

**Using a Geographical Information System to optimize access to Primary Health Care  
services within the proposed New Hanover Health District**

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Submitted in fulfilment of the academic requirements

for the degree of Master of Arts in the

Department of Geography

University of Natal

University of Natal, Pietermaritzburg.

January 1997

## **Abstract**

The health restructuring taking place within the health sector is a direct result of the unfolding socio-political processes presently sweeping across the country's very young democracy. The adoption of a Primary Health Care approach and the transition to a district-based health system is an attempt to bring the health services closer to the people and to correct or redress the way in which money is spent to keep people healthy.

Given that in South Africa more people die from preventable diseases, a Primary Health Care approach is more appropriate to deal with the country's health needs. However, many also die from degenerative diseases such as heart disease, stroke and cancer and are dependent upon curative hospital-based care. Their health needs have to be catered for as well.

Since the declaration of Alma Ata in 1978, the concept of Primary Health Care has been broadened to include other determinants of health such as water, sanitation and health education. As a result, collaboration with other service sectors became essential to support such a holistic view of health. The District Health System is the unit of management of the health system that is best able to compliment an intersectoral collaboration. The technology that is best suited to analyse health resources within a District Health System is a Geographical Information System.

The delineation of the boundaries for the proposed New Hanover District Health System was essentially a consultative process. An assessment of the health resources within the proposed district revealed spatial inequalities between the areas of the former Republic of South Africa and the areas of the former Kwa-Zulu. The former Kwa-Zulu areas are disadvantaged in term of health care facilities, health care personnel, health services, water, sanitation, roads and economic

opportunities.

DETERMINE THE  
SITES REQUIRED!

In collaboration with the Department of Health and the New Hanover Primary Health Care and Development Programme, five potential fixed clinic sites and two mobile clinic points were identified using a Geographical Information System. This study goes beyond considering population as the only and most important variable in the identification of potential sites. Other important variables such as the road network density, the number of primary schools and the number of mobile clinics within a 10 kilometre radius of each site were taken into consideration. The siting of the Khanyile and nKululueko mobile clinic points has demonstrated yet another way by which primary health care services could be made more accessible. Community participation was crucial in identifying and confirming each potential site.

A mathematical formula named Pregon's PCs formula was specifically devised to determine the 'potentiality' of each site. For example, if the PCs value was less than one then the site was not considered. In the proposed New Hanover District Health System all sites were considered.

The lack of health care facilities and lack of personnel along the densely populated eastern border of the proposed New Hanover District Health System were two major factors that affected access to primary health care services. It is envisaged that the five potential fixed clinic sites and the two mobile clinic points which were identified would help to improve access to primary health care services and at the same time redress the spatial inequalities that exist within the proposed health district. This study concluded that a Geographical Information System is a useful tool for addressing questions of access to primary health care services within a district-based health system.

## Declaration

This study represents the original work of the author and has not been submitted in any form to another university. Where the author has used the work of others it has been duly acknowledged in the text.

The study described in this thesis was carried out at the Department of Geography (University of Natal, Pietermaritzburg) and the New Hanover Primary Health Care and Development Programme NPHC-DP under the supervision of Prof. Robert Fincham (University of Natal).

A handwritten signature in blue ink, appearing to read 'P. Pillay', is written over a horizontal dotted line.

P. PILLAY

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*NO. OF PEOPLE LIVING THERE.*

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## **List of Acronyms**

<b>ANC</b>	African National Congress
<b>CBO</b>	Community Based Organisation
<b>CHC</b>	Community Health Centre
<b>CUP</b>	Clinic Upgrading Programme
<b>CPHC</b>	Comprehensive Primary Health Care
<b>DHA</b>	District Health Authority
<b>DHS</b>	District Health System
<b>DOP</b>	Dilution of Precision
<b>GIS</b>	Geographical Information System
<b>GPS</b>	Global Positioning System
<b>HIS</b>	Health Information System
<b>HSDU</b>	Health Systems Development Unit
<b>IFP</b>	Inkhata Freedom Party
<b>IRMAT</b>	Interim Regional Management Advisory Team
<b>MIS</b>	Malaria Information System
<b>MRC</b>	Medical Research Council
<b>NDHSC</b>	National District Health Systems Committee
<b>NGO</b>	Non-Governmental Organisation
<b>NHP</b>	National Health Plan
<b>NMRP</b>	National Malaria Research Programme
<b>NHPHC-DP</b>	New Hanover Primary Health Care and Development Programme
<b>NPPHCN</b>	National Progressive Primary Health Care Network

<b>PCS</b>	Potential Clinic Site
<b>PDOP</b>	Position Dilution of Precision
<b>POS</b>	Positional
<b>RDP</b>	Reconstruction and Development Programme
<b>SOG</b>	Speed Over Ground
<b>ReHmis</b>	Regional Health Management Information System
<b>STD</b>	Sexually Transmitted Disease
<b>UNICEF</b>	United Nations Children's Fund
<b>WHO</b>	World Health Organisation

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## **Acknowledgements**

I would like to place on record my thanks to the following institutions for providing me with the information needs for this project and a special thanks to individuals at these institutions for their time and effort.

### **Central Statistical Services**

Shameen Jooma

### **Computing Centre for Water Research**

Rajesh Nundalal

### **Department of Health**

Veeran Chetty, Sibongile Shezi, Brenda Sacks, Steven Stead, Krishnie Naidoo and Mrs Mthimkhulu

### **Department of Water Affairs**

Marius Roche

### **District Surgeon for New Hanover**

Dr. N. Naidoo

### **Extension Officer**

Q.V Mann

**Field Workers**

Daniel Ngcobo and Ephraim Imbata

**GISINFO**

Andre' Botes

**Health Systems Trust**

Dr. David Harrison and David Mammeja

**Maughan-Seneque-Brown SWK**

Kerry Schwartz

**Medical Research Council (MRC)**

Dr. David Le Sueur, Carrin Martin, Colleen Fraser and Malise Craig

**Mitheus Ullman Prins and Company**

Pradeep Mahabeer

**Spatial Technologies**

Jeff Conika

**Umgeni Water**

Lucy Randall and Rene Dutlow

**University of Natal :**

**Dept. Of Geography**

Prof. R.Fincham, Mrs Helena Margeot, Dr. F Ahmed and Mrs Tony Bodington

**Department of Community Health**

Dr. U. Sankar

**Department of Drama**

Heather Stead

**Department of Mathematics**

Prof. John Hearn

A very special thank you to :

Professor Rob Fincham for his guidance and support throughout this project. Mr. Gerald Gaylard and Rennila Kaisry for their time and effort with regard to the proof reading of this thesis and my wife, Merlina for her support and patience. Mr A. Singh for assisting with the mathematical notation that was needed to devise the PCs formula.

## **PREFACE**

### **GEOGRAPHY AND MEDICAL GEOGRAPHY : A CHANGING AND DYNAMIC DISCIPLINE AND SUB-DISCIPLINE**

The focus of geography continues to change as the academic discipline is enriched from within as well as by other disciplines. This change in focus is evident in geography's intellectual history from environmental determinism to postmodernism which involves a sensitivity to 'difference' and recognises the experiences of particular individuals and groups (Cloke, et al, 1991). In this regard Pickels and Watts (1992) state that geographers are fostering new critical approaches to the discipline which are transforming our research methodology and opening up new possibilities for geographical practices and pedagogy.

The quest by geographers to bring about meaningful change in their discipline has brought them in closer contact with people working in other fields. Whilst "social scientists have come to play a variety of roles in health services and policy research" (Mechanic, 1995: 1491), geographers have developed a meaningful relationship with medicine, particularly with the sub-field known as epidemiology which is the science of how diseases are spread (Gould, 1985). "The relationship between geography and medicine is an old one" (Gould, 1985: 225) and these sentiments are echoed by many. More recently Curtis and Tacket (1996: 5) state that "The recognition of the relevance of geographic factors and the nature of particular place in the study of disease is long standing".

Diseases rarely exist in isolation. An understanding of the geographic or environmental factors that cause certain illnesses and diseases are essential in order to deliver effective medical care (Starfield, 1992). Besides the natural or environmental factors, Phillips (1990) suggested that while development generally brings improved diets, housing, social change and reductions in infectious diseases it is usually associated with an increase in degenerative diseases.

As countries evolve through the various stages of demographic transition, their populations grow older and richer, and the main causes of ill health, change. As a result more people in rich countries die from degenerative diseases such as heart disease, stroke and cancer. In poor countries on the other hand, more people die from infectious and parasitic diseases (Bergman, 1995). This change in the leading causes of death in a society, is called the epidemiological transition (Bergman, 1995).

In developing a health care model for South Africa, cognisance must be taken of the living conditions of its citizens and the principal causes of death. Lund and Patel (1995:18) indicate that “in 1991, 17,3 million people, and about half (48,9%) of all households lived below the minimum level of living (MLL)”. Thus South Africa’s majority is evidently poor and as a result of this more people die from infectious and parasitic diseases.

Given the historical emphasis on curative care, which in general is not effective in improving the health of the whole population, a Primary Health Care approach to health delivery is more relevant because it emphasizes preventable care which is presumably more affordable and results in cost saving in the longer term. More importantly a PHC approach is best suited to deal with the disease profile typical of the third world and as such is relevant to the health

deal with the disease profile typical of the third world and as such is relevant to the health needs of South Africa's underprivileged majority, particularly to those who live within the proposed health district of New Hanover (Zwarenstein and Barron, 1992). Further, "the PHC approach is a comprehensive national strategy for health, based on principles of equity and affordability, effectiveness and accessibility, participation and efficiency" (Zwarenstein and Barron, 1992:1). Whilst this thesis supports the view that the entire National Health System (NHS) should be driven by a PHC approach as contained in The Reconstruction and Development Programme (RDP) as well as the New Health Plan for South Africa, it cautions that curative care is also important in a country that has potential for growth and development (ANC, 1994b).

The priority given to curative care in the past reflects the dominance of a ruling class entrenched in the colonial era and rubber-stamped during the apartheid era. Further, the emphasis on curative hospital-based care is rooted in the high level of confidence placed on the biomedical model from the early days of medicine. The biomedical model which defines health as the absence of disease can be criticised for many reasons. The most important is its narrow focus on the diagnosis and treatment of ill health. This approach to health is fundamentally technocratic and mechanistic. It believes that science, technology and medicine are all that are required to cure ill health (Phillips, 1990).

As a result of such critique there is an increasing tendency for health to be regarded more holistically taking into account the social, economic and cultural factors and how these relate to health (Curtis and Taket, 1996). An approach to deal with health care delivery in an

integrative and holistic manner, is an intersectoral approach which involves interaction with the various service sectors such as education, public works and business.

The geographical unit where social, economic and cultural factors that impact on health can be coordinated easily, is at the district level (Zwarenstein and Barron, 1992). The District Health System consisting of a clearly delineated geographical area and a well-defined population, is the unit of management of the health system that is best able to compliment an intersectoral approach (Owen, 1995b).

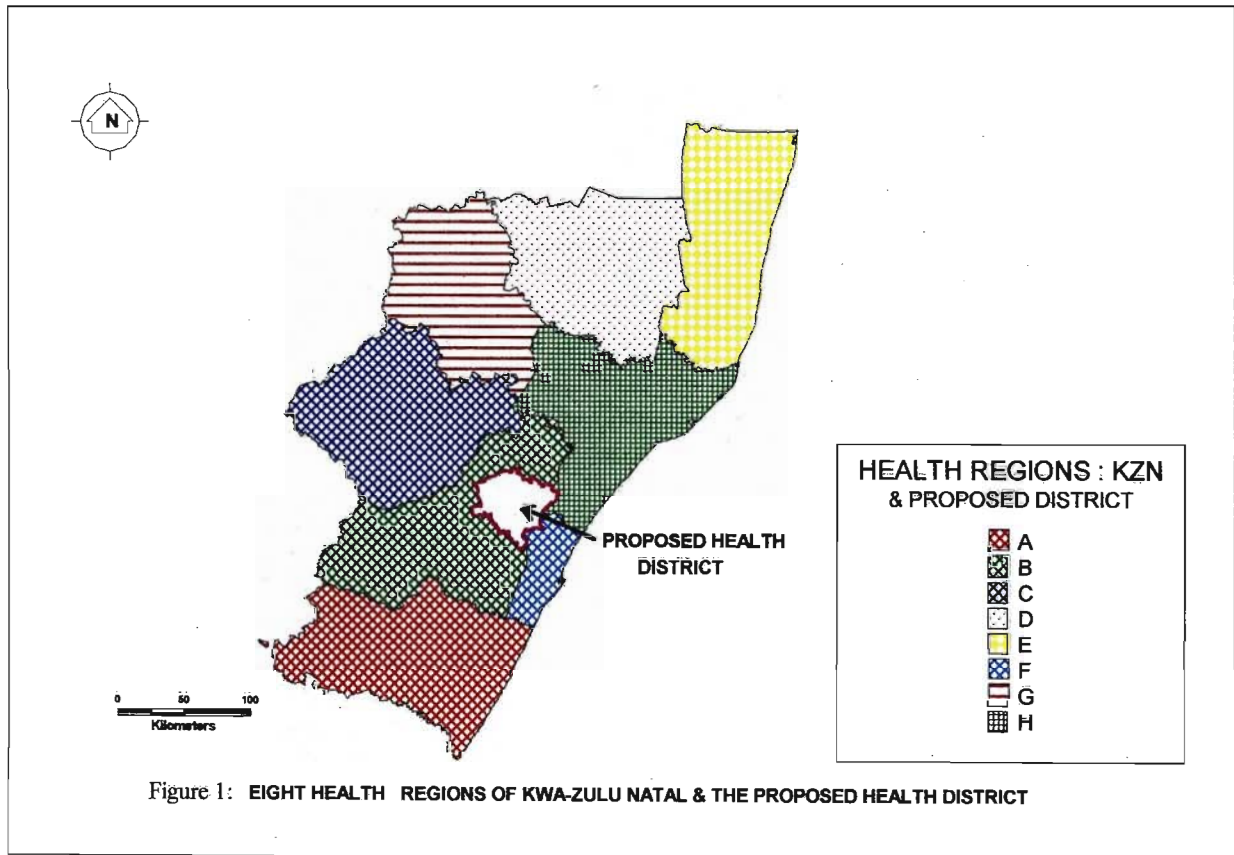
At a theoretical level this study constantly draws on inter-alia medical geography, medical sociology, health sciences, epidemiology and medicine for supporting literature. At a practical level, interaction with the Department of Health, the Medical Research Council (MRC), the Medical School (Department of Community Health at the University of Natal), the District surgeon of New Hanover and many utility companies, has become necessary.

As collaboration with outside organizations ensued, and having being appointed as a member of the Interim Regional Management Advisory Team for Region B of the Kwa-Zulu Natal Health Services and committee member of the New Hanover Primary Health Care and Development Committee (NHPHC-DP), the researcher gained hands-on experience with policy and planning issues that affect development.

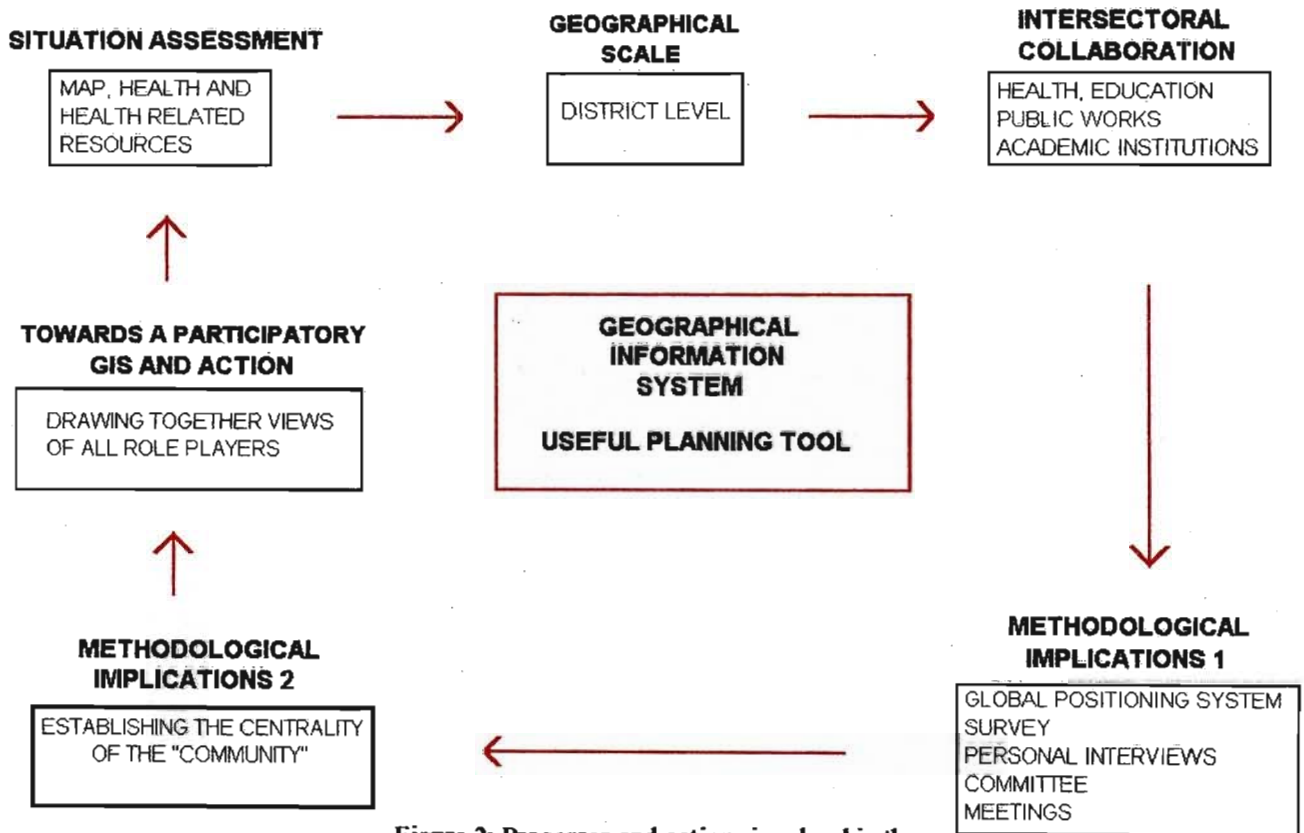
It is within this framework that the study seeks to demonstrate the use of GIS to coordinate health and health-related services within the proposed New Hanover Health District in a meaningful way, so that access to PHC services are enhanced via an intersectoral approach.



Figure one shows the proposed New Hanover health district and eight health regions of Kwa-Zulu Natal.



With reference to figure two the spatial distribution of health facilities, health-related services, landuses and population were undertaken using GIS. The situation analysis made it possible to assess the health resources at a district level. Taking into account that other determinants such as water and sanitation also impact on health, collaboration with other sectors became necessary. The methodological implications for the development of the proposed health district were twofold. On the one hand tools such as GIS, the Global Positioning System (GPS), questionnaires, personal interviews and committee meetings were used. On the other hand community participation became essential. The incorporation of the views of the local people contributes to Participatory GIS (Pickels, 1995).



**Figure 2: Processes and actions involved in the development of the proposed DHS.**

Figure two shows the processes and actions involved in the development of the proposed New Hanover District Health System.

### **Aim**

The aim of this thesis is to use a Geographical Information System (GIS) to assess ways in which access to PHC services may be optimized within a District Health System. The case of New Hanover.

## **Objectives**

- (i) To work in close collaboration with health authorities to conduct a research project geared to advance the implementation of a District Health System (DHS).
- (ii) To carry out a situation analysis of health resources and personnel within the proposed New Hanover Health District.
- (iii) To examine how the following variables impact on the delivery of Primary Health Care (PHC) services within the district:
  - the spatial distribution of mobile clinics, fixed clinics and family practitioners;
  - the provision of water and sanitation;
  - health- related education.
- (iv) To identify potential fixed clinic sites in order to optimize access to PHC services within the proposed health district;
- (v) To locate additional mobile clinic points in order to extend the coverage of PHC services within the proposed health district.
- (vi) To examine the extent to which intersectoral collaboration can take place within the health district.
- (vii) To engage the local people in discussions on the need for health care and to ascertain the delivery system regarded as most appropriate for meeting their needs.

## **Methodology**

Medical geography is one of the many fields where Geographic Information Systems (GIS) can have numerous applications. Some of the important utilities contained in most GIS packages include geocoding, overlay, standard query language and thematic mapping. The Global Positioning System (GPS), questionnaires, interviews and committee meetings were valuable sources of data. Secondary data sources were obtained from utility companies and the private sector.

## **Limitations and Assumptions**

In undertaking this study there was concern with regard to the accuracy of the demographic data and the assumption that the majority of people within the study area use motorized transport.

The spatial analysis undertaken for this study using GIS was based on the 1991 census data which was supplied by the Human Sciences Research Council (HSRC) to the consultants, Seneque Smith and Maughan-Brown and Data Research Africa. "Additional secondary information was added to this base data as it was seen to be unreliable, particularly in Black residential areas" (Seneque, et.al., 1995: 6). Hence the projected population figures for 1996 and the year 2010 presented in this thesis are not precise but they do reflect to a large extent the demographic composition of the study area as it appears on the ground.

Despite this limitation, some measure of confidence was gained while working in collaboration with the Department of Health. It became evident that those areas with a population greater than 15 000, which lacked a fixed health care facility and which were identified using GIS

The road network density and the beta coefficient index were taken into account to identify the potential site. These variables generally assume that the majority of people use motorized transport to attend a health facility. However in an earlier study undertaken within the study area Sankar and Jinabhai (1996) found that between 30% to 87% of the respondents interviewed walked to the nearest health facility.

### **New directions in identifying potential clinic sites**

The potential sites identified by the Department of Health were selected either on the basis of an area inhabited by more than 10 000 people and lacked a fixed health facility or by the community's request for a fixed health facility. In either case the actual site was further investigated by the Department of Health in consultation with the community concerned . This thesis goes beyond considering population as the only and most important variable. Other important variables, such as the road network density, the number of primary schools, the population size and the number of mobile clinics within a 10 kilometre radius of the proposed site are taken into account.

Working within this environment of change is challenging and rewarding. A mathematical formula which was devised for this thesis served the purpose of either supporting or nullifying a potential site once identified depending on its Potential Clinic Site value (PCs value). The PCs values are numerical values arrived at when taking into account the variables that affect the potential site.

However, it was later learnt that this formula could also be used to support or nullify the decision to site a higher order health facility such as a Community Health Centre (CHC). The

However, it was later learnt that this formula could also be used to support or nullify the decision to site a higher order health facility such as a Community Health Centre (CHC). The Kwa-Zulu Department of Health, having learnt of this application, has indicated their interest to use the formula to site a Community Health Centre (CHC) within the proposed New Hanover Health District.

### **A process of change**

This thesis is characterised by an environment of change especially when one considers the new concepts and approaches such as the DHS, PHC, GIS and intersectoral collaboration which are being introduced to the South African health scenario. These changes are a direct result of the unfolding socio-political processes which is sweeping across the country's very young democracy. The Department of Health is also working in the context of change as it attempts to implement the ideals contained in the New Health Plan for South Africa. Therefore it is not easy to get the complete picture of their vision of a DHS.

### **Synopsis of each chapter**

A conceptualisation of Medical Geography, the District Health System (DHS), Primary Health Care (PHC), Geographical Information System (GIS), and intersectoral collaboration is contained in chapter one.

This thesis considers GIS to be an appropriate and valuable tool for addressing questions of access to PHC services and as such chapter two focuses on the use of GIS and other methodological tools that were employed. GIS and the Global Positioning System (GPS) are used together with conventional research methodology such as surveys, personal interviews

and committee meetings of the New Hanover Primary Health Care and Development Programme (NHPHC-DP) and the Interim Regional Management Advisory Team. Each of these methodological tools is given individual consideration as each is incorporated within a GIS.

With the conceptual framework in place and a useful set of methodological tools at hand the scene is set in chapter three to examine the background to the study area and the use of GIS to:

- (i) delineate boundaries of the proposed health district;
- (ii) map health facilities;
- (iii) map health related services such as water, sanitation and health education; and
- (iv) examine the role of the community in the DHS.

The analysis which consists of two parts namely, the factors that affect access to care and the siting of health facilities within the proposed health district are contained in chapter four.

The final chapter contains an evaluation of the health services and some recommendations that are put forward to redress some of the spatial inequalities that were identified in the previous chapters.

# CHAPTER ONE

## CONCEPTUAL FRAMEWORK

### 1.1 Introduction

To begin with, the concepts of Medical Geography, the District Health System (DHS), Primary Health Care (PHC), Intersectoral Collaboration, and Geographical Information System (GIS) need to be explained. An understanding of these concepts is crucial to the processes and actions involved in improving access to PHC services within the proposed health district.

A geographical perspective is essential in understanding the dynamics involved in the delivery of health care and as such the place of geography in health and the role of the medical geographer is examined.

The new vision of PHC, formally established in 1978 at the joint World Health Organisation (WHO) and United Nations Children's Fund (UNICEF) conference in Alma Ata, is very comprehensive (Phillips and Verhasselt, 1994). This new vision of PHC challenges medical geographers to become involved in community health needs and to examine the various political, social and economic processes that give rise to certain spatial patterns. Some of these challenges are :

- (i) To examine the place of PHC in the related areas of medical geography and the geography of health;
- (ii) To develop health care delivery systems that are able to redress the spatial imbalance of health resources;



- (iii) To examine fully the concept and definition of PHC and its geographic implications for implementation.

The concept and definition of medical geography is debated because of divergent views which centre around an appropriate title for the sub-discipline. These ensuing controversies nevertheless, seem to enrich the sub-discipline by adding to the existing body of knowledge. The section of work entitled “Future prospects for medical geography” in this chapter serves as a signpost to the role that South African universities should be playing to foster medical geography as a sub-discipline.

On a broader academic level, the concern with *who gets what, where and how* as postulated by Smith (1979), provides a useful framework to examine the place of geography in the field of health. Medical geography has a crucial role to play in terms of informing the ‘health restructuring’ debate in general and more specifically the development of the District Health System (DHS) in South Africa.

The DHS is a clearly delineated geographical area where all health and health-related activities can take place. It is an attempt to bring the health services closer to the people. Such a system is applied to the study area to constitute the New Hanover District Health system.

The concept of a DHS is a recent concept of health care delivery in South Africa, especially in terms of official health policy, although some dedicated health care professionals and individuals with a vision for a district-based health system have already initiated projects that are conducive to the development of a district-based health system in certain areas. A case

study, namely that of Bushbuckridge, is briefly reviewed here to indicate the extent of DHS development in South Africa.

A PHC approach which emphasizes promotive, preventative and rehabilitative care, considers water, sanitation and health education to be important determinants of health. In order to provide a comprehensive package of PHC services which incorporates these determinants, an intersectoral collaboration approach is essential. Intersectoral collaboration involves interaction with other service sectors such as education, water, sanitation, public works and business.

This thesis makes a strong case for an intersectoral approach to coordinate health and health-related activities within a DHS. The new legislative structures to support an intersectoral approach to health care delivery in South Africa are to date, at least theoretically, in place and are examined in this chapter (ANC, 1994a).

GIS which is a system for capturing, storing, analysing and displaying data spatially, is used to delineate the boundaries for the proposed health district, map and assess the health resources within the proposed health district. GIS is considered to be the appropriate technology to integrate the data sets from the various sectors, namely health, education, roads and public works. This view is supported by Twigg (1990) when she states that GIS and health based geographic systems in particular have great potential for analysis and management of health and health care data. These issues concerning GIS are considered against a backdrop of a potentially growing sub-discipline and new views in health and health delivery within a multi-sectoral framework as outlined in this chapter.

## 1.2 Conceptualising and Defining Medical Geography

Any attempt to understand the concept and definition of medical geography would entail a complexity of contributions made by geographers as well as non-geographers. Thus it is imperative that one works from the premise that medical geography is as interdisciplinary as the parent discipline of geography and that it is best understood in an evolutionary context.

There is considerable debate focusing on an appropriate title for the sub-discipline. Besides having to deal with this problem, medical geography is a fairly young field of study which is also beginning to feel the ripple effect of postmodern influences that enrich human geography as a whole.

A review of the literature suggests that medical geography consists of three important subsections; namely, disease, nutrition and medical care (Barret, 1993). This view is supported by others such as Paul (1985), Barret (1993), Phillips (1990), Jones and Moon (1992). Kerns and Joseph (1993) on the other hand, identify two categories: one focusing on disease geography and the other on the geography of health care. This dichotomy has prompted Learmonth to raise the prospect of a possible duality by asking the question "*two medical geographies or one ?*" (Learmonth, 1978: 239).

An attempt to unravel the concept and definition of medical geography, using the critical rationalist perspective is undertaken by Barret(1993). He put forward seven questions in an attempt to elucidate these issues. These questions are as follows:

- (i) What is medical geography?
- (ii) Are there one or two medical geographies?

- (iii) Is the geography of health care separate from medical geography?
- (iv) Is the geography of health a more accurate title than medical geography?
- (v) What is the relationship of medical geography to the related fields of ecology and epidemiology?
- (vi) Are disease ecology and geographical epidemiology sub-sections of medical geography?
- (vii) What is the relationship of medical geography to geographical medicine?

It is beyond the focus of this thesis to enter into arguments for and against each of the above questions. These questions, nevertheless, indicate very clearly that medical geography is interdisciplinary and that it is related to the well-established disciplines of medicine, biology and health. Pyle is also supportive of this view when he states that, "medical geography has changed ... because it has been receiving continued influences from a variety of approaches utilized by many scientific disciplines "(Pyle, 1979: 9).

Barret, in his endeavour to validate the title 'medical geography' as opposed to 'the geography of health,' provides logical and realistic reasons as to why the title of 'medical geography' is more appropriate than 'the geography of health' for the sub-discipline. Firstly, medical geography studies spatial problems, but seldom studies health per se. It is also clear from a review of the literature that a high percentage of medical geographical studies analyse facilities rather than people. Secondly, the title, 'medical geography' dates back to at least the eighteenth century (Barret, 1986).

Paul (1985:399), however avoids getting entangled with arguments pertaining to the appropriate title for the subdiscipline or dichotomies within the sub-discipline. Instead, he states that, "medical geography has now become a well recognised sub-field".

