EXECUTIVE SUMMARY

Through case study investigation in Cala, Kayamandi and Wonderfonteinspruit this study aims to develop methodology for analysis of social vulnerability and resilience to natural and man-made hazards in relation to potable water supply.

Intensive efforts to mainstream Disaster Risk Reduction into development have been underway, internationally, since 2005. These efforts arose from the Hyogo Framework of Action (HFA) 2005-2015, which is a ten-year plan to substantially reduce losses following disaster and to improve upon coping capacity before, during and following hazard or disaster It was adopted at the World Conference on Disaster Reduction in Kobe, Hyogo, Japan (18 to 22 January 2005) to which South Africa is a signatory.

The focus of this study is a meeting between Water Resource Management (WRM) and Disaster Risk Reduction (DRR) at the local level. The first aim of the study was to propose a straightforward methodology for understanding vulnerability and resilience to hazards that negatively impact the supply of potable water at the community-level. The second aim was to identify opportunities to mainstream DRR into aspects of water services, thereby improving the sustainability of all water service provision and increasing the resilience of communities to water-related hazards.

METHODOLOGY

During case study research and development of the methodology for Risk Assessment at a community level, problems were identified regarding the lack of proactive risk reduction approaches in relation to water infrastructure.

In relation to these problems the team developed a method for incorporating a risk management approach for implementation of water infrastructure. This approach provides the context and roadmap for Water Service Authorities (WSAs) to integrate a human element that contributes to lessening risk in all aspects of water services delivery. This includes conception, planning, financing, implementation, monitoring, evaluation, operations and maintenance of operations. It identifies gaps within existing approaches and adds value by applying a "risk" as opposed to a "service delivery" lens.

The result is a conceptual framework for action to integrate risk management into water service delivery operations and maintenance, with an emphasis on the psycho-social-political dimensions. The study explored:

- *Methods and metrics for analysing social vulnerability in a data scarce environment;*
- *The interaction between risk, service delivery, and community expectations;*
- *The nexus between water resource management and DRR;*
- *How people respond to water-related hazards; and*
- *How water and water-related infrastructure is used.*

Measurement of vulnerability and risk at a local scale is paradoxically an important tool for improving understanding of the capacity of communities to overcome disasters. Working towards improving this understanding, a community level risk index was developed through the identification of indicators for Social Vulnerability (SV) and Coping Capacity (CC). Social Vulnerability indicators illustrate variation in the preparedness and response capacities of different communities and use various socio-economic variables, such as community level of education and dependency ratio. The CC indicators encompass aspects of infrastructural and institutional preparedness, for example Early Warning (EW) and Disaster Management. The concepts of SV and CC are contained in the mathematical expression for Risk used by the UN/ISDR in the Hyogo Framework for Action (HFA) (UN/ISDR, 2005):

where,
*R = the level of **R**isk impact from a particular Hazard event in a particular area*
*H = the probability for the **H**azard event occurring*
*V = **V**ulnerability of receiving environment and people*
*C = **C**oping **C**apacity of receiving community*

In the study, these Risk Assessment components are calculated in the following way:

- *Evaluate the probability of each selected Hazard event occurring in each study domain (H);*
- *Develop Key Outcomes (KO) based on the HFA Priorities for Action adapted to community-level risk assessment;*
- *Develop Statements of Intent as goals to achieve the KOs;*
- *Select a comprehensive set of indicators to measure the achievement of these goals;*
- *Score each vulnerability and coping capacity indicator (V and C); and*
- *Calculate the Risk Index using the equation R = H x (V/C) and prepare a Risk Map.*

Risk Assessment components included:

1. *Hazard identification and hazard assessment, based on likelihood and impact of a hazard occurring at a particular location.*
2. *Development of Key Outcomes (KO) that contribute to Disaster Risk Reduction (through decreasing Vulnerability and/or increasing Coping Capacity of a particular community). This is also based on the HFA Priorities for Action, but adapted to community-level risk assessment with the SLF in mind. These are:*

    a. *KO1: Assess Vulnerability to Hazards*
    b. *KO2: Reduce Vulnerability through Infrastructure*
    c. *KO3: Reduce Vulnerability and Increase Coping Capacity through Social Elements*
    d. *KO4: Improve Communication*

3. *Statements of Intent developed as important goals to realise the Key Outcomes. These Statements of Intent can vary depending on the social, physical, political and economic context of a community.*
4. *Selection of a comprehensive set of possible Indicators for measuring the achievement of the individual goals within each Statement of Intent.*
5. *Scoring system for evaluating the data of each Vulnerability and Coping Capacity Indicator.*
6. *Final calculation of a Risk Index, and further application through Risk Mapping.*
7. *Review and analysis of results as required.*

In this study we focussed on the intersection between water resource infrastructure and management and DRR. Vulnerability at the community level was examined in the context of R = H x (V/C)
hazards that have a negative impact on the quality of, or access to, water services. Water related hazards could be natural (e.g. floods, droughts, storms) or induced by human processes (e.g. pollution, climate change, dewatering of aquifers, mismanagement of water resources and water-related infrastructure, leading to long term degradation of supply in terms of both quality and quality, amongst other consequences).

