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# **A Spatial Analysis of the Alternative Admissions' Research Project at the University of Cape Town, 2000 – 2005**

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**UNIVERSITY OF CAPE TOWN**

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## **Abstract**

The purpose of this dissertation is to demonstrate the potential contribution of spatial analysis using GIS on candidates who undergo the Alternative Admissions Research Project (AARP) tests for alternative admission to University of Cape Town (UCT). Spatial analysis may be useful in interrogating existing information on the geographical distribution of AARP candidates, in particular, those who are regarded as educationally disadvantaged as a result of apartheid policy and practices of the past. GIS techniques and tools were applied in order to assess accessibility of UCT AARP services provided to students nationally, and to demonstrate how GIS may be incorporated into the various academic faculties at UCT, particularly academic faculty recruitment planning. The results showed schools or candidates that may have difficulty in accessing test centres given the approximated distance. Results further showed that a display of data by faculty identified areas (municipalities) where learners have not undergone the AARP test. This study concluded that a geographical base or spatial analysis is useful in achieving a more diverse student body which incorporates racial and gender composition of students, a well-balanced local, provincial and national geographical distribution of students and a range of resourcing levels among the target schools.

University of Cape Town

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## **LIST OF ABBREVIATIONS, ACRONYMS AND GLOSSARY**

AARP – Alternative Admissions Research Project
DET – Department of Education and Training
EC – Eastern Cape Province
EMIS – Education Management Information System
FS – Free State Province
HOA – House of Assembly
HOR – House of Representatives
GIS – Geographical Information System
GT – Gauteng Province
KZN – Kwazulu Natal Province
LP – Limpopo Province
MACH – Mathematics Achievement
MCOM – Mathematics Comprehension
MP – Mpumalanga Province
NC – Northern Cape Province
NW – North West Province
PTEEP – Placement Test in English for Educational Purposes
QLT – Quantitative Literacy Test
SRT – Scientific Reasoning Test
UCT – University of Cape Town
WC – Western Cape Province

# **1 CHAPTER 1: INTRODUCTION, AIMS and OBJECTIVES**

## ***1.1 Introduction***

Higher education institutions collect and analyse a vast amount of student data that contains spatial information and many institutions, particularly in South Africa, have not realised the spatial component inherent in the data. The application of the Geographical Information System (GIS) has shown a different component of analysis which may assist in better admissions planning and in more informed decision-making with regard to service accessibility and distribution of university services and resources. Given the past education inequalities experienced in South Africa which were as a result of the apartheid system, higher education institutions still face challenges in providing equitable access to education to a diverse student body. Transformational agendas both to improve access and to attain a diverse student body at institutions such as the University of Cape Town (UCT) have been at the forefront of the university's agenda (University of Cape Town Student Equity Policy, 2004). In order to achieve equitable access and a diverse student body that reflects the entire population of South Africa, the Alternative Admissions Research Project (AARP) was introduced at UCT. AARP facilitates alternative entry to candidates who would otherwise not receive admission to study at UCT. This will be discussed in detail later.

This research is intended to explore issues that are current and could be of value to AARP, the UCT admissions office and academic faculties and departments of the university. Since the university aims to attract a diversity of students, both nationally and internationally, information on the geographic distribution of AARP candidates may identify patterns and trends that would otherwise not have been revealed. Spatial analysis may be useful in interrogating existing information on the geographical distribution of AARP candidates, in particular those who are regarded as educationally-disadvantaged as a result of the apartheid policy and practices of the past. Access to this kind of analysis, for example regarding student geographical origins, may help faculties to understand and plan their academic activities and resources more appropriately.

Universities globally are putting in greater effort into the analysis of geographic data relating to the student body (Christie and Ferries, 2006; Granados, 2003; Zhou and Wu, 2006). Student application data is important when one conducts institutional research, particularly where

transformational issues regarding access, race and gender are being addressed. Therefore, this research presents an opportunity to apply spatial analysis and data visualisation tools using GIS to the UCT admissions' process, its institutional planning and management, particularly as it applies to AARP.

Institutional planning and management at a university should include, inter alia, a balanced distribution of its resources and services. In the case of admissions policy and practice, there is a spatial element to these services, because applications and admissions administration, especially in the context of a transformational agenda, needs to demonstrate comprehensive geographical coverage. For the purpose of this dissertation, the services under scrutiny are those offered through the AARP test centres. The test centre locations, and their ease of physical access, may contribute to a more efficient and fair admissions' process for applicants to UCT. For example, for many students it is not feasible to travel to UCT to write the tests and, to those for whom it is compulsory to do so, this could represent a major constraint. Beyond the external services offered to candidates, resources within the university to address the range of academic needs may also be considered prior to admission using GIS, in order to understand patterns in schooling and socio-economic background.

AARP endeavours to identify educationally-disadvantaged learners who have the potential to succeed at university. This is detailed in a later section. In this way AARP is able, to some degree, to assess the levels of preparedness of students to cope with undergraduate programmes (Christie and Ferries, 2006). Christie and Ferries (2006) conducted studies on levels of student preparedness in the United States of America; this is similar to the analyses conducted by AARP. A combination of such studies with GIS could help determine the geographic distribution of the levels of preparedness, using school-leaving results per school, as also the type of school. The ability to analyse the AARP data both spatially and visually may better facilitate continuous monitoring of those schools with learners classified as previously-disadvantaged; more especially those with a proportion of learners who demonstrate a high level of test performance. In this way, a more diverse student body may be attained and sustained, thus meeting one of UCT's transformational goals. This diversity incorporates racial and gender composition of candidates, a well-balanced local, provincial and national geographical distribution of candidates and a range of resourcing levels among the target schools.

The test centres are currently located in urban areas in all nine provinces of South Africa. It is in the interests of AARP to ensure that the test centres are conveniently located and sufficiently accessible to all those who wish to write. Spatial analysis of candidates relative to these test centres may provide a visual means of evaluating the test centres in terms of their accessibility. Trends in spatial patterning of participating schools and candidates over time should also reveal information of value to AARP.

## **1.2 Aim**

Student records of higher education institutions around the world contain rich information about students and their attributes. These records contain information regarding, for example, the school attended, type of school, place of residence, gender, race, and identity of first choice faculty. Such data has great potential for spatial analysis, something which has been overlooked until the development of mapping using GIS technology. The admissions data, in combination with National Census data collected by Statistics South Africa, may be used to understand the geographic distribution of the student body. The power of GIS lies in the synthesis and visualisation of very large datasets based on geographic location as well as the potential for spatial analyses of these datasets.

The main aim of this research is to demonstrate the potential contribution of spatial analysis using GIS: to understand how GIS may be utilised in making informed decisions within the UCT admissions' process using the additional geographic component of AARP candidates, in order to fairly distribute resources to students upon admission as well as to provide an equal and accessible distribution of the AARP services throughout the country.

## **1.3 Research Objectives**

1. How accessible are the AARP test centres to learners?
2. How can the AARP test centres be better located in relation to all secondary schools in South Africa, particularly those candidates targeted to address the transformation agenda of the university?
3. How can GIS be incorporated into the admissions' process so as to ensure that the university, through the various academic faculties, recruits and admits both the best and the targeted candidates?

4. What are the spatial and temporal trends in AARP candidates' time over 2000-2005 and what are the geo-demographic characteristics of the candidates recommended by AARP for admission? (Geo-demographic includes geographic location, population groups in that area, gender distribution, socio-economic status and other factors associated with a certain geographic space).

5. To what extent are the South African schools spatially referenced and compatible for GIS use?

#### **1.4 Research Justification**

Spatial analysis has clearly proved in various ways to be of assistance in institutional decision-making. The following examples demonstrate how GIS can effectively be used in higher education institutions.

When effectively applied, GIS can increase awareness of the geo-demographic distribution of the institutions' admission stream. A geo-demographic contrast between potential and actual applicants may be established so as to reveal characteristics of learners attracted by UCT. As noted below, this contrast can illustrate the extent to which UCT is meeting its transformational goals in relation to the demographic structure of its students. The geo-demographic analysis provides a perspective on UCT admissions policy. Although GIS does not provide the 'final word' in decision-making and planning, it does, nevertheless, provide opportunities more effectively to prioritise scarce resources.

It is clear that the spatial component of higher education institutions' data is under-utilised. Higher education institutions possess databases that are rich in information useful for research such as that conducted by AARP. In particular, the development of GIS provides opportunities as never before to explore and analyse the geographical distribution of students. Students come from various geographic locations with unique characteristics, including cultural, language, socio-economic status, schooling quality, physical infrastructural, and so on. GIS allows the visual combination of these factors based on location, and may thus enhance the understanding of the student body within the institution. GIS is capable of overlaying many different factors, such as those mentioned above, allowing the university to see which potential source areas are under-served or even beyond the reach of the university.

As noted at the Conference of the Association for Institutional Research in Boston, Massachusetts (2004), higher education institutions indicated the kind of geographic information analysed in their institutions. For example, Gavilan College in the United States of America utilised GIS in their discussions with the local government regarding the construction of new facilities. The University of Memphis used GIS to understand the university's competition areas and where recruitments could be focused. In such ways, GIS is proving to assist in higher education institutional research and planning, and understanding the institutional resources and the student body distribution.

This dissertation is an extension of a pilot research project conducted during a previous study (Rambuda, 2006). In the pilot project, only data for Limpopo Province was mapped, and the results demonstrated the clear need for an additional test centre in the region. Thus, it was deemed important to extend the project so as to include all provinces, because some schools are located at the provincial boundaries and the nearest test centre could be in the neighbouring province.

The dissertation represents an attempt to illustrate the potential of introducing GIS to mobilise the spatial component of the data, so as to see how an understanding of the geographical distribution of UCT students who wrote the AARP test may contribute to recruitment and admissions planning, particularly in the light of transformation of the student body at UCT. GIS methods have clearly proven to be highly informative in analysing attributes of the student body such that real time data, i.e. information on students as collected through the admissions' process, can be spatially visualised and manipulated.

### **1.5 The Alternative Admissions Research Project at UCT**

The University of Cape Town is the oldest university in South Africa, founded in 1829 as a South African College for Boys (Phillips, 1993). Following the establishment and rapid growth of diamond and gold mining in South Africa in the second half of the 19th century, the institution expanded, and science laboratories were established. It was only in 1920, however, that the first small cohort of Black\* students was admitted. Although the number of Black

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\* The definitions of the racial categories in South Africa today are similar to those used in the apartheid period except that individuals, according to Statistics South Africa, are free to classify themselves. However, the term Black refers to ethnic Africans, White – anyone of European descent and Coloured refers to those of mixed races, particularly those of Malay descent (Farquharson, 2007).

students remained low until the 1980s and 1990s, by 2004, of the 20 000 students that were enrolled at UCT, half were Black and just under half were female (UCT, 2008). Today, the student population of the university is highly diverse in terms of race, gender, religion, culture, ethnicity and geographical area (both local and international), although it still does not approximate the demographic characteristics either regionally or nationally.

Significant inequities were amplified during the apartheid years, particularly in 1983 when the Tri-cameral Parliament was born (South African History Online, 2010). In this period until the introduction of the democratic government, the South African schooling system was divided by population groups. This system was designed in such a way that each population group was administered by a different education department or authority, i.e. the Department of Education and Training – DET (Black schools), House of Delegates – HOD (Indian schools), House of Representatives – HOR (Coloured schools) and House of Assembly – HOA (White schools). There were enormous imbalances in the quality of education and resources received in all four departments. White schools received remarkably superior education (Sennett et al., 2003) with good school-leaving results; followed by Indian, Coloured and Black schools which experienced a lack of resources as well as very poor quality education\*. Black schools were also marked by a lack of capacity, especially in the teaching of Science and Mathematics, which limited the range of courses that Black students could study at higher levels of education.

The primary purpose of AARP has been to devise admissions' tests, the results of which may be used in addition to, or as an alternative to, results in school-leaving examinations in order to admit students to UCT (Cliff, 2007a). A strong focus of the project is put on both identifying educationally-disadvantaged students who have the potential to succeed at UCT, and on facilitating an alternate form of entry to such students. The expectation is that, given the capacity of academic support and curriculum structures at UCT, the students so identified and provided with an alternate entry opportunity, are then able to cope with the academic rigour of university studies. If applicants do not meet regular admission requirements on the basis of their school-leaving results, then AARP scores are used, to decide whether the applicant may be suitable for alternate admission.

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\* Quality of education is defined in terms of the resources available in the school and also the teacher-learner ratio.

In addition to devising the tests and providing alternative entry to applicants, the vision of AARP is to conduct meaningful research and testing initiatives which contribute to a greater understanding of access and success issues in the higher education sector, primarily in South Africa (Cliff, 2007b). The AARP research focus areas are as follows: (AARP annual report, 1999):

- Academic literacy and students' learning, students' conceptions of learning, admissions' testing, diagnostic profiling of students' academic literacies and numeracies;
- Alternative admissions, assessments and survival analyses;
- Statistical analysis – data mining, reliability and validity of tests, relationships between tests and academic performance; and
- Educational assessment of students vs. assessment in the classroom; developing and using classroom assessment.

UCT has, over time, undergone considerable change within its student body in terms of race, gender and geographic distribution. The diversity of applicants attracted to UCT has increased considerably over time; however, there are variations in academic success rates associated with this diversity. According to the UCT Student Equity Policy (2004), the university recognises past inequities and strives to achieve equity of access to all who wish to study at UCT. This means that specific measures need to be taken to address equity in admitting those who were previously-disadvantaged on the grounds of population group, gender or disability, or a combination of these factors.

In 1986, AARP was established as a means of fair testing for students wishing to gain admittance to UCT. This was in response to the realisation that diverse and variable school-leaving results emerging from the less well-resourced schools did not reflect a student's ability, but rather the inadequacies of the system they had passed through. Following the end of the era of segregated schooling and separate examining of schools in South Africa in 1996, AARP extended the opportunity to write the test to all UCT applicants as opposed to only those considered previously-disadvantaged (AARP annual report, 1999). The emergence of the new dispensation for education, however, did not immediately improve the conditions under which the schools were operating (AARP annual report, 1999). The former DET schools

remain, to a large extent, disadvantaged and / or under-resourced. The status of the school-leaving results compelled AARP still to consider student results in terms of their historical education background and population group when offering them a place to study at UCT (AARP annual report, 1999).

According to the methodology of the AARP, all candidates are tested equally using identical test papers, although results are assessed and analysed under three main categories, viz., educational background in terms of the former education system to which a learner belonged, race, and gender (AARP annual report, 1999). The three categories are considered in the admission process at UCT and may be spatially represented in order to understand their degree of geographic inclusion or exclusion.

### **1.6 AARP Requirements and Location of Test Centres**

AARP tests are written across South (and southern) Africa and even overseas. Other South African universities and private institutions also use the AARP test for admission.

At UCT, AARP tests are not compulsory in all academic faculties but students are strongly advised to write the tests prior to registration both for admission and placement in the academic stream as well as for research purposes\*. Candidates may write the tests before applying to UCT, or before or after applying to another university. AARP makes recommendations for academic placement to various academic faculties based on the test scores of the candidate. Thus, writing the tests earlier in the year increases the students' chances of receiving an early offer from the university, a place at the university residence, as well as an early offer of financial aid.

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#### **\*Ethical Statement**

When students write the AARP test, they sign a form to give consent that their information may also be used for research purposes in addition to the information being used for alternate entry. Although students consent to their results or information being used for research purposes, their individual privacy is protected and their identity is not revealed in the dissertation.

The original records supplied by AARP were listed by student, however, these were aggregated by school for mapping purposes and no personal or individual data was used. The analysis was based on the summary data per school. The nature of this analysis does not therefore infringe on any personal privacy of students. Although the geographical location may indicate the name of the school, the use of school names was kept to a minimum.

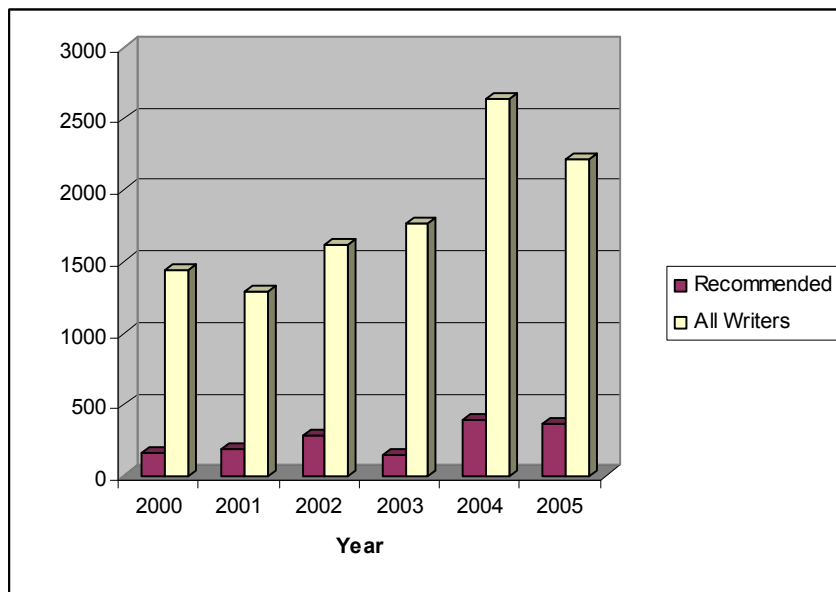
In 1996 there were 16 test centres across the country (AARP Annual Report, 1999). AARP tests are now written at 25 venues across South Africa (See Figure 1.1 and Table 1.1). There are five test centres in the Western Cape (WC); four in Gauteng (GT), Kwazulu Natal (KZN) and Eastern Cape (EC); two test centres Limpopo (LP), Mpumalanga (MP), Free State (FS) and one each in North West (NW) and Northern Cape (NC). The test centres are currently in the major cities or towns of the respective provinces. Candidates may choose the venue geographically nearest to them, irrespective of their province of residence.



Figure 1-1: AARP test centres in South Africa. Source: AARP, 2007

Table 1-1: Number of test centres per province

Province	No of Test Centres
Eastern Cape	4
Free State	2
Gauteng	4
Kwazulu Natal	4
Limpopo	2
Mpumalanga	2
North West	1
Northern Cape	1
Western Cape	5



**Figure 1-2: All AARP candidates and those that were subsequently recommended for admission**

There has been an increase in the number of UCT AARP candidates since 2000, (Figure 1.2), from below 1 500 in 2000 to over 2 000 in 2005, as well as in those who were recommended for admission through taking the test. Some students write the test following their acceptance to and arrival at UCT; these results clearly cannot be used as an admission tool but are added to the dataset and used for research purposes. However, most of the candidates shown in Figure 1.2 wrote either in their province of residence or at their preferred or nearest test centre (Van der Ross, 2007, pers. Comm.). Given the increase in the total number of candidates, it is interesting to consider their regions of origin and the degree of accessibility of the various test centres to such candidates; this is assessed in detail in this dissertation. It is noteworthy that the number of students recommended for acceptance constitutes a relatively small proportion in each of the years from 2000-2005. This too is analysed in the dissertation.

The AARP test centres have become UCT resources that need to be optimally distributed for access to the growing number of applicants as shown in Figure 1.2. There is obviously an enormous potential and need for further analysis so as better to understand the spatial and demographical patterns and processes underlying the growth in AARP candidate numbers.

## 1.7 Dissertation Structure

The structure of the dissertation is as follows: in this introductory chapter, the aims and research objectives and justification for presenting this dissertation have been identified and explained. A brief history of the University of Cape Town as well as the introduction of the Alternative Admissions Research Project is presented. Chapter One concludes with a brief description of the AARP test centre locations, and trends in candidate numbers.

Chapter Two presents a review of the appropriate literature, examining how GIS is used to measure accessibility in various activity sectors. The application of GIS, as reviewed in this chapter, is similar, and provides insight into the methodology of this research.

Chapter Three details the methodology, and outlines how and where the data was obtained. The methods employed to create maps and to analyse the variables present in the data are also described. Limitations and challenges encountered in the development of this dissertation are also discussed.

Chapter Four presents the results, which include a series of maps showing accessibility to the AARP test centres in various provinces, while the results in Chapter Five concern the use of GIS within the academic faculties, and demographic characteristics of the AARP candidates. Further analysis reveals trends in candidate numbers, their geographical origins and their distributions by faculty.

Chapter Six presents a discussion of the results as a whole in relation to the main aim of the dissertation.

Finally, Chapter Seven states the main conclusion of the dissertation; it also presents future implications of the study.

**Note:** This dissertation was first submitted in 2009. As this is a resubmission, it is acknowledged that the situation and statistics have changed and that there have been further developments pertaining to the accessing of higher education. For example, the admissions policy (UCT, 2012) at UCT has been reviewed, and there are now two South African applicant categories: the redress category and the open category. AARP (now formally called National Benchmark Tests (NBT) only administers two tests, namely, the Academic and Quantitative Literacy test, and the

Mathematics test (National Benchmark Tests, 2012). The latest research and developments are noted in the following documents – Parliamentary Monitoring Group (2011), Sedibe (2011), Badat (2011), Badsha and Cloete (2011); and Rollnick (2010), to mention but a few. Such information has not been updated and included in the reworking of this dissertation as it does not correlate with the data provided by AARP at the commencement of this study.

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## **2 CHAPTER 2: LITERATURE REVIEW**

### **2.1 Introduction**

The primary focus of this literature review is on the application of GIS in the education sector. The review also explores instances in business and health so as to offer additional informative examples of how useful GIS has become in these fields. The health and business sectors offer a fair amount of literature, particularly case studies that indicate the role of GIS in these sectors. Both sectors have certain similarities in the manner in which they approach data querying and analysis of GIS data. Various GIS methods and approaches of the business and health sectors are examined. In considering the education sector, the use of GIS within a higher education institution is reviewed in relation to its effectiveness as a planning and resource utilisation tool.

The review of these elements of GIS provides the framework that guides the structure, approach and methodology of the dissertation. The aim here is not only to identify gaps in the literature per se, but to contextualise the aims, objectives and methodology of this dissertation.

To start with, a brief overview of the South African education history is herewith provided for contextual purposes of this dissertation. Given the nature of AARP data and AARP's transformational role – which is to identify educationally disadvantaged students with the potential to succeed at UCT, a brief review of South African education history is essential.

### **2.2 South African Education in Context**

It is pertinent briefly to review the broader context of education in South Africa because the candidates that form the subject of the dissertation are clearly a product of that system. This dissertation observes the current distribution of AARP services from UCT, a historically 'White' university, that are offered to learners of all races and backgrounds who may aspire to the utilising of these services. Inequity in education in this country is a result of socio-economic disparities that arose principally from the unequal distribution of educational resources within the South African school system during the apartheid years, an inequity that, regrettably, seems to be perpetuated under the new government (Hofmeyer, 2000).

The core of the apartheid scheme was to define people on the basis of race and, in so doing, to determine their socio-economic and political status. As a result, schools were racially segregated (discussed further below) and, since apartheid was rigorously implemented through the imposition of rigid geographical boundaries, a strongly spatial pattern of resource availability and access emerged. This obviously renders a situation suitable to a GIS application. It is not the objective of this dissertation to map out the detailed history of the South African education and schools' system in relation to the distribution of resources and the changes thereof: this would result in certain assumptions and simplifications of the analysis. For example, schools in the former homelands (or Bantustans) are not distinguished from other Black schools but are all grouped together with the ex-DET schools because they can be regarded as sufficiently similar in terms of resources. However, a brief background of education within South Africa is necessary for contextual purposes.

In apartheid South Africa, the type of school a student attended determined, to a great extent, which higher education institution he might attend (Makhalemele, 2005). As indicated earlier, the education system was racially divided, both at school level and at the level of higher education institutions. Three population groups – Whites, Indians and Coloureds – were administered under separate education departments that mirrored their representation in Parliament: as the House of Assembly (HOA), House of Delegates (HOD), and House of Representatives (HOR), respectively (Sedibe, 1998). The Black population group was administered under the general affairs of the government through the Department of Education and Training (DET).

Since the early 1990s and the demise of apartheid legislation, one of South Africa's major goals has been the dismantling of the former racial divisions. Racial integration or 'transformation' as it has become known, is obviously of great concern to higher education institutions (Makhalemele, 2005), and is also being addressed at school level. This is expressed in the formal legislation as promulgated in the 1996 South African Schools' Act (SASA). The preamble to this Act declares that South Africa...

...requires a new national system for schools which will redress past injustices in educational provision, provide an education of progressively high quality for all learners and, in so doing, lay a strong foundation for the development of all our people's talents and capabilities, advance the democratic transformation of society,

combat racism and sexism and all other forms of unfair discrimination and intolerance .... protect and advance our diverse cultures and languages, uphold the rights of all learners, parents and educators, and promote their acceptance of responsibility for the, governance and funding of schools in partnership with the State. (South African Schools Act, 1996).

Since the separate education departments were disbanded in 1996, research has been conducted to evaluate progress in schools and higher education institutions in relation to the goals highlighted in the preamble to the Act. Considering the situation pre-1994, most former DET schools were very poorly resourced; classes were overcrowded and were characterised by high learner-teacher ratios (Sedibe, 1998). White schools, on the other hand, were the complete opposite and had lowest learner-teacher ratios: they were well resourced. Indian and Coloured schools fell into intermediate categories (Sedibe, 1998).

The research on post-1994 developments has demonstrated that the quality of education remains distinguishable on the basis of the historical divisions. For example, in both primary and secondary schools, learners in the former HOA and HOD schools seemingly still outperform learners in the Black and Coloured schools (Van der Berg, 2008). This trend was most evident when one looked at the school-leaving results, although the spatial manifestations of this pattern have not been fully explored. The dismantling of the former education departments resulted in the inflow of Black and Coloured learners into former White and Indian schools, but disparities are still very noticeable (Van der Berg, 2008). The differences in socio-economic status of the individual learners still appears to be related to measured underperformance of previously-disadvantaged learners who have transferred into White and Indian schools (Van der Berg, 2008).

According to Kamwangamalu (1997), South Africa formally recognised that the country is multi-lingual at the end of the apartheid era, and constitutionally adopted eleven official languages. During the apartheid period, South Africa was considered, in essence, bilingual – English and Afrikaans – although these two languages remain prominent in the new South Africa as languages of commerce. The other nine (now official) languages (Tshivenda, Sesotho, Sepedi, isiXhosa, isiZulu, Tswana, Ndebele, Tsonga and siSwati) were conventionally used in educating Black people, yet none of these languages was used in government administration or indeed in many other domains. While so-called mother-tongue education has its

proponents, this concept was actually used by the apartheid government as a means of ethnic educational segregation in South Africa and oppression, by restricting access of the oppressed to the language of power (Kamwangamalu, 1997). In addition, the ethnic divisions promoted superiority of education for Whites, who had better access to resources and a greater range of privileges in education compared with those received by Blacks.

An average South African learner is still taught in the mother tongue for the first four or five grades of his schooling, and until the final year of school, English and Afrikaans are introduced as second languages. The switch over is abrupt, and when combined with inadequate preparation prior to the use of the language, this results in high failure and dropout rates (Lanham 1978; Musker 1993; Alexander 1997 and Hartshorne 1995).

In general, the Bantu Education Act promoted the use of three languages – English, Afrikaans and mother tongue for Black learners, and English and Afrikaans for White learners (South African History Online, 2010). One of the most serious implications of the Bantu education system was that it limited access of Blacks into higher education, thereby limiting their social and economic progress. The dynamics and power relations of the apartheid language policy saw many Blacks in South Africa rejecting Afrikaans as a medium of instruction in schools, leaving English as the primary language of instruction in many spheres of operation. Today, many schools and institutions of higher learning use English as the medium of instruction and Afrikaans remains a second language; the other nine official languages may be considered very much minority modes of communication in the formal educational context.