The geography of health care, on the other hand, " embraces two broad categories of research; the spatial properties of delivery systems and the accessibility, utilization and planning of health care services " ( Kerns and Joseph, 1993: 712). Criticism against the geography of disease is that these studies " have been strongly, descriptive, cartographic and deterministic in orientation " (Mohan, 1989: 167). There is, however, consensus that the geography of health which addresses questions of provision, location, distribution, accessibility and utilization of health facilities is a recent strand of medical geography (Mohan, 1989).

The evolutionary context of medical geography proposed by Pyle is evident in the more recent postmodern influences that enrich the sub-discipline. For example, Kerns and Joseph (1993:711) argue that "a re-examination of the interrelationship between the constructs of place and space is crucial to geographical involvement in the broader endeavour of health research". These writers acknowledge the dichotomy between the geography of disease and the geography of health care but add that " there is a need to examine closely the relationships between place and space in health (care) given the socio - political processes occurring in the changing times of the 1990s " (Kerns and Joseph, 1993: 711).

The shift in focus from the preoccupation with spatial variations in disease to the provision and delivery of health care services has resulted in the concept and definition of medical geography being thrown into further debate. This shift in focus is nevertheless advantageous and offers

medical geographers a window of opportunity to examine the social, political and economic factors that affect the delivery of health care. Concepts of space and place may be better understood when health and health care is related to the social and economic context in which it occurs. It is for this reason that Kerns and Joseph (1993: 711) are of the opinion that there is a need to " explore the changing expression of space and place concepts in research as they relate to the incorporation of advances in social theory into medical geography".

In concluding the above issues, medical geography uses geographical skills to deal with health and health-related problems in a holistic manner in an ever changing society. The concept and definition of medical geography is inextricably linked to time and space as these manifest themselves across the cultural landscape. There is no compelling reason why the focus of medical geography could not change in the future given the changes in health-based information systems, postmodern influences and the unfolding socio-political process such as the new found democracy and its new administrative machinery that is sweeping across the world and South Africa in particular.

### **1.2.1 Medical Geography in South Africa**

The earliest works in the field of medical geography in South Africa focused on mortality and morbidity patterns (McGlashan, 1972). This phase parallels the early stages of medical geography abroad. The South African literature also contains works on all three sub-sections of medical geography namely, disease, nutrition and medical care. These include contributions by geographers and non-geographers. The move to a district-based health system and the emphasis on a PHC approach to health care delivery as contained in the New Health Plan for

South Africa is bound to direct more research into the area of health policy and planning by geographers and health professionals.

Inquiries into environmental causation gave rise to works around neonatal and infant mortality patterns across South Africa. Other studies that fall into this category include an inquiry into cancer distribution in Transkei.

Dauskardt (1992) bemoans that little attention has been given by geographers to the role of the political economy of health. Whilst Dauskardt's view can be justified to some extent, contributions to unravel the disease of apartheid are evident. There are studies that explore the relations between poverty and malnutrition and show how apartheid has affected health and distributed disease unevenly across both race and space.

More recent work in South Africa, examines the way in which the migrant labour system is dramatically affecting the geographical and social spread of AIDS/HIV. Other valuable contributions in the neglected field of nutrition include "Combatting the legacy of apartheid in health" (Mckerrow and Fincham, 1995).

The removal of restrictive legislation in South Africa, together with the 'health restructuring' currently taking place, is bound to direct more research into areas of health policy and planning. Already, the concept of the District Health System (DHS) is giving rise to a plethora of related research topics and agendas. For example, "Primary health care depends on the district health system" by (Merrick, et. al., 1993) and "Managing primary health care in South Africa at a district level" (Merrick and Barron, 1993).

The introduction of GIS in the field of health in South Africa has led to the use of GIS software in the Department of Health and the Medical Research Council (MRC) to map health resources and to undertake spatial analysis. Geography departments at certain universities are using GIS in health applications, for example, Stuttaford's (1994) thesis entitled: "Aspects of a geographic information system for medical geographers and malaria control". This study exemplifies an interdisciplinary approach to malaria control, drawing from geography, health, medicine and using a Geographical Information System (GIS).

The relationship between the Health Systems Trust (HST), the academic institutions and the Department of Health is significant in terms of attempting to identify ways to improve health care delivery. This partnership would help to inform the 'health restructuring' debate and contribute to the existing body of literature relevant to medical geography and other disciplines in South Africa. These contributions will result in a reawakening in medical geography which would in turn result in future prospects for medical geographers.

### **1.2.2 Medical Geography: Future Prospects**

The high level of research activity around the health care system at present in South Africa provides a fertile area for research for medical geographers. More specifically the adoption of a PHC approach to health care delivery and the move to a district-based health system as contained in the RDP and the National Health Plan for South Africa offers ample opportunity for research in policy and planning from a geographical perspective. Given this scenario, it is imperative that universities do not lag behind in providing students with the necessary training and skills required to make meaningful geographic contributions to the health care system in South Africa.



The National Health Plan For South Africa makes provision for intersectoral committees at community, district, provincial and national levels (ANC, 1994a). The interdisciplinary nature of geography ensures that medical geographers in particular are ideally placed to make a worthwhile contribution.

The quest for an integrated bottom-up approach to health planning would make many geographers feel the way Prothero felt when he undertook work for the World Health Organisation (WHO). " Prothero recounts how, while working with WHO, people would ask him 'What are you doing?', 'Why should a geographer be working for the WHO?' Prothero (1962:17) answers by describing the work he undertook while as a consultant to the division of malaria eradication". Prothero (1962: 489) continues " there should be a place for geographers to work in the field with the eradication teams ... for the planning for successful malaria eradication requires an integrated evaluation and understanding of the complex relationship between the physical environment, parasites, mosquitoes and human beings".

"Because of the direct relevance of Prothero's insights for the organisation of disease control programmes, he has frequently been called upon to serve as a consultant for WHO anti-malarial programmes in Africa" (Stock, 1986: 691). Hunter has followed a similar path with his studies of onchocerciasis in Northern Ghana, having served as a WHO consultant (Stock, 1986). These early examples set by Prothero and Hunter indicate avenues for applied medical geography. They also indicate that in time medical geography may become a 'service discipline.

Medical Geographers working with Community Based Organisations (CBO's) and Non-Governmental Organisations (NGO's) together with local people can assist in the demarcation of health boundaries (ANC, 1994b).

Medical geographers with GIS skills can also contribute to the process of delineating health district boundaries, mapping and assessing health resources. As medical geographers with GIS skills, map and assess health resources they would be in a position to identify under-serviced areas. With such knowledge they would be able to influence the resource allocation process positively. However, medical geographers must proceed with caution and avoid perceiving the resource allocation process as one which is purely technical or one that can be solved using GIS only. Issues of equity and past inequalities are bound to surface and burden the planning process. These issues in turn call for medical geographers to play an advocacy role by focussing on the needs of the poor.

GIS can assist in the resource allocation process by identifying under-serviced or over-serviced areas. As medical geographers in South Africa undertake such tasks, they would invariably contribute to redressing past spatial inequalities. Such research may also contribute to a very neglected area of research, that which relates to the political economy of health (Mohan, 1989).

Taking into account the transition to a district-based health system and an adoption of a PHC approach there is scope for medical geographers to assess ways to improve access to Primary Health Care (PHC) services. This task becomes even more challenging as it does not simply

involve the use of location-allocation models as questions of equity and history have to be addressed. As such local, cost-effective, analytical and creative endeavours are needed.

The fact that "other disciplines have been grappling with questions that are very clearly geographical" (Bentham, et.al.,1991: ix), is of concern to the geographer. This is pertinent to the health sector and the Medical Research Council (MRC). At present these departments are using Geographical Information Systems (GIS) to map health care facilities and resources. These are inherently geographical planning tasks which are undertaken by health and medical professionals. Clearly, the examination of disease patterns and possible environmental links calls for geographic instruction and guidance.

For as long as universities in South Africa do not develop a medical geography curriculum and adequately prepare students with Geographical Information Skills (GIS) skills, 'geographic health studies' will continue to be undertaken by health and medical professionals. This is not to say that there is a problem with medical or health personnel undertaking studies which are geographic in nature. After all, one must acknowledge that the earliest works in medical geography were undertaken by physicians and that these contributions have enriched the sub-discipline. However, the argument is that it is this kind of situation that perpetuates the past imbalance of " many geographic" studies on disease and health care being produced by non - geographers " (Dauskardt, 1992: 207). Besides, the perspective of the geographer is unique and without this perspective medical geography would be less comprehensive.

"Achieving a greater status for medical geography in geography departments as well as attention to career opportunities for graduates in it " is a step in the right direction and one that

is favoured by (Phillips, 1990 : 405). Phillips (1990) has taken this process even further to suggest a 'core curriculum' for the student in medical geography to follow. The core curriculum includes aspects of disease ecology, cartography, demography, statistics, health economics, medical sociology and social policy (Phillips, 1990). Other subjects that should also be included are Geographical Information Systems (GIS) and geographical epidemiology.

The fact that medical geography is interdisciplinary in nature and that South African universities currently have limited resources, innovative ways to meet some of these suggestions put forward by (Phillips, 1990) are needed. For example, some of the courses can be offered at the department of geography, whilst other courses such as medical sociology may be offered at the department of sociology and statistics at the commerce department or at other departments on the same university campus.

In conclusion, the National Health Plan for South Africa provides a window of opportunity for the medical geographer to make his or her contribution to the Reconstruction and Development Programme (RDP) and at the same time enrich the sub-discipline. Before medical geographers start to make their contribution to the RDP, they need to consider the place of geography in health.

### **1.3 The Place of Geography in Health**

The distribution of health care resources and personnel within any geographic region gives rise to certain spatial patterns and is of concern to the geographer. For example, the over-concentration of health facilities and personnel in the urban areas requires some sort of spatial intervention in order to bring about a more equitable distribution of resources in non-urban

areas. Since geography is a spatial science, a concern with “who gets what, where and how” in terms of health care forms the cornerstone of the task and place of the geographer in the field of health (Smith, 1979).

A concern with “who gets what, where and how” (Smith, 1979) is linked most directly to mechanisms that affect the distribution process over time and space. Within such a framework, the spatial distribution of health care resources and personnel in the New Hanover Health District is the concern of the geographer.

“If the phrase ‘Who gets what where’ encapsulates the basic issues of spatial distribution, then the question of *what* is distributed is of critical importance” (Smith, 1979: 19). In terms of health care, ‘what is distributed’ translates into the monumental challenge of striking an appropriate balance between curative care and preventive care.

In a study carried out in the New Hanover health district, the demographic, socio-economic and key health status indicators reveal a health profile typical of the third world, and as such the primary health care approach which emphasises preventive care is most appropriate for this health district (NHPHC-DP, 1993).

The bias towards curative care and the neglect of primary care in South Africa and the New Hanover in particular is indicative of a class struggle, one in which the ruling class in the past dictated that high tech hospital-based care was appropriate to meet the health needs of the nation. There is now a calling for medical geographers to examine critically ‘what is distributed’ within the context of the existing power relations in the society. Once medical

geographers seek to understand 'what is distributed' in terms of health care (i.e curative vs preventive care), the question of 'why', which is fundamental to the real understanding comes into play (Smith, 1979). For example, understanding why power and wealth is concentrated in the hands of the minority which is coincidentally the ruling class, geographers may come to better understand why resources are unevenly distributed.

Thus, geographers working in the field of health care need to address the over- emphasis placed on curative treatment instead of preventative care. With the restructuring of the National Health Care system in South Africa, geographers working in the field of health care are challenged to develop appropriate health care delivery systems and health care utilisation models within a district-based health system.

Geography is as essential to the field of health as other fields such as medicine and epidemiology. The geographer will invariably stress certain facts such as the spatial distribution of health resources and relationships such as the ratio of health personnel per 10 000 people or the number of facilities in terms of the total population, some of which tend to be neglected by the health analyst, medical sociologist, economist or physician (Smith, 1979). In other words, the geographer's perspective of the health terrain is unique and essential not only in its contribution to existing literature but also to applied policy and planning issues such as the planning and developing of district-based health systems using GIS.

#### **1.4 Conceptualising and Defining the District Health System**

“The concept of a district health system emerged whilst the WHO Expert Committee examined the implications of the role and function of hospitals at the first referral level” (Phillips, 1990: 299). The World Health Organization (WHO’s) definition of a district health system is as follows: “A District Health System (DHS) based on Primary Health Care (PHC) is a more or less self-contained segment of the National Health System (NHS). It comprises first and foremost a well-defined population, living within a clearly delineated administrative and geographical area, whether urban or rural. It includes all institutions and individuals providing health care in the district, whether governmental, social security, non-governmental, private or traditional. A district health system therefore consists of a large variety of inter-related elements that contribute to health in homes, schools, work places, and communities, through the health and other related sectors. It includes self-care and all other health care workers and facilities, up to and including the hospital at the first referral level and the appropriate laboratory, other diagnostic and logistic support services ” (Tarimo, 1991: 4).

In the case of South Africa, the National District Health Systems Committee (NDHSC) is considering a definition that is more appropriate and which incorporates the definition of the WHO. The definition in the South African context in its current form is as follows: "The NHS being developed for South Africa is one based on the Primary Health Care approach. It is concerned with keeping people healthy, as well as caring for them, when they become unwell. These concepts of "caring " and "wellness" are promoted most effectively and efficiently by creating small management units of the health system, adapted to cater for local needs" (Owen, 1995a: 1).

The way in which a district health system is defined depends on various factors, some of which relate to the political economy of a country, the level of development, resources and the capacity that exists for health decentralization.

For the purpose of this thesis a District Health System (DHS) should essentially comprise a well-defined population living within a clearly delineated administrative and geographical area, where all health-related activities can take place. Further, it should include other sectors such as agriculture, business, housing, education and public works. Having defined the DHS focus can now be turned to DHS development in South Africa. A selected case study, that of Bushbuckridge is reviewed here and serves as a barometer to measure the extent of DHS development in South Africa.

#### **1.4.1 South Africa's Participation in District Health Systems**

South Africa is one of twenty one countries involved in a comparative study dealing with health decentralization and health systems change. The South African involvement in the study was first suggested by Dr. Katja who is a member of the division for strengthening health services at the WHO headquarters in Geneva. She suggested two objectives relevant to South Africa's participation. The first is to examine issues affecting decentralisation and the second is to form part of a larger study that attempts to draw broad lessons about the development of district based-health systems.

In South Africa some areas have gone ahead with the concept of a district health system for as much as five years prior to the initiation of the concept of health decentralisation. Such areas



include Escourt and New Hanover in Kwa-Zulu Natal. Areas outside Kwa-Zulu Natal include, Bushbuckridge in Gauteng and Khayelitsha in the Cape.

#### **1.4.2 Selected Case Study: Bushbuckridge**

A brief background to the study area, a situation analysis, some achievements and lessons learnt are mentioned with regard to the Bushbuckridge case study.

##### **1.4.2.1 Background**

Bushbuckridge lies some 500 Km north-east of Johannesburg. Although the Bushbuckridge area is presently treated as a single geographical entity, it comprises three separate administrative and political units. The two health wards namely Mhala and Mapulaneng were accountable to a different homeland administration namely Gazankulu and Lebowa respectively. The third was the Hoedspruit farming area which fell under the control of the former Transvaal Provincial Administration (Tollman et. al., 1995).

The sub-district based health system which constitutes the Agincourt study area is located within the Mhala health ward in the former Gazankulu homeland. Presently, the Bushbuckridge area is the subject of a border dispute between Mpumalanga and Northern Province.

Despite these administrative setbacks, a major effort to develop a demonstration district health system in Bushbuckridge was launched in 1992. A joint partnership between the Wits Health Systems Development Unit (HSDU), local health services and the community was initiated.

The technical discussion at a workshop addressed the following key areas :

- (i) District management
- (ii) Education and local support
- (iii) Intersectoral approaches
- (iv) Health and management information systems, community structures at district level  
(Tollman et. al.,1995).

The areas of concern that were discussed at the meeting in Bushbuckridge coincided with the WHO's categorization of areas to assist with the systematic development of the district health system in support of primary health care. These areas include:

- (i) Organisation, planning and management
- (ii) Financing and resource allocation
- (iii) Development of human resources
- (iv) Community development
- (v) Intersectoral collaboration.

#### **1.4.2.2 Situation Analysis**

There are two health centres, namely Agincourt and Thulamahashe, and 13 fixed clinics in the area. These health centres and clinics are staffed mainly by nurses. Mobile clinics service the remote areas. Two hospitals, namely Tintswalo and Mapulaneng are located in the former Gazankulu and former Lebowa homelands respectively (Tollman, et al., 1995).

#### **1.4.2.3 Achievements and Lessons Learnt**

Bushbuckridge has a functioning interim district health authority. The Bushbuckridge example illustrates how health services can be improved when communities themselves

influence the health services and help set out its priorities as illustrated in the following examples:

- (i) Teenagers and women in the Bushbuckridge area decided that the health service should focus on sexual health; contraceptives, condoms and STDs.
- (ii) Other women groups focused on agriculture, nutrition, diarrhoea, lack of creches which led to the health committee prioritizing these issues.
- (iii) The Agincourt nutrition programme focussed on malnutrition in children and growth monitoring. This project recently changed its focus from the individual child to community intervention (Tollman, et al., 1995).

Initial results from the Bushbuckridge District Health System (DHS) indicate that some form of governance structure with the required authority and finance is crucial to the management of the district. Equally crucial is community involvement (Tollman, et al., 1995). In terms of the lessons learnt the Bushbuckridge case study represents a microcosm of issues and challenges that affect the development of district-based health systems nationally.

### **1.4.3 Progress towards a district based health care system in South Africa**

#### **1.4.3.1 Defining boundaries**

Presently all provinces except for KwaZulu-Natal, have regional health boundaries the same as district council boundaries. KwaZulu-Natal did not follow suit because the political boundaries were not clear at the time when the regional health boundaries were being drawn. Ideally, boundaries should be the same as other service sector boundaries, such as welfare, education and local government. In this regard the Eastern and Western Cape have been able

to convince their premiers that these boundaries should be the same that everyone uses (Pillay, 1996).

#### **1.4.3.2 District Management Teams**

To manage the districts, interim regional management teams and interim district management teams have been instituted.

#### **1.4.3.3 Governance of the district**

In the interim, the RDP, the National Health Plan for South Africa and the District Health Systems Policy Document serve as valuable references that could guide the transition to a district-based system.

The key question with regard to governance revolves around how provinces are going to restructure themselves in order to devolve control of facilities and health care in general to the district level (Robbins, 1996). To devolve responsibility effectively a financial and accounting system is being developed for districts (Pillay, 1996). An appropriate governance structure is crucial for the management of the health services at a district level and as such requires some elaboration.

#### **1.4.4 Appropriate Governance Structures to Manage the District Health System**

The fragmented nature of health services in South Africa can only be understood when one takes into account the legacy of colonial rule and apartheid which resulted in a multiplicity of service providers along racial lines. The location of two hospitals within 7km of each other is an outcome of colonial apartheid planning within the New Hanover District. This fragmentation

is not only confined to planning along racial lines but also to, “fragmentation of responsibility by area and between administrative bodies ...” (Zwarenstein and Barron, 1992: 1).

Because of the variety of conditions and situations in each province, indigenous solutions must be sought by each health district within the parameters of the health vision for the entire country (Owen, 1995b). For example, in those provinces where local government structures are in place and where health districts as well as sub-districts are delineated, the transition to district-based health is easier. However, in Kwa-Zulu Natal where local government structures are weak, other appropriate structures must be sought. It is for this reason that the district policy document outlines three governance options to suit the various provinces. These options are as follows: The provincial option, whereby the province can appoint a district health manager, who will manage the district health services on behalf of the province. The local government option, whereby democratically elected officials have the capacity to provide services and finally the District Health Authority (DHA) option, which is an autonomous body which will deliver health services (Pillay, 1996).

Primary health care attempts to bring health as close as possible to where people live and work. The district health system, where all health related activities are coordinated, provides a framework which facilitates the delivery of Primary Health Care services. Zwarenstein, et.al. (1993: 558) also point out that “the district health system is crucial to the success of Primary Health Care because it provides a framework for local resource allocation and for rational planning to meet priority needs”. So much emphasis is placed on the district because “it is at precisely this point that top-down planning meets bottom-up reality: it is within the health district that services are - or should be closest to the people” (Owen, 1995b: 185).

In August 1994, an inter-provincial committee was established to develop a district health system for South Africa. To date, the National District Health Systems Committee has produced a policy document for the development of a District Health System for South Africa. Kwa-Zulu Natal in particular has been divided into eight health regions with a regional director and an Interim Regional Management Advisory Team (IRMAT) appointed to each region.

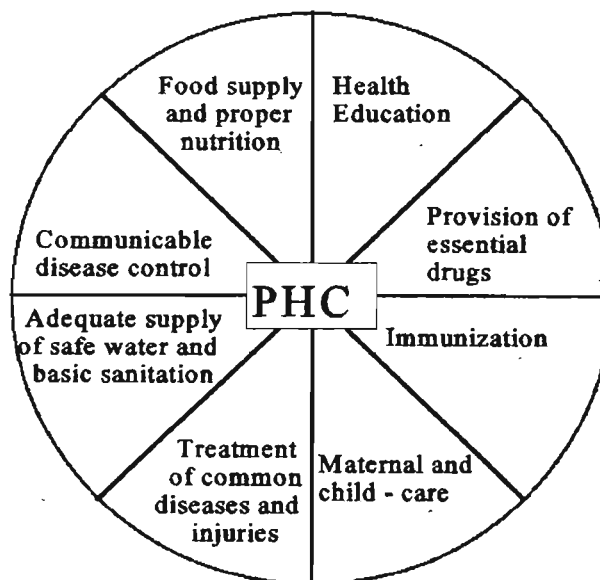
Whilst these initiatives are a step in the right direction, greater support, in terms of resources and action-oriented steps must come into play. Further, the removal of restrictive health legislation to facilitate the devolution of power to the lower levels, namely the district and local government is needed. The government of National Unity must make all its resources that are presently locked at national, provincial and local level accessible to those individuals, groups or stakeholders who are contributing to the development of the District Health System. The DHS facilitates the implementation of a PHC approach because it is the unit of management of the health service where collaboration between the various service sectors is easier to accomplish.

### **1.5 Conceptualizing and defining Primary Health Care (PHC)**

Since the declaration of Alma Ata in 1978, the concept of PHC has been broadened to include health-related services such as water, sanitation and health education as these seem to impact greatly on the lives of individuals and communities. This new philosophy of PHC requires a “national commitment to ensure health equity and justice for all” and invariably calls for a redistribution of resources which invariably has economic and political implications (Moji, 1990). This new philosophy of PHC is examined and its application to the South African health scene is discussed.

The expression “PHC” has evolved over time. Initially primary health care had been used “to mean first level contact between patients or communities and organised health care” (Tarimo, 1991: 5). More recently this vision of primary health care has been broadened to such an extent that essential health care consists of at least eight elements (figure 3), and an approach to the provision of health care that is characterised by equity, intersectoral action and community participation (Tarimo, 1991).

### EIGHT ELEMENTS OF PHC



Source: Tarimo, 1991

Figure 3: **The eight elements of Primary Health Care**

The definition of Primary Health Care as defined by WHO is as follows :

“Primary health care is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country

can afford to maintain at every stage of their life in the spirit of self-reliance and self-determination” (ANC, 1994a: 20).

In South Africa the National Progressive Primary Health Care Network (NPPHCN) originated out of a need for a national network to promote primary health care and to develop a national primary health care strategy for South Africa. In September 1978 over 300 delegates from around the country defined a progressive primary health care strategy for the country (NPPHCN, 1993). The NPPHCN endorses the concept of primary health care as adopted at the conference at Alma Ata in 1978. Such a progressive Primary Health Care approach:

- (i) challenges the society to address the socio-economic causes of poor health and makes provision for basic health needs;
- (ii) encourages community empowerment (ensuring that people are fully able to manage resources that are available to them);
- (iii) provides comprehensive quality health care including promotive, preventive, curative, rehabilitative and palliative services;
- (iv) demands concerned and accountable health worker practice;
- (v) prioritises the people who are most disadvantaged ensuring that health care is accessible, equitable and affordable to all;
- (vi) recognises the importance of integrated service provision from primary to tertiary levels of care within a coherent health system;
- (vii) promotes inter-disciplinary, multi-professional intersectoral collaborative team work for development (NPPHCN, 1993).



Further to this a mission statement was embarked upon, to promote primary health care through:

- (i) Advocating (influencing, mobilizing and lobbying) for a national primary health care policy and its implications;
- (ii) Transferring appropriate skills to community based organisation;
- (iii) Bringing together members to share information, skills and experiences;
- (iv) Providing practical support to members (NPPHCN,1993).

Although most countries are eager to accept and endorse a Primary Health Care approach as a strategy to attain health for all by the year 2000, thus far the primary health care approach has only been given universal rhetorical support. Asthana 1994: 183) supports the view that “In practice, however, governments and international agencies have rarely pursued the goal of comprehensive change in the sense of altering, economic and political structures of unequal societies”.

The definition of primary health care by the World Health Organisation is comprehensive. The application of this definition to developing countries is problematic given the nature and the cultural context in which health care has evolved in developing countries, of which South Africa is no exception. Taking the colonial bias into account, safe water, sanitation and adequate health care facilities in rural Africa, and New Hanover in particular, is a dream that is difficult to realize.

In South Africa the effects of colonialism, coupled with the legacy of apartheid make the vision of primary health care by the WHO an administrative nightmare. The cultural and socio-

political context in which health care has evolved deserves far more attention than it presently receives. One needs to acknowledge that in South Africa, traditional medicine, in which ever way it is defined, is used by millions of people. Traditional healers may be the first level of contact between patient and health care provider. Can this be considered primary health care? Although traditional medicine is socially acceptable to the people who depend on it, it is not scientific and therefore unacceptable to the medical fraternity.

It is for this reason, as well as the facts of widespread malnutrition, lack of water and inadequate sanitation, that the progressive philosophy of primary health care as enshrined in the declaration at Alma Ata is inappropriate to the socio-political, cultural and economic climate of Africa and South Africa in particular. A more extreme view is provided by Wildschut (1993: 23) where she states that “within South Africa’s health care system, there is no consensus on a definition of Primary Health Care (PHC). This leads to un-coordinated service delivery, inappropriate training, poorly equipped facilities and a lack of necessary managerial skills”.

The lack of consensus of ‘what is primary health care’ does not only confine itself to the public sector, but to physicians and general practitioners in the private sector. In a study which examines the role of the family practitioner in the delivery of PHC in the New Hanover District, the term primary health care elicited different responses from family practitioners. These responses ranged from the traditional meaning of first level contact between patient and provider to one which is more comprehensive i.e basic primary care inclusive of all eight elements of PHC (Fig.3) and an approach that is guided by equity, intersectoral collaboration and community participation (Tarimo, 1991).

### **1.5.1 Primary Health Care and its Political Overtones**

Primary health care inevitably involves a redistribution of resources and a shifting of the decision-making to local communities, who hopefully then become empowered. This devolution of power is clearly a political process. In Kwa-Zulu Natal, the stakeholders in each community are numerous. Given the diversity of the population and the divide between the Inkhata Freedom Party (IFP) and the African National Congress (ANC), greater attention needs to be paid to local institutional arrangements when adopting a Primary Health Care approach as endorsed by the Alma Ata declaration. Twumasi and Freund (1985: 1073) indicate that “experience from community participation projects ... in many countries including Zambia has shown that failure to account for local institutional arrangements and political interest has hindered success”. Muhondwa (1986: 1250) also takes cognisance of political implications and warns that “the social justice that calls for reallocation of resources and the uplifting of the poor is not only moral but also political”.

The government of National Unity has taken into account the scale of commitment that is required to implement a Primary Health Care approach. This commitment is enshrined in the Reconstruction And Development Programme (RDP) which states that “the whole National Health System must be driven by the Primary Health Care (PHC) approach” (ANC, 1994b: 45). Further commitment by government is to be found in the National Health Plan for South Africa which states that “the Primary Health Care approach requires political will on the part of government ... the government will formulate national policies, strategies and plans of action to launch and sustain Primary Health Care as part of comprehensive national health systems, and in coordination with other sectors” (ANC, 1994a: 20-21). Clearly then, the government

is supportive of a Primary Health Care approach. However, this support should ideally steer itself away from rhetoric and move into action.

A Primary Health Care approach is urgently required not only for politically motivated reasons but to improve the health status of South Africa and the New Hanover district in particular. In this regard the incident involving the heart surgeon, Dr. Serfontein, that flashed across the media goes beyond the issue of placing a moratorium on heart transplants. It in fact strikes at the very heart of the type of health care system that is appropriate for South Africa. This incident, nevertheless helped us to spur some thought on the need for curative hospital-based care since some sections of the population reveal a health profile typical of an advanced country. Since the concept of PHC has been broadened to include health-related services such as water, sanitation and health education, collaboration with other service sectors is essential. An approach that facilitates interaction between the various service sectors is an intersectoral approach.

## **1.6 Intersectoral Collaboration**

The main reason for intersectoral collaboration evolved from the idea that “efforts of the health sector alone are not enough to bring about significant improvements in health alone. Other sectors such as economic development, agriculture, education and water supply may, in some situations, have an even greater potential for improving health than the health sector itself” (Tarimo, 1991: 68). From a geographical perspective there is concern with regard to the narrow interpretation of the concept of intersectoral collaboration and the administrative and economic impediments that affect the implementation of an intersectoral approach. These

concerns and the new legislative structures to support an intersectoral approach as contained in the National Health Plan for South Africa are discussed here.

For the purposes of this thesis, intersectoral collaboration should be interpreted as coordinated efforts made by other sectors namely, agriculture, education, commerce and other health-related sectors to bring about improvements in health.

Despite widespread support, one must sound a note of caution, as intersectoral collaboration is used to convey different sets of meanings to different individuals. The term intersectoral collaboration has been recently used interchangeably with intersectoral coordination, multi-sectoral approach, and intersectoral action. As a geographer, there is no argument to be made about synonyms attached to the concept of intersectoral collaboration because it should involve as many service sectors as possible and should not be confined to collaboration within a particular sector.

