 1994 democratic elections in South Africa, an illegitimate regime needed to retain the support of white commercial farmers who owned most of the land, which led to the serious undervaluation of water (Abrams, 1996:27). In Yemen, increased water scarcity is having a social effect in the form of reduced sexual activity between married couples, because water is needed to bathe in after sexual contact prior to the next prayer session (Lichtenthäler, 1996) in terms of Islamic culture. Current research also shows that fundamental belief systems such as religion can play an important role as the normative foundation of adaptive strategies (Lichtenthäler & Turton, 1999) in arid regions where traditional belief systems are still intact. These are all based on perceptions of water[8]. Therefore, for effective WDM policies to be introduced, perceptions of water need to be understood and managed, because such perceptions can mitigate against strategies, which may be well thought out, but which ultimately fail.

Emerging from this literature review two distinct research goals were developed for the project under review. These are as follows:

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[7] This is a critical component of the Dublin Principles that actually depends on 'social ingenuity'.

[8] Hoekstra (1998) develops a framework based on four generic perceptions of water. These are Hierarchical, Egalitarian, Individualist and Fatalist, being based on the original social science work that was done by Mary Douglas. While this is a brave attempt by a non-social scientist to embrace social concepts, it is somewhat flawed in terms of social science methodology. The basic typology is quite valid, but it was originally designed to be used within a relatively small social grouping. The problem arises when one tries to extrapolate the findings from a small, reasonably homogenous social group, up to the level of a country or even a region (as Hoekstra tries to do). The book is an interesting read however, and serves to alert the reader to some of the complexities regarding an understanding of perceptions of water, and how these perceptions can be manifest in decision-making. Allan (2000:317-322) also uses the Douglas typology for analyzing the Middle East North Africa (MENA) region, illustrating its value for hydropolitical research.

Primary Research Goal

The primary research goal is to explore the interaction between the generation of solutions by technocratic elites (structural component) and the willingness and ability of the social entity concerned to accept these solutions as being both reasonable and legitimate (social component) as depicted in the model shown in Figure 1 as being 'feedback' and 'support'.

Secondary Research Goal

The secondary research goal is to begin with the process of mapping out different perspectives on water and the hydroscape that may exist in various Southern African countries, within urban and rural social settings for the purpose of incorporating these into WDM strategies in future.

Given the complexity of this project, combined with the fact that many of the key concepts are original, the reader is referred to Turton (2002a; 2002c) for a detailed review of the rest of the relevant literature.

Data Yield

Data was collected from eight research venues in two countries (Zambia and Botswana) by means of a questionnaire. The data yield is shown in Table 1.

Table 1:
Summary of Number of Respondents in Each Category at Each Research Site ("n" value for the sample size)

	GB	ML	MD	LK	KL	CC	CA	GL	Total
Users	203	253	281	297	350	350	350	350	2 434
Suppliers	1	1	1	1	11	2	3	3	23
Others	-	-	-	-	1	1	1	1	4
Reference	D1	D2	D3	D4	D5	D6	D7	D8	

The total data yield from the whole research project is presented in Table 2. This is calculated by multiplying the number of respondents polled in each category (Table 1) by the minimum potential bits of information that each questionnaire could yield.

Table 2: Calculation of Total Data Yield per Category

	"n" Value (Table 1)	Bits of Information	Total
Users	2 434	51	124 134
Suppliers	23	32	736
Other	4	6	24
		Total Data Yield	**124 894**

Attention is drawn to the fact that this is the minimum value, as additional information was often gleaned in the form of qualitative data. As such, the total yield was impressive, making this project a rich source of primary data for the two countries polled. A total of 30 new hypotheses have been generated and are available for future testing under different social conditions. These are presented in Appendix "A".

Testing of Original Hypotheses

The original three hypotheses were tested against the data yield with the following results:

Hypothesis # 1 - Findings: The social factors comprising 'adaptive capacity' are complex indeed. The research findings are encouraging however.

One of the strong elements that emerged from the whole project is the major communication gap that exists between water service providers and the consuming public that they serve. This trend is found at all eight study sites. This lack of communication by the technocratic elites has resulted in a lower level of support for water conservation strategies than would otherwise be expected. This is confirmed by the qualitative findings that most people regard water as a scarce resource, most of the under-serviced people show a high willingness to pay for water if it is made more accessible and convenient, and the low level of fatalism evident across the entire study area. Fatalism, or the belief that some deity is in charge and therefore the whole issue of sustainable water resource management is out of the hands of mere mortals, is found in places like Yemen (Lichtenthäler, 1996; Lichtenthäler & Turton, 1999), where it impacts negatively on the generation of policies. This impediment is not found to any large extent at any of the study sites.

There is a high level of support for metered water connections, and some indications that they are regarded as being a status symbol. There is also a high rate of payment being shown by people who are billed (and therefore metered). This suggests that people want to be in control of their own lives and consequently support policies that empower them with knowledge. Significantly, where meters are in place, there is a higher level of trust for the water charges being levied and consequently a greater degree of legitimacy for the policy. This can potentially be explained by the sense of inequity that is being experienced by the water using public in poor communities. The research has shown that the public perception under such conditions is that the Water Utility is powerful, whereas the water consuming public is weak. The act of metering is seen as a way to level the playing field and is consequently desirable. It is possible that meters will break down the "them" versus "us" sentiment that tends to pervade such study sites. Additional research is needed in order to verify this observation.

There is some evidence of growing anger where water service provision is bad. This is evident in Chongwe-Chalimbana where acts of civil disobedience are starting to be manifest. The negative spiral of underdevelopment is also evident at that study site where water scarcity is resulting in desiccation of the landscape, and consequently unleashing a

complex web of social and environmental interactions, which are increasing the conflict potential and delegitimizing government in the process. Current indications are that if left unchecked, an exponential reaction can be expected from the disenchanted community, who may start to manifest their anger in the form of direct political action. A similar trend may be evident in Kalomo where low levels of service delivery and high levels of discontentment with charges being levied are manifest. Corruption is also a factor that is delegitimizing the water service provision efforts in Kalomo. Additional research at these specific study sites may yield deeper knowledge of these complex dynamics.