Higher education institutions were similarly divided along lines of race or ethnicity (languages) (Sedibe, 1998), for example, the UCT is a historically White (English first language) university, the University of Western Cape is a historically Coloured institution, the University of Stellenbosch is historically White (Afrikaans first-language) and Fort Hare University was designed for Black, mainly isiXhosa-speaking students (Marcum, 1981). Black universities were very limited in resources and courses of study in that, should Black students wish to follow a particular course of study only available at a so-called White university, they were required to obtain a ministerial permit (Mabokela, 1997). In addition, Black students were usually underprepared because they came from under-resourced schools offering poor quality education. Since the demise of apartheid, and certainly since the democratic elections of 1994

and the establishment of the new non-racial constitution, access to higher education institutions such as UCT is no longer based fundamentally on racial lines; thus proper screening of students to administer a fair and equitable admissions' process is deemed essential.

Accordingly, post-1994 higher education institutions have attempted to transform and to redress the educational inequalities historically experienced in South Africa. Currently, all South African schools and higher institutions are non-racial, although success rates are still highly variable and previous disadvantage remains entrenched (Barnes, 2006). According to Jansen (2008), the urban institutions are the ones that have become more effectively multiracial, but the former Black universities, despite the merging of institutions, remain racially marginalised and less transformed.

The current South African government through its National Department of Education (the new National educational authority) is making an effort to redress imbalances (Startz, 2010), redistribute resources and to ensure a high quality of education in schools. The past ten years have resulted in a huge influx of Black students into historically White (English and Afrikaans) universities. According to Cooper and Subotzky, 2001 (in Cloete, 2002, pg.2) the "ratio of Black students in total university enrolment rose from 32% in 1990 to 60% in 2000 while in technikons it rose from 32% to 72% over the same period", which means that the majority of students in higher education (universities and technikons) are now Black. Also, the "enrolment of women increased from 42% in 1990 to 53% in 2000". These are some of the factors that are spatially analysed to ensure that, in as much as there is less gender and racial marginalisation, geographical marginalisation is concomitantly reduced.

Another element of redress is the ensuring of access to any higher institution, meaning that fair chances of success are offered to all students (Ministry of Education, 2001). Students admitted to any South African higher institution should ideally be retained until graduation and supported both educationally and financially. This is because the financial backgrounds of most Black students are poor and, due to poor quality education, most Black students are under-prepared (Zaaiman, 1998) for tertiary studies. It was partially for this reason that UCT introduced the alternative admission tests – to provide students from all school types, and particularly poorly-resourced schools with a fair chance of access. Fair chances, according to

this dissertation, commence when all students, particularly those previously-disadvantaged, are able to access the AARP test centres. Another spatial component reflects a geographical distribution of how many previously-disadvantaged schools have been reached by AARP and / or UCT.

The following section introduces GIS applications in the business and health sectors that demonstrate the potential of their being applied also to the higher education sector.

### **2.3 GIS Applications**

Location allocation is a process of finding the best locations for one or more facility that will service a given set of points, and then assigning those points to the facilities, taking into account factors such as the number of facilities available, their costs, and the maximum impedance from a facility to a point (Suomalainen, 2006 and Lai, 2007). Services such as in the business and health sectors have some similarities in that, at one time or other, information is needed as to where the services could best be located. The questions are simple and include not only decisions on where to locate a new service, but which existing facility to close down, and how to improve service locations (Mc Lafferty, 2003).

The basic components of the problem of location allocation, according to Suomalainen (2006), are facilities: the number of facilities to be located, and locations where facilities may be positioned. In his paper, Suomalainen (2006) indicated two models useful in tackling the problems of location allocation: firstly Discreet Models, also known as Site Selection Models, used if there is a prior knowledge of site candidates. Secondly, there are Site Generation (or Continuous Space) Models and in this case the models are allowed to generate the appropriate data, given the input data.

Furthermore, through employing GIS and its function(s) of location allocation, service providers may determine optimal locations of services, or assess accessibility of existing services to a given target population (Suomalainen, 2006). Yet other service providers have the primary need to understand the geo-demographics of the populations they serve. Combinations of geo-demographics and functions of location allocation may be used before opening a new service, to explore whether the service is appropriate for the target population (Cheng et. al., 2007). This dissertation draws on the techniques of location allocation, particularly the Discreet Model, in order optimally to locate the AARP test centres.

To explore the significance of GIS in the type of examples mentioned above, and as targeted by this dissertation, it is important to review case studies where the appropriate GIS functionalities have been successfully employed. The health sector seems to have an increasing wealth of literature in GIS applications that focuses on location allocation, accessibility of facilities, and using proximity functions. Some literature on GIS applications in the business sector is also included.

Today there is substantial literature on the use of GIS in addressing spatial issues in health care facilities (Noor et al, 2003) and businesses (Clark, 1996 and Julian, 1996; Hernandez and Bennison, 2000; Murad, 2003). GIS technologies and methods are advancing in such a way that planners, researchers, etc., are allowed to incorporate geographical relationships of the various data collected within their organisations. In order to utilise a GIS, it is important to set relevant aims and objectives as well as to ask questions that can have geographic answers. The papers reviewed in this section demonstrate various approaches to GIS studies which include aims, objectives or questions addressed; and GIS methods, functions or tools employed by various authors.

### **Aims and Objectives of GIS Applications**

The main aims of applying GIS to businesses are often related to the identification of suitable locations for new stores or for closing down those that are not making any profit. In banking, for instance, the aim is to grow profitability by locating new branches. Once profitability is attained, GIS is applied to remove excess bank branches from some areas (Camarata, 1996). According to Clark (1996) and Julian (1996), the aim of applying GIS in business is to clearly identify customers, and to understand their needs. It is evident that the aims are directed to the socio-economic aspects and lifestyles of customers. For instance, businesses usually target certain income groups within their market.

A GIS study conducted by Rushton (1999) sought to illustrate methods used to evaluate geographic access to local health services. Rushton (1999) addressed the following questions: (1) How is the market area determined for a local health department (LHD) or health care facility? (2) What is the market share for that LHD or facility? (3) What are some simple but useful methods of providing insight into distance-related access issues? Other aims in health

care and GIS analysis include having health services within a certain desirable radius (Noor, 2003); assessing the changes in accessibility attributable to the programme of reform of the health sector; and the corresponding impact on equity of access to health care (Rosero-Bixby, 2004).

It is important to note that the business sector is sometimes minimally concerned with the accessibility of the business location. The main interest is usually in increasing profitability: businesses simply relocate should expected profit not be attained. A particular business may be located many kilometres from its customers but, because there is demand for their particular range of products, customers make considerable efforts to access the business. Thus, distance or easy access to these businesses may be of less importance in certain instances. This situation appears to contrast starkly with health care services and academic services that are required to be easily accessible to patients and student populations respectively.

## **2.4 GIS Methods and Tools**

### **Geo-Coding**

To achieve the above-mentioned aims and questions, there are a number of methodologies and approaches used to spatially analyse business and health-related data. These may be a useful source of understanding the way in which spatial data may be represented as intended for adoption by both business and health sectors, and which also apply to this dissertation. The majority of the methods employed require a process known as address-matching or geo-coding (Clark, 1996; Schott, 1996; Rushton, 1999). Geo-coding allows customers to be individually located, and their attributes to be mapped to a precise location. Another common approach is choosing a spatial scale of analysis and sorting data using that scale (e.g. Zip-code – equivalent to Enumerator Area in South Africa), and joining multiple databases together if the data is already spatially referenced (Julian, 1996).

Relating this to the higher education sector immediately highlights a constraint, because most of the candidate location data, as mentioned earlier, is conventionally collected with no prior intention of mapping, meaning that there may be no explicit spatial references or geographic coordinates. However, geo-coding may be used to infer a location based on a school or home address. Once the data is spatially referenced and the spatial scale of analysis defined, other

data with similar spatial scales may be integrated, thus reducing the address-matching tasks to be performed. Thus, the above methodology used in the business sector is also applicable to students and patients in the health sector.

### **GIS and Accessibility of Facilities: Proximity Functions**

According to Liu and Zhu (2004), the analysis of accessibility may include a combination of the following seven aspects: the definition of spatial unit for analysis, the definition of socio-economic groups, the types of opportunity, the modes of travel, the definitions of origins and destinations, and the measurement of attractiveness and travel restriction / limitations. These aspects require data that are accurate, in order to measure each person's access to a service centre, so that better and more informed decisions may be made.

Rosero-Bixby (2004) noted that, traditionally, access has been measured by distance or travel time to the nearest facility or by presence of facilities in the communities. However, Rosero-Bixby (2004) further noted that certain factors are overlooked, such as the use of services in other communities; the failure to use the nearest facility; overlapping coverage; redundant services in a community; the size of the population served (and the potential for overcrowded facilities); and variability in quality of care.

A study conducted by McLafferty (2003) in relation to access to health care indicates that access describes people's ability to use facilities or services when and where they are needed. McLafferty (2003) further discusses two measures of geographical access; namely area-based and distance-based. Area-based measures the ratio of population need to that of services, whereas the distance-based measure of access focuses on distance or travel time or cost between population and services.

Both the area-based and distance-based measures are flawed. The choice of geographical units has effects on the results if the area-based method is being used. Cross-area travel of the population is undermined and this is an important element for both small and large spatial units. On the other hand, distance-based, which primarily utilises straight-line or Euclidean distance, fails to include factors such as ease, cost, time of travel, and access to transportation (Mc Lafferty, 2003).

The Thiessen Polygon technique is another measure of proximity, where each polygon contains only one input point, and any location within a polygon is closer to its associated point than to the point of any other polygon (ESRI, ArcGIS 9.2 Desktop Help). This technique was used by Noor et al. (2003) to generate catchment areas for each government health facility at their four study sites. Through this technique, each enumerator area was assigned to the nearest health facility catchment area.

A simple and basic measure of access is considered a buffer. A buffer created in a GIS represents a zone around a map feature measured in units of distance or time (ArcGIS Resource Centre, 2010). A buffer is useful for proximity analysis. According to Dahlgren (2005), in case studies, proximity analysis lays important foundations in describing accessibility. There are two types of buffer; namely, constant width buffer and variable width buffer (Mandangere, 2006). Buffer zones may be used to query spatial entities inside or outside the zones.

Simple Euclidean buffers were used in a study by Spencer and Angeles (2007) to define service areas and to map areas with inadequate health services in Nicaragua. Areas in this study were considered to have access to a health facility if they were within a buffer; if outside, it was assumed that they had no access. As buffers can overlap, areas that had many overlapping buffers were considered to represent over-serviced areas; few or no buffers might indicate a shortage of services. This study (Spencer and Angeles, 2007) used buffers in an attempt to reveal areas which are seriously underserved, prior to applying a more appropriate proximity measure – kernel density analysis. In this study, buffers were foundational and gave indications of areas to be closely assessed.

It is evident that, overall, accessibility of services could be analysed using a variety of GIS proximity tools. The basics of analysing accessibility include the facility(s) in question, the population served or to be served by this facility(s), the proximity to this facility(s). Using GIS, distance to a facility may be optimised and the population thus adequately served. The application of GIS to higher education draws on the above statements, because the student population is to be served by either schools, universities or other services provided outside the university campus.

## **2.5 GIS Application in Higher Education Institutions**

GIS is increasingly being used in higher education institutions for recruitment, admission and planning purposes (Christie and Ferries, 2006), as well as in understanding the geography of the student body (Granados, 2003). Higher education institutions, particularly in South Africa and even some internationally, are redressing past racial and gender inequities. Today, higher education institution strategic planning focuses on students targeted by the admissions and recruitment policies. For example, part of the mission for UCT is to be “flexible on access, active in redress and rigorous on success” (UCT Mission Statement: 1996 – <http://www.uct.ac.za/about/intro/>). UCT aims to enhance the diverse student profile to reflect the demographics of the country (UCT Student Equity Policy, 2004); the university aims to redress the racial segregation of the past.

The UCT policies mentioned above may be analysed spatially by looking at the rate of admission of targeted students since the inception of the policies, in addition to the traditional data analysis performed by admission officers. This also allows for the spatial display of the areas from which the university attracts its student body, in particular those students attracted through AARP and because the expansion of AARP test centres has, in some way, created new geographic pools for admission to UCT. Such information may be useful in allocating academic resources and financial aid to students. Data illustrated spatially may also reveal the distance travelled by students to the university. The distance travelled between the university and place of students’ residences could be used as an indicator of who is admitted to the university residence, and so on.

In Australia a study conducted by Hugo (1998) showed how GIS could assist in targeting programmes designed to ameliorate disadvantage in entering higher education, something central to UCT’s current mission. Common and basic GIS software tools may be used to show that it is possible to monitor and assess the impact of such programmes. The major applications of GIS in educational planning mentioned in the study above are as follows:

- Establishing the optimal location of new educational facilities in terms of maximising accessibility to the maximum number of potential students;
- Establishing where closure or downsizing of such a facility will affect the smallest number of students;

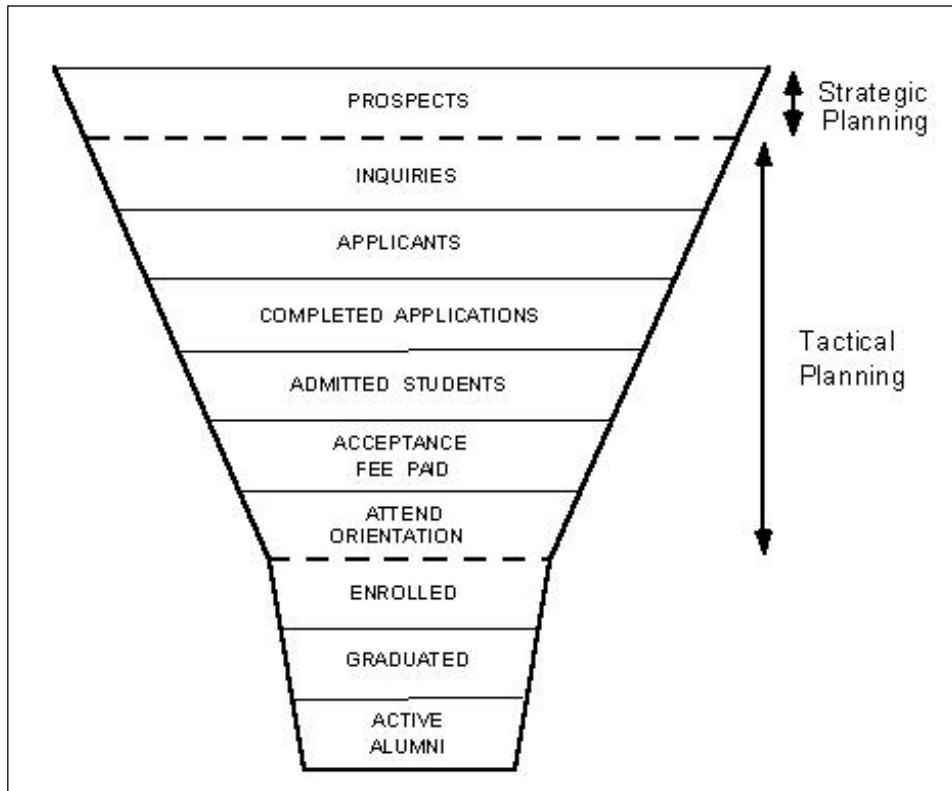
- Differentiating areas, according to their level of accessibility, to different types of educational facilities; and
- Establishing areas of high and low degrees of participation at various levels of education.

Hugo (1998) discussed inequalities experienced in university enrolment in Adelaide, Australia. It was found that the majority of students graduating from universities in Australia are densely concentrated in high income areas in the higher status parts of the city. South Africa is experiencing somewhat similar challenges, in that the racial separation of the past explains the educational inequalities experienced and currently being redressed (Sedibe, 1998). In South Africa, the educationally disadvantaged were situated in the former South African homelands, mainly rural, and the ethnic divides which, to a large extent, were also educational divides, are also spatially evident. Although educational inequalities would not notably and meaningfully change geographically, spatial analysis would assist the administrative dimension of educational inequalities.

Hugo's (1998) study generated a series of maps showing the distribution of students attending Adelaide University. The sequence of maps employed the hierarchy of administrative spatial units, in increasing order, used in Australia, namely: collection districts, post codes, and statistical local areas. The importance of using various spatial units is also illustrated in a similar study by Granados (2003), mapping data of enrolled students in the United States. The spatial units used in the United States are: states (the largest), counties, and zip codes (smallest). Each spatial unit exhibits a different pattern owing to the aggregation of data within that spatial unit. However, these are used for various reasons in the analyses, depending on the purpose of the analysis. Although the Adelaide University example (Hugo, 1998) does not detail its methodology, the paper makes the important point that GIS is not only used in analysing equity-related issues, but is also a useful tool with which, as mentioned earlier, to assist in student-recruiting activities of the university.

Herries and Marble (2006) illustrate how GIS may be used in higher education admissions planning. Using a different approach from Hugo's (1998) paper, which looked closely at the

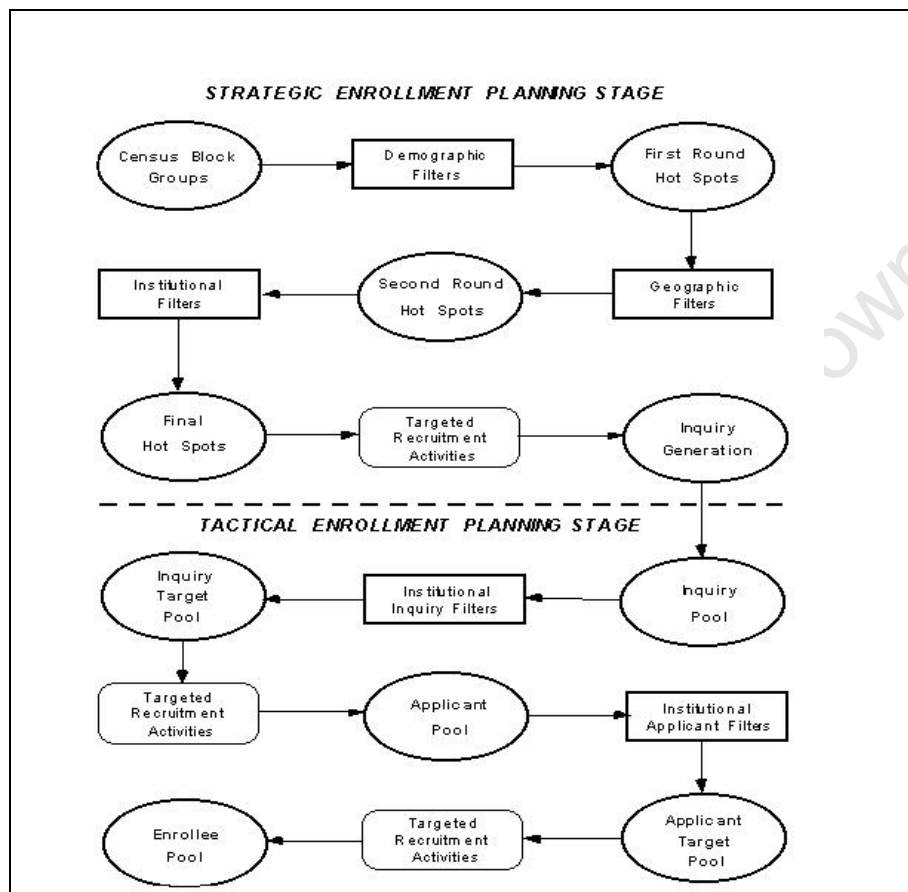
value of GIS in ameliorating gender, race and class inequalities experienced in higher institutions in Australia; Herries and Marble (2006) give conceptual models illustrating how GIS may be incorporated into any higher institution's admission process. This conceptual modelling using GIS is illustrated by the two diagrams shown below: the university admissions funnel (Figure 2.1) and the strategic admissions model (Figure 2.2).



**Figure 2-1: The University Admissions Funnel, a generic model. Source: Herries and Marble, 2006**

Figure 2.1 shows the conventional process that higher education institutions follow in the admission of students. Although this model comes in various forms, the stages depicted are typical in a large university. The funnel-shaped model simply means that not all prospects lead to inquiries, and neither do all admitted students actually enrol, with further dropouts at the graduate or active alumni levels. The challenges associated with the funnel model include the following: identifying the prospects and applicants who will ultimately enrol; and improving the performance of subsequent stages in the admissions' process to ensure positive enrolment – that is to say, positive enrolment that encompasses most geographic areas and issues such as those addressed in the study by Hugo (1998). The previous model does not

include a geographic component; however, the following model, Figure 2.2, demonstrates how GIS is incorporated, ensuring admission that targets all aspects intended by the university.



**Figure 2-2: The strategic admissions model Source: Herries and Marble (2006)**

Figure 2.2 shows how GIS may be incorporated into the admissions' process. It is the breakdown of Figure 2.1, and is shown in more detail. The challenge is to select, from a population of university prospects, those from the targeted areas that are most likely to enrol. Small spatial units, such as census block groups (urban) and block numbering areas (rural)\*, are recommended to begin the analysis. The small spatial units contain substantial amounts of socio-economic information relevant at the first stages of the admissions' process. The relevant age group (13 – 17 yrs) is displayed on the map and subset areas are selected and

\* Census block groups (urban) and block numbering areas (rural) in the United States are equivalent to Enumerator Areas in South Africa.

referred to as hotspots on the model. These are selected through the application of filters – demographic, geographic and institutional filters. As mentioned earlier, the different filters in GIS technology, especially those demographic and geographic, may be applied using various spatial units, to make informed decisions.

The tactical planning stage involves individuals that have made enquiries, and applied to a university, rather than just a group of admissible students in a particular area. At this stage, GIS may be used as a tracking device to decide whether the predicted number and quality of admitted students was met (Marble, Mora and Granados, (2007). If trends are observed, then action will be required. It is important, however, to note that GIS requires accurate data and clear definitions of methods applied satisfactorily to accept the targeted population into the university.

Herries and Marble's (2006) model illustrating the potential of GIS in admission planning provides a framework for this dissertation. AARP is integral to the admissions' process at UCT. The results from these tests are used to identify potential students and, furthermore, to allocate resources once the students are registered. In fact, the AARP process may be seen as a stand-alone admission entity, because it also offers services (test centres) outside the university campus. AARP is clearly aimed at ensuring that test centres are accessible to all prospective students. In addition, it is important for AARP to know the geography of all students, from the applicants to the alumni, to decide whether the vision of reaching the educationally disadvantaged is being achieved.

## **2.6 Conclusion**

It is clear in the literature review that GIS methods have been successfully applied in the business, health and education industries. In addition to the traditional methods of analysing data, the spatial component added to the data analysis provides a way of looking differently at service provision. Problems of location allocation and studies of accessibility in health services, using various proximity tools described in the literature review, are profitable in allocating and assessing accessibility of services offered by higher education institutions.

Meehan (2007) believes that the value of GIS lies in its ability to display data on a variety of spatial scales not easily visualised in non-spatial presentation formats. He further states that the power of GIS is not only in the colour-coding or displaying of themed-point data, but in the

advanced spatial visualisations, with the combination of business intelligence and other external data. Similarly, higher education institutions would benefit by combining the visual spatial analysis with institutional planning.

There is, therefore, a need to analyse the accessibility of university resources and facilities. As businesses aim to increase profitability (Camarata, 1996); universities are concerned with balancing recruitment resources, quality, number and diversity of students, and objectives on constrained budgets (Herries and Marble, 2006). Results from most of the reviewed papers show that people from rural areas have restricted access to services.

The South African education section was included to ensure contextualisation and good interpretation of AARP data, because a large aspect of AARP derives from the history of the divided education and the racial segregation of the past. It is inevitable that reference must be made to certain of these issues when analysing some of the data. The discussion will refer to most of these issues in an attempt to understand certain aspects of the data.

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### 3 CHAPTER 3: METHODOLOGY AND LIMITATIONS

#### 3.1 Time frame, Spatial Scale and Mapped Data

In to order improve the reliability of this spatio-temporal analysis, a period of six years was chosen, viz., 2000-2005. Adoption of this period of time facilitates the tracing of changes and trends in the various regions where students write the AARP test. Although the AARP assessment dates back to 1989, the chosen period of study provides consistency in the way that data was collected and organised; thus data prior to 2000 could not be included in the analysis. This reduces data gaps and inconsistencies and enables a more meaningful spatial analysis.

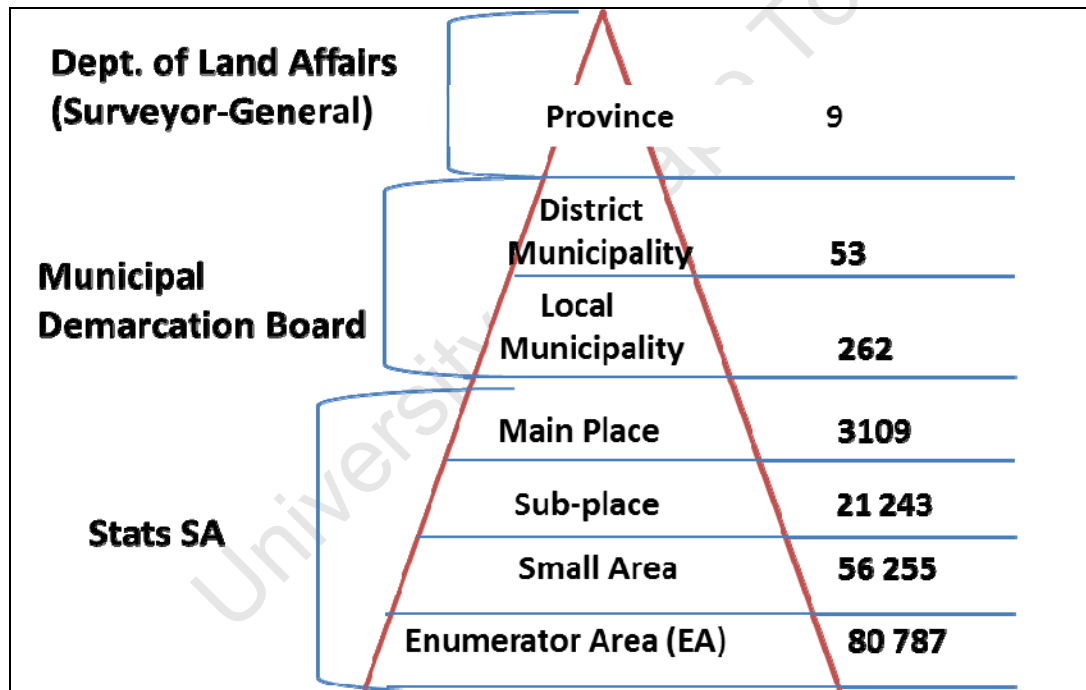
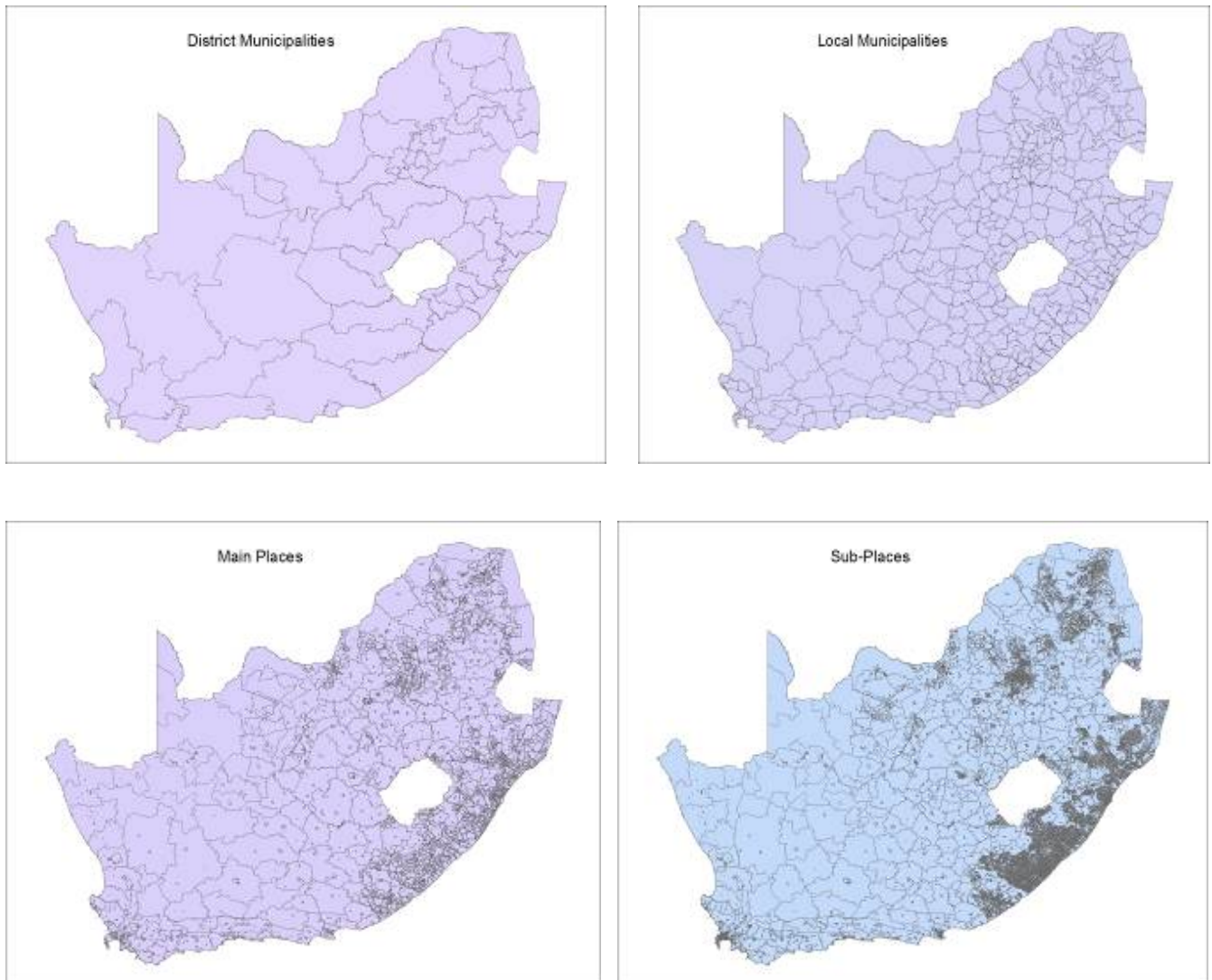


Figure 3-1: Geographical frame of South Africa. Source: South Africa Statistics Census 2001

Data examined in the dissertation covers all nine provinces in South Africa. Each province consists of a hierarchy of spatial divisions; namely, magisterial districts, local municipalities, main place, sub-place, wards (small place) and enumerator areas, in decreasing order of size (see Figure 3.1 and corresponding maps in Figure 3.2). These administrative boundaries are standard units of spatial analysis in South Africa. Thus, in the absence of geo-referenced educational boundaries, these administrative boundaries are used.