The confined interpretation of intersectoral collaboration is in fact rooted in our approach to medical care. "The medical approach considers health as the absence of disease, to be brought about by technical interventions based on modern science and technology; the community responds to directions by, and actions of, medical professionals. This has as its basis the medical model of health care, in which eradication of ill health depends on doctors and medicine" (Phillips, 1991: 68). In contrast the health planning approach denies the assumption that "medical science and technology holds the sole key to health improvements, but it couples with the technocratic in that medical advances must be integrated into a health care delivery system that allocates resources according to the community and individual needs" (Phillips,

1990: 169). It is, however, the community development approach that coincides with the way the concept of intersectoral collaboration is interpreted and envisaged for the purposes of this thesis. "The community development approach stresses that community health improvements do not stem solely from direct health-sector activities. Income generation, housing, schooling, infrastructure and general community improvements are all essential for health improvements" (Phillips, 1991: 170).

Irrespective of what approach one espouses to or which sector one finds oneself in, the benefits of intersectoral collaboration are long term and sustainable. From the stand point of the health sector, the lower incidence of water and vector-borne diseases are just some of the benefits that might accrue from improved water and sanitation provided by other sectors, namely public works or the Departments of Water and Housing. At a national level the advantages for intersectoral collaboration should culminate in efforts towards a healthy society and not just caring for the sick.

Even at an academic level one has to concede that effective medical care is not limited to the treatment of disease itself; one must consider the context in which the illness occurs, and where the patient lives. The context in which diseases occur are important in understanding questions of aetiology and environmental influences and do not serve merely as geographic preoccupation with space and location for its own purpose. Questions that relate to space-location are of paramount importance since disease rarely occurs in isolation. That being the case, one is tempted to ask the question why has it taken academics, health professionals and the like such a long time to come to the realisation that intersectoral collaboration is the way forward?

### **1.6.1 Impediments to Intersectoral Collaboration Past : Present : Future Impediments**

In the case of South Africa, like the rest of Africa, colonialism and its need for hierarchical and centralist structures was deeply entrenched in the political economy. Even after colonial rule, the apartheid era placed a strong emphasis on centralisation and hierarchical structures (Phillips, 1990). In the case of South Africa, centralisation and the need for hierarchical structures had manifested itself in the separation of various race groups into separate administrative units (tri-apartheid arrangement). Even within these structures various departments (education, health, social service etc) functioned independently of each other.

This desire for hierarchical structures and the emphasis on centralisation was by no means confined to South Africa and its apartheid policy. Most countries with capitalist type economies show a preoccupation with modernity and centralisation. The need for neatly packaged environments; residential, industrial, commercial provided a framework for people to work separately and independently. Such conformity and uniformity, ironically without interconnection, provided the developed world with a misconception that efficiency could be maintained and that modernization was a workable reality. This lack of coordination and cooperation between various sectors is the very reason that efficiency was not maintained (Phillips, 1990). The lack of coordination between the various sectors led to duplication as well as islands of lack of services in some areas.

In the South African context intersectoral collaboration is constrained because many providers of health care existed for the same geographic area or region. For example, the Natal Provincial Administration (N.P.A), Joint Services Board (JSB) and the local health department all

provided the same types of services to the same areas. The new legislative structures contained in the National Health Plan for South Africa supports an intersectoral approach to development and these are discussed below.

### **1.6.2 New Legislative Structures to Support Intersectoral Collaboration**

Local government is vital for strengthening, facilitating and integrating the various sectors of the economy. Provision for such integrative structures presently exists in the National Health Plan for South Africa as well as in the Reconstruction and Development Programme. These integrative structures take the form of intersectoral development committees that exist at community, district, provincial and national levels.

The National Health Plan for South Africa recognises and fully supports the idea of intersectoral collaboration. This commitment to intersectoral collaboration is embodied in the formation of specific intersectoral development committees at community, district, provincial and national level. Further, governmental support for intersectoral collaboration is rooted in the government's basic needs philosophy which is as follows: Health problems have many complex causes whose solution demands an intersectoral approach. The health sector has an important advocacy role in ensuring that policies, programmes and plans in other sectors take account of health. Promoting health requires far more than improving medical services. This is particularly obvious in South Africa, where decades of apartheid have led to grossly inferior education, unfair employment opportunities, inadequate housing, low income, and poor environmental conditions. All of these play a significant part in determining the health status of the majority of the population (ANC, 1994a). The attempt by the state to set up



intersectoral development committees at various levels is a positive step. For various levels Intersectoral Development Committees are at:

#### **1.6.2.1 Community Level**

According to the Health Plan for South Africa "All communities will be encouraged to form intersectoral community development committees, whose members will be elected from the community. This committee will have advocacy and advisory roles to help coordinate all aspects of development, and ensure that resources are used to the best advantage of all in the community. It will be particularly important in rural and other disadvantaged communities" (ANC, 1994a: 61).

#### **1.6.2.2 District Level**

According to the National Health Plan for South Africa " Intersectoral coordination will be ensured through the establishment of an Intersectoral Development Committee on which the District Health Authority (DHA) will be represented. This committee will ensure that health concerns are addressed by sectors such as education, engineering, water affairs, agriculture and any other sectors involved in the development activities that affect health" (ANC, 1994a: 63).

#### **1.6.2.3 Provincial Level**

According to the National Health Plan for South Africa "The intersectoral Provincial Development Committee will be similar in concept and function to the district and community development committees and will comprise members of the provincial legislature (members of the executive committee-MECs) responsible for all sectors impacting on health. It's task will be to identify development needs in the province and to mobilise and allocate resources to the

best advantage of the people of that province, particularly the poorest" (ANC, 1994a: 65).

#### **1.6.2.4 National Level**

According to the National Health Plan for South Africa "As with the other levels of the system, all sectors affecting health should be represented on this committee, which will therefore comprise the relevant government ministers. It will be responsible for intersectoral liaison with other ministries" (ANC, 1994a: 68).

The benefits of intersectoral collaboration is widely accepted. However, its application to South Africa is constrained to a greater extent by the past political and administrative divisions. Having reviewed the priority that is given to intersectoral collaboration focus can now be directed to GIS, which this thesis considers to be an appropriate and useful technology to coordinate health and health-related services within a district-based health system.

### **1.7 Conceptualising and Defining GIS**

There has been a multiplicity of attempts to define GIS. This is understandable since GIS is a fairly young science and is influenced by many disciplines and most crucial of which is geography. It is for this reason Maguire (1991: 9) suggests that "any subject or concept which is in widespread use by a heterogeneous group of users is almost certain to be difficult to define". Within the field of GIS, applications specific to health care are termed health-based GIS. The use of health-based GIS internationally and in South Africa are reviewed here.

### **Selected definitions of GIS by Maguire.**

Doe (1987: 132) "*a system for capturing checking, manipulating, analysing and displaying data which are spatially referenced to the earth*".

Parker (1988: 1547) "*an information technology which stores, analyses, and displays both spatial and non - spatial data*".

Burrough (1986: 6) "*a powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world*".

Maguire (1991) examines the plethora of definitions of GIS and draws the following conclusions. Many of the definitions are general and cover many subjects and activities but a common feature is to be found in all definitions which relates to geographic information.

#### **1.7.1. Health-Based GIS**

There is great potential for the use of geographical information systems (GIS) for the analysis and management of health and health care data (Twigg, 1990). Health-based GIS may be used for a number of purposes, some of which include: as an inventory tool of medical facilities, to better manage the future placement of medical facilities as a decision support tool and for undertaking epidemiological investigation (Twigg, 1990).

##### **1.7.1.1 Health-based: GIS the international experience**

Health-based information systems abroad are at a stage where disease mapping and associative analysis are emphasised, for example, the atlas of the distribution of diseases. In South Africa the health-based information system (ReHmis) is primarily used as an inventory tool of medical

facilities. Other studies where GIS is used as a tool in the fight against schistosomiasis indicate the use of health-based GIS as a Spatial Decision Support System (SDSS) overseas.

### **1.7.2. Health-based geographical information systems in South Africa**

The Department of Health in South Africa has a health management system called ReHmis (Regional Health Management Information System), which is designed to satisfy the information needs of regional health management at a strategic level (Department of Health, 1995a). Besides the Department of Health, the Medical Research Council (MRC) has developed the National Malaria Research Programme (NMRP) and the Malaria Information System (MIS) which are health based geographic information systems (Stuttaford, 1994).

Over and above these developments within organisations, many individual contributions to the use of health-based GIS in South Africa are evident. The use of GIS in epidemiology in South Africa, has been undertaken by Abdool Karim, et.al., (1992) in a study entitled, "Seroprevalence of HIV infection in Rural South Africa". In the area of GIS planning, Fincham and Berjak (1990) examined the, "Development of a planning and management GIS for Maputaland". In the field of disease control, Le Sueur, Sharp and Ngxongo (1991) examined, "The localisation of malaria vector breeding sites using a global positioning system to enhance malaria vector control in Natal/Kwazulu region. Adding to this field, Naidoo (1994) investigated the "War against killer mosquitoes: satellite device tracks disease" and Stuttaford (1994) investigated the "Aspects of a geographic information system for medical geographers and malaria control".

In terms of the public health sector in South Africa, a milestone has been reached. No longer is there debate as to whether the region can afford this technology but now the debate is about how the technology can the best be put to use. Management within the health sector are beginning to place confidence in the use of GIS as an important planning tool.

## **1.8 Conclusion**

The move to a district-based health system and the adoption of a PHC approach does have positive implications for the delivery of PHC services. However, the main obstacle to this transition relates to the devolution of power to an appropriate governance structure and the implementation of an appropriate district level accounting mechanism.

The governance options to suit the various provinces, the development of intersectoral committees and the adoption of a PHC approach are only some of the legislative and institutional arrangements which are needed to smooth the transition to a district-based health system. These legislative and institutional arrangements are dealt with extensively in the District Health Systems Policy Document and the Reconstruction and Development Programme (RDP) and is supported by the government.

The adoption of a PHC approach inevitably involves a redistribution of resources. Since, resources have been unequally distributed historically along lines of race, it is reasonable to expect that the transition to a district-based health system and the adoption of a PHC approach to the delivery of health to be a difficult yet challenging task.

The transition to a district-based health system needs input from experts from as many disciplines as possible. Geographers in general and medical geographers in particular are ideally placed to:

- (i) examine the place of PHC in the related areas of Medical Geography and the Geography of Health and
- (ii) develop health care delivery systems that are able to redress the spatial imbalance of health resources.

Considering the significant role that Medical Geographers can play in the transition to a district-based health system, this study recommends that South African universities need to offer courses that would enhance the sub-discipline of Medical Geography. Also significant are the GIS skills which geographers have and which can be used to develop the DHS. GIS can also be used as a methodological tool and this is considered in the next chapter.

## **CHAPTER TWO**

### **METHODOLOGY**

#### **2.1 Introduction**

Geographic Information Systems (GIS) provides a useful tool for addressing questions of accessibility to PHC services within the proposed health district. This chapter focuses on the primary and secondary data sources used for this study. Each of the primary data sources are touched upon with special attention paid to the use of the Global Positioning System (GPS) and the digitizer. The data gathering process and a brief description of the GIS system used with some lessons learnt are also discussed.

#### **2.2 Primary Sources of Data**

Primary sources of data include :

- (i) questionnaires;
- (ii) Global Position System (GPS) readings at each clinic facility;
- (iii) digitizing;
- (iv) committee meetings of the NPHC-DP and
- (v) committee meetings of IRMAT.

##### **2.2.1 Questionnaires**

Questionnaires were sent to the matron at each fixed clinic within the health district (Appendix 2). A trained field worker assisted the matron in the data collection process.

Taking into account the limited staff at these facilities as well as the available time that these senior health officials have to spare, the questionnaires were constructed accordingly. Approximately 95% of the questions were of the fixed response type which saved time

Questionnaires were also sent to the supervisor of the mobile clinic team (Appendix 3). These questionnaires were then completed at each clinic point. Here again, staff constraints and time were considered in the construction of the questionnaire and approximately 95% of the questions were of a fixed response nature.

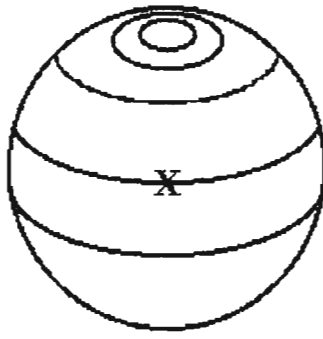
## **2.2.2 Use of Global Positioning System (GPS)**

The location of the fixed clinics, family practitioners and some of the mobile clinics were obtained, using the Global Positioning System (GPS). The GPS gives access to positional information. The way in which the GPS works is explained below with the use of diagrams.

### **2.2.2.1 How does the GPS work ?**

The GPS is based on a system of clocks measuring the time difference between a signal leaving the satellite and arriving at the receiver, which is in the position of the user. This in effect now supplies a vector of known length and narrows the position on the surface of the adjacent sphere. Figure 4 shows the position of the satellite which is at point at X (Le Sueur, et.al., 1994).





Source: Le Sueur, 1994

Figure 4: **The position of the satellite**

The second vector is provided by a second satellite that is in a suitable position for its signal to reach the receiver. This creates a second sphere and the position of the receiver is now narrowed down to somewhere within the area of overlap (Le Sueur, et. al, 1994).

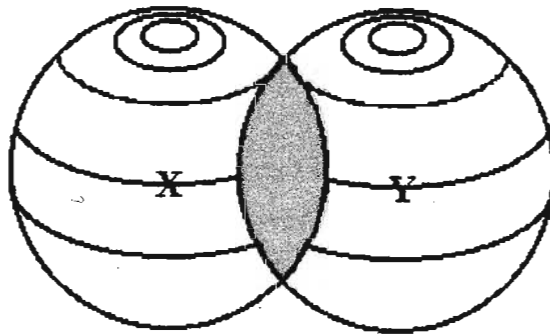


Figure 5: **The Second Vector**

Source: Le Sueur, 1994

The third vector now enables the process of triangulation to be completed and localises the position of the receiver to one of two points (Figure 6:). The one point is on the earth's surface

and the other is at some point in space. The latter is eliminated by the signal from the fourth satellite and the position of the receiver is now fixed (Le Sueur, et. al.,1994).

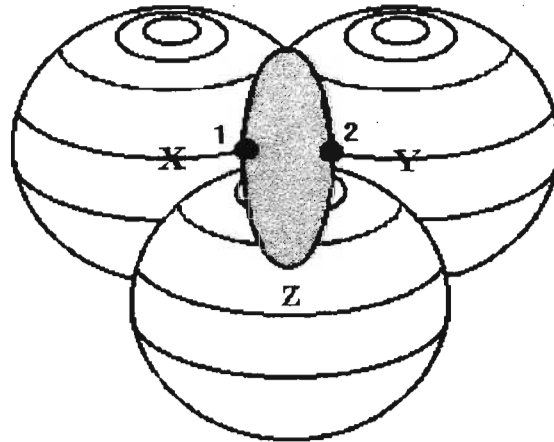


Figure 6: **The Third Vector**

Source: Le Sueur 1994

#### **2.2.2.2 Using the GPS to map health care resources**

Prior to the use of the GPS at the study area the following tasks were undertaken. Firstly, permission was obtained to use GPS at sites. Secondly, the route was planned as this saved both time and cost since most GPS units are expensive in terms of power (battery) requirements. Thirdly, a data recording sheet was prepared to facilitate the data recording process. Fourthly, the GPS unit was preset to meet South African conditions. Finally, the services of a field worker familiar with the area was sought.

##### **(i) Permission to use GPS at selected sites**

Permission to use the GPS at both public and private facilities was obtained very easily. These arrangements were made telephonically, saving time and avoiding paper work.

**(ii) Planning the route**

In order to save both time and cost GPS readings were taken of all health facilities within a particular stop or point. For example, GPS readings of fixed clinics were taken simultaneously with either hospitals or family practitioners wherever these were in close proximity to each other. A planned trip, as outlined above was a tremendous saving in term of power requirements. This is consistent with the findings of Le Sueur, et.al. (1994) who assessed three GPS units for field use, in which portability, robustness, accuracy and power requirements were looked at. The Trimble Ensign was found to be the most suitable for field use. Further, this unit is far more power efficient than other units (Le Sueur, et. al., 1994).

**(iii) Preparing the data record sheet**

Preparing a data record sheet is helpful in terms of record keeping as well as facilitating the data capture process. An example of the data record sheet is found below.

**Table 1 Data record sheet**

Health facility	Longitude	Latitude	PDOP	No. of Satellites	Altitude	Time

**2.2.2.3 Presetting the GPS**

Presetting the GPS saves time spent at each facility and saves on the life of the battery . This can be achieved if the projection system, the unit system and the accuracy filters are set prior to the use of the GPS in the field and is discussed below.

**(i) Choosing a projection system**

The Trimble Ensign has one hundred and twenty three alternative datum systems installed internally. In South Africa, the projection system used is the Trans Mercator (Gauss Conform) and the associated datum system is the Cape, South Africa (Le Sueur, et al., 1994).

**(ii) Setting accuracy filters**

Most GPS units contain Accuracy Filters, which attempt to counteract the effects of Selective Availability. In the case of the Ensign, these are POS (Positional) and SOG (Speed Over Ground) filters. The default is on Positional, which means that the position is made up of one reading and is thus more likely to be subject to variations due to Selective Availability. Increasing the values results in an averaging of the prescribed number of readings and improves accuracy (Le Sueur, et.al., 1994). In the case of the New Hanover District, an average of three readings were taken at each facility.

**(iii) Choosing a unit system : decimal degrees vs degrees, minutes and seconds**

Different GIS systems prefer their coordinate data in different formats. GPS units have the ability to present positional coordinates in different formats. The Basic Map Application (longlats) in MapInfo was used to convert the degrees, minutes and seconds coordinates into degrees decimal.

Since the area has very limited health resources, the actual GPS readings were undertaken by the researcher. However, the services of someone who is familiar with the health district and someone who is conversant in Zulu was required. In this regard the services of a development

officer who is in charge of the New Hanover District was employed. Presetting the GPS did result in observable savings in terms of time and power requirements.

#### **2.2.2.4 Improving levels of accuracy when using the GPS**

To use the GPS in health applications successfully one must ensure that the correct datum system is used and that a calibration accuracy is set so that an acceptable DOP (Dilution of Precision) level can be achieved (Le Sueur, et.al., 1994).

For the purposes of this thesis two additional steps were taken to improve accuracy. Firstly, attempts were made to achieve low levels of PDOP (Position Dilution of Precision). Secondly, the number of readings at each point were increased to three.

##### **(i) Achieving low levels of PDOP (Position Dilution of Precision)**

PDOP is a measure of the angle of the satellites relative to the user and each other. Optimally, one satellite should be directly above the user and the other three at 120° relative to each other. Under such circumstances the PDOP will be 1.639. This is the lowest value that can be achieved (Le Sueur, 1994). The positional accuracy of the Ensign as quoted by Trimble is 25 metres RMS (root mean square). Under Selective Availability the position may be degraded up to 100 metres 2D RMS). In the study undertaken, the PDOP values were between 2,5 and 3,5. Thus the levels of accuracy were 37,5m and 52,5m respectively.

##### **(ii) Increasing the number of readings at each point**

Accuracy may be increased by increasing the number of readings at the same point and taking an average of these. Increasing the number of readings does have negative implications. Firstly,

it affects the ability of the unit to respond to changes in position. Secondly, more time is spent at each facility (Le Sueur, et.al. 1994). The GPS unit was preset to take at least three readings at each facility within the health district.

In this study all possible attempts to improve accuracy as mentioned above were undertaken. The integration of the GPS readings were carefully captured and converted to decimal degrees. The MapBasic facility in MapInfo was used to convert data to decimal degrees (MapInfo Corporation, 1994). Also the relative points were checked, using topographic map sheets with scales of 1: 50 000 and 1: 250 000.

### **2.3 Digitizing the health boundary**

Very simply, digitizing means, “the conversion of information from analogue representation to numerical form” (Mather, 1991: 103). The boundary which constitutes the New Hanover Health District is digitized from a 1:250 000 topographic sheet. This boundary is made up of a single polygon that includes the former magisterial district of New Hanover as well as the surrounding districts that now form part of the newly defined health district. These districts include Umvoti to the north, Mapumulo to the north east, Ndwedwe to the east and Lions River to the west. These boundaries were developed in consultation with the New Hanover Primary Health Care and Development Programme (NPHC-DP). The NPHC-DP in turn, through a series of workshops and in consultation with the various development communities on the ground, accepted the delineation of the health boundary as being realistic and functional to some extent.

### **2.3.1 The Digitizing Process**

The actual digitizing process included the following processes:

- (i) setting the digitizer target;
- (ii) listing and converting map records;
- (iii) setting the snap tolerance and
- (iv) setting the visible map extents which are discussed below.

#### **2.3.1.1 Setting the digitizing target**

On a 1:250 000 sheet the boundaries of the health district were identified and highlighted. The newly delineated health district boundary now constituted a polygon which has a circumference and area of its own.

#### **2.3.1.2 Listing and converting map records**

At least six control points from the map were identified in order for the digitizer to recognize the coordinates within which one is working. These coordinates were taken from the edge of the 1:250 000 topographic map. The coordinates on the map appear as degrees, minutes and seconds. These were converted to decimal degrees using Mapbasic in MapInfo.

#### **2.3.1.3 Setting the snap tolerance**

The snap tolerance is used to designate the pixel distance between nodes. The snap tolerance was set to the value of five. This means that when a node is moved within five pixels of another node, the snap to node is activated and the node will snap to the next node (MapInfo Corporation, 1994)

#### **2.3.1.4 Setting the visible map extents**

The map extents are set so that the computer knows roughly what size area it is looking at and this makes it possible to view the whole map on the screen. The size of the proposed New Hanover health district is 210 km. The centre coordinate is (x:-32353m; y:-32538m). The centre coordinate point is important since it assists the computer in determining the point around which it can zoom in and out.

#### **2.4 Personal interviews and telephonic conversations**

Personal interviews were organised at the practice of each family practitioner within the health district. Numerous discussions were held with the district surgeon, Dr.N Naidoo, the extension officer for New Hanover, Mr. QV Mann, and health officials at the Department of Health.

#### **2.5 Committee meetings of the New Hanover Primary Health Care and Development Programme**

Attendance at committee meetings provided a valuable source of information about health and health-related issues and events that occurred within the district.

#### **2.6 Committee meetings of the Interim Regional Management Advisory Team (IRMAT).**

By attending committee meetings valuable information pertaining to health care provision by the Kwa-Zulu Department of Health was gained. A considerable amount of time was spent in initiating programmes and workshops that aimed to develop and promote the concept of a District Health System (DHS). Much experience was gained in understanding the implications for implementing the District Health System concept in Kwa-Zulu Natal. As a member of this



team, there was opportunity to become involved in the Clinic Upgrading Programme (CUP). Part of the exercise was to examine and evaluate applications for upgrading as well as provision of new clinic sites. On some occasions the team made recommendations for mobile clinic points.

## **2.7 The computer system and software used**

### **2.7.1 Hardware and Software**

The hardware and software was provided by the Health Systems Trust. The MapInfo software was provided by the University of Natal. The description of hardware and software used are found in table two.

**Table 2 Description of hardware and software used**

<b>HARDWARE</b>	
Computer	Personal computer (PC), 486 100 MHz Microprocessor, 8 MB ram, 540 MB hard drive, SVGA monitor and Printer.
Digitizer	Summagraphics
GPS	Trimble Ensign
<b>SOFTWARE</b>	
	MapInfo V.3.0, Windows 3.11, Perfect Office 3.0
MapInfo	MapInfo is a leading desktop GIS and mapping system which sets the standard for cost effectiveness. It is most suitable for marketing, site assessment, planning and business applications. Some of the features include display, editing, overlay, analysis, query, searching, geocoding, digitizing, and thematic mapping. MapInfo also has a relational database and is capable of handling data tables from several outside sources, for example dBASE, Excel, lotus 1-2-3 and delimited ASCII. Also, own databases can be created directly in MapInfo.

## **2.8 Problems Encountered**

MapInfo has a limited range of import file formats. The bulk of the data available for this study was made available via ArcInfo in E00 export format. All these E00 files were converted to MapInfo file format using Arclink.

## **2.9 Identification of data source**

Both the private as well as public sources were identified for spatial and attribute data. Once an initial data source is identified referral to other sources follow. Many organisations will have the required data in different file formats and in varying degrees of accuracy and reliability. Importing and exporting in Autocad DXF is tedious and often results in data being corrupted

because not all Autocad DXF formats are the same. Besides, organisations willing to provide data are reluctant to download data in Autocad DXF format because it is time consuming.

### **2.9.1. Important aspects to consider when identifying data sources**

Some of the important aspects to consider when identifying data sources include:

- (i) The file format of the data.
- (ii) If the data is not in a file format compatible with the software being used, does an appropriate converter exist?
- (iii) Is the data available at the resolution that is required?
- (iv) Obtain definitions of fields or concepts that are contained in the database that is required.

Taking note of the above mentioned aspects would save time and avoid unnecessary data conversion problems.

### **2.10 Data collection**

This is the most time consuming and costly part of the research process. There are various organisations that may offer data at reasonable costs or make such data freely available on condition that their company or firm is acknowledged. Data gathering and collection via this route does help to offset the high cost at the initial stages as well as save time. In some cases, especially privately owned businesses, the organisation may only charge the cost of labour to either download or convert the data. Where data is not available other methods may be examined before actual field collection is embarked upon. For example, by using a digitizer one can yield accurate and high quality data provided every effort is made to correct any error propagated during the digitizing process. Thus “recent interest in the sources of error in spatial

data have focussed attention more clearly on the methods used for collection and input” (Martin, 1991: 65).

### **2.11 Data Collection : New Hanover Health District.**

Data sources for this study include government departments such as the Department of Health and the Department of Roads. Data sources other than public sector organisations included Umgeni Water, which provided census and socio-economic data and Eskom, which provided data relating to water and sanitation within the health district. Eskom also provided valuable land use data which was made available via a private company named, GIS World. Seneque-Maughan-Brown provided projected population data for the health district.

Health facility data namely the location of fixed clinics, mobile clinics, hospitals, family practitioners and some smaller urban areas were obtained using a Global Positioning System (GPS). Data pertaining to the provision of Primary Health Care (PHC) services were obtained via questionnaires and ReHmis (Regional Health Management Information System). Data pertaining to the location of schools was obtained from Telkom via the Department of Water Affairs. Information pertaining to the schools where “Act Alive” AIDS education occurred was made available by Dramaide at the University of Natal, Pietermaritzburg.

### **2.12 Conclusion**

The use of the GPS and the digitizer to capture data has been demonstrated in this chapter. The GPS readings were easily incorporated into MapInfo using the conversion facilities within MapInfo. However, the incorporation of digital data from other systems such as ArcInfo and Regis were problematic because of the limited import facilities within MapInfo.

These initial problems nevertheless, raise important questions with regard to National Data Exchange Standards and need to coordinate such efforts in South Africa. The next chapter looks specifically at the use of GIS to delineate district health boundaries and to map and assess the health and health-related resources within the proposed health district.

## CHAPTER THREE

### MAPPING HEALTH AND HEALTH-RELATED RESOURCES

#### 3.1 Introduction

The delineation of the boundaries for the proposed health district sets the scene for an assessment of the health resources and the role of the community in supporting a district-based health system in this chapter. The initiatives and projects of the Greater Efaye Coordinating Committee are examined to demonstrate the importance of community participation within a district-based health system.

The delineation of the New Hanover Health District boundaries provides the starting point to develop the health district. The boundaries that constitute the health district are guided by those determined by the New Hanover Primary Health Care and Development Programme (NPHC-DP) which were determined at workshops and meetings between the NPHC-DP and the New Hanover community.

The spatial distribution of health facilities and the role these play in the delivery of PHC services within the proposed health district is noted. The utilization rates for family planning and antenatal care which are vital PHC services are examined.

Taking into account the significance of health-related services such as water, sanitation and health education, the backlogs regarding these services within the proposed district are considered.

### **3.1.1 Background to Study Area**

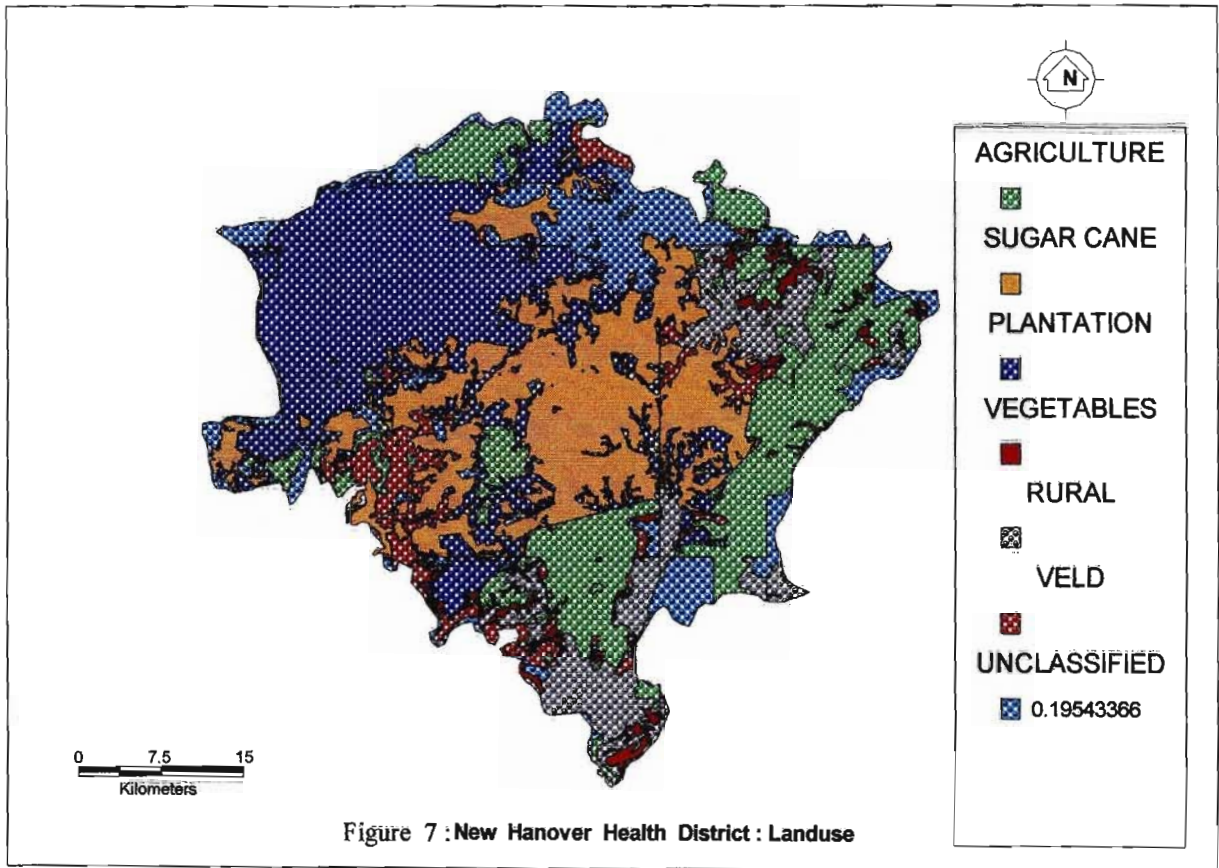
The New Hanover District is located between (30° 15" to 31° 5' East) and between (29° 03' to 29° 45' South). The New Hanover district is rural in character with three towns, namely New Hanover, Wartburg and Dalton. It is approximately 35 km north east of Pietermaritzburg on the main road to Greytown. Figure 1 shows the geographical position of the New Hanover district and its location in relation to the eight health regions in Kwa-Zulu Natal.

