Water Poverty Mapping: Development and Introduction Using a Case Study at the Local Municipal Scale for the Eastern Cape

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Water Research Commission

WATER POVERTY MAPPING: DEVELOPMENT AND INTRODUCTION USING A CASE STUDY AT THE LOCAL MUNICIPAL SCALE FOR THE EASTERN CAPE

Report to the
Water Research Commission

by

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Executive Summary

The objective of this Study is to introduce the concept of Water Poverty Mapping as a policy tool and to demonstrate its use by way of a short case study. This has been achieved through a detailed discussion of the theoretical underpinnings of water poverty mapping and the potential role that it can play as a water supply policy tool, by developing a strategic level water poverty map (WPM) at local municipality scale for the Eastern Cape.

Water poverty mapping can be defined as the mapping of water poverty indicators, aggregated to a suitable spatial scale for the purpose of identifying areas of high levels of water poverty, so as to assist in the targeting of water related policies to ensure the most efficient use of resources, in an attempt to meet the development objectives of the country. Water poverty mapping combines the strengths of the Water Poverty Index (WPI) as a composite measure of water poverty, with that of poverty mapping and geographic targeting as a way of allocating scarce resources more efficiently than traditional means tested, universal or other methods for identifying the most water-poor households and communities. Water Poverty Mapping recognises the complex nature of water poverty by adopting a comprehensive definition of water poverty developed for the WPI that is an improvement on other indicators of water poverty, by recognising both the state and the process of water poverty. Water poverty, in terms of the WPI, is defined in terms of lack of entitlements and is measured according to five key components: Resource, Access, Capacity, Use and Environment.

There are a number of potential uses for water poverty mapping and these should be grouped into two tiers. At a national and strategic level, water poverty maps could be developed at local municipality or quaternary catchment scale depending on the intended objective and use, for the targeting of limited resources such as the Municipal Infrastructure Grant (MIG) funding to municipalities that requires the most help in addressing issues of water poverty as well as tracking the general state of water poverty across the country. Finer resolution water poverty maps should be developed by the local Water Service Authorities to assist in the implementation of water supply services and other local policies to ensure that limited resources are used to the greatest efficiency in targeting the most water-poor households.

The case study of the Eastern Cape showed that there was a great variation in water poverty across the province and that the municipalities of the former Transkei tended to have the highest levels of water poverty. It was found that one of the most relevant components defining water poverty was a low Access component. In terms of targeting financial resources it was found that the available resources were not being targeted in the most water-poor areas, which may have an impact on the efficiency of addressing water poverty in that province.

In terms of the availability of data, it was found that the Water Services Development Plans (WSDPs) had great potential in providing the necessary information for developing water poverty maps at both levels, but that they were not currently sufficiently consistent. It was recommended that the Department of Water Affairs and Forestry (DWAF) include the requirements for the development of water poverty mapping in their efforts to improve the value of the WSDPs and that this information should be captured in a national database. It was also recommended that spatial data be captured as part of the WSDPs as this will facilitate the development of fine resolution water poverty maps for future implementation purposes.

This study has shown that water poverty mapping has the potential to provide a useful policy tool and that the development of this concept should be furthered through a workshop to debate the issues and lay the foundations for the development of a national strategic level WPM at local municipality scale. Ongoing research and development including a pilot study to investigate the possibility of developing a finer resolution WPM for the targeting of the water supply implementation process, should also be encouraged.

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ACRONYMS

ADM	-	Amatole District Municipality
CHDM	-	Chris Hani District Municipality
DM	-	District Municipality
DPLG	-	Department of Provincial and Local Government
DWAF	-	Department of Water Affairs and Forestry
EA	-	Enumerator Area
EC	-	Eastern Cape
GIS	-	Geographical Information System
HDI	-	Human Development Index
HPI	-	Human Poverty Index
ISP	-	Internal Strategic Perspectives
IWSF	-	Integrated Water Services Forum
LM	-	Local Municipality
MAIS	-	Monitoring and Assessment Information System
MAR	-	Mean Annual Runoff
MCDA	-	Multi-Criteria Decision Analysis
MIG	-	Municipal Infrastructure Grant
PES	-	Present Ecological Status
RDM	-	Resource Directed Measures
RDP	-	Reconstruction and Development Programme
RSA	-	Republic of South Africa
UCT	-	University of Cape Town
WARMS	-	Water-use Authorisation and Management System
WPI	-	Water Poverty Index
WPM	-	Water Poverty Map
WRC	-	Water Research Commission
WSA	-	Water Service Authority
WSAM	-	Water Situation Assessment Model
WSDP	-	Water Service Development Plan
WSP	-	Water Service Provider
WSSD	-	World Summit on Sustainable Development

1. INTRODUCTION

1.1 BACKGROUND

Water is a limited resource and yet it plays a major role in poverty and development around the world. Its efficient allocation in all countries of the world, particularly arid and semi-arid developing countries like South Africa, was one of the key concerns discussed at the World Summit on Sustainable Development (WSSD) (Desai, 2002) and one of the major outcomes from the Summit was a firm commitment by all countries to strive to reduce the number of people with out access to clean water by half (Doran, 2002). The South African government has also taken up the challenge by setting the target of providing all South Africans with at least a basic level of service by 2013 (DPLG, 2004). There are currently over 6 million people without access to even a basic level of water supply service. South Africa is not well endowed with abundant supplies of fresh water and budgets for the supply of basic infrastructure services are limited. The challenge is now on to find practical ways of ensuring the most efficient allocation of our scarce resources in order to achieve these ambitious goals. 2013 is only eight years away !

1.2 AIMS AND OBJECTIVES

The objective of this study is to introduce the concept of water poverty mapping as a possible step towards meeting the above challenge. Water poverty mapping can be defined as the mapping of water poverty indicators aggregated to a suitable spatial scale for the purpose of identifying areas of high levels of water poverty, so as to assist in the targeting of water related policies to ensure the most efficient use of resources in an attempt to meet the development objectives of the country. Water poverty mapping combines the strengths of the Water Poverty Index (WPI) (Sullivan *et al*, 2002) as a composite measure of water poverty with that of poverty mapping (Henninger, 1998) and geographic targeting, as a way of allocating scarce resources more efficiently to address poverty related issues than traditional means tested, universal or other methods (Bigman *et al*, 2000).

The specific aims of the study are as follows:

- Introduce the concept of water poverty mapping and propose guidelines on the role that water poverty mapping can play as a policy tool for the management of water resources and in particular domestic water supply services in South Africa.
- Propose suitable variables to be used to define water poverty in terms of domestic water supply.
- Investigate the availability and reliability of data for indicators for the different components of the Water Poverty Index from readily available datasets such as Water Service Development Plans and the Census.
- Demonstrate the potential for water poverty mapping through a case study at the municipal level for between 10 and 15 municipal districts in one of the primary catchments in the Eastern Cape.

- Obtain feedback on the case study and the potential of water poverty mapping.
- Lay the foundation for further research into the development and use of water poverty maps.

1.3 REPORT FORMAT

This Report starts with a short literature review on the definitions of water poverty and an introduction to the concepts of the water poverty index (WPI), geographic targeting and water poverty mapping. The potential role that water poverty mapping can play in the management of water resources is also discussed. The second half of the report focuses on the specific case study to develop a water poverty map at the local municipality scale for the Eastern Cape. The generic steps for developing a water poverty map are presented and the selection of indicators, benchmark levels and weighting factors are discussed before the results of the water poverty mapping exercise are presented. This is followed by a short discussion on the results of the exercise and the implications that this would have on the management of domestic water supply in the Eastern Cape. The reliability of the supporting datasets is discussed and emphasis is placed on the potential role that Water Service Development Plans (WSDPs) can play. The Report finishes with a few recommendations for further development of the concept and a summary of the study is given in the final chapter.

1.4 ACKNOWLEDGEMENTS

This study would not have been possible without the support of the Water Research Commission and in particular the enthusiasm for the project from Mr Jay Bhagwan. The author would also like to thank Miss Haneem Hendricks for doing some of the initial investigation into water poverty mapping in the case study area as part of her final year B.Sc. thesis, under the supervision of Prof Neil Armitage from UCT. Miss Aileen Anderson was also helpful in giving feedback on the conceptual issues covered in the project. Prof André Görgens was an inspiration for this project and his understanding of the wide diversity of issues relating to the management of water resources in South Africa was invaluable.

The help of Mr Bongani Matome and Mr Galelo Mbambisa of the Department of Water Affairs and Forestry (DWAF) Regional Office in enabling the author to attend the Eastern Cape Integrated Water Services Forum meeting in East London and to hold discussions with the delegates on the concept of water poverty mapping and some of the issues facing water service delivery in the country, is also greatly appreciated.

2. LITERATURE REVIEW

2.1 WATER POVERTY

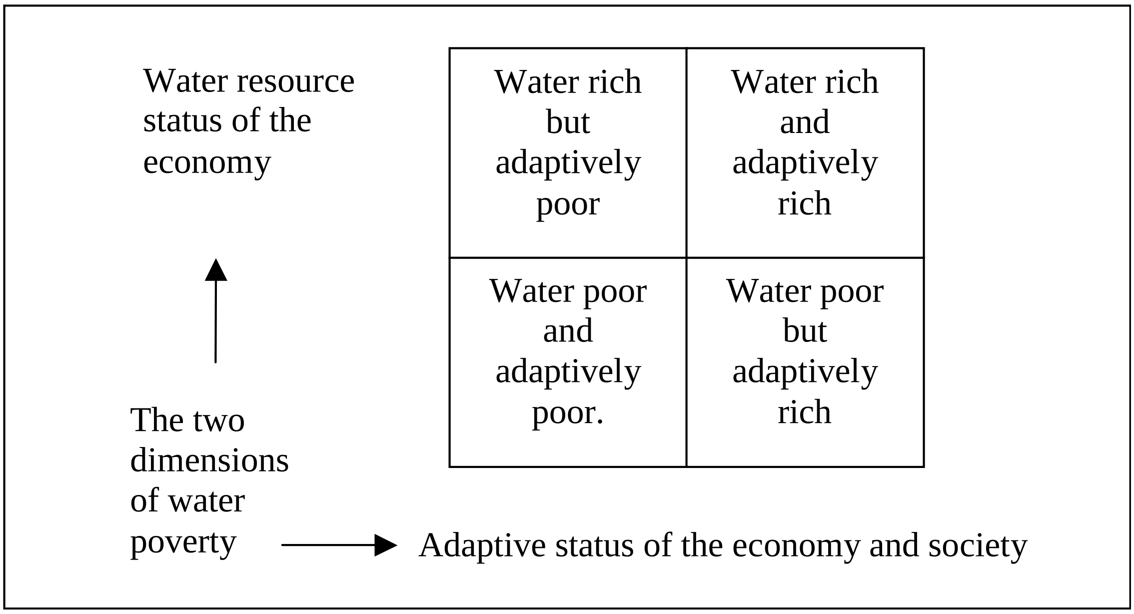
"Water is life".[1] It is an essential component of life-support systems and plays a major role in poverty alleviation and food security (FAO, 2000). Globally, some 1.3 billion people lack access to adequate supplies of clean water and three billion people lack adequate sanitation facilities (Bosch *et al,* 2001). It is generally accepted that the poor suffer most from lack of adequate water and sanitation services, with water supply being identified as both a cause and a consequence of poverty (Abrams, 1999). The World Bank identifies four key links between water supply and poverty: health; education; gender and social inclusion; and income/consumption (Bosch *et al,* 2001). The direct impact of water poverty on health is the most widely understood, but the role that water supply plays in education levels (especially young girls), gender and social inclusion and income and consumption levels is just as important and fundamental in initiating development. This link between water supply and general poverty is the most common understanding of water poverty, defined in this context as the lack of access to a suitable supply of water. This standard definition of water poverty, however, captures only the "state" and not the "process" of water poverty (Ahmad, 2003). In the same way as Sen defined poverty as more than just a lack of access to food (1999), so water poverty must be defined as more than just a lack of access to a suitable water supply. Allan (2002) bases his definition of water poverty on this concept and introduced the consideration of vulnerability of households to a lack of suitable water supply. He concludes that water poverty can be defined as both first order scarcity, i.e. a shortage of water, and second order scarcity, i.e. a lack of social adaptive capacity to deal with a shortage of water.

The consideration of the vulnerability of a community or individual to water scarcity introduces the definition of water poverty as reduced water security. Water security is defined by Soussan (2003) as a condition where people and communities have the capacity to command reliable and adequate access to good quality water to meet the full range of their needs, are able to take advantage of the opportunities that water resources present, are protected from water-related hazards and have fair recourse where conflicts over water arise. Water poverty must therefore include not only the physical availability of the resource, but also the socio-economic, political and environmental entitlements that govern a person's ability to command a secure and sustainable access to the resource in order to sustain a healthy livelihood. The idea of water poverty as defined by entitlements is particularly important as water resources are not generally privately owned (although supply technologies may be) and in addition, water resources are variable in flows, move over space and time and have multiple users (Soussan, 2003). Allan's concepts of first and second order water scarcity note that people can be water-poor in the sense

[1] Statement made by Prof. Kadar Asmal in the preface to *Overview of Water Resource Availability and Utilization in South Africa* (Basson, 1997)

of not having sufficient water for their basic needs either because it is not available, or because they cannot gain access to water that is available because, for example, they are income-poor and cannot afford to pay for it (Lawrence *et al*, 2002). In other words, there is a failure of water security. A more comprehensive definition of water poverty must therefore go beyond simply measuring the level of water supply service and factors such as water availability, access to water, capacity for sustaining access, the use of water and the environmental factors which impact on water quality and the ecology which sustains the water resource (Lawrence *et al*, 2002).