**Figure 3-2: South African administrative spatial units. (Source: Municipal Demarcation Board SA Explorer 3 software)**

Analysis of the data representing the entire country permits comparisons to be made between provinces and at lower levels of the spatial hierarchy. The inclusion of all provinces permits an imaginary delineation of provincial boundaries in order to find the nearest testing centre. This is particularly for schools that are closer to the provincial boundaries and perhaps far from the testing centre within their province.

### 3.2 Software and Mapping Tools

This dissertation makes use of the ArcGIS 9.2 software produced by the Environmental Science Research Institute (ESRI). A one-student licence to use the software was provided by the Environmental and Geographical Science Department at UCT. Within this software, as in most GIS software, it is possible to store, manipulate and retrieve data, to generate maps as well as to perform spatial analyses. The software includes both raster and vector data analytical tools, however, this dissertation made use of the vector analytical tools. Tools included are the spatial join and the buffering tools, to name but two of the tools relevant to this dissertation.

### 3.3 Data Sources Used in the Analysis

The key data under scrutiny is that drawn from two databases, namely the UCT admissions and AARP candidates' databases. Figure 3.3 illustrates the core databases used for the analysis and the corresponding original numbers of candidates in the databases across the six-year period. Although not all UCT applicants write the AARP test, the AARP candidates used in the analysis were ultimately enrolled at UCT. For this reason, the UCT admissions' database contains the most important attributes required for the analysis. The AARP candidates' database was matched to the UCT admissions' database to extract additional attributes not collected by AARP. Within the AARP candidates' database, some of the candidates were further recommended for enrolment at UCT. A separate database for these candidates was created.

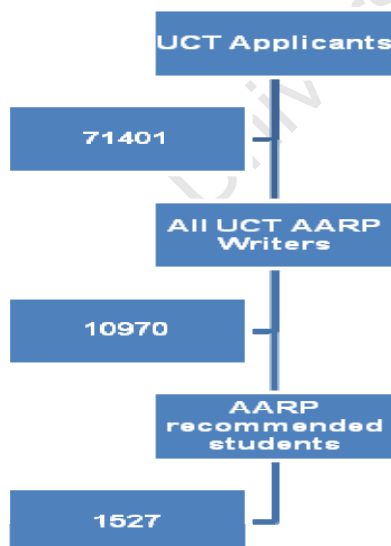


Figure 3-3: Simplified diagram of mapped attribute data and the total number of candidates

## Data Sources

- AARP and UCT admissions (2000 -2005) – records of applicant and candidate records (both spatial and non-spatial).
- South African Demarcation Board – SA Explorer version 3 (available in 2004) – geographic coordinates (shape-files) for schools, provinces, municipalities.
- National Department of Education (2007) – additional mapped schools.
- Open Spatial Solutions (2007) – geographic coordinates for schools in certain provinces.
- Matriculation Board of South Africa – pass rates of the schools (2000-2005).
- Statistics South Africa – Census 2001 data.

SA Explorer version 3 was published in 2004 by the South African Municipal Demarcation Board but the data may well have been collected earlier. However, at the time of geo-coding, SA Explorer was the most consistent database in that it contained the most accurately located schools. Thus the data was used as the primary source with which to extract the geographic coordinates of the schools. Open Spatial Solutions (OSS) is a company that in 2005 and 2006 reconstructed and updated the spatial databases of schools in South Africa for the National Department of Education. In this project, the OSS and the National Department of Education databases provided spatial references for schools not otherwise found in SA Explorer.

### 3.3.1 *AARP Database*

The AARP database provided a list of all candidates as well as the test centres at which they wrote. AARP currently has 25\* official writing centres across provinces in South Africa (Table 1.1). Each province has a number of writing centres situated predominantly in the cities or major towns of the province. The number of writing centres by province is presented in Figure 1.1 and Table 1.1.

In LP Province, since 2003, testing venues have changed slightly; for example, Capricorn High School is no longer used as one of the venues, but has been replaced by Northern Academy

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\* 'Currently' meant at the time of writing this dissertation (2007-2008)

Combined School. However, the new venue is still within the city of Polokwane, as was the former venue. Some other venues changed within the five-year period (2000-2005), but for the purpose of the spatial analysis and for consistency, 2006 venues were used, as shown in Figure 1.1 in Chapter 1. Lapsed venues were usually replaced by new ones. Writing centres in KZN, such as Michaelhouse, Pietermaritzburg Girls' High School, St Andrew's School and Maritzburg College, were all combined into a single unit, namely the Pietermaritzburg Writing Centre. All the distances calculated are directed to one of the official writing centres.

For each student, this database provides writing centre information as well as the year the test was written. Students usually write a year before coming to the university; for instance, in 2003, for admission in 2004. Other students write the test only upon arrival at UCT: these are not included in the analysis. This information is, nevertheless, included in the database so as to maintain an accurate record of how many students are writing at the various test centres.

### **3.3.2 UCT Admissions' Database**

The database is made up of all application forms submitted by prospective UCT students for admission purposes. All students who applied to UCT in the chosen study period are recorded in this database, irrespective of whether the applicant was ultimately admitted. The information needed for this project in the UCT admissions' database consists of the following fields:

- Gender;
- Population group;
- School attended;
- Education code – both old and new\* (See Appendix A);
- Year of application; and
- First choice faculty of study.

Year of application in this database matches the year the test was written and this is used as the reference in the analysis.

### **3.3.3 SA Explorer 3 (Municipal Demarcation Board)**

SA Explorer is a spatial data viewer developed by the South African Municipal Demarcation Board. The software provides a view for South African spatial viewing; attributing data for

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\* Old education departments are those that classified schools according to race while the new codes were implemented at the end of apartheid schooling. See Appendix A.

various themes such as education, cadastre, transport, and so on. The software is updated when there are major changes in spatial references and attributes. Data found in the software was published in 2004. Although many attribute fields are outdated, the spatial references have not changed and are therefore robust.

The schools recorded in the UCT admissions' database do not include geographical coordinates because the information was not intended for spatial analysis. The names of the schools in the UCT database do have a unique numerical code or ID but this is different from the EMIS number used by the Department of Education. Hence the school names in the UCT database were used to match the school names in SA Explorer database in order to extract the geographic coordinates when geo-coding.

#### **3.3.4 *Statistics South Africa***

This database includes shape-files and a database of population census data within South Africa. The census data provide some of the social, demographic and socio-economic information as well as the spatial units mentioned above that are otherwise unavailable in SA Explorer.

#### **3.3.5 *Matriculation Board of South Africa***

This database provides the matriculation pass rate for all the schools by province. In South Africa, matric (as it was commonly referred to until 2008, when it was replaced by the National Senior Certificate), or Grade 12, is the final grade prior to starting higher education studies. In this database, the following are included: school, the number of subjects written by a student, total number of students who wrote, total passed, and percentage of those who passed.

It was also important to investigate whether the best performing schools in South Africa are within reasonable distance of the AARP test centres. Thus, the national top twenty per cent of the best\* performing schools were selected using MS Excel because of data insufficiency accurately to map all best performing schools. As this was a separate database from the main AARP database; with different spellings and without EMIS numbers, to match the AARP database. The final list was 1319, including schools with 75% – 100% pass rate. The schools

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\* Schools with over 75% pass rate. This definition is not a general standard nor is it officially adopted.

were geo-coded and displayed on the map to illustrate the distribution of the best performing schools within the 50 km radius of the AARP test centres.

### **3.4 Geographic Coordinate System and Projection**

The following geographic coordinate system was used to ensure a degree of accuracy in the distance calculations:

GCS\_Hartebeesthoek\_1994

Datum: D\_Hartebeesthoek\_1994

The Albers equal area projection was applied using the following geographic parameters:

False\_Easting: 0.000000

False\_Northing: 0.000000

Central\_Meridian: 24.000000

Standard\_Parallel\_1: -18.000000

Standard\_Parallel\_2: -32.000000

Latitude\_Of\_Origin: 0.000000

Linear Unit: Metre

### **3.5 Data Organisation**

A total of 71 402 students applied for admission to UCT during the period 2000-2005. Of the total applicants, only 15% (10 970) were admitted to UCT, having written the AARP tests prior to registration. Students who wrote the test were successfully matched to the UCT admissions' database using the UCT student identification (student number) as a reference. In this way, a composite database was created, and students were then aggregated by school. However, not all the information supplied by the admissions office was necessary for this study; but the following fields were successfully retained, to re-arrange and merge the UCT admissions and AARP candidates' databases:

- Student number
- Surname
- Name
- Gender
- Population Group
- Old Education Code (see Appendix A)
- New Education Code (see Appendix A)
- Degree – First Choice

### **3.6 Data Transformation**

Microsoft Excel and Microsoft Access were used to re-arrange and organise data. Functions such as pivot tables and 'v-lookup' were vital in summarising and matching the necessary fields. The spatial analysis was carried out using ArcMap in ArcGIS 9.2. Before geo-coding, as shown in Table 3.1, data was arranged per student: a school was denoted for each candidate separately and therefore multiple times, instead of one school representing all candidates. Using the data in this way would have meant that, when geo-coding, schools would have represented multiple points on the map, one for each student in each school location. However, the manipulation of data using pivot tables in MS Excel produced a list of learners per school using the unique school codes allocated by the UCT admissions office and the EMIS numbers, where applicable. In this way, most of the data points were transformed from categorical and nominal to interval and ratio for spatial analysis (see Table 3.2). Data transformation is necessary for most spatial analysis operations. For example, representing points using graduated symbols or representing polygons using graduated colour requires values with a meaningful scale of measurement such as ratios and interval (ArcGIS 9.2 Desktop Help).

Fields such as year of application (APPYR in Table 3.1) represent the six-year census period from 2000 to 2005. The field APPYR was turned into separate fields (as shown in Table 3.2) with a count of students who applied in that year; and a 'total' field was also included. The 'v-lookup' function in MS Excel was used for other fields that could not be 'dragged and dropped' using pivot tables, such as EDCDEO (Old Education Department), PROVCODE (province code) and geographic coordinates. The final table with all the fields summarised per school was then imported into ArcGIS, ArcMap for geo-coding.

**Table 3-1: Excel extract of geo-coded data before transformation through pivot tables**

	F	G	H	I	J	P	Q	R	
	APPYR	EDCDEN	EDUCCODE	SCHOOLCODE	SCHOOL	PROVCODE	PROVINCE	EMIS	LA
1	2004	GT	TR	81	NIGEL HIGH SCHOOL	GT	Gauteng	350371	
2	2005	GT	TR	81	NIGEL HIGH SCHOOL	GT	Gauteng	350371	
3	2005		TR	81	NIGEL HIGH SCHOOL	GT	Gauteng	350371	
4	2006	GT	TR	81	NIGEL HIGH SCHOOL	GT	Gauteng	350371	
5	2006	GT	TR	81	NIGEL HIGH SCHOOL	GT	Gauteng	350371	
5	2005	KN	IN	10222	NILGIRI SECONDARY	KZ	Kwazulu Natal	250806	
7	2005	GT	IN	453	NIRVANA SECONDAR	GT	Gauteng	110262	
3	2006	GT	IN	453	NIRVANA SECONDAR	GT	Gauteng	110262	
3	2006	GT	IN	453	NIRVANA SECONDAR	GT	Gauteng	110262	
3	2004	KN	KN	14784	NIZAMIA ISLAMIC SCH	KZ	Kwazulu Natal	230991	
1	2006	EC	ET	12397	NKULULEKO SENIOR	EC	Eastern Cape	600589	
2	2006	EC	ET	930	NKWANCA SEN SECC	EC	Eastern Cape	400789	
3	2004	NP	ET	11310	NNGWENI HIGH SECC	NP	Limpopo	928330886	
4	2005	NP	ET	11310	NNGWENI HIGH SECC	NP	Limpopo	928330886	
5	2004	EC	ET	798	NONCEBA SENIOR SEC	EC	Eastern Cape	200617	
5	2006	KN	ET	13934	NONDUMISO HIGH SC	KZ	Kwazulu Natal	235357	
7	2004	WC	CO	226	NOORDER PAARL SEI	WC	Western Cape	0108473383	
3	2004	WC	CO	226	NOORDER PAARL SEI	WC	Western Cape	0108473383	
3	2005	WC	CO	226	NOORDER PAARL SEI	WC	Western Cape	0108473383	
3	2005	WC	CO	226	NOORDER PAARL SEI	WC	Western Cape	0108473383	
1	2006		CO	226	NOORDER PAARL SEI	WC	Western Cape	0108473383	
2	2006	WC	CA	14382	NOORDHOEK PRIVATI	WC	Western Cape	0104007274	
3	2004	WC	CA	14382	NOORDHOEK PRIVATI	WC	Western Cape	0104007274	
4	2005	WC	CA	14382	NOORDHOEK PRIVATI	WC	Western Cape	0104007274	
5	2005	WC	CA	14382	NOORDHOEK PRIVATI	WC	Western Cape	0104007274	
5	2006	WC	CA	14382	NOORDHOEK PRIVATI	WC	Western Cape	0104007274	

**Table 3-2: Attribute table after data transformation - new fields**

Attributes of Schools														
EMIS	NAME	Z2004	Z2005	Z2006	TOTAL	F	M	B	C	I	O	W	PROVC	EDEPNEW
922220880	MMAPHUTI HIGH SCHOOL	0	0	1	1	0	1	1	0	0	0	0	NP	NP
919340418	MOKOMENE HIGH SCHOOL	0	1	0	1	0	1	1	0	0	0	0	NP	NP
918510705	MOKOTO HIGH SCHOOL	1	0	0	1	0	1	1	0	0	0	0	NP	NP
922222473	MOLAUTSI SECONDARY SCHOOL	0	0	1	1	0	1	1	0	0	0	0	NP	NP
924641988	MOREKO SECONDARY SCHOOL	1	0	0	1	1	0	1	0	0	0	0	NP	NP
924850221	MOSHATE HIGH SCHOOL	1	2	0	3	1	2	3	0	0	0	0	NP	NP
904221067	MOTSE MARIA HIGH SCHOOL	2	4	2	8	8	0	8	0	0	0	0	NP	NP
923241054	MOUNTAIN VIEW SEN SEC SCHOOL	0	1	0	1	1	0	1	0	0	0	0	NP	NP
930351401	MPHAPHULI SENIOR SECONDARY SCHOOL	2	1	1	4	2	2	4	0	0	0	0	NP	NP
919341084	MPHUMA HIGH SCHOOL	2	0	0	2	1	1	2	0	0	0	0	NP	NP
912520238	MSENGI HIGH SCHOOL	1	0	0	1	1	0	1	0	0	0	0	NP	NP
928330442	MUSHAATHONI HIGH SCHOOL	0	0	1	1	1	0	0	0	0	0	0	NP	NP
902331698	MUSINA HIGH SCHOOL	1	0	0	1	1	0	1	0	0	0	0	NP	NP
929310974	MUTSHLUTSHU SECONDARY SCHOOL	1	0	0	1	0	1	1	0	0	0	0	NP	NP
922223261	MYNGENOEGEN ENGLISH PRIVATE SCHOOL	0	1	0	1	0	1	1	0	0	0	0	NP	NP
916420475	INGHONYAMA SENIOR SECONDARY SCHO	0	0	1	1	0	1	0	0	0	0	0	NP	NP
923260994	INGWANA-MOHUBE HIGH SCHOOL	1	1	0	2	1	1	2	0	0	0	0	NP	NP
925610162	INGWANAMALA SENIOR SECONDARY SCHO	0	1	1	2	2	0	2	0	0	0	0	NP	NP
928330886	INGWENI HIGH SECONDARY SCHOOL	1	1	0	2	0	2	2	0	0	0	0	NP	NP

### 3.7 Geo-Coding

Geo-coding is the process of assigning addresses to their corresponding spatial locations, which in this case meant the allocation of geographic coordinates to schools in order to facilitate spatial analysis. It was necessary to employ geo-coding because there were no common primary fields for directly combining the various databases. The newly created AARP database (Table 3.2) was the target table, and SA Explorer 3 database was used as the initial

address locator\* because of its comprehensiveness and reliability, in that it was considered more accurate than the others. The total number of schools geo-coded from the AARP database was 1 671. Schools from the AARP database served as the main dataset for this project.

The schools that AARP candidates attended were summarised in MS Excel in order to geo-code the school only once and in so doing, reduce the number of schools (points on the map) to be geo-coded. In 2007/08, the UCT admissions office had begun a process of matching schools in their database with the Department of Education in order to incorporate the EMIS number into the UCT database (pers. comm. Hendry, Feb 2008). Thus the EMIS number was used in the first attempt to geo-code those schools with the EMIS number in the SA Explorer database and 708 of 717 schools that had the EMIS number matched, using the batch† geo-coding tool in ArcMap. Geo-coding, and not a simple agglomeration of databases, was used, so as to maintain consistency within the final database.

In employing the batch geo-coding tool in the software, school names were used as the common field. Owing to variation in school name spellings of the databases, spelling sensitivity levels were also varied. The initial spelling sensitivity was set at 100%, necessitating that the spellings within both databases be exactly the same. However, less than 10% of the 954 schools without the EMIS number were successfully matched in this way. Interactive geo-coding was conducted to ensure that the correct names were matched. Through interactive matching, 516 schools were effectively matched and 440 were completely unmatched for the following reasons:

- The school is new and was not included in the SA Explorer data collection;
- The school is non-South African and these were beyond the scope of the study; and
- The database identified the school as 'Other' and without the school name. These could not be included in the analysis because they could not be matched (30 schools read 'Other').

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\* Address Locator – a dataset in ArcGIS that stores the address attributes, associated indexes, and rules that define them for translating non-spatial descriptions of places, such as street addresses, into spatial data that can be displayed as features on the map.

† Batch geo-coding – the process of geo-coding many address records at the same time

### **3.8 Accessibility Analysis**

Berry (2005) defined distance as the shortest straight line between two points. This usually indicates distance 'as the crow flies' as it is colloquially known. Proximity, on the other hand, establishes the shortest path (straight lines) between a set of points. The two elements – distance and proximity – are measures of accessibility. In relation to human behaviour, however, the factors of distance and proximity are more commonly interpreted in terms of a combination of cost and time, as indicated in the literature review. In this dissertation, distance (and its corollary, proximity) is incorporated, using a buffer distance from schools to a test centre and distance relates to the physical parameters rather than the more difficult-to-measure cost and time factors.

The purpose of distance analysis in this dissertation is to see whether the AARP test centres are optimally located. Are candidates easily able to access these test centres? Are candidates writing in the test centre nearest to them? Are test centres randomly or intentionally placed to serve the noted demands?

As mentioned earlier, AARP or UCT data was collected with no original intention of mapping or for spatial analysis. Complete distance analysis requires the detailed attribute information as outlined on Figure 3.4. Several measurements are not applicable to this accessibility analysis; for example, mode of travel, origins and destinations (since these are not recorded in the databases). Nevertheless, certain measurements, such as attractiveness of the writing venue, are arguably relevant because this may determine candidate preference as to where and why to write the test. Notwithstanding this, such analysis proves to be beyond the scope of this study. For example, some learners prefer to write their AARP tests at a university (such as UCT campus) setting just because they are attracted to it.

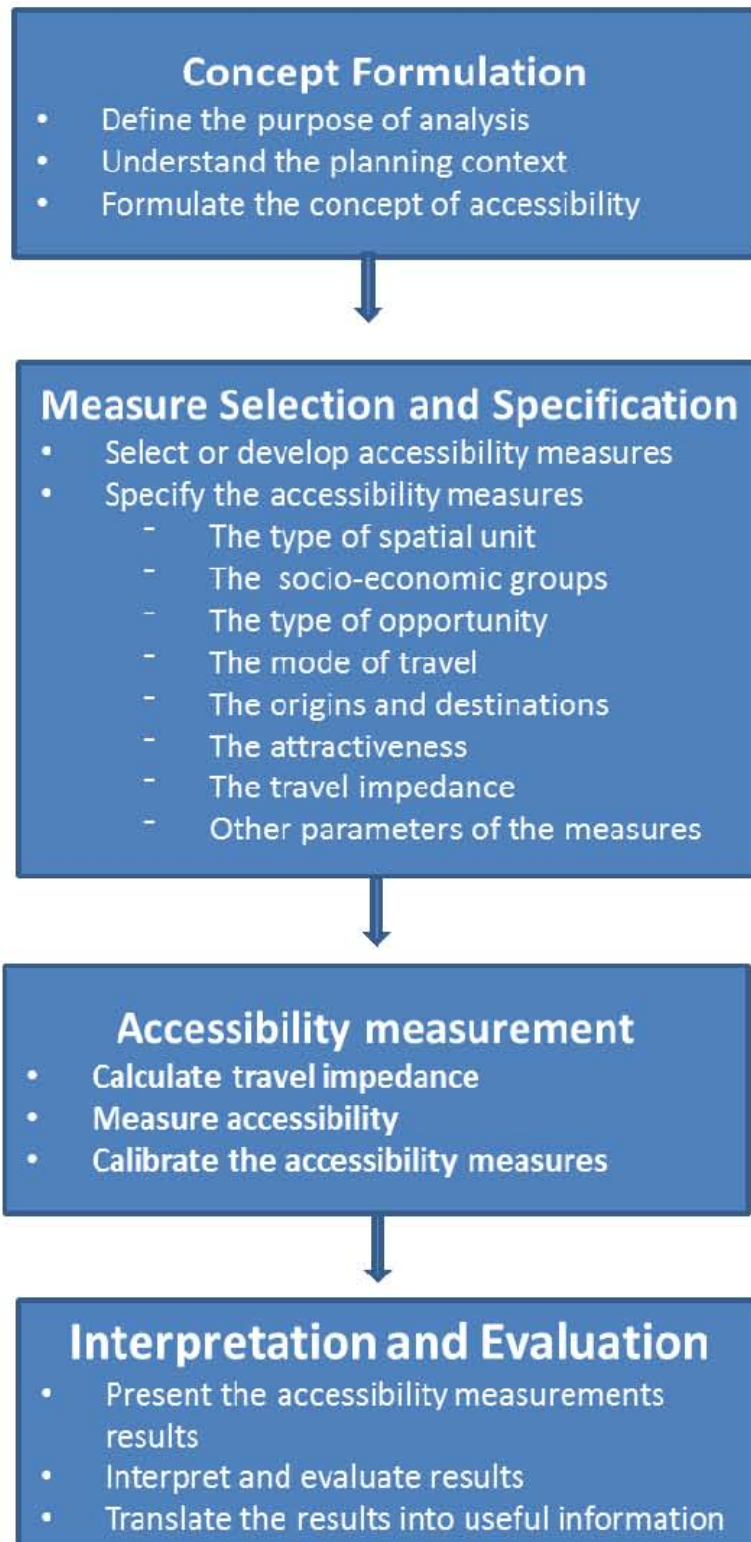


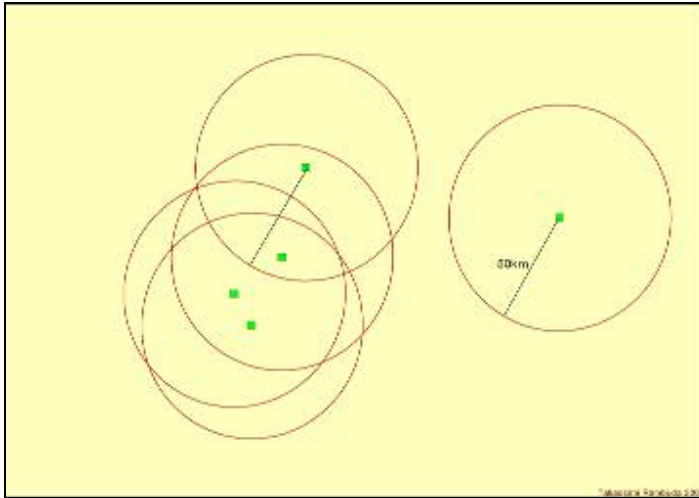
Figure 3-4: Process of accessibility analysis. Source: Liu and Zhu, 2004

### **3.9 Concept of Accessibility**

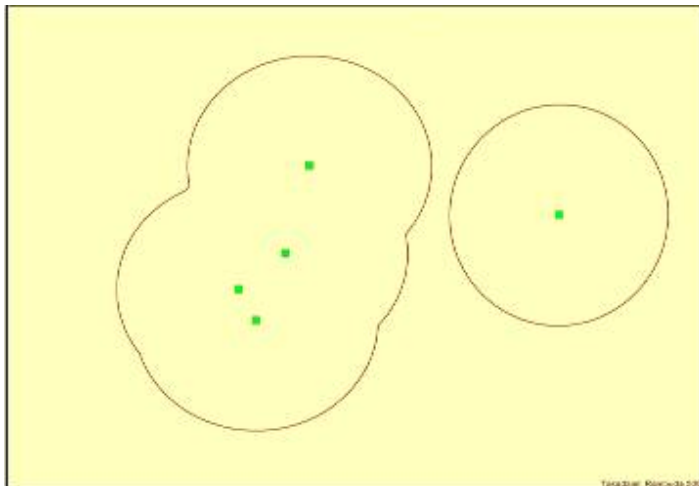
As mentioned earlier, accessibility will be measured by distance from the school to the AARP test centre, using buffering tools in ArcMap. AARP candidates have been assumed to access the AARP test centres from their school. It is possible that some learners live in close proximity to where they attend school. However, this is not the case for some learners, because they may be at a boarding school away from home. Nonetheless, the school has been used as a point of reference because of consistency in the available spatially referenced data. The points of origin and destination for students were not collected; the geo-referenced road networks are also not yet well established in South Africa, especially in rural and remote areas.

