CHAPTER 7:

Conclusion

7.1 Concluding Remarks

All microbial infections consist of interplay between the infectious agent (a pathogen), the affected host(s) and the environment in which the infection occurs. Climate can influence pathogens, vectors, host defences and habitat (Epstein, 2001). Climate is a key determinant of health as it constrains the range of infectious diseases, while weather affects the timing and intensity of outbreaks (Dobson and Carper, 1993). On the other hand, human activities are the most potent factors driving disease emergence (Wilson, 1995b). The worsening of social conditions and inadequate public health programmes underlie the rebound of an individual's vulnerability to diseases (IPCC, 2001). An understanding and a quick response to disease emergence require a global perspective, conceptually and geographically (Wilson, 1995a). This concluding discussion focuses on various factors that contributed to the outbreak of cholera and its subsequent spread to epidemic proportions at the community level. The issues put forth is as a result of using available data on the disease together with the demographic, socio-economic and climatic data of KwaZulu-Natal (KZN) to model different scenarios in order to obtain information that could be used in the management of cholera.

The occurrence of outbreaks of cholera in Africa in the 1970s (Goodgame and Greenough, 1975; WHO, 1991; WHO, 2000) and mainly in coastal communities of Peru in 1991 (CDC, 1991; Tauxe *et al*., 1994; Seas *et al*., 2000), in India (Blake, 1994; Finkelstein, 1999) and in Bangladesh (Shimada *et al.,* 1993; Lobitz *et al*., 2000) have stimulated efforts to understand environmental factors influencing the geographic distribution of epidemic *V. cholerae*. Included in these efforts was this study, whose primary objective was to evaluate the dynamics of the 2000-2004 cholera epidemic in KZN, with respect to the natural environment, i.e. temperature, rainfall and humidity and the socio economic status of the communities in that region. In particular investigate how issues associated with sanitation, water supply, population density; income and housing expose communities to the risk of cholera.