One of the earliest settlers in the area were a group of Germans who settled near the Sterkspruit in the early 1850's. This area is now known as New Hanover. This group of settlers were complimented with a group of missionaries who began farming in the area. Wattle plantations were the key factor in the development of the region and commercial wattle plantations began in 1886. Timber related industries led to the development of the railway and shopping centres (Chief Town Planner, 1987).

The location of the New Hanover Health District, its landuses and the population distribution are displayed using thematic maps generated by a GIS and each are elaborated upon.

### **3.1.2 Landuses**

The greater part of the New Hanover district is taken up by sugar cane and wattle plantations and is rural in character. Farming and forestry are the dominant activities. Most commercial farming and forestry are concentrated in the former areas of the Republic of South Africa (Figure 7).



### 3.1.3 Population of the Proposed Health District

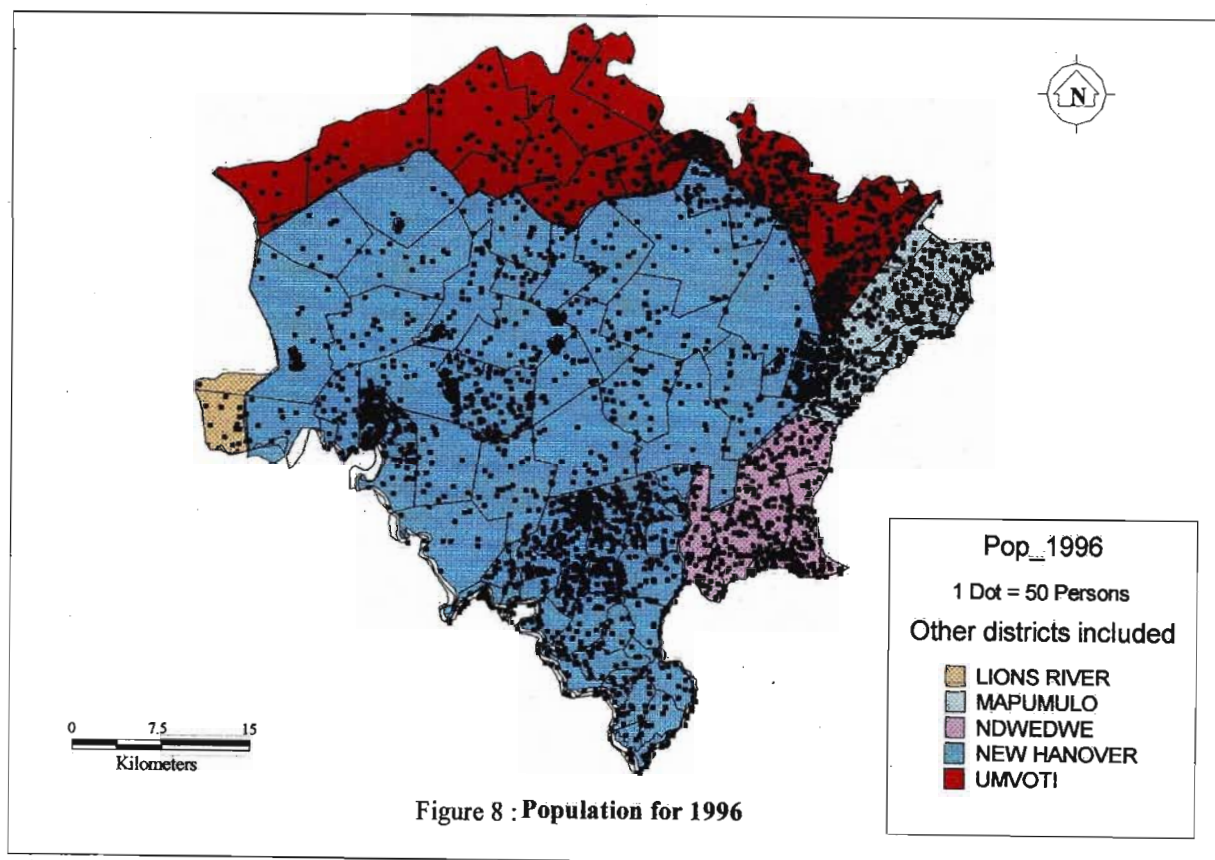
**Table: 3 Population of proposed New Hanover Health District**

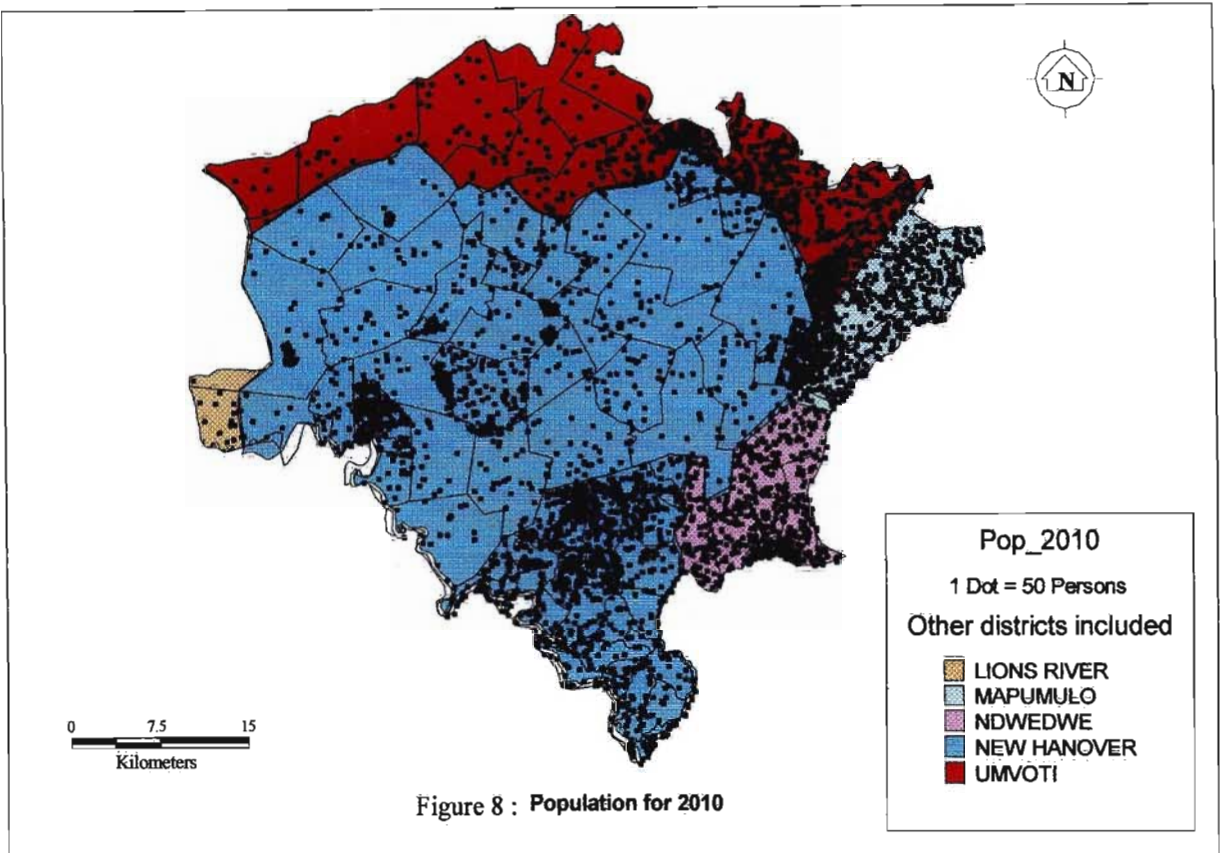
The population for the New Hanover health district is based on the 1991 census.

DISTRICT	AREA Sq /Km	POPULATION	
		1996	2010
New Hanover	1105	47 549	53 384
Umvoti	279	5 786	5 626
Lions River	36	875	851
Ndwedwe	132	22 762	29 061
Mapumulu	310	54 258	69 270
Mpumalanga	258	36 755	46 927
<b>New Hanover Health District</b>	<b>2112</b>	<b>167 985</b>	<b>202 119</b>



The total population for the health district is determined by adding the total population of the magisterial district of New Hanover to those areas of other districts that are now included in the proposed health district as shown in Table 3. Figures 8 and 9 show the population for the years 1996 and 2010 respectively.





An assessment of the resources within the proposed health district reveal that commercial farming and forestry, which are the dominant commercial activities, are concentrated in the former areas of the Republic of South Africa (RSA) whereas the former areas of Kwa-Zulu are dominated by subsistence farming. Unfortunately, the population of the New Hanover Health District is very unevenly distributed. Again the former Kwa-Zulu areas (eastern parts) of the health district are disadvantaged because they are densely populated. These areas contain 67% of the population which occupy 700 square kilometres of the land, compared to the former RSA areas of New Hanover that contained 33% of the population which occupied twice as much land, that is approximately 1420 square kilometres. The result is an improvised eastern border which is coincidentally densely populated.

### **3.2 Delineation of Health District Boundaries**

The delineation of boundaries for the health district is a complex issue because of unequal development which is evident in the distribution of services and facilities throughout South Africa. A challenge to those involved in the delineation of health districts as well as sub-districts is to find creative ways of marrying well-resourced areas with under-resourced areas. The criteria to delineate health district boundaries as proposed by the National District Health Systems Committee (NDHSC) is examined here because this study incorporates some of these criteria to delineate the boundaries for the proposed health district using GIS.

It is imperative that the health districts have clearly delineated boundaries. Some of the reasons being:

- (i) to prevent the oversupply and duplication of service provision;
- (ii) to prevent islands of no service provision and
- (iii) to deliver health care economically and efficiently.

#### **3.2.1 Criteria for the delineation of health district boundaries**

Some of the criteria proposed by the NDHSC include:

- (i) Health districts to be coterminous with local government boundaries;
- (ii) Size of the population;
- (iii) Infrastructure;
- (iv) Health needs;
- (v) Socio-economic conditions;
- (vi) Topography and
- (vii) Transportation infrastructure (Owen, 1995a).

The criteria proposed by the NDHSC is helpful but falls short in specifying how it would be applied to rural and urban areas since there are different considerations for delineating health districts in urban and rural areas because each is very distinct both in terms of its character and function.

Whilst the concept of district health systems is in its infancy in South Africa, the international experience indicates that the boundaries of the health district should preferably be congruent with the boundaries of one or more local governments and with the administrative boundaries of other sectors (Owen, 1995a). This idea is reinforced in the National Health Plan For South Africa, which states that "the district boundaries will as far as possible be coterminous with those of the administrative and political boundaries in order to facilitate effective, integrated and comprehensive service delivery" (ANC, 1994a: 62). It is also advisable that these boundaries be "soft boundaries", in other words they should be subject to change (Owen, 1995b).

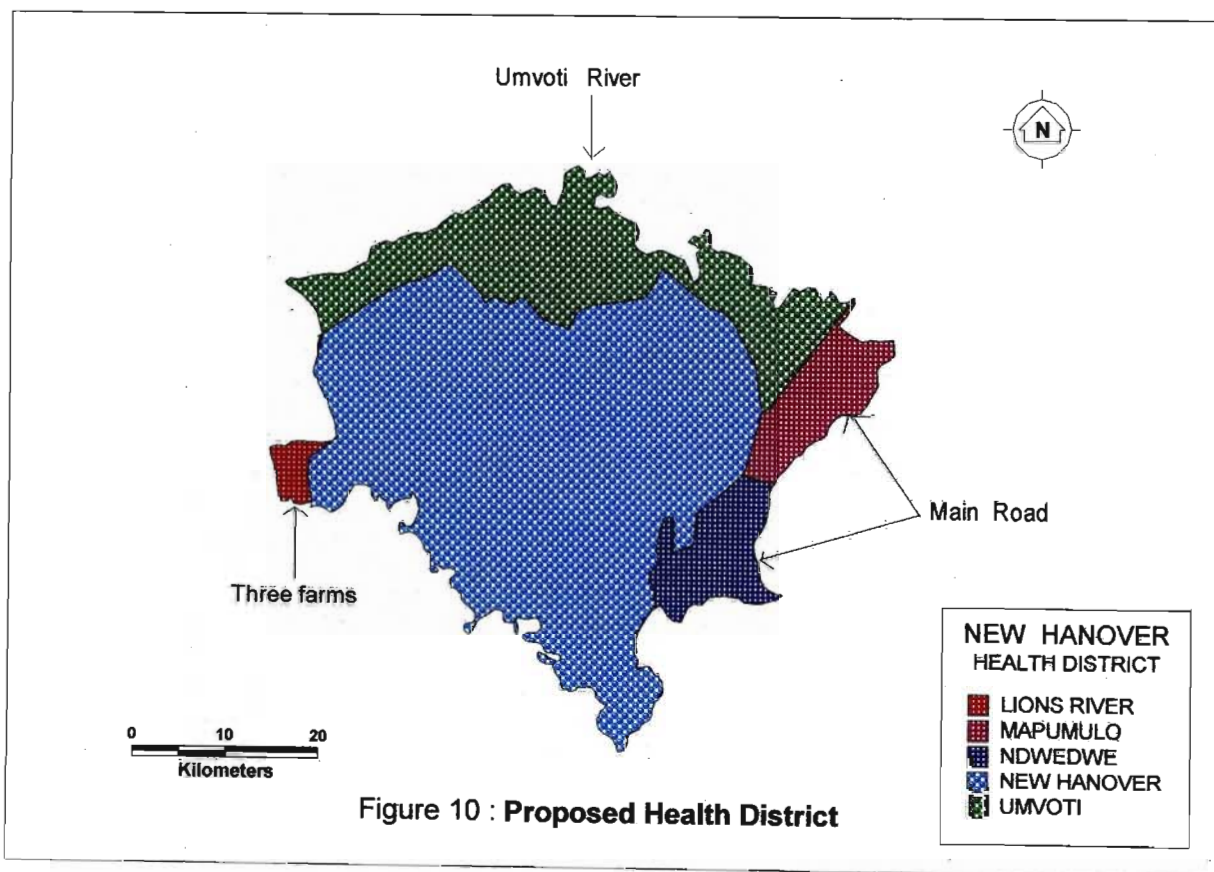
Having examined some of the issues that affect the delineation of boundaries for health districts and sub-districts the focus can now be turned to the delineation of the New Hanover health district boundaries.

### **3.2.2 Demarcation of the New Hanover Health District**

The proposed boundaries that constitute the New Hanover Health District are those developed by the New Hanover Primary Health Care and Development Programme (NHPHC-DP) during a series of workshops with the local people. The proposed New Hanover Health District is

delineated on the basis of including people of other areas that currently use the services and facilities of the New Hanover District.

The existing magisterial area of New Hanover is 1105 square Km with a total perimeter of 224,1 Km. The health district proposed by the NPHC-DP is now 2112 square Km with a total perimeter of 291,3 Km. Part of other districts that are now included within the New Hanover Health District are Umvoti to the north, Mapumulu to the north east, Ndwedwe to the south east, Empumalanga to the south and Lions River to the west (Figure 10).



- (i) The northern border now extends to the Umvoti River which serves as a more practical boundary than the existing divisions that cut across farm boundaries.
- (ii) In the north east, the boundary extends right to the Nzusa River which is currently part of the Mapumulo district.
- (iii) The new eastern boundary cuts across the Ndwedwe district to include Nonti, Dibinhlangu and Afrond. The main road serves as the boundary until it meets the Umvoti River, to constitute the eastern border.
- (iv) In the west, three farms from the Lions River District are included. The three farms, namely Veronique, Bucklands and Shootershill, supply sugar cane to the Noodsberg mill in the New Hanover District.

One can understand the need by the NHPHC-DP to delineate functional health district boundaries. The need is reflected in the view expressed by Zwarenstein et.al., (1993: 558) on district health boundaries that "We must develop functional units now ! This need not wait for the constitution to be finalised; it does not depend on the next elections. It waits only for each health authority to commit staff at a local level, and for them, with major local political players, and representative community bodies, to begin discussing and developing mechanisms and boundaries for districts to function".

These proposed boundaries are a step in the right direction but have inherent constraints, namely:

- (i) The proposals emanate from individuals and stakeholders within the New Hanover District only and since other magisterial districts are involved, wider consultation with these areas is required;
- (ii) The incorporation of areas from other magisterial districts would inevitably have implications for New Hanover as well as the neighbouring districts concerned. For example, the extension of the northern boundary up to the Umvoti River reduces the sphere of influence and area under control of the Greytown magisterial district;
- (iii) Also the question of whether the proposed new district would be functional and efficient in terms of health care delivery needs to be further investigated.

Despite the inherent limitations of the health boundaries proposed by the NPHC-DP, these boundaries are functional to the extent that they include areas or communities that make use of the infrastructure, facilities and services within the newly defined health district boundary (Figure 10).

The demarcation of the New Hanover Health District boundaries can only be developed by extensive consultation with the local communities. There are various levels at which such consultation should occur: local residents, local chiefs and local authorities within the New Hanover district as well as those districts which will be affected.

According to the New Hanover Primary Health Care and Development Programme (NPHC-DP) this consultative process has been completed. However, since this process has commenced prior to the new dispensation, it is advisable that the process be revised for the following reasons. Firstly, to bring on board other stakeholders who refrained because of politically related affiliations or other reasons. Secondly, broader consultation will be possible. A committee should be appointed from this collective consultation to examine issues of defining the health district boundaries.

In concluding the issues affecting the demarcation of health district boundaries in general and those of the proposed New Hanover Health District in particular, this study indicates that it is essentially a consultative process. Further, it is advantageous from an administrative point of view to have these boundaries congruent with the boundaries of other service sectors such as education and local government. Having delineated the boundaries of the proposed district, the health and health-related services within the district can now be examined.

### **3.3 Health Resources Within the Proposed Health District**

The spatial distribution of fixed clinics, mobile clinics, hospitals and family practitioners were examined and their spatial pattern noted.

#### **3.3.1 Spatial Distribution of Health Care Facilities**

The Appelsbosch and Montebello hospitals are the only hospitals within the health district and are located in the eastern extremities of the district. Their catchment area however is very extensive as people from the neighbouring districts, such as Ndwedwe, Mapamulo and Umvoti attend these hospitals. These hospitals are approximately 6,5 Km away from each other and



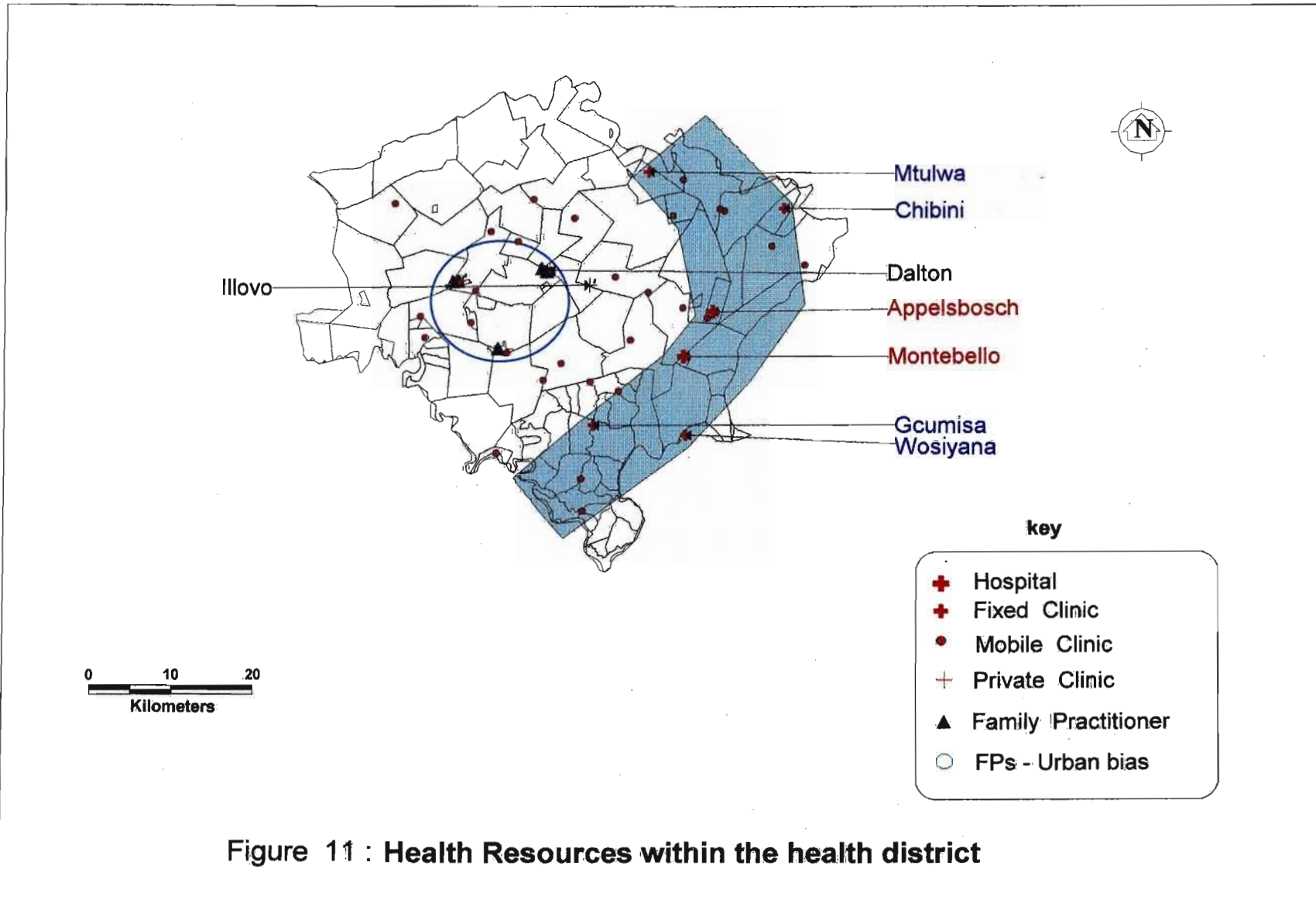
lie along the eastern border of the New Hanover Magisterial District. The location of the two hospitals so close to each other and located on the eastern border is an outcome of apartheid planning (Figure 11).

The public clinics that service the area are Mtulwa, Gcumisa, Wosiyana and Chibini. There are two private clinics, namely Illovo and Dalton, which are situated on business premises and cater for the needs of their workers. The fixed clinics also contribute to this eastern bias (Figure 11). The sparsely populated rural areas within the district are serviced by approximately 30 mobile clinics. These mobile clinics visit designated points between one and three times per month.

The spatial distribution of family practitioners in New Hanover exhibits a total urban bias since all of them are located in the urban areas of Dalton, New Hanover and Wartburg within a radius of 7,1Kms (Figure 11).

### **3.3.2 Formation of the New Hanover Health Arc**

The concentration of health resources namely the fixed clinics and hospitals along the eastern border of the New Hanover health district gives rise to, what may be called a '**Health Arc**'. The arc begins in the far north east of the health district connecting the Mtulwa and Efaye clinics and then veers southwards connecting the Appelsbosch and Montebello hospitals and the Wosiyana clinic. The arc then tapers off westwards to connect the Gcumisa clinic (Figure 11).



### **3.3.3 Evaluation of spatial patterns**

Most of the present health care facilities are found in areas that have a population in excess of 10 000 people. Most of the fixed public facilities are located along the eastern border of the magisterial district of New Hanover. The only exception to these are the Dalton and Illovo clinics which are located in the centre of the health district, on industrial premises. The reason for this anomaly is that these two clinics are private and cater for their workers. The Mpolweni area is one of the areas which is densely populated but has no fixed clinic. Having mapped all health facilities an assessment of PHC services at each of these health facilities can now be discussed.

### **3.4 Delivery of PHC services**

#### **3.4.1 Delivery of PHC at the fixed clinic**

All fixed clinics offer all or most of the following services.

- (i) postnatal care;
- (ii) antenatal care;
- (iii) immunization;
- (iv) family planning;
- (v) nutritional education;
- (vi) HIV/AIDS counselling and the treatment of:
- (vii) under five's;
- (viii) tuberculosis and
- (ix) sexually transmitted diseases.

### 3.4 Delivery of PHC services

#### 3.4.1.1 Treatment of STDs at fixed clinics

Figure 12 indicates that STDs are a very common condition within the district.

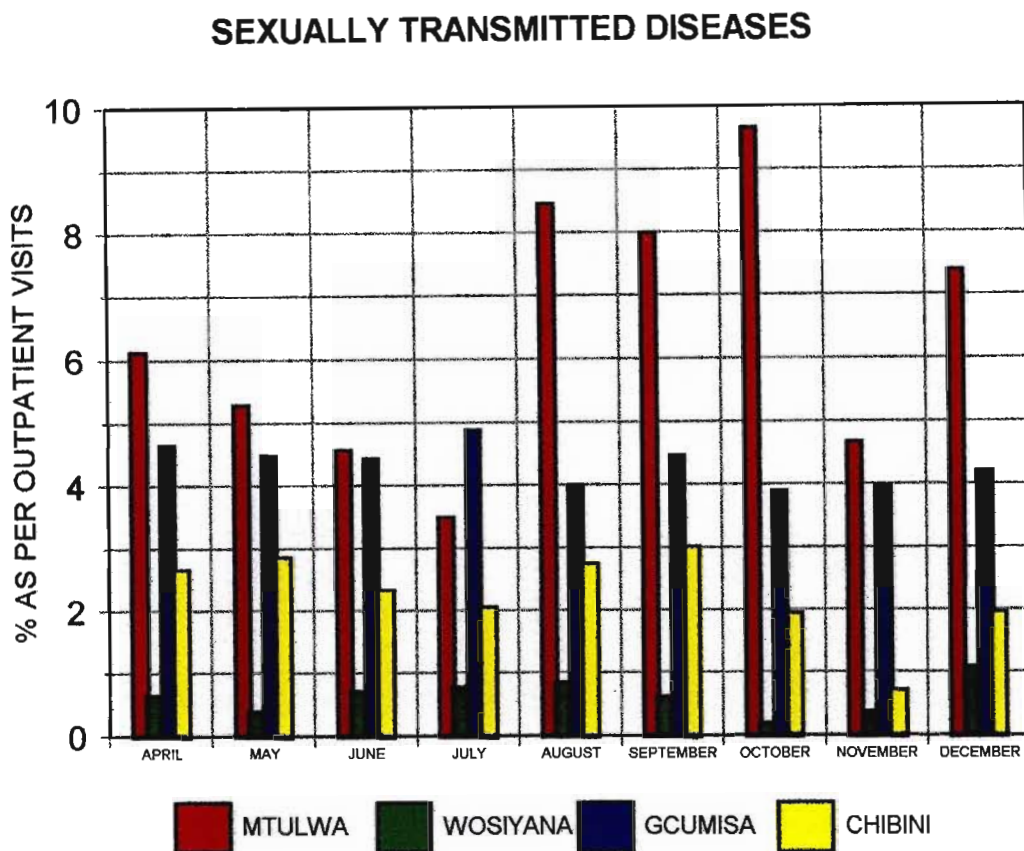


Figure 12: Sexually Transmitted Diseases

In view of the fact that there is a very high correlation between STDs and HIV/AIDS, STDs within the health district should be given priority and as such, one needs to:

- (i) confirm that STD protocols which have been standardised are being adhered to;
- (ii) investigate what facilities are available for follow ups;
- (iii) investigate the availability of condoms and
- (iv) develop a Comprehensive approach to STD within a DHS, ie. link treatment to PHC within the DHS (Per. Com., Naidoo, 1996).

### 3.4.1.2 Utilization of antenatal care services at fixed clinics

The low utilization rates with regard to family planning and antenatal care services at fixed clinics shown in figures 13 and 14 indicate that access to these vital services may be constrained.

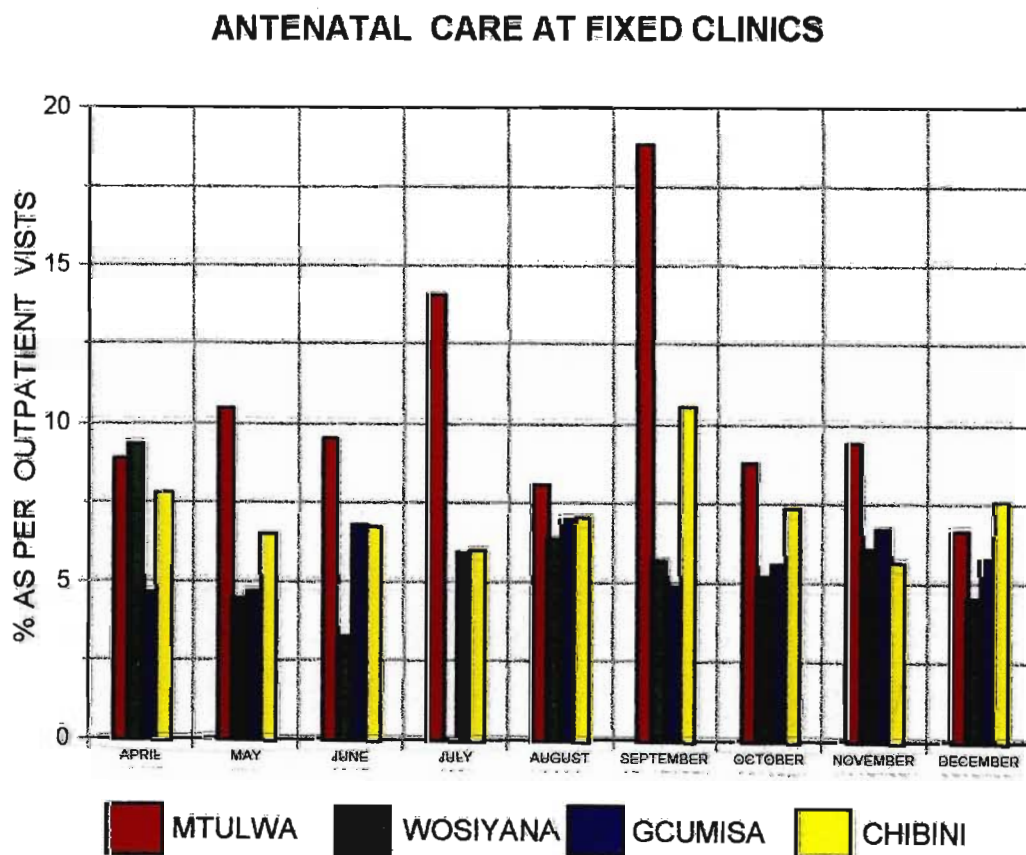


Figure 13: Antenatal care services at fixed clinic

Some of the reasons for the low utilization rates for family planning and antenatal care put forward by the matrons at these fixed clinics include:

- (i) the need for more staff.
- (ii) improvements in especially the roads in order to make the facility more accessible and to be able to transport patients even in inclement weather.