The 50 km constant-width buffers were created around each of the test centres. The numbers of schools and learners that fell within that 50 km radius were calculated. Schools that were outside the radius were also calculated. School point data and provincial boundaries' polygon data were joined using the 'Join data based on spatial location' tool in ArcMap. Then the schools were coded using graduated colours and 'natural breaks' (Jenks) classification. The distance coding was displayed on the map using three distance categories: 0 – 50 km, 50 – 100 km, and 101 km and above.

Buffering a point involves demarcating a circular polygon around that point. The radius of the test centres' buffering was specified and kept constant within the abovementioned distances. In some provinces the test centres were in close proximity to each other, leading to overlapping of the 50 km buffers (see Figure 3.5). However, the software has a built-in buffering algorithm that allows for dissolving the overlapping buffer rings as in Figure 3.6 (Mandagere, 2006). The dissolved buffers in Figure 3.6 are inclusive of all areas between buffers. In other instances, gaps exist between dissolved buffers and it is important to note the buffer demarcations if they are dissolved. Accuracy of the distance measured, using buffers or other methods, is dependent on the precision of the locational geographic data. Less than a 1 km error from the actual location was estimated. However, data frame projection applied (see geographic coordinates and projection) also contributes to the accuracy of the distance calculations.



**Figure 3-5: Overlapping buffer rings**



**Figure 3-6: Dissolved buffer rings**

National and regional roads in South Africa were not included in the analysis. National Road System is defined as a network of highways that links all the major population centres in South Africa. Regional Routes are secondary highways in South Africa linking pairs of cities or serving as feeder roads to the National Road network from cities not situated on National Roads. Network analysis of the roads was originally intended to reveal any association between the main travelling routes and the distribution pattern of schools but in general was often topologically incorrect and thus was not used for further network analysis.

### 3.10 Demographics Background Maps

Demographic data for the country was obtained from Statistics South Africa. The following attributes were extracted at local municipality level for further analysis: (Census 2001)

- Language
- Race

These attributes are important in understanding the background of the AARP candidates as well as potential candidates in the municipalities and provinces. Language and racial distributions were mapped; thus serving as backdrops to the AARP candidate data. For language and population group, diversity indices were calculated for better representation of the data, using the Simpson's Diversity Index (<http://www.countrysideinfo.co.uk/simpsons.htm>).

Biological diversity formulae proved to be useful in calculating the racial and language diversity of the demographic data. Biological diversity is measured by the richness and evenness of species. Richness is a measure of the number of the different kinds of organism present in a particular area. The richness of the local municipality was measured by the variety of population groups represented in that local municipality. Evenness is a measure of the relative abundance of the various species making up the richness of an area.

The Simpson Index (D) is measured using two formulae; however, the following formula was applied:

$$D = \sum (n / N)^2$$

n = the total number of organisms of a particular species (total no. of people of a particular language)

N = the total number of organisms of all species (total population including all languages)

The results for D are between 0 and 1; 0 represents infinite diversity and 1, no diversity. Greater D values depict lower diversity. However, for simplicity, the value of D is subtracted from 1, and then the greater value for D shows greater diversity and the smaller value less diversity.

Criteria for dominance, as given in Census 2001:

*Dominant population group is defined as:* One population group having more than 50% of the total population of the municipality; or between 33% to 50% of one population group and no other population group having more than 25%;

*Multiple-dominance is defined as:* One population group having between 25% to 50% of the total population and one or more other population group(s) with more than 25% of total population of the municipality; and

*None or no dominance is defined as:* No one population group with more than 25% of the total population of the municipality.

In each local municipality, the percentage of different language and population groups was calculated from which the appropriate thresholds (greater than 50%; not less than 25%, etc.) were imputed. The total number of different languages spoken was also recorded. The highest percentage of the four population groups was determined and computed as the dominant population group. For those local municipalities with a single language, the language type was computed and for those with multiple languages the area was called MULTI – multiple.

### **3.11 Academic Faculty Analysis Using ‘Spatial Join’**

There are many tabulations of demographic and spatial data in the Statistics SA database, among which there is a table that records all the magisterial districts in SA with cross-boundary entities split according to which province they belong. This is the so-called Magisterial District\_ Province\_ South Africa (MD\_PR\_SA) table in the Statistics SA database, the chosen spatial unit for the spatial join with the AARP candidate attributes, to create backdrop display data for the various UCT academic faculty analyses. For each academic faculty, only students who chose that faculty as their first choice of study were selected and displayed. As detailed in the results section, the target groups for admission for each faculty were taken into consideration. For example, the Science faculty is targeting more female students, therefore the geographic locations of female students were indicated (Pers. Comm. Cliff, 2008).

For each of the academic faculty maps, the backdrop data represents the total number of AARP candidates by district municipality. The overlay point data includes the number of recommended students as well as the relevant target students for that faculty. The annual trend analysis also utilised the ‘spatial join’ of the AARP candidate attributes and the local municipality spatial unit. In order to determine the trend, students who wrote in a particular year were selected and displayed.

### **3.12 Limitations of the Study**

The primary limitation is that time and resources did not permit a more thorough investigation into other considerations such as modes of travel, expenses incurred when travelling to the test centre, rationale, and success rates (in terms of test scores) of the candidates. Recently, AARP started collecting more personal details on each individual AARP writer through a six-page biographical information form (Pers. Comm. Van Der Ross, 2007). The rationale behind the issuing of the form was to develop an understanding of the educational and home environment of each test candidate. Unfortunately, this information could not be included in this study because the dates did not coincide with the time period under investigation. Furthermore, this data was inconsistently captured and not suitable for incorporation into the study (Pers. Comm. Cliff, 2008).

AARP tests are also administered for other South African higher education institutions (AARP report, 1999). For example, learners who wish to study at Stellenbosch University, Witwatersrand University or the University of Pretoria can undertake the AARP tests utilising the same venues as UCT applicants. However, this dissertation only analysed students who were enrolled at UCT. Applicants for UCT are not evenly distributed geographically and it is possible that those students who live in particular regions are attracted to other higher education institutions. However, the dimensions of the total dataset were such that it was not feasible to conduct a comparison study including other higher education institutions in order to see the overall distribution of all AARP candidates from all institutions. An additional challenge was the difficulty of approaching other institutions to obtain personal information for students supplied to their respective admissions office, given the logistical difficulties in obtaining ethical clearance from all institutions. In addition, the geo-coding process would have posed a major time constraint given the time taken to geo-code the UCT data.

The data represents all students who enrolled at UCT during the period 2000 to 2005 and who wrote the AARP tests. While many of these students may have met admission criteria without the AARP scores, it was not feasible, using the provided dataset, to distinguish students admitted via different routes; for example, those admitted primarily using AARP test scores and those that met admission requirements. Thus it was also impractical to show the geographical distribution of such candidates.

Another limitation is the manner in which the students were geographically located, using schools as a proxy for a home address. Schools were used because home addresses were captured in different formats. The addresses in rural areas did not reflect the home address and also did not identify a street address. Thus it would have been difficult to place most students in the correct location, given that some students only provide a postal address which may not reflect their residential area. Using schools as a proxy for home address required aggregating the UCT / AARP database by school, then using geo-coding algorithms to match school names in the UCT / AARP database to mapped schools in other spatially referenced databases (detailed in the methodology). Geo-coding was used because tabular joins would not work with text data, where names did not match exactly between databases; and numeric keys such as the EMIS number were not consistently used (Chisholm and Mohammad, 2006).

### **3.12.1 Data Quality Limitations**

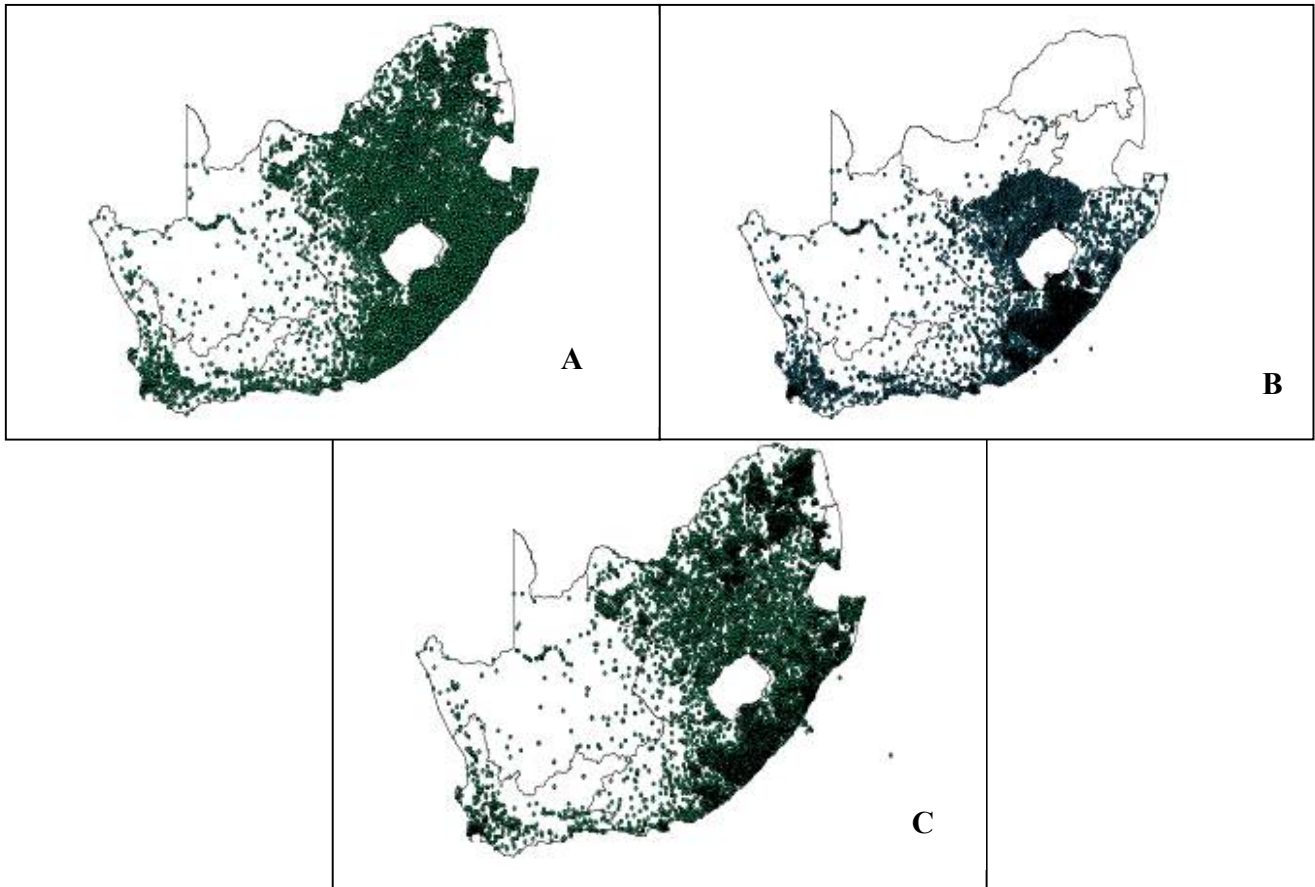
Spatial data quality is defined as the degree to which the data can satisfy the purpose for which it is intended (Srivastave, 2008). This is fundamental in order to achieve the intended results from the data. Data quality can be categorised into four components (Srivastave, 2008 and Schukraft and Lenz, 2005), namely:

- Data completeness – when all the data needed for a specific analytical purpose is included in the database, with no omissions;
- Spatial data accuracy – the agreement between the actual attribute data and the coded attribute values;
- Spatial data precision – the degree of detail that may be displayed on a uniform space, time and theme; and
- Consistency – the absence of apparent contradictions in the data.

In this dissertation there are certain spatial analyses, such as spatial modelling, that could not be performed because of the absence of data meeting these four quality requirements. There is a need to assess the quality of the various databases employed for this dissertation as well as to stating limitations that resulted from data quality and availability.

At the time of geo-coding the schools' data, three databases were used as spatial reference tables from which spatial references are extracted. Databases utilised were from: a) the South African Municipal Demarcation Board (referred to as SA Explorer), b) Open Spatial Solutions,

which was still under construction at the time of access, and c) the National Department of Education. Figure 3.7 illustrates the completeness and positional accuracy of each of the databases at the time of analysis.



**Figure 3-7: Distribution of South African Schools from three sources: A – South African Demarcation Board, B – Open Spatial Solution (incomplete version) and C – National Department of Education.**

It is understood that the Open Spatial Solution database was incomplete; however, the three figures (Figure 3.7a, b and c) illustrate elements of data quality inherent in data that have been captured by different organizations and for different purposes.

All data points in the SA Explorer (version 3) database fall within the South African geographical boundaries (Figure 3.7a), whereas on the other two maps (Figures 3.7b and c), some of the schools fall outside the boundaries. This indicates that these points are misplaced and cannot be used. Uncertainties around spatial accuracy clearly cast suspicion that other

points may also be misplaced but are within the South African boundary. In assessing the patterns of dispersion of points on the maps, there are noticeable differences. While the points on Figure 3.7a appear to be consistently distributed, the distribution in Figure 3.7c has gaps that are not visible in Figure 3.7a. This can be attributed to the differences in the years in which the data was collected. Although the date of the National Department of Education data collection is unknown, this data is older than the SA Explorer data which was released in 2003. On the other hand, Figure 3.7b shows a high density of schools in areas where Figures 3.7a and 3.7c do not have high concentrations of schools. Issues such as these were of great importance when geo-coding schools for the purpose of this dissertation. The SA Explorer database provided a more reliable dataset to use for geo-coding. For this reason, it was used as the initial and main database and the other two were used as supplementary databases.

### **3.12.2 Data Entry Inaccuracy**

Other limitations of this study are mainly spelling errors between the various databases. The geo-coding process was slowed down by spelling errors. Eighty per cent of the schools were found in the SA Explorer database but some of the spellings of their names were different from those of the names of the schools captured in the UCT database; for example, Queens School could be spelled as Queen's or Queens'. Another example is St Andrew's School; this could be spelled as St Andrews or spelled out in full as Saint Andrews School. A slight difference in spelling, when geo-coding, can result in a school's not matching in the reference table, thus hampering the geo-coding process. This is why the spelling sensitivity during geo-coding was set quite low, and much interactive geo-coding was employed so as to ensure that the right candidates were matched. In other instances, many schools have identical or similar names. For example, Khanyisa High School is a popular name in most of the provinces, therefore it is important to ensure that the correct school is placed in the correct location because the attributes each schools are also different. Other school names may be presented in different languages on different databases; for example, Hoërskool Meisies, Pretoria (Afrikaans) could be Pretoria Girls High (English). Errors such as these made the geo-coding process time-consuming, and the analysis could not proceed without a more complete database. Despite efforts to conduct analysis on a more complete and accurate database, around 5% of South African schools could still not be located.

### **3.12.3 *Insufficient Data***

Data insufficiency was one of the major setbacks of this project. The manner in which data was collected made it difficult to geo-code all schools. While, as indicated earlier, each school in South Africa has a unique code known as the EMIS number, the UCT admissions office did not include the EMIS number when capturing the information off application forms at the time of geo-coding. Had this number been available, it would have taken less time to join different tables because of this unique and common field within databases. Some schools had EMIS numbers and no spelling errors, resulting in an accurate match of data. However, in some cases, the geographic coordinates were not available. Therefore, using schools' names to join or geo-code, led to data uncertainty and loss of data integrity resulting from spelling errors, as mentioned above.

AARP data collection has been modified over the years in search of a more standardised way of storing all the information. Therefore, over the period of six years used in this study, the data was collected in various formats. In some years there were more attribute fields than in others. This posed a problem, particularly when attempting to aggregate the test scores of the candidates.

When analysing spatial data for decision-making; the spatial units used need to represent data as close to reality as possible. In other words, data may become generalised depending on the spatial unit used. In this dissertation, it would have been ideal to use demarcations relating to the regional education departments but at the time of undertaking this research, there was no spatial database of these regions on a consistent scale across the country. Accordingly, administrative (i.e. municipalities and provinces) boundaries were utilised.

## **4 CHAPTER 4: RESULTS – AARP TEST CENTRE ACCESSIBILITY ANALYSIS**

### **4.1 Accessibility of AARP Test Centres**

As shown earlier, spatial analysis of accessibility using GIS has become common in numerous sectors such as education, health and business (Herries and Marble, 2006; Buckner, 1996; and Rushton, 1999). This is clearly a location allocation issue, concerning the provision of a service or services to satisfy a spatially dispersed demand (Indriasari and Mahmud, 2009). This chapter examines the general accessibility of the AARP test centres to matriculants across the country in order to assess whether services from the university are optimally located to serve all that are targeted by AARP, and those who may wish to write. The maximum reasonable travel distance to a testing centre was set at 50 km, although actual travelling times could vary according to mode and efficiency of transport. Learners at schools that fall within 50 km of a test centre were deemed to have reasonable access to the AARP testing services offered by UCT (Pers. Comm. Van der Ross, 2007).

Three factors have been identified with which to assess the 'efficiency' of distribution of test centres. Firstly, the distribution of actual AARP candidates' schools provides insight into the spatial relationship of these in relation to the distribution of current test centres. If there are many candidates who are remote from the test centres, this indicates the need to add or relocate existing test centres. Secondly, an assessment of the number of potential candidates based on the distribution of all secondary schools and secondary school learners provides an indication of AARP test centre accessibility in relation to future possible candidates. Finally, the best performing schools are used so as to identify areas with recruitment potential but at present not being reached by the current test centres.

The maps in this section are employed to analyse the distance from candidates' schools to the testing centre. As noted earlier, candidates are most likely to commute from home to the AARP test centre, but owing to the inconsistencies in home address formats and the non-availability of national street level address point data, school addresses were used as an expedience. The underlying assumption is that the school location is accessible to the learners and that, therefore, the school location can be used as a reasonable proxy for home address in assessing accessibility of the AARP test centres. As a result, the data is anonymous, the focus

no longer being on the individual candidates *per se*. The national overview of the distribution of AARP candidates is described and interpreted and the national overview is then further analysed by province.

According to the AARP project manager (Pers. Comm. Van der Ross, 2007); some of the test centres were inherited from the previous project administrators. Over the years, test centres have increased in number to accommodate the growing number of AARP candidates across the country. The main criterion used in selecting the original and current test centres was the attempt to place them as central to the province in question and, therefore, to make them as accessible as possible to the greatest number of possible candidates. Any identified need for a new test centre must fulfil the minimum stipulated venue conditions and be suitable for the role in terms of, for example, capacity, and basic services such as electricity, adequate security, and accessibility to public transport. These factors are, however, not included in the analysis because the information is not consistently available, therefore only the 'physical' accessibility of the test centres in terms of distance from school to a test centre is considered.

In order to analyse the spatial data in the context of the study, it must first be described (McDonald and Hong, 2002). This is similar to data viewing, exploring what is available and what may be done with it. Hidden spatial trends, patterns and relationships are then further examined. The final stage is to make the data suitable for further inference, decision-making and predictions. Longley et al.'s (2005) words describe what is aimed at here (p 278): "...the approach taken here is to regard spatial analysis as spread out along a continuum of sophistication, ranging from the simplest types that occur very quickly and intuitively when the eye and brain focus on a map, to the types that require complex software and sophisticated mathematical understanding".

## 4.2 Distance to AARP Test Centres

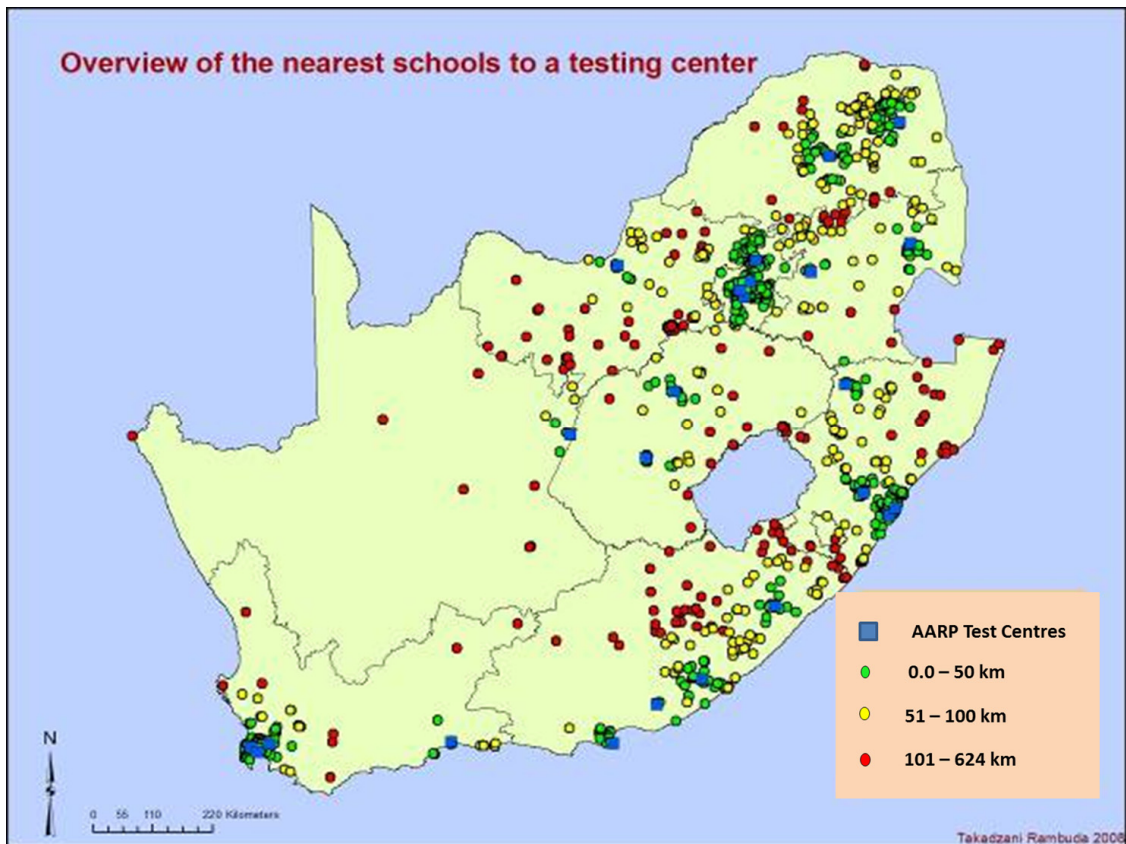


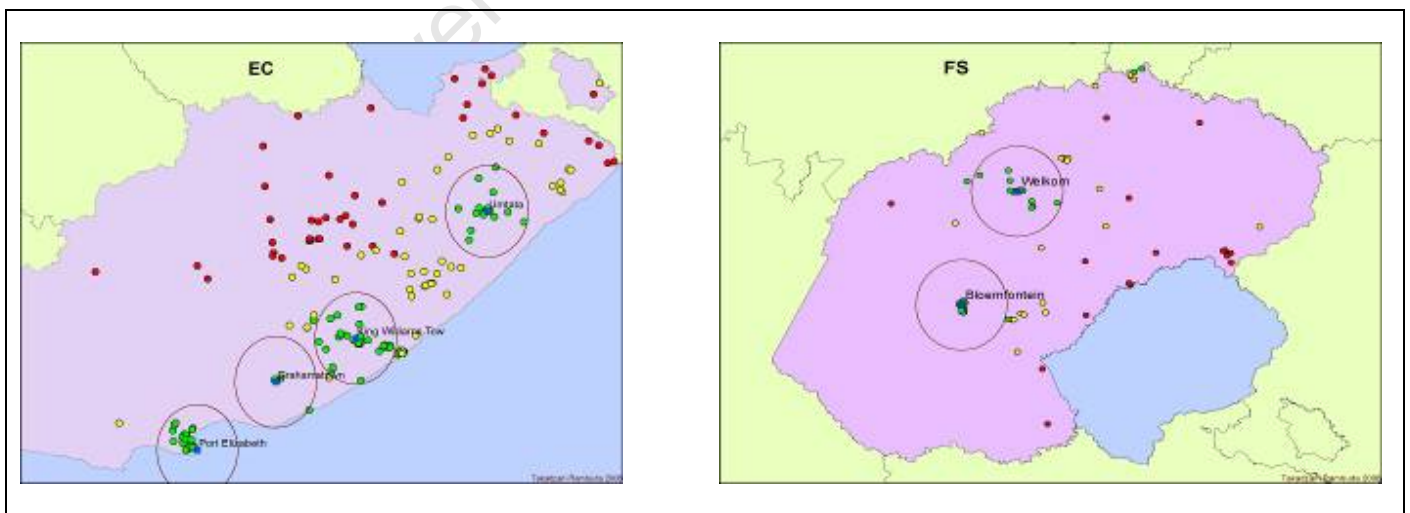
Figure 4-1: National overview of schools' proximity to AARP test centres (distance in metres)

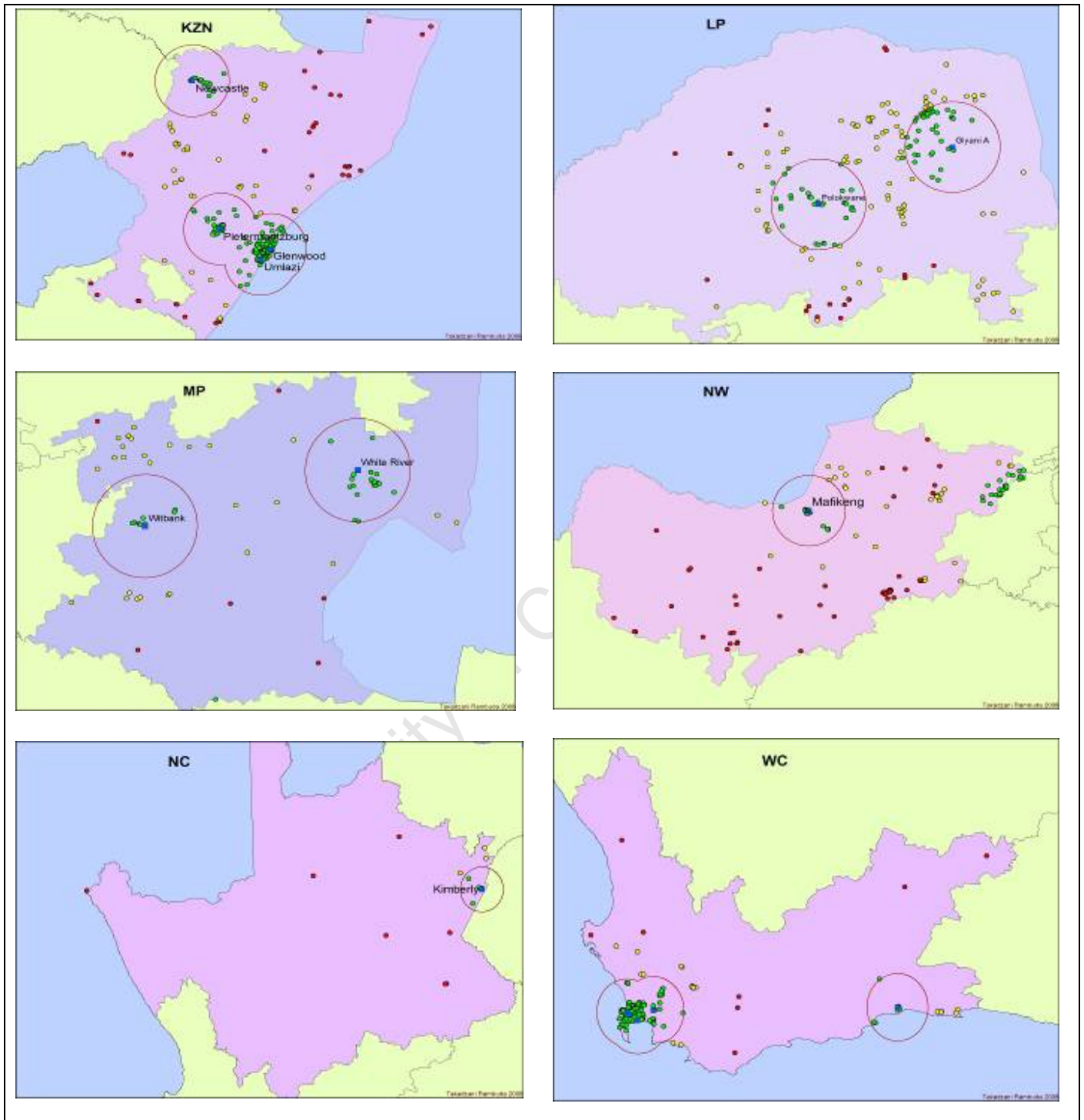
The national overview map (Figure 4.1) shows all the mapped schools in three different colour codes. The colour codes represent the three distances from any of the AARP test centres. The schools in green are within a 50 km radius of a testing centre, those marked in yellow are within a 100 km radius and those in red are more than 101 km away from any of the test centres. Most schools are in closest proximity to the test centres within their province but some are closer to test centres in other provinces (to be discussed later in this section). Five of the 25 test centres do not have a substantial number of AARP candidate schools within 50 km; numbers of learners and schools within the 50 km radius are now considered on a province by province basis so as to establish whether there are spatial patterns in respect of better access to the test centres.

