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Improving Flood Risk Management in Informal Settlements of Cape Town

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Executive Summary

During the month of July 2007, unrelenting rains dumped over 120 millimetres of rain over a period of five days on the City of Cape Town, leading to flooding that impacted 8 000 households (38 000 residents) located primarily in the informal settlements outside of the City, such as the Bongani TR Section of Khayelitsha (Figure 1) and Phola Park Philippi. Such flooding is increasingly common and compromises public health and safety, destroys personal property, and adversely impacts livelihoods. The causes of flood vulnerability are complex, and the economic situation of the residents is perhaps even more debilitating than the geographic situation of the Cape Flats, the low-lying area where the informal settlements are primarily located. The extreme poverty of the residents can be attributed to the remnants of apartheid, which relocated black and coloured South Africans to designated, undeveloped land outside of the City. While the formal system of apartheid no longer exists in South Africa, its legacy is very much alive, as demonstrated by the continuing population growth within flood prone areas the City recognises as being unsuitable for living. This project focused on helping the City manage flood risk in the informal settlements by developing tools for better understanding and responding to these complex natural, technological and social factors.

Figure 1: Bongani TR Section of Khayelitsha

To address these factors, the city has adopted a strategic flood risk management plan, which includes a Master Plan and a Winter Readiness Programme. Thus far, these initiatives have been most successful at improving and maintaining the stormwater infrastructure in the informal settlements, resulting in a dramatic decrease in the number of settlements affected, from 80% to 25% over the past seven years (Hendricks, 2007). Because much of the problem is inherent in the location of the informal settlements, the long-term goals of this strategic

flood risk management plan are primarily focused on relocating the residents and restricting migration into these dangerous areas. Nonetheless, the city recognises people with limited means will continue to live for some time in flood-prone areas, and that the emphasis in international flood management "has moved away from [relying only on] physical control and engineering construction (structural measures) towards reducing human vulnerability through non-structural approaches" (Smith, 1992). The city's flood risk management plan thus addresses four broad domains (Figure 2) to address a range of issues inhibiting faster progress, among which are ineffective communication between various stakeholders, the lack of available City resources, the absence of community involvement in the City's flood risk management scheme, and the nonexistence of a method to prioritise the areas most devastated by flooding.

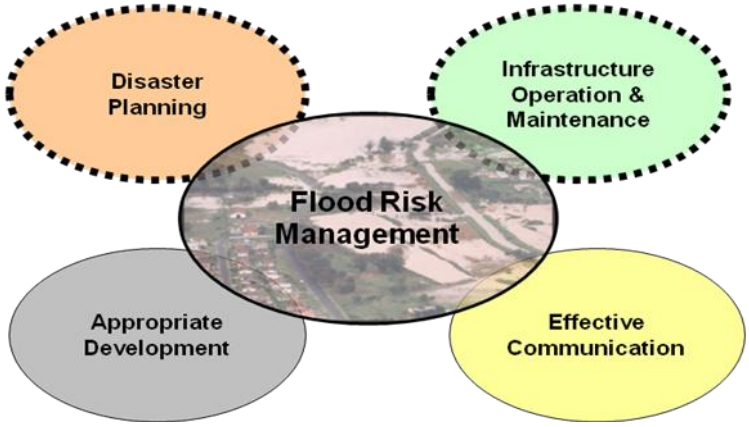

Figure 2: The City's current flood risk management scheme (Wood, 2007)

Through this project, our team, working closely with Mr. Mogamat Kenny of the Catchment, Stormwater & River Management Branch (CSRM), sought to address these issues through the following objectives that linked to the four flood risk management domains:

Conduct a flood risk index (FRI) pilot study to explore possibilities for developing a comprehensive FRI to improve disaster planning. This objective involved exploring different methods for the assessment of past flooding events and the mapping of high-risk areas;

Create guidelines for community-level structural improvements and effective communication methods, which suggest both changes residents could make to their homes and how to appropriately convey these suggestions to communities.

Generate recommendations for the City to improve current flood risk management strategies based upon our findings in the aforementioned objectives.

To begin our flood risk index work, we examined various case studies, which represent the best of international thinking, for determining disaster risk. One such method from an Indonesian case study involved a series of indicators: hazard (probability, severity), exposure (structures affected, population), vulnerability (physical/demographic, social), and capacity and measures (physical planning, societal economic, and institutional capacities). While we looked at potential indicators in all these areas, we did more work on essential quantitative, physical indicators of flood risk, since social issues were addressed more in our other objectives.

We began by analysing hazard through the examination of past flood events; this entailed evaluating trends in rainfall data and incident reports, as well acquiring and evaluating GIS data. For the assessment of these events, we analysed rainfall numbers for the past four years and flood incident report data to identify trends. This analysis revealed that the current flood incident reporting system is underutilised by the residents in informal areas, flood records are limited, and GIS data is inconsistent. Consequently, we have formed relevant recommendations to aid in more effective means of record keeping. These recommendations include: the job creation of a flood marshal to report flooding events, accurate record keeping regarding those residents displaced, and the investment in alternative methods for collecting topographical information.

In the attempt to acquire and utilise data for social indicators of the FRI, the team learned through various interviews, field studies, and case study research, that the flooding problem within the settlements is rooted much more deeply in this area than the team had predicted. While social indicators are not present in our final prototype FRI due to their current absence, the team believes that it is nevertheless essential for the City, in the future, to evaluate the social aspects in order to ensure a complete risk assessment. However, before this assessment can be conducted, community-based programmes and measures of awareness need to be implemented. We recommended that the City train and employ flood marshals in informal areas who are responsible for reporting flooding incidents to Disaster Risk Management.

To further encourage self-sufficiency in managing flood risk, we explored various existing structural techniques that residents could utilise to reduce the impact of flooding at the household level. To prevent flooding from water seepage, we investigated options such as the use of pallets, concrete floors, and stilts. We also proposed an additional low-cost method involving sandbags containing a mixture of sand and concrete. The team evaluated the efficiency of each proposed method based on the cost, feasibility, and materials required. However, for these structural guidelines to be effective, they must be communicated successfully to the residents.

Appropriate methods of communication are crucial to the success of conveying such information and further developing the capacity of the community. As a result of our research and various interviews, the team suggests the City move away from using pamphlets, their current strategy for promoting awareness. Instead, we recommend using posters and signs in public, as well as newspaper articles, accompanied by an education programme for children. This programme would work to establish an understanding of the mechanisms of flooding and preventative measures that can be taken. It is our goal that, once implemented, our suggested means of communication will not only help lessen flood-related losses but also serve as a template for the City for further efforts of communication, regardless of their specific nature.

The successful development of a FRI, conveying of awareness measures, and the promotion of guidelines all rely on the implementation of community-based programmes. For this reason, the team strongly recommends that the City consider utilising a Community Based Disaster Risk Programme (CBDRM). Such a plan relies on the consultation of those who specialise in community-based risk management (NGOs and academic institutions such as the Disaster Mitigation for Sustainable Livelihoods Programme at the University of Cape Town), the City would generally take the following steps in introducing such a programme. First, a Disaster Risk Reduction Committee must be formed, comprised of community leaders, government officials, and representatives from academic institutions. The committee

will work to assess the risk of the community and develop community-based workshops to generate and implement risk reduction programmes. Once implemented, it is the responsibility of the Disaster Risk Reduction Committee to continuously monitor and evaluate the effectiveness of the programmes. Not only will the implementation of a CBDRM programme fulfil the existing gap in the capacity and measures indicator of the FRI, but it will empower the community to foster a self-sustaining manner for reducing the effects of flooding.

Through this project, the team addressed the four areas of the City's current flood risk management scheme by executing these three major objectives: the implementation of a flood risk pilot study, the creation of guidelines to assist communities while analysing the most appropriate means to convey such information, and the formation of a series of recommendations for the City. Through the development of the index, the team concluded that there was a strong need for the City to begin to look towards building community capacity before any type of risk assessment could be done. Not only will the implementation of a management programme involving the community allow the City to effectively identify those high-risk areas, but it will also ensure sustainability by allowing residents to manage flooding at the community level. This project will expectantly set the premise for the continuing efforts of the City to improve flood risk management within the settlements.

Abstract

This project focuses on the management and reduction of flood risk in the informal settlements of Cape Town, and is intended to aid in the creation of a safer living environment for the residents. The team assessed past flooding events, mapped high flood risk areas, generated structural guidelines for residents, created a flood risk index, examined strategies for effective communication, and provided recommendations for several departments of the City about how they can reduce flood risk.

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Chapter 1: Introduction

During the month of July 2007, unrelenting rains dumped over 120 millimetres of rain over a period of five days on the City of Cape Town and the surrounding region. This particular flooding episode affected 8 000 households (38 000 residents) located primarily in the informal settlements outside of the City. The consequences of this flooding included the compromise of public health and safety, the destruction of personal property, and adverse livelihood impacts (Wood, 2007). This project focuses on the management of flood risk in the informal settlements of Cape Town. The City has accomplished a great deal concerning this urgent problem. It has adopted a strategic flood risk management plan, which includes a Master Plan and a Winter Readiness Programme. Thus far, these initiatives have been most successful at improving and maintaining the stormwater infrastructure in the informal settlements, resulting in a dramatic decrease in the number of settlements affected, from 80% to 25% over the past seven years (Hendricks, 2007). Because much of the problem is inherent in the location of the informal settlements, the long-term goals of this strategic flood risk management plan are primarily focused on relocating the residents and restricting migration into these dangerous areas (Wood, 2007).

Furthermore, poverty is a key component of the flooding problem in Cape Town. The economic situation of the residents is perhaps even more debilitating than the geographic situation of the Cape Flats. Their poverty can be attributed to the remnants of apartheid, which was in place from the late 1940s until the early 1990s and was designed to repress black South Africans through segregation. This segregation forced black South Africans to live in designated areas, which eventually evolved into the informal settlements of the present day. While the formal system of apartheid no longer exists in South Africa, its legacy is very much alive.

Consequently, the issue of environmental justice is an important facet of the problems facing Cape Town today. The constitution of South Africa states that citizens have the right to water, health care, a clean environment, housing, and dignity. Section 24 refers explicitly to the issue of environmental justice by giving citizens the right to an environment that is not harmful to their health or wellbeing (Dixon, 2006). Because of the legacy of apartheid, the residents of the informal settlements are hindered in their ability to ameliorate their financial situations without a push for environmental justice. The ultimate aim of this project, in conjunction with the City of Cape Town, is to contribute to environmental justice for all.

Despite the efforts of the City, the countless impacts of flooding in the informal settlements are still very much apparent. The existing stormwater infrastructure in these affected areas is often ill-maintained, which exacerbates the problem. The flooding has left many areas of the informal settlements uninhabitable for various reasons including health risks and physical dangers. There has not yet been a thorough assessment of the habitability of the affected areas. Although many of them are hazardous, many residents continue to live there, not only because they lack the economic means to move elsewhere but also because they are largely unaware of the dangers associated with flooding. Previous efforts have not been entirely successful in minimising the impact of flooding at the household and community levels (Wood, 2007). In other words, there was a lack of involvement by and collaboration with the residents of the informal settlements about flood risk management.

These recent events have prompted an "emphasis [that] has moved away from physical control and engineering construction (structural measures) towards reducing human

vulnerability through non-structural approaches" (Smith, 1992). In accordance with this movement, the City of Cape Town is now moving from a reactive to proactive approach for handling the flooding. In May 2007, the Catchment, Stormwater & River Management Department (CSRM) established objectives to improve existing conditions in the settlements. With the help of WPI students, the City raised awareness among the residents about the dangers associated with flooding as well as proper self-sustaining stormwater management techniques.

The goal of this project was to minimise the impact of flooding upon the community as a whole while further empowering the residents of these settlements to improve their quality of life. We reviewed and assessed past flood events in Cape Town to establish flood vulnerability trends and identify flood prone areas, which aided in the development of a flood risk index. In addition, we prepared guidelines to assist communities in managing flood risk at the household and community levels. To successfully communicate these guidelines to the residents, we suggested effective strategies for communicating within the settlements. Finally, because effective flood risk management relies upon the collaboration of various departments, we provided recommendations for these government branches to improve cooperation in managing flood risk in the informal settlements.

Chapter 2: Background

The system of racial segregation was intensified in South Africa during the late 1940s. Formally called apartheid, which literally translates to apart-hood, the segregation separated black Africans and coloureds from the rest of the white population. The term "coloureds" refers to individuals who were of mixed race, of both white and black descent. The whites considered the black and mixed coloured Africans to be inferior and forced them to move out of Cape Town proper. Many of the blacks unwillingly moved into areas of Cape Town known as the Cape Flats. Even though the formal end of the segregation occurred in 1994, the legacy of apartheid still remains evident, especially in the shanty towns of the Cape Flats. These areas are stricken with poverty and, due to their geographical location, are very susceptible to flooding. In recent years, the flooding has escalated, which has elicited a growing response from the City to aid the residents of the informal settlements.

In this chapter, we will examine the nature of the flooding in Cape Town, as well as provide relevant information, which serves as a foundation for our methodological approach.

2.1 Flooding in Cape Town

The City of Cape Town suffers from relatively heavy rainfall every year during the wet months of winter. While most of the City has established sophisticated and fully functional stormwater infrastructure, the poorer areas located in the Cape Flats, such as Khayelitsha and Philippi, lack sufficient modern stormwater infrastructure, as seen in Figure 3.

Figure 3: Stormwater infrastructure in the informal settlements

The flooding can not only be attributed to the lack of a formal catchment system, but a myriad of other issues as well, as seen in Figure 4. A more detailed breakdown of this complex problem can be found in Appendix VIII.

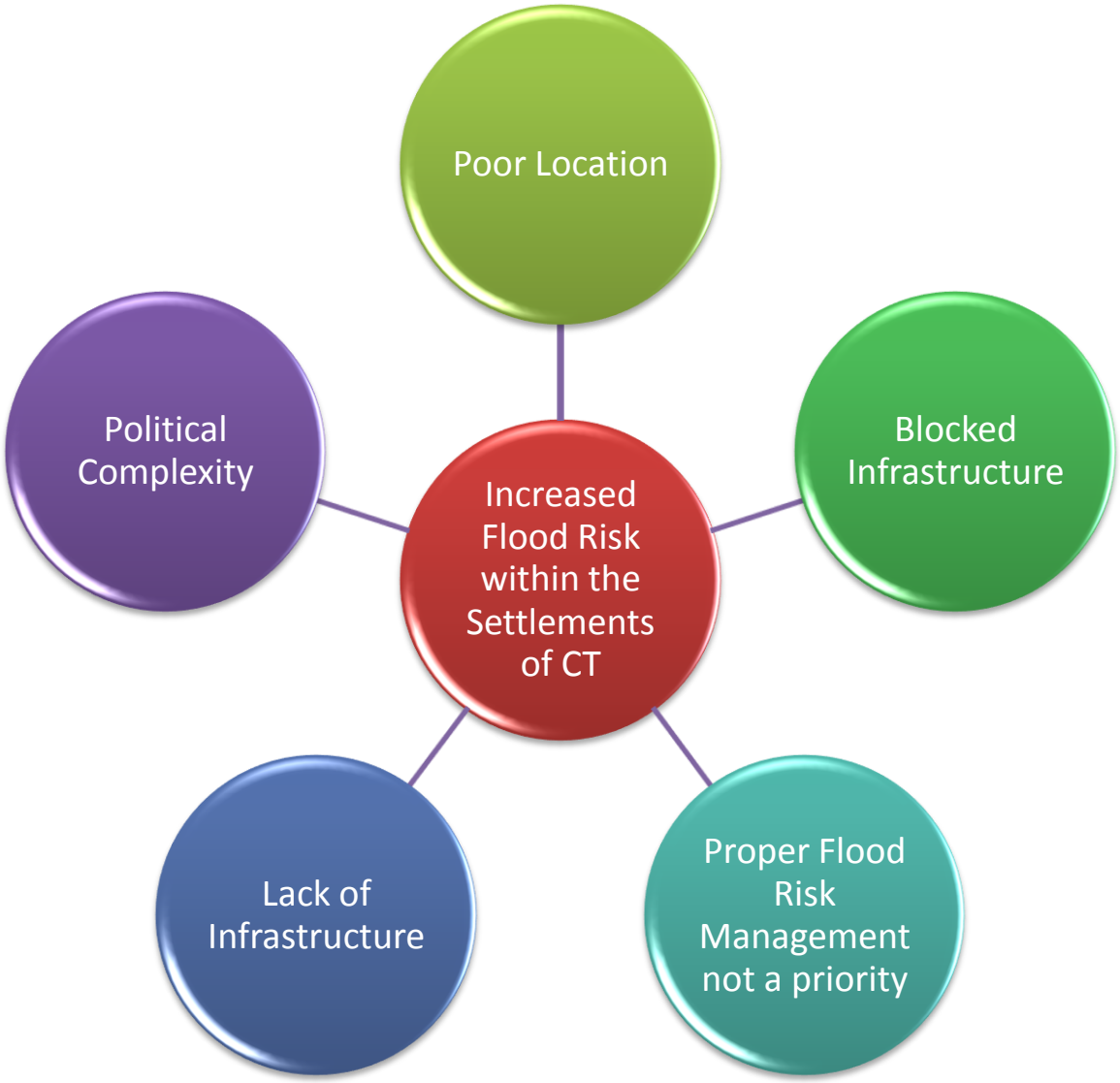

Figure 4: Factors that increase flood risk in the informal settlements

While most of these townships do not have formal catchment systems, there is a basic level of service provided by the City, which includes retention ponds around the area, drains around paved roadways, and formal trenches. However, in many cases, these basic services are ineffective due to consistent blockages. There are three main types of blockages which are common to these systems: silt accumulation, man-made blockages, and rubbish build up. Silt accumulation can be attributed to the grey water, which accrues within the trenches. Residents dispose of wash water and latrine contents in these areas, resulting in large amounts of grey water. Man-made blockages are also frequent within settlement areas. The City places pipes through locations in the area to transport the water to retention ponds, and many times residents block these pipes with various materials so that they can settle in those areas. This results in the pooling of water and consequent flooding during the winter months. Rubbish blockages are perhaps the most debilitating to the catchment system. The lack of skips or improper location of skips (rubbish collection bins) within these areas results in residents disposing of their rubbish in retention ponds, trenches, and streets. This trash subsequently ends up in the drains and causes blockages. In Figure 5, the accumulation of

silt and rubbish is apparent. This drain is supposed to be one metre deep; however due to the blockage it is now only 0.25 metres deep.

Figure 5: Silt and rubbish accumulation in drain

Another aspect which contributes to flooding is the fact that flood risk management is often not a priority at household and community levels. Though this is not the case for all residents, many are primarily concerned with being relocated or being provided housing. There is little motivation for residents to properly protect their homes from flooding because often they believe that if they are the worst affected, they will be the first ones to be relocated. While some do have the means to prevent flooding within their homes, others lack the means and knowledge of how to do so.

The location of townships also plays a large part in increasing the risk of flooding. The informal settlements are situated in the Cape Flats, an area of lower elevation in comparison to the surrounding mountainous terrain, making them susceptible to the accumulation of water. Though the area is unsuitable for living due to this risk, there continues to be a great influx of residents, primarily from the Eastern Cape. These new residents move to the Cape Flats during the summer months when there is no flooding, find an open location, and unknowingly settle in an area of high flood risk. There is little to no control over how many people move into an area or where they settle in that area.