A step towards the development of a more comprehensive measure of water poverty was taken by Ohlsson (1998), who defined a Social Water Stress/Scarcity Index by linking an assessment of available renewable water (first order water scarcity) to an assessment of adaptive capacity (second order water scarcity) as defined by the Human Development Index (HDI). This approach, not only measured the state of water scarcity in terms of the number of people without access to water, but also gave some indication of the underlying causes that define the process of water scarcity and its impact on livelihoods. Based on this measurement of water poverty any country or community could be placed in one of four quadrants as shown in **Figure 1** below.



(Source: adapted from Sullivan *et al*, 2002)

Figure 1: Water resources and adaptive capacity

This comprehensive approach to measuring water poverty was taken forward by researchers at the Centre for Ecology and Hydrology in Wallingford, UK. They developed the Water Poverty Index (WPI) in an attempt to quantify the link between water and poverty by combing hydrological data with socio-economic data to provide a complex indicator that reflects the true nature of a community and its access to clean water (Schulze and Dlamini, 2002).

2.1.1. The Water Poverty Index

The WPI defines water poverty according to five components developed by Sullivan *et al* (2002). These five components are based on the theoretical foundation that poverty is a relative concept and is defined by capability deprivation leading to a failure to command access to a sufficient water supply to maintain a healthy livelihood. The five components of the WPI recognise that any measure of water poverty must include not only the physical availability of the resource, but also the socio-economic, political and environmental entitlements that govern a person's ability to command a secure and sustainable access to the resource in order to sustain a healthy livelihood. Water poverty therefore encompasses a number of factors such as water availability, access to water, capacity for sustaining access, the use of water and the environmental factors which impact on water quality and the ecology which sustains the water resource (Lawrence *et al*, 2002).

This conceptual framework as a definition of water poverty was developed in consultation with a range of physical and social scientists, water practitioners, researchers and other stakeholders during the development of the WPI (Sullivan *et al*, 2002). The result was a definition of water poverty according to five key components. The five components of the WPI are :

- Resources — The physical availability of both surface water and groundwater, taking account of the variability and quality of the resource as well as the total amount of water.
- Access — The extent of access to water for human use, accounting for not only the distance to a safe source, but the time needed for collection of a household's water and other significant factors. Access means not simply safe water for drinking and cooking, but water for irrigating crops or for industrial use.
- Capacity — The effectiveness of people's ability to manage water. Capacity is interpreted in the sense of income to allow purchase of improved water, and education and health, which interact with income and indicate a capacity to lobby for and manage a water supply.
- Use — The ways in which water is used for different purposes; it includes domestic, agricultural and industrial use.
- Environment — An evaluation of environmental integrity related to water and of ecosystem goods and services from aquatic habitats in the area.

The definition of water poverty in terms of these five components enabled individual indicators to be selected for each component. The indicators would differ depending on the purpose for which the user wanted to measure water poverty. The structure of the WPI is based on other composite poverty indices such as the Human Development Index (HDI) and Human Poverty Index (HPI), but addresses some of the concerns regarding the use of these indices (see for example Shirivisaan (1994)). In order to get a comprehensive measure of water poverty, the individual indicators of the WPI are given a relative score out of 100. This enables the different indicators for different components to then be combined to give a single composite score for each spatial unit according to the formula given below:

$$WPI = \frac{\omega_r R + \omega_a A + \omega_c C + \omega_u U + \omega_e E}{\varpi_r + \omega_a + \omega_c + \omega_u + \omega_e}$$

Where WPI = WPI Score out of 100

R = Resource Component score out of 100

A = Access Component score out of 100

C = Capacity Component score out of 100

U = Use Component score out of 100

E = Environment Component score out of 100

ω = weighting factor

The scale at which the indicators are aggregated and the weighting of the various components to form the composite WPI will depend on the purpose of the water poverty map. To date, work has been done on developing a national WPI for some 140 countries (Lawrence *et al*, 2002) and a community level WPI (Sullivan *et al*, 2003) at twelve study sites in three countries (South Africa, Tanzania and Sri Lanka).

Schulze (2002) notes the importance of being able to develop a WPI at the water basin or meso-scale level, but as yet little assessment has been done at this level. This is largely due to the difficulties in assessing socio-economic and political/institutional issues at this spatial scale (Sullivan *et al*, 2002). These issues are currently being addressed by researchers in South Africa (Dlamini *et al*, 2003) who are developing WPI indicators for the management of the resource at the sub-catchment scale. While the sub-catchment is the level at which water resource planners operate and make decisions on integrated water resource management, this may not be suitable for the socio-economic and political factors that define the provision of domestic water supply infrastructure. For this application of the WPI, the author proposes that the appropriate meso-scale should be the local municipality, which has been assigned the responsibility of ensuring the provision of domestic water supply services to the people of South Africa under the Municipal Services Act. This Study will make a first attempt at developing such a meso-scale WPI, showing how it can be used to develop a water poverty map to assist in the strategic allocation of resources to the local municipality with the highest level of water poverty in terms of domestic water supply and hence, the greatest need of assistance in the provision of domestic water supplies.

2.2 POVERTY MAPPING AND GEOGRAPHIC TARGETING

To tackle the problem of income, food or water poverty, particularly in developing countries, such as South Africa, the dual challenge of rising public deficits and shrinking public resources needs to be addressed. Poverty mapping involves the presentation of certain welfare indicators in a spatial context so that policy planners can identify the geographic areas and communities in which to focus their efforts for maximum impact (Henninger, 1998). The focusing of efforts in key areas is known as "geographic targeting". The argument for geographic targeting stems from the observation that poverty tends to exist in pockets caused by a combination of individual and structural factors (Miller, 1996). These pockets can be fairly easily identified in both urban and rural areas (Bigman & Fofack, 2000). Intuitively, water poverty and food security will tend to have a more obvious geographic nature than income poverty owing to the importance of environmental factors and the level of local infrastructure development in defining both the availability of the resource and people's ability to access it.

The use of poverty maps to facilitate geographic targeting of policy initiatives has been identified as the most cost-effective use of scarce resources for stimulating the development of the poor (Bigman & Fofack, 2000). Ravallion & Woden (1997) find that geographic location is more important in identifying target groups than other characteristics while Baker & Grosch (1994), when looking at Mexico and Jamaica, find that the reduction in poverty that can be achieved through geographic targeting is greater than that achieved through an equally expensive universal distribution programme.

Geographic targeting will, however, not work in all situations. In Panama, for example, the use of geographic targeting led to very high errors of exclusion (Foster *et al*, 2000) while in other cases, such as in Chile and Columbia, there was little difference in comparison to an individual means-tested subsidy (Gomez-lobo *et al*, 2000).

In South Africa, geographic targeting has been suggested as one of three ways of ensuring that the poorest households in the rural areas of South Africa benefit from the government's Free Basic Water policy (DWAF, 2001a). In essence, the current system for allocating Municipal Infrastructure Grant (MIG) funding to local municipalities is also a form of geographic targeting. Local municipalities are ranked according to a number of development indicators, one of which is water supply backlog, and MIG funding is proportionally assigned to these indicators with the most funding going to the municipality with the worst score in terms of these indicators. This principal of allocating the most funds to the worst-off area is premised on the understanding of justice, that the greatest good to society can be achieved by addressing the concerns of the poorest first. One of the potential uses for water poverty mapping as discussed in this Report will be to slot into this MIG funding allocation process and replace the current indicator of water supply development with a more comprehensive indicator of water poverty.

2.3 WATER POVERTY MAPPING

Water poverty mapping can be defined as the mapping of indicators of water poverty aggregated to a suitable spatial scale for the purpose of identifying areas of high levels of water poverty so as to assist in the targeting of water related policies, to ensure the most efficient use of resources in attempting to meet the development objectives of the country. Water poverty mapping combines the strengths of the Water Poverty Index (WPI) as a composite measure of water poverty, with that of poverty mapping and geographic targeting as a way of allocating scarce resources more efficiently to address poverty related issues than more simplistic definitions of water poverty and traditional means tested, universal or other methods for identifying the most water-poor households and communities.

The concept of water poverty mapping as a policy tool was introduced by Cullis (2004) by way of a small case study of the Escourt Municipality. The author used a simple WPI to produce a set of water poverty maps at three different scales to introduce the concept and highlight the importance of choosing a suitable scale for targeting water-poor households. Water poverty mapping takes its definition of water poverty from the five key components of the WPI and combines it with the flexibility of Geographic Information Systems (GIS) mapping and geographic targeting to provide decision makers with a policy tool that describes the spatial distribution of water poverty within an area. The WPI variables are aggregated on a suitable scale and each component is presented as a different layer in the water poverty map (WPM) with the final layer being the total WPI value for each aggregated area. **Figure 2** is an example of a WPM for the Estcourt municipal district at the sub-catchment scale, showing how the sub-catchment with the lowest WPI can easily be identified and targeted.

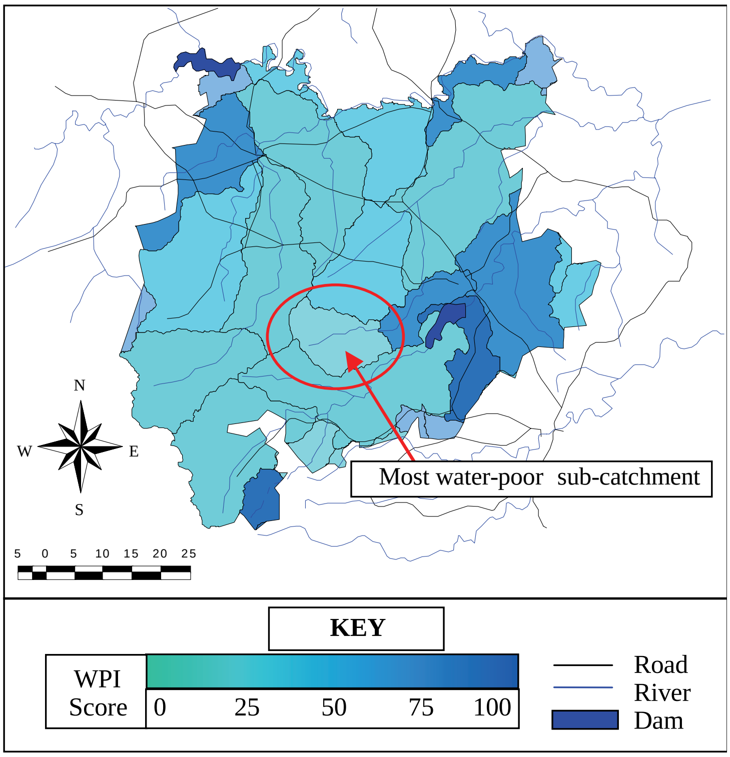


Figure 2: A sub-catchment scale water poverty map

The use of layering to present the complex nature of water poverty, as well as the ability to visualise the distribution of water poverty in an area, are just two ways in which water poverty mapping builds on the strengths of the WPI. Water poverty mapping utilises the many other benefits of GIS based mapping, some of which are given below (after Henninger, 1998) :

- A GIS WPM makes it easier to integrate data from different sources and allows the switch to new units of analysis from, for example, administrative boundaries to ecological boundaries such as sub-catchments.
- Maps are a powerful visual tool and are more easily understood by a wider audience of stakeholders, particularly in developing countries.
- Poverty maps can be expanded to include political factors as well as ecological factors, such as water and environmental quality not included in traditional poverty surveys.
- The spatial nature of water poverty, such as the distance to the nearest water source or the water supply infrastructure, can also be incorporated easily in a GIS and used in the calculation of the WPI.
- Water poverty maps can be produced at a number of different resolutions depending on their purpose and the cost of data collection.
- Internationally compatible poverty maps, applying a constant set of indictors at sub-national level, can improve decision making and strategy planning of international development organizations.
- WPMs can not only help in our understanding of the spatial nature of water poverty, but the use of layering can also be useful in identifying the underlying causes of water poverty in an area.

Cullis (2004) proposed that these water poverty maps be used to provide a visual summary of the information on the socio-economic situation with respect to water or water poverty in an area, such as is captured in the Water Service Development Plans (WSDP), as well as providing a fair, equitable and transparent decision-making process for the allocation of resources between areas so as to achieve the greatest efficiency in meeting certain development objectives. These maps could be used to identify the most needy area and then allocate water use licenses and permits, funds for the development of water services, or identify areas where job creation could help in improving access to basic services. The role that water poverty mapping could play in the management of water resources and the battle against water poverty is elaborated on in the following sections of this Report.