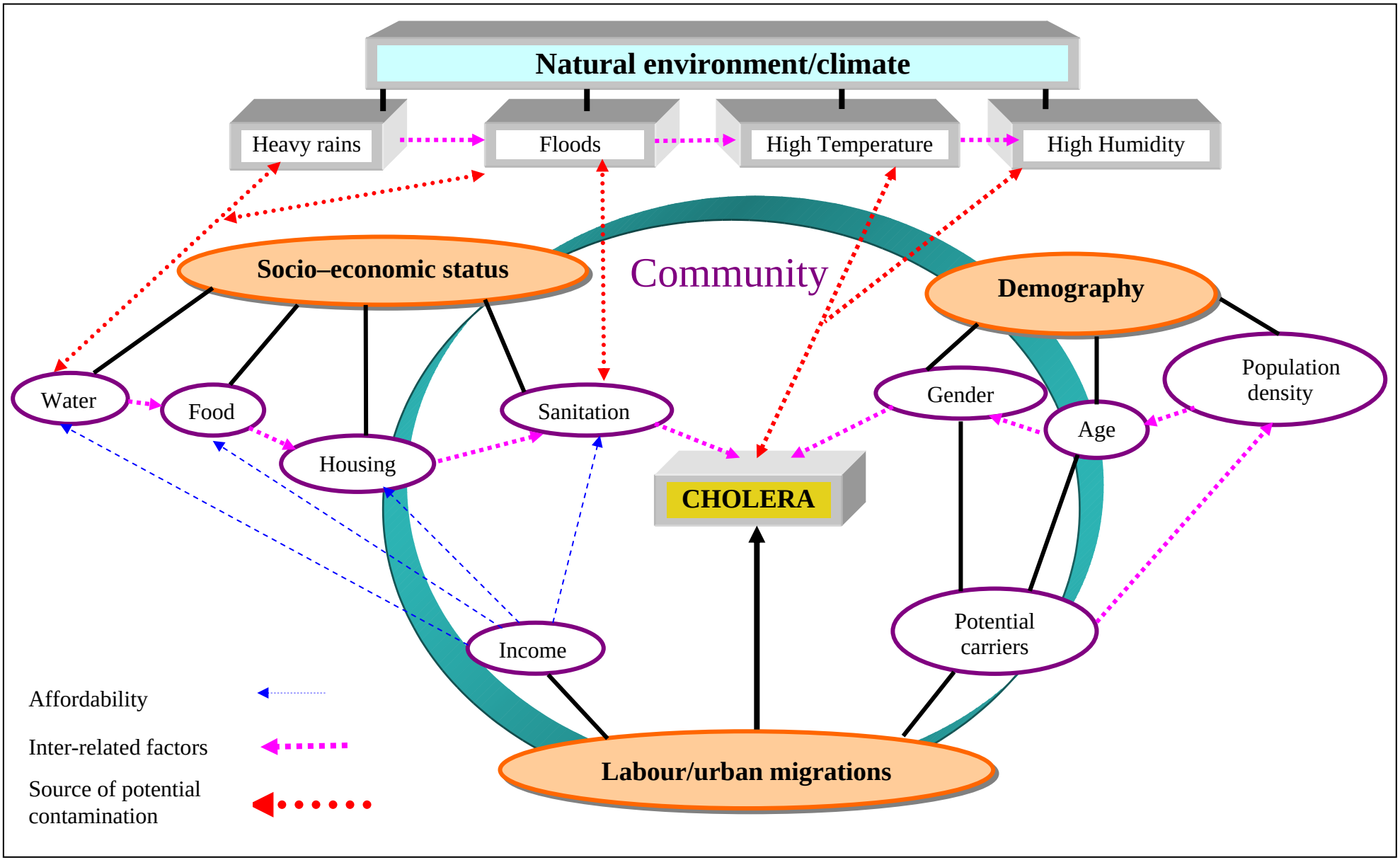

Figure 7.1: The role of the natural and social environment in the cholera epidemic of KZN

The study was therefore, an integration of knowledge about cholera and how it relates to the natural environmental, especially the local climate, the socio-economic status and demography (Figure 7.1). This holistic approach brought to the fore factors implicated in previous cholera outbreaks and more (Isaäcson *et al.*, 1974; Kustner *et al.*, 1981; Tshibangu, 1987; Küstner and du Plessis, 1991; Athan *et al.*, 1998; Keddy and Koornhof, 1998).

There was no link to the local climatic conditions to the incidence of cholera in KZN, though an overall seasonality to the incidence of cholera in KZN was demonstrated (Chapter 5: 5.2.2). Spatial analyses using GIS technology demonstrated that the incidence of cholera in KZN concurred with the seasonal variations in rainfall, humidity and temperature. Cholera case numbers increased in the summer months when high rainfall and elevated ranges of temperature and humidity exist in KZN. While the opposite was true in the winter months whereby case numbers would wane to a minimum when rainfall, temperature and humidity are at their lowest annual levels. Similar seasonal patterns have also been observed in previous epidemics in South Africa (Isaäcson, 1976; Sitas, 1986; Küstner and du Plessis, 1991). The decrease in case numbers in winter is indicative of such climatic conditions as not being supportive of the optimal growth conditions of *V.cholerae*.

The secondary aspect of the study set to investigate the hypothesis involving socio-economic variables and their contribution to the spread of cholera. This relationship was proved to be positive (Chapter 6: 6.1). Furthermore, it was realised during the study that the dynamics of cholera is however a complex issue involving interrelationships between the natural environments and factors associated with the socio-economic status of the affected communities, especially with the supply of basic services (Figure 7.1). It is reasonable to understand that water and sanitation plays a significant role in the transmission of cholera considering the pathogen is waterborne and its entry and exit from the human host is through the oral-faecal route.

During the height of the epidemic period, the following conditions/situation prevailed:

- Heavy rains were recorded in KZN at the time (Nov-Jan 2000/01).

- It was during the end of annual festive season (Nov-Jan 2000/01).
- The population was highly migratory as is usually is the case during such festive periods when migrant labourers return to their homes.