Significantly, where there is a high level of infrastructural development (in a relative sense), but a low level of community involvement, there is also strong evidence that discontentment will increase with a possible political backlash. This is the case in George Complex, where JICA has constructed a sophisticated water treatment and reticulation system, but where lack of community involvement is resulting in high levels of reliance on alternative contaminated water sources such as shallow wells and scoop holes. Left unattended, the JICA project represents a classic example of a good development project going wrong, because the people it is intended to serve are withholding legitimacy. Ironically, a small adjustment in policy and a greater degree of community involvement would rectify this situation, and turn the dynamics around. Significantly, such policy changes are second-order intensive, so in the absence of such institutional adaptive capacity, the George Complex site remains an interesting case study that will yield valuable insight into the social dynamics of legitimacy.

Finally, an interesting and unanticipated phenomenon has been discovered during this research project. Tentative conclusions are that there is a distinct difference between "institutional adaptive capacity" and "social adaptive capacity", but both are linked. The data from some study sites in Zambia shows that individual level "social adaptive capacity" is highest where there is an apparently low level of "institutional adaptive capacity". For example in George Complex, the management system is rigid and water delivery is confined to short periods of time daily. This forces people to adapt by falling back onto a reliance of highly contaminated shallow wells and scoop holes, with dire health consequences, (particularly for marginalized people such as the elderly, the sick, the unemployed or the very young), despite the existence of a well engineered and robust water treatment and reticulation system. In Chongwe-Chalimbana, low levels of service delivery have forced individuals to adapt by seeking alternative supplies from shallow wells, boreholes and rivers. The opposite is true in Gaborone, where there is low reliance on alternative supplies in the face of a reliable primary source of water and what appears to be an adaptive institution. This nuance could be unraveled further in follow-up research projects.

Hypothesis # 2 - Findings: The results of the research project indicate that this hypothesis is valid, but overly simplistic.

The 'institutional component' can be seen as being a vertical hierarchy of interactions. One of the core functions of this component is the generation and processing of data on which management decisions can be made. In Botswana, there are strong indications that

the formal institutions have this capacity. Even rural standpipes are metered for example, and in general there is a higher level of billing based on meter readings than in Zambia. Botswana consequently seems to be best described by the concept of "Structurally Induced Relative Water Abundance" (SIRWA) as suggested by other components of this overall project (see Leather, 2001; Turton & Warner, 2002; & Turton 2002a). There is also evidence to suggest that the conclusion by Brooks et al., (2002:11) that a research capacity is a fundamental part of the 'institutional component' is valid, because the capacity to generate effective management solutions is dependent on data that is processed through the research endeavor. Consequently, a country like Zambia, which has a high level of water availability, but is unable to translate that into economic growth and social development, can best be categorized as "Structurally Induced Relative Water Scarcity" (SIRWS), because of its inherent scarcity of second-order resources (see Leather, 2001; Turton & Warner, 2002; & Turton 2002a).

Another core function of the 'institutional component' is the capacity to generate a sustained cash flow. In Botswana this is evident, again lending credence to the hypothesis that second-order resources determine the outcome (Allan, 2000, 322-325; Leather, 2001; Turton & Warner, 2002), because the institutional arrangements are able to generate data on water use, translate that into a set of accounts and then collect the revenue from the public. Interestingly, in Botswana where the highest degree of formal institutional development is evident, there is also the lowest level of reliance on alternative sources of water, and the lowest level of knowledge about the true cost of supplying water. This suggests that as formal institutions develop and become more sophisticated, the water user becomes increasingly remote from the source of supply and consequently ignorant about what it takes to make water services sustainable. This places a greater need on communication between suppliers and users as formal institutions develop and informal institutions decline.

The 'social component' can also be seen as being a vertical hierarchy of interactions within the specific community being served. In homogenous communities found in underdeveloped areas, there is a high degree of social cohesion and traditional leadership structures play a major role in forming public opinion. This is evident for example in Letlhakeng, where recourse to the social institution known as a *Kgotla* is common. There are other key gatekeepers that have been identified in this project. In Zambia the Tap Leaders play an important role in disseminating information and therefore in legitimizing issues such as pricing or other water conservation policies. People staffing pay points also act as an interface between Suppliers and Users. Village Water Committees are an important institution within the 'social component' that tends to have a high level of legitimacy, because it consists of local leaders who tend to articulate the interests of, and are also directly accountable to, the constituency that they represent. An interesting empirical example of water-related division within a given community is found at the Chainda-Avondale study site. Two separate water service providers serve one community. Each service provider has different hardware, different pricing structures and different payment systems, which has introduced a source of division into a community that one would expect, would be otherwise more united. This tendency should be researched further in order to develop more knowledge on this phenomenon.

The ‘communication component’ is dynamic and complex. Data from all eight research sites has shown that communication between the water service provider and water user is bad in both countries, but worst in Zambia. Similarly, the research has shown that the public has a high knowledge that water is scarce and consequently costs money, particularly in areas where service provision is minimal. The research has also shown that the public is mostly unaware of the existence of a formal water conservation strategy. There is a high level of support for such a strategy if it were to be developed and communicated. In fact, qualitative data suggests that the consuming public expects such conservation strategies to be developed by government, so where they are not forthcoming, government is seen to be failing in one of its key functional areas of responsibility. Finally, it has been noted that as formal institutions develop in complexity, there is an increased need for effective communications with the consuming public if legitimacy is to be maintained, because formal institutions tend to replace informal institutions over time, but the legitimacy of the latter tends to get lost in the process. This can become the subject of a separate research programme in its own right, because the importance of the phenomenon is high in developing countries such as those found in the SADC region.