3. THE ROLE OF WATER POVERTY MAPPING

The general purpose of developing water poverty maps is to monitor the state of water poverty in an area and to identify areas in which efforts and resources should be focused to target the poorest of the poor as well as giving an indication of what type of intervention would be most appropriate. By making use of a composite indicator of water poverty, water poverty mapping provides a monitoring and evaluation tool that is more comprehensive than existing water poverty indicators and can be used to ensure that scarce resources are used to the greatest degree of efficiency in meeting water-related development objectives such as those outlined in the Millennium Development Goals.

3.1 DIFFERENT MAPS FOR DIFFERENT USES

For any monitoring objective it is important to clearly define the intended purpose of the monitoring tool. This is particularly true in this case given the complex nature of the role that water plays in achieving a variety of development objectives. Water poverty mapping, as described in this Report provides a framework for achieving this objective, but the selection of supporting indicators for each of the five components of water poverty and the scale of aggregation of these indicators must be defined by the intended purpose of the water poverty mapping exercise. The relative weighting of the indicators and components in the calculation of the final water poverty map is also dependent on the intended purpose. Because of this flexibility water poverty maps can be used by a variety of stakeholders. Each of these users have different requirements which result in water poverty maps that are unique to that specific objective and differ in terms of scale, indicators and weighting factors. Some of the main uses of water poverty mapping in South Africa are described in a later section of this Report, but first it is important to investigate the issue of scale.

3.2 SCALE ISSUES WHEN DEVELOPING A WATER POVERTY MAP

The question of scale is one of the most important considerations in water poverty mapping and geographic targeting. The appropriate resolution of any water poverty map depends on the study's objectives, the environment under consideration and the kind of information required (Stephen *et al*, 2001). A map at too coarse a resolution is of little use for many applications as it neglects the heterogeneity within each unit. In a country or region, the patterns that identify who could be water-poor (e.g. single mothers in rural areas) are more visible at smaller scales (Stephen *et al,* 2001). These local level factors are particularly important when dealing with multivariate and complex problems such as water poverty (Fotheringham, 1997). The research practitioner needs to balance this assumption of homogeny with the additional costs and logistics of producing a more detailed map (Henninger, 1998). The empirical issue of spatial resolution and the question of whether information about a particular phenomenon occurring at one scale can be applied to another scale has still to be answered, particularly in the social sciences (Gibson *et al,* 2000), but Stephen and Downing (2001) feel that the presence of fractals in mapping sciences tends to show that the real world is not constant at all scales.

This highlights the importance of getting the scale right if using geographic targeting for development policies. If, for example, a household level development policy, such as a food subsidy or basic water supply system, is targeted at households defined as poor at the province or sub-catchment scale and it turns out that the factors determining the poverty level, are very different at the provincial or sub-catchment level than they are at the household level then the policy will fail in its attempt to address the needs of the poorest households. Great care therefore needs to be taken when trying to address poverty at the household level by targeting it at a coarser resolution such as sub-catchment or provincial level to make sure that the correct households are being targeted.

Dlamini *et al* (2003) show that the dilemma of selecting a suitable spatial unit for evaluating multi-disciplinary indices such as the WPI is an inevitable consequence of their multi-disciplinary nature as the components are suited by different spatial units and scale. They observe that while administrative or historical units such as magisterial districts suit socio-economic-political issues, they are not suitable for the quantification of physical phenomena such as water resources, and the converse is true for physically delineated units such as meso-catchments. Therefore, they suggest that the choice of the spatial unit should be determined by the primary foci of individual evaluations of the indices because in any event, for whichever unit used, there will be a compromise of accuracy in one or more components. If the accurate representation of water resources precedes that of socio-economic-political issues, the catchment should be used and administrative/historical districts should be adopted where socio-economic issues are of higher priority than physical issues.

3.3 WATER POVERTY MAPPING IN SOUTH AFRICA

Water poverty mapping is faced with the dilemma of balancing the importance of measuring water poverty at the household level with the cost of gathering the data necessary to put together a detailed household level water poverty map. In order to solve this problem it is proposed that water poverty mapping be developed at two distinct levels as shown in **Figure 3** that relate to the hierarchy of information requirements outlined in DWAF's Monitoring and Assessment Information System (MAIS) (DWAF, 2001).

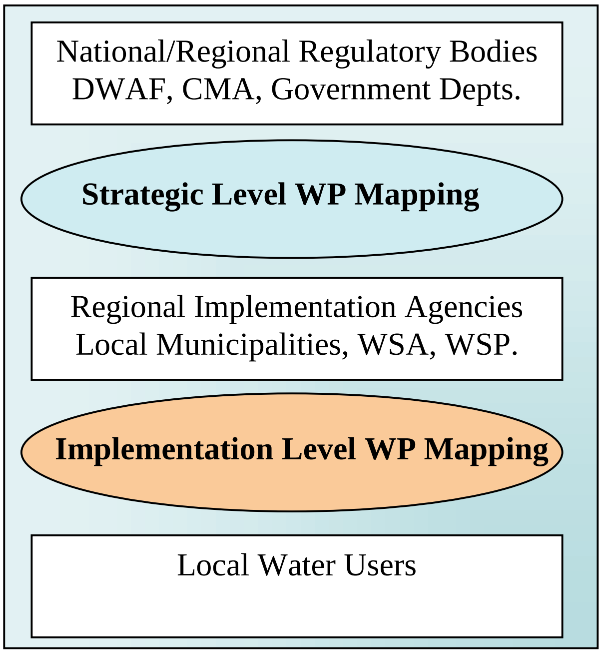


Figure 3: The Two Proposed Levels of Water Poverty Mapping

At the regional or national level, DWAF and other national institutions could make use of more generalised water poverty maps for strategic and regulatory purposes such as the allocation of resources to local municipalities or between large-scale users. They would also be useful in monitoring the general changes to the level of water poverty in the country as a whole, in the same way as other development indicators such as the Human Development Index (HDI) are used to track the general state of poverty. In doing this, water poverty mapping would also give an initial indication of the degree to which the aims and objectives of the National Water Act and the Water Services Act are being achieved across the country.

At the local level more detailed water poverty maps could be of use to local municipalities, Water Service Authorities (WSA) and Water Service Providers (WSP) for targeting the implementation of water supply infrastructure and related localised policies. At the local implementation level it is much more important to capture the small scale issues that are fundamental in understanding water poverty at the household level. An understanding of these issues is imperative if a local implementation of water supply is to be successful, but requires much greater effort to capture. At the regional and national level it is not possible to measure these more detailed factors and as a result the indicators used become more generic and are based on readily available national databases such as the Census.

This two tiered approach to water poverty mapping will ensure that the small scale local issues are identified when implementing a particular policy or designing a new water supply scheme. At the more strategic level of tracking water poverty across the country, a compromise can be reached in terms of the effort required to collect the necessary data to make the process feasible and to at least give a first order estimate of where the main problem areas are in the country and some idea of what the underlying cause of water poverty is. As the two processes are based on the same conceptual framework it is possible that they would be interconnected which would enhance the potential of both approaches.

3.3.1. Water Poverty Maps for Strategic and Regulatory Purposes

At the regional or national level there is a general separation in the management of water in South Africa between the water resource focused management of the country's water resources as a whole and the socio-economic focus on ensuring that all citizens have access to at least a basic level of water supply for domestic purposes. This division of responsibilities is in line with the separation of powers between the National Water Act and the Water Services Act and is reflected in the administrative structure of DWAF. It is proposed that water poverty maps at different scales and with different supporting indicators be developed for these two different sides of water management in South Africa, in line with their different focus areas, requirements, aims and objectives.

Socio-economic focused water poverty maps

Under the National Water Act, the role of the DWAF is expected to move from the implementer of water supply services to the role of regulator with the responsibility of implementation shifting to the district and local municipalities. In order to fulfil this more strategic role, DWAF needs to keep an eye on the general progress of water supply policies across the country as well as being able to identify which municipalities should receive institutional or funding support. DWAF's role is therefore to ensure that the available resources, such as the available water and the funds made available by the Municipal Infrastructure Grant (MIG), are used most efficiently in addressing water poverty as well as to give guidance and assistance to the municipalities. For this purpose, a water poverty map at the local municipal scale would be most appropriate.

Current systems of identifying water-poor municipalities in terms of the water supply backlog, measure only the current state of water poverty and not the process as described by Ahmed (2003). By using a more comprehensive measure of water poverty, water poverty mapping measures not only the state of water poverty (i.e. in terms of Access) but also gives an indication of the underlying causes of this water poverty in terms of the available supply, capacity and use. The water poverty map would therefore not only identify which municipalities need assistance, but would also give some indication of the type of assistance required to address this water poverty as it would not necessarily be the same for all cases. If, for example, the WPI of a municipality was low due to limited access, but there was sufficiently available resource, then the development of water supply infrastructure should be encouraged. If, however, the WPI was low due to limited capacity then DWAF should encourage job creation to improve individual capacity to purchase water before they contemplate introducing more than a basic level of service.

Obviously, a strategic decision would have to be made as to whether or not the provision of an improved service may in itself encourage job creation and therefore improve capacity, but this would require the assessment of a number of factors outside of the supply of water, and should be done in close co-operation with other government departments. The assessing of a municipality's ability to implement and manage its infrastructure is also important and already forms part of the approval process for MIG funding (DWAF, 2003).

The case study presented in this Report is an example of a water poverty map of this type. A further discussion of the potential role of water poverty maps of this type is given in the section discussing the results of the case study.

Water Resource Focused Water Poverty Maps

The strategic planning division of DWAF could make use of a water poverty map at catchment scale to identify catchments where water resource development may have the potential for reducing water poverty, i.e. in catchments with a low resource or low access component, but high capacity. In this case, the water poverty map could be expanded to include other water uses such as irrigation and industrial usage (see for example Dlamini, 2003), but again it is important to clearly define the objective of the water poverty map required.

The water poverty map developed for this purpose may also identify catchments where water resource development may not be the solution as there is already a high resource component, but potentially a low access which may be due to low capacity or low environmental quality leading to low use. This would result in a different strategic approach to addressing water poverty in these catchments and may require co-operative governance to, for example, encourage employment to increase capacity in an area or reduce environmental pollution of the resource.

The development of water poverty maps to be used in deciding on the most beneficial allocation of water in a catchment is faced with the challenge of comparing different types of water use. This is much more complex than measuring water poverty in terms of domestic water supply only and is an area that still needs to be explored in greater depth.

3.3.2. Water Poverty Maps for Local Implementation Purposes

The task of implementing domestic water supply services and meeting the development objectives has been delegated, under the Water Services Act, to the district municipality as the WSA with the local municipality acting as the WSP in the majority of cases. From an implementation objective, the WSA and/or the WSP, needs to know which areas within the local municipality should be targeted first in order to reduce household water poverty. For this purpose a water poverty map at a finer resolution, such as enumerator area, would be most appropriate as it would be able to pick up the small-scale issues that are often the most significant in terms of water poverty. As with the regional level water poverty map, the small-scale water poverty map would be useful in making a first order estimate of the most appropriate way of addressing water poverty in the targeted areas.

This level of detail would require the collection of additional information that would not be practical for the more strategic objectives of DWAF. Household information on capacity and use, would have to be obtained either from Census data at a finer resolution than for the more strategic level WPMs, from municipal records of water use and in some cases even from selected household surveys. The use of GIS would also be most beneficial in this instant as much of the information that will have to be collected would be spatial in nature. An example would be information on the distances to communal pipes and the number of people using a particular standpipe, which will influence the access of individual households to this water supply. Alternatively, the location of bulk distribution systems could be used to give a more complete description of the available resource. This level of detail is required for the implementation of water supply systems by the municipalities, but is not necessary or even practical, for the more strategic level planning objectives of the national organisations such as DWAF or the Department of Provincial and Local Government (DPLG). Apart from use in implementation planning, the municipalities could use these more detailed water poverty maps to show to DWAF and other stakeholders how the allocation of funds for water supply services has impacted on water poverty and why certain areas were specifically targeted. This would provide an important feedback mechanism to ensure that the allocated resources are being used efficiently. The use of a comprehensive measure of water poverty such as the WPI would also provide a far better tool for monitoring the performance-based outcomes of the WSDP, in terms of addressing water poverty. Simply recording the amount of money spent, the jobs created and the number of taps installed may be appropriate for other strategic objectives such as job creation or the need to spend the annual budget, but does not necessarily result in reduced water poverty. For this, a more comprehensive, outcomes-based monitoring tool such as that provided by the WPI and water poverty mapping, is required

An example of a simple water poverty map at the enumerator area scale is shown in **Figure 4** (taken from Cullis, 2004) for the township of Wembesi, Kwa-Zulu Natal. In this example, Census data on Access and Capacity is obtained at enumerator area (EA) scale, while the distance from the river is calculated using GIS and is included along with the mean annual runoff (MAR) of the catchment in the Resource indicator. The Use component is again calculated based on a simple model dependent on household characteristics. The distinction between the "formal" and "informal" parts of this township is obvious with the "informal" area having a much lower WPI score.