Cholera was more severe in the rural areas and townships of KZN. More so around the peri-urban areas near the town of Empangeni in District Council (DC) 28 (Map 27). The cholera epidemic revealed a possible interdependence of facilitating factors such as water, sanitation, housing and climate and social behaviour, which made the epidemic picture complex (Chapter 6: Table 6.4). It was easy for cholera to spread from DC28 to the adjacent DCs and subsequently spread further because the status of the basic service delivery (water, sanitation, housing) was either at the same level as that of DC28 or most of the time even worse off as spatially demonstrated spatially by Maps 6-17.

The environmental reservoir of cholera has been established to be the aquatic environment and it is linked to biological sources including cyanobacteria, zooplankton and copepods (Colwell, 1996; Colwell *et al*., 1981; Hood *et al*, 1981; Huq *et al*., 1983; Colwell and Huq, 2001). An epidemiological and ecological surveillance lasting 4 years by Huq *et al*., (2005) has revealed significant correlations of water temperature, water depth, rainfall, conductivity, and copepod counts with the occurrence of cholera toxin-producing bacteria. Marine studies of *Vibrio cholerae* and its link to outbreaks of cholera in South Africa have yet to be established. To date, there is no conclusive evidence as to the exact source, be it aquatic or terrestrial, of the 2000-2004 cholera epidemic. The source may have well been a traveller from one of the neighbouring countries such as Mozambique where cholera is known to be endemic. Alternatively, cholera may have already been endemic in KZN communities, and the timing of the extreme weather condition of the last quarter of the year 2000 offered optimum conditions that supported the proliferation of *V. cholerae* to infective doses; leading to an epidemic.

The social-economic factors supporting the outbreaks clearly point to the low level of delivery of water and sanitation services in the affected communities. In addition, the development of man-environment transmission cycle that stems from unsatisfactory

disposal of sewage or uncontrolled defecation, contributes to contamination of the environment with vibrio-bearing faeces. Establishment of a transmission cycle through pollution of water sources appears to have been the most common form, though soil and food may also have been contaminated. The scourge of HIV/AIDS within the last two decades also inevitably further complicates the disease picture of cholera epidemics. Albeit, although unsafe drinking water, inadequate sanitation and environmental pollution have previously been associated cholera pandemics, the main issue underlying all these shortfalls is poverty.

7.1.1 Priorities in meeting basic needs

Access to safe and sufficient water and sanitation are basic human needs and essential to the health and well being of an individual. Domestic water is recognised as the first priority in national water policies in many countries including South Africa. The provision of improved sanitation and hygiene is often linked to this. Improved sanitation and hygiene are proven to be most effective in reducing diarrhoea morbidity (even more so than the water quantity and quality). Thus the provision of basic sanitation should be considered just as important as that of water services in the most affected areas. Linked to this but secondary, are issues that involve women such as fetching water from rivers for domestic uses and as caregivers to cholera victims. These are the target groups of choice in addressing social habits, which require cultural/educational programmes (WHO, 2002). The above-mentioned factors/issues supported the spatial model (Chapter 6: 6.3.1) in selecting for areas with a high potential to cholera outbreaks. The model can thus also be used to prioritise management efforts in other provinces to improve the implementation and roll out of basic services.

7.1.1.1 Managing risks

Provision of security from floods, pollution and other water related hazards, is a basic human right as it directly impacts on the basic human requirements of safe water, food and shelter.

- Recognise the link between population growth, climatic and environmental change, global migration, human health and security (Wilson, 1995a). Understanding how climate affects the transmission of these diseases will led to enhanced preparedness for early and effective interventions as well to control the resurgence of infectious disease.
- Develop databases that combine information about climate, demography, population movements, and communicable diseases that will improve surveillance and response capability. This was aptly demonstrated where clusters of cholera cases were shown to be confined to certain climatic ranges (Chapter 6: 6.2.4). Such initiatives will also ensure that long-term disease monitoring programmes become an integral part of health surveillance systems.
- Identify markers for regions or populations at high risk of epidemic disease as illustrated by the creation of Map 33 (Chapter 6: 6.3.1); so that interventions to reduce the impact of disease can be put in place. Timeous warning systems based on the health monitoring programme will lead the way to environmentally sound public health policies and interventions (Epstein, 2001).