FINDINGS

The Risk-Based Approach was applied to three case study areas, namely the rural town of

Cala and selected surrounding villages in the Eastern Cape, the township of Kayamandi in the Western Cape and the mining town of Carletonville in the Wonderfonteinspruit catchment in Gauteng. Data collection and desktop research was conducted for each case study. Case study fieldwork was conducted in Cala and nearby Tsengiwe village, and Kayamandi.

Cala is a rural town and settlement situated approximately 100 km west of Umtata in the Eastern Cape province of South Africa. It has a temperate inland climate. The Tsomo River runs through the area just to the west of the town. Seasonal water scarcity and drought, a lack of water services, food security issues and social problems are experienced in Cala. Ineffective governance by local and regional leaders and limited service delivery in general also contribute to the problems experienced by the community. One of the main key issues identified by the local municipality is the dispersed settlement pattern of developed centres surrounded by scattered, underdeveloped rural villages, which makes providing access to basic infrastructure and services more costly, resulting in fragmented development. Many people in the area live in poverty as a result of the high illiteracy (90%) and unemployment (80%) rates. This has led to many social problems including crime (such as theft, murder and rape), drug abuse, alcoholism, youth suicide, gender inequality and the rapid spread of HIV/AIDS. The Cala area was selected as a case study because of the presence of the Masiphile Project, which is a community and church supported, multi-disciplinary social upliftment project. The project was founded by community member Nomfundo Lily-Rose Mlisa, a former nurse and trained clinical psychologist who is currently the Director of Counselling Services at Fort Hare University and a church leader in Tsengiwe Village. The project is currently run by a small group of women from Tsengiwe Village, overseen by Nomfundo Lily-Rose Mlisa. The project focuses on the support and upliftment of people infected and affected by HIV/AIDS (Mlisa, 2009).

During the study, the Cala community was found to have little initiative for income generation, little drought preparation (focusing mainly on quick onset disasters), and minimal municipal coordination and a lack of strong leadership. However the community also has solid community-based organizations with multi-pronged and coordinated activities which increase the coping capacity of the community.

Kayamandi is an informal settlement on the banks of the Plankenburg River on the outskirts of Stellenbosch in the Western Cape Province. The population is approximately 22 000 with a large percentage living below the poverty line. Water sampling along the Plankenburg River, in the vicinity of Kayamandi, have shown greatly elevated levels of E. coli Streptococcus, Staphylococcus and Enterobacter bacteria that cause serious disease and illness in both humans and animals. The majority of the community of Kayamandi have impaired immune systems, and there is a high prevalence of tuberculosis and HIV/AIDS. Contact crimes such as murder, rape, assaults and robberies are prevalent.

During the study it was found that Kayamandi suffers from poor service delivery and service maintenance coupled with a lack of respect for infrastructure. Women are vulnerable to violence and rape and primary education enrolment is low. Kayamandi high school provides a high standard of education and has relatively high pass rates but few students go into tertiary education. There are many NGOs in Kayamandi with a diverse focus, however their activities are uncoordinated and the benefits not significant to the overall risk faced by Kayamandi residents.

The Wonderfonteinspruit Catchment Area (WCA) forms the eastern catchment of the Mooi River, and straddles both the Gauteng (upper catchment) and North West (lower catchment) provinces over a distance of approximately 100 km. Approximately 400,000 people live within the WCA, with the Wonderfonteinspruit passing many towns, formal townships and informal settlements. A large percentage of these towns and settlements are related to mining activities within the catchment. Rand Water supplies most of the towns with domestic water. Carletonville lies within the WCA and is the largest gold-mining complex in South Africa, employing approximately 75 000 workers. Carletonville was selected as the urban centre of an LM which is representative of the challenges and hazards faced in the WCA. Gold mining in the WCA affects water resources in two ways, namely water availability (quantity hazard) and water pollution (quality hazard). The HIV infection rates in the

Wonderfonteinspruit area are among the highest in the world. There are also high rates of tuberculosis and other sexually transmitted diseases. Poor water and sanitation service delivery in the area compound the vulnerability.
The study revealed an extreme lack of data and monitoring information from the Department of Water Affairs on the Wonderfonteinspruit, there is little to no data available regarding exposed populations, and the data for formal areas tends to hide the risks faced by informal areas. Poor communities such as Khutsong Township are vulnerable to mining-related pollution and sinkholes.