Possibly the most complex aspect is the political structure of the settlements. Community leaders oversee their respective wards that may encompass one or more settlements. While many of these community leaders are looking out for the best interest of the residents, others

have their own agendas. For instance, some leaders demand payment from those who come to the Cape Flats for land that they know will flood in the winter, just to earn money (Environmental Health, Personal Communication, 2007). Sometimes political leaders purposely overcrowd areas to gain votes for an upcoming election. This overcrowding also results in a higher flood risk because more people are potentially affected by the flooding. Another problem is the issue of employment within the settlements. Eighty percent of jobs within the settlements must be provided to those who reside within these areas. It is known that residents sometimes create jobs for themselves by littering and throwing rubbish into their settlement, which collects in the drains and trenches, resulting in pooling and overflow of water (Environmental Health, Personal Communication, 2007). They are aware that the City must hire people to clean the area, and 80% of those workers must be from that specific settlement.

Unfortunately, the City is limited in their ability to resolve the problem due to a lack of manpower, inadequate land availability and potential political conflicts that may arise between the government officials and settlement groups. However, the City cannot overlook the importance or necessity of action in the affected areas to provide a better living environment for the people in the settlements.

2.1.1 Recent Severe Flooding Events

In the past few years, flooding has begun to become more severe, which some suggest is due to global warming. The flood waters pose a serious threat to residents and they also raise concerns about public safety. After a recent storm, there were "[An] estimated 38 000 people displaced from their homes" (Africa News Service, 2007). The effects of the flooding are widespread in the informal settlements, and with an insufficient amount of resources to aid in relief, many residents have been growing impatient. "About 25 percent of the City's 226 informal settlements were affected by the recent flooding." Noahmaan Hendricks, the Director of Development Services stated, "The City is trying its best to reach all flood-ravaged settlements as quickly as possible, but resources are spread quite thin and we appeal to affected communities to exercise patience" (Africa News Service, 2007).

When a substantial storm hits the Cape Flats, the combined factors of low elevation, heavy rainfall, and poor maintenance of the minimal existing infrastructure create a major disaster as was the case in August 2007. Basil Davidson, Manager of Housing for the City, reported, "The fact is that when floods occur like they did the past week it is mostly the new arrivals, people who move to Cape Town from the rural areas, who are worst hit" (Du Plessis, 2007). However, it is not only households that are being affected by the heavy rains. Bongolethu Primary school in the Philippi settlement area suffered substantial flooding during the past year. The school was expected to receive twenty computers for educational purposes, but the shipment was withheld until the school's flooding problem was resolved. The City saw the computers as very costly and a too risky of an investment for a school prone to flooding.

2.1.2 Economic Implications

Ideally, although not realistically, the City of Cape Town would like to be move the affected individuals to higher grounds in areas not prone to flooding. Unfortunately, there are a few economic factors that prevent this solution from happening. One factor is a current lack of funding to expend on the flood prone settlements and additionally, there are far too many residents to relocate. There are roughly 120 000 households located in the settlements, which equates to about a half of a million residents total. One reporter wrote, "The City of Cape

Town gets only enough subsidies from the national and provincial governments to provide 6 000 to 7 000 housing 'opportunities' a year" (Du Plessis, 2007). At that rate it would take over fifteen years to accommodate every resident with new housing. However, this would assume that the population is stagnant and neglects the fact that there are 18 000 to 20 000 new families every year that move into the informal settlements. The number of new families far outweighs the rate at which the City is able to provide housing. In addition considering new families that move into the area, the City of Cape Town must allocate some funding to aiding in the relief of disaster victims. The cost of cleanup and disaster relief in general is absorbed by the government's budget, although some volunteer work is conducted by agencies such as the Salvation Army and the South African Red Cross.

2.1.3 Health Implications

A notable danger associated with the flooding in the Cape Flats is the detriment to the health of the residents. The floods create large bodies of stagnant water that pose several health concerns. When the rainfall occurs on a steep gradient (e.g. mountainous terrain), the duration of the flooding is relatively brief. However, when the terrain is flat, the duration is extended because the water drains far more slowly (Miller, 2007). There are many times when the Flats experience multiple storms over the course of a week, which can prolong the period of time it takes for the water level to lower. The period of the flooding is dependent upon both the amount of water and the gradient of the flooded stream.

The informal settlements are crowded with homes situated in very close proximity to one another. Disease can spread very rapidly under these conditions, so minimising this threat is essential. During a flood, this runoff combines with human wastes from sewers, drains, and latrines and spreads throughout the homes and streets of the settlements. "These wastes carry bacteria, viruses, and parasites that are responsible for a wide number of gastro-intestinal infections, including diarrhoea (which kills over three million children around the world per annum), typhoid, cholera, and intestinal worm infections" (Kolsky, 1998). Also, moist soil serves as an optimal breeding ground for worm infections, such as roundworm, hookworm, and whipworm, which can ultimately lead to anaemia.

One resident of the Philippi area stated, "We need a drainage system - we need all the basic services. We don't even have a sewerage system. We are using the bucket system" (Prince, 2007). The Mayor of Cape Town reported that there "had been no rubbish collection in the area for six months" (Medved, 2007). One school in the Philippi area was closed down due to stagnant flood waters that had "been standing in the grounds for nine days" (Prince, 2007) and posed a health risk.

2.2 Geography and Climate

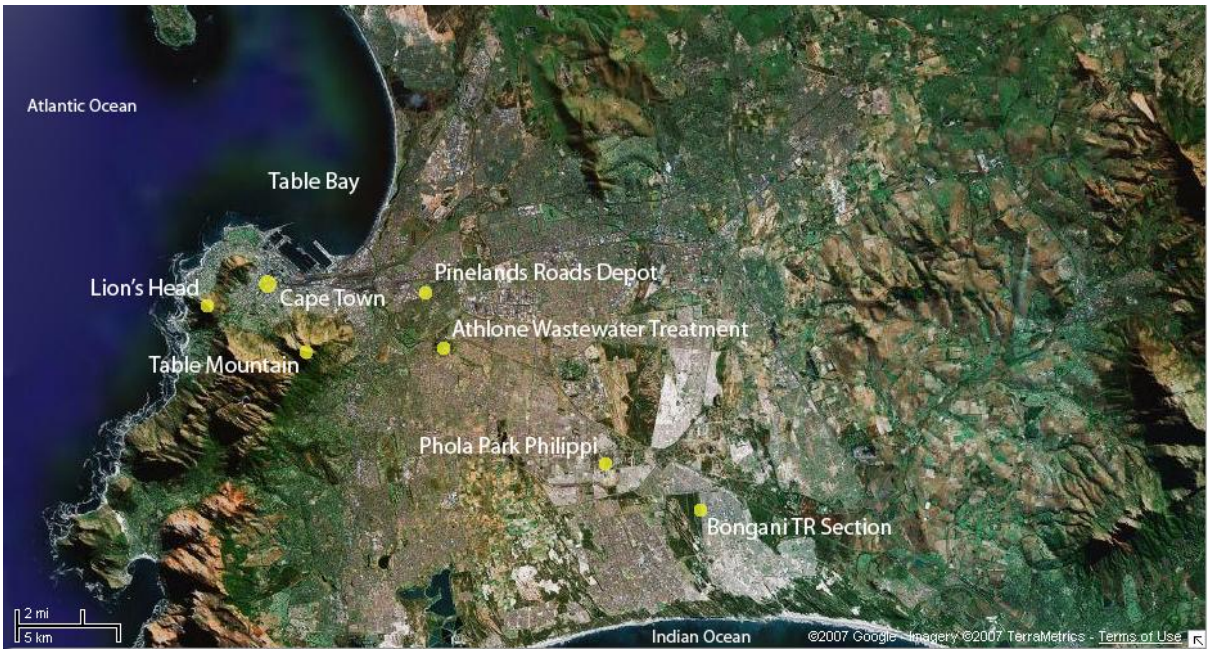

Figure 6: Map of Cape Town and the surrounding region (Google Maps)

The geographical situation of the City of Cape Town and its surrounding areas (Figure 6) is one of the primary reasons for the flooding in the informal settlements. Several geographical formations enclose the City itself, including Table Mountain (elevation: 1 086 metres) to the south with Devil's Peak (elevation: 1 000 metres) to the southeast and Lion's Head (elevation: 669 metres) to the southwest. The commercial centre of the City is situated between Table Mountain and Table Bay. There are numerous suburbs extending to the south and southeast in an area known as the Cape Flats, which is where many of the informal settlements are located. Figure 7 provides a detailed illustration of the considerable difference in elevation between the City proper and the Flats. The black square roughly encompasses the Cape Flats. Because these areas are significantly lower in elevation than the actual City, there is frequent flooding, especially during the winter months.

Figure 7: Landsat image of Cape Town and the surrounding region

In addition to the geography, the regional climate is another factor that contributes to the problem of flooding. Winters in Cape Town are typically cool and rainy while summers are warm and dry, due to the Mediterranean climate of the region. The warm, dry summers instil a false sense of security among the residents, leading them to believe that the lowlands are suitable for living. The average yearly rainfall for the City is 515 millimetres, with significantly more rainfall in the higher elevations (South African Weather Service, 2007). The bulk of this rainwater eventually finds its way to the lowest elevations.

2.3 Motivating Factors behind a Flooding Mitigation System

There are several motivating factors behind the City of Cape Town's initiative to improve stormwater management in the informal settlements. The City examined the effects of flooding in the settlements and concluded that the devastating impacts are severe and diverse.

The City has identified several ramifications of flooding, which are varying and hazardous. Flooding may contribute to the loss of life, damage to personal property and key infrastructure services, health issues, as well as disruption to economic and institutional functions. All of these factors increase demand for health and emergency services. Due to the overwhelmingly large amount of requests for assistance, the City is currently incapable of providing aid in a timely manner. Jackson Mkhizwane, a resident from an informal settlement, stated to reporters that since his area was clearly unfit to live in, he believed it was the responsibility of the municipality to provide assistance and relocate him. He said, "Why should we just sit on top of a pile of rubbish where water is easily absorbed and will rise again as soon as it rains? This is a cheap place where people cannot live, we need to be relocated" (Medved, 2007). Cape Town has approximately a R34 million budget for flooding disaster relief, which provides emergency shelter, meals, blankets, and limited amounts of plastic sheets for waterproofing purposes. However, the settlement residents believe that

much more can be done to help. This matter is also very political; despite efforts being made, some residents of the settlements have held protests, declaring that the City has not provided adequate assistance.

In June 2007, residents of Philippi "burnt tyres and threw rubbish bins and bucket toilets in the streets, demanding that they be moved to other land. They said they had identified vacant land belonging to the CoCT after their informal settlement was flooded following the heavy rains at the weekend" (Witbooi, 2007). There have been similar protests in Gugulethu. In July 2007, approximately 400 residents protested and "burnt tyres and threw stones at vehicles… because residents had not yet received emergency relief after heavy rains" (Times Media, 2007). These protests signify this issue is something that has not been receiving the attention that the residents believe it deserves. The way to improve this situation lies in the union of Cape Town proper and the settlement residents working together to improve existing conditions.

Currently, the flooding is exacerbated by the lack of integration between City departments. The flooding extends beyond the scope of the CSRM department. Trash build up in existing infrastructure, poor placement and design of standpipes also intensify the flooding problem, which are responsibilities of the Solid Waste and Water Demand departments respectively. The Disaster Risk Management department is responsible for communication and awareness materials to be distributed within the settlements. The CSRM, however is responsible for making recommendations to Disaster Risk Management based on what they feel the key issues are concerning flooding. Without the proper communication and cooperation between the departments, the City will only be wasting resources.

2.4 The Catchment, Stormwater & River Management Branch

The City of Cape Town administration (Figure 8) is made up of about 22 000 staff members in total. We worked in collaboration with Mr. Mogamat Kenny and others of the Catchment, Stormwater & River Management Branch of the City of Cape Town to complete our project. This department is responsible for creating and maintaining stormwater infrastructure for the City proper and has been assigned the task of curtailing the flood risk in the informal settlements.

Figure 8: Administrative structure of the City of Cape Town

Mr. Barry Wood is the manager of the Catchment, Stormwater & River Management division. Mr. Mogamat Kenny is the head of Specialist Operational Support for the CSRM.

The CSRM department is responsible for the entire metropolitan area of Cape Town. This contains over three million people including those in the informal settlements. Over the past few years, flood risk has increased and with that, the residents in the settlements have become angry and in some cases, even erupted in protests. Past efforts have been made to address the flood risk but mainly by other organisations in the form of educational materials. Attempts to decrease the flood risks have not been wholly successful and the City is seeking more options.

Although the CSRM division of the City is responsible for creation of infrastructure, they are limited as to what they can accomplish in the settlements. There is a lack of space available for construction. Moving residents to other areas also presents a problem because there is a dearth of available land. Moreover, for the City to install significant stormwater infrastructure in the informal areas would create the perception that the City supports this unlawful occupancy.

In addition to the CSRM department, there are several other organisations whose work is affected by flooding including Housing, Disaster Risk Management, Water Demand, Solid Waste Management, and other non-profit organisations unaffiliated with the government. The CSRM department works in collaboration with some, but not all of these associations.

2.5 A Framework for Flood Risk Management

Globally, there has been a recent proactive shift from disaster relief to disaster risk management. A change to this type of management requires an identification of the risk, the development of strategies to reduce that risk, and a programme that implements these strategies. In many cases, risk cannot be completely eliminated, but it can be lessened.

Based on guidelines set forth by the United Nations for flood risk management, it is necessary "to calculate the probability or likelihood that an extreme event will occur and to establish and estimate the social, economic and environmental implications should the event occur under existing conditions" (United Nations, 2005). Flood risk management also includes helping the community to understand the potential hazards of flooding and what measures should be taken in order to protect themselves and their livelihood. Figure 9 is a visual representation of the approach the United Nations suggests should be taken in flood risk management.

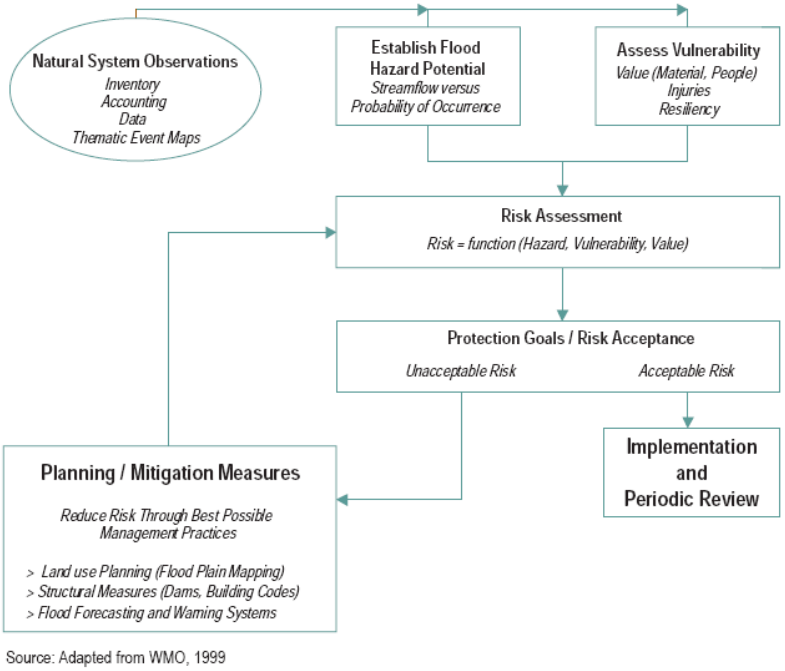

Figure 9: Framework for flood risk assessment and risk management (United Nations, 2005)

2.5.1 Flood Risk Management in Cape Town

The Northern and Western Cape are the two South African provinces most at risk of climate-induced warming and rainfall changes (Mukheibir, 2006). The prediction of future flood events leads to an increase in the cost of losses to the public and private sectors, as well as in the personal hardships of the residents of Cape Town, particularly those in the Cape Flats. In order to reduce the risk of flooding and lessen the impacts in the wake of a flood, the City of Cape Town adopted a flood risk management plan to better its approach to flood risk management (Figure 10).

A key component of the City's overall flood risk management strategy is the Master Plan, which entails the upgrading of all 226 informal settlements within the metropolitan area. Nearly 25% of the settlements were affected by the flooding of 2007, compared to 80% seven years ago. "The improved situation can be attributed to Cape Town's pro-active cleansing operations, upgraded drainage systems, and ongoing community education programmes" (Hendricks, 2007).

As far as other long-term actions, Cape Town's plan includes a technical assessment of all flood occurrences, education on better house building techniques, stricter enforcement against migration into high risk areas, and the acquisition of land adequate for the relocation of people residing in areas of great flood risk (Wood, 2007).

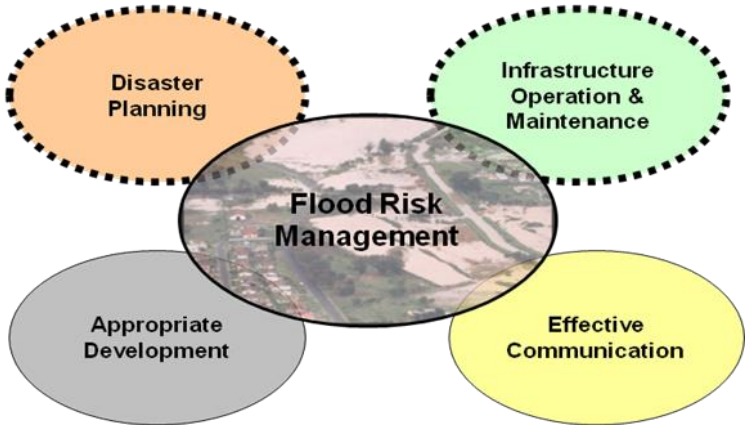

Figure 10: Cape Town's strategic approach towards flood risk management (Wood, 2007)

2.5.2 Stormwater Management in Cape Town

The need for improved stormwater management in Cape Town is partly due to the fact that the City as a whole is rapidly growing. This extreme urbanisation has increased the extent of hardened surfaces, which has caused more stormwater runoff to be directed into catchment systems instead of being absorbed by the ground. Additionally, silt accumulates in the limited drainage systems present in the informal settlements. These obstructions in the drains contribute to flooding particularly during the winter months.

As of 2006, certain strategies were implemented by the City in order to improve its stormwater management policies. One initiative included an ongoing monitoring and warning system, which relied on monitoring stations. Flood retention ponds and weirs (small, overflow type dams) were also developed to strengthen the stormwater infrastructure in place. The City also looked to increase the flood event return period (the time interval between flood events) for which the infrastructure was designed. Also, there was an effort to maintain the infrastructure by relieving the drainage systems of built-up sand and debris. And lastly, mostly pertaining to the informal settlements of Cape Town, the City looked towards "the development of resilient infrastructure to include appropriately designed and constructed low-income homes, storm-water drainage and sewage treatment installations to cope with flash-floods" (Mukheibir, 2006).

In accordance with the City's 2007 Winter Readiness Programme, an additional series of measures was taken relating to stormwater and river cleaning. These measures included a metro-wide proactive stormwater piping cleaning programme, a solid waste area cleaning, and regular inspection and monitoring of critical catchment systems.

The solid waste area cleaning is the main task outlined by the readiness programme, as it is an ongoing process for the City that aims to prevent the ingress of litter and other solids into stormwater systems. The City explained that in the past, blockages caused by garbage dumped in drains, canals, and rivers have resulted in widespread flooding and caused rivers in many areas to burst their banks.

Currently, City workers and contractors are continuing to remove this debris in the City's drainage system which contains a series of 6 035 km of pipes and culverts, 1 200 km of rivers, 140 km of open channels and canals, and 680 detention ponds. As of 2007, the Solid Waste department has supplied over 1 700 cubic metres of clean sand and 1 500 cubic metres of rubble to fill low spots and raise floor levels in the 70 affected settlements, all in an effort

to manage flood risk. In the year 2007 alone, before the onset of winter, the City spent R76 million on the cleaning of the catchment infrastructure.