7.1.2 Issues at hand

Whether cholera originated from an undiscovered endemic site or from a fresh importation is unknown. The cholera epidemic persisted for four years, so permanent endemicity in KZN must be considered a definite possibility. The continued survival of *V. cholerae* makes new epidemic outbursts probable in the future. Especially as one considers that with time, antibody levels in the population will decline and the numbers of individuals like young children, old people and new community members with no previous exposure to cholera will increase (Stock, 1976). As the level of susceptibility of the population rises, so does the risk to new epidemics.

This state of affairs immediately put forward certain issues that either had a direct or indirect impact on the cholera outbreak and its subsequent spread to epidemic proportions. These include the influence of the local climate on disease transmission, the economic and social factors of poverty, HIV/AIDS, the gender biased disease picture and the role of travel in the dissemination of the disease.

7.1.2.1 Poverty

The issues that were proven to be significant in this study related to issues highlighting the inefficiencies in the provision of water and sanitation, which go hand in hand with poverty. Thus the issue of poverty was indirectly reflected in the data and statistically supported as an issue that compounded the cholera epidemic. The poor are most vulnerable to water related hazards; extreme floods, pollution etc. and often suffer from multiple vulnerabilities, the effects of which compound each other (Soussan, 2003). Health hazards where water is a vector are endemic in many regions. Poor people also suffer disproportionally from malnutrition and other health problems, which are exacerbated by a lack of water and sanitation (WHO, 2002). In South Africa, the lack of a social security and high levels of unemployment mean that poor households and communities slip further and further into poverty and deprivation. Invariably, with the burden of coping falling on women, particularly girls and grandmothers (AFSA, 2005).

7.1.2.2 HIV/AIDS

The national average of the proportion of HIV positive women attending antenatal clinics in 2003 was 27.9%. The province of KwaZulu-Natal continued to have the highest prevalence, at 37.5% (AFSA, 2005). Waterborne diseases like cholera are a threat to people living with HIV/AIDS. The risk of cholera to immuno-compromised individuals will thus always be an issue, considering their increased susceptibility to infections including cholera. The link between HIV/AIDS and water reflect some of the often-unanticipated long-term implications in the provision of clean water to communities (Ashton and Ramasar, 2002). Exposing people infected with HIV/AIDS to poor quality water heightens the risk to waterborne diseases like cholera. In the meantime, individuals with healthy immune systems will continue to be challenged as they get in contact with *V. cholerae* from neighbouring aquatic environments to become asymptomatic carriers and serve as transient reservoirs for *V. cholerae,* until conditions are suitable for the organism to start another epidemic cycle. Consequently, the pool of carriers may in turn help to seed the aquatic and terrestrial environments even further with *V. cholerae* if among them are those that cannot afford basic water and sanitation services.

7.1.2.3 Women

Gender issues continuously come to the spotlight and it was no exception with the resultant picture of this cholera epidemic. Acknowledging the fact that females operate in a defined social structure especially in rural settings goes hand in hand with the associated social and environmental responsibilities. To suggest to rural women to boil or chlorinate water increases the already heavy labour burden, in terms of collecting firewood and water; the labours of cooking, cleaning and child-care (Mbali, 2002). The multiple demands on women in the rural world are intensified in the case of households headed by women; moreover, these women do not have equal access to resources, wages, credits or decision-making. The cost recovery initiatives especially in the water sector that were implicated in fuelling the cholera epidemic in question, also increases the amount of time women had to spend caring for sick family members and in child care (Mbali, 2002). As such, these issues can only start to be addressed once the availability of safe drinking water and the availability of safe excreta disposal become basic services available to all individuals.

7.1.2.4 Travel and labour migrations

Travel is a potent factor in the emergence of diseases. Migration of humans has been the pathway for disseminating infectious diseases through various mechanisms. In addition, social, economic, political, climatic, technologic and environmental factors shape disease patterns and influence emergence (Wilson, 1995a). To assess the impact of travel on diseases emergence, it is necessary to consider the receptivity of a geographic area and its population to microbial introduction. The likelihood of transmission involves many biological, social and environmental variables (Wilson, 1995a). Another type of travel relevant to disease emergence is the shift of populations to urban areas. It is estimated that by 2025, 56.9% of the world population will be living in urban areas (Harpham and Stephens, 1991). This may even further take away focus on rural areas to try and cope with the urban slums as far as water and sanitation are concerned.