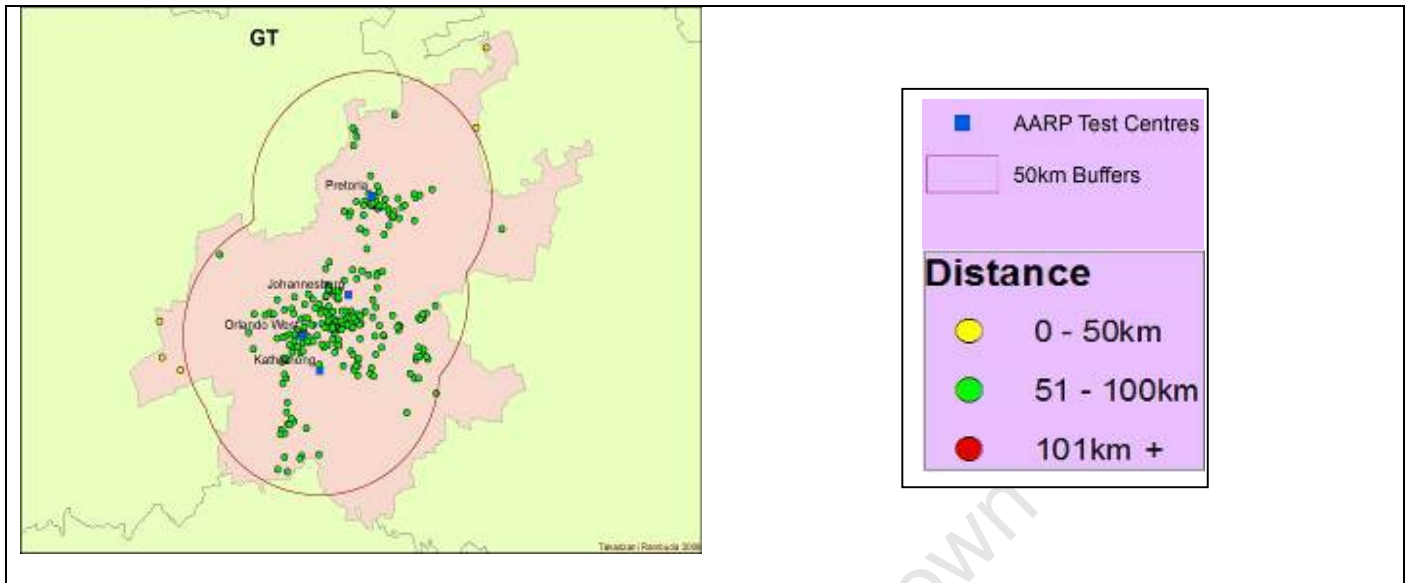
**Table 4-1: Provincial land area, population, number of schools and learners**

Province	Province land area %	Population %	No. of Secondary and Combined Schools	No. of learners in Secondary and Combined Schools	No of Test Centres	% of schools less than 50 km from a test centre	% of schools between 50-100 km of a test centre
EC	13.90%	13.46	5886	2100425	4	43.75	56.25
FS	10.60%	5.72	1818	685971	2	43.75	56.25
GT	1.40%	21.55	2388	1863375	4	98.26	1.74
KZN	7.70%	21.15	5954	2768015	4	67.07	32.93
LP	10.30%	10.8	4102	1771320	2	41.49	58.51
MP	6.30%	7.51	2079	1092382	2	50.70	49.30
NW	8.70%	2.18	1841	772044	1	12.21	87.79
NC	30.50%	6.75	622	261736	1	47.62	52.38
WC	10.60%	10.88	1579	978517	5	89.42	10.58

Table 4.1 shows information by province; land area, total population, number of combined and secondary schools, the number of learners in each of the combined and secondary schools, percentage of mapped schools within 50 km of a test centre and percentage of mapped schools between 50-100 km of a test centre. These factors are included because they have an impact on the data results.







**Figure 4-2: Distance from school to AARP test centres.**

The varying shapes and sizes of provinces (Figure 4.2) do not necessarily accord with their populations. For instance, NC is the largest in area but has the lowest population, while GT is the smallest in area but with the highest population. This also affects the number of AARP candidates to be expected per province. On the other hand, the distances from schools to AARP test centres are impacted by the shape and size of the province; however, this is also dependent on the number and distribution of test centres in that province. WC has five test centres and 89% of schools within 50 km of a test centre, but GT only 1.4% in land area and 98% of schools within 50 km of a test centre (Figure 4.2).

### 4.3 Number of AARP Candidates per Province

Table 4.2 illustrates the number of schools and the number of candidates per testing centre. Within each province, candidates are categorized by the test centre at which they wrote. The average, minimum and maximum distances are shown. However, in most provinces there are instances where candidates chose to write in another province. The distances on Table 4.2 were generated using candidates who wrote in that test centre regardless of their province of origin.

**Table 4-2: Number of AARP schools and candidates by province and test centre**

	Number of participating schools	Number of candidates	Ratio (schools to candidates)	Average distance to testing centre	Min distance	Max distance
<b>Western Cape</b>						
Rondebosch, UCT	63	2455	40	20.55	0.26	624.20
Athlone	95	1781	18.8	8.20	0.75	23.58
Mitchell's Plain	43	287	6.7	6.35	0.00	22.09
Stellenbosch	55	269	5	40.68	0.42	253.97
George	17	73	4.3	56.83	0.00	254.20
<b>Eastern Cape</b>						
King Williams Town	96	375	4	63.33	0.68	190.16
Mthatha	63	342	5.4	81.02	0.00	167.85
Port Elizabeth	32	138	4.3	25.22	5.33	220.65
Grahamstown	10	69	6.9	40.74	0.67	150.21
<b>Free State</b>						
Bloemfontein	31	132	4.3	40.22	1.26	210.49
Welkom	32	102	3.2	75.87	0.63	150.41
<b>Gauteng</b>						
Johannesburg, WITS	102	497	4.9	16.27	4.38	41.98
Pretoria, UP	58	216	3.7	28.57	1.68	142.23
Soweto	82	198	2.4	36.78	2.41	123.12
East Rand	47	117	2.5	24.69	0.43	122.97
<b>Kwazulu Natal</b>						
Durban	65	395	6.1	33.01	0.00	153.86
Pietermaritzburg	33	327	11.3	39.75	0.73	120.99
Umlazi	49	166	3.4	23.87	0.92	141.34
Newcastle	20	64	3.2	77.80	0.00	176.43
<b>Limpopo</b>						
Giyani	85	266	3.1	51.80	1.63	127.80
Polokwane	82	257	3.1	57.95	0.00	148.96
<b>North West</b>						
Mafikeng	42	273	6.5	68.59	0.00	189.25
<b>Mpumalanga</b>						
White River	33	91	2.8	64.11	0.62	253.24
Witbank	33	67	2	64.56	0.82	109.73
<b>Northern Cape</b>						
Kimberley	20	49	2.2	119.65	0.39	344.86

The high ratio of schools to candidates indicates that there were more schools and many candidates participating in the AARP tests at that particular test centre. The low ratio indicates the opposite; fewer schools and learners undertaking the tests. Rondebosch (UCT) (40) and Athlone (18.8) show a large number of participating candidates per school. Pietermaritzburg's (11.3) ratio is also relatively high compared with all other test centres, ranging from 2 to 6.9.

Although travelling less than 50 km to a testing centre was deemed reasonable (Pers. Comm. Van der Ross, 2008), the average distance to all test centres, however, is less than 100 km. This is excluding the average distance in NC at 119.65 km, given the semi-desert nature of the area. The relatively low average distance may be an indicator of schools' being mainly found near the town or in the city centres where test centres are located.

The minimum distance is seen in most cases to be less than a kilometre from a test centre. Some of the schools were used as test centres and thus show the minimum distance of 0 km. The minimum distances for Port Elizabeth and Johannesburg WITS were 5.33 km and 4.38 km respectively.

Athlone, Mitchell's Plain, and Johannesburg WITS test centres show a maximum distance of less than 50 km from a school. All other test centres show a maximum distance of more than 100 km. In most cases, the maximum distance would identify candidates who wrote in another province. However, in the case of KZN, none of the candidates wrote in another province, implying that candidates in other provinces are travelling further to a test centre than are those candidates in KZN.

Although there are fewer AARP candidates coming from the schools surrounding the township test centres, their location in the poorer areas is an important element of the recruitment strategy for higher education institutions. Learners may be persuaded that, despite their not attending high-profile, high-achieving schools, higher education institutions are accessible to them. While such learners may not necessarily achieve university admission requirements, their aspirations may improve overall performance at school.

#### 4.4 Test Centre Allocation

Having assessed the distances to test centres using buffers and the number of learners and schools serviced by the test centres, it was apparent that some of the candidates are underserved in the spatial pattern of test centre locations. The number of learners per test centre, as opposed to the number of contributing schools, is of significance when trying to determine the best location for a new test centre or in relocating one that exists. The map displaying test centres (Figure 1.1) in the initial chapter reveals that most are located in the major cities and towns, as is also suggested by the names of the test centres.

The locations of test centres in the various provinces have both advantages and disadvantages. The advantages are that, firstly, the test centres are centrally-located to the general population simply because they are in the towns. Secondly, accessing towns is perceived as relatively easy for many people, including those in rural areas, because most of the services other than AARP test centres are naturally located in towns. Thirdly, the road networks converge on the towns. The main disadvantage is that students who live far away may not feel motivated to write the tests. It is also the case that those communities located furthest away are precisely those that are the primary targets for the AARP project. It would not, therefore, be cost effective for the AARP test centres to be located where schools are widely dispersed and / or have few learners.

The three approaches to locating new centres or relocating those already in existence, as mentioned in the introduction to this chapter, are as follows:

- There are relatively large numbers of candidates mapped that are at schools far from the test centres, and these are indicators for adding or relocating an existing test centre;
- There are significant numbers of potential candidates based on the number of secondary / high schools with grade 12 (matric) learners; and
- Finally, the best performing schools are identified and located on the map to view the proportion of these that are underserved by the current test centres.

In three of the nine provinces there appears to be a need either for additional test centres or for the relocating of those already in existence. Three provinces; LP, NW and the EC should

have new test centres located and / or relocated based on the number of candidate schools. However, in LP there are two options: either relocating one of the test centres or adding a third test centre. Given the concentration of schools and candidates in the proposed area, it is recommended here that the single test centre be relocated, leaving LP with two test centres. EC and NW should have new test centres in addition to those currently operating.

#### 4.4.1 Allocation Based on the Mapped AARP Candidates

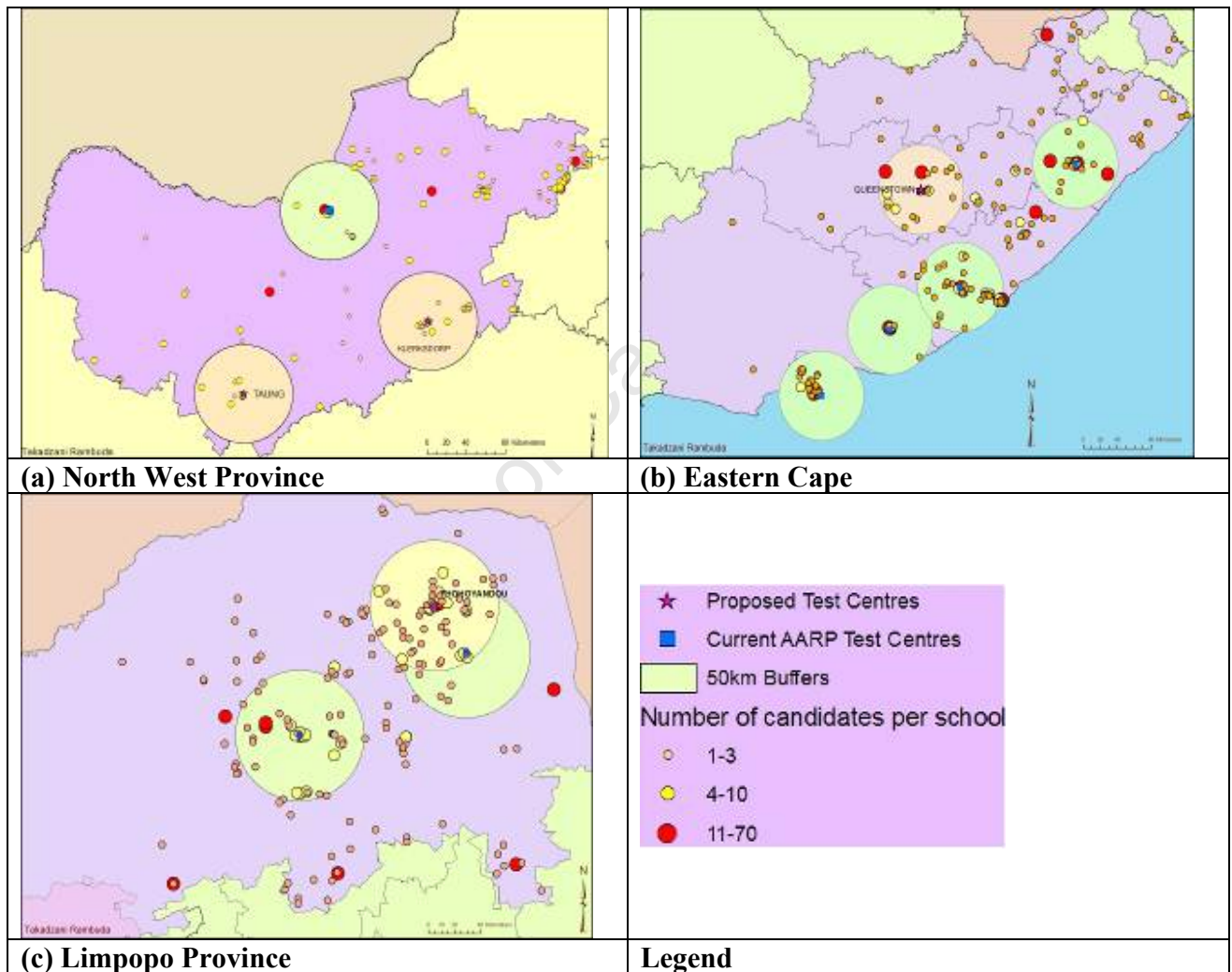


Figure 4-3: (a) North West’s new test centres based on the mapped AARP candidates (Taung and Klerksdorp), (b) Eastern Cape in Queenstown, (c) Limpopo Province in Thohoyandou town

Figure 4.3 illustrates the distribution of AARP candidate schools classified by the number of candidates from each school. The red dots depict schools with more than ten candidates over

the study period of six years. The olive green buffers with blue squares represent the original AARP test centres, whereas the light peach buffers show the proposed test centres.

### ***North West Province***

Two possible test centres may be added to the existing NW test centre in Mafikeng, the largest town in the province. One test centre is recommended to be placed in the town of Taung, in the south-western part of the province in the Bophirima District Municipality. There are 11 schools with 29 AARP candidates within a 50 km radius of the proposed Taung test centre. Assessing the potential candidates, which motivates for locating the Taung test centre, one observes that there are 26 schools with potential candidates for writing AARP tests in the future.

Klerksdorp is another potential test centre location situated south of the Mafikeng test centre in the Southern District Municipality. This test centre has 24 schools that are within a 50 km radius, and a total of 48 candidates. The number of potential candidate secondary schools here is 55, which is just more than half the number of schools in the town of Taung.

The cohort of schools clustered in the Bojanala District Municipality (north-east of Klerksdorp test centre) are shown to be closer to the GP test centres than to test centres within their province. The schools that are very close to the border (Bojanala District Municipality-City of Tshwane border) fall within the 50 km buffer of the test centre at the University of Pretoria (see Figure 4.2 showing the buffer distance maps above). Also, 110 learners from around that area wrote their tests at the University of Pretoria.

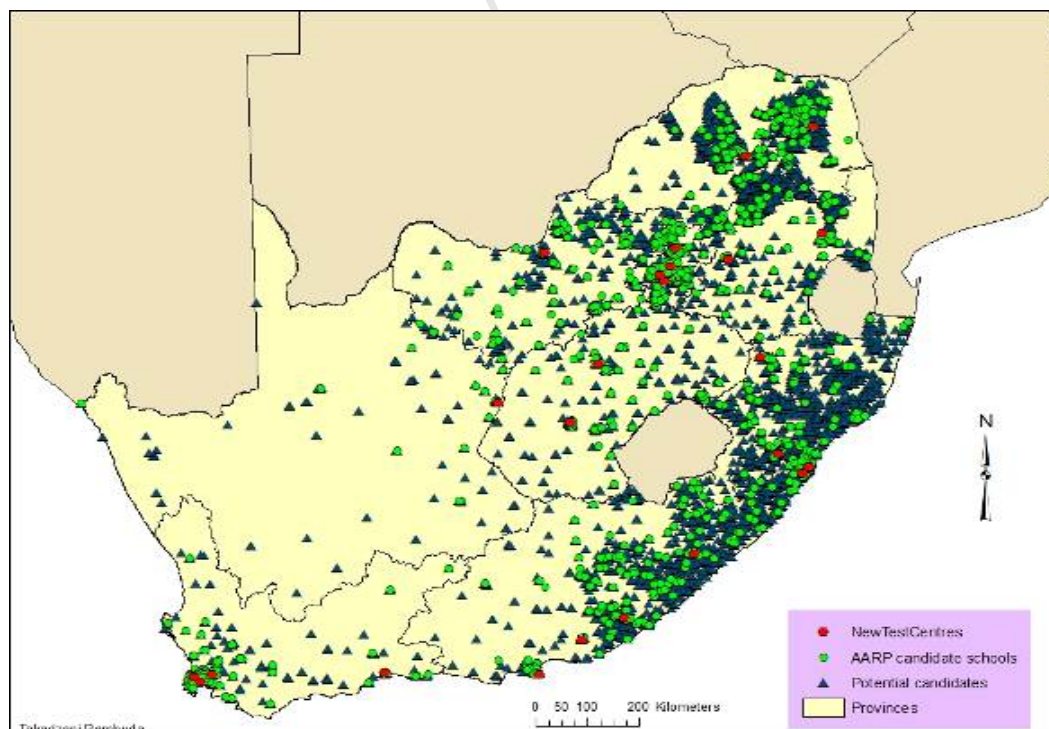
### ***Eastern Cape***

In EC an additional test centre proposed is Queenstown, situated in the Chris Hani District Municipality. Queenstown covers a similar area and pattern of school distribution to other test centres. It is situated further inland and also has a large catchment of potential candidate schools (see Figure 4.4 below, showing the distribution of potential candidates' schools). There are 25 schools mapped which have learners writing the AARP tests, with 87 candidates during the study period; there are a further 65 potential schools within the 50 km buffer zone.

### *Limpopo Province*

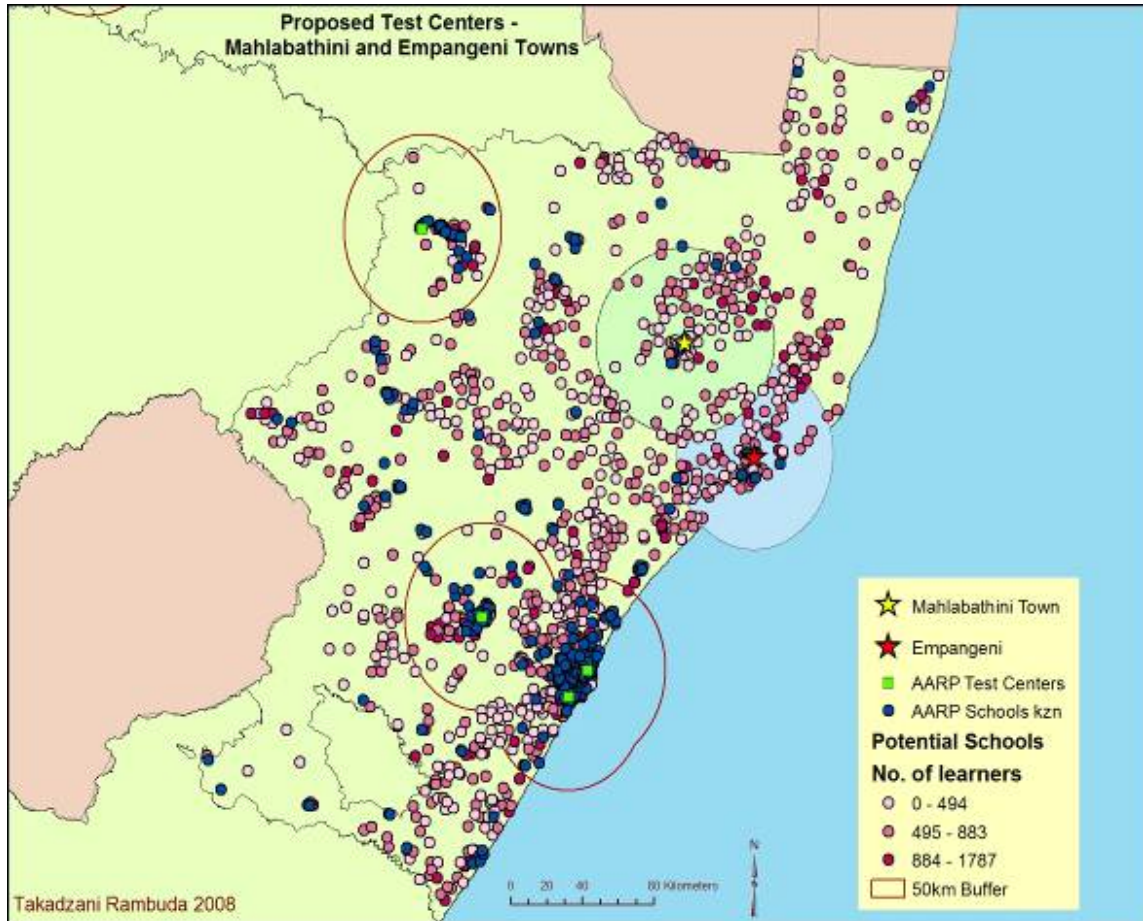
The proposed test centre for Thohoyandou is less than 100 km from the existing test centre in Giyani. The University of Venda is situated in Thohoyandou. It would be ideal either to relocate the Giyani test centre to Thohoyandou or to evaluate it as a third test centre before deciding on which one is convenient for candidates. Based on the 50 km buffer distances, the schools' coverage would be wider for the Thohoyandou test centre, with 60 schools and 206 candidates whereas Giyani has 47 schools with 175 candidates. There is a concentrated spatial clustering of schools with future candidates around the Thohoyandou centre and very few schools for Giyani. The spatial distribution of schools also plays an important role in determining the placement of the test centres.

The overall distribution pattern (see Figure 4.4 distribution of potential schools) of schools in LP has a similar pattern to the one depicted in Figure 4.3(c). The schools seem to be clustered almost at the centre of the province with only a few scattered schools at the peripheries. As with NW, LP has schools that are significantly remote from the test centres and are mostly located near the southern border of the province. These are the schools that are closer to the neighbouring province facilities such as the White River test centre in MP and other test centres in GT.



**Figure 4-4: The national distribution of AARP candidates and potential schools / candidates**

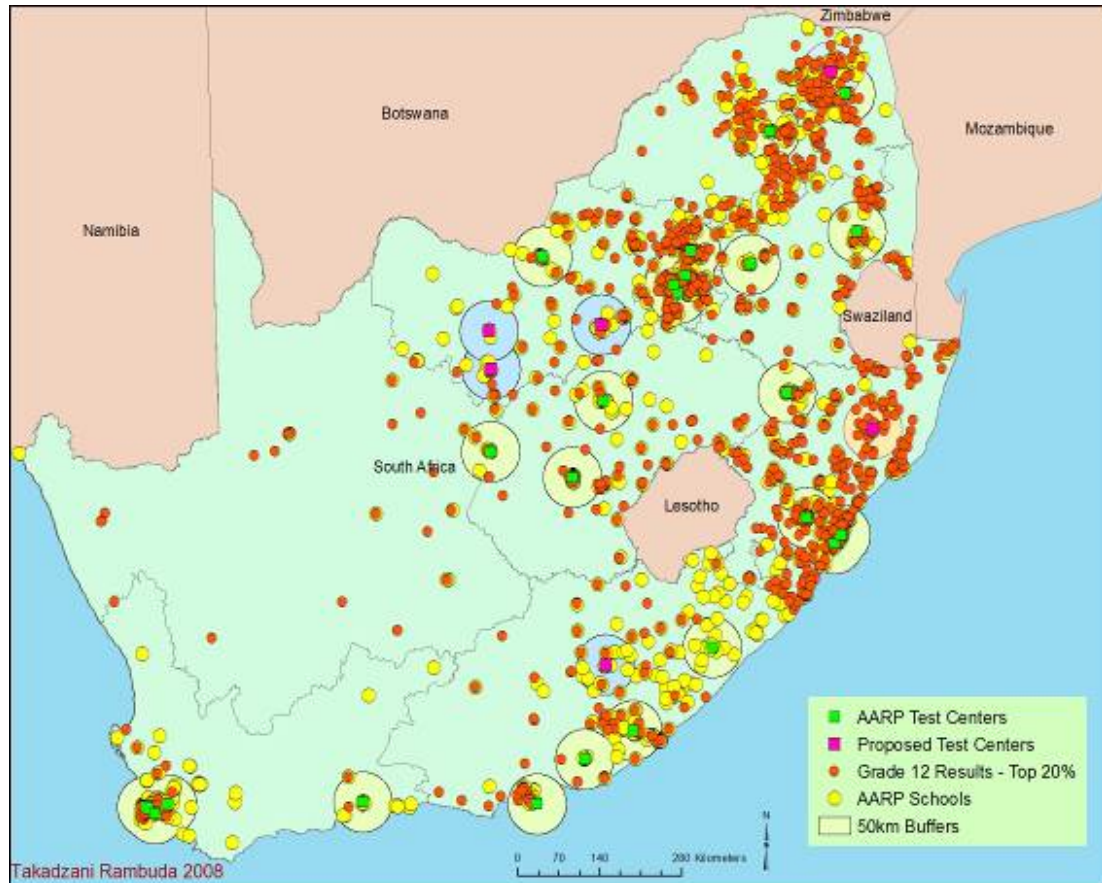
#### 4.4.2 Allocation Based on Potential Candidates and Best Performing Schools



**Figure 4-5: Proposed test centres in KZN - Mahlabathini and Empangeni Towns**

According to the Department of Education (EMIS report, 2006) and as shown on Table 4.1, KZN has the highest number of schools, but many of the schools are in rural areas and have very low numbers of learners. As indicated earlier, the test centres in KZN are proposed based on the number of potential AARP candidate schools within a 50 km radius of the suggested town locations (Figure 4.5). The number of current AARP schools within a 50 km radius is nine (27 candidates) and six (33 candidates) in Empangeni and Mahlabathini respectively. These are rather modest numbers of AARP candidates compared with most other provinces. However, were the test centres to be located in these areas there could be an increased interest in writing the AARP tests, given the large number of secondary schools within 50 km of the proposed test centres. This would result in an increased pool of prospective higher education

students from this area. The numbers of potential schools are similar, being 104 within the Mahlabathini buffer and 106 for Empangeni.