Hypothesis # 3 - Findings: The research findings are the way that decision-making elites incorporate social norms, aspirations and public support into their policies is low across the entire study area. In fact, formal water providing institutions in the study area tend to be elitist and highly centralized, making them distant and somewhat removed from the public that they serve. This is caused primarily by the lack of communication between the water service providers and their respective consuming publics. There are strong indications that public support for water conservation policies is currently low, but there is a high potential for that support. In fact, the research has shown that a well articulated social norm is the acceptance that water is scarce at all eight study sites, and consequently in need of conservation. As a result of this, there is a strong possibility that improved communications will translate into higher levels of legitimacy for government and a strong support from the public for water conservation. There is also no empirical evidence to support a commonly held belief, which is often articulated by water service professionals, that water is a free gift from God, meaning that it cannot be given a monetary value.

The research has shown that there are two distinct forms of ‘adaptive capacity’ however.

- Personal “social adaptive capacity” is found at the level of the individual in society. This embraces the range of coping strategies that they have developed in order to deal with the consequences of water scarcity.

- “Institutional adaptive capacity” is found at a level of society higher than the individual, but not necessarily only at the level of the government or local authority. There is some evidence to suggest that water management institutions found in local communities (informal institutions) tend to have a high level of

inherent legitimacy, whereas similar institutions that have been created by government (formal institutions) tend to have a lower level of inherent legitimacy.

As a result of these two distinct forms of 'adaptive capacity', evidence from the research project suggests that an inverse relationship exists between the two forms.

- A high level of "social adaptive capacity" is found at the level of the individual, specifically where there is a low level of "institutional adaptive capacity", and where formal institutions are ineffective and non-responsive to the actual needs of the individual. Under such conditions, informal institutions are likely to be more intact because they service a specific social need.

- A low level of "social adaptive capacity" is found at the level of the individual where there is a high level of "institutional adaptive capacity", and where formal institutions are effective in meeting the needs of the individual. Under such circumstances, informal institutions are unlikely to exist, because there is a limited role that they are needed for.

This discovery is closely related to Homer-Dixon's (1994; 2000) two distinct concepts of "ingenuity".

- Informal institutions, or those with a closer relationship to the communities that they serve, tend to be more "social ingenuity" in structure and orientation. This is what gives them the higher level of legitimacy that they seem to exhibit. This is why so many development projects are focused on stimulating technical competence through local institutions such as Village Water Management Committees.

- Formal institutions, or those with a closer relationship to government, tend to be more "technical ingenuity" in structure and orientation. This is what makes them able to manage the technical problems that form their core business focus (such as water service provision), but it is also what makes them tend to be elitist with a lower level of inherent legitimacy. This is why more development projects should be focused on stimulating the social interaction aspects of formal government structures, thereby encouraging "good governance".

Evaluation of Original Model

It is now possible to return to the original theoretical aspects of the model under review in order to determine the viability of the respective components. This will help us to develop a deeper insight into the various elements, and in particular, to unravel the linkages between individual concepts and variables. In particular, an evaluation of the model shown in Figure 1 was possible. The data yield has shown that the two countries are at different stages in the journey to "natural resource reconstruction" and consequently sustainable development. This is shown in Figure 2.

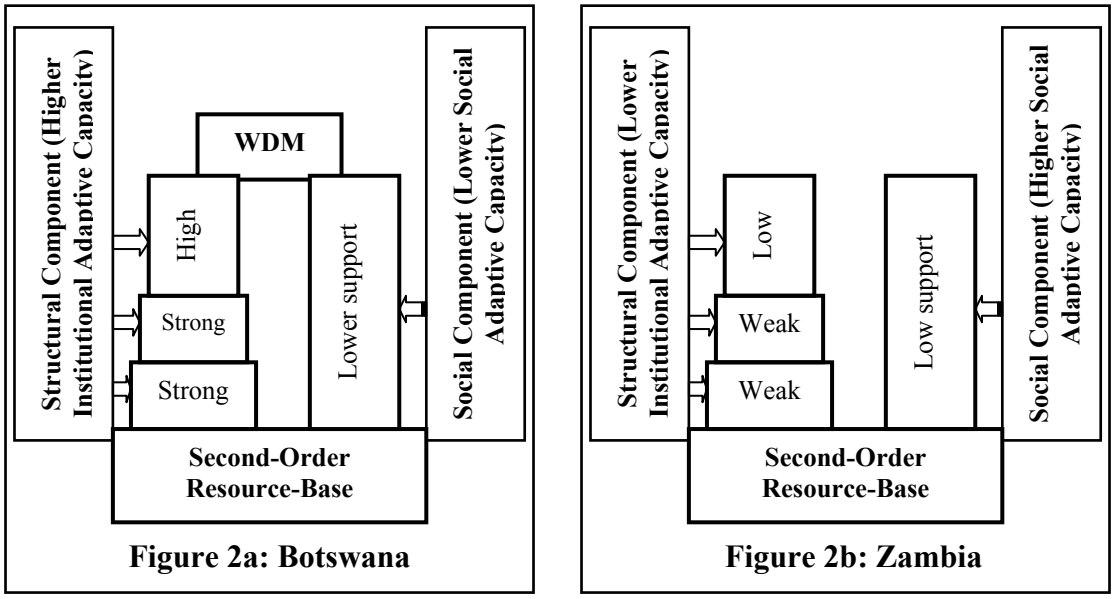

Figure 2. Schematic representation of the current state of "Natural Resource Reconstruction" in the research area as depicted by the initial model (Turton, 2002c:73).