The large volume of travellers supported the transmission of the infection in the urban centres located in the vicinity of cholera-affected areas. Specific rural functions such

as funerals were frequently found to be responsible for the introduction and dissemination of cholera into other villages. As the pool of susceptible individuals had increased in the different areas during the festive season, some were bound to have sourced their water from contaminated water bodies. At the same time, visitors who could afford to travel to areas with high potential for cholera outbreaks may have also become carriers in the process and spread it further to other areas.

7.1.3 Predicting cholera

There was no proof that a direct link exists between the local climatic variables of KZN and the transmission of cholera. Notwithstanding, there was an overall seasonality revealed by the data, as seen with the cases peaking and waning between the summers and the winters respectively (Chapter 5: Figure 5.3). Furthermore, GIS mapping revealed a concurrence between the incidence of cholera and the climatic variables of rainfall, humidity and maximum temperature (Chapter 6: 6.2.4). There may have well been a statistically supported correlation between %CIR cholera and climatic variables within localised areas though for the purpose of this study, the focus was to seek correlations for the entire province. Therefore, chance events whereby heavy rains are experienced in cholera prone areas should still be considered as an alarm that, given certain conditions are fulfilled, a chain of events can be set off that could trigger an outbreak of cholera. This was aptly demonstrated with the spatial model (Chapter 6: 6.3).

Being able to predict the diffusion of cholera would clearly be of considerable value. Control measures could then be focused on preventing the establishment of the infection in highly susceptible communities or minimising its impact. Results from this study revealed that cholera diffusion did not occur uniformly within the areas affected by the epidemic, but diffused and persisted in particular ecological niches and conducive to environmental settings. Thus the scarcity of human resources, and time, to combat cholera necessitates the selection of particular high-risk target populations as the primary concern of control programmes. The census data used in the study was helpful in pointing out the level of basic service delivery at the MD level (Chapter 6: Table 6.2), which can be useful in selecting high-risk target populations. Notwithstanding, prediction is more likely to be feasible on the local scale, while low

population density areas may be ideal locations for intensive campaigns to inhibit further diffusion.

7.2 Towards the future

The epidemic did eventually come to pass, as with the previous epidemics. Nonetheless, future cholera outbreaks are almost certain unless the delivery of basic services is guaranteed for all. Controlling the environment which *V. cholerae* depend on for its survival would be difficult because of the fact that it is primarily an aquatic organism. Thus ideally, the definitive control programme should involve the elimination of the transmission routes, suitable for *V. cholerae* survival through improved sanitation and housing and the provision of protected water supplies. This ideal is not far fetched though it involves huge financial implications and a longer time frame. Meanwhile, as the socio economic picture improves, albeit at a slow pace, areas with low delivery of basic services may still have to opt for natural water sources and alternative sanitation measures irrespective of the consequences.

The findings of the study through the use of data as a disease management tool emphasized the implication that interactions exist between people, their socio-economic issues and the environment. Subsequently, it is these interactions that become the deciding factors as to whether a community resists or succumbs to cholera. One helpful avenue is by using awareness campaigns instituted by educational policies, to address problematic issues like hygiene through behavioural change.

7.2.1 Campaigns to eradicate poverty

- Central to the cholera epidemic are issues of poverty. Alleviating poverty is vital in improving the standard of living of underprivileged communities. For an individual to be out of the state of poverty implies that one has a reasonable income that affords basic services of clean water, adequate sanitation, housing and education.
- Most often than not, the poor communities of the urban slums and rural areas pose the highest health risks. Thus such communities should be given priority

in issues of water supply and sanitation. Cholera affects the poor living in crowded unsanitary conditions.

- Creation of income generating opportunities in a province like KZN will contribute significantly to the well being of its people including population stabilization and income distribution.
- Women should be encouraged to take a greater role in self reliance activities considering that there is a tendency of the men moving out to urban areas of KZN or other provinces altogether in search for work..