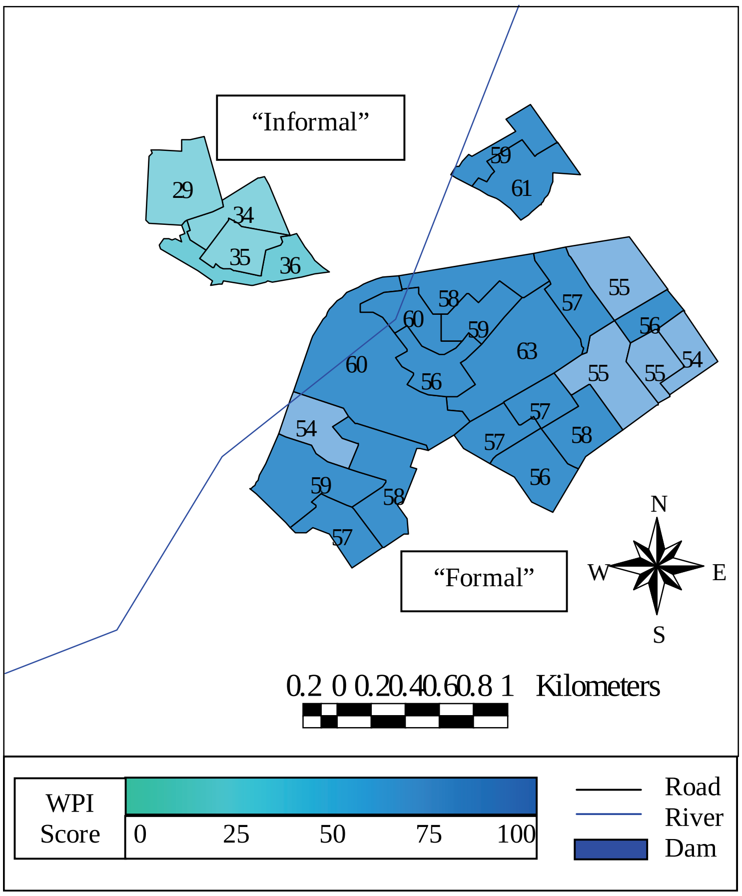


Figure 4 : Water Poverty Map at Enumerator Area Scale

On closer examination of the key components **(Table 1)**, it is clear that the difference between the formal and informal areas is due largely to the Access component followed by the Capacity component. If actual use figures had been used for the Use component, this may well have also indicated a marked difference between the two communities.

Table 1: Table of Component Scores at Different Scales

Component	Formal EA	Informal EA	Place Name Scale	Sub-catchment Scale
Resource	35.2	32.5	43.7	46.9
Access	99.1	3.8	78.1	78.2
Capacity	73.7	51.0	68.7	70.4
Use	47.0	47.0	47.0	71.5
Environment	33.0	33.0	33.0	33.0
WPI	**57.5**	**33.5**	**56.8**	**60.0**

Information such as that presented in the above water poverty map is essential to municipalities and WSPs in terms of deciding where and how to address water poverty and which communities within the municipal area are most in need of water supply services as well as what sort of assistance would be most effective in these areas. While the differences between communities may appear obvious to anybody living in the area, it is reassuring that this assumption can be supported by a quantitative measure such as water poverty mapping and provide a way of identifying the most needed areas that is consistent in all areas and is not subject to any prejudices and assumptions. The WPM also provides a powerful tool for the communication to stakeholders of why a water supply development option has been targeted for a particular area or community,

Table 1 also shows the difference that scale makes in calculating the WPI for a certain area and the importance of selecting a suitable scale for the intended purpose of the water poverty map. This re-enforces the importance of adopting a two-tiered approach, where water poverty maps at municipal level are used for the general strategic monitoring and evaluation and targeting of national resources such as bulk water and MIG funding to individual municipalities, while the municipalities themselves develop much more detailed water poverty maps that can be used to identify the specific communities that need assistance and what the best form of assistance is.

4. SELECTION OF CASE STUDY

4.1 INTRODUCTION

For the purposes of this project a case study was conducted to produce a water poverty map of the Eastern Cape. Initially, only two municipal districts in the Eastern Cape, Amatola and Chris Hani, were considered. After a discussion of the initial findings at a meeting of the Integrated Water Services Forum (IWSF) for the Eastern Cape, there was a request from some of the other municipalities to extend the coverage of the case study. Due to the constraints of the project it was not possible to develop water poverty maps at the finer enumerator area scale that would be used by local water supply authorities and service providers for the targeting of the implementation of local water supply services. Instead, this case study focuses on the more strategic level of water poverty map that could for example be used by DWAF for identifying the local municipalities that should receive the most support to ensure that the available resources (natural, financial and institutional) are used most efficiently to address water poverty in South Africa. As is discussed below, the chosen scale of the water poverty map was the local municipality scale. It had been hoped that the WSDPs could provide the necessary information for developing the WPMs at this scale, but after examination of the WSDPs for the Amatola, Chris Hani and O.R. Tambo District Municipalities, it was found that there were too many inconsistencies in the presentation and level of detail of the information contained in these to make them suitable for the development of the WPM. Instead, nationally available databases such as the Census and Water Situation Assessment Model (WSAM) were used as, despite the limitations of these, they were at least consistent across all municipalities.

4.2 CASE STUDY AREA

Figure 5 is a map of the Eastern Cape. On it are shown the main towns in the area, the district and local municipalities as well as the catchment boundaries from quaternary catchment to water management area. The District and Local Municipalities of the Eastern Cape are listed in **Table 2**.

The Eastern Cape is one of the poorest areas of South Africa and is one of the most seriously affected by the legacy of apartheid. The old homelands of the Transkei and the Ciskei make up at least half of the Eastern Cape and these areas have been subject to years of neglect and insufficient infrastructure provision under apartheid. The level of access to water and sanitation in the Eastern Cape is amongst the worst in the country and has been target by DWAF and the Water Research Commission (WRC) as a focus area for addressing issues relating to water poverty. It is therefore obvious that a tool such as water poverty mapping be developed initially for the Eastern Cape to assist in these efforts.

Table 2: District and Local Municipalities of the Eastern Cape

District Municipality		Local Municipality	
DC10	Cacadu	EC101	Camdeboo Municipality
		EC102	Blue Crane Route Municipality
		EC103	Ikwezi Municipality
		EC104	Makana Municipality
		EC105	Ndlambe Municipality
		EC106	Sunday's River Valley Municipality
		EC107	Baviaans Municipality
		EC108	Kouga Municipality
		EC109	Kou-Kamma Municipality
		ECDMA10	Western District Municipality
DC12	Amatole	EC121	Mbhashe Municipality
		EC122	Mnquma Municipality
		EC123	Great Kei Municipality
		EC124	Amahlati Municipality
		EC125	Buffalo City Municipality
		EC126	Ngqushwa Municipality
		EC127	Nkonkobe Municipality
		EC128	Nxuba Municipality
DC13	Chris Hani	EC131	Inxuba Yethemba Municipality
		EC132	Tsolwana Municipality
		EC133	Inkwanca Municipality
		EC134	Lukhanji Municipality
		EC135	Intsika Yethu Municipality
		EC136	Emalahleni Municipality
		EC137	Engcobo Municipality
		EC138	Sakhisizwe Municipality
		ECDMA13	North East
DC14	Ukhahlamba	EC141	Elundini Municipality
		EC142	Senqu Municipality
		EC143	Maletswai Municipality
		EC144	Gariep Municipality
		ECDMA14	Ukwahllamba
DC15	O.R. Tambo	EC151	Mbizana Municipality
		EC152	Ntabankulu Municipality
		EC153	Qaukeni Municipality
		EC156	Mhlontlo Municipality
		EC157	King Sabata Dalindyebo Municipality
		EC155	Qaukeni Municipality
		EC154	Qaukeni Municipality
DC44	Alfred Nzo	EC05b1	Umzimkulu Municipality
		EC05b2	Umzimvubu Municipality
		ECDMA44	DC44
Port Elizabeth		Nelson Mandela Metropolitan	

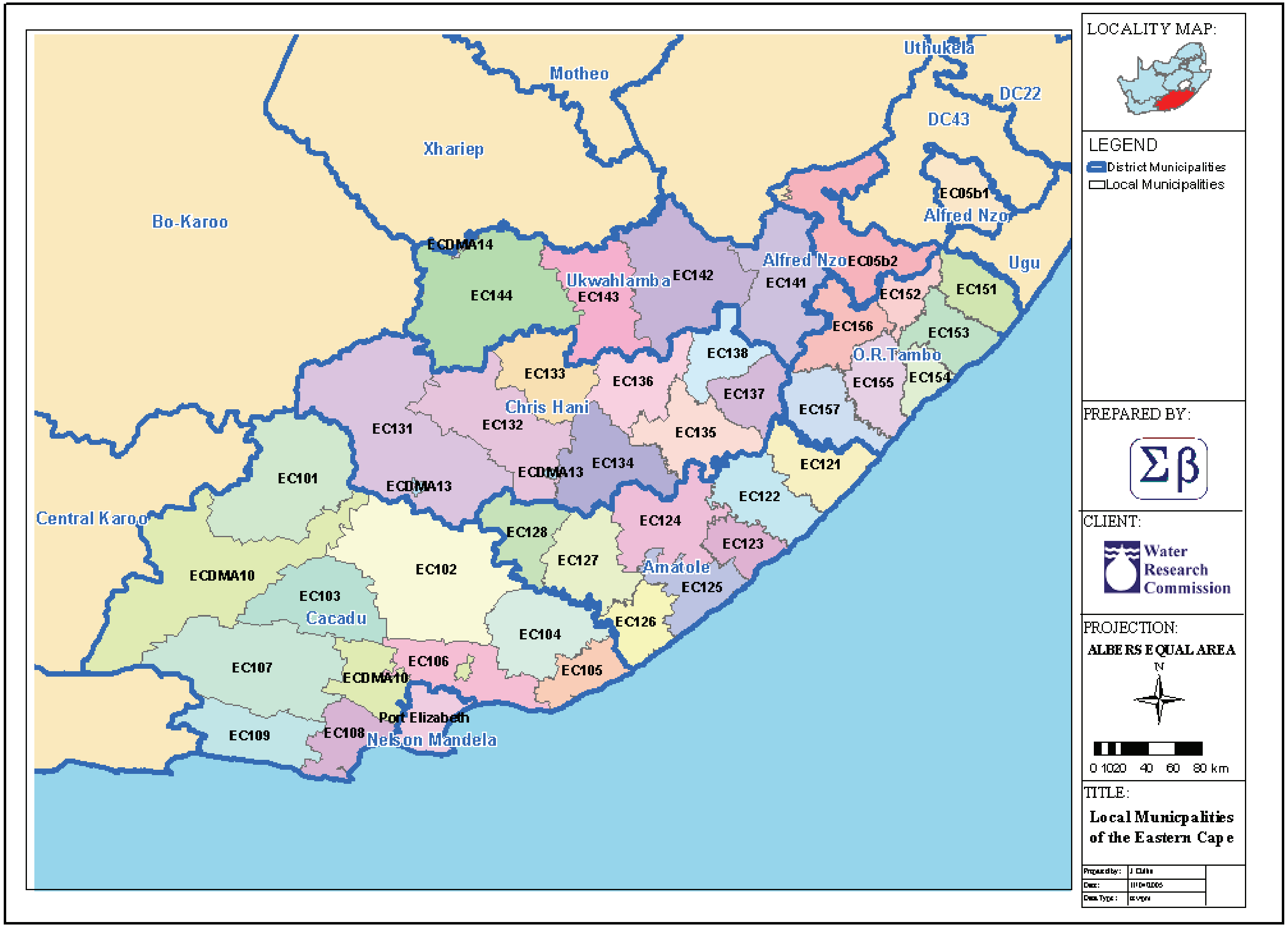


Figure 5: Case study area

5. DEVELOPING THE WATER POVERTY MAP

5.1 GENERIC STEPS FOR DEVELOPING A WATER POVERTY MAP

The generic steps for creating a water poverty map that were followed during this case study are as follows :

- Defining the purpose and expected use of the water poverty map
- Identify the relevant scale of the water poverty map
- Select the indicators to be used for the five components of the WPI
- Determine the need for sub-indicators and the appropriate weightings of these
- Identify the source of information for the above indicators
- Calculate the indicator values for each of the five components at the relevant spatial unit
- Set the threshold levels for each component and convert the indicator value into an indicator score out of 100
- Determine the weightings to be used for each component and calculate the WPI for each spatial unit
- Decide on the best way to present the information with regard to the purpose of the water poverty map

5.2 DETERMINING THE PURPOSE AND IDENTIFYING A SUITABLE SCALE

As has been stated earlier the intended purpose of the water poverty map developed in this case study is to demonstrate how a similar map could be useful to DWAF for strategic purposes such as identifying the most water-poor local municipalities for the purpose of ensuring that limited resources (natural, financial and institutional) are allocated to the local municipalities where they will have the most impact on addressing the overall level of water poverty in South Africa. For this purpose, water poverty is limited to the supply of water for domestic purposes only and it has been decided that a water poverty map at the local municipality scale is the most appropriate and the measure of water poverty should be based on the Water Poverty Index. In this case "domestic purposes" includes water needed in addition to the basic human need of 25 ℓ/c/d, for livelihoods support through the indirect use of water for industrial use in urban areas and for small scale stock and subsistence farming in rural areas.