The case study research informed the selection of a list of indicators and associated scoring system, based on available data and relevant contextual information. Individual scores were calculated, and averaged (with weighting) across the indicators. Scores were calculated per main hazard and per case study for hazard risk, vulnerability and coping capacity. These were subsequently input to the Risk Index Equation. The final scores could range in value from 0.1 (very low risk) to 25+ (very high risk). The final results of the risk index scoring for the case studies are presented in ***Table 1*** *below.*

Table 1 Summary Results of Risk Assessment for priority hazard in each case study
Hazard Risk Index
Hazard Score Vulnerability
Score
Coping
Capacity Score
H X (V/C)
Drought (Cala) 4 3.9 0.8 **19.5**
Biological (Kayamandi) 5 3.6 0.7 **24**
Technological (Carletonville) 5 3.6 0.4 **44**

The concepts of the methodology were also applied, using Expert Risk Assessment at Local Municipality (LM) level in the Western Cape, to prepare a risk map, based on the results of the Department of Water Affairs (DWA) study "Development of Reconciliation Strategies for selected Towns in the Southern Planning Region" (July 2008-30 June 2011) currently nearing completion (DWA, 2010a, b).
During the case study research and the development of the methodology for Risk Assessment at community level, problems were identified regarding the lack of proactive risk reduction approaches in relation to water infrastructure. Some of the issues identified included:
- *Lack of vision for long-term sustainability and relationship to Disaster Risk Reduction;*
- *Public participation is a case of ticking boxes;*
- *The funding system and cycle supports new infrastructure rather than the maintenance and operation of existing infrastructure; and*
- *General institutional failure and a lack responsibility as long as Key Performance Areas (KPA) can be seen to be met.*

An SV index, using the approach developed, can help local decision-makers and policy implementers to improve DRR and resilience at the community level by considering the social, as well as the built and natural environment.
The team has also developed an approach, expanded in ***Section 5****, for incorporating a risk management approach into implementation of water infrastructure. The approach provides the context and roadmap for Water Service Authorities (WSAs) to integrate the human element that contributes to increased risk into all aspects of water services delivery: from conception, planning, financing and implementation, monitoring and evaluation to operations and maintenance. It picks up on gaps in existing approaches and adds value by applying a "risk" as opposed to "service delivery" lens.*
It proposes a multidisciplinary and collaborative way to mitigate risks and maximize

opportunity in the water services sector, building on the HFA and the municipal processes for planning, implementing and funding infrastructure projects. It draws on the principles and practice of cooperative governance and community participation outlined in relevant legislation and the best practice of constructive dialogue and adaptive management established in the water sector.
The result is a conceptual framework for action for integrating risk management into water service delivery operations and maintenance, with an emphasis on the psycho-social-political dimensions.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations of the study are summarised as follows:

- *During future studies, the risk assessment methodology should be disaggregated to groups within sub areas of a community, e.g. gender and age specific groups/data within formal and informal settlements within Kayamandi. These can be defined after initial data survey and field work. Thereafter indicator definition and selection to best reflect the complex realities on the ground (i.e. establish a conceptual model of this reality indicating variations in and between sub groups/genders) to establish whether further field work, data collection at village and or household level and scoring approach is decided upon. Careful note of power and rank relationships, levels of competence and adequacy of governance in institutional layers within communities and groups are important when defining indicators that reflect the efficacy of these and can evaluate increase in coping capacity from grass roots levels up. Furthermore, regular application of monitoring and evaluation using the risk assessment methodology developed in this study is required in order to help us realise our goals, and tells us, as unequivocally as is possible, whether we have realised them.*
- *The application of the risk management approach to the implementation of water infrastructure (as outlined in Section 5) should be piloted in order to develop rigorous guidelines and facilitate mainstreaming of psycho-socio-political risk into water infrastructure development, operations and maintenance.*
- *Prepare a Tool Box to support the guidelines and training of WSA/WSP project managers in risk reduction approaches and participatory local government using guidelines and Tool Box.*
- *Mainstreaming DRR into water infrastructure development, operations and maintenance in rural and informal areas within the context of climate change.*
- *Development of Guidelines for other target audiences, including community leaders, councillors and politicians.*
- *Development of education material aimed at community level to educate and build awareness on water demand management, water and health related matters as well social vulnerability and what communities can do for themselves to improve coping capacity in relation to hazards related to water and its infrastructure. Such material needs also to be less generic and more relevant to the circumstances of the communities.*

The deliverables produced in this study included an article submitted for the July/August 2012 Water Wheel and a final report (this document), containing:

- *Methodology for measuring risk at the community level;*
- *Application of method on selected case studies;*
- *Risk maps at the LM scale for the Western Cape;*
- *Conceptual Approach to Mainstreaming Risk Management into Water Services.*