7.2.2 Public awareness campaigns

- The success of public awareness on the benefits of a healthy environment and the associated risks of neglected environments is dependent on the availability of basic services of water and sanitation to all. In particular, environmental sanitation, pollution and protection of water sources.
- While initiatives to provide the basic services are underway, educational programmes on hygiene, improved household water storage and safe sanitation should be introduced in parallel as an ongoing concern to all the communities. Programmes such as clean up campaigns; chlorination may be used to reduce the favourability for survival of cholera organisms.
- Children in schools should be one of the major targets of health education. Children are more impressionable and this attitude should be exploited to introduce them to healthy habits like boiling water, washing their hand after using the toilet and before eating to name a few.

7.2.3 Women as partners in progress

- Women ought to be accommodated and recognised as important members of communities. Above all, women should be encouraged to take active in matters pertaining to community public health and environmental issues.
- Empower women, through a participatory process in issues of water management and sanitation.

- In the political environment, decision-making processes and policies should be gender sensitive, particularly those appertaining to public health and the socio-economy of communities.
- Women should be the focus of public health education especially because they have a close relationship with issues of water, sanitation and housing. Simple messages targeting women to promote within their households hand washing with soap before preparation of food and after dealing with faeces.
- Through women, encourage their children to be ambassadors of change. For example, women should be educated on the dangers of children bathing in infected rivers, as children's exposure to microbiological contamination in water is greater than that of adults. Children need to be taught healthy behaviours such as hand washing and encouraged to use sanitation facilities.

7.2.4 Introduction of simple and effective technologies

The global shortage of clean water and inadequate sanitation to the world's poor, has witnessed a myriad of simple and effective technologies towards the supply of water and sanitation. Each community is unique in its environment and its needs. Such factors have to be considered in the choice of technologies to be introduced.

- The ideal technologies would be those that are affordable, easy to install and operate and simple to put back into working order in instances of breakdowns.
- Women (both urban and rural) should be encouraged to participate in understanding matters pertaining to the management of water supply and sanitation technologies.

7.2.5 Management of natural resources

Community resources can be better managed with appropriate interventions directed at issues that place the community most at risk. Natural resources like water bodies (dams, rivers, streams etc) and forests have a direct influence on the lives of people especially those in rural areas. Communities should be educated on the general effects of the use and misuse of these resources. For example, the consequence of river pollution should be addressed and the community encouraged to make concerted efforts to ensure their water resources are protected. Above all, communities should

be made to feel that they have a collective ownership to these resources such that individuals will take a keen interest in protecting them.

7.3 Final Conclusion

Reliable data, in addition to being used for monitoring and evaluation purposes can also be used in disease management issues. This study made efficient use of available data resources as a disease management tool to understand the relationships between the incidence of cholera and the different factors previously implicated in its spread to epidemic proportions. The scope of this ecological analysis was to test the application of retrospective data to shed new light on our understanding of occurrence of cholera as well as how to use this knowledge in controlling the disease. In general, there was a search for spatial patterns that might suggest an environmental etiology. The study showed that an ecological analysis could be used to establish a link between a risk factor and the disease (Morgenstern, 1982). Furthermore, the exercise demonstrated the important role of routine environmental surveillance using health, climatic and socio-economic data. The ability to evaluate geo-spatial information associated with health and socio-economic data provides a unique perspective of public health issues to water resource managers such as endemic and emerging infectious diseases and environmental health (Waring *et al.*, 2005). As such, methodological development of such studies can give important contribution to the public policy of the sector. Thus, the development of integrated information systems to handle information and provide authorities with successful solutions is explicitly encouraged.

All the emergent issues are pertinent at the community level. And although there has been significant progress in improving the supply of safe water in South Africa, the backlog in basic sanitation services still calls for attention, as an estimated 16 million still lack basic sanitation and an estimated 6 million do not have access to safe drinking water (DWAF, 2002b). The results from this study further confirm the negative health effects of inadequacies in water and sanitation services. It is hoped that the findings of this study will contribute in the prediction and management of diseases like cholera at the community level in the future.