5.3 SELECTING THE INDICATORS OF THE WATER POVERTY INDEX

The motivation for the indicators selected to develop the five components of the WPI as well as a brief description of the method of calculation used are discussed below.

5.3.1. Resource

Motivation

For the purposes of measuring water poverty in terms of domestic water supplies there was some debate over whether the Resource component should refer to the natural availability of raw water or the availability of treated water in terms of the capacity of existing water supply schemes in each local municipality. The motivation for this was that the objective of the water poverty map is to identify areas where domestic water supply schemes are insufficient, and not necessarily where raw water availability is limited. In the end, it was decided that this component should be representative of the total available yield from the catchment as this would take into account both the total volume of the resource as well as the influence that infrastructure such as dams would have on the reliability of this resource. If it was found that the Resource component was a limiting factor in a particular area, then a comparison of the mean annual runoff with the available yield could give some indication as to whether or not the Resource component could be improved with the development of additional storage, or would require an inter-basin transfer. It must be noted that the available yield is for all forms of water use and not just domestic water use. Two ways of addressing this issue could be to look at the actual allocations of water to water service providers as recorded in the Water-use Authorisation and Management System (WARMS) database, or the capacity of the bulk water supply to each municipality as recorded in the WSDPs. It is recommended that these be considered as the concept of water poverty mapping is developed further.

Method of Calculation

The Resource component was calculated as the average per capita yield. The yield was measured in terms of the total surface water yield at the 98% assurance level plus the total estimated groundwater potential and any contributions from return flows and imports. The data was obtained from the WSAM at quaternary catchment scale. The total yield was adjusted to local municipality areas by using simple area weighting, as was the total population. The average per capita yield was then calculated by dividing the one by the other and this was used as the Resource component value.

5.3.2. Access

Motivation

This component deals with the extent to which water becomes available for domestic use. Access is determined by both physical and social aspects. Most measures of water poverty are done in terms of the former. Social aspects, however can be just as significant, for example a household may have a communal tap within 200m, but its access to this water source may be restricted due to the number of households having to use this resource or by certain factions of the community monopolising the facility. At the finer scale of water poverty mapping for the purposes of implementation it will be important to note these additional aspects of access, but for the more strategic purposes of this case study it is not feasible to gather the necessary data and as such the Access component was measured only in terms of physical access to a private supply as recorded in the level of service provision.

Method of Calculation

The level of access was calculated using data at the local municipality level from the Census 2001 database. The Access component was calculated as the percentage of households that obtained their water supply either from a tap within the dwelling or from a yard tap. It was decided to set a higher standard of access than the current Reconstruction and Development (RDP) standard as it was felt that there were so many issues affecting the access to a communal tap that this level would not provide an individual with sufficient control over their water supply. The issue of accessibility to communal taps should be addressed at the more detailed implementation scale of water poverty mapping.

5.3.3. Capacity

Motivation

This is essentially the effectiveness with which people are able to manage and command access to a safe water supply. Two areas were considered appropriate for defining this; income and education level. Income is particularly important for the sustainability of supply in a cost-recovery system. Education level is important as a measure of an individual's ability to efficiently manage the available resource. The two variables used to represent these two aspects of Capacity are :

- Percentage of households able to afford a basic suite of services
- Percentage of population with above a Grade 4 level of education

The inclusion of a third indicator in terms of health was also considered and has been included in other cases where the WPI has been calculated. It was felt that the best indicator of health with respect to water supply was the under 5 mortality rate as this was the age group most susceptible to health problems relating to insufficient water supply. For the case study, it was not possible to obtain suitably detailed information on mortality rates at the local municipality level, but it is recommended that this be included in the further development of water poverty mapping.

Method of Calculation

Income Capacity

According to the Amatole District Municipality WSDP, people are willing to spend between 1 - 5 % of their disposable income on services. It is assumed that the residents of the other municipalities would have a similar approach to expenditure on services. The WSDP also reveals that a suite of basic services (i.e. water, sanitation and drainage) costs amount to R80 per household per month. The calculation to determine whether people are able to afford this suite of services is thus based on the threshold figure of affordability of R80 per household per month.

The information used to determine the household income is obtained from the Census 2001 database. The census records the number of households that fall into a number of annual income brackets. Based on the above assumption that a suit of services costs approximately R80/month and that a household is prepared to pay 5% of its annual income on these services, the threshold for affordability was taken as an annual income of R19 200. This annual household income is equivalent to two times the minimum basic wage of R800 per month.

The sub-indicator value is therefore calculated accordingly :

$$\text{Income Capacity (\%)} = \frac{\text{Households earning} > \text{R19 200}}{\text{Total number of Households}}$$

Education Capacity

It is usually assumed that at a certain educational stage some information about basic health practices, especially regarding water use, is disseminated. Learning outcomes for present day scholars often gives the approximate grades when this basic health promotion is taught at around Grade 4 (WCED, 2004). This was assumed to be the threshold level of education at which people are sufficiently educated to manage their water supply efficiently and was used in the calculation of the education capacity component.

$$\text{Educational Capacity (\%)} = \frac{\text{Persons with above Grade 4 level of education}}{\text{Total Applicable Population}}$$

For the purpose of this Case Study equal weighting was given to income and educational capacity. The capacity component was therefore calculated as the average of the educational capacity and the income capacity.

5.3.4. Use

Motivation

In the WPI one of the most important components is determining the amount of water that people use for domestic purposes. This data should be contained within the WSDPs and should be based on the actual physical amount that households are using. All three WSDPs studied contained information regarding the use of water but at a district municipality scale and not at the local municipality scale that is required. In addition, these figures were also based on estimates made in water resources assessment reports such as the Internal Strategic Perspectives (ISPs) and not the actual records of water use. Efforts to obtain the actual information from the various municipalities were unsuccessful, with only the Amatola District Municipality being able to provide some limited information on urban consumption. While this sort of information is notoriously difficult to obtain it is an essential part of the management of water services and every effort should therefore be made by the municipalities to capture this information and record it in the WSDPs.

For the purposes of this Case Study it was decided to use the water consumption estimates contained in WSAM (DWAF, 2003). The model calculates estimated water demand at the quaternary catchment level for urban and rural use, based predominantly on population statistics and level of service. The WSAM database was also the source of information for the water use estimates made in the WSDPs.

Method of calculation

Direct urban requirement

The algorithm used to calculate direct urban requirement in WSAM takes into consideration a number of variables such as population statistics, levels of service and housing conditions. The structure of the algorithm also encapsulates a 98% level of supply assurance for per capita water use for the different categories of services or housing conditions. The algorithm does not account for any conveyance or distribution losses. The formula for calculating the direct urban requirement is as follows :

$$nUDRo = 365.25 * 10^{-9} * oPOPi * \{fUPLi * nUClo + fUP2i * nUC20 + ... + fUP7i * nUC70\}$$

Where nUDRo = direct urban water requirement, excluding losses at the 98% level of assurance [Mm^3/a]

oPOPi = total urban population [number]

fUP1i to fUP7i = portion of urban population living in serviced categories 1, 2, 3,4,5,6 or 7 (fUP1i + fUP2i + … + fUP7i = 1.0) [factor]

nUC1o to nUC7o = per capita use of population living in serviced housing categories 1, 2, 3, 4, 5, 6, 0r 7 at the 98% level of assurance [ℓ/c/d]

The estimated consumption level for each category of housing level is shown in **Table 3**.

Table 3: Estimated Urban Consumption Levels

Category	Description	Default Usage (ℓ/c/d)
1	Fully serviced houses on large erven (erven > 500 m^2)	320
2	Fully serviced flats, townhouses or cluster homes	320
3	Fully serviced houses on small erven (erven < 500 m^2)	160
4	Small houses, and shanties with water connection, but no or minimal wastewater service	90
5	Informal houses and shanties serviced only by communal taps and no wastewater	10
6	No service from any water distribution system	6
7	Other/Miscellaneous (includes hostels, military camps, hospitals, schools, etc)	90

Rural Water Requirement

This water requirement refers to the demand for water in rural areas for livelihood support and includes basic domestic requirements as well as additional requirements for limited stockwatering and subsistence irrigation on small rural garden plots. The domestic requirement is based on per capita consumption rates and as with the direct urban water requirement, the rural water requirement takes into consideration the 1:50 year probability of failure to supply the demand. The formula used to calculate the rural water requirement is as follows :

$$gRURO = \frac{365.25 * 10^{-9} * (((nRCRo * oPORi)) + (nRSRo * oRSUi)) + nRIRo}{(1 - fRTLi)}$$

Where: gRURo	=	gross rural water requirement	[Mm^3/a]
fRTLi	=	Portion of total net rural water requirement that is lost during bulk transport and distribution (ranges from 0.1 to 0.3)	[factor]
oPORi	=	The rural population	[Number]
nRCRo	=	Net per capita water requirement and usually varies between 25 to 50	[ℓ/c/d]
oRSUI	=	No. of large stock units	[Number]
nRSRo	=	The water consumption per large stock unit is normally in the range of 10 to 50 [ℓ/lsu/d] (smaller animal numbers are adjusted to arrive at an equivalent no. of so-called large stock units or LSUs)	[ℓ/lsu/d]
nRIRo	=	Estimated volume of water required for small scale subsistence irrigation	[Mm^3/a]

The urban and rural population was also estimated using the data contained in the WSAM. As with the Resource component, the urban and rural population and estimated demand were converted from quaternary catchments to local municipalities using simple area weighting The Use component value of average per capita water use (ℓ/c/d) was calculated according to the following equation:

$$\text{Average per capita water use} = \frac{(\text{gRURo} + \text{nUDRo})}{(\text{oPoRi} + \text{oPoPi})} * \frac{10^9}{365}$$

South Africa is a dry country and as such, the target of any water supply should not simply be to increase the use of water, but to attempt to increase the efficiency of use. This implies that too much use is almost as bad as too little use as it limits the potential of others to have access to a sufficient supply. It was therefore decided that the use component should be scored in terms of an optimum level of use and that use in excess of this would be scored on a negative scale. This would result in the use component becoming a measure of the efficiency of use within a municipality rather than simply a measure of the total use. A benchmark of 160 ℓ/c/d was selected as the optimum level of use. This is the estimated use of a fully service house on a small erven as shown in **Table 3.**

5.3.5. Environmental

Motivation

The Environmental component is an evaluation of the environmental integrity of the water resource used to provide domestic water supply. This is particularly relevant to communities that obtain their water directly from the resource but is also significant in the case where water is supplied via an infrastructure scheme as it would give an indication of the level of treatment required with associated cost implications. In the case of a community drawing water straight from a stream, the Access component would be low, as they would not be linked to a water supply system. While this would be a major concern if the water source is in poor condition, it may not be so significant if the water source was in a good condition. The inclusion of the environmental component would therefore lead to the calculation of reduced water poverty, because although they are not getting water from a regulated and protected supply, they still have access to a relatively clean source of water from a stream in a good environmental condition. The inclusion of the environmental component, therefore incorporates the value of environmental goods and services on water poverty and it is often the poor who are the most dependent on these environmental goods and services.

Method of Calculation

For the purposes of this case study, the estimated Present Ecological State (PES) recorded in WSAM was used as a proxy of environmental integrity. The PES of each quaternary catchment is recorded as a rank out of 5 in the WSAM, as variable cEPCi. This indicator was adjusted to local municipality areas by taking the average rank of all quaternary catchments that occur in the given municipal area. Future developments in the Resource Directed Measures (RDM) section of DWAF to develop a composite set of indicators of environmental sustainability could be considered for this component in future.

5.4 SUMMARY OF THE WPI COMPONENTS

Table 4 is a summary of the variables used for each of the five components of the WPI as well as the relevant data sources.

Table 4: Summary of WPI Components

WPI Components	Variable Used to Represent the WPI Component	Data Source
Resource	Per capita surface and ground water yield at 98% assurance [m^3/c]	WSAM
Access	Percentage of households with access to a protected water source (%)	Census 2001
Capacity	Household able to afford a basic suite of services (%) Population with above Grade 4 level of education (%)	Census 2001
Use	Average per capita domestic water requirements (ℓ/c/d)	WSAM
Environment	Average Present Ecological Class (rank)	WSAM

5.5 SETTING THE BENCHMARK LEVELS

The conversion of indicator values to indicator scores by way of setting unique benchmarks for each indicator makes it possible to compare and combine indicators with different units and scales of measurement. The indicator scores run from 0 to 100 with the maximum and minimum values being defined for all areas according to the particular considerations for each indicator. For the purpose of this case study, these indicator values were set in a very simplistic way, but in the development of future water poverty maps it is important to carefully select these benchmark levels through a public participation process. The maximum and minimum levels for each of the indicator values are given in **Table 5**. As can been seen from this table, the minimum indicator value was always set at 0 and the maximum value was set slightly above the largest value from all the municipalities for that particular indicator. The only exception is the Use component, where the maximum value is actually a measure of the optimum amount of use and any indicator values above this optimum level are scored on a negative scale in terms of their distance away from this optimum value. This also results in two minimum values, which are 0 and twice the optimum value, i.e. 320 ℓ/c/d.