Though the City of Cape Town has made extensive efforts in theses aspects of stormwater management, these measures have proven not to be sufficient, as demonstrated by the extreme flooding events in Cape Town in the winter of 2007. Flood risk management depends on the allocation of efforts in not only stormwater management but in other areas, as well.

2.6 Community Communication and Flood Awareness

Risk communication is an essential element in any type of risk management approach. To many, the term "risk communication" suggests the one-way delivery of a message. The connotation associated with this term creates an image of a group of experts enlightening or persuading an uninformed and passive public. However, this one-sided approach by government officials will have limited effectiveness. Risk communication should be more appropriately defined as "an interactive process of exchange of information and opinion among individuals, groups, and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk, that express concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management." (National Research Council, 1989)

The National Research Council attributes successful risk communication to many factors such as the understanding of the intended audience. Accordingly, the Council states, "the important attributes of the audience include its makeup in terms of cultural background, shared interests, concerns and fears, social attitudes, and its facility with language." While a particular message may have an impact on one audience, it may have a different effect on another. For this project, it was essential for the group to submerge itself in the culture of the settlements to understand the intended audience. Our specific approach can be found within the methodology section of this report.

According to the Council, another factor to consider is that the source of a message can affect how the recipients respond. In other words, the residents will react to the message based on the credibility of the source, how much the source is trusted, and the degree of expertise they believe the source possesses. This was important to take into consideration when recommending guidelines to the City when they communicate risk to the residents.

Additionally, risk communication involves a certain colloquial language common to all parties— risk experts, policy makers, and the affected citizens. The goal of communication is to make the public aware of risk as well as to have them understand the dangers of disasters, such as flooding. If a common language is not used to relay this message, the message will be unsuccessful. For example, within the informal settlements of Cape Town, a large portion of the residents are functionally illiterate (City of Cape Town, 2005). Therefore, if City officials were to communicate the dangers associated with flooding by distributing technically worded pamphlets, this means of communication would be ineffective.

However, there are also certain ethical issues that may arise in communicating risk. "Producing any form of technical communication can result in ethical difficulties. Questions like how much information to release, to whom it should be released, and who makes those decisions are connected with the dissemination of any type of information" (Lundgre, 1998).

Some aspects of social ethics to consider are whether the risk is being applied equally to all ethnic groups, as well as who should bear the consequences if messages (such as disaster warnings) are misunderstood. Moreover, it is important to consider the ethical advantages and disadvantages of involving the public in communication (Table 1). One must be concerned about the effect of the communication process on the target audience whether they are involved in the process or not.

Table 1: Advantages and Disadvantages of Involving the Public in Risk Assessment, Management, and Communication (Lundgren, 1998)

	Involving the Public	**Not Involving the Public**
Advantages	• Because public participates in risk decision, decision is likely to last • Can increase organisation's credibility	• Organisation won't have to change the way it does business • No chance of loss of control
Disadvantages	• Risk managers may resist because of fear of loss of control • Lack of organisational commitment can result in loss of credibility • Requires more time at the beginning of the process	• Organisation's credibility decreases

2.6.1 Communication and Awareness in Cape Town

The City of Cape Town's approach to spreading awareness of the consequences of flooding is the execution of their communication and awareness programme. The aim of the programme is to educate the residents in the Cape Flats as to the actions they should be taking so as to lessen the effects of flooding. The key activities of this programme include: a community capacity building programme, media briefings, information collation and reporting, and regular media releases and public advisories (Wood, 2007).

A community capacity building programme involves brochures, tips, workshops, and flood risk education, including notification to informal communities within flood prone areas. As far as collation and information reporting, the City broadcasts weather warnings as well as regular flood incident reports. Figure 11 is an example of an educational piece whose purpose is to guide the residents as to how to protect themselves from floods.

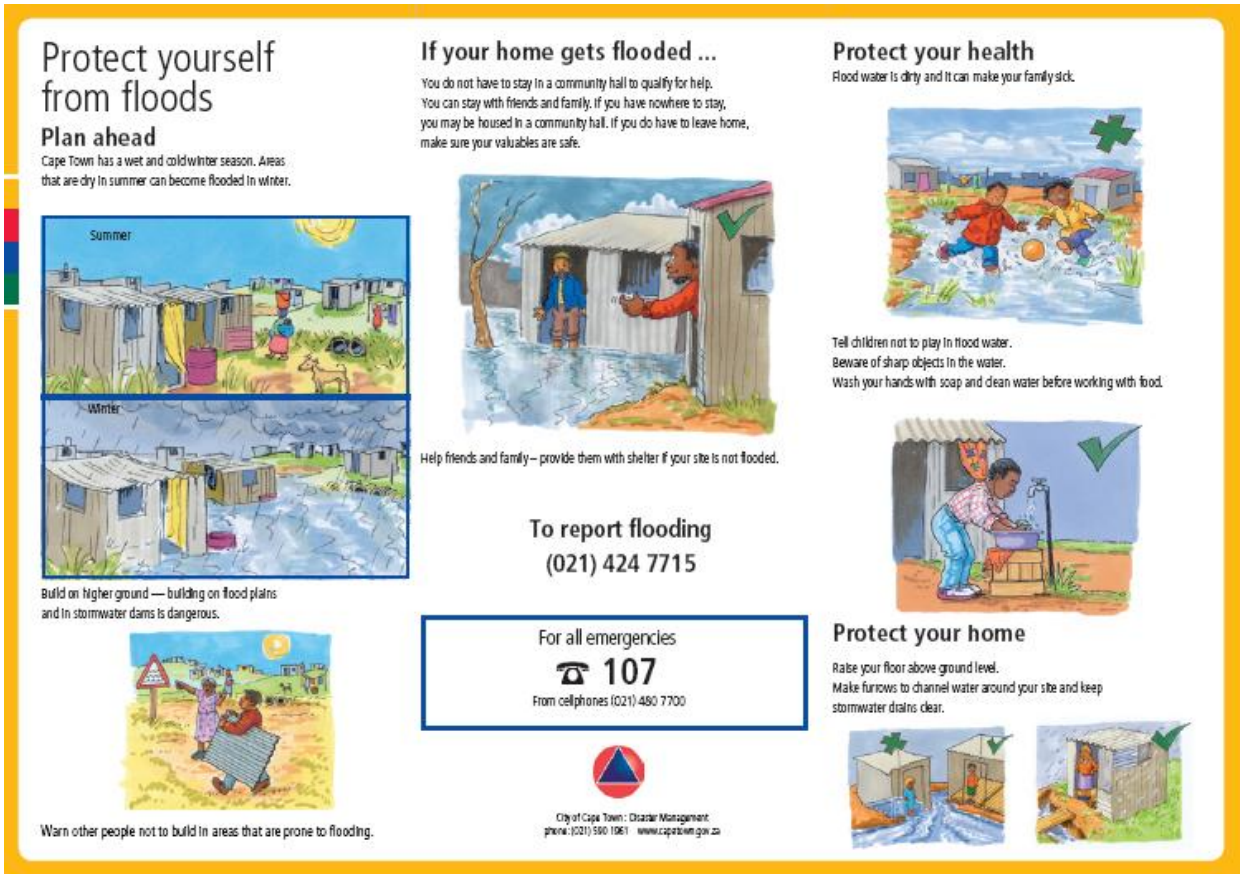

Figure 11: An educational piece produced by the City (City of Cape Town, 2007)

2.7 Global Community Participation and Flood Response

In the Philippines, where the situation resembles that of Cape Town, "local authorities who already knew the cycle of disaster management lacked the skills and/or resources to undertake activities to operationalise the measures for risk reduction" (United Nations, 2005). A lack of resources at all government levels can ultimately be named as the reason for improper management within informal settlements in many cases. In this case, officials recognised that the situation could be improved by enlisting the participation of the residents.

The village of Talba in the Philippines was at great risk for floods due to its proximal location to a river originating from Mt. Pinatubo. The assistance of non-government organisations (NGOs) was requested to aid in the development of a disaster management group within the community. This established group came to be known as the Barangay Disaster Response Organisation. Communication between the City officials and this community group was facilitated through annual meetings.

In Talba, the government was "open" to coordinating with the people of the village which ultimately allowed for a cooperative approach. The success of this organisation can be attributed to the allowance of "the people's organisation to maintain its identity, instead of co-opting it or forcing its integration with the government structure."

In Vietnam, the United Nations opted for promoting community awareness in order to better manage flood risk. "Vietnam is one of the most disaster-prone countries in the world." Due to the large devastation caused disasters such as typhoons, floods, drought, and wildfires, the United Nations Development Programme stepped in to improve community preparedness.

The aim of this project was to introduce disaster awareness and preparedness into the elementary school systems of Vietnam.

School children from selected communities were taught strategies on how to appropriately deal with disaster damage at a household level. This programme was intended not only to educate but also to promote a greater awareness of the risks associated with such disasters at both the household and community levels. The three main objectives of this project were: to develop a community-based disaster awareness and preparedness training programme, to develop a "nucleus" of master trainers for the future, and to strengthen the establishments that manage disaster within Vietnam. This programme's approach included the development and constant revision of a training manual intended for the teaching of "master trainers," and the training of students and teachers within selected communities.

2.7.1 Community Assistance and Flood Response in Cape Town

The City of Cape Town has undertaken a number of initiatives to assist the community in their response to flooding. One of the ongoing measures is the use of public call centres, which ensure that complaints and requests for assistance are dispatched to the appropriate department(s). Furthermore, the City aims to better coordinate the reporting of flood incidents within the informal settlements. Regarding public wellbeing, the health directorate is responsible for providing primary and secondary healthcare service and education to the public. Finally, to promote the security and wellbeing of citizens, Cape Town officials will continue to provide severe weather advisories via television and radio broadcasts.

2.8 Developing a Flood Risk Index

Flood risk and the critical time of occurrence are "difficult to monitor and detect," and therefore the development of a flood risk index would be a crucial addition to any flood risk management plan. An adequate flood risk index can significantly reduce the consequences of flooding by allowing not only City officials to identify flood prone areas but citizens as well. The following sections will discuss a case study in which the Cordoba Province of Argentina employed the Standard Precipitation Index as a means of flood risk assessment. Additionally discussed is a literature review from the *Journal of Applied Sciences and Environmental Management* that details various aspects which should be taken into account in assessing flood risk. These aspects were useful when considering those attributes which defined the flood risk index criteria for Cape Town.

2.8.1 Cordoba Province Case Study

The Standard Precipitation Index (SPI) is a commonly used tool to monitor and detect drought. However, based on the recurrent floods affecting the southern Cordoba Province in Argentina, scientists proposed that the SPI could also be utilised as a means for monitoring flood risk in that region. Results from this study "indicate that the SPI satisfactorily explained the development of conditions leading up to the three main flood events to occur in the region during the past 25 years" (Seiler, Hayes, & Bressan, 2002).

Flooding within the Cordoba Province can be attributed to excessive rainfall in the flood prone basin area in which the province is situated. Other factors which also contribute to this natural disaster include: soil saturation, volume of runoff, and the physical characteristics of the zone such as type of soil, size of the flood zone, topographic relief, control structures, and management.

Researchers gathered monthly precipitation data sets from a weather service station in the province to calculate the frequency of flooding events. A series of probability functions was calculated using these data so to derive a value for the SPI. A wet period can be predicted with this probability function when the value is continuously positive and reaches +1 or higher. Figure 12 shows the SPI for the Mercedes region of the Cordoba Province.

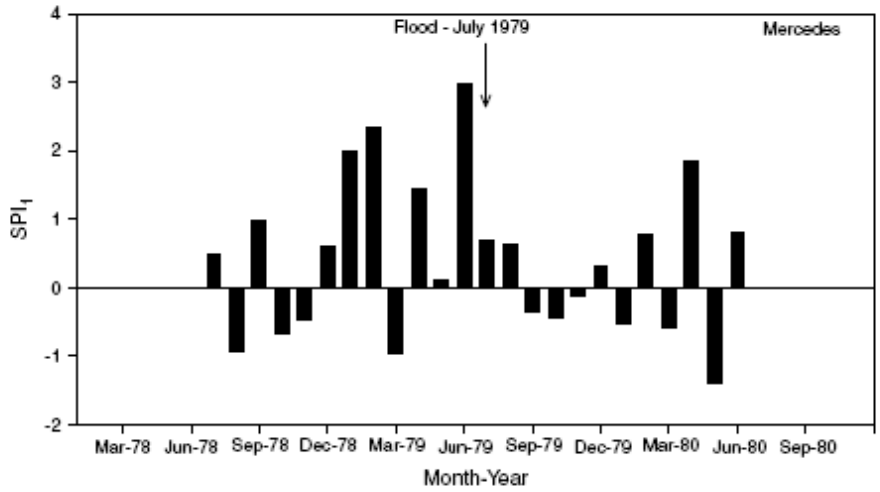

Figure 12: Graph of SPI for Mercedes region (Seiler, 2002)

While researchers were pleased with the success of the ability of the SPI to predict flood events, for the scope of our project, a case study such as the Indonesian Study subsequently discussed may be more comprehensive and useful to our research.

2.8.2 Indonesian Case Study

A comprehensive, numerical, community-based disaster risk index was piloted in three districts in Indonesia. This risk index is unique because it measures risk on a much smaller scale, focusing on the specific situations of the local communities. It involves the scoring and weighting of disaster risk indicators, which are separated into four main factors: hazard, exposure, vulnerability, and capacity and measures (Figure 13).

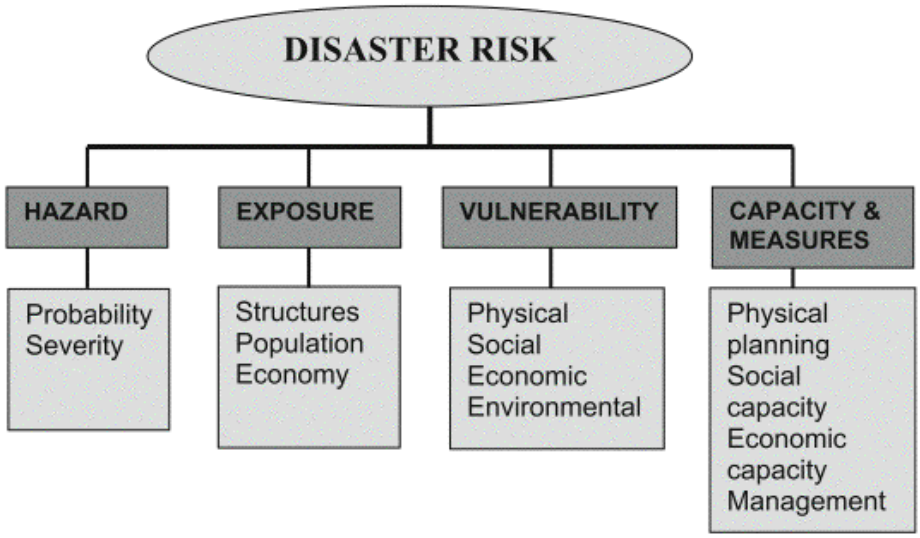

Figure 13: The conceptual framework to identify disaster risk (Birkmann, 2006)

A few examples of the 47 total risk indicators from the Indonesian pilot implementation include: population density, poverty level, literacy rate, and availability of risk maps and emergency plans. These indicators were assigned weights based on the relative importance of each indicator as well as the importance to the community. The relativity of these indicators is crucial because the importance of certain factors is highly dependent upon the conditions in a specific country. Finally, the individual indicators were scored by assigning a value of 0, 1, 2, or 3 (not applicable, low, medium, and high) to each. By adding these weighted scores, the total score for each of the four main factors was obtained, as seen in Figure 14.

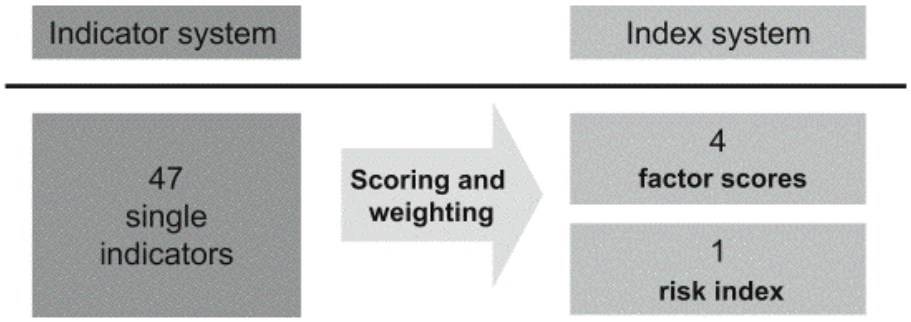

Figure 14: Indicator and index system (Birkmann, 2006)

Finally, the composite risk index was calculated using the equation:

$$R = w(HH + EE + VV) - wCC$$

where *R* is the overall risk index, *HH*, *EE*, *VV*, and *CC* are the scores of each of the four main factors (hazard, exposure, vulnerability, and capacity and management), and *w* is a constant coefficient (0.33) to ensure uniform weights for each of the main factors. This equation yields the overall risk index on a scale of 0 to 100 (Birkmann, 2006).

According to the case study, the benefits of this disaster risk index allowed the researchers to:

- Compare different regions so as to identify areas with high disaster risks
- Determine whether the flood risk stems from the hazard itself or is due to high vulnerability levels or comes from a lack of capacity
- Distinguish the different possible magnitudes of damages through the exposure score
- Reveal deficits in flood risk management capacities and potential areas for interventions

For example, Figure 15 displays the disaster risk index values for a district in Indonesia prone to landslides. An interesting thing to note is the low capacity (C) score, indicating that the primary problem is the lack of capacity and management in this district. Further analysis of the capacity and management (C) indicators would reveal precisely where capacity and management is lacking and the relative urgency of each indicator.

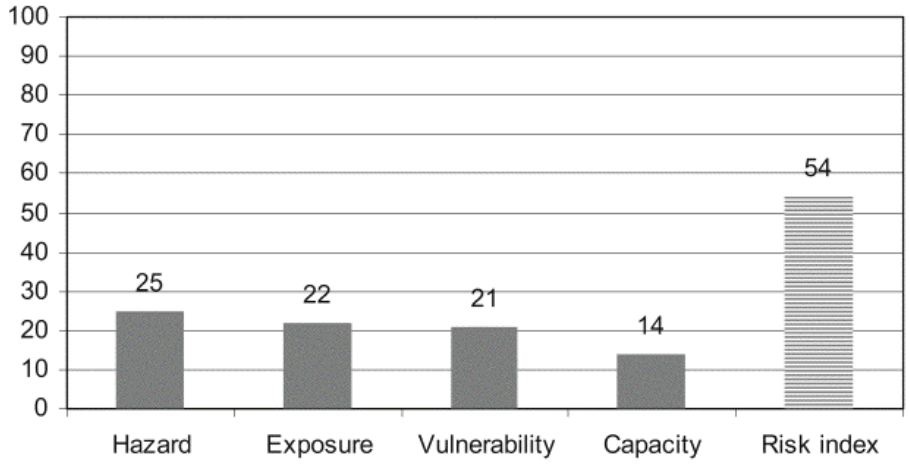

Figure 15: Disaster Risk Index of a district in Indonesia prone to landslides (Birkmann, 2006)

2.8.3 Additional Case Studies

Also constructive for our research was use of The *Journal of Applied Sciences and Environmental Management,* which reviews some of the methods of flood risk assessment using case studies from various countries. Though this assessment of different flood risk strategies does not use a definite flood risk index, it does cite many elements that were considered in the development of an index of this sort.