The Botswana case is shown in Figure 2(a) where it is evident that "institutional adaptive capacity" is somewhat higher (Hypothesis # 12 & 14), whereas "social adaptive capacity" is somewhat lower (Hypothesis # 26) than the comparative country. This combination has resulted in a stronger water management institutional base (structural component) with a resultant higher capacity to generate technocratic solutions (Hypothesis # 3, 5, 17 & 24). The outcome has been a formal water conservation strategy (Hypothesis # 17). The social component shows a lower level of individual "social adaptive capacity" than the comparative country. This is in keeping with Hypothesis # 26. Due to the level of formal institutional development, there is a higher level of metered connection (Hypothesis # 3) with a greater capacity to generate individual billing (Hypothesis # 24) and a lower reliance on alternative sources of water (Hypothesis # 4). There is also a higher level of billing, at least at three of the study sites (Hypothesis # 5) and a lower willingness to pay (Hypothesis # 6). Public perceptions of service reliability are high (Hypothesis # 7) with a lower level of understanding that water service delivery costs money (Hypothesis # 10 & 16). As the formal institution has developed, there has tended to be a loss of legitimacy (Hypothesis # 30) because it has not yet overcome the "technical ingenuity" dominance that is inherent to such developments (Hypothesis # 29). The one weakness in the current formal institutional capacity is related to the loss of intimate contact with the resource by the consumer as infrastructure is developed and security of supply is improved (Hypothesis # 27). This has resulted in a temporary institutional bottleneck (Hypothesis # 9), similar to the "Turning of the Screw" model (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Turton, 2002a). There is a low level of communication between Supplier and User (Hypothesis # 20) so consequently the consuming public has a low level of knowledge about issues such as the cost of water supply (Hypothesis # 16) and what sustainability means (Hypothesis # 18, 19 & 20). As a result of this poor

information flow, the Supplier has been unable to generate the degree of support from the public that is potentially possible (Hypothesis # 9 & 11). This can easily be rectified however, as the higher level of "institutional adaptive capacity" means that the necessary communications strategy can be developed once the knowledge about the bottleneck becomes known to the technocratic elites.

The Zambian case, shown in Figure 2(b), is somewhat different, where a lower level of "institutional adaptive capacity" is associated with a higher level of "social adaptive capacity" within society at large (Hypothesis # 12, 13 & 26). In Zambia there is a weaker institutional base in the formal sense (structural component) with a resultant lower capacity to generate technocratic solutions (Hypothesis # 3, 5, 17 & 24). The result is the absence of a formal water demand management or conservation strategy (Hypothesis # 17) and a low level of knowledge amongst the Water Utility employees about the cost of treating and reticulating water in their respective areas of responsibility (Hypothesis # 25). Due to institutional shortcomings, there is a consequent higher reliance on alternative sources of supply (Hypothesis # 4), a higher willingness to pay (WTP) (Hypothesis # 6), a lower perception of service reliability (Hypothesis # 7) and also a higher level of "social adaptive capacity" at the individual level (as manifest in the use of scoop holes and shallow wells) (Hypothesis # 26) than the comparative country. These factors result in a higher reliance on informal institutions, ranging from shared scoop holes or dependence on the use of a private standpipe in another persons yard. Zambia also has a lower number of metered connections (Hypothesis # 3) and a low level of individual billing (Hypothesis # 5 & 24). Due to the more intimate relationship between the individual user of water and the source, there is a high understanding of the cost of water (Hypothesis # 10 & 16). Zambia is thus a mixture of formal and informal water supply institutions, with the informal institutions enjoying a higher level of legitimacy (Hypothesis # 28) but a lower level of technical capacity. This has resulted in a major institutional bottleneck (Hypothesis # 9), similar to the "Turning of the Screw" model (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Turton, 2002a) with the resultant generation of drivers of discontentment that can manifest as social unrest and direct political action. Information flow between the Suppliers and Users is low (Hypothesis # 9 & 24) so there is a resultant lower level of support for water conservation strategies (Hypothesis # 11). As a result the loss of legitimacy that occurs when formal water institutions grow cannot be overcome (Hypothesis # 30). Given the low level of "institutional adaptive capacity", this is a major constraint so increased levels of political backlash are likely, making the development of an effective communications strategy (Hypothesis # 27) a matter of considerable urgency. No form of "natural resource reconstruction" is evident and there are only rudimentary forms of water conservation strategy in existence. The development in the Zambian water sector is thus unsustainable at present.

It is evident from the research outcome that a number of new concepts have been developed, or the refinement of older concepts has occurred. Associated with this development has been a deeper understanding of the relationship between key variables. Central to this are the following:

- "Adaptive capacity" clearly has two major generic forms, which can also be described as being the "second-order locus" in which each form is dominant.

    - "Institutional adaptive capacity" is the ability of institutions to respond appropriately to a change in the social, physical, political or economic environment in which they are embedded.

    - "Social adaptive capacity" is the ability of people to respond appropriately to a change in the social, physical, political or economic environment in which they are embedded.

- The two forms of "ingenuity" (Homer-Dixon, 1994; 2000) are manifest in two distinct forms of institution in the Southern African water sector.

    - "Social ingenuity" tends to be the dominant form found in more informal social institutions. These can range from individual people sharing an alternative water source such as a scoop hole, shallow well or a private standpipe through Tap Leaders to more structured Village Water Management Committees. These institutions tend to have high levels of inherent legitimacy because the key people occupying gate-keeping positions are close to their respective constituencies and as such are directly accountable to them. Conversely, they tend to be weak when it comes to developing technical solutions to water management problems, so they function in a part of the spectrum closest to the level of the individual. "Social adaptive capacity" seems to be the most appropriate form of "adaptive capacity" with which to describe these dynamics.

    - "Technical ingenuity" tends to be the dominant form found in more formal institutions. As such they tend to be linked with government and are thus furthest away from the level of the individual and closest to the level of the state. These institutions tend to lack natural legitimacy because of their degree of remoteness from the public that they serve, so consequently a higher level of communication is needed if support is to be generated for technocratic solutions such as water conservation strategies. "Institutional adaptive capacity" seems to be the most appropriate form of "adaptive capacity" with which to describe these dynamics.

Some of these concepts are new, being either a direct product of the research project, or the result of a refinement of older concepts through the research process, and the general relationship that they seem to have with each other has been captured in the form of Hypothesis # 26. Central to these concepts is a redefinition, or at least a refinement of, what we previously understood by the term "second-order resource". In the context that

has emerged from the research project, what was previously known as "social adaptive capacity" can now be refined into the two forms - "institutional adaptive capacity" and "social adaptive capacity" - with each displaying a dominant form of what Homer-Dixon (1994: 2000) has called "ingenuity". The nuanced relationship that these concepts have with one another, as broadly captured in Hypothesis # 26, is shown schematically in Figure 3.