Table 5 : Benchmark Values for Indicators used in the Case Study

Component	Indicator	Unit	Minimum Value	Maximum Value
Resource	Per capita yield	m^3/c/a	0	5000
Access	Percentage of households with access to above RDP level of water supply service	%	0	100
Capacity	Percentage of households with above threshold income and percentage of population with above Grade 4 education	%	0	100
Use	Average per capita domestic water use requirement	ℓ/c/d	0/320	160*
Environment	Average present ecological class	rank	0	5

* Optimum use value

It must be noted that the very high yield in the Gariep Local Municipality was due to the presence of the Gariep Dam. This value was significantly higher than the available resources value in all other areas. As such it was not possible to assign a score of 100 to this maximum value. Instead a 100 score was assigned to a value of twice the average yield value. This resulted in a number of local municipalities with an indicator value above this, but it resulted in a much more even spread of values than had the maximum indicator value been used. It was assumed that in areas with a per capita yield above this level, the available resource was not a concern and as such it was acceptable to assign them a maximum score of 100.

5.6 CALCULATION OF THE WATER POVERTY INDEX

The WPI for each local municipality in the Case Study was calculated using the following composite index formula, where R, A, C, U and E stand for the individual component scores out of 100 and w_r, w_a, w_c, w_u, and w_e are the weightings assigned to each component.

$$WPI = \frac{w_r R + w_a A + w_c C + w_u U + w_e E}{w_r + w_a + w_c + w_u + w_e}$$

The weightings for each component (w_i) were taken from the recommended table of weightings (Sullivan *et al*, 2002) for the specific purpose of the water poverty map. These weightings are shown in bold in **Table 6**, but it is recommended that these weightings be assigned through a multi-criteria decision analysis (MCDA) process involving all stakeholders relevant to the particular water poverty map being developed.

Table 6: Hypothetical Weights to be Added to WPI Structure

Local condition descriptors			Variable weights				
Hydrological condition	**Economic Condition**	**National Priorities**	**Resource**	**Access**	**Capacity**	**Use**	**Environment**
Very Good	Unknown	Ag, Ind, and Soc	1	2	2	3	1
Average	**Average**	**Soc**	**1**	**2**	**2**	**1**	**1**
Very Good	Good	Env and Soc	1	2	2	1	2
Unknown	Unknown	Ind and Ag	1	2	2	2	1

(Source: Sullivan *et al*, 2002)

A final summary of the indicators and weightings used to calculate the WPI for each local municipality is shown in the **Table 7.**

Table 7: WPI Component Indicators and Weighting

Component	Component Weighting	Indicator	Indicator Weighting
Resource	1	Per capita yield	1
Access	2	Percentage of households with access to above RDP level of water supply service	1
Capacity	2	Percentage of households with above threshold income	1
		Percentage of population with above Grade 4 education	1
Use	1	Average per capita domestic water use requirement	1
Environment	1	Average present ecological class	1

6. RESULTS OF THE WATER POVERTY MAPPING EXERCISE

The component indicator scores and final WPI composite index scores for each local municipality area are shown in **Table 8.** The lowest score for each component has been highlighted.

Table 8: WPI Scores for the Local Municipalities

Local Municipalities		Resource	Access	Capacity	Use	Environment	WPI
EC101	Camdeboo Municipality	100	91	53	49	65	72
EC102	Blue Crane Route Municipality	59	77	45	71	69	63
EC103	Ikwezi Municipality	100	91	44	41	70	69
EC104	Makana Municipality	64	76	55	81	73	69
EC105	Ndlambe Municipality	60	62	49	97	68	64
EC106	Sunday's River Valley Municipality	100	62	45	78	77	67
EC107	Baviaans Municipality	100	86	49	31	67	67
EC108	Kouga Municipality	100	75	60	78	76	75
EC109	Kou-Kamma Municipality	100	77	53	60	66	70
ECDMA10	Western District Municipality	25	73	46	37	68	52
EC121	Mbhashe Municipality	15	5	28	29	60	24
EC122	Mnquma Municipality	20	15	36	41	65	33
EC123	Great Kei Municipality	81	31	37	91	75	55
EC124	Amahlati Municipality	98	22	40	57	75	51
EC125	Buffalo City Municipality	24	59	54	77	75	57
EC126	Ngqushwa Municipality	28	10	36	37	79	34
EC127	Nkonkobe Municipality	89	30	44	59	75	53
EC128	Nxuba Municipality	100	66	45	41	75	63
EC131	Inxuba Yethemba Municipality	**5**	85	48	0	72	49
EC132	Tsolwana Municipality	100	40	38	70	78	58
EC133	Inkwanca Municipality	100	85	39	34	74	65
EC134	Lukhanji Municipality	79	59	46	83	80	64
EC135	Intsika Yethu Municipality	53	6	31	26	74	33
EC136	Emalahleni Municipality	98	17	31	36	71	43
EC137	Engcobo Municipality	24	5	29	28	68	27
EC138	Sakhisizwe Municipality	53	38	39	76	63	49
ECDMA13	North East	25	48	79	49	74	57
EC141	Elundini Municipality	60	10	33	44	56	35
EC142	Senqu Municipality	100	22	36	67	60	49
EC143	Maletswai Municipality	100	64	45	**0**	62	54
EC144	Gariep Municipality	100	75	39	7	72	58
ECDMA14	Ukwahllamba	25	100	54	9	82	61
EC151	Mbizana Municipality	24	**3**	27	28	48	23
EC152	Ntabankulu Municipality	11	3	28	27	58	23
EC153	Qaukeni Municipality	24	8	29	30	48	25
EC156	Mhlontlo Municipality	11	5	**27**	30	**42**	**21**
EC157	King Sabata Dalindyebo Municipality	13	4	30	40	57	25
EC155	Qaukeni Municipality	79	6	33	31	63	36
EC154	Qaukeni Municipality	37	24	39	40	64	38
EC05b1	Umzimkulu Municipality	23	11	35	40	49	29
EC05b2	Umzimvubu Municipality	26	8	35	29	50	27
ECDMA44	DC44	0	0	0	0	0	0
Port Elizabeth		25	80	62	87	47	63

The component indicator scores and final WPI composite index scores for each district municipality and the final scores for the whole of the Eastern Cape are shown in **Table 9**.

Table 9: WPI Scores for the District Municipalities and the Eastern Cape

District Municipalities		Resource	Access	Capacity	Use	Environment	WPI
DC 10	Cacadu	100	75	52	69	68	70
DC 12	Amatole	37	37	44	77	71	50
DC 13	Chris Hani	75	32	37	64	73	50
DC 14	Ukahlamba	100	27	36	90	63	54
DC 15	O.R.Tambo	29	10	32	34	56	29
DC 44	Alfred Nzo	25	9	35	34	66	30
Province							
Eastern Cape		100	37	42	66	66	56

The same results are shown in graphical form by way of a WPI pentagram for the DM scores (**Figure 6**) and WPI component stacked bar chart for the LM scores (**Figure 7**).

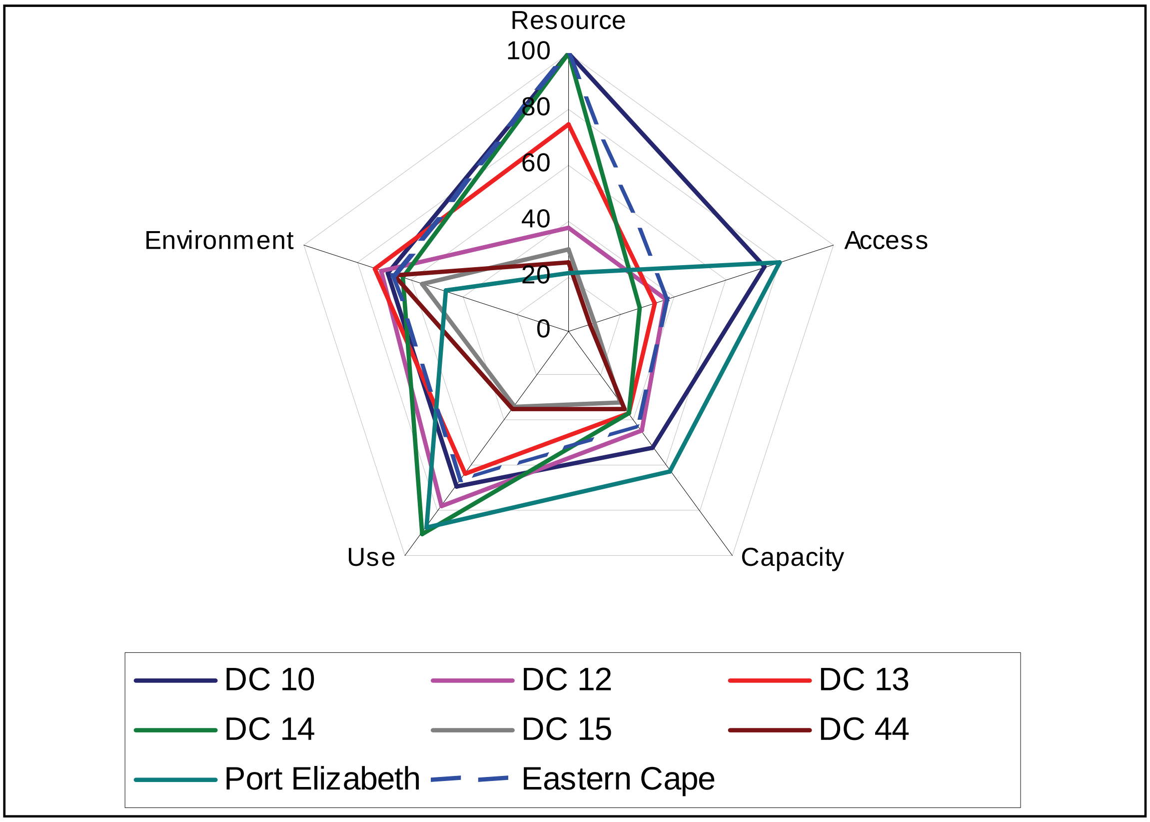


Figure 6: WPI pentagram of District Municipalities

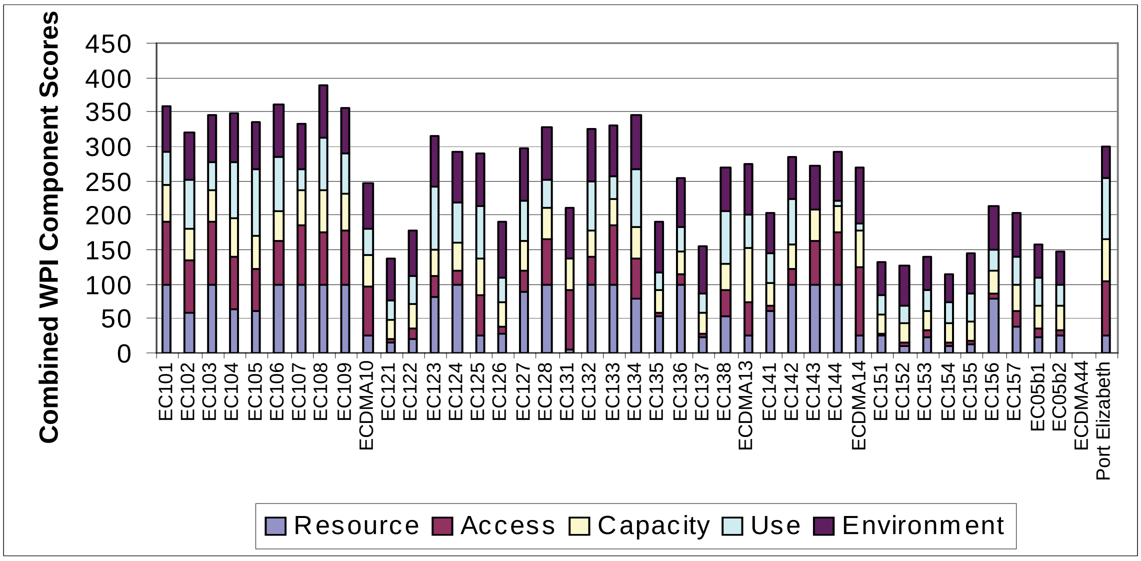


Figure 7: WPI component scores for Local Municipalities

Figure 8 shows the relative component indicator scores for each local municipality ordered in terms of the final WPI score.