- (iii) the need for a telephone instead of relying on two way radios that often are out of order.

### 3.4.1.3 Utilization of family planning services at fixed clinics

Family planning services needs to be coordinated and integrated within a District Health System (Pers. Com., Naidoo, 1996).

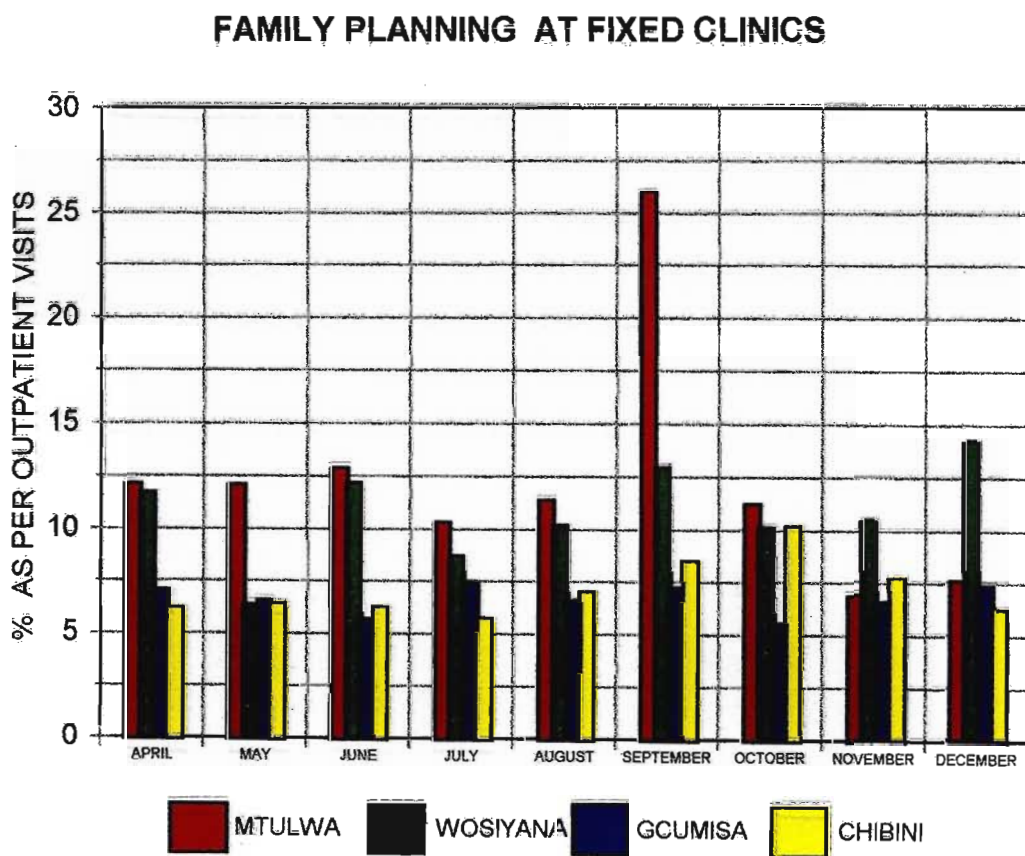


Figure 14: Family planning services at fixed clinics

Figure 14 shows a low percentage usage, ie. less than 15 % of the total out-patient visits per month, which indicates that the family planning service is neglected and that there is much room for improvement.

### 3.4.2 Utilization of mobile clinic services

There are approximately 30 mobile clinic points within the proposed health district which play a vital role in the delivery of PHC services.

#### 3.4.2.1 Cases presenting with STD's at mobile Clinics

Facilities such as couches inside the vehicles and tents which adjoin the vehicle are important determinants of privacy which patients need and which in turn affect the utilization rates at mobile clinic points.

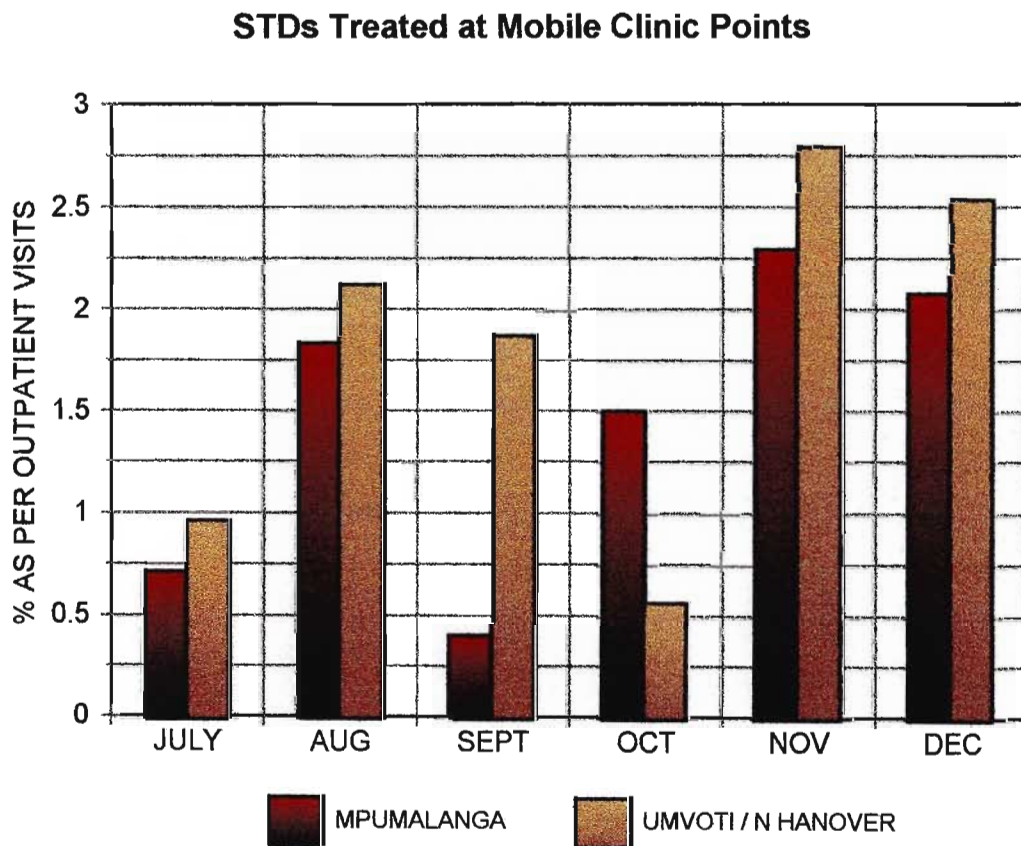


Figure 15: **STDs Treated at Mobile Clinic Points**

Figure 15 shows that a higher percentage of patients present with STDs at the mobiles that service the former RSA areas. This is probably due to the fact that these mobiles have facilities such as tents and couches (Pers. Com., Shezi, 1997).

### 3.4.2.2 Utilization of Antenatal Care services at mobile clinics

Figure 16 shows the poor usage of antenatal care services in the Mpumalanga District which is strikingly evident when compared to that of the Umvoti and New Hanover district.

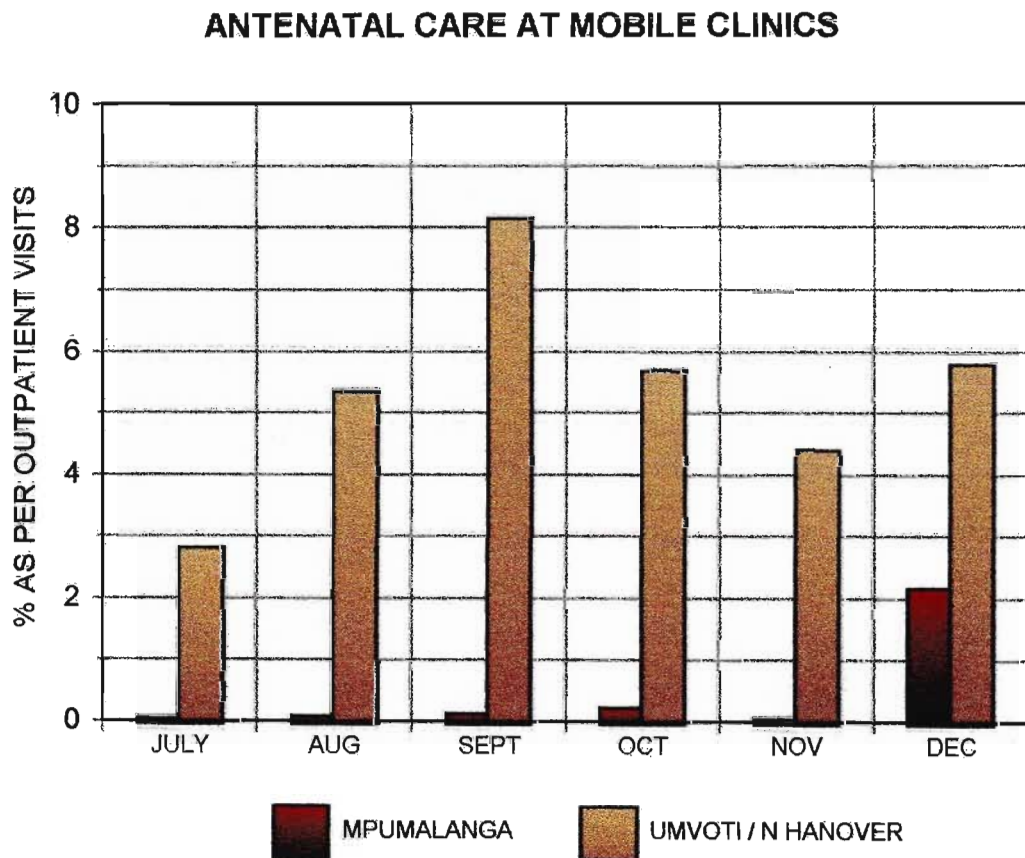


Figure 16: Antenatal care services at mobile clinic points

The reasons for the disparity between the Mpumalanga District and that of the Umvoti and the New Hanover District may be because of a lack of facilities such as a couch and tents and the fact that the nurses are not trained to offer ante-natal care at mobile clinics that service the Mpumalanga area (Pers.Com., Shezi, 1997).



### 3.4.2.3 Utilization of Family Planning services at mobile clinics

Family planning services are vital services which are offered at mobile clinic points and these need to be coordinated within a District Health System.

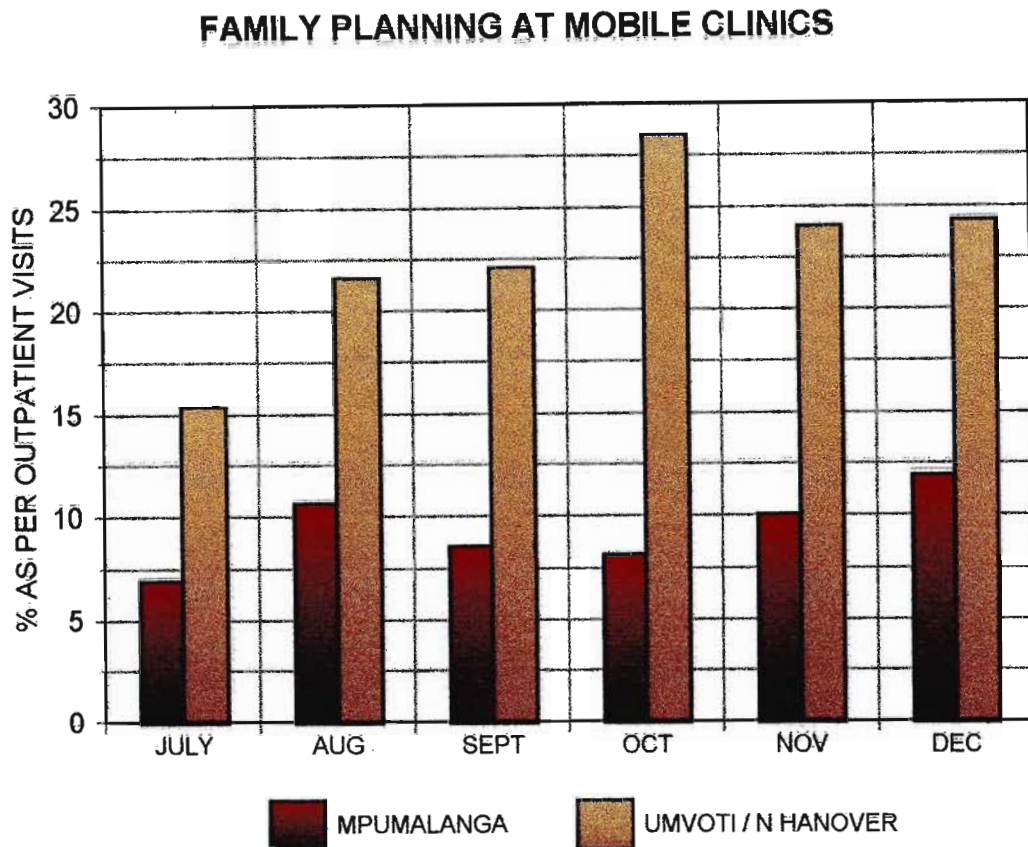


Figure 17: Utilization of family planning services at mobile clinics

Figure 17 indicates better utilization of family planning services at mobiles that service the New Hanover/Umvoti areas which may probably be due to the training of staff in family planning which is available and the active marketing of this service which includes a sterilization programme (Pers.Com., Shezi, 1997).

### **3.5 Delivery of PHC services at the Hospitals.**

The same basic package of PHC services delivered at the mobile and fixed clinics is offered at the Appelsbosch and Montebello hospitals. In addition, these hospitals are placing a greater emphasis on preventive and promotive care, for example the emphasis placed on the expanded immunization programme and the in-service training for nurses tones down a disease-oriented approach to care and emphasizes a preventive and promotive approach to health care (Pers. Com., Mthimkhulu 1997).

An examination of the utilization rates for family planning and antenatal care services at mobile and fixed clinics provide valuable insights into factors that affect access, especially at facilities where utilization rates are low. The low utilization rates also motivate for these services to be coordinated and managed within a DHS. Also significant in terms of the new progressive philosophy of PHC are health-related services such as water, sanitation and health education. These are also examined spatially within the proposed health district in the next section.

### **3.6 Health-related resources**

Water, sanitation and health education are considered important elements of PHC. The delivery of these health-related services are examined from the perspective of the international experience as these relate to issues of health. Also the provision of these services within the proposed health district are examined.

#### **3.6.1 Relationship between water, health and disease**

Some of the eight basic elements of the new progressive philosophy of primary health care include clean water supply and adequate sanitation. The provision of clean water and adequate

sanitation is as equally important as the other elements of primary health care, namely the provision of family planning and treatment of injuries. Access to clean water is important since, “continued good health, which includes daily well being, long term survival and maintained productivity (both biological reproduction and economic production) is dependent upon reliable supplies of good water” ( Roundy, 1985: 294).

The International Drinking Water Supply and Sanitation Decade was declared by the United Nations to extend from 1981 to 1990. The elusive goal of this particular decade was to provide safe drinking water and sanitation for all by the year 1990. This period was declared because of the growing realization that the majority of the world’s population is inadequately served with water supplies and waste disposal. But more importantly the justification for clean water is that it is a prerequisite for good health and is consequently related to productivity (Roundy, 1985).

Water is associated with health and disease in a variety of ways. For example, “water is a vehicle for waterborne diseases and it can provide a breeding ground for some vectors of disease; however, it also serves as a medium to prevent water-washed diseases” (Learmonth, 1978: 284). In the case of communicable diseases, four basic water-disease associations are recognised. These may result in water-borne, water-washed, water-based and water-related diseases (Roundy, 1985).

### **3.6.2 Provision of water within the proposed health district**

Water improvements at farm schools between the period (1986 -1995) include the following:

- (i) ten new improved water sources and
- (ii) fifty new water points.

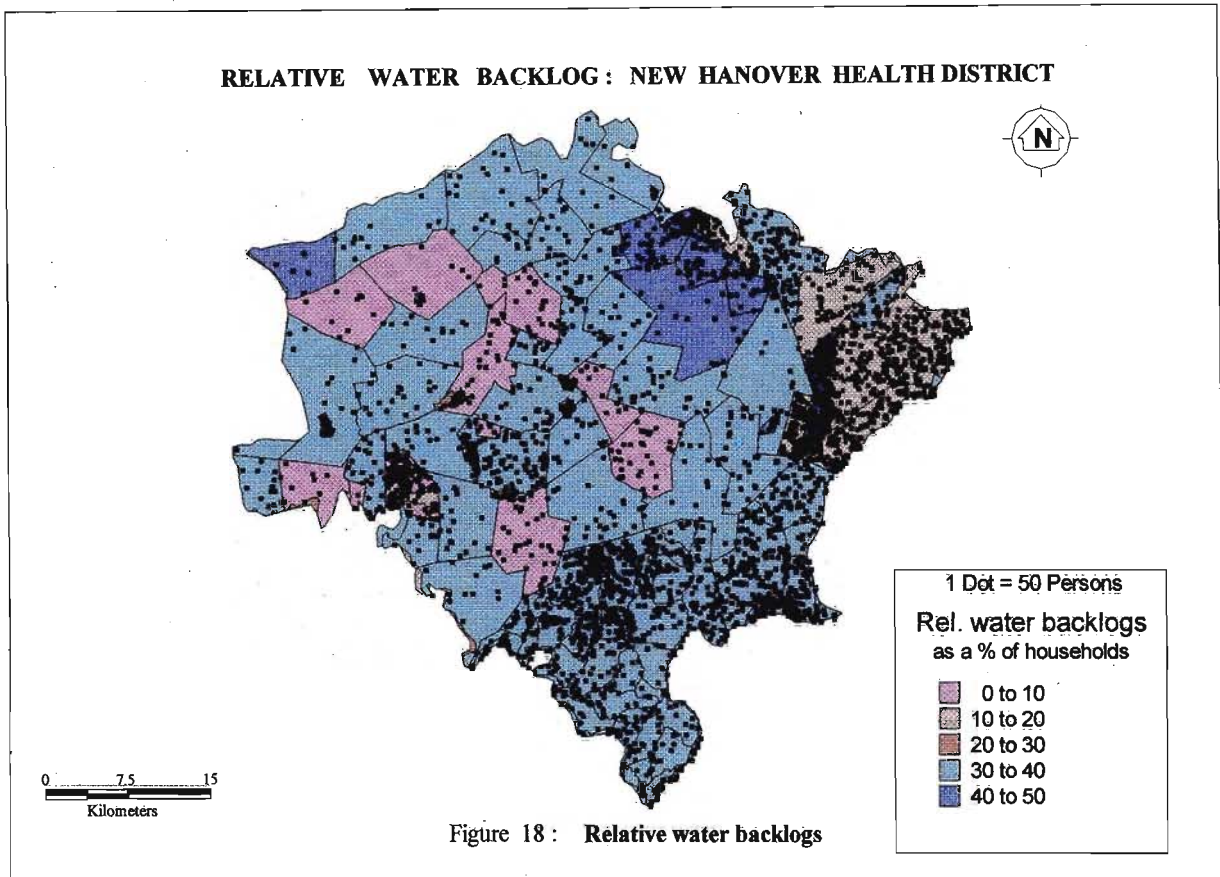
Water improvements at farms between the period (1986-1995) include the following:

- (i) eighty new water points and
- (ii) twenty water sources treated / safeguarded.

However, according to the Senior Environmental Health Officer the above initiatives were not sustainable within the district because of the following reasons:

- (i) lack of land which creates insecurity;
- (ii) lack of ownership of the facility or facilities belong to the farmer;
- (iii) lack of adequate involvement of the beneficiaries in the improvements and
- (iv) the level of poverty on the farms.

### 3.6.3 Relative water backlogs within the proposed health district.



The relative water backlog data set reveal spatial imbalances between the former areas of RSA and the former Kwa-Zulu areas. For example, in the former RSA areas backlogs in 10 to 30 percent of households are found compared to Mapumulu where 40 to 50 percent of households lack water (Figure 18). Spatial imbalances also exists within the former RSA areas. Variations ranging from 10 to 50 percent are evident. Spatial imbalances are also evident within the former Kwa-Zulu areas. Variations ranging from 20-50 percent are evident. However, in the case of Ndwedwe and Mpumalanga the relative water backlogs are between 30-40 percent of households throughout (Figure 18).

The relative backlogs in water provision within the health district exhibits a spatial imbalance that is rooted in apartheid planning. The areas with the greatest backlogs (30-40 % of households) are found in the former Kwa-Zulu areas (Figure 18). Bearing in mind the relationship between water and water-related diseases, the need to overcome these backlogs is of paramount importance if the aim is to offer a comprehensive package of PHC services in order to improve the health status of the entire health district.

Any intervention or programme to redress these water shortages must take into cognisance that the area is economically disadvantaged in terms of economic opportunities and that it is these areas that are experiencing positive population growth.

### **3.7 Sanitation**

#### **3.7.1 Historical background to the provision of sanitation in South Africa**

The lack of access to safe sanitation (toilet) facilities is a significant cause of ill health in South Africa. Despite the health risks, there has been an almost complete neglect in the delivery of rural sanitation by the public sector. Public sector intervention has been largely restricted to crisis management, only responding to areas where disease outbreaks have threatened. Further, the provision of adequate sanitation at rural schools and clinics is neglected and in some cases non-existent (WRC, 1995).

Problems encountered in the delivery of rural sanitation relate to lack of responsibility by any particular department within the public sector to become the administrative provider. Which department should be responsible for the provision of sanitation is debatable. "In the past, no government department assumed national responsibility for rural sanitation. The Department

of Health notes that the Department of Water Affairs has assumed responsibility for rural sanitation and will act as the principle lead organisation. It is a widely held view that the Department of Health should not be involved in the actual provision of sanitation facilities. At the same time, the Department of Health cannot relinquish responsibility for the health component of a national rural sanitation programme, although there is recognition that sanitation is an 'under-explored area' within the department" (WRC, 1995:13).

### **3.7.2 Provision of sanitation facilities within the proposed health district**

Sanitation improvements at farm schools between the period (1986 -1995) include the following:

- (i) 156 new toilets;
- (ii) 15 new staff toilets and
- (iii) 10 new pupils urinals (Chetty, 1996).

Sanitation improvements at farms: Improvements from the Farm Survey Programme between the period (1986-1995) include the following:

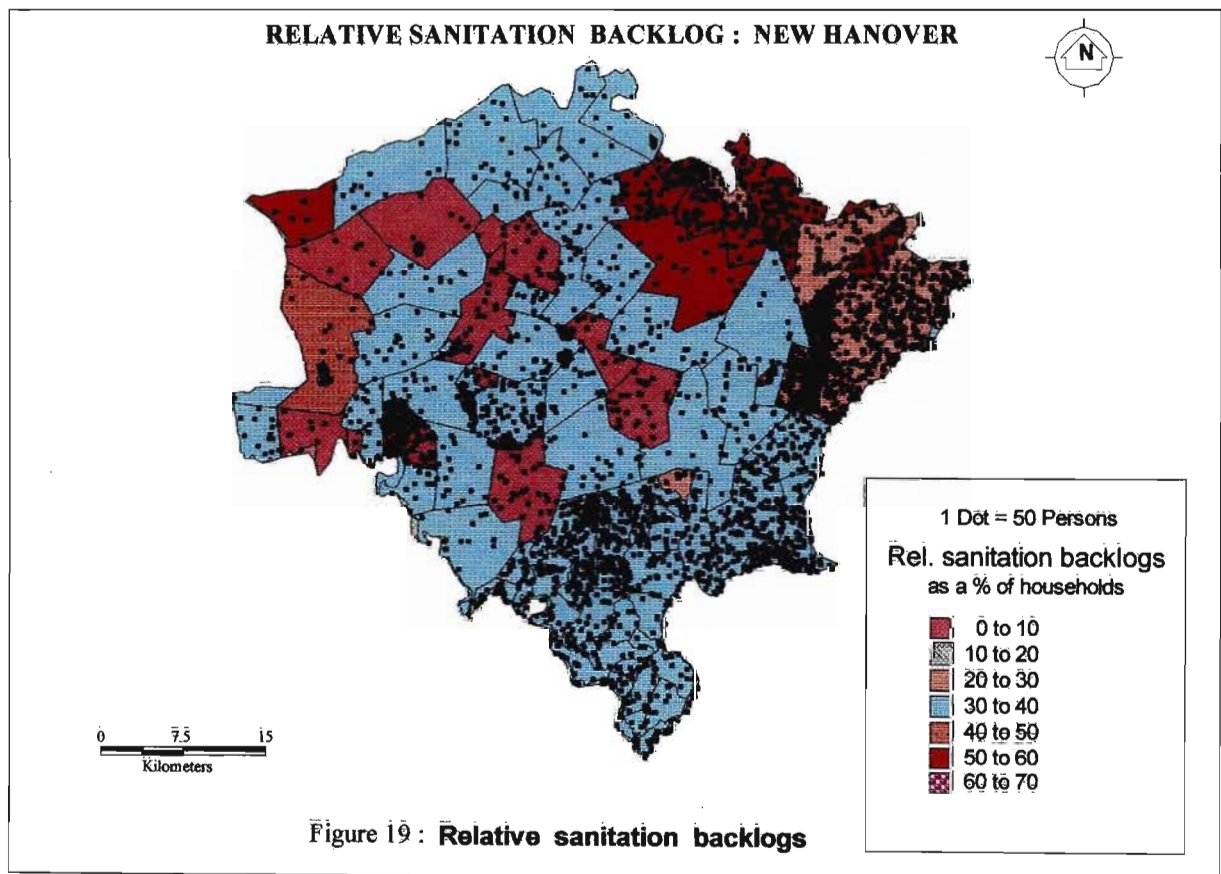
- (i) 40 new water closets;
- (ii) 60 new pit toilets and
- (iii) 60 toilets renovated (Chetty, 1996).

In South Africa, the Department of Water Affairs has taken a lead in rural sanitation policy development and advocates that sanitation should be strongly linked to water supply programmes (WRC, 1995). Clearly then, water, sanitation and health care are interrelated in

terms of development issues which need to be tackled in an integrative manner. For example, water supplies become unsafe where proper sanitation facilities are lacking.

### 3.7.3 Relative backlogs in sanitation facilities within the proposed health district

Figure 19 shows the same spatial patterns of imbalance in the relative backlogs for water coincide with that of sanitation for households within the proposed health district.





### **3.8 Health Education**

Although formal schooling usually does not contain much health education it is still regarded as essential (De Kadt, 1989). The absence of health education in schools is a growing concern among parents and teachers. Health-relevant knowledge is essential, and should be viewed as a preventive measure or life skill. In the absence of formal health education in the New Hanover health district, the HIV/AIDS Programme by Dramaide does help to bridge the gap and contribute to the acquisition of important life skills. The benefits of health education and the coverage of life skills within the proposed health district are discussed below.

The global community has presented many health promotion efforts. Some of these initiatives include: Health for All (1977), the Alma Ata Declaration on Primary Health Care (1978) and the World Health Organisation Charter on Environmental Health (1989). More recently the emphasis is placed on a 'Settings Approach', encouraging action for the environment and health in places where people live and work (Mattee and Byrne, 1996).

The need for preventive and promotive care is ever-increasing, given that many people die from diseases that are preventable. Under such circumstances, projects that aim to promote health or health-relevant education are necessary. Such projects, however, need to be appropriate to the needs of those communities for which they are intended. For example, 'The Greater Johannesburg Healthy Schools Initiative' is aimed at enhancing the quality of the environment, health and general well-being of school children. One such project is entitled 'I'm Too Special To Smoke' (Mathee and Byrne, 1996). A particular advantage of using the 'Settings Approach' is that "it facilitates integrated intersectoral action on a wide range of issues" (Mathee and Byrne, 1996: 48).

In terms of Primary Health Care (PHC), health education constitutes one of the eight basic elements. Better knowledge of what to eat, why and how to avoid contaminated water, what to do during pregnancy and how to care for babies is essential knowledge that results in better health and may be acquired via health education at schools (De Kadt, 1989).