**Figure 4-6: Distribution of the top 20% best performing schools and the AARP candidate schools**

Figure 4.6 shows the distribution of AARP schools overlaid by the mapped distribution of the top 20% (see methodology chapter for the selection of the top 20% schools) of best performing schools in South Africa. The proposed test centres on this map are indicated by pink squares in LP, NW, EC, and KZN. There is a high concentration of the best performing schools corresponding with the distribution of AARP schools especially in the north-eastern half of the country. In the provinces with the proposed test centres, only KZN and LP sufficiently cover the existing AARP candidate schools. NW test centres, both existing and proposed, do not have many best performing schools. Similarly, the proposed test centre in EC only seems to be convenient for the current AARP candidate distribution and also for a very few of the best performing schools. However, both the Port Elizabeth and King William’s Town

test centres have best performing schools while Mthatha has no best performing schools within a 50 km radius of the test centre.

GT has the largest number of best performing schools within 50 km of the test centres. WC has fewer schools overall, but most of these are within 50 km of the province's test centres. Interestingly, there are more best performing schools in NC than schools that have taken the AARP tests. However, given the semi-desert nature of NC landscape, the schools are very scattered; placing a test centre based on these best performing schools would pose a challenge because the distance between these schools is also considerable. This pattern is, however, important in revealing which schools may have not been reached by the recruitment officers of the universities as a whole as well as by UCT faculties. In FS, best performing schools are distributed in approximately the same pattern as the AARP schools. MP has clusters of best performing schools that are more than 50 km from the test centre but still relatively close to current test centres.

University of Cape Town

## **5 CHAPTER 5: ACADEMIC FACULTY ANALYSIS, SPATIO-TEMPORAL TRENDS AND DEMOGRAPHICS OF AARP CANDIDATES**

### **5.1 Introduction**

This chapter presents the spatio-temporal assessment of the AARP candidates by the academic faculty at UCT. Firstly, factors such as population group and gender, some of the factors considered during admission, are considered spatially in relation to the academic faculty of application at UCT. As part of the admissions' process, faculties use AARP results differently, but the results are generally a prerequisite for admission. In the faculties of Science, Commerce and Engineering, for example, the results are only needed for academic stream placement once the student has been offered a place. Each faculty has specific academic requirements, recruitment strategies and targets. The geographic coverage of each faculty as well as the propensity for attracting diverse and targeted students through the AARP tests is explored here.

Secondly, the spatial distribution of candidates over the six-year period is analysed in order to see whether there are any temporal trends in the writing of AARP tests across the various provinces. As the number of candidates increases or decreases in an area, the geographical distribution of candidates also changes. This may impact on the diversity of the student body; it may also enable the reaching into areas that may not have been reached before. As a measure of student diversity, this chapter further explores the geographical distribution of candidates by language group. Finally, this chapter assesses the geo-demographics of the AARP candidates, particularly those that performed sufficiently well in the test.

In order to ensure diversity of the student population, integral to UCT's achieving its mission, the population diversity found throughout South Africa (which, as noted, exhibits strong spatial differentiation in ethnicity and language) is an important consideration for an institution such as UCT. It is essential for a higher education institution to have feeder schools, but diversity in culture, language, race and gender is obviously constrained if the student intake is limited to the immediate surrounds of the university. The various provinces in South Africa differ greatly in terms of language and population groups. Municipalities were selected as the appropriate primary spatial unit for this chapter in order more effectively to reveal detailed patterns in this diversity in relation to the university's applicant pool.

## 5.2 Admission Process at UCT

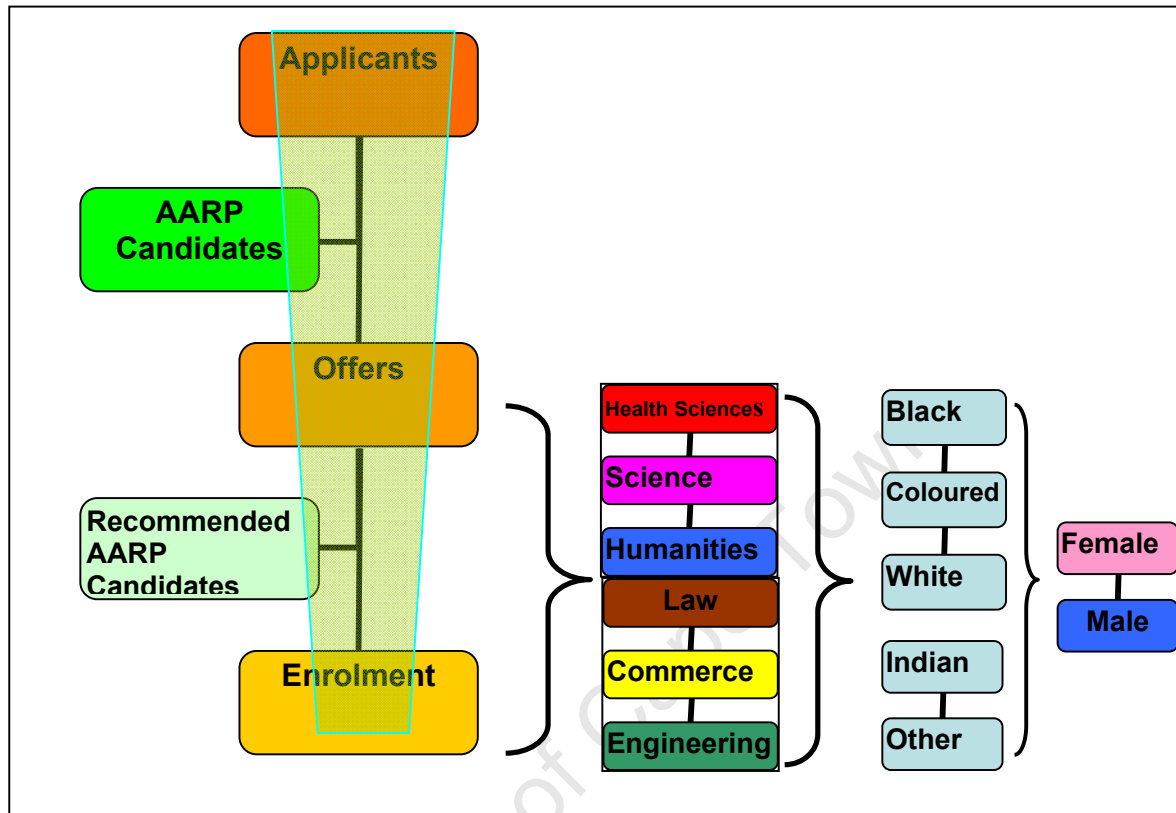


Figure 5-1: Admission Process of the University of Cape Town (Takadzani Rambuda, 2008)

In order to contextualise the manner in which faculties operate, the admission process is briefly described. Although the admissions system at UCT involves deeper strategic and recruitment plans that are not possible to depict schematically, Figure 5.1 nonetheless provides a general overview of the process involved. The details of this process do not, of course, necessarily directly apply to other universities in South Africa or beyond, but the reality in this country is that if universities are engaged in attempts to redress past educational inequities they are likely to have to consider some sort of race-based selection procedure. Some universities may use the quota system where a certain number of students from a particular population group, gender, socio-economic class or geographic area is used to fill the allocated spaces. The quota system may, to some extent, discount the prior academic performance of the applicants but the target system administered at UCT over the study period seeks a balance in the quality and diversity of its student body.

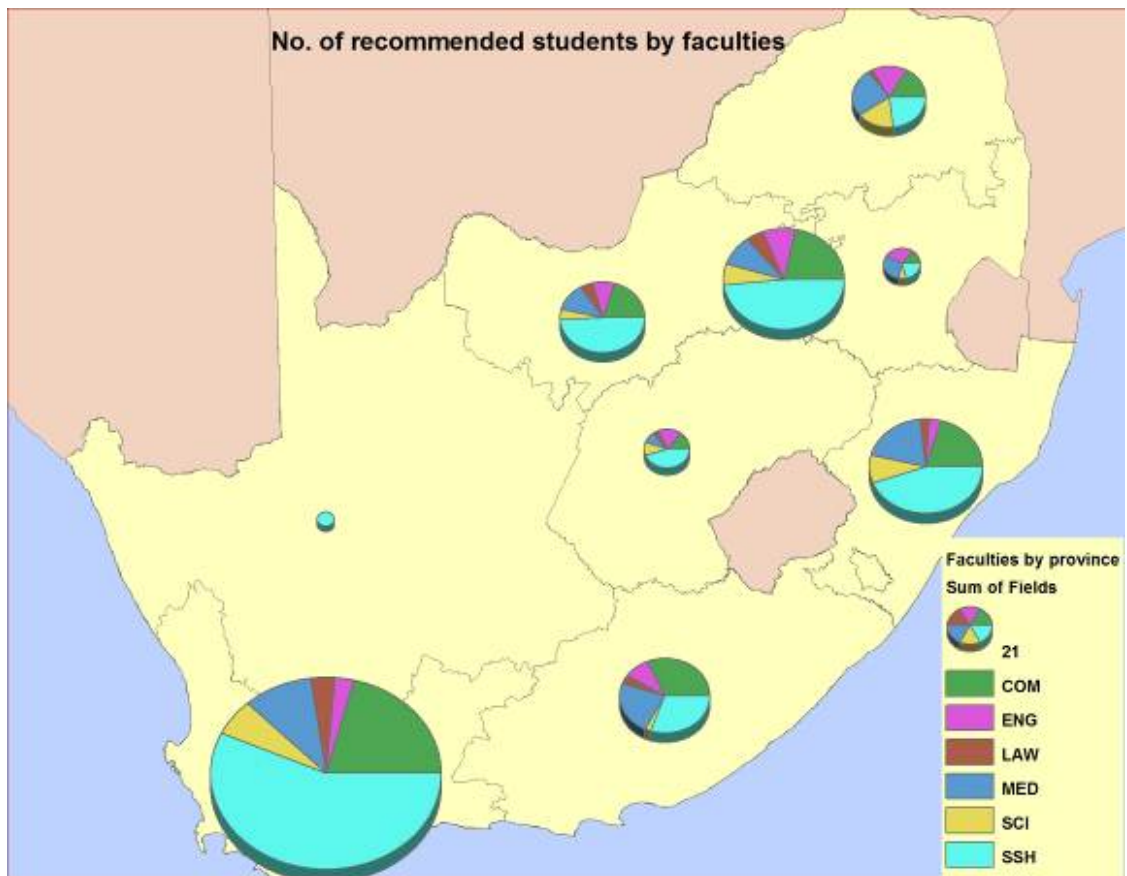
The first stage of the admissions' process involves a large pool of applicants submitting their initial applications. During the period under investigation (2000-2005) it was not compulsory for students to write the AARP tests when applying, although some indeed wrote the test before application. Writing the AARP test assists the candidates in acquiring an early offer and in placing students in appropriate programmes. From the pool of applicants, offers are made to those who meet the university's requirements. The number of offers made is carefully adjusted so as to achieve the enrolment targets (only around 50-60% of offered places are actually taken up – the so-called 'take-up' rate). Offers to AARP candidates identified as having potential are made throughout the year owing to the varying times of application and writing of the test. In effect, the admissions cycle may be viewed as a funnel, starting with a large pool of applicants and ending with a smaller number (approximately 25% of the original pool) of students actually registered.

The university comprises eight faculties, namely, Science, Commerce, Humanities, Engineering and the Built Environment, Law, Health Sciences, The Graduate School of Business and the Centre for Higher Education. The latter two are not included in the analysis because they do not admit first-time entering undergraduate students, and the AARP tests do not, therefore, apply.

The following sections present the spatial analysis by faculty considered against the faculty's recruitment targets (Pers. Comm. Cliff, 2007c). Spatial representation of faculties is displayed according to the candidate's faculty of first choice as the application was captured into the UCT database, although students may change faculties at or following registration. Spatial representation of the recruitment target data in each faculty (Figure 5.2) illustrates the geographical sources of AARP candidates.

The total number of students recommended between 2000 and 2005 is 1 527 from more than 448 schools. Given that more than 45%, at least, of the candidates are from Cape Town, the City of Cape Town Municipality will be excluded in most interpretations. This is because UCT is located in Cape Town and the focus of this chapter is to view the geographic spread of candidates outside the vicinity of UCT.

### 5.3 Overview of Candidates by Faculty



**Figure 5-2: Number of AARP recommended candidates by faculty displayed by province (2000-2005) (Faculties: COM- Commerce, ENG-Engineering, LAW – Law faculty, MED – Medical Science, SCI – Science, SSH – Social Sciences and Humanities)**

Figure 5.2 provides a general overview of the faculties that students are attracted to per province. The pie charts display the six faculties at UCT that offer undergraduate degree programmes, while the size of the pie shows proportionately the number of students that were recommended in that province. Humanities (SSH) faculty has the greatest proportion of students in seven of the provinces, the exceptions being LP and MP. The second-largest most prominent faculty in relation to these students is the Commerce faculty which accounts for about 25% of the students. LP has approximately equal numbers of students across all faculties, with Health Sciences' student numbers marginally higher than those of other faculties. In the NC, from which a very small number of students was accepted, these were all Humanities students.

In FS, EC, GT, and NW there are more Engineering students than there are Science students. There is a remarkably high number of Health Sciences' students recommended, amounting to almost 25% of the recommended total in EC, 33% in KZN and MP, and a notable proportion in WC, NW and GT. The distribution of students by faculty changes when displayed by municipality as discussed below (see Figure 5.3).

#### 5.4 Analysis by Faculty

The spatial analysis of recommended students per faculty shows the total numbers of AARP candidates by municipality, while the maps depicting the demographics of students are displayed per province as a whole. The municipality data is presented in such a way that the darker the shading on the map, the greater the number of candidates in that municipality. There are 366 municipalities in South Africa and they differ in terms of the type and number of schools, services, their levels of education, language and population groups. The graduated colours of the municipalities will be overlaid by the schools that had students recommended into that faculty. The overlaid schools will also show the recruitment student targets for each faculty, for example, the Science faculty is currently striving to recruit more female students and, particularly, Black females (Pers. Comm. Cliff, 2007c).

**Table 5-1: Percentage of total AARP-recommended candidates by population group and faculty (2000-2005)**

<b>% of total recommended candidates by population group and faculty</b>				
<b>Faculty/Race</b>	<b>Black</b>	<b>Coloured</b>	<b>Indian</b>	<b>White</b>
SSH	82	89	17	382
%	14.3	15.5	2.97	66.7
COM	62	35	32	108
%	26.1	14.7	13.4	45.4
SCI	33	9	2	32
%	43.4	11.8	2.63	42.1
ENG	43	4	9	20
%	56.6	5.26	11.8	26.3
LAW	18	12	6	9
%	40	26.7	13.3	20
MED	36	28	38	44
%	24.3	18.9	25.7	29.7

(Faculties: SSH – Social Sciences and Humanities, COM- Commerce, SCI – Science, ENG- Engineering, LAW – Law faculty, MED – Medical Science)

Table 5.1 is used for reference to text in the following sections 5.4.1, 5.4.2 and 5.4.3.

### 5.4.1 Health Sciences' Faculty

In the Health Sciences faculty, all applicants are required to write all three AARP tests and one additional test, also administered by AARP, that applicants to other faculties do not have to sit. The tests are: Placement Test in English for Educational Purposes (PTEEP), Mathematics Achievement (MACH), Mathematics Comprehension (MCOM) and Scientific Reasoning (SRT), (the additional Health Sciences' requirement). The Health Sciences' intake per annum is 200 students. During the period under investigation, the faculty process involved, firstly, making offers to students in what is termed the 'open' category, i.e. students are ranked based on their school-leaving results' scores and AARP test scores, the strongest students being chosen. Secondly, criterion based on race is then applied as follows in relation to specific targets: the candidates are classified into two groups, Blacks and Coloureds in one and Whites and Indians in the other. Black students and female students are particularly sought after, not only in the MbChB stream but in other programmes of study such as occupational therapy.

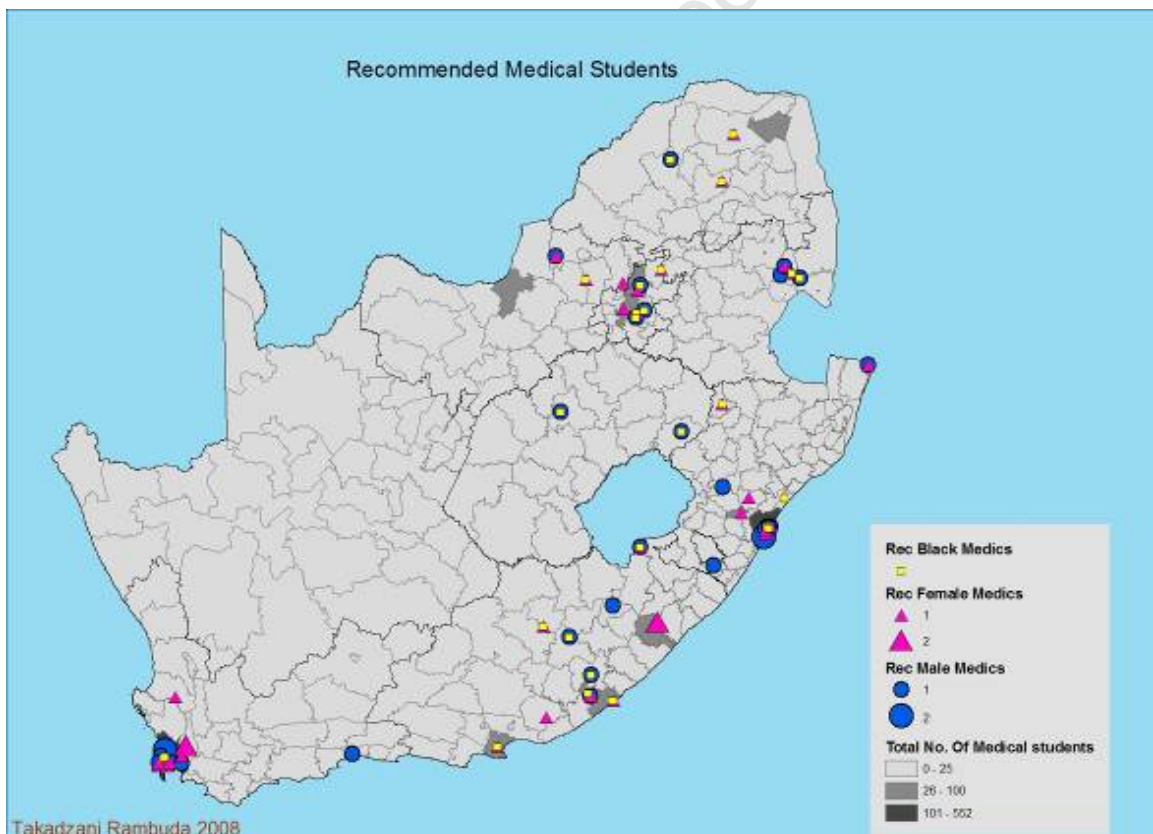


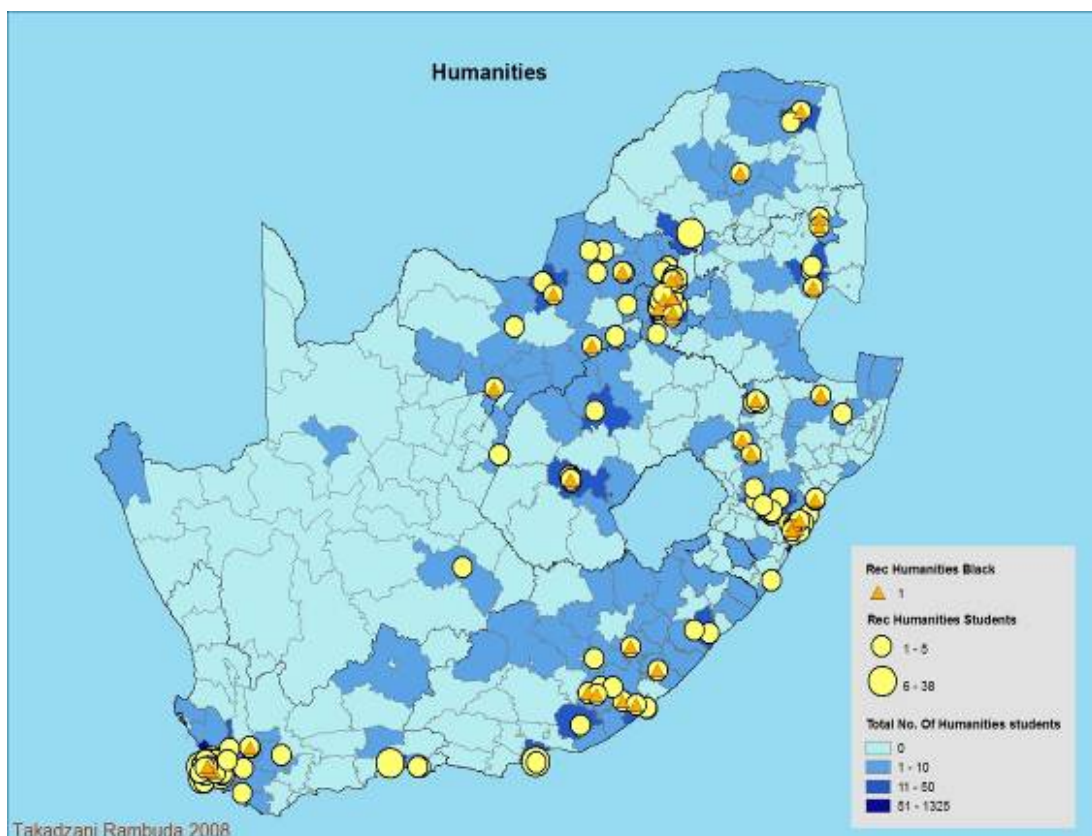
Figure 5-3: Recommended candidates: Health Sciences' Faculty (2000-2005)

The total number of Health Sciences' (Figure 5.3) candidates recommended for enrolment was 148 of the 1 751 that sat the tests. Ethekewini municipality (KZN) and the City of Cape Town in WC have the highest numbers of students attempting the test for entry into the Health Sciences' faculty (see Figure 5.3). Other provinces with municipalities that have more than 26 candidates (total number of candidates who wrote the test, darker shading on the backdrop municipal map) are LP (1), NW (1) and EC (3) and GT (3) – number of students recommended in brackets. The remaining municipalities have fewer than 25 AARP candidates.

Considering the targets required, a total of 16 Black male (BM) and only 6 Coloured male (CM) students were recommended. In comparison, a total of 20 Black female (BF) and 22 Coloured female (CF) students were recommended by AARP throughout the country for UCT only in 2000-2005. Figure 5.3 does not distinguish gender by population group, although it is evident from Figure 5.3 that the recommended BM are from only five of the provinces. Other than in the metropolitan areas, recommended students in the Health Sciences are not necessarily from the municipalities with the highest number of AARP candidates.

#### **5.4.2 *Humanities and Law Faculties***

Prospective students in both Humanities and Law faculties at UCT are required to write two tests; in Humanities these are PTEEP and QLT; in Law, PTEEP and SRT. Both school-leaving results and AARP scores are used as selection criteria in the Law faculty. Both of these faculties use the AARP test results to help assign students to the various academic streams available.

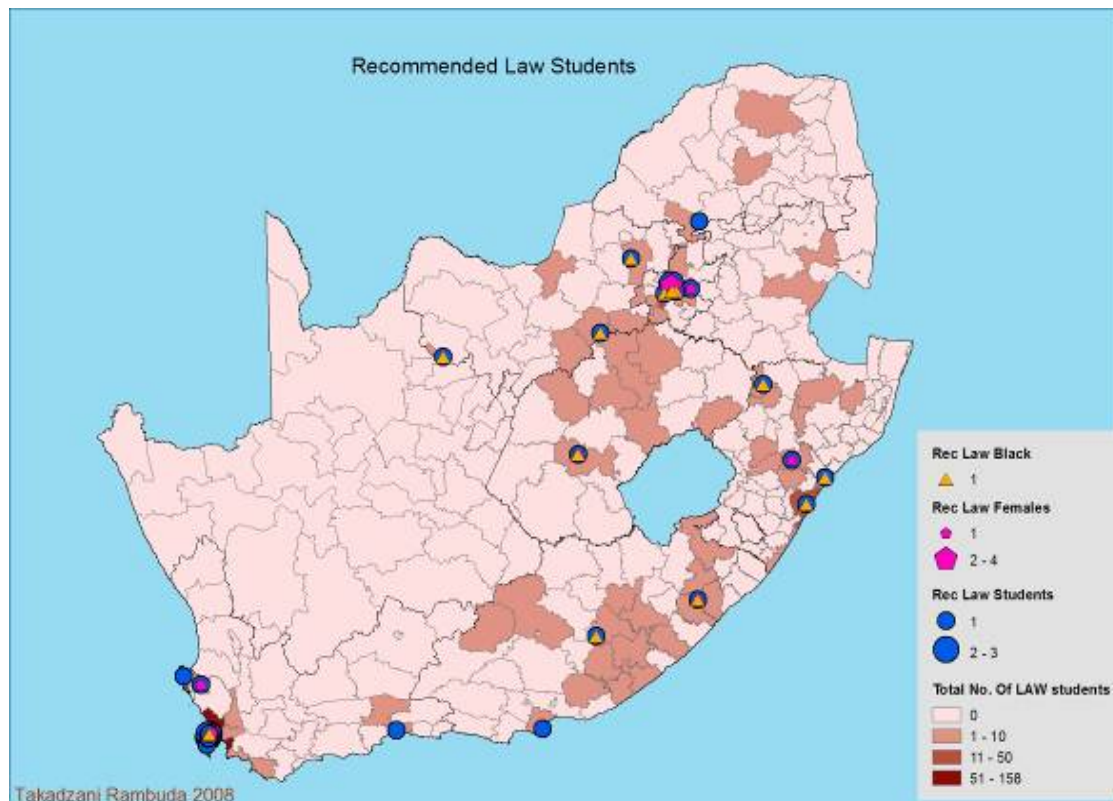


**Figure 5-4: Recommended candidates by academic faculty: Humanities' Faculty (2000-2005)**

In the Humanities' faculty, the recruitment practice targets Black students specifically for programmes such as Fine Art, Drama, and Film and Media Studies (Figure 5.4). Humanities' faculty recruitment officers visit township schools during their recruitment campaigns especially to market the above-mentioned courses. Prospective students are in fact given an opportunity to write the AARP tests during these recruitment visits and the results are used to fine-tune recruitment strategies as well as to facilitate university access for the target groups. The Law faculty (Figure 5.5) is also aiming for more Black South African students to register for its range of programmes.