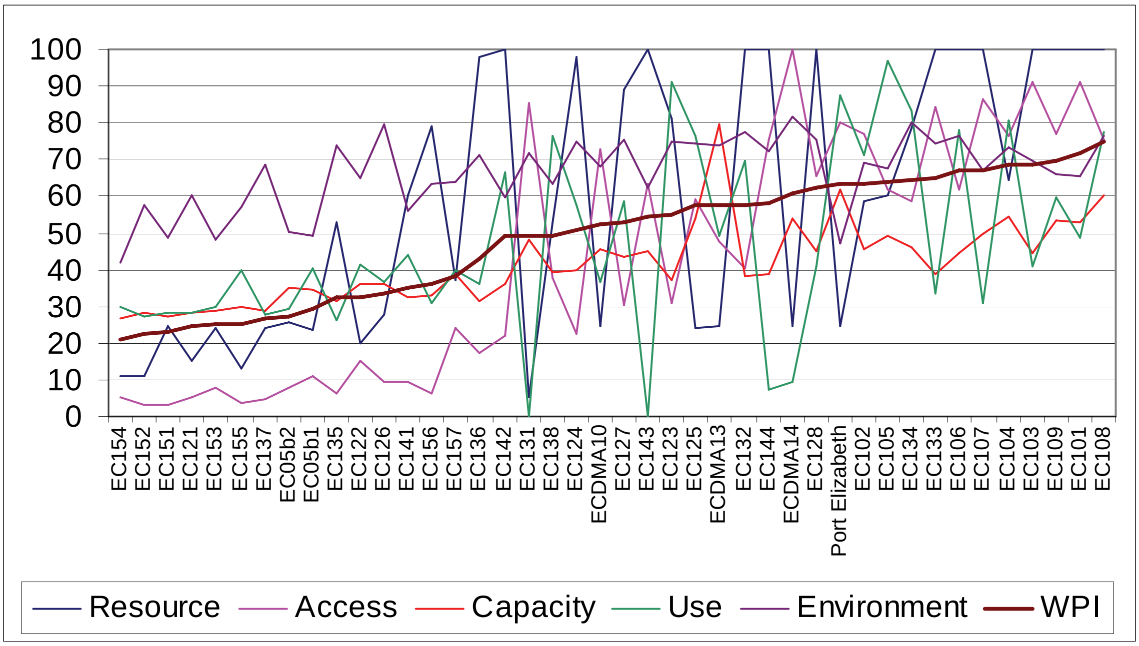


Figure 8: Local Municipalities ordered by WPI Score

The final water poverty map of the Case Study area is shown in **Figure 9**. In the water poverty map the individual local municipalities are colour coded according to the WPI score and the bar charts show the values for each of the five WPI components. This ensures that the component indicator scores are kept alive in the final presentation of the water poverty map as they are vital to the interpretation of the meaning of the map and the relative WPI scores for each local municipality.

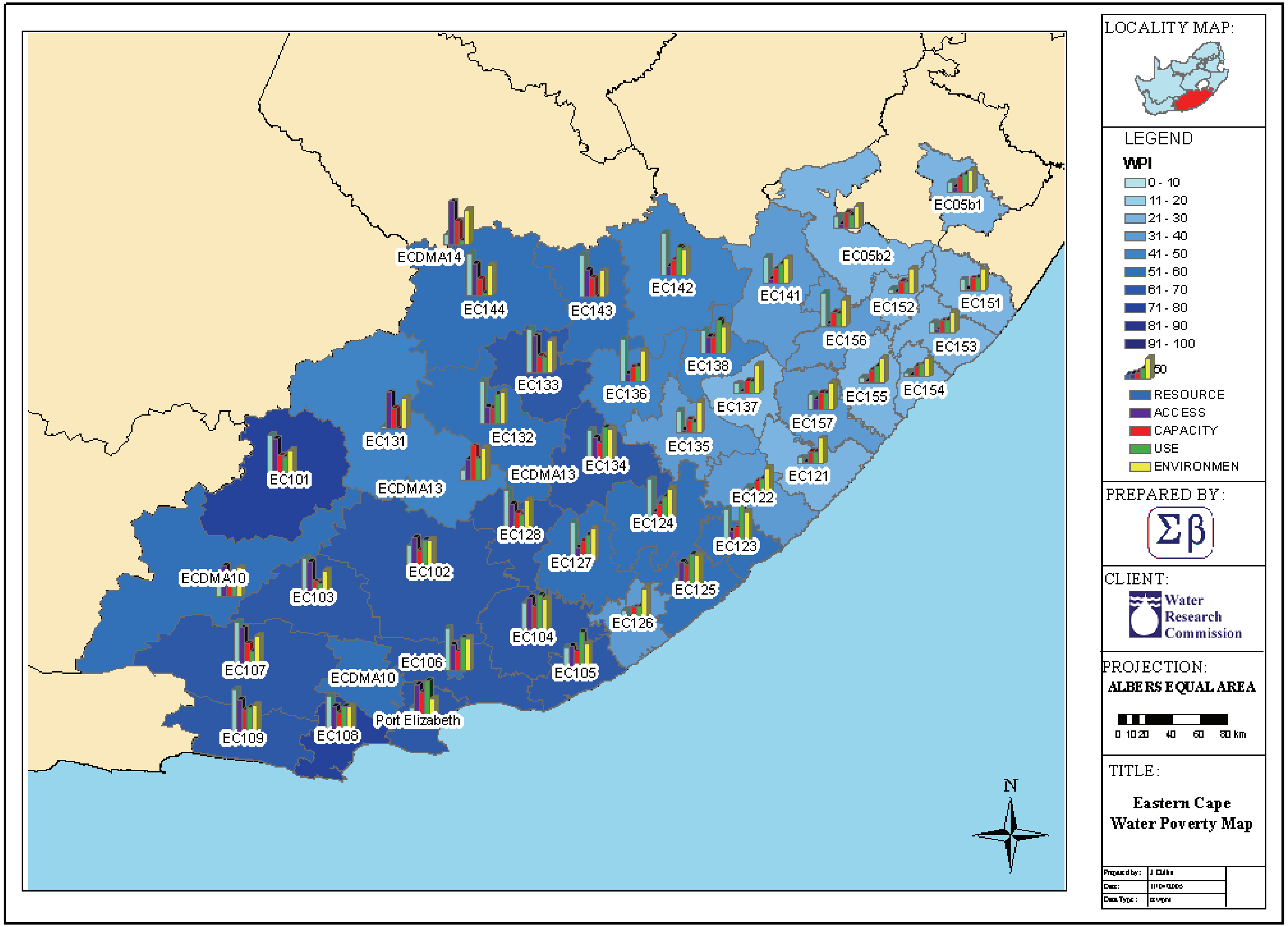


Figure 9: Water Poverty Map of Case Study Area

To obtain a better understanding of the relationship between the various components of the WPI a table of correlation coefficients was determined using the data from all of the local municipalities in the Case Study area. The results of this correlation exercise are given in **Table 10**.

Table 10: Correlation Coefficients for the WPI Component Scores

	Resource	Access	Capacity	Use	Enviro	WPI
Resource	1.00					
Access	0.41	1.00				
Capacity	0.18	0.73	1.00			
Use	0.26	0.16	0.36	1.00		
Enviro	0.45	0.45	0.40	0.19	1.00	
WPI	0.66	0.90	0.77	0.47	0.59	1.00

The two tables below show how the calculated WPI relates to the total capital expenditure (Capex) budget allocation for the local municipalities in the Amatole (**Table 11**) and the Chris Hani District Municipalities (**Table 12**) according to data recorded in the relevant WSDP.

Table 11: Capex Budget Allocation for the Amatole Local Municipalities

Local Municipality	LMID	WPI	Capex: Total	Population (2002)	Capex: per capita
Mbhashe Municipality	EC121	24	R 38,818,498	279758	R 139
Mnquma Municipality	EC122	33	R 46,093,859	342618	R 135
Great Kei Municipality	EC123	55	R 5,692,198	45953	R 124
Amahlati Municipality	EC124	51	R 17,081,110	136075	R 126
Ngqushwa Municipality	EC126	34	R 15,764,645	149561	R 105
Nkonkobe Municipality	EC127	53	R 20,999,824	169169	R 124
Nxuba Municipality	EC128	63	R 3,949,558	31697	R 125

Table 12: Capex Budget Allocation for the Chris Hani Local Municipalities

Local Municipality	LMID	WPI	Capex: DWAF (R)	Capex: CMIP (R)	Capex: Total (R)	Population (2001)	Capex: Total per capita
Inxuba Yethemba Municipality	EC131	49	0	3,361,165	3,361,165	62 963	53
Tsolwana Municipality	EC132	58	1,705,000	7,004,740	8,709,740	38 173	228
Inkwanca Municipality	EC133	65	0	1,653,508	1,653,508	21 235	78
Lukhanji Municipality	EC134	64	1,856,240	63,287,552	65,143,792	167 311	389
Intsika Yethu Municipality	EC135	33	9,515,000	13,676,959	23,191,959	220 686	105
Emalahleni Municipality	EC136	43	6,412,900	12,831,595	19,244,495	153 285	126
Engcobo Municipality	EC137	27	1,200,000	7,395,109	8,595,109	167 346	51
Sakhisizwe Municipality	EC138	49	1,100,000	11,374,475	12,474,475	54 542	229

These tables are summarised in **Figure 10**, which shows the relationship between the WPI and the total per capita Capex budget allocation. This chart can be used to determine whether the allocation of funds for the development of water supply infrastructure is being directed towards the most water-poor areas.

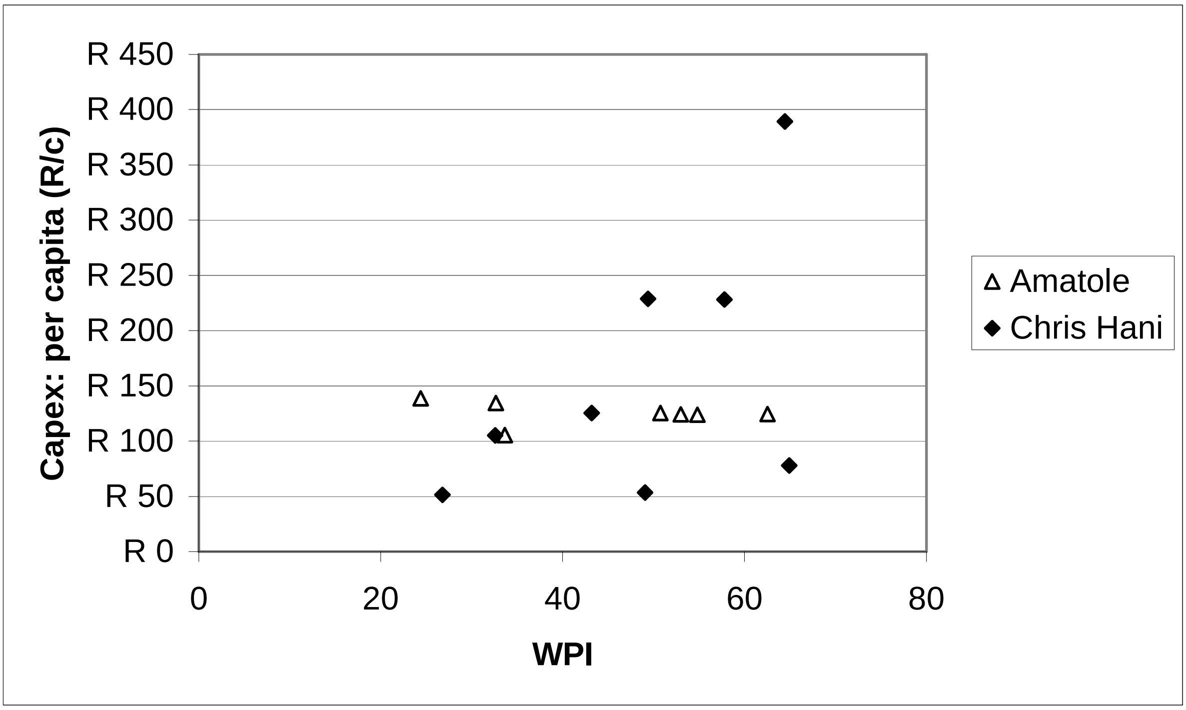


Figure 10: Comparison of Capex Funding and WPI

7. DISCUSSION OF RESULTS AND METHODOLOGY

7.1 WATER POVERTY IN THE CASE STUDY AREA

The WPI is a relative measure of poverty. It is therefore not possible to determine the absolute state of poverty in the case study area from the water poverty map in **Figure 9**. It is only possible to draw some conclusions on the relative nature of water poverty between the local municipalities.

The following conclusions can be drawn from the water poverty map and the correlation coefficients for the WPI components :

- The Kouga Local Municipality (EC108) has the highest relative WPI score and is therefore the least water-poor local municipality in the area.
- The Quakeni Local Municipality (EC121) has the lowest WPI score and is therefore the most water-poor local municipality in the area.
- The Cacadu District Municipality (DC10) has the highest relative WPI score and is therefore the least water-poor district municipality in the area. In addition the seven highest scoring local municipalities are part of this district.
- The O.R. Tambo District Municipality (DC15) has the lower WPI and is therefore the most water-poor district municipality. In addition, five of the six lowest scoring municipalities are located within this district.
- In general, the municipalities with the lowest WPI tend to be the predominantly rural municipalities located in the former Transkei such as those in the O.R Tambo DM, while those with the highest WPI tend to be the more urban municipalities located in the Republic of South Africa (RSA) such as the Cacadu DM.
- The access component appears to be the most significant factor in determining water poverty, with correlation coefficients of 0.90. This can partly be explained by the increased weighting given to the access component in the calculation of the WPI score.
- The use component appears to have a weak correlation with the final WPI score (0.47), this is most likely to change if it was felt that the weighting of this factor should be increased or if actual use figures were used instead.
- There appears to be a correlation between access and capacity (0.70), which implies that access to water services in the case study area may be restricted through lack of income or education. It could also be argued that the capacity of this area is limited due to the lack of access to domestic water supply services and a high degree of water poverty.