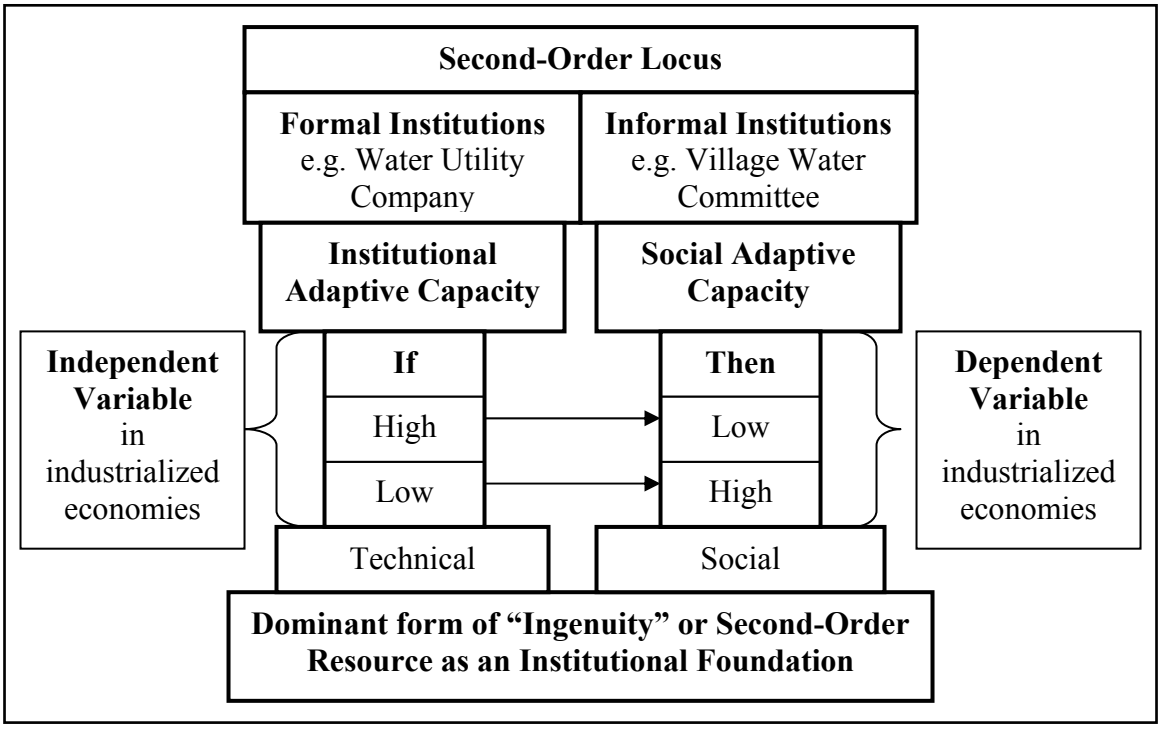

Figure 3. Schematic rendition of Hypothesis # 26 showing the Second-Order Locus, dominant form of Second-Order Resource such as "Ingenuity", and the fundamental relationship between the key variables (Turton, 2002c:76).

From this it is evident that "institutional adaptive capacity" is the independent variable in keeping with Hypothesis # 12. Seen in this light, it seems that not only is the second-order resource the determining factor, but the locus of that resource is also important. If the second-order locus is dominant within formal institutions, then it is the adaptive behavior of those institutions, as they grow in complexity in response to the challenges outside of their direct field of engineering competence, which determines the final outcome. This is what makes some institutions more responsive than others to the needs of the public that they serve. Adaptive institutions are therefore necessary as the economy of a developing country grows. The success of those adaptations depends on a number of interceding variables such as the ability to meter connections (Hypothesis # 3), the ability to generate a sustainable cash flow (Hypothesis # 5), the ability to generate an appropriate series of technical solutions such as a water conservation strategy (Hypothesis # 17) and the ability to solicit public support (Hypothesis # 9, 27 & 30). The relative scarcity (or abundance) of second-order resources, particularly when located in formal institutions, is the key variable for sustainable development to occur. This is offered as a refinement of

the work by Barbier & Homer-Dixon (1996:7), where they have shown that resource depletion in poor economies may have their most adverse effect, not by directly constraining growth, but by directly affecting the potential of those economies to innovate and adapt. The current research concludes therefore that the failure of formal institutions in developing countries to adapt is a specific form of second-order resource scarcity - namely a low level of "institutional adaptive capacity" - that in turn inhibits innovation in the broader economy. These concepts are related to each other as shown schematically in Figure 3.

The research has also shown that second-order resources tend to be the determining factor, and this has now been encapsulated formally in Hypothesis # 12. In addition to this, the research has shown that there are two distinct forms of second-order resource in what was previously called "social adaptive capacity". This has been refined into either "institutional adaptive capacity" (most commonly found in formal institutions), which has now been described as the "second-order locus" in which "technical ingenuity" (Homer-Dixon, 2000) is the dominant form (Hypothesis # 29); or "social adaptive capacity" (most commonly found in informal institutions), which has now been described as the "second order locus" in which "social ingenuity" (Homer-Dixon, 2000) is the dominant form (Hypothesis # 28). Furthermore, it has been shown that an inverse relationship exists between "social adaptive capacity" and "institutional adaptive capacity", which has now been formalized in Hypothesis # 26 and shown in Figure 3.

It is now possible to unravel the linkages between "institutional adaptive capacity" and "social adaptive capacity" in order to determine which of the two is the independent variable, and what range of interceding and dependent variables can be derived in support of the thirty new hypotheses that have been developed. Other researchers can now test their validity at new research sites, as a contribution to the water service management knowledge-base in Southern Africa. The way that the author understands these linkages is shown schematically in Figure 4.