The Humanities faculty had 537 recommended students compared with the Law faculty's 45. As noted above, there are more municipalities with students who undergo the AARP tests in relation to an application for entry into Humanities' programmes than in relation to other faculties. There appear to be particular clusters of schools in EC, NW, KZN (excluding the eThekweni Municipality), FS and LP. Two municipalities in NC and three in MP also have

students that were recommended to the Humanities' faculty. In terms of population groups, Black students constitute 14% of all recommended students, Coloured 16%, Indian 3% and White 67% (Table 5.1).



**Figure 5-5: AARP-recommended candidates - Law Faculty (2000-2005)**

With the exception of the City of Cape Town, which has more than 50 candidates for the Law faculty, the City of Johannesburg and the eThekweni Municipality are the only two municipalities with 11 or more candidates for the Law faculty. All other municipalities have fewer than 10 candidates and in most instances only one person writing. Of the 341 candidates across the country, only 13.2% (45) of students were recommended to the Law faculty. It is clear from Figure 5.5 that there are no apparent geographic clusters of recommended students in the case of this faculty, and the recommended students appear to be quite widely dispersed. NC and MP provinces produced no Law students, while KZN, LP, NW and EC have fewer than four schools with at least one student recommended. In WC, three contributing schools were outside the City of Cape Town Municipality. Black students

constituted the largest proportion of the recommended students, at 40%, in the Law faculty (see Table 5.1).

### 5.4.3 *Commerce, Science and Engineering Faculties*

These three faculties have similar admissions' requirements (Pers. Comm. Cliff, 2007c). They all use the students' school-leaving results for admission and AARP test scores for placement into different academic programmes. Although it is not compulsory for the students to write the tests, they are, nevertheless, strongly advised to undergo PTEEP, MCOM and MACH tests. In essence, the AARP tests for these faculties are not used to distinguish students in the sense of acceptance per se, but for diagnostic purposes, i.e. to allocate the accepted students to a particular programme. The tests are therefore used to identify students who may need extra or special assistance to survive the academic workload at university. At the other end of the ability spectrum, the AARP test scores in these faculties are used for scholarship awards.

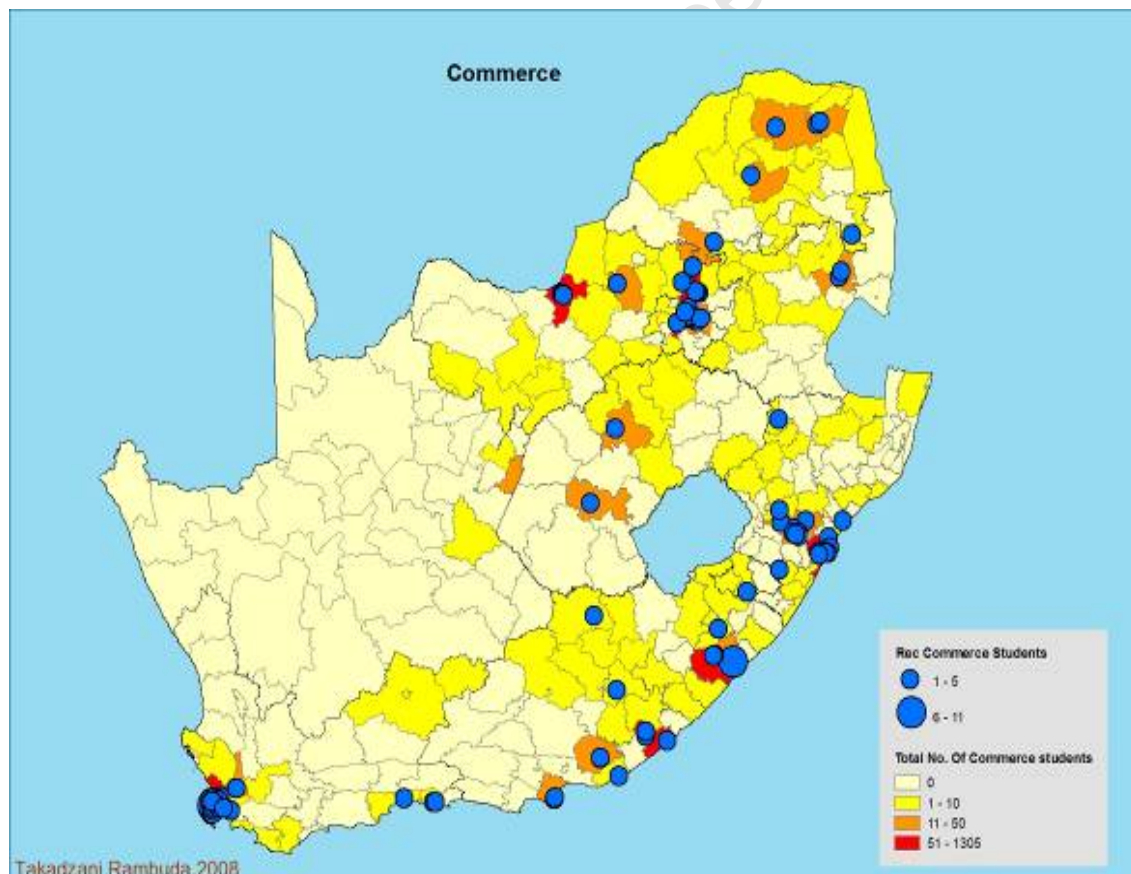


Figure 5-6: AARP-recommended candidates Commerce Faculty (2000-2005)

The Commerce faculty (Figure 5.6), on the whole, attempts to develop a balance in terms of population groups and gender of applicants. The students accepted into Commerce come from many municipalities (with more than 50 candidates in a municipality) than do those accepted into other faculties such as Law (Figure 5.5). Almost all municipalities in LP have at least some students writing the tests that result in some being admitted to the Commerce faculty. Only one school in the EC has more than six students recommended for acceptance by this faculty.

Although not spatially represented, the proportions by population group of those who took the test for the Commerce faculty are 26% Black, 15% Coloured, 13% Indian and 45% White (see Table 5.1). In terms of gender, there are more male students recommended (149) than females (89). There is also a fair distribution of recommended students throughout the six-year study period. However, in 2001, no students were recommended to the Commerce faculty. For each population group and gender (Figure 5.7), 2002 had the highest number of recommended students, except for the White population group, which had the highest numbers in 2004.

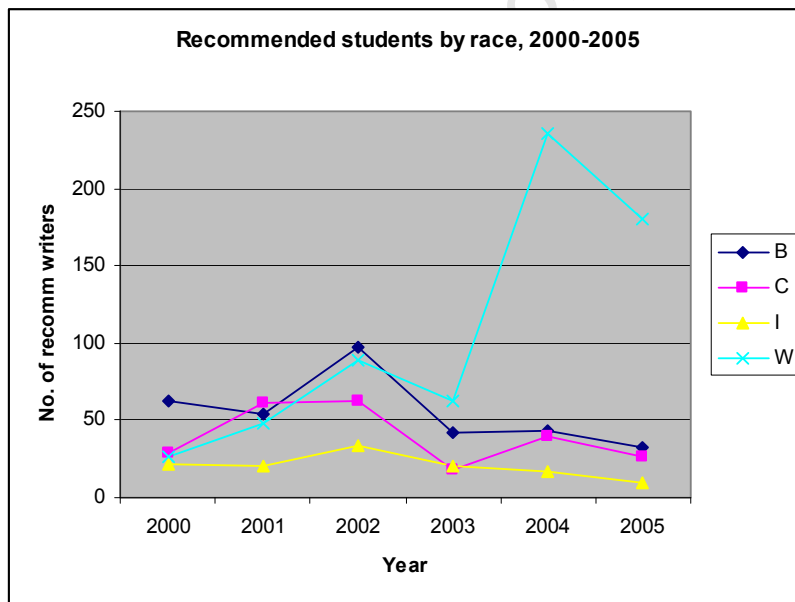
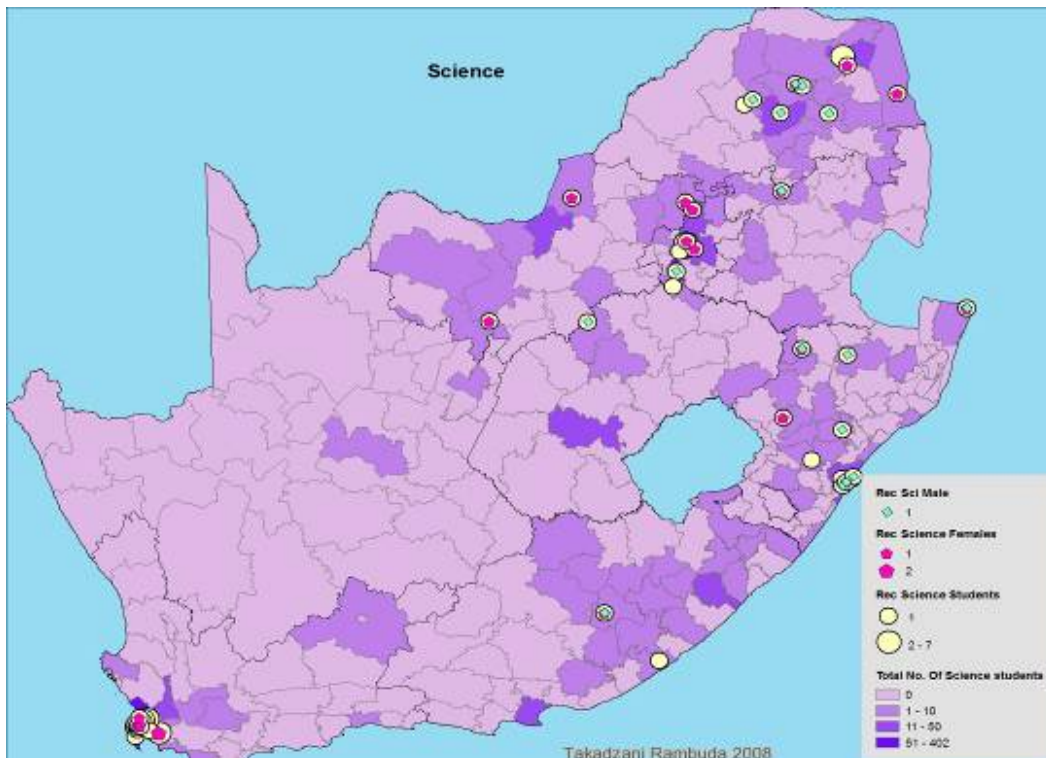


Figure 5-7: Recommended students by race, 2000 - 2005

The total number of recommended students in the Science faculty over the six year study period is 76. LP and KZN provinces have more schools with students recommended to the

Sciences. Also, these schools are not clustered in one municipality. Apart from the City of Cape Town, only one school in LP has at least more than one recommended student, with both males and females recommended. EC and NW have at least two schools, while FS and MP have one school each (Figure 5.8).

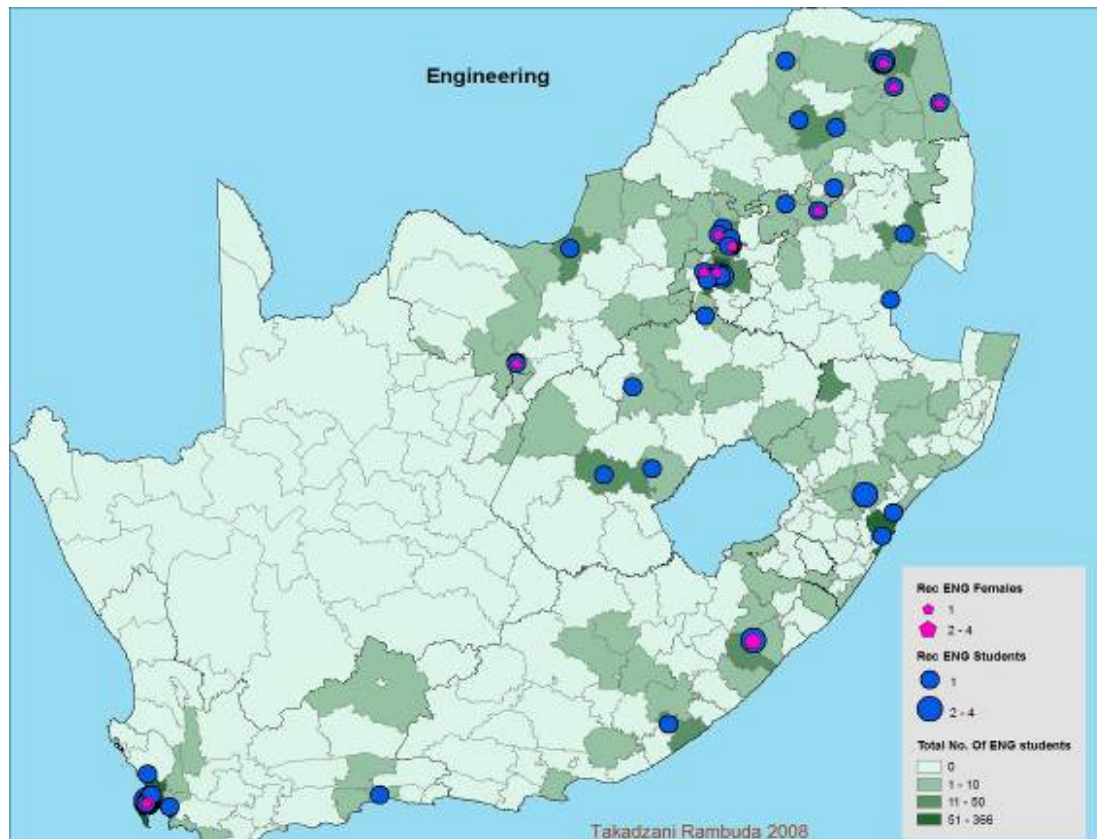


**Figure 5-8: AARP-recommended candidates in Science Faculty (2000-2005)**

The Science and Engineering faculties are the two faculties with more Black students recommended than White students. Black students in the Science faculty comprise 43%, with 42% White, 12% Coloured and 3% Indian (see Table 5.1). There is less discrepancy in the Science faculty between the genders, with 36 females and 40 males, compared with other faculties over the six-year study period.

The Faculty of Engineering and Built Environment is commonly known to have more males than females. The total number of recommended Engineering students was 76, with twice as many males (51) as females (25); (see Table 10 Appendix C). Some of the recommended females are from similar schools to those recommended to the Science faculty. Excluding WC and GT, LP has the highest number of recommended Engineering students. Other provinces have two or three schools with recommended students. Each of the schools is in a different

municipality. The distribution of candidates by municipality is evenly spread for the Engineering candidates compared with the Sciences, particularly in EC. However, this is the opposite in FS. KZN, LP and MP have almost the same number of municipalities with AARP candidates. (Figure 5.8)



**Figure 5-9: AARP-recommended candidates Engineering Faculty (2000-2005)**

In terms of population groups, Blacks constitute the highest percentage of the total number of students recommended to the faculty of Engineering at 57%, Whites (27%), followed by Indians (12%) and Coloureds (5%) (see Table 5.1). Over the six-year period, Black students remained the population group recommended more to the Engineering faculty than to all other faculties (see Table 5.1). There were 7 Blacks of the 9 recommended students in 2000, 19 of 30 in 2002, 9 of 19 in 2003, and 4 of 7 in 2005. However, 2004 was the exception, with the highest number of recommended students being White (7 of 11) and, on the contrary, in 2001 none was recommended.

## 5.5 Annual Writing Trends by Province

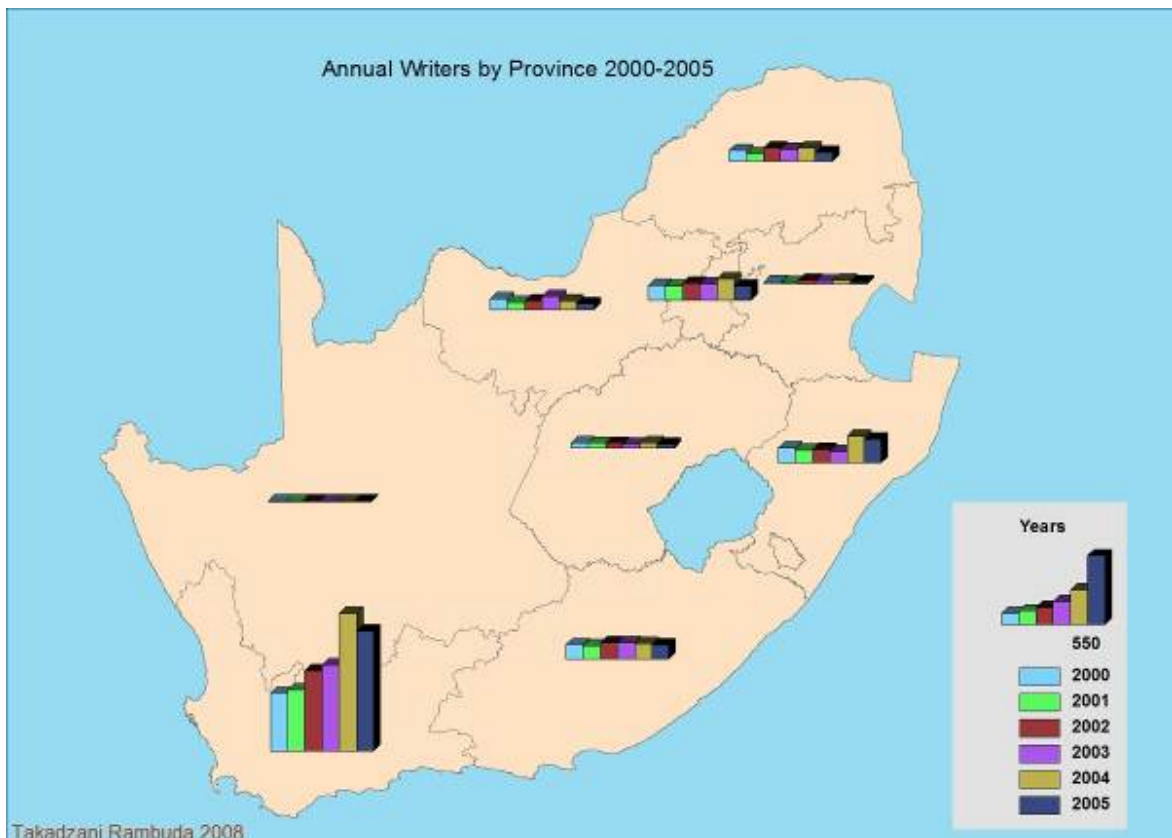


Figure 5-10: Annual number of all AARP candidates, 2000-2005

Over the study period, the number of AARP candidates in various provinces has fluctuated (Figure 5.10). Some provinces have low numbers of candidates annually. The number of candidates peaked in 2004 in all provinces except in NW. The WC has had a general increase in test writing and, as mentioned earlier, and evident on the above map, this province has the highest number of candidates. On the other hand, the NC has had the lowest number of candidates throughout all the years. This may be attributed to there being few schools in the province, to Afrikaans language dominance, and to a relatively small population. Other factors such as the absence of a test centre (in earlier years), or distance to the introduced AARP test centre, may be relevant. Despite having two test centres, the number of candidates in MP is also low, making it the second-lowest after NC, followed by FS.

According to the education statistics in South Africa published in 2008, KZN has the highest number of schools and learners (see Table 9 in Appendix C); yet the annual number of AARP candidates in KZN looks similar to that of GT. Again, GT has as high a number of potential candidates as WC but the gap in the number of annual candidates is significantly wide. NW shows a three-year fluctuating pattern. There is a decrease in the number of candidates from 2000 to 2002, reaching the peak in 2003 and decreasing to the lowest number in 2005. EC and

LP seem to have been constant over the six-year period, but 2005 in all provinces saw a significant decrease in the number of candidates from 2004. As mentioned earlier, the provincial summaries generalise data; were the same data displayed by municipality or sub-place, there may have been years during which there were no candidates.

### **5.6 Population Group, Language and Gender of AARP Candidates by Province**

The census data from Statistics South Africa (2001) are used to assess spatially the demographic characteristics (language and race) of the UCT applicants who write the alternative admissions' tests. These two factors add to the diversity of the student body. The intention is to show the language, racial background and gender of AARP candidates based on the type of school they attended and the municipality from which they originated.

According to SA Statistics 2001, South Africa has 10.6 million isiZulu-speaking people of whom 7.6 million reside in their home province of KZN (see Figure 5.11). This makes the isiZulu-speaking people the largest population group in South Africa with the most dominant language (Figure 5.11), followed by the isiXhosa-speaking people in the EC. NC and WC are dominated by Afrikaans-speaking people; whereas FS by Sesotho-speaking, NW by Setswana-speaking and LP dominated by Sepedi-speaking people.

The Indian population, in the context of race and language dominance, do not dominate any one of the municipalities, but the Indian people dominate certain areas in KZN more than in any other province of South Africa. There are more Black African candidates writing AARP tests, followed by Indian and then White candidates. This sequence of candidates per population group is a reflection of the total population in KZN. The Coloured population in KZN is the lowest, as in most provinces. As in other provinces, male candidates are still higher in number than are females.

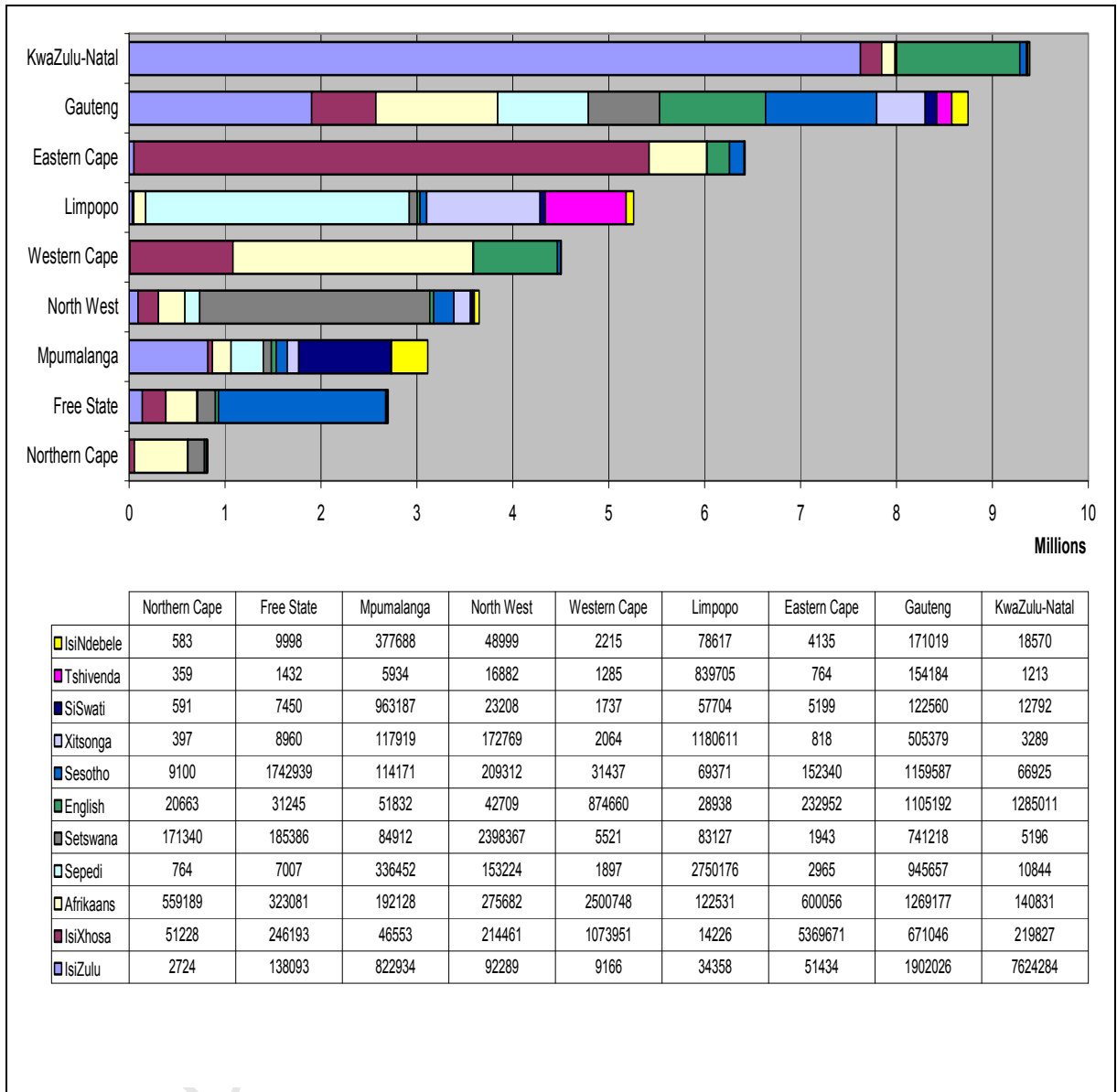
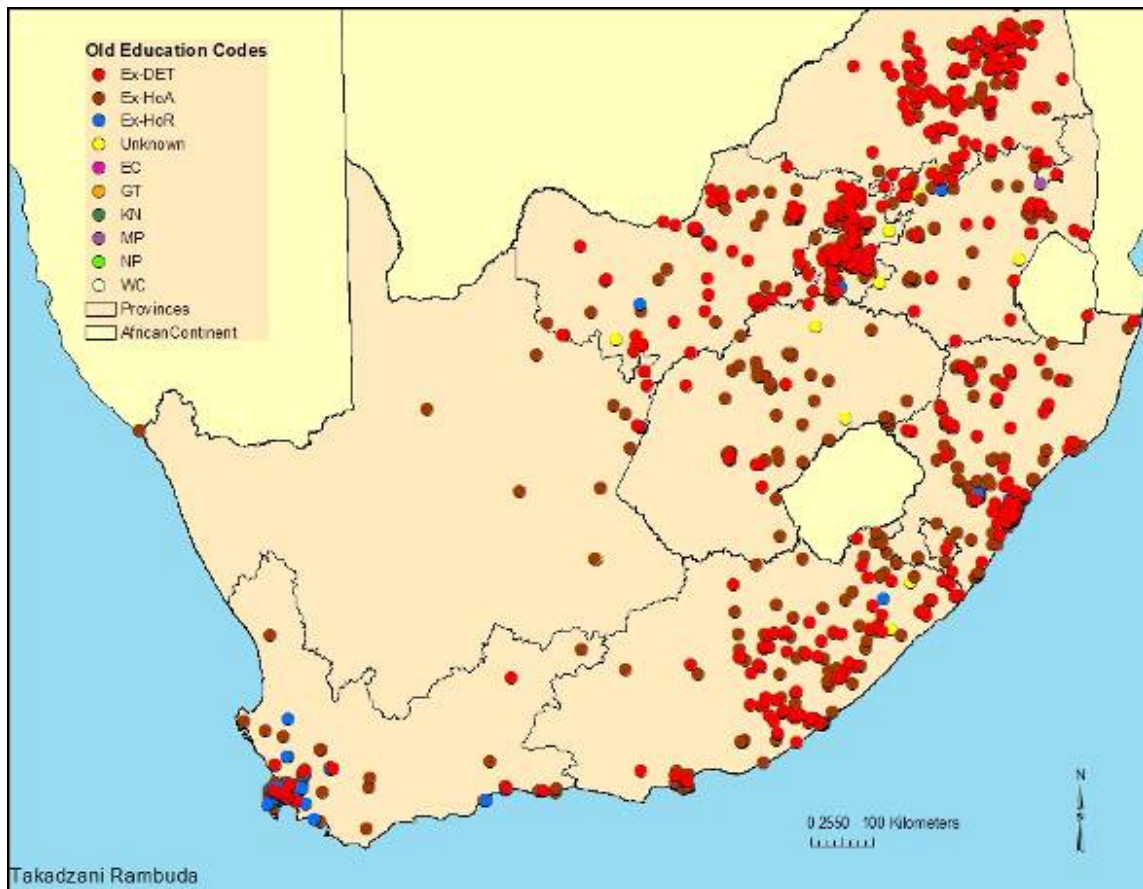