Most promising in terms of the studies analysed is one that was conducted in 1994 (Oriola, 1994). It was observed that flooding in many of Nigeria's urban environments could be attributed to socio-economic activities. Such activities were characterised by "increased paved surface and poor solid waste disposal techniques, due to a high level of illiteracy, a low degree of community awareness, poor environmental education, ineffective town planning laws and poor environmental management." In conclusion, Oriola decided that flood risk in the Ondo urban environment of Nigeria was to take into account the following aspects: disposal habits, pattern of land use, the structure of the buildings, the distance between dwellings and rivers or streams, the amount and duration of rainfall, characteristics of the terrain, slope, gradient, and other basin parameters.

Another study conducted in 2004 analysed the flood risk in the Niger Delta. This assessment utilised a combination of flood risk indicators such as "measurable physical characteristics of flooding and socio-economic techniques based on vulnerability factors." These physical attributes of flooding included the depth of flooding, duration of flood, estimated frequency of flood occurrence, and elevation. The vulnerability aspects were the proximity to hazard source, land use, flood alleviation techniques, and "perceived" extent of flood damage. From here, a rating scale was developed for the nine selected parameters. Next, eighteen settlements were randomly selected across the three ecological zones in the region, and they were rated on the basis of these parameters. Based on these evaluations, three main assessment groups were developed: severe, moderate, and low flood risk zones.

2.9 Summary

Currently there are many factors that intensify the flooding problem in the informal settlements of Cape Town. To successfully address the problem, we must address the issues from a technical, social, and political stand point. The social and political aspect will consist of the communication and awareness potion of the project. The technical aspect will include

the flood risk index. This combination is intended to address the flooding problem by incorporating municipal mitigation with community capacity measures.

Chapter 3: Methodology

The ultimate goal of our project was to improve the City of Cape Town's approach to flood risk management in the informal settlements by working closely with our sponsor, the Catchment, Stormwater & River Management Branch (Section 2.4). After arriving in Cape Town, our first step was to clarify exactly what was expected of our group by meeting with our liaison, Mr. Mogamat Kenny. This allowed us to focus our efforts on realistic goals for the remainder of the project, which included six deliverables: an assessment of past flooding events; maps of high-risk areas; a flood risk index; structural guidelines for the residents; effective communication methods; and recommendations for relevant government departments. Additionally, Mr. Kenny selected two pilot sites for which we were to conduct the flood risk index pilot study: the Bongani TR section of Khayelitsha and Phola Park Philippi.

In this section, we will describe how we approached this complex problem. Specifically, we will explain the processes by which we created the six deliverables mentioned above, which we developed in Cape Town from October 22 through December 13, 2007. Table 2 shows the schedule of our project tasks.

Table 2: Schedule of project tasks

TASK	WEEK							
	PQP	1	2	3	4	5	6	7
Research: FRI case studies, flood risk management strategies, Cape Town flooding background								
Meetings with City departments and academic institutions								
Field surveys, observations, and community interviews								
Evaluate current educational materials								
Rainfall, incident report, GIS data analysis								
Brainstorm best communication methods								
Generate FRI indicators and ratings, community guidelines, and recommendations								
Apply flood risk index to pilot area								
Final presentation and report submission								

3.1 Assessing Past Flooding Events

Prior to the development of our deliverables, we first had to assess the past flooding events in the City of Cape Town to gain a better understanding of this complex situation. This assessment required that the Catchment, Stormwater & River Management department provide us with a variety of data resources, such as rainfall data, GIS data, and flood incident report data.

At the request of Mr. Kenny, we began the assessment by comparing the rainfall data and the number of flood incident reports. This required that we obtain rainfall data for the past five years (2003 through 2007). Using the rainfall numbers from the monitoring station in the Pinelands Road Depot (Figure 6), we calculated the total rainfall during the rainy season (March through August). In addition, Mr. Kenny provided us with information about the number of flood incidents reported per year in each CSRM management district over a four year period (2004 through 2007). We chose to compare the number of flood incident reports in two districts, Athlone and Khayelitsha, which are situated near the Pinelands Roads Depot. This allowed us to identify any correlations between total rainfall and flood incident reports; the results can be found in Section 5.1.1.

The next step consisted of field work in the form of site visits to the informal settlements and interviews with the residents and community leaders. We conducted site visits to Marcus Garvey and Lotus River, in addition to our pilot sites of Phola Park, Philippi and the Bongani TR section of Khayelitsha. We were accompanied by Mr. Kenny and several members of the CSRM District 7 Response Unit who were familiar with the area. They were present for on-site information, background knowledge, translation, and safety reasons.

During these site visits, we observed the existing stormwater infrastructure (if any) and noted reasons for its malfunction. Because we conducted these site visits during the dry summer months, we gathered firsthand knowledge of past flooding events through interviews with the residents of the Bongani TR section of Khayelitsha. Finally, we photographed our discoveries to document our findings for the CSRM department.

3.2 Mapping of High Risk Areas

During the project we were presented with a request for an additional deliverable. We were asked to map out high risk areas in TR section and Phola Park. The goal of this deliverable was to create an easy way to identify flood prone areas based solely on their topographical location.

To identify these areas we digitally layered an aerial photo of the settlements with a contour map and took note of any bodies of water were located in or around the area of the settlement. We then identified the elevation range present throughout the settlement and determined a subset of this range to identify as high-risk. All of the areas in the high-risk elevation range were then highlighted on the aerial photograph.

3.3 Developing a Flood Risk Index

Our highest priority deliverable was a flood risk index. This index was unique to the complex situation of the informal settlements. However, we researched disaster risk and flood risk indices from other sites when drafting our index. Our on-site visits allowed us to determine any irrelevant indicators as well as adding others that did apply to the settlements.

One of the most promising implementations of a risk index is the community-based disaster index in Indonesia (Birkmann, 2006). Although it encompasses a wide variety of natural disasters, we feel that this particular risk index can be easily tailored to the situation in the informal settlements. Similar to the indicators in the Indonesian pilot study, the flood risk indicators for Cape Town would be separated into four main factors: hazard, exposure, vulnerability, and capacity. These indicators can be found in Table 3.

Table 3: List of selected flood risk indicators from Indonesian case study

Main factor and components	Indicator name	Indicator
HAZARD		
Probability	(H1) Occurrence (past)	Frequency of floods in past 20 years
Severity	(H2) Intensity (past)	Intensity of the worst flood event in the past 20 years
EXPOSURE		
Structures	(E1) Number of housing units	Number of housing units
Population	(E2) Total population	Total population
VULNERABILITY		
Physical/demographic	(V1) Density	People per km^2
	(V2) Demographic pressure	Population growth rate
	(V3) Unsafe settlements	Homes in flood prone areas
Social	(V4) Poverty level	% of population below poverty level
	(V5) Literacy rate	% of population that can read and write
	(V6) Attitude	Priority of population to protect against flooding
CAPACITY & MEASURES		
Physical planning	(C1) Infrastructure	Existing stormwater infrastructure
	(C2) Maintenance	Regular maintenance of infrastructure
Societal capacity	(C3) Public awareness programmes	Frequency of public awareness programmes
	(C4) Emergency response drills	Ongoing emergency response drills
	(C6) Local risk management/emergency groups	Grade of organisation of local groups
Economic capacity	(C7) Emergency funds	Access to emergency funds
Management and institutional capacity	(C8) Risk management/emergency committee	Meeting frequency of committee
	(C9) Risk maps	Availability of risk maps
	(C10 Emergency plan	Availability of emergency plans
	(C11) Early warning system	Effectiveness of flood warning systems
	(C12) Institutional capacity building	Frequency of training for local institutions
	(C13) Communication	Frequency of contact with national level flood institutions

Subsequent to our meetings with various City departments and field studies, we prepared a list of objective flood risk indicators to be used in determining the overall flood risk of each settlement. We refined our list after examining indicators that were relevant to flooding and that could also be found throughout the settlement. Our indicators also reflected data that could be obtained with minimal personal judgement to create an index that would be as consistent as possible regardless of the settlement or the person conducting the assessment.

After we created our index and weighted each indicator based on inferences we had made in our field studies, we then applied it to the Phola Park Philippi pilot site. This allowed us to calculate the overall flood risk for the area. We were not able to apply our index in both sites due to time constraints, so we chose to use the Phola Park site. Since we could conclude the severity of the flood risk in the Bongani TR section from a visual inspection, the application of the index was not needed for this site.

3.4 Establishing Structural Guidelines for Residents

One of the primary causes of the increased flood risk in the informal settlements is the inadequate building practices used by the residents. Because their deficient structures were erected in unsuitable locations, the flood risk is further elevated. There are relatively simple and inexpensive building techniques that can reduce the flood risk. If the City of Cape Town were to communicate a set of structural guidelines to the residents in the areas prone to flooding, the residents would be more aware of their ability to minimise flood risk at the household level.

We visited numerous informal settlements prone to flooding, such as Marcus Garvey, Phola Park Philippi, Lotus River, and the Bongani TR section of Khayelitsha, to gain a better understanding of what the residents had already pursued with regards to structural improvements. We focused primarily upon the flooding area of leakage and seepage, which are the primary causes of flooding at the household level. During these site visits, the team photographed the various structural improvements whenever possible to ensure visual documentation of these structures.

After conducting these site visits, we assessed the difficulty, approximate costs, pros and cons for each method (Section 5.3). Finally, we documented our findings and provided sample educational materials (Appendix VI) to assist the City of Cape Town with communicating these strategies on a large scale to the residents.

3.5 Generating Strategies for Communicating Between the Informal Settlements and Cape Town

A large portion of this project focused on involving the settlement communities in the effort to reduce flood risk. After the material to be presented to the communities was established, we then needed to determine the best means to convey it. It is important to realise that "communities should not be passive recipients of information. There is a need to encourage people to help themselves, and communities must be provided with the mechanisms to do so" (United Nations, 2005). There have been previous efforts by the City to show communities how they can lessen the risks of flooding, and our first objective for this task was to examine the effectiveness of existing efforts. By observing what measures were and were not successful (and why), the team intended on avoiding the repeat of past mistakes in our suggestions. We achieved this objective by interviewing City officials who were either in charge of past awareness programmes or had knowledge of the awareness efforts of their department.

Early upon our arrival in Cape Town, we met with Johan Minnie, Manager of Disaster Risk Management for the City. He presented the team with a wealth of examples of his awareness material, including DVDs, posters and pamphlets. Mr. Minnie stated that a drawback to using pamphlets or other handouts is that it is difficult to gauge their success. He also

indicated that radio is an extremely effective means of communication, but it is mostly used for short notices and warnings.

A meeting was also conducted with the Environmental Health department. Zanele Figlan, Levina Petersen, and Vuyokazi Ruiters, who represented the department, noted an issue they had with some of the existing posters and/or pamphlets from many city divisions: the pictures were illustrations, and the settlement residents could not relate to the images. The illustrations displayed various disaster-related situations (flooding, fire, etc.), and they believe the images were ineffective at conveying risk because the situations do not seem realistic. If the residents cannot relate to an image or comprehend the risk or consequences of a situation, the attempt to convey the information is essentially futile.

The team met with Leander van Oordt, Manager of Public Awareness and Education from the Cleansing Branch of the Solid Waste department. Ms. van Oordt noted the sensitivity of some communities; she believes most areas are resistant to new programmes unless they are endorsed by their community leader. Her department largely uses radio and local newspapers to communicate to the settlement residents.

Because this deliverable involved communication with the residents of the settlements, it was essential to educate ourselves by interacting with members of the community itself. Through our on-site visits, we were able to speak directly with members of the community and ask them questions pertaining to the effectiveness of the current awareness material. We generated a list of questions (Appendix I) and conducted interviews with a community leader and a group of residents in the Bongani TR section of Khayelitsha.

After gathering suggestions from interviews, the team decided to create a list of communication methods the City had not explored. Also in this list were the current strategies the City is using to communicate to the residents. We evaluated the benefits and detriments of each means, predicted the audience affected by the means, as well as the quantity required, materials needed, and rated the projected cost (Table 8).

3.6 Developing Recommendations for the City of Cape Town

Through our assessment of the nature of flooding within the settlements, the team has become aware that flooding within the informal settlements is a complex problem which relies on the work and theoretical collaboration of many different departments. However, the team has seen that there is little to no collaboration amongst different departments, and oftentimes the practices of one department interfere with the practices of another, which ultimately leads to improper flood risk management.

Consequently, the team developed a set of recommendations for the City of Cape Town. We needed to understand the specific responsibilities of each department and how they pertain to proper flood risk management. This was done through a series of interviews, as previously discussed. The particular interviews which were pertinent to flood risk management were the following:

- Leander van Oordt, Manager of Public Awareness and Education for Solid Waste Planning
- Johan Minnie, Director of Disaster Risk Management
- Dr. Ailsa Holloway, Director of the Disaster Mitigation for Sustainable Livelihoods Programme at the University of Cape Town

- Mogammad Benjamin, Graduate Student at University of Cape Town

Questions and minutes for each meeting can be found in Appendices I and II. With the information gathered from our meetings, the team was able to list the gaps in management for various problems and then developed a list of solutions for each of the gaps. These solutions have been written as a set of recommendation which will be distributed to each relevant department in hopes of promoting awareness of these hindrances in flood management practices. The team also hopes these guidelines will spark more collaboration within the City departments to work together in the alleviation of the flooding problem within the settlements.

The conference with Dr. Holloway and two of her graduate students explored the feasibility of working with the public to develop a flood risk management programme at the household and community level. The team believes that a community-based maintenance programme would be the most successful way to minimise flood risk but needed to further understand the logistics behind such a programme. Minutes from this informative interview are located in Appendix II.

Chapter 4: Flood Risk Index Pilot Study

This chapter describes results of our flood risk index pilot study conducted in Phola Park Philippi. The intent of the study was to test the effectiveness of our FRI. After meeting with various City departments, conducting interviews and performing field work, we adjusted our original indicators and reviewed the intended audience for the flood risk index. Originally, we intended to communicate the results of the index directly to the community. However, subsequent to these meetings, we came to understand the gravity of the illiteracy rate and the lack of education among the residents. It was then that our focus shifted to providing a more reliable measurement of flood risk when considering the City's Master Upgrade Plan (Appendix III), which characterises flood risk in a settlement as being high, medium, or low. Additionally, we planned to use the index to evaluate settlements so that city infrastructure investments and community capacity measures can be targeted to areas of greatest need.

After examining all of the factors to include in the flood risk index, we compiled and weighted them (Table 4) according to what we believed to be more significant factors based on our research and observations. We felt it necessary to apply weights to each factor, although we did recognise the subjectivity of this action.

Table 4: Flood risk indicators, weights, and conditions

Indicator	Condition	Weight	Percentage of Houses	Rating (Weight*Percentage)
Roof structure	Flat (pitched)	0%		
	Flat	10%		
	Bowl	19%		
Floor structure	Above ground	0%		
	Level with ground	9%		
	Below ground	27%		
Topographical location	Highest Third	0%		
	Middle Third	14%		
	Lowest Third/Valley	27%		
Bodies of Water	None	0%		
	Bordering	14%		
	Within	27%		
Frequency of rubbish removal	< Monthly	0%		
	< Weekly – Monthly	-7%		
	Daily – Weekly	-15%		

To find the overall risk rating, the number of dwellings that apply to each condition was recorded as a percent of the houses examined, with the exception of the water and rubbish removal indicators. For these two indicators the number 1 is placed in the box with respect to the condition in the settlement. The percentage number was then multiplied by the respective weight to find the overall risk for each indicator. Lastly, these values were summed to find the flood risk for the entire settlement.

The indicators were chosen based on their presumed objective nature. We assumed that the indicators would allow for a relatively uniform application regardless of who was using the

index or settlement to which the index was being applied. In addition to their expected ability to provide meaningful results, these indicators were chosen on the basis of their applicability throughout the settlements of Cape Town. The frequency of rubbish removal was accounted for as a capacity indicator because of the consistency of clogged infrastructure in the settlements.

Many factors considered when creating our flood risk index were not included due to the fact that they did not pertain to the Cape Town settlements. Numerous other indicators were examined and discarded due to their subjective nature. These indicators are discussed in the subsequent sections.

After completing the flood risk index, we applied it to the Phola Park settlement in Philippi (Appendix IV). We calculated the risk with respect to the floor and roof structure by taking a sample of just under 10% of the total houses in the settlement. Due to time constraints, we had to choose a manageable sample size that we felt would still be accurate. The other indicators were measured using aerial photographs, contour maps, and information gathered from the Solid Waste department. From our pilot study, we were able to draw some conclusions and recommendations regarding the effectiveness of the index. Although we do not recommend the continued use of the FRI in its current state, we do feel that the current FRI is valuable to the City because of the knowledge gained from the assessment, which is discussed below.

Chapter 5: Findings & Recommendations

The development of a flood risk index involves a great deal of research, planning, and testing before it can be successfully implemented not only in Cape Town but anywhere in the world. After we applied the flood risk index in Phola Park, we eventually recognised the flaws inherent in several of its indicators. Furthermore, we discovered that the data intended for some of its indicators was both unreliable and incomplete. Despite the limitations of our FRI, we recognise its merit as a valuable learning process. In this section, we will analyse the shortcomings of our FRI and propose recommendations, summarised in Table 5, as to what steps the City of Cape Town might take in order to implement a successful flood risk index. We shaped this analysis in accordance with the framework outlined in the Indonesian case study (Birkmann, 2006), which represents the best of international opinion.

Table 5: Summary of findings and recommendations

DOMAIN & Indicators	**Relevant Data**	**Finding**	**Recommendations**
HAZARD Probability Severity	Flood incident reports	Current incident reporting system is underutilised in informal areas	Institute flood marshal system
		No systematic data collection	Collect names/addresses of displaced residents
	Topographical data	Current data is insufficient for use in FRI	Investigate improved topographical data collection methods
EXPOSURE Structures Population	Number of housing units in settlement	Not explored; data is available	Incorporate in FRI
	Population in settlements		
VULNERABILITY Density Structural resistance	Population density	Not explored; data is available	Incorporate in FRI
	Floor structure	Measurement is too subjective	Do not incorporate in FRI unless better method of measurement is conceived
	Roof structure		
CAPACITY & MEASURES Physical capacity Societal capacity	Frequency of rubbish removal	Skips underutilised by residents	Allow for community preference regarding placement of skips
	Public awareness programmes	Residents unaware of flood risk when moving into area	Implement community-based disaster risk management programme

5.1 Hazard

Probability and severity, encompassed by the hazard indicator, are two crucial components of an effective flood risk index. Prior to our arrival in Cape Town, we presumed that fairly reliable hazard data would be available in a GIS that would serve as a valuable resource for

identifying the locations of past flooding incidents. Unfortunately, due to the lack of an effective flood incident reporting system in informal areas, there were a minimal number of incidents mapped in the GIS database. In this section, we will present our findings and recommendations regarding the flood incident report data and topographical data.

5.1.1 Flood Incident Reporting

Ideally, the City of Cape Town would have reliable records of past flooding events in informal areas. The Disaster Risk Management (DRM) department presently relies on residents to call a designated line to report flooding incidents in their homes. We evaluated the effectiveness of these data as an indicator of flood risk by comparing the number of flood incident reports from two districts. Using the rainfall data from the Pineland Roads Depot and the records of flooding incidents in District 6 (Athlone) and District 7 (Khayelitsha), we compared the flooding events in the districts from 2004 through 2007. Figure 16 highlights the locations of these two districts.