It is apparent that the one independent variable is "institutional adaptive capacity" (IAC), at least within industrialized economies. This may be different in non-industrialized economies, and the difference in fundamental relationships between this one independent variable, and a wide range of interceding and dependent variables, is the veritable engine room that drives institutional dynamics. If there are different levels of adaptive capacity within formal institutions, then a range of institutional responses can occur. Some of these have been shown as interceding variables in Figure 4, attempting to map out the key variables that have become apparent in this specific research project, and which have been formally captured in the thirty new hypotheses. So for example, a formal institution with a high level of IAC, is likely to be able to develop a more sophisticated water conservation or water demand management strategy because of the greater capacity to process data, which in turn means that a higher degree of institutionalized learning takes place. It is this institutional learning that is a central feature of highly adaptive institutions; because perceptions by decision-making elites about the core problem being managed are changed as a direct result of this institutionalized learning process. Adaptive institutions learn, whereas non-adaptive institutions do not. This is the heart of the matter.

Similarly, adaptive institutions are more likely to have an institutionalized form of conflict resolution capability, thereby preventing an erosion of legitimacy. This in turn results in more economic growth potential and a higher capacity for social development. These conditions are all manifestations of Structurally Induced Relative Water Abundance (SIRWA), which can also be used as indicators for sustainable development.

The outcomes of these institutional processes (shown as interceding variables) are the different manifestations presented as dependent variables. Thus a highly adaptive institution is likely to result in a lower dependence on individual level "social adaptive capacity" (SAC), with a lower need for informal institutions such as Tap Leaders or Village Water Committees. In addition to this, a lower dependence on alternate water sources will be evident in society at large, along with a lower conflict potential. Higher levels of metering and billing will also be manifest, which enables a better information flow to be generated between Supplier and User, with this all translating into a more sustainable cash flow and consequently a more stable water management institution.

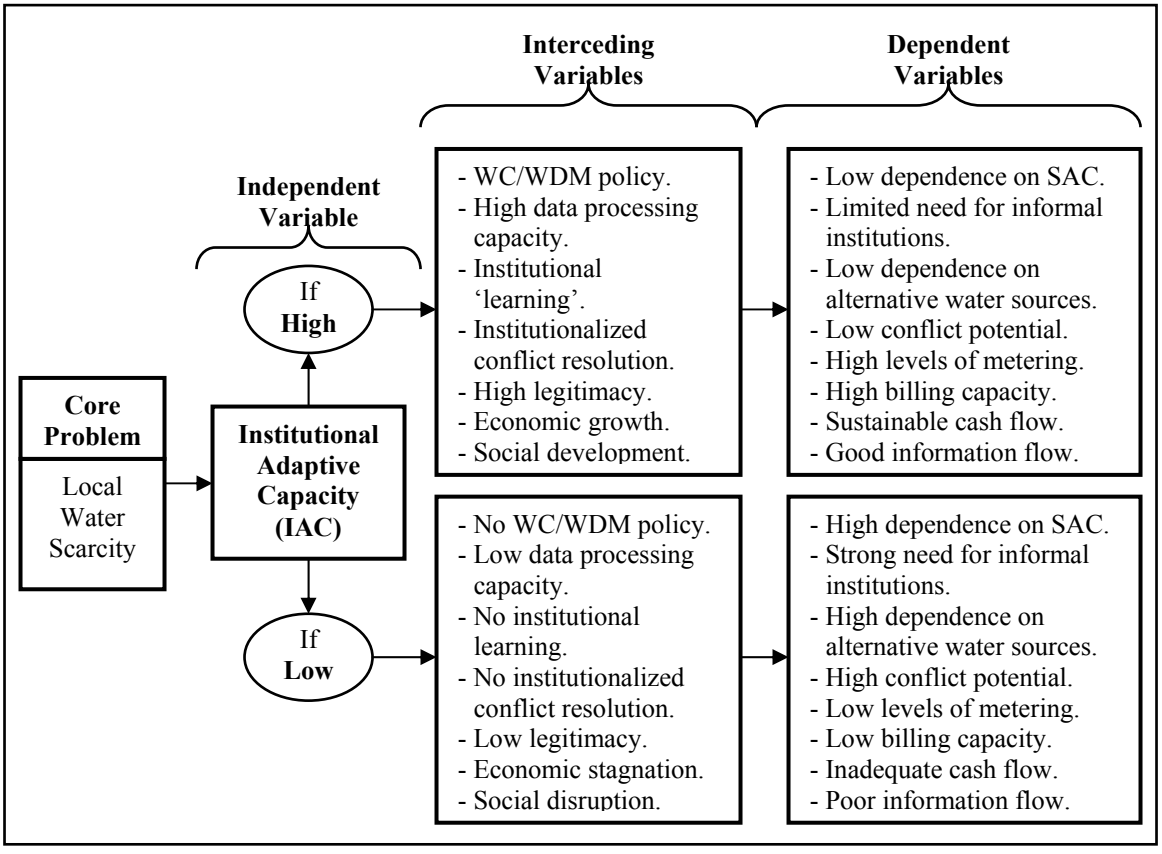

Figure 4. Schematic representation of the way the author sees the fundamental relationship between variables in the context of institutional development in the Southern African water sector (Turton, 2002c:77).

The opposite is likely to hold true for water management institutions with a low inherent IAC level. Under such conditions, poor policy formulation is likely to be the norm, largely because of the low data management capacity inherent in non-adaptive

institutions. This in turn means a limited capacity for institutional learning and the stunted development of formal conflict resolution mechanisms. The likely result is a spiral of economic stagnation, social disruption and long-term political decay. The combined outcomes of these institutional processes are likely to be manifest as a higher dependence on SAC at the level of the individual, with a stronger reliance on informal institutions and a higher dependence on alternative sources of water such as scoop holes and shallow wells. This has an inherently higher conflict potential because consumer grievances are not dealt with in a satisfactory manner, allowing tension to build up in society, thereby eroding the legitimacy base of government structures. Other manifestations are likely to be lower levels of individual metering and billing for water, a poor information flow and a resultant inadequate cash flow. These conditions are all manifestations of Structurally Induced Relative Water Scarcity (SIRWS) and are central to the absence of sustainable development.