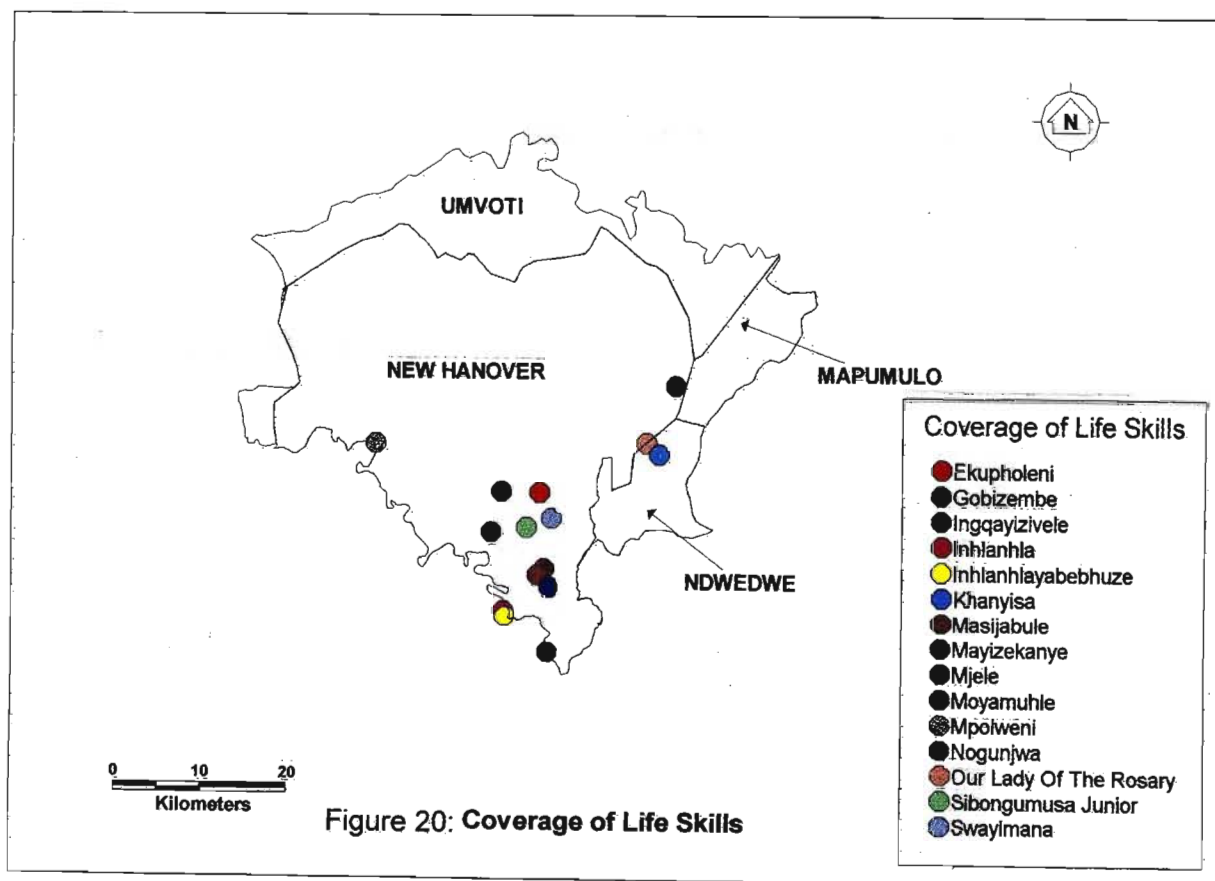
Considering the high incidence of STDs and HIV/AIDS along the eastern border of the New Hanover Health District, the contribution made by Dramaide to health education is beneficial. As such the Dramaide HIV/AIDS programme helps to extend the coverage of Primary Health care (PHC) services within the health district.

### **3.8.1           Dramiade : A drama approach to Aids education**

Dramaide is an a four-year state funded programme in which a drama approach to health, sexuality, life skills and HIV/AIDS education is offered in secondary schools in Kwa-Zulu Natal. The Dramiade programme started off as a pilot project in July 1991 when the South African National Department of Health awarded a tender to the Drama Department of the University of Zululand. The success of the pilot project led to the implementation of Dramaide to secondary schools in Kwa- Zulu Natal (Dramaide, 1996).

### 3.8.2 Coverage of Life Skills within the New Hanover Health District

The Dramaide programme is offered at schools that are located within the Empumalanga and Ndwedwe districts and is ideally concentrated in the improvised parts of the district helping to redress the past spatial inequality to some extent (Figure 20). There is a need to extend the Dramaide programme to other high schools in the Mapumulu and Umvoti areas that lie within the health district since most of the people in the eastern border die of preventable disease. Further, the incidence of STDs is also a growing concern within these areas. With the health district boundaries delineated and the health and health-related resources mapped, the stage is now set to examine the role of the community.



### **3.9 Community Participation**

It is commonly agreed amongst those who are involved in service delivery and development that community participation is crucial if any project or programme is to succeed. What is often not easily resolved is that community participation must lead to community empowerment and ultimately to the community becoming an equal partner with various stakeholders.

The National Health Plan for South Africa as well as the Reconstruction and Development Programme (RDP) make reference to various Community Health Committees which comprise voluntarily elected community representatives. The inclusion of intersectoral committees, NGO's and CBO's at various levels of the government tier provide a platform for communities to voice their opinions (ANC, 1994a).

The structures for community participation that are contained in the RDP, the National Health for South Africa and the recently published policy document for the development of a District Health System (DHS) are extensive. Some of these structures take the form of intersectoral committees and the District Health Authority (DHA).

Having local people participate in various committees is an important starting point. What is now required is that every member of the community in question, be responsible and take appropriate action to improve health within the community. Action by individuals and by the community may bring about marked improvements in health (Tarimo, 1991). Communities within the proposed health district must link with the NPHC-DP and take responsibility for their health and their actions must be directed towards the attainment of a healthy lifestyle.

### **3.9.1 Capacity building within the New Hanover Health District**

A senior environmental health officer Veeran Chetty, who is also a committee member of the NPHC-DP, initiated the Efaye Community Liaison Forum in 1992. This committee attempted to address the needs of the Efaye Community by undertaking the following projects:

- (i) a community hall built;
- (ii) basic improvements to roads initiated;
- (iii) bulk water supply introduced;
- (iv) training of 6 creche teachers;
- (v) building of four new classrooms at the Efaye primary school;
- (vi) new toilets and fencing for two schools and
- (vii) AIDSs Research and a “Children in Distress” study undertaken (Chetty, 1996).

These projects indicate the capacity that exists for community participation within the proposed health district

### **3.9.2 Other community driven projects in other areas within the health district**

Other communities within the proposed health district have also shown their eagerness to become involved in community projects. These communities include the:

#### **3.9.2.1 Mpolweni Community**

The following community driven projects were undertaken:

- (i) approved funding for the completion of two creches;
- (ii) provision of a community hall-cum-clinic;
- (iii) facilitation of a bulk water supply;
- (iv) bilharzia research study and
- (v) a new creche building (Chetty, 1996).

### **3.9.2.2 Chameni Community**

- (i) Facilitations for a water supply for the community.

### **3.9.2.3 Mpofeni Community**

- (i) A drinking water and irrigation scheme put in place.

### **3.9.2.4 Appelsbosch Community**

- (i) Facilitation for a bulk water supply for the community (Chetty, 1996).

The dedication of the senior environmental officer: Veeran Chetty, members of The NHPHC-DP and concerned individuals from the Efaye District itself led to community support for the Efaye Committee. The success attained by the forum in turn led to its expansion and incorporation into the surrounding areas; and as a consequence became known as 'The Greater Efaye Co-ordinating Committee' (Chetty, 1996).

Historically, there were eight settled communities within the magisterial district of New Hanover. These included Efaye, Mount. Elias, Mtulwa, Berlin / Mpofeni, Khamanzi, Molweni, Nene's Farm and Chameni. All these communities were encouraged to link up with the NHPHC-DP in order to coordinate the various community organisations. These committees from the surrounding areas became actively involved with the NHPHC-DP. Workshops were held with the intention of developing capacity of the various committees that were linked to the NHPHC-DP (Chetty, 1996).

## **3.10 Conclusion**

The background to the study area revealed spatial inequalities of health and health-related services between the former areas of the RSA and the former areas of Kwa-Zulu. These

inequalities are evident in the delivery of health care facilities, health care personnel, water, sanitation and economic opportunities such as commercial farming and timber-related industries. In all of the above mentioned aspects the former areas of Kwa-Zulu are disadvantaged.

With regard to the delineation of the health district boundaries, this study indicates that the delineation process is essentially a consultative process. The boundaries proposed by the NHPHC-DP should be considered as 'soft' boundaries, ie. it is subject to change. Greater consultation with people from the surrounding districts needs to take place in order to make the delineation process more inclusive and transparent.

An examination of the utilization rates for family planning and antenatal care services at health facilities were useful, as it provided insights into factors that affect access to services especially in cases where utilization rates were low. Some of the factors which emerged included inadequate roads, lack of health personnel and the infrequency of service delivery. Also the low utilization rates provide good motivation for all health services to be coordinated within a DHS.

Community participation is crucial in terms of satisfying the health needs of those who live within the proposed health district. The community driven projects undertaken within the health district indicate that capacity building is evident and this needs to be strengthened. Also there is collaboration among some sectors, namely education, health and academic institutions with regard to developing the proposed health district. There is a need to extend this collaboration to include as many sectors and organisations as possible.

Taking into account the spatial inequalities in the distribution of health facilities, five potential fixed clinic sites and two mobile clinic points were identified using GIS. The factors affecting access to services and the siting of these facilities are discussed in the next chapter.



## CHAPTER FOUR

### ANALYSIS

#### 4.1 Introduction

The analysis consists of two parts: a review of the factors affecting access to services from the point of view of the health professionals surveyed and an examination of the processes involved in the siting of health facilities using GIS.

The views of the health professionals regarding the factors that affect access to health services were noted. Of these factors more attention was paid to the available hours of service and the health personnel within the proposed health district.

Each potential fixed clinic site was examined in terms of its population size, the road network density, the number of mobile clinics and the number of primary schools found within a 10 kilometre radius. A mathematical formula (Pregan's PCs) was used to determine the 'potentiality' of each site and an evaluation of this formula is undertaken in this chapter.

With regard to the siting of mobile clinic points, the nKulululeko and Khanyile mobile clinic points were used to demonstrate how PHC services could be made more accessible by introducing more mobile clinic points. All of the issues raised above as well as the concept of accessibility are revisited and discussed in this chapter.

#### **4.1.1 Defining and Conceptualising Accessibility**

Accessibility implies 'get-atable'; and takes into account not only physical distance but the factors such as social distance, cost distance and opening hours (availability) of services (Phillips,1990). There are a multitude of factors that can affect one's access to health care. Some of these include the cost, time, distance, transport, available hours of service, restrictive legislation, quality of care, perceptions of health care institutions, attitude of health care providers and the availability of qualified personnel.

Some of the models used to optimize access include:

- (i) Spatial allocation models;
- (ii) Multi - Criteria Decision Aid-Decision Support Systems (MCDA-DSS) and
- (iii) Simple catchment - area models (Phillips, 1990).

Most of these models are inappropriate to South African conditions and circumstances because of:

- (i) the inherited spatial imbalances which are a direct result of disproportionate spending along lines of race, place of residence and wealth;
- (ii) the multiplicity of health care providers within any given geographic region for example, Provincial, Local Authority and the Joint Services Board who provide similar services to the same area. This results in the duplication of services and a waste of scarce resources and
- (iii) the lack of reliable data and a health information system to support the volume of accurate data that is required by most models.

#### **4.2 Ways by which services could be made more accessible from the point of view of the health professionals**

There were many factors which affected access to PHC services. Some of these included:

- (i) Mobile clinics to be sent to geographically inaccessible areas or where transport is a problem.
- (ii) More staff required, especially professional nurses to support the existing 24 hour service.
- (iii) Improvement of security at clinics to support existing 24 hour service.
- (iv) More staff, especially nurses for home visit to those that encounter difficulty in reaching the clinic.
- (v) Improvement of infrastructure (roads, telephone) and
- (vi) Insufficient fresh water supplies at certain clinics.

From the above factors, the available hours of service and the insufficiency of health personnel will now be elaborated upon.

#### 4.3 Available hours of service at clinics within the health district

**Table 4 : Available hours of service**

The table below shows the available hours of service for clinics within the proposed health district. The number of days per week and the number of hours per day the services are available are indicated.

<b>Name of clinic</b>	<b>No. Of days per week service is available</b>	<b>No of hours per day service is available</b>
<b>Mtulwa</b>	7	24 hrs
<b>Chibini</b>	7	10-12 hrs
<b>Gcumisa</b>	5	7-9 hrs
<b>Thafamasi</b>	7	24 hrs
<b>Wosiyana</b>	7	24 hrs
<b>Illovo</b>	5	7-9 hrs

Although three clinics, namely Mtulwa, Thafamasi and Wosiyana have a 24 hour service, health personnel at these institutions claim that in the case of Wosiyana and Thafamasi, services could be made more accessible to their communities if more professional nurses are deployed to support a 24 hour service. A suggestion of this nature by health personnel is a significant one which serves as a useful indicator when examining the effectiveness of making other clinics operate a 24 hour service. Clinics that offer a seven day week service also offer a 24 hour service with the exception of the Chibini clinic.

#### 4.4 Health personnel at fixed clinics within the health district

Health personnel are unevenly distributed throughout the proposed health district. There is also shortages of nurses and doctors, especially along the densely populated former areas of Kwa-Zulu.

**Table 5 : Health personnel at clinics**

Name of clinic	No. Of clerks	No.Of staff nurses	No.of. Prof. nurses	other
	n = 1	n = 14	n = 11	n = 14
<b>Mtulwa</b>	-	2	2	2
<b>Chibini</b>	-	3	2	4
<b>Gcumisa</b>	-	3	2	7
<b>Thafamasi</b>	-	3	1	-
<b>Wosiyana</b>	-	3	1	-
<b>Illovo</b>	1	-	3	1
<b>TOTAL</b>	1	14	11	14

The ratio of staff/ professional nurses is less than two per 10 000 people. It is evident from the ratio of both staff/professional nurse per 10 000 that the health district is severely under-nursed. The outcry by health personnel for additional staff at each clinic, with the exception of the Illovo clinic, is justified and needs to be urgently attended to, in order to improve access to Primary Health Care (PHC) services in the district.

None of the clinics in the health district have resident doctors. However, in the case of the Gcumisa Clinic a doctor visits the clinic three times a month. The Illovo clinic which is a private clinic has the services of a doctor for three hours per week. The densely populated eastern border of the New Hanover health district is severely under-doctored. Although there are five family practitioners within the health district, they are concentrated in the urban centres

of Dalton, New Hanover and Wartburg. The ratio of family practitioners per 10 000 people in the areas of the former RSA (New Hanover, Umvoti, Lions River) is 1: 10 000 people. Besides the District Surgeon who is also a private family practitioner there is no state doctor in the former RSA area. Within the former Kwa-Zulu areas four doctors are stationed at Appelsbosch and seven at Montebello hospital. The ratio of doctors per 10 000 people for the entire health district is 1: 10 000.

#### **4.5 The role of the family practitioner in the delivery of PHC services**

In an earlier study carried out in the New Hanover Health District, family practitioners indicated their eagerness to become involved in promoting the principles of Primary Health Care (PHC) as enshrined in the Alma Ata declaration but were constrained by the lack of family planning materials and remuneration, to mention just a few. Although there is scope for family practitioners to play a role in promoting the principles of Primary Health Care, they are already strained by the number of patients they have to attend to as well as time to perform other health-related duties (Pillay, 1994).

The factors that affect access to health services as perceived by the health professionals within the proposed health district are legitimate since these factors affect the country as whole. Two major challenges confront health restructuring presently taking place in South Africa. The first involves the redistribution of services and health personnel to the under-serviced rural areas. The second involves the adoption of a PHC approach to support the National Health System. Having taken into account the factors affecting access to health services, attention can now be paid to the siting of facilities to redress this spatial imbalance within the proposed health district.

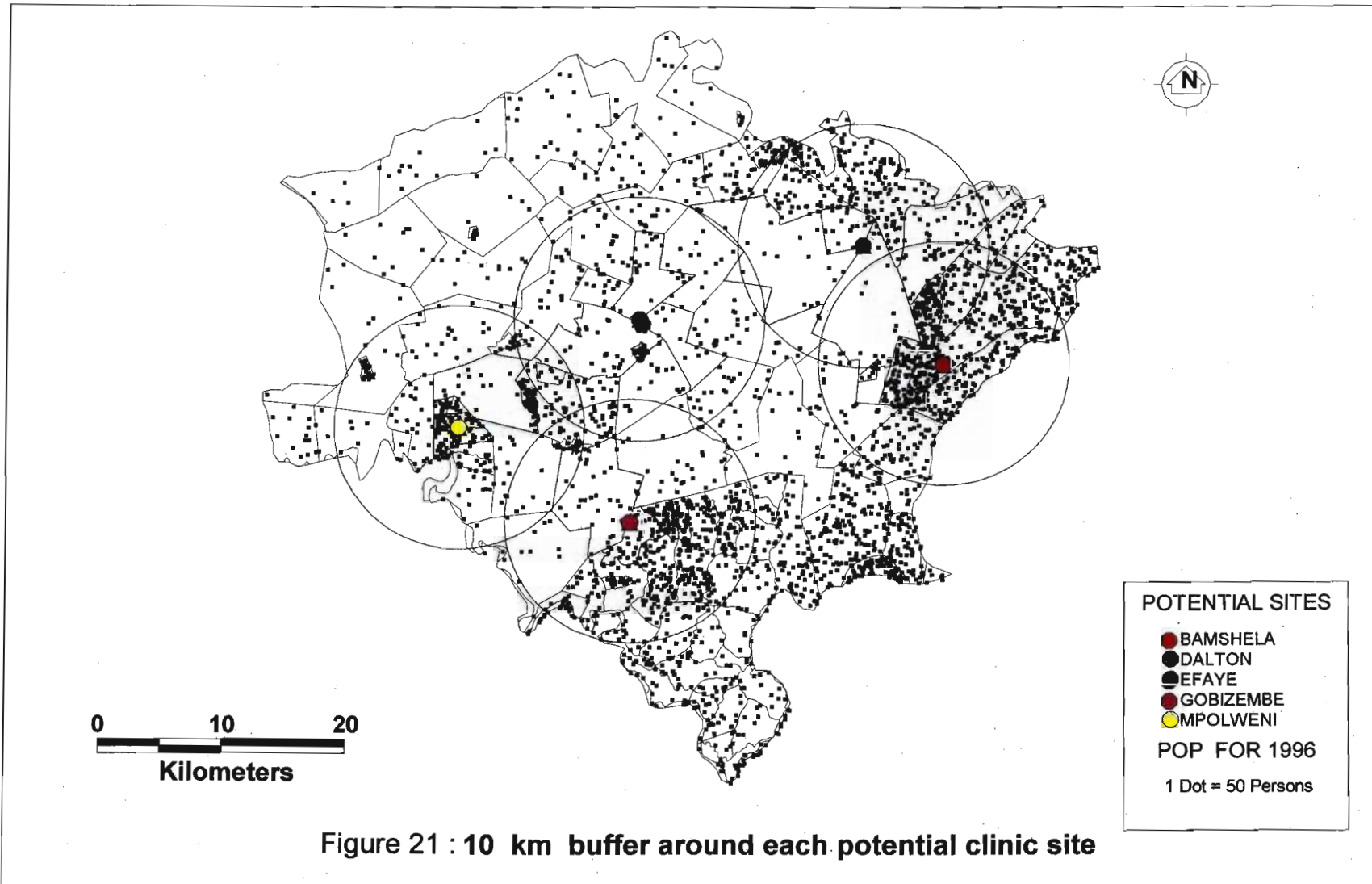


Figure 21 : 10 km buffer around each potential clinic site

## **4.6 Identification of potential fixed clinic sites**

The five potential sites that appear in figure 21 were identified as result of collaboration with the Department of Health and the New Hanover Primary Health Care and Development Programme using GIS. The actual processes by which the sites were identified are discussed in detail below.

### **4.6.1 Processes involved in the siting of potential fixed clinics**

- (i) Using Standard Query Language (SQL) a single or group of polygons that contained a population of 15 000 people or more were identified. The 1996 population database was used for this query.
- (ii) The Department of Health confirmed that these were areas that require, facilities but exactly where the potential site was to be placed needed to be discussed with the communities concerned.
- (iii) Each of the areas identified were discussed further with the Department of Health and the New Hanover Primary Health Care and Development Programme. The discussions centered around, identifying suitable locations within these areas taking into account the need for a facility and the request by the community for such a facility. For example, in the case of Dalton which does not have a proper public clinic and since there were numerous request for a clinic in the Dalton area, a temporary site was identified at the existing old clinic which is used only once a week. A Global Positioning System (GPS) was used at the temporary site to determine its exact latitudinal and longitudinal position.



The latitudinal and longitudinal position was then converted into decimal degrees, using the longlats application in MapInfo. A MapInfo table was created. This table contained the name of the potential site and its X and Y coordinates. The projection system LO 31 was installed in MapInfo and selected. The potential clinic site was then geocoded with its corresponding X and Y coordinates so that it could appear in its geographical position within the proposed health district. A similar procedure was applied to the other sites and as a result one layer or coverage containing all five potential sites was developed.

Other layers or coverages that were developed included:

- (i) towns
- (ii) population for 1996 and 2010
- (iii) existing clinics
- (iv) existing hospitals
- (v) existing mobile clinic points
- (vi) family practitioners
- (vii) schools (high and primary) and the
- (viii) road network density.

These coverages were viewed simultaneously and therefore it was possible to examine the potential sites in relation to the existing facilities.

Using the overlay technique and the mathematical formula, all of the above coverages were layered over the potential site layer. Each of the five potential fixed clinic sites were then investigated taking into account the size of the population, the road network density, the number of primary schools and the mobile clinic points within a 10 kilometre radius. Information pertaining to each of these variables are contained in table 6.

A mathematical formula, Pregon's PCs formula (Appendix 10) was applied to each site. The values obtained from the use of the formula was then used to determine the 'potentiality' of each site and to prioritize each site according to the values obtained. These temporary sites were discussed with the New Hanover Primary Health Care and Development Programme. The NPHHC-DP, the Department of Health and the researcher have jointly reached agreement on the validity of the areas which require new facilities. However, further consultations regarding the actual physical sites with each community concerned needs to be entered into at a series of workshops.

#### **4.6.2 Variables considered for siting of fixed health facilities**

Whilst many studies use simple catchment models that place emphasis on the minimum population (threshold population) to support a facility, this study considered the population size and additional variables such as the road network density, the number of primary schools and the number of mobile clinics within a 10 kilometre radius of the potential site.

The norm used by most countries is 10 000 people to support a clinic, however in this study a minimum of 15 000 people was used as the minimum population to support a potential site

because it was felt to be realistic given the huge demand for such facilities and the limited resources available for health delivery.

The road network was considered because a fixed facility is dependent on roads for the transportation of drugs and patients to and from the health facility. The most accessible point within a 10 kilometre radius of a potential fixed clinic site was determined by calculating the dispersion index for the buffer using a dispersion matrix table (Appendix 4-8). A dispersion matrix table contains the points where roads intersect. Each point is a node that is labelled using letters. The most accessible points were indicated using letters that appear in table 6. The beta coefficient was calculated in order to determine whether the transport network was efficient within a 10 kilometre radius from the potential fixed clinic site (Appendix 9). By simply examining the network it was difficult to state which of the two sites were more efficient, but by giving each network a numerical value, according to the Kansky beta index, it is possible to compare the two networks to see which was the more efficient. The beta index was applied to each of the potential sites.

The beta index was calculated using the formula below

$$B = \frac{a}{n}$$

where

a = the number of arcs (road between two nodes).

n = the number of nodes (points where roads meet).

In the beta index the vital statistic is one. The higher the index, the more efficient is the network. A value of less than one indicates that the network is not efficient.

The number of mobile clinics were considered because the greater the number of mobile clinics within a 10 kilometre radius the stronger the motivation for these to be replaced by a fixed facility. The number of primary schools were considered because it provided some measure of confidence with regard to the future patient support for the facility. The trouble spots were defined as those areas experiencing politically-related violence. The values for each of these variables are found in table 6 and actual calculation of these values are found in the relevant appendices.

#### **4.7 Buffer analysis at each potential clinic site**

Figures 22, 23, 24, 25, 26 shows a 10 kilometre buffer around each potential clinic site and contains the variables that were considered to support each potential site. The buffer facilitated an assessment of the road networks, mobile clinics, primary schools and the population within a 10 kilometre radius. The buffer was also helpful in examining the potential site in relation to other health care facilities within a 10 kilometre radius.

**Table 6: Buffer analysis at each potential fixed clinic site**

The table below contains the values for each of the variables considered in the mathematical formula. The actual calculations are found in the relevant appendices.

ASPECT	EFAYE	BAMSHELA	DALTON	MPOLWENI	GOBIZEMBI
<b>POPULATION</b>					
1996	25 887	43 548	18 254	23 079	29 823
2010	32 711	55 087	19 393	26 838	37 852
<b>Primary Schools</b>	9	9	6	2	9
<b>High Schools</b>	2	6	1	2	5
<b>Other Ed. Inst.</b>	-	1	-	-	-
<b>Hospitals</b>	-	1	-	-	-
<b>Fixed Clinics</b>	1	-	2	-	1
<b>Mobile Clinics</b>	4	4	7	4	5
<b>Most accessible point</b>	B	D	B	O	H
	C		C	P	
	-	-	D	-	-
<b>Road network density</b>					
<b>Main road/Sq/Km</b>	0,0494 km	0,1031 km	0,418 km	0,349 km	0,179 km
<b>District road /Sq/Km</b>	0,1451 km	0,0940 km	0,024 km	0,095 km	0,174 km
<b>Total road density</b>	0,1946 km	0,1972 km	0,442 km	0,445 km	0,353 km
<b>Trouble Spots</b>	1	-	-	-	-
<b>Beta index</b>	0,7	1	1,2	1,2	1

Pregan's Potential Clinic Site formula (Appendix 10) was applied to each site using the values contained in table 6. The PCs values obtained at each potential site were evaluated and from this evaluation, generalizations and conclusions were drawn.

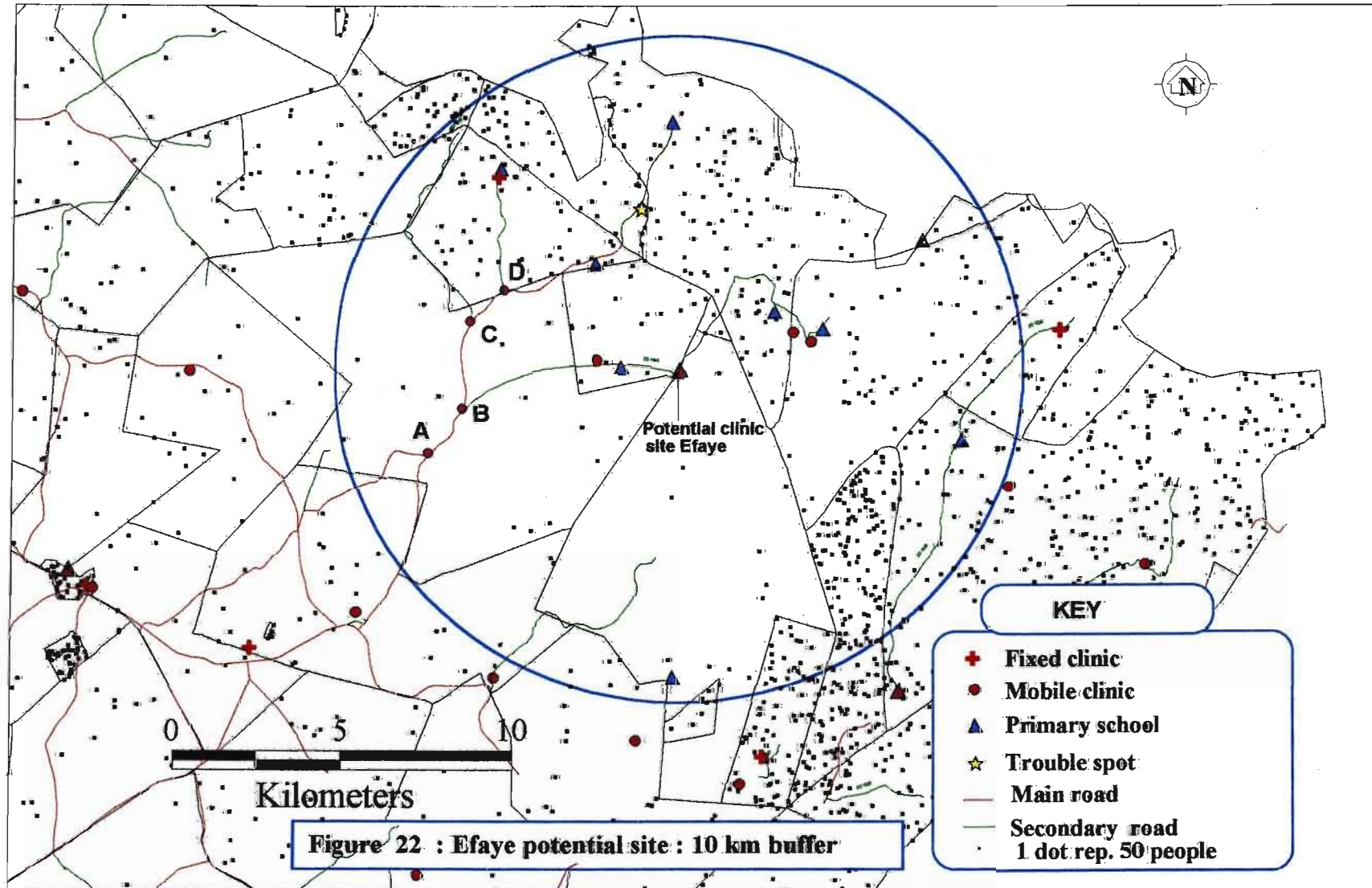
#### **4.7.1 Potential clinic site : Efaye**

Figure 22 shows that the most accessible points are at B and C but the potential clinic site is at neither B nor C. In fact, the potential site is at an area of high population concentration. The Efaye potential site has a low PCs value of two because of a trouble spot (area of violence) within the buffer. The trouble spot reduces the PCs value which in turn reduces the 'potentiality' of the site.

Ironically, the area to the west and south of the potential site is sparsely populated but has higher road network density whereas the area to the north and east of the potential site is densely populated and has a lower road network density (Figure 22).