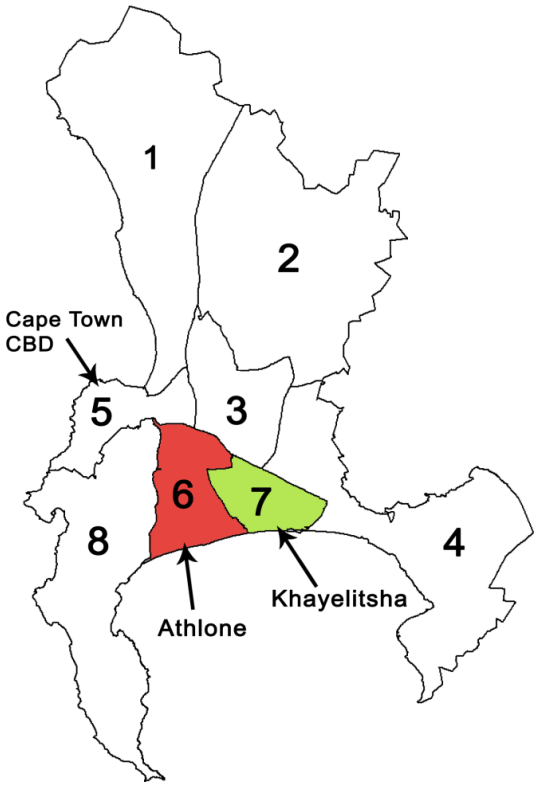

Figure 16: Spatial Planning Districts (May 2007)

Figure 17 compares the total rainfall during the winter months (March through August) and the total number of flood incident reports from each district.

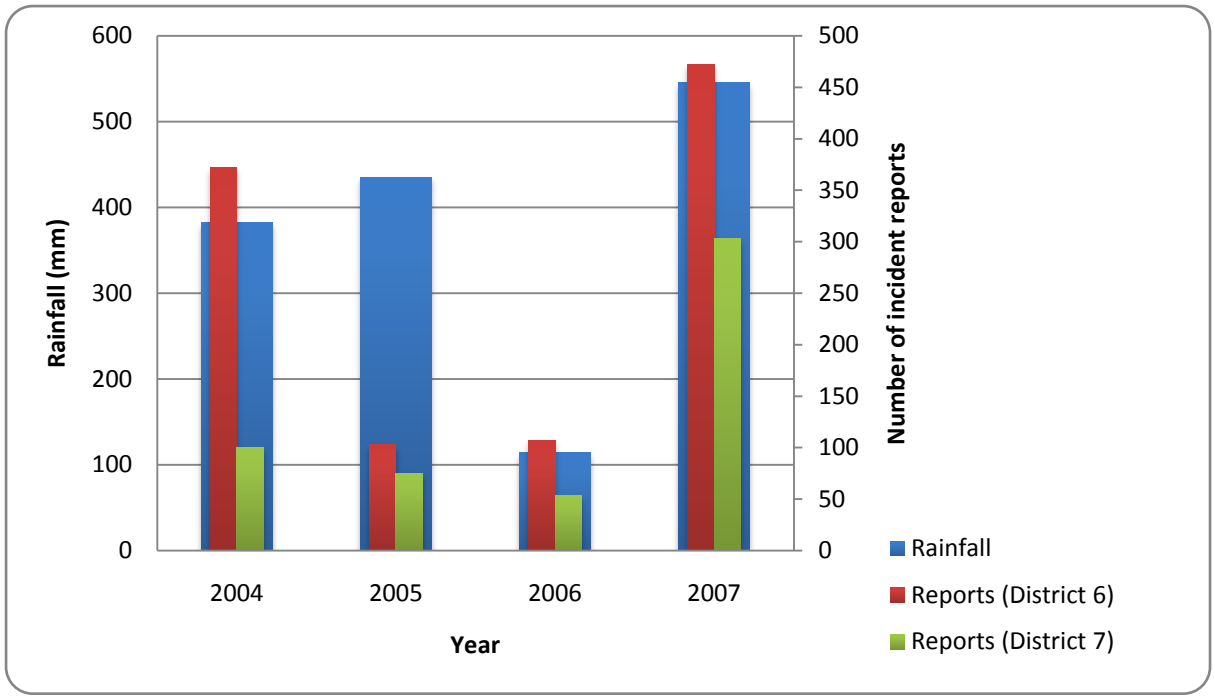

Figure 17: Comparison of rainfall data and number of incident reports by year

With the exception of 2005, there is a distinct correlation between the amount of rainfall and incident reports. Also, the number of incident reports from the Khayelitsha District is continually less than the number from the Athlone District, which was not expected.

Table 6: Comparison of demographic data from Districts 6 and 7 (City of Cape Town, 2007)

District	Population	Pop. density (per km^2)	% Informal	Service Level Index
6-Athlone	512,958	3827	15.19	10.90
7-Khayelitsha	719,512	8283	43.74	26.37

Table 6 shows that flooding should affect significantly more residents in District 7 than in District 6. It is known that the topology of Khayelitsha causes it to be more prone to flooding than Athlone. Not only is the population density in Khayelitsha over twice that of Athlone, but the percentage of informal dwellings in Khayelitsha is almost three times that of Athlone. Moreover, the Service Level Index (SLI), which is a measure of access to basic services (lower SLI is better), is much higher in Khayelitsha than in Athlone, indicating a significant lack of infrastructure in Khayelitsha compared to Athlone. Based upon these data, one would expect there to be considerably more incident reports from District 7, but this is not the case.

The current method of reporting flood incidents is ineffective for many reasons, such as the possible inconsistencies in the reporting (i.e. what constitutes "flooding") and flood occurrences are often not reported at all. One possible reason for this is the lack of incentive for the residents to report flooding because they do not necessarily see the immediate results of doing so. Moreover, they may not know how to report incidents. Another reason may be that flooding poses less of an urgent threat than other disasters such as fire, and the residents may be unaware of the various dangers associated with flooding. For these reasons, we have

concluded that the current flood incident reporting system is ineffective in the informal settlements, resulting in a lack of proper flood records in these most vulnerable areas.

Therefore, we recommend that Disaster Risk Management employ a number of residents to operate as flood marshals who would be responsible for reporting flood incidents to them. The flood marshal would inspect each house within their designated area after a heavy rainfall event to verify if the house was flooded. They would be responsible for recording the approximate depth of flooding around and inside the dwelling. Furthermore, the flood marshal would serve a dual purpose by also educating the residents of the mechanisms of flooding as part of their responsibilities for the dry summer months. The marshal would help to raise awareness as to how to minimise flood risk. Not only would the implementation of a flood marshal improve the current method of data collection, but it would create jobs, as well. By employing settlement residents in any type of flood management procedure, the DRM would be establishing a meaningful community-based programme. As previously mentioned, involving the community is a crucial and effective means of empowering the residents and creating a sense of ownership of the problem.

Additionally, there is a lack of data collected in the wake of a flood event. During heavy rains, those residents whose homes are unsuitable for occupancy are given the opportunity to relocate to community halls. Currently, the DRM logs the number of displaced residents by counting the number of free meals served at these community relocation halls. Although the flooding has been less severe during the past few flood events, the data shows that the number of residents displaced (in reality, the number of hot meals served) has grown exponentially. City officials believe that these increasing numbers are not indicative of the actual number of flooded dwellings because some residents, whose homes are not actually flooded, see relocation to the community halls as an opportunity to temporarily escape their dismal situation for a place to sleep and a hot meal.

Therefore, we recommend that Disaster Risk Management adopt a more precise method of tallying displaced residents. This can be achieved by more effectively monitoring those residents who come to the halls. Residents should be required to give their names and house number upon entering the hall and the DRM workers would be responsible for the data. By obtaining the house number of each individual, the DRM would then be able to verify if their homes had in fact been flooded.

5.1.2 Mapping of High-Risk Areas

Given that flooding probability and severity are closely linked to topography, we investigated the mapping of high-risk areas based on contour maps and aerial photos provided by the GIS department. We outlined high-risk areas by overlaying an aerial photograph with a contour map of the settlement. When determining the high-risk areas, we examined the topography of not only the interior of the settlement, but also that of the area in close proximity to the settlement's borders. The change in elevation was divided into thirds and areas in the lowest third were marked as being high-risk (Appendix V).

There were two problems that gave rise to the questionability of our results. Firstly, the contour maps we used were created using software that can only differentiate between elevations at two-metre intervals. However, in the Phola Park settlement there is only a two-metre range of elevations, which means the City does not have the technology available to gather topographical information in the area that is detailed enough for use in high-risk mapping and the FRI. To overcome this obstacle, we had to examine the contours on 0.25

metre intervals despite the inaccuracy of this measurement. Additionally, we found obvious discrepancies between the contour map of Phola Park Philippi and visual observations from our site visits and aerial photos. The contour maps indicated higher elevation landmasses located where the aerial photos (consistent with our site visit) show a drainage trench. We must therefore note that our mapped areas are not precise outlines of the high-risk areas.

When calculating topographical risk, we relied on the risk map that we created for Phola Park Philippi. We outlined the three different elevation ranges and counted the number of houses in each range. The aerial photo, however, was taken at an aspect ratio of 1:5000. Although the photograph was at too small a scale to be able to unerringly distinguish and count every house, we obtained an approximate quantity of houses in each section.

Based on the potential information that can be gained regarding flood risk in the settlements, we feel that it would be essential to look into enhancing current data collection methods. We suggest that careful consideration be taken into investing in alternative methods for collecting topographical information, which we understand the GIS department is currently investigating, that will result in more accurate and complete data sets.

5.2 Exposure

Exposure includes indicators such as total population and number of housing units in the settlement. We did not consider exposure as an indicator in our flood risk index because it is not a direct indicator of whether or not an area is prone to flooding. Exposure does, however, account for the human element of flood risk.

We believe that exposure is a valuable indicator of flood risk and recommend that it be incorporated into a future flood risk index. The population and housing data is readily available for each settlement through the Strategic Information Branch, as it is necessary for many basic municipal functions.

5.3 Vulnerability

Vulnerability indicators provide insight into the physical and demographic susceptibility of a particular settlement with respect to flood risk. In the Indonesian case study, Birkmann recommends the incorporation of population density into the disaster risk index, the data for which is available through the Strategic Information and GIS department and could be included in the future. For the pilot implementation of our flood risk index, we attempted to evaluate roof and floor structures as indicators of physical vulnerability because leakage and seepage are two major sources of flooding at the household level. While examining the floor and roof structures of the houses in Phola Park Philippi, we realised the inherent subjectivity of both indicators. For example, when considering roof structure, we had to use our best judgment to determine whether or not a roof was sufficiently pitched. This added a subjective aspect to the indicator, which would inevitably result in inconsistency when applying the index to various settlements. Alternatively, to set a minimum pitch angle, as well as use a more precise measurement technique, would be too time-consuming. The floor structure indicator also has its downfalls. To assess the relative height of a floor independently of the surrounding topography is insufficient. If there is a house built on stilts at the bottom of a ditch, it may be more prone to flooding than a house built level with the ground at the top of a hill. Therefore, we do not recommend using either of these indicators in a flood risk index, unless a more uniform method of measurement is conceived.

Instead, we believe that it would be more sensible for the DRM or Health department to communicate helpful structural guidelines to the residents. Through our on-site visits, we were able to observe many approaches that some of the residents had taken to reduce their vulnerability to flooding. The primary structural improvements were the use of pallets, concrete flooring, and stilts to minimise seepage. Refer to Figures 18 through 20 for photographs of these methods.

Figure 18: Use of pallets in Lotus River to prevent seepage

Figure 19: Use of concrete flooring in Lotus River to reduce seepage

Figure 20: Use of stilts in Marcus Garvey to prevent seepage

In addition to these existing, but rarely used, methods, we proposed a new technique (Figure 21) involving the use of sandbags and soil. The residents could line the perimeter of the base of their house with sandbags. Then, they could fill the area contained by the sandbags with a mound of soil to raise the floor of their house. The sandbags would prevent the raised soil floor from washing away during a flooding event.

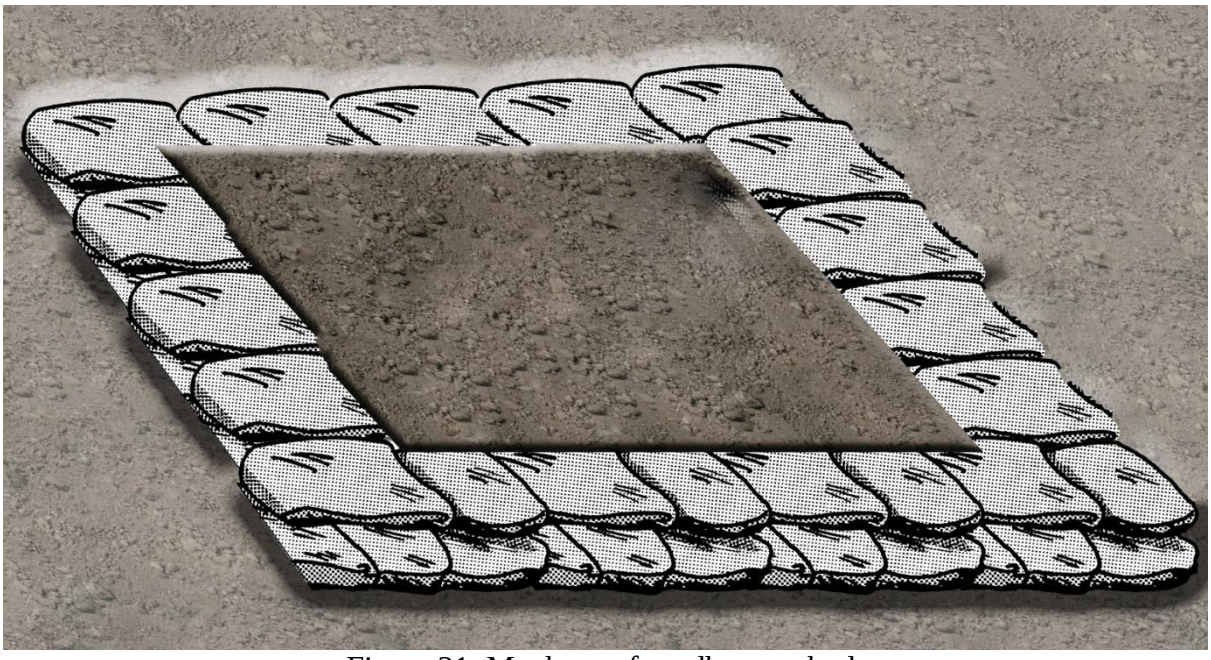

Figure 21: Mock-up of sandbag method

After observing these structural techniques, we compared the different methods by evaluating the difficulty, estimated costs, and pros and cons for each (Table 7).

Table 7: Comparison of structural techniques to reduce seepage

Method	Difficulty	Estimated cost	Pros	Cons
Pallets	Easy	None to low	Cheap	Open floor (seepage)
			Readily available	Rotting
			Can be handmade	Low stability (stacking)
			Simple to set up	Low strength
			Easily repaired	
Sand/concrete bags	Easy/medium	Low	Cheap	Does not prevent seepage
			Easy	Stability decreases with height
			Provides foundation	
			Mobile	
			Easy repair	
			Minimal building materials	
Concrete	Medium	Low to medium (50 kg @ R47,90)	Long life	Pooling may occur
			Foundation	Cold (no insulation)
			Sturdy	May be difficult to pour
			Prevents seepage	Not mobile
				Not easily repaired
Stilts	Difficult	Probably costly	Raise house to desired level	Requires some level of engineering
			Area for storage	Low stability if constructed improperly
				Dangerous
				Lumber not readily available

Additionally, during our site visits, we observed the use of plastic sheeting, canvas, and caulking to reduce or prevent leakage through holes in the roof.

We recommend that the City communicate helpful structural guidelines to the residents to make them more aware of their ability to reduce the impact of flooding at a household level. In particular, we believe that the techniques involving pallets and sandbags would be most successful because they are both relatively inexpensive and simple. A few samples of educational materials for the residents can be found in Appendix VI.

5.4 Capacity & Measures

”Capacity and measures” indicators reflect a community’s ability to minimise the effects of flooding. We did not include any indicators of this type in our pilot study for a few reasons. First of all, we were limited in the amount of time we had to complete the project. We also were not able to conduct interviews with the residents of Phola Park to determine what capacities and measures, if any, were present in the settlement. In the process of obtaining

data for the FRI, we were not only able to gain a better understanding the dynamics of the communities within the settlements, but how essential involving the community is towards any disaster risk reduction plan. We therefore developed a number of recommendations for collecting capacity and measures information for a future FRI and at the same time to strengthen community capacity to reduce the effects of disasters, such as flooding. These ideas include physical capacity and measures and societal capacity and measures, which are described below.

5.4.1 Physical Capacity & Measures

Physical capacity denotes the ability to manage risk based on the presence of infrastructure and maintenance programmes. A large contributor to flooding within the settlements is the blockages of infrastructure; therefore, one of the indicators utilised in our index represented how frequently rubbish was removed from the area. However, based on our findings, the team concluded that the frequency of rubbish removal is, in fact, not indicative of flood risk. This was due to the fact that the infrastructure still remained clogged regardless of how often rubbish was removed (Figure 22). The blocked infrastructure is not necessarily associated with the regularity of rubbish removal from the skips, but more so with the efforts of citizens to utilise the skips. Therefore, we formulated suggestions to reduce this problem.

Figure 22: Blocked infrastructure in Phola Park Philippi

The Solid Waste department is primarily responsible for the management of rubbish removal, and consequently, the department has an important role in minimising catchment obstructions. The first proposed solution is the implementation of a programme in which the residents express preference as to what method of rubbish removal is used within their section. In general, skips are the most widely used waste disposal method, but they are often not utilised by the residents (Figure 23).

Figure 23: Unused skip in Lotus River settlement

Skips are used infrequently because they are often located too close to residents' homes, and the smell produced by the skips is displeasing to them. Other times, skips are located sparsely throughout the settlements and are not within a feasible walking distance from dwellings, and consequently, residents dispose of litter in the nearest trench or retention pond area, unaware that their actions are impeding flood mitigation.

A possible solution to this problem is to eliminate skips in general and use a method which is more convenient for the community, such as trash pickup from trash bins or trash bags, which allows for rubbish management at the household level (L. Van Oordt, Personal Communication, 1 November 2007). Each home would be responsible for their own trash, which is convenient in that they would not be required to leave their homes to dispose of rubbish. Consequently, the Solid Waste department would need to employ a community member to collect trash from households and bring it to a centralised location for rubbish removal at least once every week. This sort of rubbish removal system requires more manpower and an organised pick up schedule.

According to the United Nation's "Guidelines for Reducing Flood Losses", an incentive programme is a valuable tool for any risk management plan- "incentives should be developed that encourage flood proofing or relocation" (United Nations, 2005). Though previous incentive programmes regarding rubbish removal in Cape Town have been attempted and been unsuccessful, the team believes if there were a dedicated effort by a department such as Solid Waste, then a successful plan could be established. One previous incentive programme that was ineffective gave monetary compensation for those citizens who brought in rubbish to a community collection bin. However, this failed because citizens would bring trash to the bin, collect their money, steal the trash back from the collection bin, and then collect the compensation again, repeating this process multiple times. It is evident, in this case, that the

incentive programme structure is flawed, in that residents were rewarded for the quantity of trash collected and not for the settlement being clean in general.

While solely rewarding individuals, exemplified in the aforementioned case, can lead to conflict and abuse of the incentive system, rewarding the community as a whole as well as at the individual basis may ensure success. For example, the Department may choose an incentive which benefits the community in its entirety based upon its appearance (i.e. if the area is rubbish-free and the skips are utilised) during random assessments. In addition to rewarding the community as a whole, those individuals who actively participate in the clean up should also be rewarded, so as to further encourage participation. These examinations would need to be random to ensure that the area is rubbish-free. This programme would empower the community to work consistently together to attain a common goal.