From this model it becomes apparent that the one independent variable (Institutional Adaptive Capacity) results in a wide range of possible outcomes, which are influenced by a number of interceding variables, most of which are located within the institution itself. The dependent variables are also linked, with only some of them being related to "social adaptive capacity" at the individual level, or as found in informal institutions. "Institutional adaptive capacity" is therefore clearly the independent variable. Finally, it must be noted that not all of the thirty hypotheses have been shown in Figure 4, but the most important have been.

It seems that this level of detailed understanding is what is missing from the Karshenas model (Allan & Karshenas, 1996). It also seems that the initial concept of "adaptive capacity" (Ohlsson, 1999) is overly simplistic, and the concept of "ingenuity" (Homer-Dixon, 2000) is more nuanced than initially anticipated. These improved models may also be of value for further development of the initial hydropolitical work by Trottier (1999) in the occupied territories of Palestine, and to the explanation of the Middle East North Africa (MENA) region by Allan (2000).

Conclusion

This project has allowed for the development of some fundamental new concepts that are needed to explain and predict institutional development processes in the Southern African water sector. In addition it has enabled concepts to be developed into a rudimentary model, while allowing the linkages between key variables to be explored. The data yield has been large, and has not been adequately covered in this paper. The thirty new hypotheses that have been generated (Appendix "A") are offered to scholars and researchers in the Southern African region in order for them to be refined, refuted or modified as necessary.

Acknowledgements

This report is a smaller component of a wider project. The author wishes to acknowledge WARFSA for their support and encouragement in this specific component. The

Woodrow Wilson Centre for International Scholars also played an important role in allowing some of the core concepts to be developed. The combination of these sub-projects is being brought together in Phase II of the IUCN Water Demand Management Study for Southern Africa, thereby allowing for the further integration of these concepts into a wider policy platform. Finally, the initial interest in these core concepts arose from research being done at Pretoria University, where these models, concepts and linkages between variables form the foundation of the Doctoral Thesis currently in the final stages of completion by the author. All of these organizations are gratefully acknowledged, but the author alone accepts full responsibility for the research findings, which does not necessarily reflect the official opinion, or the endorsement of the findings by, either of these institutions.

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Appendix "A"

Generation of New Hypotheses

A number of new hypotheses have been generated as a result of the research project. Many of these were unknown at the start of the project, and consequently represent a major development in new knowledge. These hypotheses can form the foundation of new research projects, and can also be used to guide water service managers in their decision-making process:

Hypothesis # 1: *Standpipe use* is not necessarily an indicator of *low water quality* or *low levels of service satisfaction* among the consuming public. This relates to Hypothesis # 8.

Hypothesis # 2: *Standpipe use* can be used as a broad indicator of second-order resource deployment in a given social entity. In this regard, a high level of standpipe use indicates a *low institutional capacity* to service the community by individually metered connections.

Hypothesis # 3: The number of *metered connections* in a given social entity is a good indicator of second-order resource deployment. In this regard, a high level of metering indicates a *high level of institutional capacity* to capture and manage data that is needed for the development of management solutions and consequently "institutional adaptive capacity". There is a linkage with Hypothesis # 5, 23, 24 & 25.

Hypothesis # 4: Reliance on *alternative sources of water supply* is a good indicator of second-order resource deployment in a given social entity. In this regard a low level of reliance on alternative sources of supply indicates a high level of reliability of the primary water service provider, and consequently a higher *level of institutional capacity*. There is a linkage with Hypothesis # 26.

Hypothesis # 5: The *level of billing* is a good indicator of second-order resource deployment within a given social entity. In this regard a high level of billing implies a high level of *capacity to capture and process data* on which management decisions can be taken, and also a *higher level of cost recovery* and consequently sustainability. There is a linkage with Hypothesis # 3, 23, 24 & 25.

Hypothesis # 6: The *willingness to pay (WTP)* for water is inversely proportional to the availability of that water in a given social entity. In this regard, a high WTP is an indicator of a second-order scarcity, because such a scarcity is associated with a low *level of adequate service delivery*.

Hypothesis # 7: Perceptions of *service reliability* are a good indicator of second-order resource deployment in a given social entity. In this regard, a high perception of reliability is an indicator of *satisfactory service provision*. Additional research needs to be done in order to formulate guidelines for high and low values if such an indicator is ever to be used.

Hypothesis # 8: Perceptions of *water quality* have no general value as indicators of second-order resource availability. This relates to Hypothesis # 1.

Hypothesis # 9: The *flow of information* from decision-making elites and consumers is a good indicator of second-order resource deployment in a given social entity. In this regard, the flow of information is an indicator of the *capacity to process data* and also the *capacity to generate support* for changes in water conservation strategies. Under conditions of second-order resource abundance, the indicator of effective communication is the level of public support for WDM or water conservation policy. There is a linkage to Hypothesis # 11, 17, 18, 19, 20, 21, 22, 23, 24, 25 & 30.

Hypothesis # 10: A high *perception that water service provision costs money* is possibly correlated to low *levels of water service delivery* in a given social entity. In this regard, a high perception of cost can be an indicator of second-order scarcity because the opportunity cost of water retrieval is high. This needs additional research in order to validate or refine. There is a linkage to Hypothesis # 21.

Hypothesis # 11: *Public support for water conservation strategies* is likely to be higher in areas that are serviced by meters and that are regularly billed. In this regard, the higher *level of billing* implies a higher level of communication between suppliers and users, and the higher *level of metering* implies a higher *level of legitimacy* and trust between suppliers and users. There is a linkage to Hypothesis # 9, 18, 19, 20, 21, 22, 23, 24 & 30.

Hypothesis # 12: The relative scarcity (or abundance) of *second-order resources tends to be the determining factor*. In this regard, the existence of sufficient second-order resources enables data to be captured and processed, and consequently *stimulates "institutional adaptive capacity"* by generating viable alternative strategies with which to manage water scarcity in a sustainable fashion. There is a linkage with Hypothesis # 15, 17, 24, 25, 26 & 30.