The purpose of the development of this scale of water poverty map is to assist in the targeting of resources to ensure the greatest efficiency in addressing water poverty in the area. The results of the water poverty mapping exercise indicate that these resources should be targeted at the

Quakeni Local Municipality (EC154) as it is the most water poor in the area (WPI = 21) as well as to the other municipalities in the O.R. Tambo district.

The water poverty map can also be used to give some indication of the potential cause of water poverty in this area to assist in the targeting of resources. All the component scores for the Quakeni LM (EC154) are low. The Capacity (C=27) and Environmental (E=42) components are the lowest of all municipalities in the Eastern Cape. While the Use (U=30) component is not the lowest, it must be noted that the majority of municipalities with Use components of less than 30 are as a result of over-consumption of water. The Resource (R=11) and Access (A=5) components, while not the lowest are very low and probably the greatest area of concern. The lack of available resource is probably due to the deficiency of storage capacity in the area, which, like the low access component, is most likely a legacy of the apartheid era funding for water supply infrastructure in the area. It appears then that the best way to address water poverty in the area would be to consider increasing the available resource through increasing the yield and by improving the level of service delivery in the area. It is, however, important to note that the capacity component is quite low, which could have implications on the type of service provision considered for the area. It may therefore be necessary to also ensure increased employment in the area to help fund any water supply development project. It is also important that the capacity of the WSA to address water poverty be assessed before funding is allocated to the targeted LM.

In terms of the allocation of resources such as Capex funding in the two districts for which data was available, it is clear that in order to address the main areas of water poverty, additional funding should be targeted at the low WPI municipalities such as Mbashe, Mnquma, Intsika Yethu and Engcobo. Instead, it appears that funding is directed towards the medium to high WPI municipalities such as Lukhanji, while Engcobo receives the least Capex funding per capita. Capex funding is currently determined by factors such as development objectives, basic services backlog and the number of towns per municipality. While this may result in some development objectives being met it appears that this method for directing funding does not result in an efficient allocation of funds for the targeting of water poverty.

The general conclusion from this water poverty mapping exercise is that the targeting of resources to address all five components of water poverty in the Quakeni Local Municipality will have the greatest impact on reducing water poverty in the Eastern Cape area by ensuring that the most water-poor areas are tackled first. If the situation in terms of the allocation of Capex funding in the other municipalities is similar to that in the Chris Hani DM then it appears that resources are not currently targeted at the most water-poor areas.

7.2 RELIABILITY AND VALIDITY OF THE DATA SOURCES

Any monitoring system is only as good as the data that supports it. South Africa has a relatively good attitude towards the collection of socio-economic and hydrological data. The reliability and validity of the three main data sources used in this case study are discussed below. It must be noted that as the water poverty mapping concept is developed further it may make use of additional data sources that were not available given the limitations of this case study.

7.2.1. Census 2001: Statistics South Africa

National Census Statistics have the advantage of being conducted on a national scale at the household level. In this case the Census 2001 information was used for the calculation of the Access and Capacity components. There have been some concerns over the reliability of the Census data. The Census does, however, form the basis of most strategic decision making in the country and therefore is ideally suited for the purposes of the local municipality scale water poverty map used in this case study. When developing a finer resolution water poverty map for implementation purposes it would be necessary to do some additional data collection to test the validity of the census data in the relevant area. This would also be necessary to adjust for any changes since the collection of the original Census data.

7.2.2. Water Situation Assessment Model

The WSAM model was used to calculate the Resource, Use and Environmental components. While there have been some concerns about the algorithms used in the WSAM, particularly with regard to how the impact of alien vegetation is determined, this model still provides one of the best data sources of national hydrological information for strategic decision making. The base year for the data in WSAM is 1995, which introduces some uncertainty in extrapolating the data for later dates. The reliability of data is further compromised by the fact that all data in WSAM is recorded at the quaternary catchment scale. While this is the relevant scale for hydrological decision-making, it is not necessarily the correct spatial scale for socio-political decision-making. For this reason, the data had to be interpolated from quaternary catchments to local municipalities boundaries, which could potentially introduce some spatial inaccuracies.

7.2.3. Water Service Development Plans

It seemed a natural assumption that the WSDP should be the most useful compact form of information with regards to reporting issues pertaining to water poverty at the local municipality level. During the course of this study, however, it was found that there exist significant gaps in reporting of the information, which would be most useful for the purpose of water poverty mapping. The WSDPs of three LMs were studied and it was found that there were significant disparities between the quality of information contained in the Amatola, Chris Hani and Oliver

Tambo WSDPs. This made it difficult to use the WSDPs to provide consistent information across the case study area.

DWAF is currently in the process of developing an assessment guide to ensure the consistent quality of WSDPs. If consistency can be achieved and indicators can be included based on a consideration of the possible uses of this information, then the WSDPs have great potential in providing the information necessary to develop a water poverty map for strategic and even implementation purposes. It would also be very useful to capture the information contained in the individual WSDPs in a national database.

Some of the information that should be contained in the WSDP and is either not currently captured or is not sufficiently consistent or complete, but would enhance the quality of water poverty maps at the local municipality level is as follows :

- Complete calculation of the yield from all water supply infrastructure
- Actual domestic water use figures for each local municipality
- Individual capacity of households within each local municipality in terms of :
  - income,
  - education, and
  - health in terms of at least under five mortality
- A measure of the reliability of supply rather than just the level of service.

The development of fine scale water poverty maps for the implementation of domestic water supply services will require a great deal of additional research and is not covered in this case study. It is at this scale that the ability of water poverty maps to incorporate a wide variety of spatial and non-spatial data is the most significant. The WSDPs could also assist in the development of finer scale water poverty maps for the implementation of domestic water supply services with the inclusion of more detailed information for each component, particularly if they are geared to include spatial data in the form of a GIS.

In addition to supplying the information necessary to produce water poverty maps at both the strategic and implementation scales, water poverty maps should be included as part of the WSDP. **Figure 11** below shows how the data from chapters of the WSDPs could be incorporated into a water poverty map as a way of summarising the information contained in the WSDP that could be used as part of a multi-criteria decision analysis process for identifying future water supply projects, which is one of the intended objectives of the development of the WSDPs.

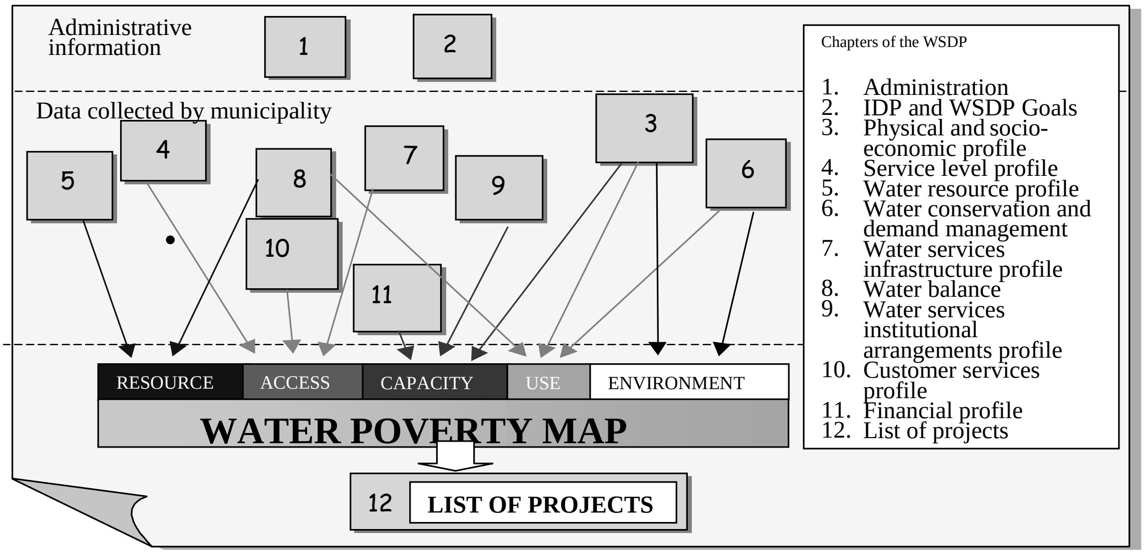


Figure 11: The link between the chapters of the WSDP and a WPM

7.3 HOW THE WATER POVERTY MAP COULD BE USED

The purpose of the development of the water poverty map shown in **Figure 9** is to assist in the efficient allocation of scarce resources to address the problem of water poverty. It is therefore proposed that the water poverty map developed above, or a similar one developed for the whole country following a discussion of this case study, be used in the following way :

1. A strategic level WPM is developed and the most water-poor municipalities identified. DWAF should also use the WPM to identify areas in which they and other institutions can intervene to assist in addressing water poverty, by for example developing bulk water infrastructure to improve the available yield.
2. The MIG funding for water supply development is allocated to each municipality according to their relative WPI score.
3. The capacity of each municipality or district municipality to implement water supply services is assessed and the final budget allocation of MIG funding is agreed.
4. The budget allocation is announced at least six months in advance of the funding cycle to give municipalities time to draw up suitable business plans for addressing water poverty in their area. The strategic level WPM could be used to give some advice to municipalities on what aspect of water poverty needs to be addressed and this should be supported by the development of a finer scale WPM for implementation purposes within each municipality, to identify the specific areas in which to locate any proposed developments.
5. The municipality or district municipality, depending on who is the designated WSA in the area, must submit their completed business plans for individual projects to DWAF who can assess them against the findings of strategic and implementation scale water poverty maps as well as against other criteria such as institutional capacity.
6. Individual projects should be approved before the start of the funding cycle in order to give municipalities a full year to implement the project.

7. After implementation, the success of the project should be monitored through the recalculation of the water poverty map at regular intervals and this information should be used to improve the efficiency of future developments.
8. The WPM should be presented on a regular basis to all stakeholders by way of annual reports to inform all interested parties on the progress that DWAF and other institutions are making on the implementation of the objectives of the National Water Act and the Millennium Development Goals.

8. RECOMMENDATIONS

This case study has shown that it is possible to develop a water poverty map of local municipality scale from readily available national data sets. The case study showed how it was possible to develop a comprehensive measure of water poverty and display this in an attractive and easy to interpret format as a water poverty map. The resulting water poverty map can then be used to target the most water poor areas, identify the key aspects of concern for addressing water poverty in these areas and assist in the targeting of resources. Below are a few recommendations for the further development of water poverty mapping that could help develop the concept into a powerful policy and decision support tool for DWAF and other national departments as well as the municipalities, WSPs and WSAs.

- A workshop should be held to discuss the approach adopted in the case study as well as the potential uses of water poverty mapping and the availability of information. This information should be used to improve the method used to develop a strategic level water poverty map as well as set the foundation for the development of a finer scale implementation level water poverty map.
- A separate research project should be instigated to investigate the feasibility of developing a comprehensive water poverty map at a finer resolution for the purpose of the implementation of water supply infrastructure or alternative water supply development policies within each municipality this should be done on a case study basis.
- It is important that the data used in the development of any monitoring system is reliable and appropriate to the intended purpose. With this in mind DWAF should be encouraged to improve the quality of water related data by for example :

    - Developing systems for recording actual water use that could either be used instead of the current estimates based on population characteristics or at least be used to validate these estimates.
    - Develop a uniform system for recording water supply scheme capacity and reliability. This would greatly assist in determining a better measure of the access to water supply services that goes beyond simply recording how many such systems have been installed, irrespective of whether they continue to function efficiently or not.
    - The requirements for the information to be contained in the WSDPs should be adjusted so as to incorporate issues relevant to the measuring of water poverty and the production of water poverty maps. This would include improving the quality of the existing requirements as well as the possible incorporation of non-water related figures such as income level, education and health and improved consistency in the quality of WSDP from different municipalities. The capturing of spatial data should also be included as part of the WSDP.

9. CONCLUSIONS

The objective of this Study was to introduce the concept of Water Poverty Mapping as a policy tool and to demonstrate its use by way of a short case study. This has been achieved through a detailed discussion of the theoretical underpinnings of water poverty mapping and the potential role that it can play as a decision support tool for the management of water resources, and by developing a strategic level water poverty map at local municipality scale for the Eastern Cape as a specific case study.

This study has shown that water poverty mapping has the potential to provide a useful policy tool and that the development of this concept should be furthered through a workshop to debate the issues and lay the foundation for the development of a national strategic level WPM at local municipality scale, and ongoing research and development including a pilot study to investigating the possibility of developing a finer resolution WPM for the targeting of the water supply implementation process.

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