5.4.2 Societal Capacity & Measures

Societal capacity indicators reflect how well people are educated about and prepared to manage the risk(s) to which they are being exposed. This aspect was not included in our flood risk index because currently there are not enough city-initiated programmes to be measured. Therefore, we recommend a Community-based Disaster Risk Management (CBDRM) Programme to help involve communities in mitigating flood risk. It is also recommended that the City look to utilise alternative methods of communication within the settlements, which will improve the conveyance of risk-related information between the City and the residents, thus increasing societal capacity. The trash incentive program and educational materials about roof and floor design mentioned above are examples of social capacity building measures. In this section, we describe a number of other capacity building measures that we recommend the City consider.

5.4.2.1 Involving the Community in the Mitigation of Flood Risk

One of the principal issues which increase the effects of flooding within the settlements is the lack of household and community participation in flood risk management. This point was reinforced by the team's various site visits and community interviews. One technique that could potentially be used by the Disaster Risk Management department to better manage this issue is the implementation of a CBDRM Programme. According to the Red Cross and Red Crescent Societies, "It is really only at the local level that detailed measures can be planned and undertaken. They [the community members] have the capability because there is always local knowledge, practice, and resources if they can be effectively mobilised" (Red Cross and Red Crescent Societies, 2006). Optimally, our research, findings, and recommendations hope to serve as a means of mobilizing a CBDRM-type effort in the City.

A CBDRM approach takes into account the following points, which are especially relevant to the situation of the City of Cape Town:

- Governments and administrations in developing countries lack the financial, personnel, organisational and legal capabilities to reduce disaster risk through prevention (drafting and control of land-use and building plans, advance warning systems, environmental protection and resource conservation, etc.) and effective disaster preparedness.

- The poverty of broad parts of the population make them more vulnerable to disaster due to restricted preventive and self-help capabilities and a lack of social and financial security in the case of disaster (Bollin, 2003).

Key principles of community-based disaster risk management are shown in Figure 24.

Figure 24: Key principles of CBDRM programme (Holloway, 2007)

While introducing this sort of plan relies on the consultation of those who specialise in community-based risk management, the City would generally take several steps (Figure 25) in introducing such a programme.

Figure 25: Steps of CBDRM programme (Holloway, 2007)

While this method of flood risk management requires resources and proper execution from various City departments, this type of plan would be a definite step in the right direction. Much work in this area has been implemented by Dr. Ailsa Holloway and her colleagues at the University of Cape Town (UCT). Having a deep understanding of the CBDRM approach is crucial before the implementation of any sort of community-based programme; therefore, the team recommends that the City first form a Disaster Risk Reduction Committee (DRRC) which includes members from various City departments and international groups, as summarised in Figure 26. In the past, it is possible that City departments and academic

institutions have been unaware that the work of other groups also pertains to minimising the effects of flooding, therefore resulting in minimal collaboration in the past. However, the formation of this committee would open doors for City departments and groups to share resources and provide an organised approach to minimising flooding.

Figure 26: Groups involved in the proposed flood risk management scheme

This group should look to collaborate closely with the UCT Disaster Mitigation for Sustainable Livelihoods Programme and other academic institutions and NGOs, whose work is focused on community-based risk reduction, to create a DRRC. It is essential for the City to collaborate with these organisations because they specialise in the areas of community based risk reduction programmes while the City does not have this background.

Another recommended resource for the DRRC to utilise is the ProVention Consortium, which is "a global coalition of international organisations, governments, the private sector, civil society organisations and academic institutions dedicated to increasing the safety of vulnerable communities and to reducing the impacts of disasters in developing countries. It provides a forum for multi-stakeholder dialogue on disaster risk reduction and a framework for collective action" (Red Cross and Red Crescent Societies, 2006).

5.4.2.2 Strategies for Communicating in Informal Settlements

We realise that the development and implementation of a CBDRM programme relies on the collaboration of various organisations and may take place over a substantial period of time; therefore, we also formulated a series of recommendations to aid in short term improvements.

We learned from community interviews that many people were not aware of educational materials which created by the Disaster Risk Management department for distribution in high-risk areas. The Bongani TR section of Khayelitsha, for example, was one such area. While ensuring that all areas are given brochures is helpful, it is, at the same time, not entirely effective. To guarantee their effectiveness, it is essential that the brochures are distributed in a door-to-door manner and explained to the recipients. This method was highly recommended by the workers of the Environmental Health department, who have a great deal of experience in the delivery of awareness material. While brochures are one way to convey information and raise awareness in the community, the team feels that there are other methods which may be even more successful in communicating ways to minimise risk at the community level.

It is essential to provide settlement residents with information they need to prepare and respond to flooding at a community and individual level. An appropriate method of communication is crucial to the success of conveying such information. We have formed the following recommendations (Table 8) for communicating flood risk strategies, ranked by what is the most to least recommended option, and described in detail below.

Table 8: Comparison of suggested means of communication

	Positive	Negative	Audience	Amount Generated	Resources Needed	Cost
Folders	Tangible, can include large amounts of information, multi-purpose product (less likely to be thrown away)	Target audience may be small compared to number of residents in community	Children in schools	Dependent on school enrolment numbers	Folders Personnel: Author and illustrator, distributors	✖✖
Posters or Signs in Public Areas	Highly visible, can be placed in many areas (taps, bathrooms, etc.), unable to be ignored, can include large amounts of information	Subject to vandalism, theft and/or weathering	All residents	Low	Outside: Metal Inside: Paper (laminated) Personnel for one-time setup	✖✖✖
Radio Announcement	Large audience due to various locations of radios (public and private areas), up-to-date/urgent information can be received	Only practical for short messages or warnings, no visuals or way to recollect information, requires partnership with radio station(s)	All residents with radio access	One recording to be broadcasted	Personnel to record announcement	✖✖
Newspaper	Tangible, editorials can include large amounts of information	Editorials may be overlooked, paper must be purchased	All literate residents	High	Author and illustrator	✖✖
Colouring and Activity Books	Tangible, multi-purpose product (less likely to be thrown away)	Target audience may be small compared to number of residents in community	Children	Dependent on number of children	Paper Crayons or coloured pencils Personnel: Author and illustrator, distributors	✖✖✖✖
Pamphlets	Tangible, can include large amounts of information	Needs explaining, doesn't serve another purpose than educating, can contribute to litter	Older residents	V. High	Paper Personnel to distribute and explain information	✖✖✖
SMS Messages	Up-to-date and urgent information can be received	Only practical for short messages or warnings, some phones may not be text-enabled or subscribed to receiving messages, list of numbers is needed, requires partnership with cell phone provider(s)	All residents with SMS-enabled cell phones	One message to be sent to given numbers	Means to send message	✖✖

School Folders and Curriculum

It is very important to involve children when considering any type of community interactions, as they are widely known to be the most receptive to new information. We suggest that the City involve children in their community education programme. One way to convey information to children is to print information on school folders. This can be very effective, mainly because the folders are multi-use product that, unlike a pamphlet, also serves a functional purpose. A printed folder may include information on how to prepare for flooding, what to do during a flood, or how to respond after it occurs. The information on the folder can be explained by the teacher as part of a school-level educational program about flooding. Another advantage of folders is that a reasonably large amount of information can be expressed in a relatively small area.

A possible drawback to this method is that the target audience may be small compared to the number of residents in the community. Information on school folders is not likely to be received by a resident who does not have children in school. For a flood awareness programme which includes all members of the community, we suggest that this method be combined with other efforts.

The cost of folders is not projected to be very large. Although an author and/or illustrator will need to be hired, and the folders will need to be bought and printed, the amount of folders generated is much less than pamphlets. The number of folders to be printed depends on the enrolment numbers of schools in the target area(s). Since the folders are a multi-use product, it is nearly guaranteed that the information will be looked at more than once, which will help reinforce the ideas printed on the folder. Since the folder can also be used by schoolchildren, it is less likely than a pamphlet to be thrown away.

Posters or Signs in Public Areas

The "Protect Yourself from Floods" pamphlet (Figure 11) shows a woman pointing to a sign denoting a flood prone area. After several site visits to Philippi, Gugulethu, Khayelitsha, and other areas accumulating to over 20 hours walking in the settlements, the team did not see any public notifications about the risk of flooding akin to what was illustrated in the pamphlet. Consequently, if the presence of signs is going to be advertised, the team suggests the City place such signs in public areas.

Posters or signs are a very practical approach to public notification. When placed in high traffic areas, it is nearly impossible to avoid absorbing some of the contents. It is suggested that laminated posters be placed inside areas such as telephone shacks (with permission), toilet stalls, and other areas visited by members of the community. These posters can communicate anything from preventative measures for flooding to how to respond during a flood.

If made of durable material, these posters can be made into outdoor signs (Appendix VII). Signs expressing the same information as posters can be placed in common outdoor areas such as the communal taps. It is possible that when more than one person is gathered around the tap, positive conversation about the sign will arise, which helps reinforce its ideas.

During our interview with a community in Bongani TR, the residents exclaimed that they had no idea the area was prone to flooding when they moved there during the summer months. Signs distinguishing flood prone areas that are unsuitable for living will be helpful guiding new settlers away from residing in seasonally dry areas like vleis.

Unfortunately, by being in public areas, signs and posters are subject to vandalism or possibly theft. A way to deter theft of signs is to anchor them into the ground. This can be done by very sophisticated methods or simply by creating a large concrete base that makes the sign too unwieldy to be moved or stolen.

The cost of this method is largely dependent on the number of signs and posters created. This method has a moderate to high cost, but is made less expensive because the number of personnel required is much lower than other strategies. The only personnel required are people who hang up posters or install signs, which only needs to be done once and can be completed relatively quickly. If an anchoring method such as a concrete base is used, it will raise the cost of this option. The team highly recommends the City consider this option when creating their future educational programmes.

Radio

Radio is an extremely effective medium of communication, which is why the City currently uses it to broadcast warnings and notifications. On-air announcements are an attractive means of communication due to the large audience of listeners, as radios are used in public (e.g. shebeens) and private areas. A radio broadcast is largely effective at conveying urgent information such as flood warnings, but impractical for describing lengthy procedures.

Challenges in using this method include language barriers and the choice of which station(s) to have broadcast the announcement. The team recommends that the notifications be done in either of two ways: an announcement in multiple languages, with one said after the other, on one radio station or multiple single-language announcements which would be broadcast on different stations. Although the latter suggestion may reach more people, the former will be less costly. It is our suggestion that the use of radio broadcasts continue to be used as a technique to notify City residents of hazards such as flooding.

Newspaper

Prior to winter, an advertisement proclaiming a reminder of the upcoming flood season will be helpful to initiate action to prepare for the months to come. This preparatory method reinforces the idea that a more proactive approach to flooding needs to be taken by the settlement residents. Another advantage of using newspapers is that they are useful for expressing messages without regard to length.

However, using this method of communication risks the possibility that the advertisement could be overlooked and never considered, especially if it was only featured for one day. A possible way to avoid this is to have a multi-part editorial. It is best to have this series featured when there is ample time to read each of its contents, which is why it is recommended to print the articles during the end of the week and into the weekend. A sample schedule of articles can be seen in Table 9.

Table 9: Sample schedule of newspaper articles

	Thursday	**Friday**	**Saturday**	**Sunday**
Article Contents	Photographs of flood damage from last year and homes that survived	Methods to mitigate flooding at household level	Methods to reduce flood risk in community (e.g. proper rubbish disposal)	Emergency procedure(s) and related information

Creating this method of communication does not require the use of many resources. An author and illustrator will need to be hired to create the article contents. The intended audience for the articles is anybody who reads the newspapers; essentially, there is no target age or gender. However, it is important to note that a study found that one quarter of adult residents in the settlements had only primary school education, and are categorised as being "functionally illiterate" (City of Cape Town, 2004). Therefore, the amount of newspaper readers in the settlements may be low. It is projected that this method will not be very costly to the city, especially if this series of articles is only featured in one newspaper. However, to reach more residents, these articles should be made in other languages such as Afrikaans and Xhosa. If this series is printed in more papers then undoubtedly the cost will rise. To increase awareness of the articles, a radio announcement could refer to the newspaper(s) which features the series on managing flood risk.

Colouring and Activity Books

Similar to school folders, colouring and activity books have children as a target audience. The children will colour houses that are properly prepared for flooding, and are safe from flooding. Also in the colouring book will be dwellings that are inadequately prepared, and thus flooded. Another section of the book will be devoted to several small activities to reinforce flood risk strategies. This interactive method aims to establish an understanding of flooding in children who use this book.

To create these books, an author and illustrator will be needed, as well as a company to publish them. Crayons or coloured pencils will also be required to accompany the books. Lastly, personnel must be hired to distribute the books within the neighbourhoods. Although this is the most expensive option, the team believes it is still worth considering, as it will include all children of the settlements, not just the ones enrolled in school.

Other Strategies

Pamphlets are currently a tool used by the City to communicate flood risk. They allow the City to publish a large amount of information at one time, but there are some obstacles to overcome to make them effective.

The current education materials feature drawings, not photographs (Figure 11). As noted by Figlan, Petersen, and Ruiters (31 Oct 07), it is more difficult to relate to drawings than to actual pictures. Another challenge is that the pamphlets cannot simply be handed out to a large audience. To ensure the pamphlet is understood, it requires trained personnel to explain its contents to a very small group of people, or preferably, one-on-one. Unfortunately, the city lacks the resources and time to conduct this type of distribution.

Although printing pamphlets is relatively inexpensive, employing trained personnel to distribute them significantly raises the direct cost. An indirect cost is that improperly disposed pamphlets can end up in rivers, storm drains, and block types of infrastructure that are designed to mitigate flooding. It is our suggestion that the City consider other methods of communicating flood risk than pamphlets.

SMS messaging is an option that the City has not explored. One reason this option was considered was that much like radio, SMS messages are an instant form of communication.

However, there are several limitations to using SMS messages. Only short messages or warnings can be sent, and the audience for these messages is small. The messages must be sent to SMS-enabled phones and/or those with SMS subscription plans. A list of phone

numbers is required, which is difficult to obtain, as some residents may be hesitant to release such personal information. If a flood marshal is employed by the city, it may be worth considering contacting the marshal via SMS messages. Thus, we recommend that the City does not pursue SMS messaging as a communication tool.

Summary of Communication Strategies

For future communication efforts, the team suggests the City move towards a more integrative approach to flood risk management. Instead, we recommend using posters and signs in public, as well as folders for schoolchildren, accompanied by an education programme. We advise the City to implement our ideas on a small scale (e.g. "pilot sites") to examine the effectiveness of the suggested methods. If proven to be effective, the methods could be used for communications with all of the settlements. Although this initiative may initially be costly, the positive long-term effects make this a wise investment. With successful education efforts, flood-related damages will decrease, and fewer people will be displaced from their homes. Ultimately, this will cost the City less money per flood because Disaster Risk Management will not have to provide as many displaced residents with blankets, food, and shelter during times of need.

It is our goal that, once implemented, our suggested means of communication will not only help lessen flood-related losses but also serve as a template for the City for further efforts of communication, regardless of their specific nature.

5.4.3 Recommendation: Increasing Departmental Collaboration

A large issue which affects the City is the lack of communication between departments. In many cases, when one department implements something within the settlements, it does not consult first with other divisions, and consequently impedes the work of these other departments. For example, taps were installed in the Lotus River Community to facilitate washing, however, the responsible department failed to primarily consult with the CSRM department. Subsequently, the tap system was put into use without proper drainage, allowing the water to run off into homes.

Therefore, a proposed solution is for the City to develop a database which allows access to the various City departments within the disaster risk management scheme. It is here that City departments would be able to provide reports pertaining to their work within the settlements, particularly within the realm of disaster risk management. Also each department would have the access to the work done by other departments. This method would ultimately facilitate information exchange between departments.

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Appendix I. Interview Agendas and Questions

Disaster Risk Management Meeting Agenda

29 October 2007

Johan Minnie

Director and Member of Executive Committee

Johan.Minnie@capetown.gov.za

1. Introduce mission statement and objectives for project
2. Questions for Johan
    - What are the responsibilities of your department?
    - When do you typically begin alerting the residents of flooding?
    - What are some of the problems you have come across in trying to communicate with the public?
    - How effective do you believe your current educational programmes are?
    - (Show pamphlet) Any other awareness efforts besides these pamphlets?
    - How effective do you believe the pamphlets were in communicating the risk of flooding?
    - What is the behavioural response from the residents when you try to communicate the risks associated with flooding?
    - What do you believe the best method of communication and why?
3. Questions for Students
4. Other

Environmental Health Department Meeting Agenda

31 October 2007

1. Introduction to students and project
2. Questions for Environmental Health Department:
    - What are the health implications associated with flooding?
    - What are the main duties of your department?
    - Is there a treatment plan after a major flood?
    - Is there a before, during, and after plan for flooding?
    - What are the precautions you advise residents to take to reduce health implications?
    - Who are most at risk?
    - Could you elaborate upon any educational plan or educational materials you distribute in the settlements?
3. Other

Solid Waste Planning Meeting Agenda

Leander van Oordt

Manager: Public Awareness and Education

Leander.van_oordt@capetown.gov.za

1. Introduction to students and project
2. Questions for Leander
    - What are the responsibilities of your department?
    - How is rubbish collected within the informal settlements?
    - How do you determine the placement of skips?
    - How often are the skips cleaned?
    - As you are the manager of public awareness and education for the solid waste department, what do you believe is the best method of communication within the informal settlements?
    - Is there any type of recycling programme within Cape Town?
    - Would a recycling programme be feasible within the settlements?
    - Is there any incentive for the proper disposal of recyclables and rubbish?
3. Other

Dr. Ailsa Holloway and UCT Staff Meeting Agenda

7 November 2007

Director of the Disaster Mitigation for Sustainable Livelihoods Programme

University of Cape Town

Ailsa.holloway@uct.ac.za

1. Introduction to students, advisors, and project description
2. Presentation from Ailsa and students on flood risk management and CBDRM
3. Questions for Ailsa and students:
    - What are some of your experiences working within the informal settlements of Cape Town?
    - What are the most effective means of communicating risks within the informal settlements?
    - What are key approaches to disaster management?
    - A large part of our project deals with the development of a flood-risk index. Are you aware of any risk indices that are widely used in informal settlements elsewhere in the world?
    - Another aspect of our project is to create guidelines for the community so that they can prepare for flooding at the household level (i.e. better construction of homes, maintaining infrastructure). What do you feel is the best way to go about this?
    - Do we as students have access to the UCT Library?
    - What do you and your staff find most challenging when working in the informal settlements?
    - What are your views of the incentive structure or previous incentive programmes that have been implemented by the City within the settlements?
    - Could you elaborate more on your experience regarding flood risk?
    - What do you believe would be a successful early warning system?
    - Are there any NGO's which are participating in flood risk management here in Cape Town?
4. Questions for WPI students and advisors
5. Other

TR Section Community Interview Questions

14 November 2007

Questions for Residents:

- Are you aware of the flooding?
- How many times were you flooded last year?
- How long does your house stay flooded?
- Were you prepared for the flooding?
- Flooding from roof or the ground?
- Why did you move here?
- Have you tried moving to higher areas?
- Do you do anything to minimise flooding in your homes?
- Have you thought about building your house above ground, or raising the floor (on bricks, or stilts)?
- Are you aware of informational material on how to protect yourself and your family during floods?
- What is the extent of flooding? (floor moist, fill with water, unliveable, etc.)
- Are there any areas to properly dispose of trash/rubbish?
    - If so, are they close enough and do you or others around you use them?
- Would you use them if they were available?
- If you received money for throwing away trash would you do it?
- Are you aware of the problems that the trash causes?