Hypothesis # 13: The concept of *"Structurally Induced Relative Water Scarcity" (SIRWS)* is valid for Zambia, because high levels of precipitation and high levels of potential water resource availability per capita, cannot be translated into high levels of economic growth or social development because of *the scarcity of second-order resources that inhibits "institutional adaptive capacity"*. There is a linkage with Hypothesis # 15.

Hypothesis # 14: The concept of *"Structurally Induced Relative Water Abundance" (SIRWA)* is valid for Botswana, because low levels of precipitation and potential water resource availability per capita, are not an inhibiting factor in generating high levels of economic growth or social development, because *the relative abundance of second-order resources stimulates "institutional adaptive capacity"*.

Hypothesis #15: An indicator for SIRWS is the number of *food gardens* in existence within a given social entity. In this regard, the coexistence of high levels of precipitation

and high levels of poverty, are not translated into food garden cultivation as a result of *second-order resource scarcities*, even though such food gardens would improve household food security. There is a linkage with Hypothesis # 12 & 13.

Hypothesis #16: *Awareness of the cost of water* is generally inversely proportional to the *level of service provision*. In this regard, a high awareness of water cost is found where people are poor and are forced to pay for water as they draw it, whereas a low awareness of the cost of water is found in areas where water services have resulted in people taking such services for granted. As such it is an indicator of second-order resource deployment. There is a linkage with Hypothesis # 22.

Hypothesis #17: The development of a *water conservation strategy* is an indicator of second-order resource availability in a given institution. In this regard, the development of such strategies stimulates *"institutional adaptive capacity"* by allowing incremental policy adjustments to be made. There is a linkage to Hypothesis # 9, 12 & 25.

Hypothesis #18: Low *levels of billing* for water services correlates with a low *level of knowledge about what sustainability means*. There is a linkage with Hypotheses # 9, 11, 19, 20, 21, 22, 23 & 24.

Hypothesis #19: A high *willingness to pay* correlates with low *levels of knowledge about what sustainability means.* There is a linkage with Hypotheses # 9, 11, 18, 20, 21 & 22.

Hypothesis #20: Low *levels of satisfaction with the amount and type of information being provided* by the supplier correlates with low *levels of knowledge about what sustainability means.* There is a linkage with Hypothesis # 9, 11, 19, 21, 22, 23, 24 & 25.

Hypothesis # 21: High *levels of belief that there is a cost attached to the supply of water* correlates with low *levels of knowledge about what sustainability means*. There is a linkage with Hypothesis # 9, 10, 11, 19, 20, 22, 23 & 25.

Hypothesis # 22: Low *levels of satisfaction with current levels of accessibility* correlates with low *levels of knowledge about what sustainability means*. There is a linkage with Hypothesis # 9, 11, 16, 18, 19, 20, 21 & 23.

Hypothesis #23: Low *levels of billing* correlates with low *levels of information exchange* between Suppliers and Users. There is a linkage with Hypothesis # 3, 5, 9, 11, 18, 20, 21, 22 & 24.

Hypothesis # 24: The *ability to manage data flow* in order to generate *individual bills* is a good indicator of second-order resource deployment. There is a linkage with Hypothesis # 3, 5, 9, 11, 12, 18, 20, 23 & 25.

Hypothesis #25: *Knowledge of the actual cost of treating and reticulating a given volume of water* by the water service provider is a good indicator of second-order resource deployment. In this regard a low level of knowledge correlates with a low *institutional*

capacity to capture and process data. This is a manifestation of data capture, processing and management, which is a core function of the structural component in the model under review. There is a linkage with Hypothesis # 3, 5, 9, 12, 17, 20, 21 & 24.

Hypothesis #26: There is an inverse relationship between *"social adaptive capacity"* and *"institutional adaptive capacity"*. In this regard, a high level of adaptation at the level of the individual is necessary where formal institutions are failing to service the direct needs of the consuming public. Under these conditions there tends to be a high reliance on alternative water supplies. There is a linkage with Hypothesis # 12 & 14.

Hypothesis # 27: As *formal water supply institutions* develop, the users become more remote from the source of supply and consequently become more dependent on the water service provider, and therefore less knowledgeable about key issues such as the cost of water service provision. This places an increased *need for adequate communication* between the suppliers and users of water as formal institutions develop in complexity, and as informal institutions decline. There is a linkage with Hypothesis # 28, 29 & 30.

Hypothesis #28: *Informal institutions* tend to be *"social ingenuity" sufficient* but "technical ingenuity" deficient. Informal institutions consequently tend to have a *higher level of inherent legitimacy* because key decision-makers articulate the interests of, and are directly accountable to, the local community that they represent. There is a linkage with Hypothesis # 27 & 30.

Hypothesis # 29: *Formal institutions* tend to be *"technical ingenuity" sufficient* but "social ingenuity" deficient. Formal institutions consequently tend to have a *lower level of inherent legitimacy* because key decision-makers do not articulate the interests of, and are not directly accountable to, local communities. There is a linkage with Hypothesis # 27 & 30.

Hypothesis # 30: The natural *tendency for water supply institutions to lose popular legitimacy as they develop* from informal to formal institutions, results in the *need for better communication between decision-making elites and the consumers* if support is to be generated for water conservation strategies. This can be seen as being one of the classic bottlenecks that the "Turning of the Screw Model" illustrates (Ohlsson & Turton, 1999; Ohlsson & Lundqvist, 2000; Turton 2002a; 2002b). There is a linkage with Hypothesis # 9, 12, 27, 28 & 29.

It must be noted that these hypotheses are all tentative, and that some are likely to be more valid than others are. The linkage between some variables seems obscure, but such linkages have been observed when analyzing the data in the project under review. *It is therefore necessary to caution the reader not to regard these hypotheses as having been validated yet.* For those interested in designing new research projects, these hypotheses can be used as a point of departure in the planning of those projects. Such research would be valuable, because it would be creating new knowledge, and is therefore to be encouraged.