##### **4.7.1.1 Suggestions to improve the 'potentiality' of the site at Efaye**

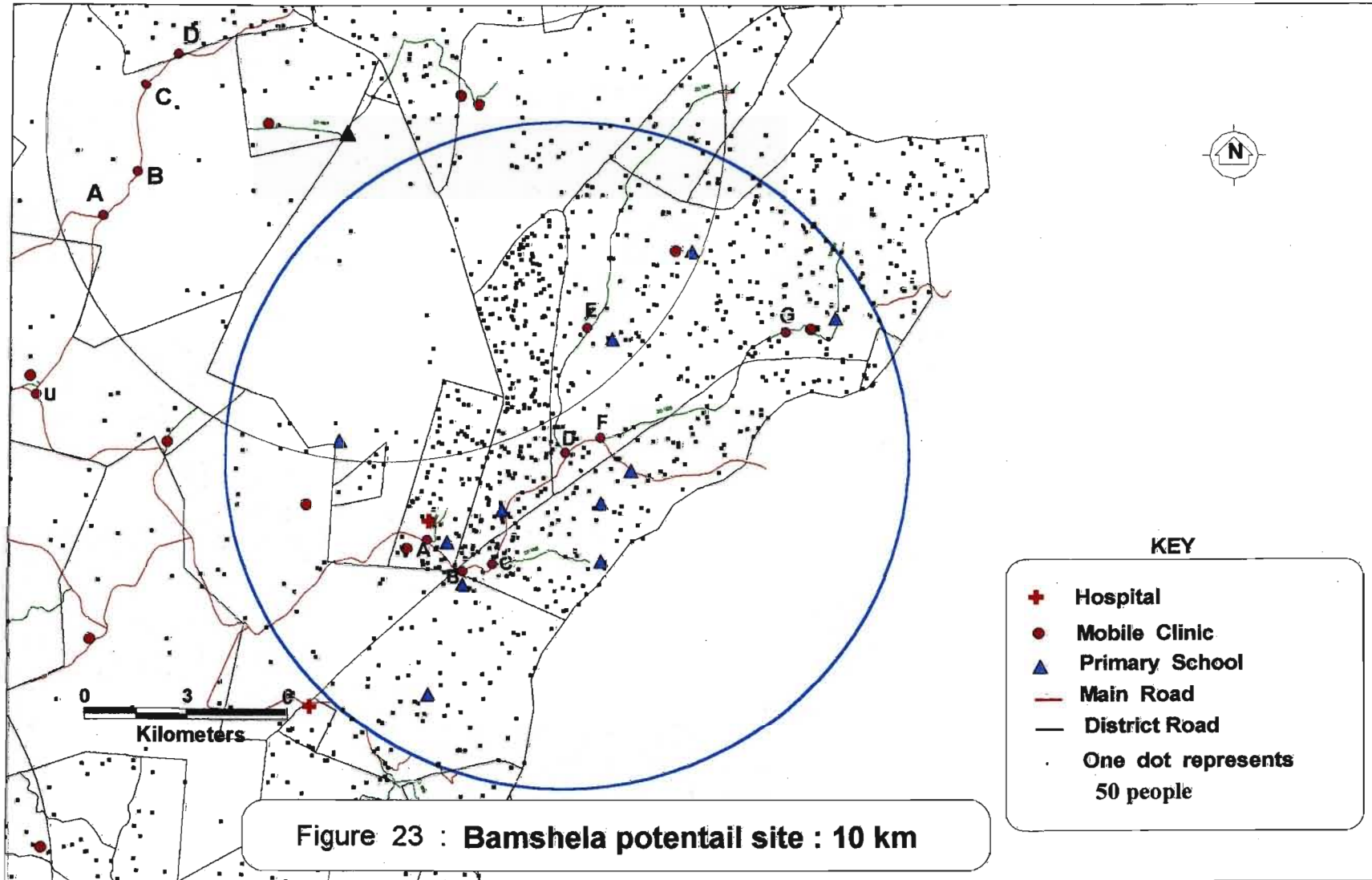
- (i) Reduce politically-related violence.
- (ii) Improve the road network density along the densely populated areas to the east of the potential site.



#### **4.7.2 Potential clinic site : Bamshela**

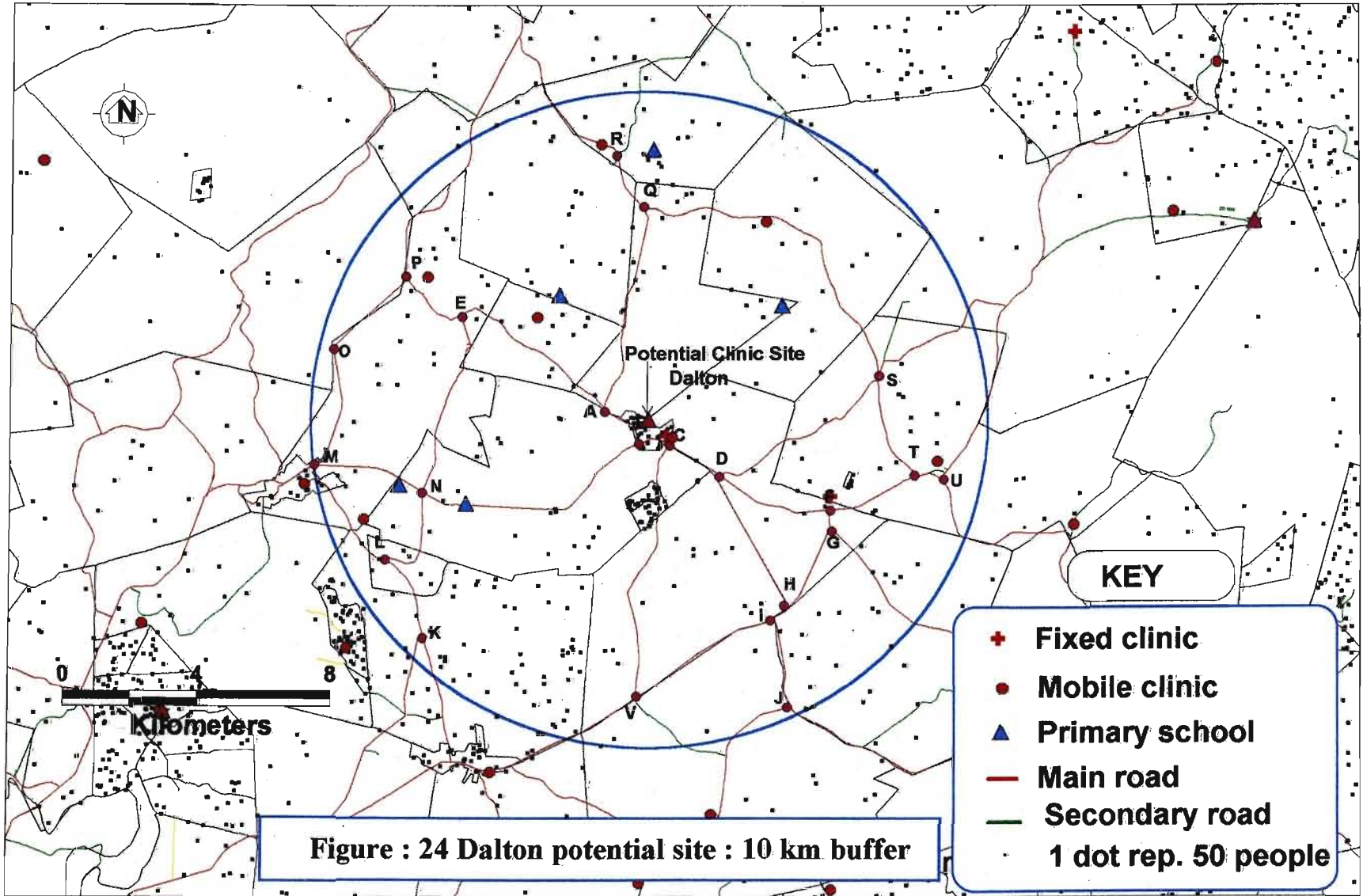
Figure 23 shows that the Bamshela potential clinic site coincided with the most accessible point which is labelled D. This site has a high PCs value of four despite the fact that a hospital is found within the buffer. The high population and the large number of primary schools within the buffer contributed to the high PCs value. Taking into account that the present population for Bamshela is 43 548, the potential site could be re-considered for a (CHC) Community Health Centre which requires a population of 50 000 to support such a facility.





### **4.7.3 Potential clinic site : Dalton**

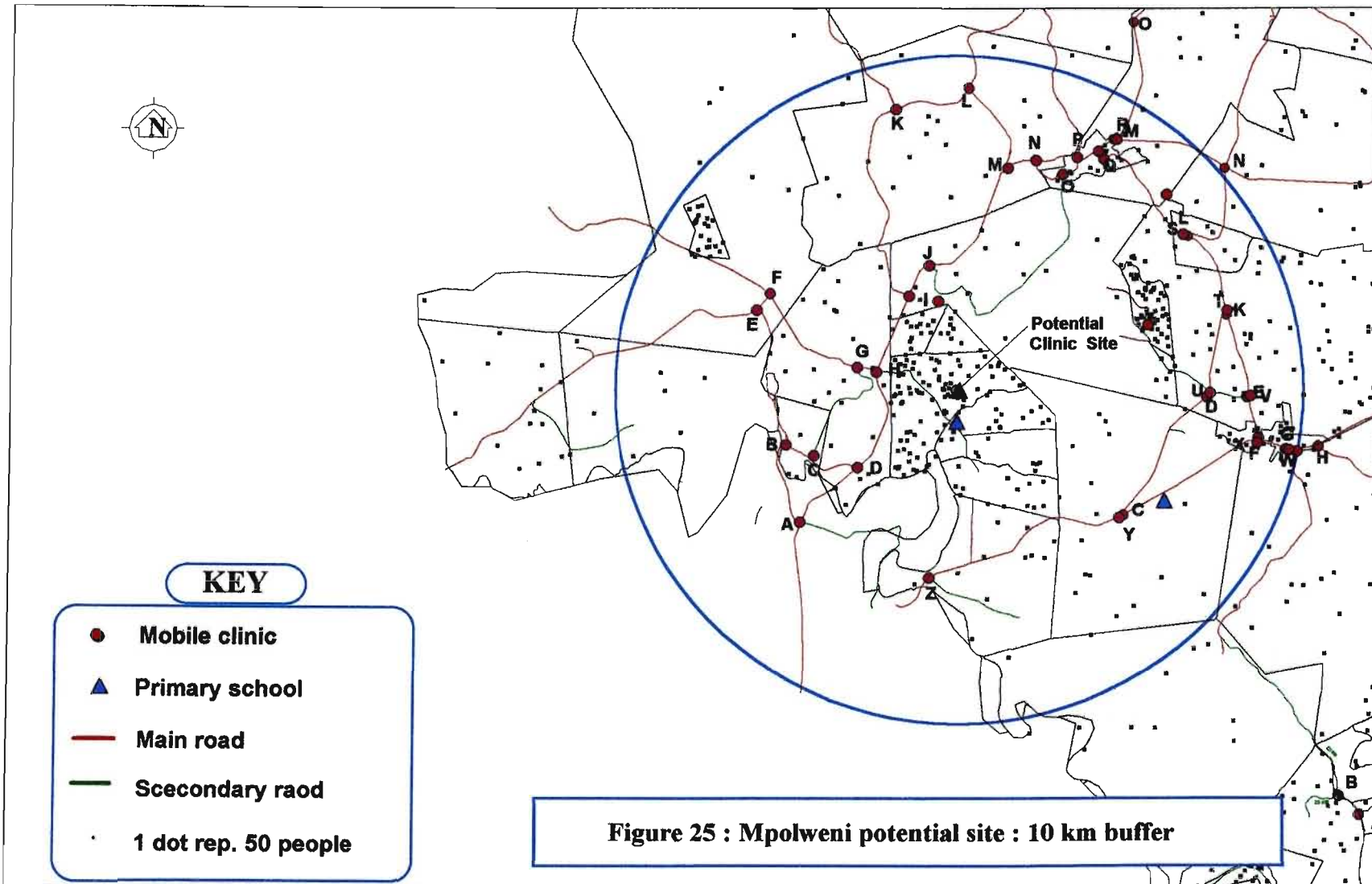
Figure 24 shows that the Dalton potential clinic site coincided with the most accessible point labelled B. Unlike the other potential sites, the population is evenly distributed and the road network is evenly developed within the buffer. Although the potential site at Dalton has the lowest population of 18 254 in comparison to the other sites it has a high PCs value of four. The main factors that enhances the 'potentiality' of the site at Dalton are its well-developed road infrastructure and the fact that it is serviced by seven mobile clinics. A fixed facility is essential in the Dalton area because it lacks one. Also a fixed clinic would be helpful in replacing the large number of mobile clinics. Besides, these mobiles can be deployed to areas of rugged terrain for which they were designed for.



#### **4.7.4 Potential clinic site : Mpolweni**

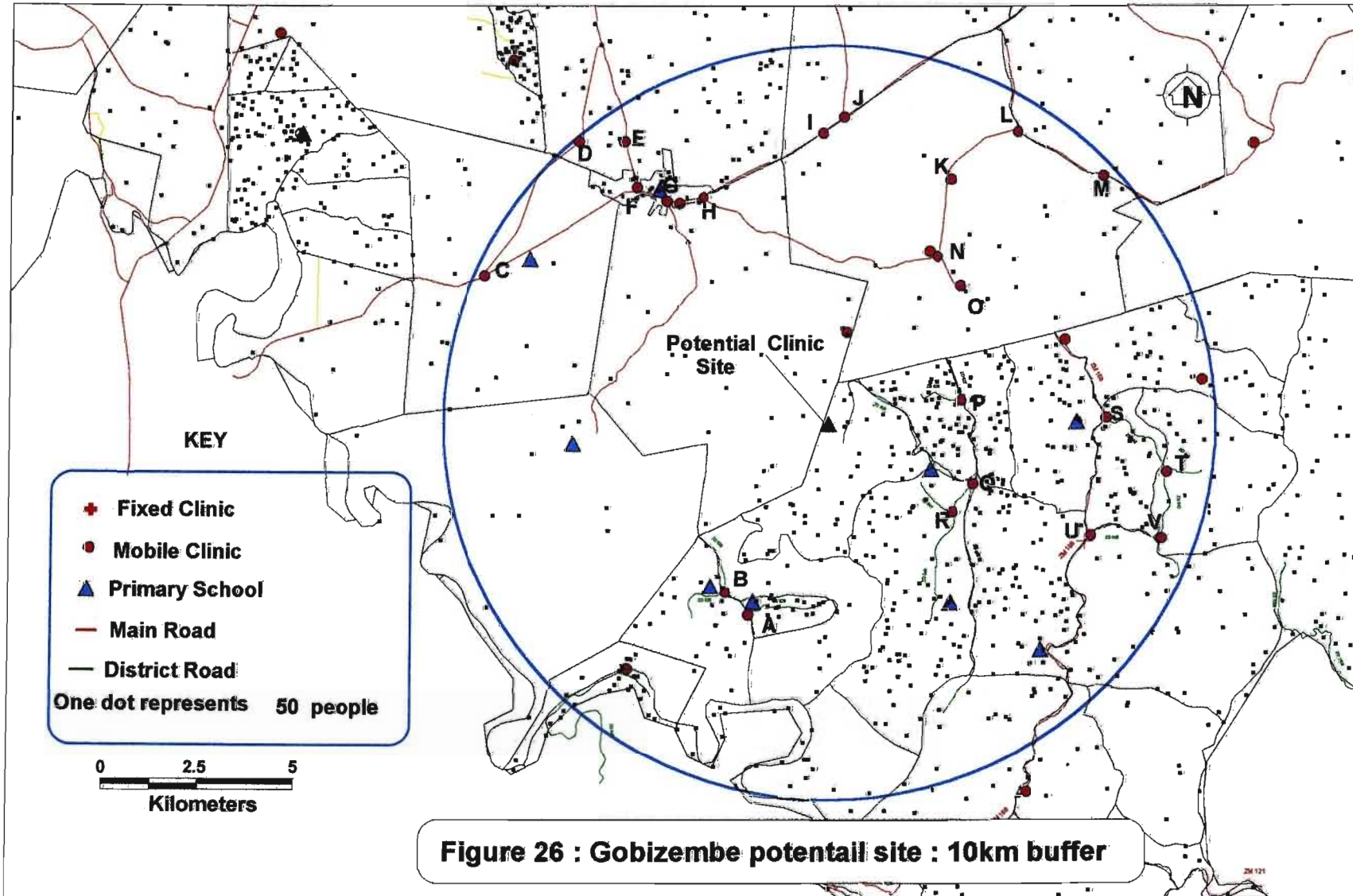
Figure 25 shows that the Mpolweni potential clinic site does not coincide with the most accessible points labelled O and P, instead it is found in an area where the population is concentrated. The PCs value for the Mpolweni site is one which is the lowest compared to all other sites. Although the Mpolweni site has the lowest PCs value of one, the following factors should be considered in order to increase its 'potentiality'.

- (i) The fact that there is no fixed health facility within the buffer.
- (ii) There are only two mobile clinics that service the area.



#### **4.7.5 Potential clinic site : Gobizembe**

Figure 26 shows that the Gobizembe potential fixed clinic site does not coincide with the most accessible point labelled H within the buffer. Instead, the Gobizembe potential site is at an area of high population concentration and has a PCs value of two. The poor road network density reduces the PCs value of the site and invariably its 'potentiality'. Although the Gcumisa Clinic is situated 7,6 kilometres south east of the potential site, due consideration should be given to the high concentration of people to the south of the potential site and that fact that the population is expected to grow to 37 852 by the year 2010.



#### **4.7.6 An assessment of variables using the PCs formula**

It was noted that low PCs values were associated with:

- (i) a small population size;
- (ii) a low road network density;
- (iii) a small number of primary schools;
- (iv) a small number of mobile clinic points and
- (v) areas of politically-related violence.

The converse holds true for sites that have high PCs values. Thus the higher the PCs value the greater the 'potentiality' of the site.

The PCs values were found to be consistent in terms of the values it arrived at, in determining the 'potentiality' of the site. For example, in the case of Bamshela and Dalton where the potential sites coincide with areas of high population concentration as well as the most accessible points, the PCs values were high which in turn resulted in greater 'potentiality' of these sites. Whereas in the cases of Efaye, Mpolweni and Gobizembe, the potential sites are located away from the most accessible points but within areas of high population concentration. This resulted in low PCs values which in turn reduced the 'potentiality' of these sites.

An assessment of the PCs formula indicated that accessibility was an important factor that influenced the potentiality of a site. This is a significant finding in terms of the 'placement' of facilities in accessible areas as opposed to only taking into account the size of the population.



#### **4.8 The community's choice for a potential site versus that generated using GIS: The case of Gobizembe.**

The potential site of Gobizembe was used to demonstrate a situation where a site has been identified and requested by the community without the use of GIS compared to the same site generated by GIS.

An application for a fixed clinic was proposed in 1993 by the community of Gobizembe. It was a former Kwa-Zulu application which was turned down because of insufficient funds at that time. With the present amalgamation of health departments, this application was passed on to the Clinic Building and Upgrading Programme where it was subjected to further investigation. The Provincial Minister of Health, Mr. Mkize, in the meantime suggested that the Swayimane district in which Gobizembe is found, should be prioritized. As a result the potential site at Gobizembe is now put on the priority list (Pers.Com., Sacks, 1996).

##### **4.8.1 Advantages and Disadvantages of the Potential Site at Gobizembe.**

The actual clinic site is fairly flat but is situated on high lying ground. There is a road that leads to the clinic site. However it might be problematic during rainy periods since the road is not tarred. Services that are in close proximity to the site include, telephone, electricity and water supply. Facilities within close proximity include a high school, a proposed primary school, a creche and a shop. It is also the point where mobile clinic utilization is high. A disadvantage however, is that the site lies at the edge of the community (Pers.Com., Sacks, 1996).

In the case of Gobizembe the communities choice coincided with the potential site generated using GIS. However, it could occur that a potential site for a fixed clinic which is generated

by a GIS does not correspond with the site chosen by the community concerned for various reasons. GIS users and planners need to accept this reality.

Taking into account the limited resources available, it would not be possible for all sites to be developed simultaneously. In order to prioritize the sites according to 'greatest need', a mathematical formula was developed by the researcher and applied to each site.

#### 4.8.2 Using Pregar's Potential Clinic Site Formula.

Let PCs be the "Potential for clinic sites"

let  $M_p$  = Population index

$M_m$  = Mobile clinic index

$M_s$  = Primary school index

$M_b$  = Beta coefficient index

$T_s$  = Trouble spot index (areas experiencing political violence )

Now 
$$PCs = \frac{(M_p)(M_m)(M_s)(M_b)}{T_s}$$

**The population index:** Indicates the total population within a 10km radius.

**The mobile clinic index:** Indicates the number of mobile clinics within a 10km radius.

**The primary school index:** Indicates the number of primary schools within a 10km radius.

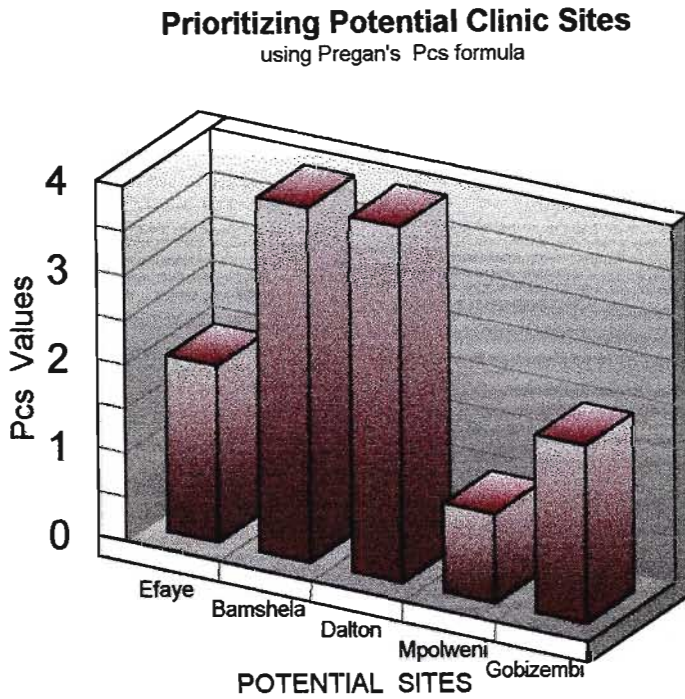
**The beta index :** Indicates the efficiency of the road network within a 10km radius.

**Trouble spot index:** Indicates areas of politically-related violence.

All the above indices are considered within a 10km radius from the potential clinic site.

### 4.8.3

### Prioritizing Potential Clinic Site



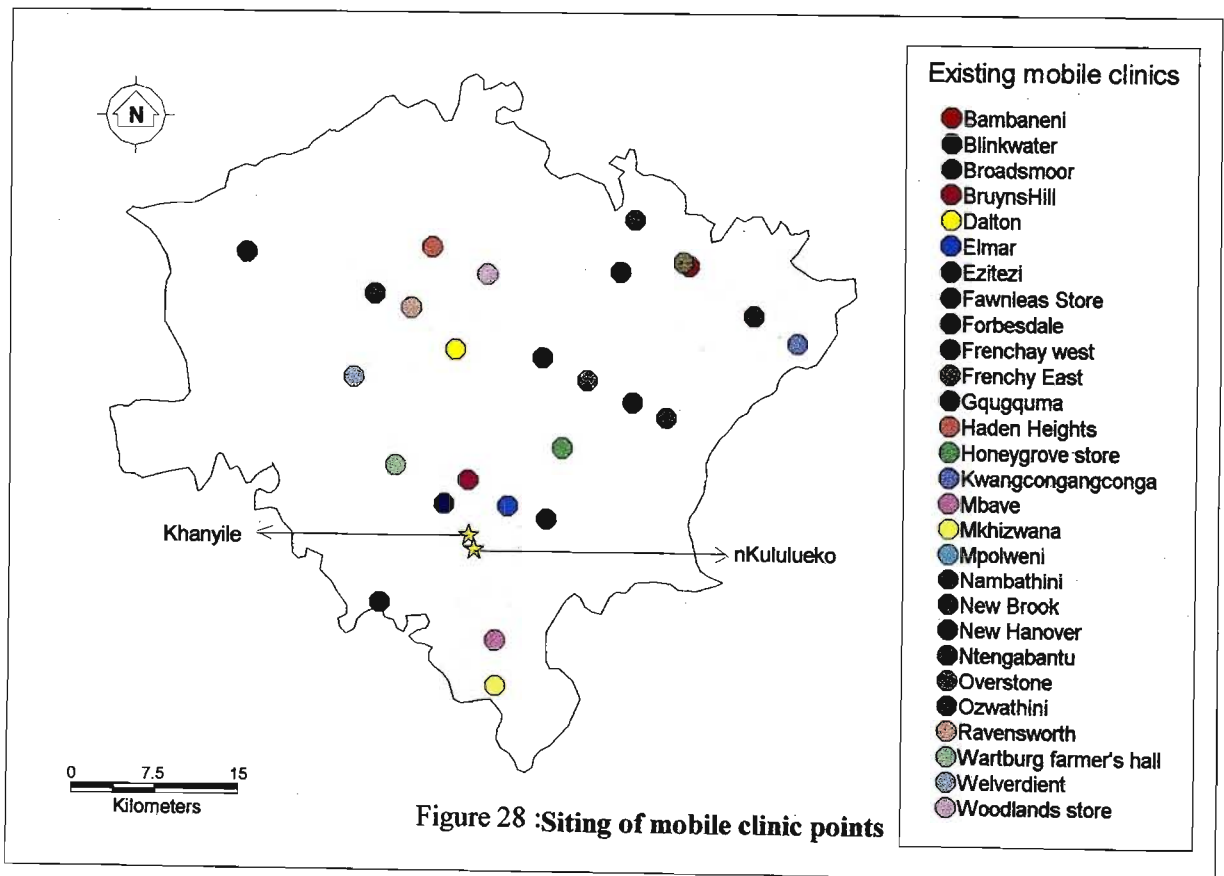
**Figure 27:** Prioritizing potential clinic sites

Figure 27 shows that the potential sites at Bamshela and Dalton should be prioritized since these have the highest PCs value. The mathematical calculations for the application of the PCs formula at each site is shown in (Appendix 10). The higher the PCs value the greater the need. Where a value of 16 or more is obtained a higher order centre, preferably a Community Health Centre (CHC), should be considered. Where a value of less than one is obtained the site should not be considered. In the case of the New Hanover Health District all sites should be considered because none have a PCs value of less than one.

#### 4.9 The siting of mobile clinic points

The siting of the potential nKululueko and Khanyile mobile clinic points provided an opportunity to examine the processes involved in the siting of mobile clinic points and how these may be used to improve access to PHC services within the health district. The position of two potential sites in relation to the existing mobile clinic points and the processes involved in their placement are outlined below. Figure 28 shows the existing mobile clinics and the newly sited nKululekho and Khanyile mobile clinic points.

##### 4.9.1 The siting of the nKululueko and Khanyile mobile clinic points



#### 4.9.2 Processes involved in the siting of the mobile clinic points

A mobile clinic point can be requested by members of the community or one can be placed by the Department of Health in consultation with the community. In either case the Department of Health and the community discuss:

- (i) the services to be rendered;
- (ii) the importance of working together;
- (iii) the actual site for the mobile clinic point depending on security and accessibility to the community and
- (iv) convenient times and dates of service delivery (Pers.Com., Shezi, 1997).

In addition to this the community plays an important role in maintaining and sustaining the service by:

- (i) supporting the service;
- (ii) participating in polio campaigns;
- (iii) setting up creches and woman's groups;
- (iv) informing the health services of imminent danger and violence at certain times and
- (v) evaluating the services rendered via their comments and suggestions (Per.Com., Shezi, 1997).

In the case of nKululueko it was an existing mobile clinic point which was moved in order to make the service more accessible. In the case of Khanyile it was a new mobile clinic point. In either case there was numerous discussions held with the community concerned. With regard to the new mobile clinic points numerous discussions took place between the communities concerned and the Department of Health.

#### 4.10 Conclusion

The factors that affected access to health services, put forward by the health professionals within the district, also affect the country as a whole, especially when one considers the shortage of health facilities and health personnel in the under-serviced rural areas. In addition the views of these health professionals provided valuable insights into other factors such as the lack of telephones and inadequate fresh water supplies at some fixed clinics, which were taken for granted.

GIS can be used as a spatial decision support system as demonstrated in the case of the Gobizembe potential site. The siting of the nKulululeko and Khanyile mobile clinic points demonstrated another way by which PHC services could be made more accessible.

The mathematical formula that was devised proved to be useful, in terms of attaching some quantitative value to each potential site, so that the sites could be prioritized according to need. The PCs formulae were found to be consistent in terms of the values it arrived at, in determining the 'potentiality' of the site. An assessment of the PCs formula indicated that accessibility was an important factor that influenced the 'potentiality' of the site. From a geographical point of view this is significant as it contributes to our understanding of accessibility and the placement of facilities. In retrospect this chapter has demonstrated that GIS is a useful tool to identify potential fixed clinic sites and mobile clinic points. However, the use of GIS must be complimented with extensive consultation and input from the health care providers and the communities concerned.

## **CHAPTER FIVE**

### **EVALUATION AND RECOMMENDATIONS**

#### **5.1 Introduction**

An assessment of the health resources in chapter three and the siting of potential health facilities in chapter four sets the scene in this chapter for a macro analysis of the health and health-related services within the proposed New Hanover District Health System. Also some recommendations to improve the delivery of PHC services within the proposed health district are contained in this chapter.

The macro analysis focuses on the spatial patterns with regard to the following:

- (i) health care facilities;
- (ii) health care personnel;
- (iii) health services;
- (iv) water;
- (v) sanitation;
- (vi) road network density and
- (vii) economic activities / opportunities.

The recommendations to improve the delivery of PHC services takes into account the spatial inequalities in the distribution of health resources and the existing norms for the delivery of PHC services within the proposed health district.

## **5.2 Health care facilities**

The health care facilities are unevenly distributed throughout the proposed health district.

Most of the public clinics and hospitals are located on the eastern border of the former

New Hanover magisterial district which is at the edge of the densely populated areas of the

Ndwedwe and Mapumulu districts. If the norm of 10 000 people per clinic is applied the

district would require an additional twelve clinics.

## **5.3 Health-care personnel**

The ratio of staff/ professional nurses per 10 000 people is less than two and as such the

proposed health district is severely under-nursed. Also there are no resident doctors at any

of the fixed clinics within the proposed health district. There are no private family

practitioners along the densely populated eastern border. The shortage of nurses and

doctors especially in the densely populated rural areas is well documented throughout the

country and attempts to redress this imbalance are underway.