Questions for Community Leaders:

- Is there a sense of community in your sect?
- Do neighbours help each other during the floods?
- What is your role in the sect?
- Do you warn new residents of the flooding danger?
- Have you tried to block off land that always floods in the winter?
- Are you aware of flood guidelines?
    - If so do you let others know of these guidelines?
- What are the best methods of communication for the guidelines?
- Are there any areas to dispose of trash/rubbish?
    - If so, do you use them?
    - Does the rest of the community use them?
- Are you aware of the problems that the trash causes?
    - If so, do you let the community know?
- How involved are you with helping others in the community and sharing what you know?

Appendix II. Meeting Minutes and Field Notes

Disaster Risk Management Meeting Minutes

- This department works in collaboration with various others, including CSRM
- Department looks at water table level before sending warnings to residents
    - Use radio stations
    - Work through ward counsellors to distribute warning info
    - Occasional language barrier
- "Residents accept the risk- little to no motivation to manage risk"
- Use posters, pamphlets, and work through counsellors
- Have trialled a "focus group"
    - Was successful, but requires much manpower
- Also supply a DVD for education programme
- Have trialled an interactive programme
    - Skits, plays, scripts
- Must go door to door with information
    - Generally pamphlets end as litter
    - Lack of manpower
    - Lack of funds

Environmental Health Department Meeting Minutes

- Their department doesn't just focus on flooding- various other aspects
- They deal with the aftermath—stagnant/grey water
- TB and scabies are most common after floods
- They provide posters and pamphlets advising residents as to good hygiene practices, as well as community meetings
    - No particular pamphlets regarding health risks associated with flooding
- Monitor drinking water on weekly basis
- Difficult to trace patients- must do investigative work in settlements to track patients
- Shortage of nurses—curative vs. preventative
- Health is not a priority—housing is number one priority
- Crime is a large fear while families are dislocated during flooding
- Have heard of residents flooding their own houses so that they will be relocated first
- Politicians place dwellings in low lying areas to overcrowd a certain ward so to gain votes

Solid Waste Department Minutes

- The department is working on minimising waste and diverting trash from landfills
- Looking towards a regional landfill
- Not a big push for residents to recycle—lack of participation. Residents must sort their own recycling
- Department goes through contractors to implement rubbish pick up in the settlements
    - This creates jobs
    - Contractor works closely with community leader
    - Many times these jobs are correctly done due to the political nature of community leaders and contractors
- The department is trying to move away from use of skips
    - Skips are often destroyed because residents do not want them near their homes
    - Lack of skips
    - Various settlements have looked towards using black bags
- "Think Twice" Project
    - Getting citizens to think about recycling
    - Create infrastructure geared for recycling
    - Market recycling programme
- Suggests to us: to communicate try radio and or door to door approach. Personal interaction is a necessary aspect.
- Problem with rubbish in the settlements is a result of lack of infrastructure

UCT Meeting Minutes

- Work in the Western Cape regarding community risk assessments
- "Challenged to urban flood risk reduction"
    - Ecological
    - Hydraulic
    - Human geography
- Rapid flooding near ravines
- Poor structural integrity of dwellings
    - Damage can extend from 3-4 years before any repair
- Climate change can be attributed to these extreme weather events
- Look towards popularizing process of roof structure and proper construction
- Trying to minimise one risk may impede another (building houses on stilts may make them more susceptible to wind damage)
- Leakage, Seepage main cause of flooding in the informal settlements
- 39/40 households in one pilot area sent their children to the clinic after a severe flooding event
- Risk Factors:
    - Environmental
    - Social
    - Demographic
    - Economics
    - Political
- CBDRM- Community-based Disaster Risk Management
- CRA- Community Risk Assessment
    - These strategies are important to any time of risk prevention programme in the informal settlements
- Tools for CRA: community mapping, committee formation, problem tree, risk list, focus groups
- www.ProVention.gov –great resource for CBDRM programmes
- Should communicate risk off season- prepare for rainy season in summer and fire season in winter
- Maybe team should look towards cost implications of building a robust roof?

TR Section Community Interview Minutes

- Many residents have been in this extreme high risk area for upwards of 15 years
- The water generally rises to knee length level
- Flooded even during summer months
- The homes generally stay flooded for 3-6 weeks at a time
- The majority of the water is coming from the roof
- During flood events residents in the lower lying areas relocate to higher areas in the section
- Relocation is #1 priority for the residents
- Residents have received no awareness material from Disaster Risk Management Department
- Around 1000 dwellings in area
- Regarding trash- the residents would utilise the skips if there were an adequate number
- Material for homes is generally purchased or taken from vacant houses
- As a precautionary measure for flooding, residents build up near the base of their homes using sand, which is sometimes provided by the City

Appendix III. Master Upgrade Plan

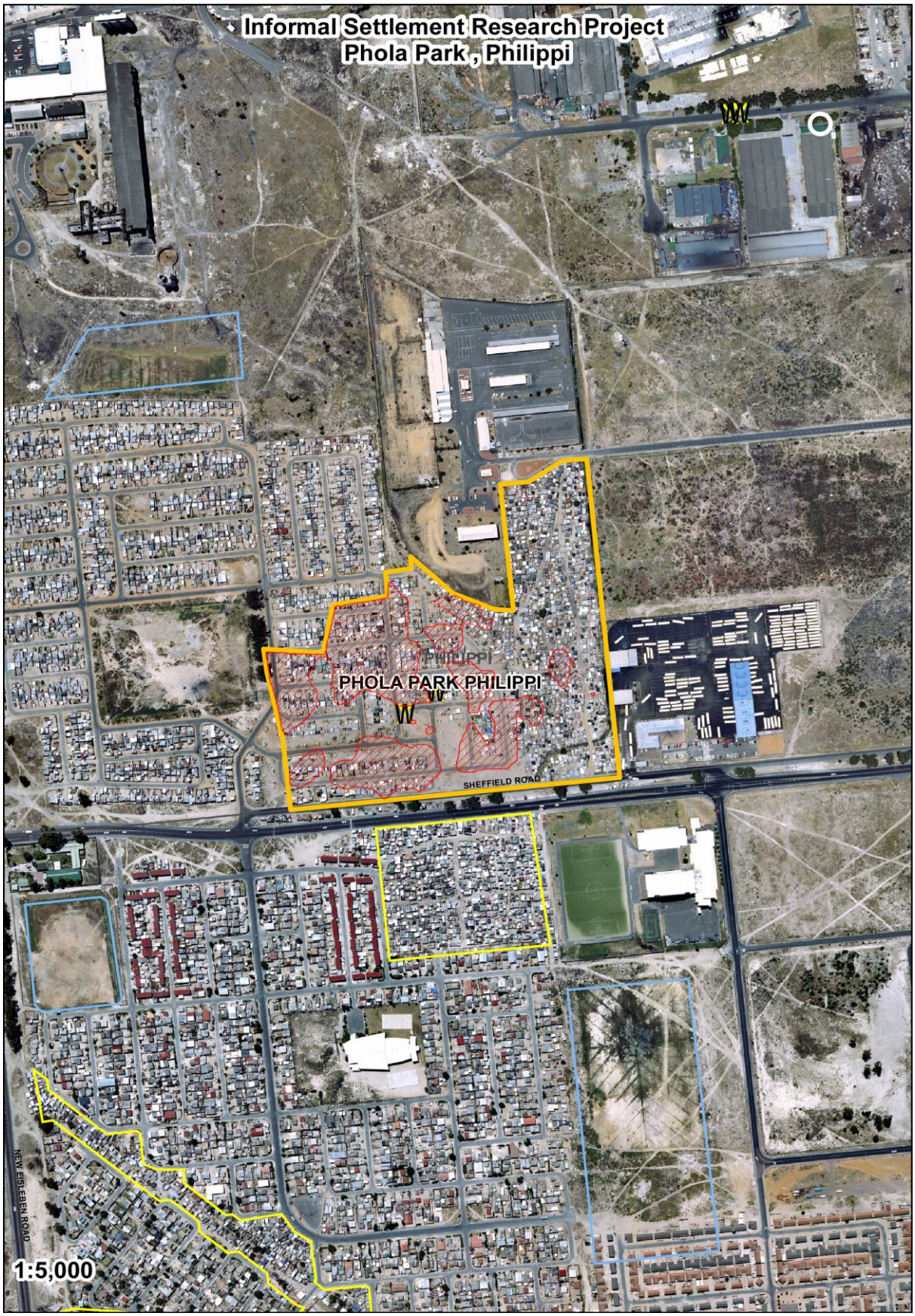
City of Cape T	Required Budget	Dev Time Frame	Age of Settlement			Water Availability		Sanitation Availability	Flood Prone	Fire risk
146	R 1,409,982.00	>10yrs = 5	>10yrs = 5	No. of Dwellings (du) / Area (ha)	No. of Dwellings (du) / No. of Standpipes (Sp)	>200 = 5	No. of Dwellings (du) / No. of Toilets (T)	> 20 = 4	High = 5	High = 5
	R 141,150.00	3 - 10yrs = 3	5 - 10yrs = 4			150 - 199 = 4		11 - 20 = 3	Medium = 3	Medium = 3
		< 3yr = 1	3 - 5yrs = 3			100 - 149 = 3		6 - 10 = 2	Low = 1	Low = 1
			1 - 3yrs = 2			40 - 99 = 2		1 - 5 = 1		
			< 1yr = 1			<40 = 1				

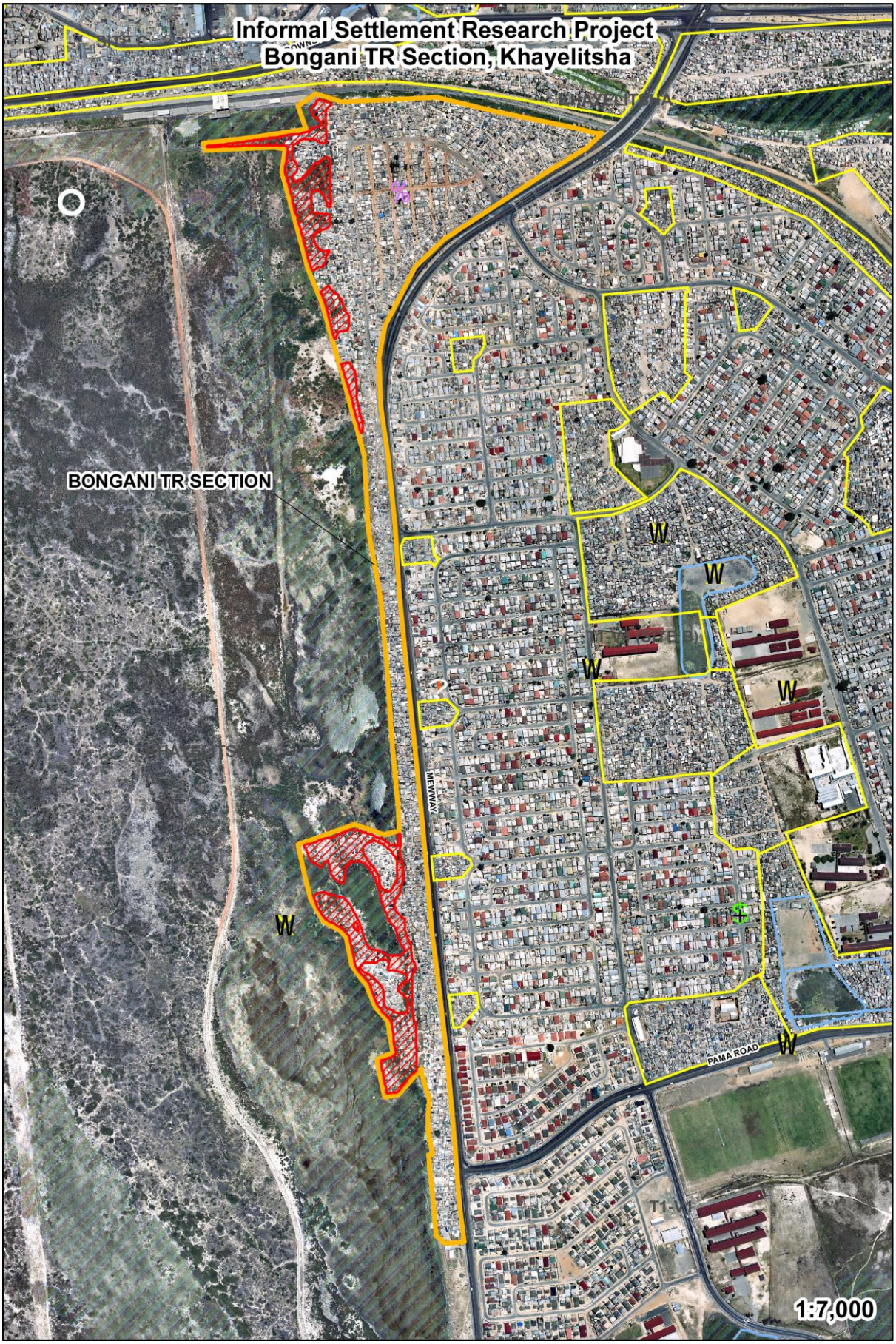
		Electricity	Prioritisation									
Priority No.	Settlement	Area Lighting Current Estimate	Formal Development Timeframe (0)	Age of Settlement (20)	Density (du / ha)	Water Availability ratios (Du / Sp)	Water Availability (20)	Sanitation Availability ratios (Du / T)	Sanitation Availability (20)	Flood Prone (20)	Fire risk (20)	Score (100)
1	Kanana	R -	0	20	162	1981	20	12	15	20	20	95
2	Monwood South	R 10,588.13	0	20	159	300	20	0	20	12	20	92
3	CL Section	R 7,500.00	0	12	179	0	20	0	20	20	12	84
4	Masiphumelele Wetlands	R 8,250.00	0	16	263	116	8	35	20	20	20	84
5	Doornbach	R 27,693.75	0	16	190	112	8	23	20	20	20	84
6	LT Section	R 7,500.00	0	20	257	0	20	0	20	4	20	84
7	Gxagxa	R -	0	16	224	162	16	29	20	20	12	84

Appendix IV. Prototype Flood Risk Index

Phola Park Philippi						
	Houses Indexed:	122				
	Total Houses:	1375				
	Percent Total	8.87				
		Total Count	Percentage	Weight		Risk
Roofs	Pitched	58	0.475	0.000		
	Flat	47	0.385	0.100	Roof Risk	0.07
	Bowl	17	0.139	0.190		
Floor						
	Above	10	0.082	0.000		
	Level	59	0.484	0.090	Floor Risk	0.16
	Below	53	0.434	0.270		
Topography						
	Highest Third (37-37.5m)	190	0.138	0.000		
	Middle Third (36.25-36.75m)	800	0.582	0.140	Topographical Risk	0.16
	Lowest Third/Valley (<36.25m)	385	0.280	0.270		
Bodies of Water						
	Not Present	X	0.000	0.000		
	Bordering	X	1.000	0.140	Body of Water Risk	0.14
	Within	X	0.000	0.270		
Rubbish Removal						
	Daily-Weekly	X	1.000	-0.150		
	<Weekly-Monthly	X	0.000	-0.070	Rubbish Removal Capacity	-0.15
	<Monthly	X	0.000	0.000		
Flood Risk:	**0.37**					

Appendix V. Maps of High-Risk Areas



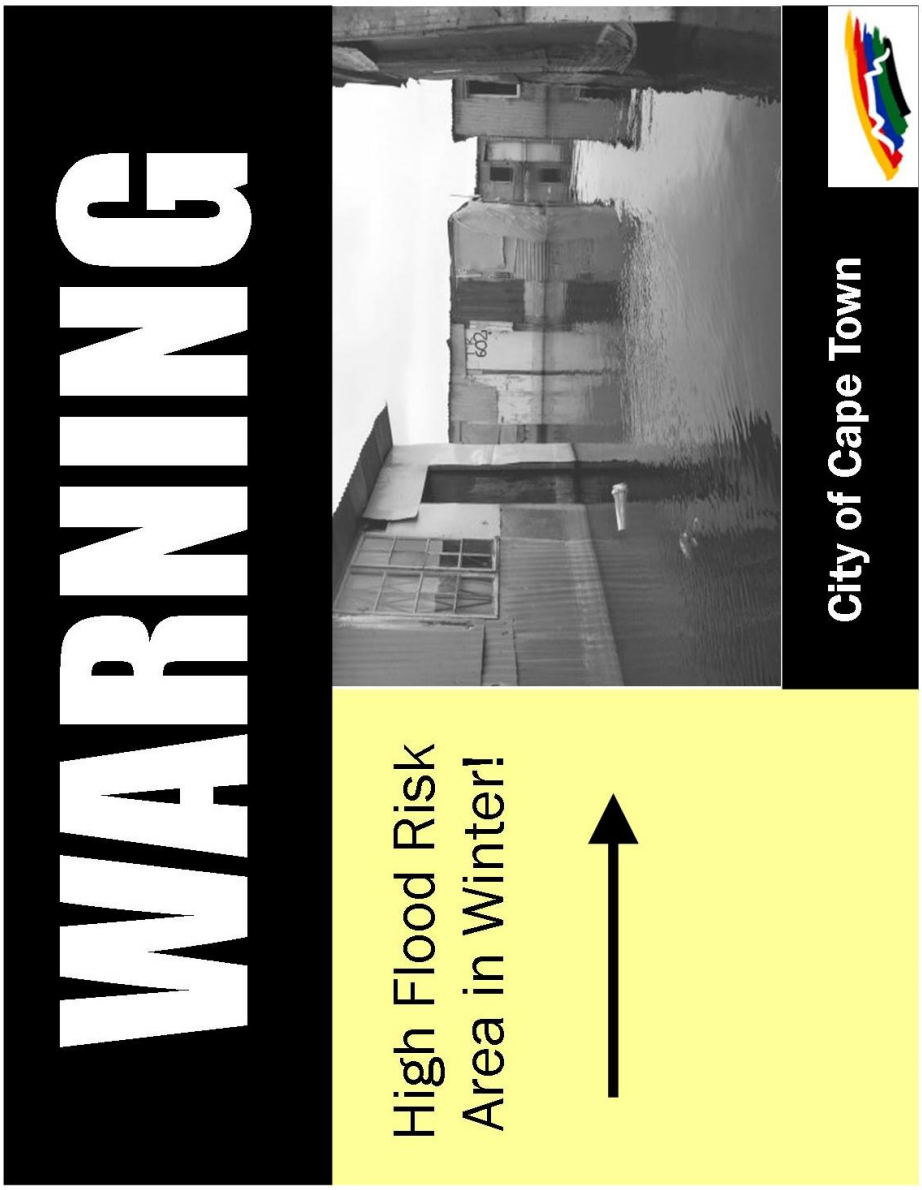

Informal Settlement Research Project
Bongani TR Section, Khayelitsha
BONGANI TR SECTION
MEWWAY
PAMA ROAD
1:7,000