## **5.4 Health care services**

The mobile clinics, fixed clinics and the hospitals deliver a package of PHC services which

include:

- (i) Postnatal care;
- (ii) Antenatal care;
- (iii) Immunization;
- (iv) Family planning;
- (v) Nutritional education;
- (vi) HIV/AIDS counselling and the treatment of:



- (vii) Under five's;
- (viii) Tuberculosis and
- (ix) Sexually transmitted diseases.

The low utilization rates of vital services such as antenatal care and family planning are of concern. There are a multitude of factors which may be responsible for this and must be investigated further. Nevertheless, the low utilization rates indicate the need for these services to be improved and coordinated within a District Health System.

### **5.5 Water**

The relative backlogs in water within the health district exhibits a spatial imbalance that is rooted in apartheid planning. The areas with the greatest backlogs per household (30-40%) are found in the former Kwa-Zulu areas.

The need to overcome these backlogs is of paramount importance, if the aim is to deliver a comprehensive package of PHC services in order to improve the health status of all who live within the proposed health district.

### **5.6 Sanitation**

The lack of access to safe sanitation facilities is a significant cause of ill health in South Africa, of which the New Hanover district is no exception. The former areas of Kwa-Zulu which have the greatest relative backlogs in sanitation facilities need to be urgently addressed.

## **5.7 Road network density**

The road density in the former Kwa-Zulu areas ranges between 0,1946Km to 0,353Km per square kilometre compared to the former RSA where it ranges between 0,442 Km to 0,445 Km. per square kilometre. The need to develop the road infrastructure especially in the former Kwa-Zulu areas is important in terms of:

- (i) stimulating economic development;
- (ii) improving access to and within the proposed health district and
- (iii) providing more tributary routes that could support the mobile clinics to reach areas that lack a fixed health care facility.

## **5.8 Economic activities and opportunities**

Commercial farming and forestry are the dominant primary activities within the proposed health district but these are concentrated in the former RSA areas. Opportunities for commercial farming and forestry need to be promoted and enhanced in the former Kwa-Zulu areas within the proposed health district. The generation of economic opportunities in these under-resourced areas is crucial in terms of acquiring essential services such as water, sanitation and basic goods such as food and warm clothing.

## **5.9 Recommendations**

The World Health Organisations (WHO's) norm of one clinic per 10 000 people is often used in the context of projecting a country's need for additional health resources (Doherty and Rispel, 1995). This norm is not to be rigidly adhered to. Instead it should serve as a guideline since there are a multitude of factors that make adherence to the norm problematic.

If the WHO recommendation of one clinic per 10 000 people is applied to the proposed health district, then 12 additional clinics are required, taking into account that the population is 167 000 for the current year.

Taking into account the limited resources and the great demand for fixed facilities, this study uses a norm of 15 000 people to support one clinic. As a result, five potential fixed clinics are recommended. In addition more mobile clinics are recommended in the densely populated former Kwa-Zulu areas.

In terms of developing hierarchical health structures, this study recommends that a Community Health Centre (CHC) to be built in the Mpumalanga district which lies in the southern part of the proposed health district.

The Mpumalanga district has a population of 36 755 and the Gcumisa clinic is the only fixed health care facility in the area. The recommended CHC would be helpful in terms of developing hierarchical health care structures which would be able to offer more specialised services. Also the CHC may be used to support satellite clinics and serve as a referral centre.

Should it not be financially possible to build a CHC in the Mpumalanga area, then it is recommended that the Gcumisa clinic be upgraded to the status of a CHC and is supported by more mobile clinic points. In terms of health-related services, areas of greatest backlogs need to be overcome by those responsible for the delivery of such services.

## **5.10 Conclusion**

The macro analysis of resources within the proposed health district revealed spatial inequalities with regard to health resources and economic opportunities.

Most striking is the contrast between the densely populated areas of the former Kwa-Zulu and the former RSA areas. The former Kwa-Zulu areas are disadvantaged in all of the above mentioned aspects. It is envisaged that the five potential fixed clinics and the two potential mobile clinic points that are identified, will help to redress the existing spatial imbalance and at the same time improve the delivery of PHC services within the proposed health district.

It is imperative that those responsible for the delivery of health and health-related services for the proposed health district take into account the spatial inequalities that exist. The delivery of services need to be guided by issues of optimizing access and consideration given to the question of equity.

## CHAPTER SIX :CONCLUSION

The context in which this research was undertaken, is characterized by change and new beginnings from the outset. This change is evident, in the new concepts and approaches such as the District Health System, Primary Health Care, Geographical Information System and intersectoral collaboration which are presently being introduced to the South African health scenario. The Department of Health is also working in the context of change as it attempts to implement the ideals contained in the New Health Plan for South Africa. These changes are a direct result of the political transition taking place in the country.

This thesis also represents new beginnings in terms of:

- (i) Using GIS to develop a framework for DHS development in Kwa-Zulu Natal;
- (ii) Using GIS to identify potential sites for health facilities in Kwa-Zulu Natal;
- (iii) Using GIS as planning tool to address questions of accessibility to PHC services at a district level.

Other characteristic features of this thesis include the use of a multi-disciplinary approach and an intersectoral approach to address questions of access to PHC services at a district level.

The adoption of a PHC approach and the transition from a highly centralised health system to a district-based health system is an attempts to bring the health services closer to the people, and to correct or redress the way in which money is spent to keep the people healthy, especially in poor countries. Given that in South Africa a large number of people

die from preventable diseases, a PHC approach is an appropriate strategy to deal with the country's health needs. However there are also segments of the South African population who die from degenerative diseases such as heart disease, stroke and cancer. These citizens are dependent on curative hospital-based care and their health needs have to be catered for as well. A challenge to health care providers is to be able to allocate resources for curative care and preventative care, taking into account the cultural and socio-economic diversity in each community in South Africa.

The setbacks encountered in attempting to improve the delivery of PHC services within the proposed health district are rooted in the broader socio-political processes taking place in the country. These processes relate to:

- (i) the development of appropriate local government structures;
- (ii) the development of appropriate governance structures which will eventually be responsible for the delivery of health services at a district level and
- (iii) the devolution of power to the appropriate governance structure (Owen, 1995a).

These processes have been dealt with extensively in the National Health Plan for South Africa and the District Health Systems Policy Document. Once the governance structure ultimately responsible for the delivery of services at a district level is in place, the health and health-related activities within the proposed health district can be coordinated into the New Hanover District Health System. Presently these administrative and institutional requirements for a district-based health system are theoretically in place.

There are many factors that affect access to PHC services within the proposed health district. Some of these factors are general whilst others apply only to specific facilities.

Some of the most important factors that affect access to PHC services within the proposed health district include:

- (i) the lack of a fixed health care facility where the population is greater than 15 000 people;
- (ii) insufficient health care personnel, especially staff and professional nurses at existing health care facilities;
- (iii) the lack of resident doctors at fixed clinics and
- (iv) insufficient number of mobile clinic points in the densely populated areas of Mpumalanga, Ndwedwe and Mapumulu which are included in the proposed health district.

Other related factors included:

- (i) Inadequate road infrastructure;
- (ii) lack of a proper telephone service for emergencies;
- (ii) lack of water and sanitation in the majority of households.

It is envisaged that the identification of five potential clinic sites and the siting of mobile clinic points within the proposed health district would help to improve the delivery of PHC services within the proposed health district, which invariably would improve access to vital services.

The use of GIS in this study clearly demonstrates that GIS has a vital rôle to play in the development of a district-based health system. In terms of improving the delivery of health care GIS was used to:

- (i) help resolve issues around the delineation of the boundaries of the health district;
- (ii) map health resources and identify areas of need;
- (iii) map health-related resources;
- (iv) identify potential sites for fixed clinics and;
- (v) site mobile clinic points in order to improve delivery of PHC services.

The very powerful capabilities of GIS offer a world of opportunity for planners to remove the colonial and apartheid stamp (viz. magisterial districts and Bantustans) from the South African landscape. More specifically, if planning was based on the previous magisterial districts, then the past inequalities may be perpetuated. Using GIS, well-resourced areas and under-resourced areas can delineated into a single geographic unit preventing the development of densely populated areas of underdevelopment.

The use of GIS for mapping health resources and undertaking spatial analysis as dealt with in this thesis are only some of the functions of GIS. The use of GIS to integrate and coordinate health and health-related activities within a district-based health system will launch GIS applications in the area of health planning. As South Africa moves towards a district-based health system, it would require an Health Information System (HIS). The technology best suited to integrate disparate data sets from the various sectors is GIS.



This thesis represents one of the first attempts to use GIS in a health context, more specifically to identify potential clinic sites and as such it goes beyond considering population as the only and most important variable. Other important variables, such as the road network density, the beta co-efficient, the number of primary schools, the population size and the number of mobile clinics within a 10 kilometre radius of the potential site within the proposed New Hanover Health District, were considered.

This thesis also demonstrated the interface between technology on the one hand and people on the other hand. The technology (GIS) cannot be used in isolation, it needs to be supported by those who are responsible for service delivery and the community in which facilities are to be built.

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## **APPENDIX 1: GLOSSARY**

Those definitions that are not acknowledged are those of the author which were either coined or interpreted.

### **Accessibility**

Accessibility implies 'get-atable'; and takes into account not only physical distance, cost distance and opening hours (availability) of services (Phillips, 1990).

### **Arc**

These are links or lines joining two nodes (Shah, 1982).

### **Beta index**

A numeric value obtained using the Kansky beta index to compare network efficiency (Shah, 1982).

### **Buffer**

A specified area surrounding a point or line .

### **Data**

Raw material to be processed by a computer (Capron, 1987).

### **Dispersion index**

Using a matrix to compare accessibility of nodes or centres within a network (Shah, 1982).



**Digitizing**

The conversion of information from analogue representation to numerical form (Mather, 1991).

**District Health System (DHS)**

A District Health System essentially comprises a well-defined population living within a clearly delineated administrative and geographical area, where all health-related activities can take place (Tarimo, 1991).

**Fixed health care facility**

A building from where health care is provided.

**Geographical Information System (GIS)**

An information technology which stores and displays both spatial and non-spatial data (Maguire, 1991).

**Global Positioning System (GPS)**

Calculates the distance to a set simultaneously viewable satellites to intersect a position according to a specific geodetic referencing system (Eastman, 1992).

**Hierarchical health service**

The ranking of health services in terms of speciality and range of services.

**Health Arc**

Arc shaped area that contains health care facilities.

**Health resource**

Refers to health facilities, health and health-related services and health professionals

**Health terrain**

Refers to health facilities, health and health-related services and health professionals over a geographic area.

**Intersectoral Collaboration**

Refers to interaction with other service sectors namely water, education, welfare and public works.

**Mobile Clinic**

A mobile clinic is a vehicle which when parked somewhere, functions as a location from which health services are rendered. The service need not be rendered exclusively from the vehicle, but the vehicle must function as an integral part of the location. The vehicle must have structural modifications in order to serve as a mobile clinic.

**Network**

A network is formed when places are connected by arcs and nodes (Shah,et.al., 1982).

## **Nodes**

These are places or points in a network (Shah et al., 1982).

## **Primary Health Care (PHC)**

Primary health was used initially to mean first level contact between patient or community and doctor or organised health care provider. More recently the term has been broadened to take into account issues such as water, sanitation, health education, equity and justice in health care provision (Tarimo, 1991).

## **Position Dilution of Precision (PDOP)**

Is a measure of the angle of the satellites relative to the user and each other (Le Sueur, 1994).

## **Root Mean Square (RMS)**

The root-mean-square error is a measure of the variability of measurements about their true values (Eastman, 1992).

## **Selective availability**

The process imposed by the USA Department for distorting the signals from the GPS satellites from the GPS satellites so that civilian uses cannot achieve full accuracy of the navistar system (Logsdon, 1992).

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**APPENDIX TWO : QUESTIONNAIRE FOR FIXED CLINIC**

CONFIDENTIAL

IMPROVING ACCESS TO PRIMARY HEALTH CARE SERVICES WITHIN THE NEW HANOVER HEALTH DISTRICT SYSTEM USING GEOGRAPHICAL INFORMATION SYSTEM (GIS).

1. NAME OF CLINIC: \_\_\_\_\_

2. HOW MANY DAYS OF THE WEEK ARE THE SERVICES AVAILABLE ?

(Please tick below)

ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
-----	-----	-------	------	------	-----	-------

3. FOR HOW MANY HOURS ARE THE SERVICE AVAILABLE FOR VISITS PER

WORKING DAY ? (Please tick below)

0-3 HRS	4-6 HRS	7-9 HRS	10-12 HRS	24HRS/OTHER
---------	---------	---------	-----------	-------------

4. WHAT IS THE APPROXIMATE NUMBER OF PATIENTS SEEN AT THIS CLINIC

PER WORKING WEEK? (Please tick below)

0-100	101- 200	201- 300	301- 400	401- 500	501- 1000	1001- 1500	1501- 2000	2001- 2500	ABOV E 2501
-------	-------------	-------------	-------------	-------------	--------------	---------------	---------------	---------------	----------------

5. WHICH OF THE FOLLOWING SERVICES ARE PROVIDED AT THE CLINIC ?

TYPE OF SERVICE	YES	NO
PROMOTIVE & PREVENTIVE		
REHABILITATIVE		
CURATIVE		
OTHER		

6. LIST SOME OF THE WAYS BY WHICH THE SERVICES OFFERED AT THE CLINIC MAY BE MADE MORE ACCESSIBLE OR A GREATER COVERAGE MAY BE ACHIEVED.

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7. PLEASE TICK THOSE SERVICES THAT ARE OFFERED AT THIS CLINIC.

TYPE OF SERVICE	YES	NO
CHILDREN UNDER 5		
POST NATAL CARE		
ANTE NATAL CARE		
FAMILY PLANNING		
IMMUNISATION		
NUTRITIONAL EDUCATION		
TB		
HIV / AIDS COUNSELLING		
STDs		
MINOR INJURIES		
CHRONIC INJURIES		
OTHER		

8. LIST THE NUMBER OF STAFF THAT WORK AT THE CLINIC.

(Please indicate in the space provided)

CLERKS	STAFF/N	PROF/N	DRIVERS	OTHER

9. WHAT MEDICAL OR DOCTOR COVER IS AVAILABLE TO THE CLINIC ?

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THANK YOU FOR YOUR COOPERATION.

YOURS IN HEALTH.

MR. P. PILLAY.

UNIVERSITY OF NATAL (PIETERMARITZBURG)

## APPENDIX THREE : QUESTIONNAIRE FOR MOBILE CLINIC POINT

CONFIDENTIAL

IMPROVING ACCESS TO PRIMARY HEALTH CARE SERVICES WITHIN THE NEW HANOVER HEALTH DISTRICT SYSTEM USING GEOGRAPHICAL INFORMATION SYSTEM (GIS).

1. NAME OF MOBILE CLINIC POINT: \_\_\_\_\_

2. HOW MANY DAYS OF THE MONTH ARE THE SERVICES AVAILABLE ?

(Please tick below)

ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
-----	-----	-------	------	------	-----	-------

3. FOR HOW MANY HOURS IS THE SERVICE AVAILABLE FOR VISITS ?

(Please tick below)

0-3 HRS	4-6 HRS	7-9 HRS	10-12 HRS	24HRS/OTHER
---------	---------	---------	-----------	-------------

4. WHAT IS THE APPROXIMATE NUMBER OF PATIENTS SEEN AT THIS MOBILE CLINIC POINT ? (Please tick below)

0-100	101- 200	201- 300	301- 400	401- 500	501- 1000	1001- 1500	1501- 2000	2001- 2500	ABOV E 2501
-------	-------------	-------------	-------------	-------------	--------------	---------------	---------------	---------------	----------------

5. WHAT TYPE OF SERVICE IS PROVIDED AT THE CLINIC ?

(Please tick)

TYPE OF SERVICE	YES	NO
PROMOTIVE & PREVENTIVE		
REHABILITATIVE		
CURATIVE		



6. LIST SOME OF THE WAYS BY WHICH THE SERVICES OFFERED AT THE MOBILE CLINIC MAY BE MADE MORE ACCESSIBLE OR A GREATER COVERAGE MAY BE ACHIEVED.

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7. PLEASE TICK THOSE SERVICES THAT ARE OFFERED AT THIS MOBILE CLINIC POINT.

TYPE OF SERVICE	YES	NO
CHILDREN UNDER 5 s		
POST NATAL CARE		
ANTE NATAL CARE		
FAMILY PLANNING		
IMMUNISATION		
NUTRITIONAL EDUCATION		
TB		
HIV / AIDS COUNSELLING		
STDs		

THANK YOU FOR YOUR COOPERATION.

YOURS IN HEALTH.

MR. P. PILLAY.

UNIVERSITY OF NATAL (PIETERMARITZBURG)

**APPENDIX FOUR : EFAYE - DISPERSION MATRIX**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>TOT</b>
<b>A</b>	0	1	2	3	6
<b>B</b>	1	0	1	2	4
<b>C</b>	2	1	0	1	4
<b>D</b>	3	2	1	0	6

B AND C are the most accessible points

**APPENDIX FIVE : BAMSHELA - DISPERSION MATRIX**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>TOT</b>
<b>A</b>	0	1	2	3	4	4	5	19
<b>B</b>	1	0	1	2	3	3	4	14
<b>C</b>	2	1	0	1	2	2	3	11
<b>D</b>	3	2	1	0	1	1	2	10
<b>E</b>	4	3	2	1	0	2	1	13
<b>F</b>	4	3	2	1	2	0	1	13
<b>G</b>	5	4	3	2	1	1	0	16
<b>TOT</b>								

D is the most accessible point

APPENDIX SIX : DALTON - DISPERSION

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	TOT
A	0	1	2	3	1	4	5	4	5	6	4	3	3	2	3	2	1	2	4	5	6	3	69
B	1	0	1	2	2	3	4	3	4	5	3	2	2	1	4	3	2	3	3	4	5	2	59
C	2	1	0	1	3	2	3	2	3	4	4	3	3	2	5	4	3	4	2	3	4	1	59
D	3	2	1	0	4	1	2	1	2	3	5	4	4	3	6	5	2	3	1	2	3	2	59
E	1	2	3	4	0	5	6	5	6	7	3	2	2	1	2	1	2	3	3	6	7	4	75
F	4	3	2	1	5	0	1	2	3	4	6	5	5	4	7	6	5	4	2	1	2	4	76
G	5	4	3	2	6	1	0	1	2	3	7	6	6	5	7	7	7	5	3	2	3	3	88
H	4	3	2	1	5	2	1	0	1	2	6	5	5	4	6	6	5	6	4	3	4	2	77
I	5	4	3	2	6	3	2	1	0	1	7	6	6	5	7	7	4	5	3	4	5	1	87
J	6	5	4	3	7	4	3	2	1	0	8	7	7	6	8	8	5	6	6	5	6	2	109
K	4	3	4	5	3	6	7	6	7	8	0	1	3	2	4	4	5	6	6	7	8	5	104
L	3	2	3	4	2	5	6	5	6	7	1	0	2	1	3	3	4	5	5	6	7	4	84
M	3	2	3	4	2	5	6	5	6	7	3	2	0	1	1	2	4	5	5	6	7	4	83
N	2	1	2	3	1	4	5	4	5	6	2	1	1	0	2	2	3	4	4	5	6	3	66
O	3	4	5	6	2	7	7	6	7	8	4	3	1	2	0	1	4	5	7	8	9	5	104
P	2	3	4	5	1	6	7	6	7	8	4	3	2	2	1	0	3	4	6	7	8	5	94
Q	1	2	3	2	2	5	6	5	4	5	5	4	4	3	4	3	0	1	1	2	3	4	69
R	2	3	4	3	4	5	6	6	5	6	6	5	5	4	5	4	1	0	2	3	4	5	88
S	4	3	2	1	3	2	3	4	3	6	6	5	5	4	7	6	1	2	0	1	2	3	73
T	5	4	3	2	6	1	2	3	4	5	7	6	6	5	8	7	2	3	1	0	1	4	85
U	6	5	4	3	7	2	3	4	5	6	8	7	7	6	9	8	3	4	2	1	0	6	106
V	3	2	1	2	4	4	3	2	1	2	5	4	4	3	5	5	4	5	3	4	6	0	72

B - C - D are the most accessible points

**APPENDIX SEVEN : MPOLWENI- DISPERSION MATRIX**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	Tot
A	0	1	2	1	2	3	3	2	3	4	4	5	5	6	5	6	7	8	8	9	10	10	12	11	11	12	150
B	1	0	1	2	1	2	2	3	4	5	5	6	6	7	6	7	8	9	10	11	11	11	13	12	12	13	168
C	2	1	0	1	2	2	1	2	3	4	4	5	5	6	5	6	7	8	8	9	10	10	12	11	11	12	147
D	1	2	1	0	3	3	2	1	2	3	3	4	4	5	4	5	6	7	7	8	9	9	11	10	10	11	131
E	2	1	2	3	0	1	2	3	4	5	5	6	6	7	6	8	8	9	9	10	11	11	13	12	12	13	169
F	3	2	2	3	1	0	1	2	3	4	4	5	5	6	7	6	7	8	8	9	10	10	12	11	11	12	152
G	3	2	1	2	2	1	0	1	2	3	3	4	4	5	4	5	6	7	7	8	9	9	11	10	10	11	130
H	2	3	2	1	3	2	1	0	1	2	2	3	3	4	2	5	5	6	6	7	8	8	10	9	9	10	114
I	3	4	3	2	4	3	2	1	0	1	1	2	2	3	2	3	4	5	5	6	7	8	9	8	8	9	105
J	4	5	4	3	5	4	3	2	1	0	2	2	1	2	1	2	3	5	4	5	7	6	8	7	7	8	101
K	4	5	4	3	5	4	3	2	1	2	0	1	2	3	4	4	5	6	6	7	8	8	10	9	9	10	125
L	5	6	5	4	6	5	4	3	2	2	1	0	1	2	3	3	4	5	5	6	7	7	9	8	8	9	120
M	5	6	5	4	6	5	4	3	2	1	2	1	0	1	2	2	3	4	4	5	6	6	9	7	7	8	108
N	6	7	6	5	7	6	4	4	3	2	3	2	1	0	1	1	2	3	3	4	5	5	7	6	6	7	106
O	5	6	5	4	6	5	4	3	2	1	4	3	2	1	0	1	2	3	3	4	5	5	7	6	6	7	100
P	6	7	5	5	5	5	5	5	3	2	4	3	2	1	1	0	1	2	2	3	4	4	6	5	5	6	97
Q	7	8	7	6	8	7	6	5	4	3	5	4	3	2	2	1	0	1	1	2	3	3	5	4	4	5	106
R	8	9	8	7	9	8	7	6	5	5	6	5	4	3	3	2	1	0	2	3	4	4	6	5	5	6	131
S	8	9	8	7	9	8	7	6	5	4	6	5	4	3	3	2	1	2	0	1	2	2	4	3	3	4	116
T	9	10	9	8	1	9	8	7	6	5	7	6	5	4	4	3	2	3	1	0	1	1	3	2	2	3	128
U	10	11	10	9	1	10	9	8	7	6	8	7	6	5	5	4	3	4	2	1	0	1	3	2	1	2	145
V	10	11	10	9	1	10	9	8	7	6	8	7	6	5	5	4	3	4	2	1	1	0	2	1	2	3	145
W	12	13	12	11	1	12	11	10	9	8	10	9	9	7	7	6	5	6	4	3	3	2	0	1	2	3	188
X	11	12	11	10	1	11	10	9	8	7	9	8	7	6	6	5	4	5	3	2	2	1	1	0	1	2	163
Y	11	12	11	10	1	11	10	9	8	7	9	8	7	6	6	5	4	5	3	2	1	2	2	1	0	1	163
Z	12	13	12	11	1	12	11	10	9	8	10	9	8	7	7	6	5	6	4	3	2	3	3	2	1	0	187

O and P are the most accessible points

**APPENDIX EIGHT : GOBIZEMBE DISPERSION MATRIX**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	TOT
A	0	1	4	5	4	3	2	3	4	5	5	6	7	4	5	6	7	8	6	7	7	8	107
B	1	0	3	4	3	2	1	2	3	4	4	5	6	3	4	5	6	7	5	6	6	7	87
C	4	3	0	1	2	1	2	3	4	5	5	6	7	4	5	6	7	8	6	7	7	8	101
D	5	4	1	0	1	2	3	4	5	6	6	7	8	5	6	7	8	8	7	8	8	9	118
E	4	3	2	1	0	1	2	3	4	5	5	6	7	4	5	6	7	8	6	7	7	8	101
F	3	2	1	2	1	0	1	2	3	4	4	5	6	3	4	5	6	7	5	6	6	7	83
G	2	1	2	3	2	1	0	1	2	3	3	4	5	2	3	4	5	6	4	5	5	6	69
H	3	2	3	4	3	2	1	0	1	2	2	3	4	1	2	3	4	1	2	3	4	5	55
I	4	3	4	5	4	3	2	1	0	1	1	2	3	2	3	4	5	6	4	5	5	6	73
J	5	4	5	6	5	4	3	2	1	0	2	3	2	3	4	5	6	7	5	6	6	7	91
K	5	4	5	6	5	4	3	2	1	2	0	1	2	1	2	3	4	5	3	4	4	5	71
L	6	5	6	7	6	5	4	3	2	3	1	0	1	2	3	4	5	6	4	5	5	6	89
M	7	6	7	8	7	6	5	4	3	4	2	1	0	3	4	5	6	7	5	6	6	7	109
N	4	3	4	5	4	3	2	1	2	3	1	2	3	0	1	2	3	4	2	3	3	4	59
O	5	4	5	6	5	4	3	2	3	4	2	3	4	1	0	1	2	3	1	2	2	3	65
P	6	5	6	7	6	5	4	3	4	5	3	4	5	2	1	0	1	2	2	3	3	4	81
Q	7	6	7	8	7	6	5	4	5	6	4	5	6	3	2	1	0	1	3	4	4	5	99
R	8	7	8	8	8	7	6	5	6	7	5	6	7	4	3	2	1	0	4	5	5	6	118
S	6	5	6	7	6	5	4	3	4	5	3	4	5	2	1	2	3	4	0	1	1	2	79
T	7	6	7	8	7	6	5	4	5	6	4	5	6	3	2	3	4	5	1	0	2	1	97
U	7	6	7	8	7	6	5	4	5	6	4	5	6	3	2	3	4	5	1	2	0	1	97
V	8	7	8	9	8	7	6	5	6	7	5	6	7	4	3	4	5	6	2	1	1	0	115

H is the most accessible point

## Appendix nine : Calculation of the beta index

Formula for beta index is :

$$b = \frac{a}{n}$$

where a = the number of arcs

where n = the number of nodes

$$\begin{aligned} \text{Efaye} \quad b &= \frac{a}{n} \\ &= \frac{3}{4} \\ &= 0.75 \end{aligned}$$

$$\begin{aligned} \text{Bamshela} \quad b &= \frac{a}{n} \\ &= \frac{6}{6} \\ &= 1 \end{aligned}$$

$$\begin{aligned} \text{Dalton} \quad b &= \frac{a}{n} \\ &= \frac{27}{22} \\ &= 1.2 \end{aligned}$$

$$\begin{aligned} \text{Mpolweni} \quad b &= \frac{a}{n} \\ &= \frac{34}{28} \\ &= 1.2 \end{aligned}$$

$$\begin{aligned} \text{Gobizembe} \quad b &= \frac{a}{n} \\ &= \frac{24}{22} \\ &= 1.2 \end{aligned}$$

## Appendix 10 : Using Pregan's Potential Clinic Site Formula .

Let PCs be the " Potential for clinic sites "

let  $M_p$  = Population index

$M_m$  = Mobile clinic index

$M_s$  = Primary school index

$M_b$  = Beta coefficient index

$T_s$  = Trouble spot index

Now 
$$PCs = \frac{(M_p)(M_m)(M_s)(M_b)}{T_s}$$

$$M_p = 0 \text{ if } 0 \leq p < 15000$$

$$= 1 \text{ if } 15\,000 \leq p < 30\,000$$

$$= 2 \text{ if } 30\,000 \leq p < 45\,000$$

$$= 3 \text{ if } p \geq 45\,000$$

Where  $p$  represents the present population .

$$M_m = 1 \text{ if } 0 \leq m \leq 5$$

$$= 2 \text{ if } m > 5$$

Where  $m$  represents the present number of mobile clinics .

$$M_s = 1 \text{ if } 0 \leq s \leq 5$$

$$= 2 \text{ if } s > 5$$

Where  $s$  represents the present number of primary schools .

$$\begin{aligned}
 Mb &= 0 \text{ if } b \leq 0.5 \\
 &= 1 \text{ if } 0.5 < b \leq 1.5 \\
 &= 2 \text{ if } b > 1.5
 \end{aligned}$$

Where b represents the  
beta coefficient

$$\begin{aligned}
 Ts &= 1 \text{ if } 0 \leq Ts \leq 1 \\
 &= 2 \text{ if } Ts > 1
 \end{aligned}$$

Where Ts represents the  
trouble spots .

### Calculating the PCs Values

$$\begin{aligned}
 \text{Efaye PCs Value} &= \frac{(Mp)(Mm)(Ms)(Mb)}{Ts} \\
 &= \frac{(1)(1)(2)(1)}{(1)} \\
 &= \frac{2}{1} \\
 &= 2
 \end{aligned}$$

$$\begin{aligned}
 \text{Bamhsela PCs Value} &= \frac{(Mp)(Mm)(Ms)(Mb)}{Ts} \\
 &= \frac{(2)(1)(2)(1)}{(1)} \\
 &= \frac{4}{1} \\
 &= 4
 \end{aligned}$$



$$\begin{aligned}
 \text{Dalton PCs Value} &= \frac{(Mp)(Mm)(Ms)(Mb)}{Ts} \\
 &= \frac{(2)(1)(2)(1)}{(1)} \\
 &= \frac{4}{1} \\
 &= 4
 \end{aligned}$$

$$\begin{aligned}
 \text{Mpolweni PCs Value} &= \frac{(Mp)(Mm)(Ms)(Mb)}{Ts} \\
 &= \frac{(1)(1)(1)(1)}{(1)} \\
 &= \frac{1}{1} \\
 &= 1
 \end{aligned}$$

$$\begin{aligned}
 \text{Gobizembe PCs Value} &= \frac{(Mp)(Mm)(Ms)(Mb)}{Ts} \\
 &= \frac{(1)(1)(2)(1)}{(1)} \\
 &= \frac{2}{1} \\
 &= 2
 \end{aligned}$$