Appendix VI. Structural Guidelines

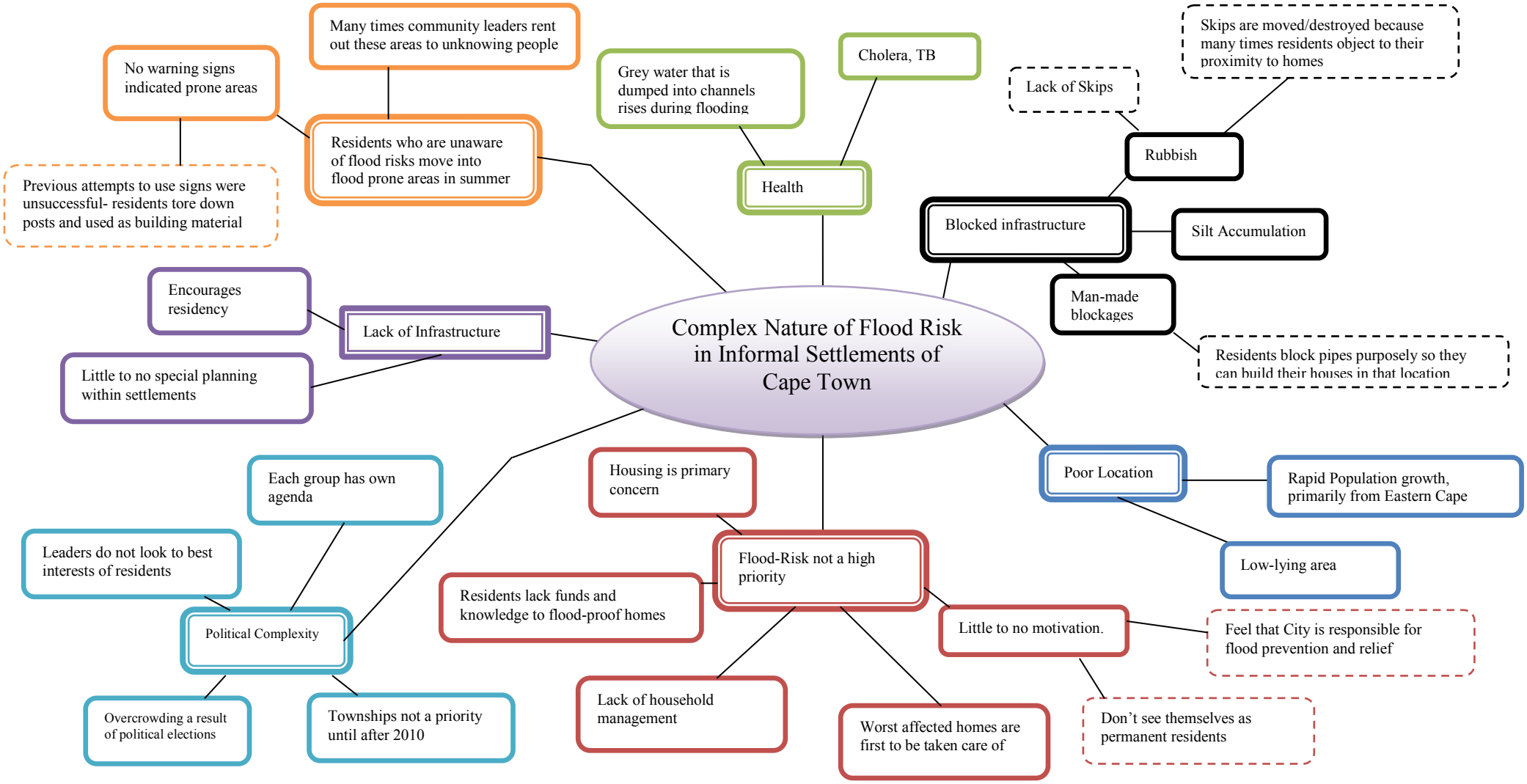

155
Stay dry!
Build your house on concrete.


Protect yourself from flooding!
Raise one side of your roof.

Appendix VII. High Flood Risk Area Proposed Sign



Appendix VIII. Diagram of Complex Nature of Flood Risk



Appendix IX. Annotated Bibliography

Cape Town City Profile
General Flooding Information
Flood Risk Management
Flood Risk / Stormwater Management in Cape Town
Flood Risk Index Development
Newspaper Reports of Cape Town Flooding
Stormwater Management
Educational Tactics

Cape Town City Profile

Browning, K. (2002). Shanty towns: a South African case study. *Geography Review*, *15*(5), 2.

This source gave a closer look into everyday life in Gugulethu settlement. It also provided insight regarding current problems, solutions and policies in the area.

Study on the Social Profile of Residents of Three Selected Informal Settlements in Cape Town. (n.d.). Retrieved September 3, 2007, from City of Cape Town - the official website: http://web.capetown.gov.za/eDocuments/Main%20Report_2722006113759_359.pdf

This source provided insight into specific aspects of informal settlement life in Cape Town which were compiled by a series of surveys and case studies by the Cape Town government.

General Flooding Information

Jonkman, S. N. (2005). An analysis of the causes and circumstances of flood disaster deaths. *Disasters*, *29* (1), 75-97.

Rating: Useful background material
This article examines the underlying causes of deaths related to flooding disasters. It provides detailed information (including statistics) about drowning, physical trauma, and electrocution as a result of flooding. Furthermore, it contains references to other articles that focus on the non-lethal effects of flooding disasters.

Kolsky, P. (1998). Storm Drainage: An engineering guide to the low-cost evaluation of system performance. London, UK: Intermediate Technology Publications.

This novel was written to help engineers understand surface water drainage problems more clearly so that they can work on more realistic solutions.

Smith, R. (2001). *Ecology and Field Biology* (6 ed.). Boston, MA: Benjamin Cummings.

The Flood Pulse Concept is introduced in the Comparative Ecosystem Ecology chapter of this book. There are also analyses of several types of land (wetlands, floodplains, flats, etc). Factors such as soil permeability, elevation, and general hydrology are also examined, to provide a comprehensive, ecological look at flooding.

Tapsell, S. M.-R. (2002). Vulnerability to flooding: Health and social dimensions. *Philosophical Transactions: Mathematical, Physical and Engineering Sciences, 360*, 1511-1525.

Rating: Useful background material
This article looks at the health and social consequences of flooding. It provides very detailed information about the following:

- *physical health effects of flooding*
- *mental health effects of flooding*
- *behavioural changes due to flooding*

Flood Risk Management

Miller, E. M. (2000). *Natural disasters: floods: a reference handbook.* Santa Barbara, CA: Contemporary World Issues.

Rating: Useful for both background information and methodology
This is a reference handbook that contains a bulk of useful information regarding flooding in general. It explains the origins of floods, flood warning systems, forecasting techniques, flood control, and the various types of flooding. The forecasting techniques could prove to be useful in the development of a flood risk index.

Napier, M., & Rubin, M. (2002). Managing Environmental and Disaster Risks Affecting Informal Settlements: Lessons in Innovative Practice From South African Local Authorities. International Conference and Meeting of CIB Task Group 40 on informal settlements, Pretoria, South Africa.

This paper presents a number of case studies which demonstrate how municipalities manage disasters such as flooding. Three types of emergency situations are reviewed: flooding, fires, and evictions. The paper discusses the flooding management policies of South Africa set forth after the establishment of the National Disaster Management Centre.

Napier, M. d. (2002). Understanding the interface between the environment and sustainable livelihoods in the integration of informal settlements in Asia, Latin America and Africa: a review of current thinking and practice. Pretoria, South Africa: CSIR Building and Construction Technology.

Rating: Useful background information
This publication describes the connection between the environment and sustainable development in not only Africa, but also many other poorer areas around the world. This resources touches upon many aspects of the informal settlements, such as the socio-economic conditions of the inhabitants, the formation of the settlements, types of informal housing, environmental impacts of settlements, basic services, and the various hazards associated with these settlements.

National Research Council. (2000). *Risk Analysis and Uncertainty in Flood Damage Reduction Studies.* New York: National Academy of Sciences.
This document defines risk analysis and also looks into risk communication briefly. This was helpful in our Flood Risk Management section to further define flood risk and what it means when a community is at risk for flooding.

Structural Engineering Institute. (2000). *Flood Resistant Design and Construction.* Reston, VA: American Society of Civil Engineers.

This provides a look into flood resistant structures and their designs. It also contains information on flood prevention in United States, as well as storm proof buildings in United States. It is a reference that provides examples of successful existing flood prevention plans.

United Nations. (2005). The United Nations: Guidelines for Reducing Flood Losses. Retrieved September 28, 2007 from http://www.un.org/esa/sustdev/publications/flood_guidelines.pdf.

This book of guidelines is a compilation of three seminars held by the United Nations in which discussions were held regarding the reduction of flood losses, particularly in informal settlements. It describes several case studies in areas of high poverty and limited resources. All of the information and tactical approaches to flood risk management are relevant to the scope of our project.

United Nations Centre for Human Settlements. (1996). Guidelines for Settlement Planning in Areas Prone to Flood Disasters.

This manual is targeted at public officials, land planners, and builders of settlements who have the responsibility in their regions to reduce the risks and losses from flooding. It discusses some of the important aspects of flooding (which would be particularly useful since flooding is such a broad topic and this manual would highlight only the topics which are applicable to planners). Another section of this manual which would pertain to our project is the section entitled: Institutional Organisation for Flood Disaster Mitigation. The authors explore particular scenarios in Bangladesh and Thailand.

Flood Risk / Stormwater Management in Cape Town

Cape Town, C. o. (n.d.). *Protect yourself from Floods*. Retrieved September 1, 2007, from City of Cape Town website: http://web.capetown.gov.za/Documents/Disaster_Management_ENG

The city of Cape Town website provides "Awareness and Preparedness" documents which demonstrate to citizens how to be prepared in the wake of a disaster, such as flooding and fire. One of our objectives is to educate the community about flooding and this is an existing educational document put in place by the city of Cape Town.

Grobicki, A. (2001). Urban catchment management in a developing country: The Lotus River project, Cape Town, South Africa. *Water Science and Technology*, *44* (2-3), 313-319.

Examples of other stormwater management are examined in this article. It applies directly to our project and focuses on underdeveloped areas in Cape Town and will provide insight into what has been implemented in other areas. The above article will most likely be used in the 'Flooding in Cape Town' and 'Stormwater Management' sections of the outline.

Mukheibir, P.; Ziervogel, G. (2006). Framework for Adaptation to Climate Change in the City of Cape Town. Retrieved September 4, 2007, from City of Cape Town Official Website: http://web.capetown.gov.za/eDocuments/Framework_for_Adaptation_to_Climate_Change_(FAC4T)_08_2006_38200713832_465.pdf

This report focuses on the effects of climate change on the City. The authors describe and overarching framework which would reduce the vulnerability of the city to climate impacts. This is particularly useful to our group, as it discusses the approaches in which the city is taking to minimise flood risk. It also describes the stormwater infrastructure of the city.

Flood Risk Index Development

Ologunorisa, T., & Abawua, M. (2005). Flood Risk Assessment: A Review. Journal of Applied Sciences and Environmental Management, 9 (1), 57-63.

Contained in this article is a review of some of the techniques of flood risk assessment using case studies from different countries in the world. The explored techniques include: meteorological, hydrological, hydrometeorological, socio-economic, and those based on the Geographic Information Systems (GIS). As a conclusion, the authors suggest that the GIS technique appears to be the most promising as it is capable of integrating all the other techniques of flood risk assessment. It also illustrates the three distinct steps which are encompassed by the term "risk assessment". This journal article was very useful to our group in that it delves deeper into what it actually means to "assess the risk" of a potential disaster. The article also explores various case studies and suggests the most efficient means to assess flood risk.

Seiler, R., Hayes, M., & Bressan, L. (2002). Using the Standardized Precipitation Index For Flood Risk Monitoring. *International Journal of Climatology*, *22*, 1365-1376.

The authors of this journal article claim that the availability and application of adapted indices will allow the continuous monitoring of the potential threat of possible flood events in "order to promote preventive actions to mitigate the impacts of the phenomenon". Currently, there is no certain way to monitor flood risk areas. The aim of this paper, which was largely based on the recurrent floods affecting the Cordoba Province in Argentina, is to analyse the SPI (standardized precipitation index) as a means for monitoring flood risk in this particularly poorly drained, low lying area.

Newspaper Reports of Flooding in Cape Town

Barnes, Clayton. (2007, July 28). Kosovo families wading through hopelessness; City's most flood prone community. *Cape Argus,* p. 5. Retrieved September 23, 2007 from LexisNexis database http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110111214&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2110110323&cisb=22_T2110110318&treeMax=true&treeWidth=0&csi=312414&docNo=16

Cape Council. (2007, August 10). Relief efforts bring justice for dispossessed flood victims. *Cape Argus,* p. 16. Retrieved September 23, 2007 from LexisNexis database http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110269651&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2110269654&cisb=22_T2110269653&treeMax=true&treeWidth=0&csi=312414&docNo=2

Africa News Service (August 1, 2007). Cape Starts Post-Flood Recovery. NA. General OneFile. Gale. Worcester Polytechnic Institute. 3 Sept. 2007

This article gives a closer look into current policies regarding flood relief in the settlements.

Dentlinger, Linsay. (2007, July 31). We can't move everyone, says housing boss Sites need to be prepared. *Cape Argus,* p. 4. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110111214&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2110110323&cisb=22_T2110110318&treeMax=true&treeWidth=0&csi=312414&docNo=9

Du Plessis, Henry. (2007, July 31). New arrivals set up shacks in areas prone to flooding. *Cape Argus,* p. 4. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110111214&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2110110323&cisb=22_T2110110318&treeMax=true&treeWidth=0&csi=312414&docNo=10

Medved, Matt. (2007, July 31). Informal residents want houses and toilets – and to be moved out of 'unfit' places. *Cape Argus*, p. 5. Retrieved October 1, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2161777257&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2161777261&cisb=22_T2161777260&treeMax=true&treeWidth=0&selRCNodeID=37&nodeStateId=411en_US,1,20&docsInCategory=51&csi=312414&docNo=11

This article presents the opinions of informal settlement residents, particularly their unhappiness with the city's response to flooding.

Medved, Matt. (2007, August 7). Philippi clean-up to begin; Community to choose 80 workers for project today. *Cape Argus*, p. 4. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110284144&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2110284147&cisb=22_T2110284146&treeMax=true&treeWidth=0&csi=312414&docNo=5

Mzolisi Witbooi. (2007, June 12). Woman shot during protest over flooding; 'ANC councillors involved in clash'. *Cape Argus*, p. 4. Retrieved September 16, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?start=2&sort=BOOLEAN&format=GNBFI&risb=21_T2063383583

An important part of the project is the motivation behind the change. In this newspaper article it describes a situation that occurred and how the flooding is causing violence among in the community, which is likely one of the motivating factors.

Oliver, Lenore. (2007, August 1). Government team to assess flood damage; Recovery plan needed for Cape Flats. *Cape Argus*, p. 6. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110111214&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2110110323&cisb=22_T2110110318&treeMax=true&treeWidth=0&csi=312414&docNo=4

Prince, Natasha. (2007, August 2). Flooded school suspends classes Pupils and staff sent home as floodwater in the grounds poses safety and health risk. *Cape Argus*, p. 4. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110763069&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2110763072&cisb=22_T2110763071&treeMax=true&treeWidth=0&csi=312414&docNo=6

Sandiso Phaliso. (2007, August 27). Flood-hit school to take high ground. *Cape Argus*, p. 7. Retrieved September 16, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2063502547&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2063502550&cisb=22_T2063502549&treeMax=true&treeWidth=0&selRCNodeID=2&nodeStateId=411en_US,1,2&docsInCategory=165&csi=312414&docNo=8

Staff Reporter. (2007, August 24). Heavy rains flood Philippi school. *Cape Argus*, p. 3. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110276540&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2110276543&cisb=22_T2110276542&treeMax=true&treeWidth=0&csi=312414&docNo=2

Staff Writers. (2007, August 03). City braces for more floods; '10% of informal settlements at risk'. *Cape Argus*, p. 4. Retrieved September 16, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2063519818&format=GNBFI&sort=BOOLEAN&startDocNo=1&resultsUrlKey=29_T2063519821&cisb=22_T2063519820&treeMax=true&treeWidth=0&selRCNodeID=25&nodeStateId=411en_US,1,2&docsInCategory=1&csi=312414&docNo=1

Flooding has affected the informal settlements in many different ways. This article gives insight into some of the impacts. The article will be a part of the major section of the background which will focus significantly on 'Flooding in Cape Town'.

Times Media. (2007, July 30). Hundreds demand relief in Gugulethu. *Business Day*, p. 3. Retrieved October 1, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2162202780&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2162202792&cisb=22_T2162202791&treeMax=true&treeWidth=0&selRCNodeID=4&nodeStateId=411en_US,1&docsInCategory=12&csi=230184&docNo=5

Witten, Jade. (2007, August 1). Houses on stilts could help alleviate flooding in townships. *Cape Argus*, p. 4. Retrieved September 23, 2007 from LexisNexis database. http://www.lexisnexis.com/us/lnacademic/results/docview/docview.do?risb=21_T2110111214&format=GNBFI&sort=RELEVANCE&startDocNo=1&resultsUrlKey=29_T2110110323&cisb=22_T2110110318&treeMax=true&treeWidth=0&csi=312414&docNo=12

Stormwater Management

Ferguson, B. (1990). On-site Stormwater Management: Applications for Landscape and Engineering. New York: Van Nostrand Reinhold.

This book will be valuable for looking at designs of stormwater management systems in the settlements. Contains information on:

- *urban runoff*
- *watershed management*
- *urban hydrology*

Hoch, C. (2000). *The Practice of Local Government Planning.* Washington, D.C.: International City/County Management Association.

Two important concepts are discussed in this book: Using Site Analysis to Improve Project Design and Elements of a Comprehensible Sustainable Development Strategy. Site Analysis describes the important steps and considerations to follow when trying to improve an already existing project design. This applies to our project because one of our objectives is to examine the existing plan that the city of Cape Town has already implemented in the informal settlements. Elements analyses many factors that are often overlooked when trying to form a sustainable development strategy. Some of these elements apply to our project, such as Compact Urban Form (overcrowding). There is also a case study about stormwater management in Tulsa, OK and the environmental impacts of flood prevention options (dams, levees, drains, etc).

Parkinson, J. (2003). Drainage and stormwater management strategies for low-income urban communities. Environment and Urbanization, 15, 115-26.

Based upon a review of the literature, this paper focuses on the provision of drainage systems and stormwater management strategies in low income urban settlements. "Although engineered infrastructure is a necessary component for drainage of urban runoff, non-structural approaches are important complementary measures, focusing on actions to prevent and mitigate problems related to flooding, as well as those related to pollution and deterioration in environmental health conditions." This paper was useful in that it particularly focuses on low income urban settlements.

Whipple, W. (1983). *Stormwater Management in Urbanizing Areas.* Englewood Cliffs, NJ: Prentice Hall.

Another book that can be referenced for designs of stormwater management systems. Contains information on:

- *storm sewers*
- *urban runoff*
- *flood damage protection*

Educational Tactics

Lammerink, M. &. (2002). Supporting community management: A manual for training in community management in the water and sanitation sector. Delft, The Netherlands: IRC International Water and Sanitation Centre.

Rating: Very useful resource for methodology
This publication provides many detailed methods and plans for educating and training communities. By educating the communities themselves, this would empower them with a greater responsibility to reduce the impact of flooding upon the community. The publication explains many tools that would be quite useful when trying to obtain the various experiences and perceptions of the community itself.

Lundgren, R; McMakin, A. (1998). Risk Communication: A handbook for Communicating Environmental, Safety, and Health Risks. Copyright 1998; Bettelle Memorial Institute.

This book also provides risk communication strategies to raise awareness of disasters. Particularly, it goes into detail about the ethical issues in risk communication. It is important for the team to be familiar with ethical concerns so that when we are devising our communication plan, we are not offending anyone.

National Research Council. (1989). Improving Risk Communication. New York: National Academy Press.

This source summarizes general information regarding risk communication. It also offers structure as to how a community should improve risk communication and describes in detail successful communication approaches. It particularly looks to make the public involved in any sort of risk communication. This was particularly useful in our communication methodology.