Figure 5-11: Language distribution by province. Data source: Statistics SA, 2001 (Rambuda et. al, 2008)



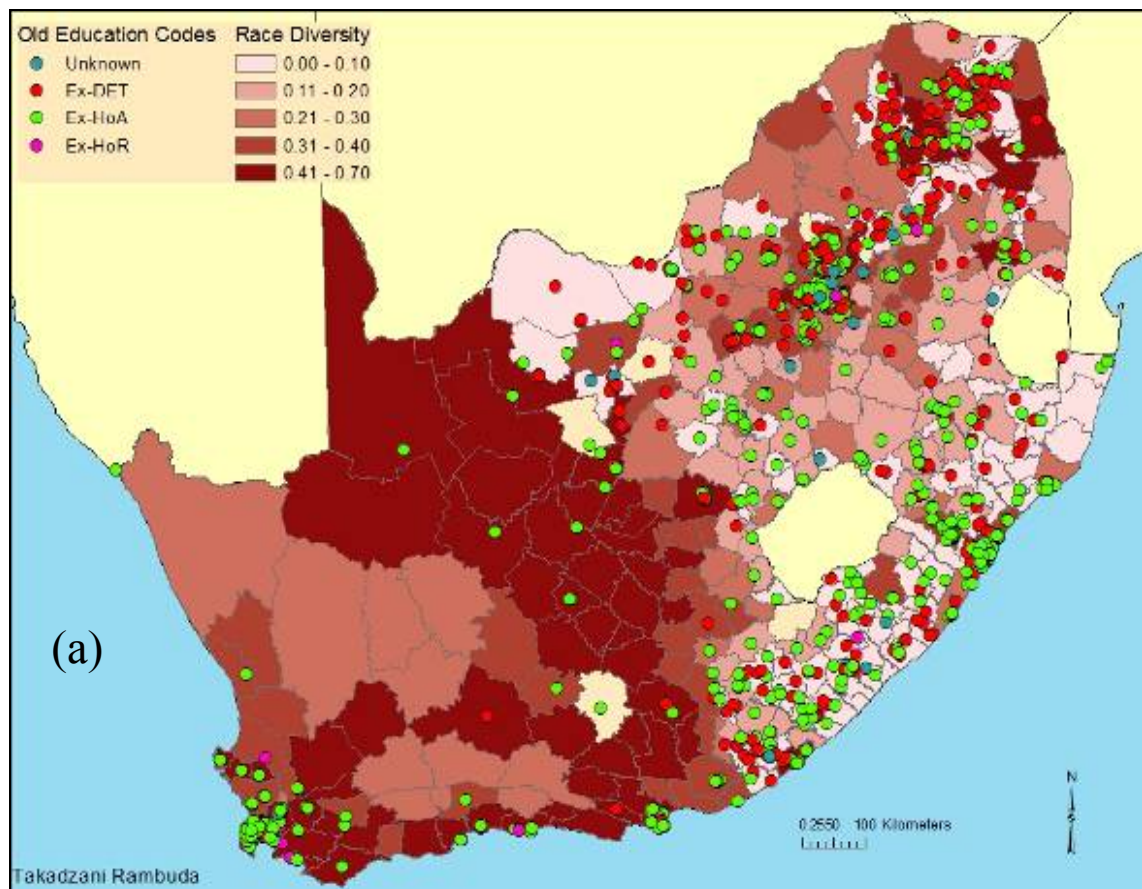
**Figure 5-12: AARP schools symbolised by South African former education departments**

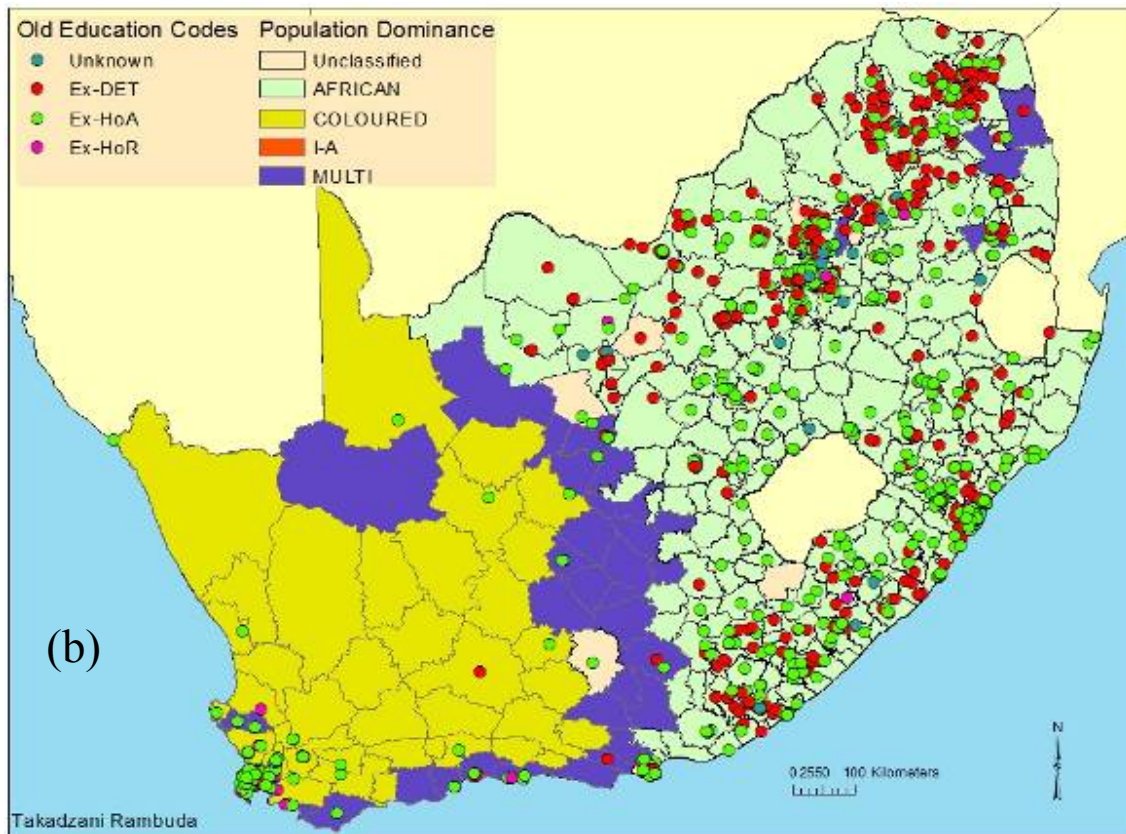
In apartheid South Africa, the type of school one attended was an enormous constraint, and determined especially the type of higher education institution one could attend, although the after-effects are still visible. The main factors that contributed to lack of access to any higher institution of choice were educational background, financial problems, medium of instruction (Sedibe, 1998) and race. This section attempts to analyse spatially these factors, using the census data.

Prior to 1994, South African schools were classified under different government education departments based on race (Figure 5.12). The old education departments were mapped as provided in the UCT database (detailed in Appendix A). The significant codes to note are ex-DET, ex-HOA (includes Whites and Indians) and ex-HOR. Other departments denoted by provincial codes are new schools assigned post-1994 following the cessation of classification of education departments based on race. Figure 5.12 focuses on the former education departments codes (ex-DET, ex-HOA and ex-HOR).

### 5.7 Population Diversity and Dominance

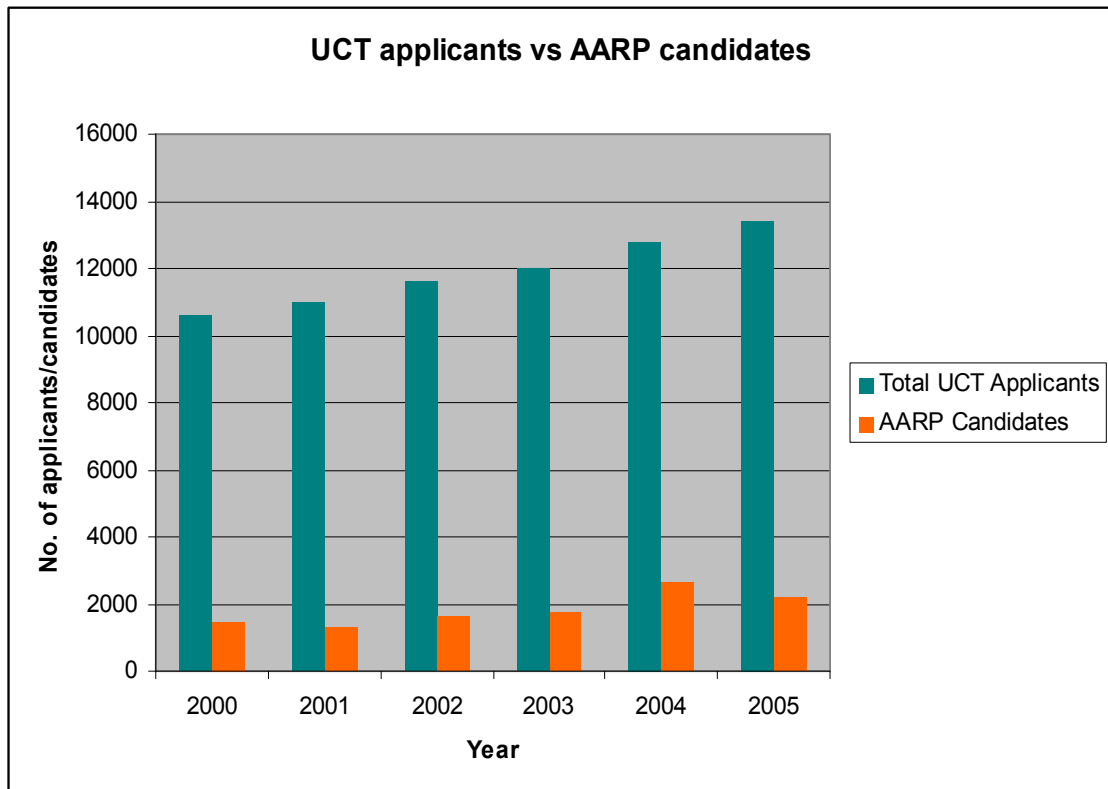
The legend on the diversity maps (Figure 5.13a) depicts low values (closer to 0) for no diversity and high values (closer to 1) meaning that two or more population groups are represented and that several of the eleven languages of the country are used in that area for the language diversity map (Figure 5.15a). The diversity and dominance maps are overlaid by the type of schools using the ex-education departments.





**Figure 5-13: Population diversity (a) and Population dominance (b) in South African municipalities.**

The population dominance map (Figure 5.13a) shows the four population categories. The three categories – Black African (referred to as Black hereafter), Coloured and Indian Asian all have municipalities in which they are strongly dominant. Only the White population group does not dominate in any one of the municipalities. According to the population dominance distribution, the types of schools reflect the dominating population in that municipality. The eastern half of the country is predominantly Black (olive green areas on Figure 5.13a) and there is a high diversity of the type of schools. This diversity is a reflection of the UCT student body.



**Figure 5-14: UCT applicants compared to AARP candidates**

Figure 5.14 shows a high number of UCT applicants and AARP candidates respectively. According to AARP reports, Black students constitute a majority of the applicants and candidates. It has been noted that the number of Black applicants and AARP candidates reduces drastically to those that are recommended for registration through AARP (Pers. Comm. Cliff, 2007c). However, on the population dominance and diversity maps, it is interesting to observe the wide geographic spread of ex-DET candidates that are clearly not simply concentrated in the big cities.

## 5.8 Language Diversity and Dominance

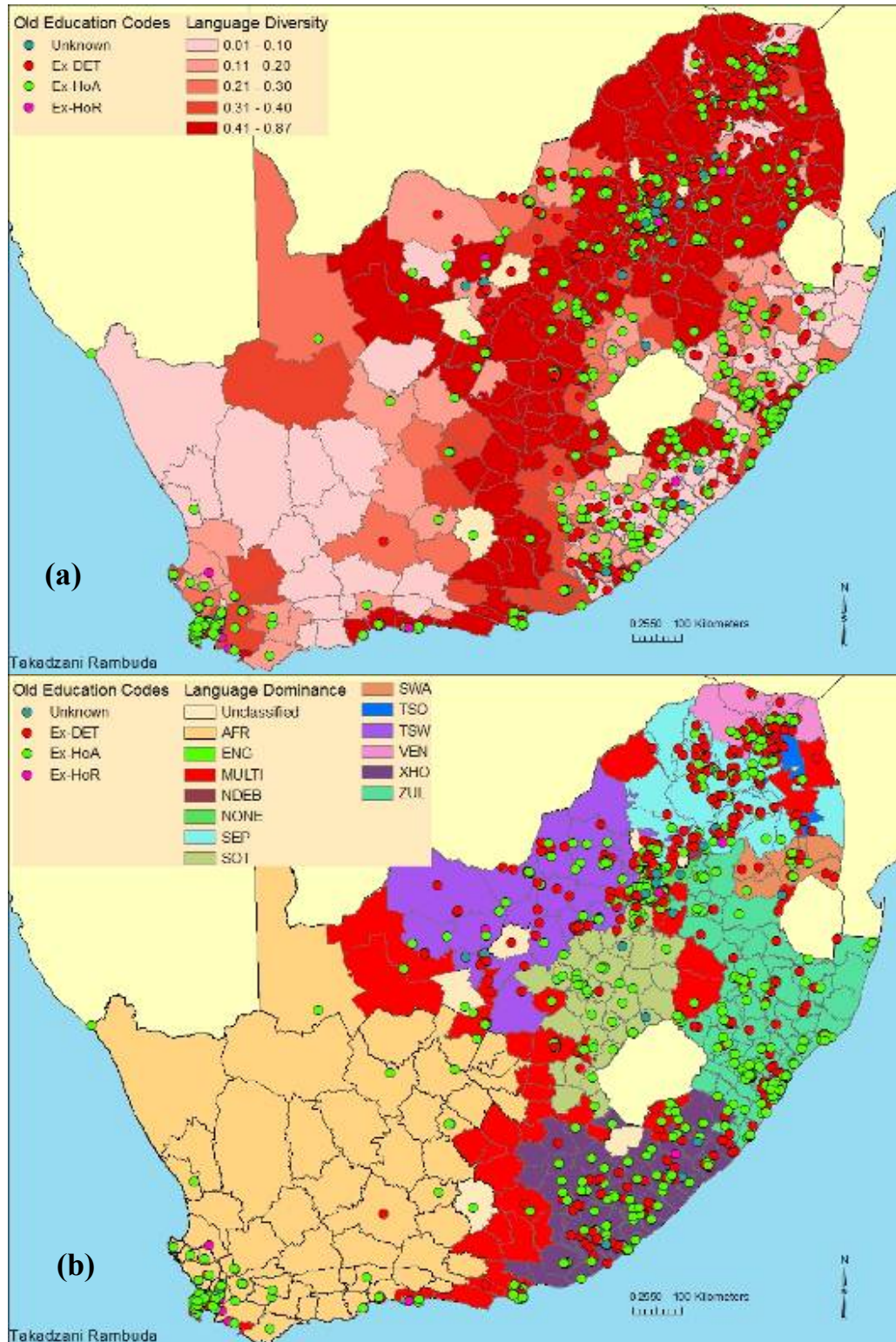


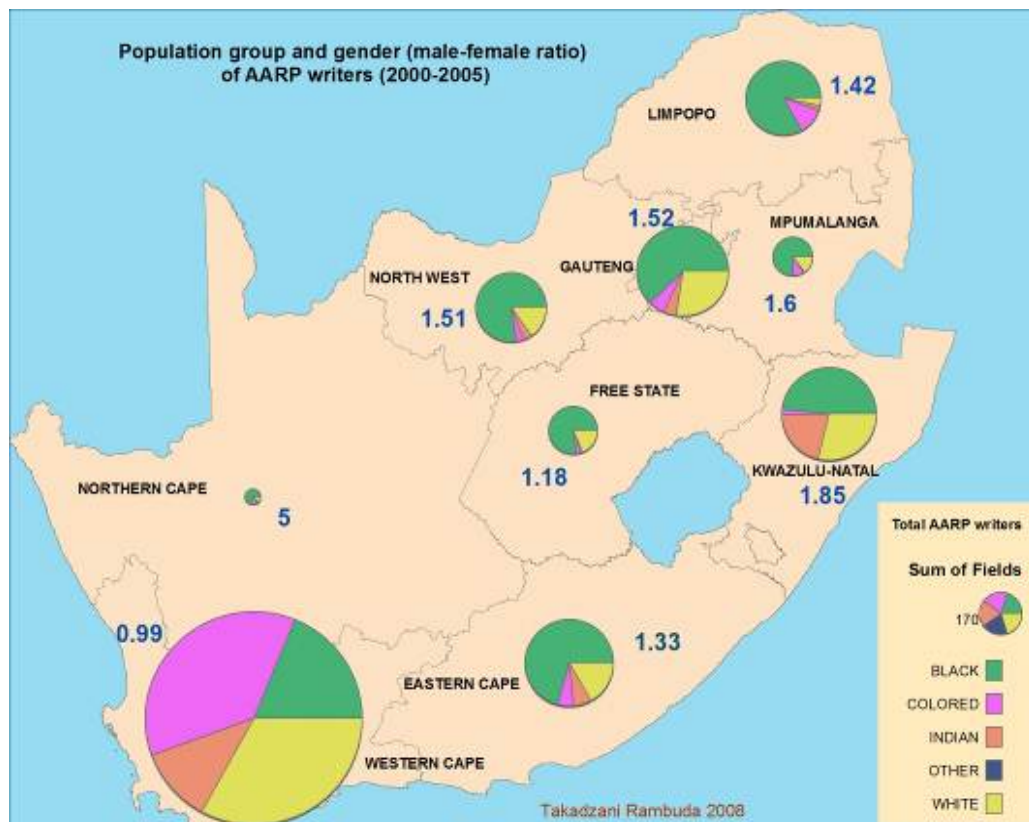
Figure 5-15: (a) The diversity of languages and (b) Language dominance in South African municipalities

In view of the information on the literature review, the maps based on census data and presented in Figure 5.15 depict the geographic demarcation of the eleven languages in South Africa as well as the level of diversity of languages within a municipality. In an attempt to understand some of the elements of the transforming UCT, it is important to compare the distribution of the country's language distribution and the types of schools attracted by UCT across the geographic space. This focuses attention in particular on the distribution of the population speaking various South African languages against the background that the AARP tests are administered exclusively in English and Afrikaans.

The EC, KZN, NC, along with some parts of the WC, show rather low levels of diversity in terms of both language and population group (Figures 5.13a and 5.15a). LP Province also has notably large areas displaying low levels of language diversity. The majority of municipalities that are multi-lingual are located on the borders of the provinces. It was the case that different ethnic groupings, as indicated by their mother-tongue language, were often associated with a particular institution of higher learning; for example, Xhosa with the University of Fort Hare, 'Coloured' with the University of the Western Cape, 'Indian' with the University of Durban-Westville, etc.

Figure 5.15b shows the languages that dominate in different municipalities. This language distribution depicts generally fewer than three dominant languages per province. Some municipalities are effectively multi-lingual (orange colour), having two or more languages. English is dominant in only five municipalities spread across just three provinces – KZN (Chatsworth), WC (Cape Town Municipality) and GT (Randburg, Johannesburg and Germiston) – see Appendix B Figure 1a, b and c). The ex-HOA schools (mainly former so-called model Cs) have a significant count on the African-language dominating municipalities.

## Gender Representation by Province



**Figure 5-16: Number of candidates by gender ratio and population group (170 next to the pie chart on the legend is an indication of how many candidates are represented on a pie chart)**

Figure 5.16 shows the total number of mapped AARP candidates summarised by province. The pie charts represent the population groups (Black, Indian, Coloured, White, and Other for any groups that were unclassified) and the gender ratio. It is evident that in all provinces, excluding WC, there are more Black candidates than in other population groups. In WC there is an equitable distribution amongst the population groups, and, as WC is dominated by the Coloured population group, this is also reflected in the number of Coloured candidates writing the AARP tests. Also, the gender ratio in WC is close to 1, indicating an almost equal number of male and female candidates undergoing AARP tests. However, other provinces have more male candidates than females, with the highest ratio of 5 observed in the NC.

Five provinces; namely LP, EC, NW, MP and FS, contribute more than two-thirds of the Black AARP candidates. In four of these provinces (EC, NW, MP and FS) the White population group is the second-largest group while, in LP, the Coloured group ranks second-highest. The Indian population group represents the minority in the EC, NW and FS, while there are no Indians

writing in LP and MP. In general, there are still marginally more male students than females writing the test, across all provinces. It is important to note that, when analysed by municipality, the representation changes. There are more municipalities with no female students writing the AARP test; for recruitment purposes it is essential to address such concerns, especially if this is an annual occurrence.

In conclusion, this chapter has served to demonstrate how GIS and spatial analysis may be incorporated into the UCT recruitment planning process. AARP data was spatially engaged to specific faculty recruitment requirements. A visual representation of the AARP admissions' targets by faculty has been achieved. At the same time, the display of data by faculty identified areas (municipalities) where learners have not taken the AARP test. Based on the knowledge of the country, the annual number of candidates and the distribution of the population groups of AARP, candidates have been shown to reflect the total population in that province. However, UCT admissions are predominantly from the WC, which is geographically adjacent. Nationally there appears to be gender discrepancy in terms of candidates; there are still more males than females writing the AARP test, and this could be an issue that requires further discussion amongst higher education authorities.

The maps in this chapter demonstrate that UCT is certainly reaching out to students in areas that are geographically far removed from UCT and that were not traditionally part of its catchment area. Large numbers of schools in rural and poorer areas as well as areas of diversified ethnicity are being reached by the AARP testing programme.

## **6 CHAPTER 6: DISCUSSION**

### **6.1 Introduction**

The main aim of the dissertation was outlined in Chapter 1: to demonstrate the potential use of GIS in the University of Cape Town admissions' process, in order to make better-informed decisions that would assist in fulfilling the AARP mission; by identifying students with academic potential to study at UCT, in particular those from disadvantaged backgrounds. UCT recognises inequality in education in South Africa and strives to achieve equity of access through redress to all who wish to study at UCT (UCT Student Equity Policy, 2004). The university also recognises that specific measures need to be taken to address equity in admitting those that were previously-disadvantaged in relation to their population group, gender, disability or a combination of these factors. GIS further explores the addressing of equity by 'discovering' geographical areas that are untapped.

AARP administers the alternative admissions' tests across South Africa and internationally. One of the objectives of AARP and this dissertation is to ensure optimal accessibility of the AARP services throughout the country. The spatio-temporal trends in the number of AARP candidates were also explored. Issues explored in this chapter arise from the observations of both the spatial distribution of the AARP writers and other graphical representations of the available data. The spatial analysis raises some important questions on the geography of the student body. Questions relating to the recruitment and admission as well as access to UCT services are also considered.

### **6.2 Summary of Results**

The main results are summarised in bullet points below:

- Five of the 25 test centres did not have a substantial number of AARP candidate schools within a 50 km radius these are; Witbank, George, Kimberley, Grahamstown and Bloemfontein. (Figure 4.1)
- The average distance indicates that the majority of candidates are less than 100 km from the test centre at which they wrote. However, the maximum distances denote candidates from other provinces, but in the case of KZN, some candidates are travelling longer distances; this observation lends itself to further scrutiny. (Table 4.2)

- For *current* AARP candidates, three provinces showed the need either to add or relocate test centres in order optimally to locate them for candidates. (Figure 4.4)
- There are many schools in KZN that have not participated in the AARP tests, particularly when *potential* candidates were observed; two test centres were proposed for *potential* candidates. (Figure 4.6)
- The best-performing schools are seemingly distributed in approximately the same pattern as the *current* AARP candidates in most provinces, with the exception of EC. However, best-performing schools in NC are highly scattered, posing a serious challenge should a test centre need to be placed there. (Figure 4.7)
- The ratio of candidates to schools has a noteworthy pattern. Large cities have few schools participating but more candidates, whereas township / rural schools have more schools with fewer candidates participating in AARP tests. (Table 4.2)
- LP and MP have fewer candidates writing for Social Sciences' and Humanities' faculties. (Figure 5.4)
- The Law faculty has the right targets and no apparent geographic clusters: this may be a good idea / factor showing that every year students come from different areas. (Figure 5.5)
- The faculty of Commerce draws from more municipalities with candidates participating in AARP tests than do all other faculties. (Figure 5.6)
- Science and Engineering faculties have more Black students recommended by AARP than White students (Table 5.1). The faculty of Engineering has consistently had Black students more than any other group recommended to them over the study period.
- There are twice as many male as female candidates recommended to the faculty of Engineering, which is known to be male-dominated.
- Almost all provinces, with the exception of the WC, have more male candidates than females writing the AARP tests.
- Using the population dominance and diversity maps (Figure 5.13 and 5.15) it is observable that the wide geographic spread of ex-DET candidates that write is not simply concentrated in large cities.
- The English language is only dominant in five municipalities spread across three provinces. (Appendix B)

### **6.3 Interpretation of results**

The accessibility results in chapter 4 demonstrate here that most of the test centres are indeed optimally located relative to the distribution of schools. However, in LP, one test centre could perhaps be relocated so that the majority of existing AARP candidate schools as well as potential candidates in that area can have better access to the test centre. In EC and NW there were areas with a high number of candidates and potential candidates studying at schools further than 100 km from the test centres. For this reason, additional test centres should be placed in these high population density areas. The proposed test centres are placed in towns because they are, in practice, central and accessible to all, although this may warrant further study.

According to the literature review on this dissertation, it is clear that over and above buffer distance as a measure of proximity and accessibility, there are other factors that need to be considered in order to determine accessibility, and optimally to locate a service. For example, mode of travel (Liu and Zhu, 2004), and failure to use the nearest facility (Rosero-Bixby, 2004), amongst others, could impact on the results of accessibility applications. Nonetheless, buffer distances are usually foundational, and point to areas that need to be closely assessed, as well as to the selection of an appropriate proximity measure.

As indicated earlier, AARP test centres are currently situated in the cities, major towns or townships in each province. It is also evident that most of the AARP candidates are clustered around these main centres and thus constitute the largest proportion of candidates. On the peripheries of the cities, more than 100 km from the test centres, candidate schools are very sparsely distributed in these mainly rural areas. Most of the schools situated in the townships seem to have made encouraging progress in accordance with the South African education transformational agenda; e.g. improved quality of education and resources, but there remains only marginal progress in poor rural schools (Chisholm, 2008). This could partially explain the reason for most schools on the periphery of the AARP test centres' being less well-represented in the pool of those that are most likely to qualify for university studies.

In addition to the support that rural and poor schools are receiving from the Department of Education, the university's admission recruitment office and faculties could target their recruitment activities to enumerator areas from which no school or learner has yet

participated in the AARP tests. Remote areas that have difficulties in accessing their nearest towns to the AARP test centres will be more likely to lack access to higher education opportunities. This was evident in the results presented in Chapter 4, particularly the provinces that are pinpointed as needing new test centres. For example, candidates from NW have transport difficulties (Thibedi, 2006) to towns in which the AARP test centres are located (or should be located). As it is the objective of this dissertation to highlight issues within the AARP project associated with spatial patterning among candidates, the distribution of poorly-resourced schools in rural areas, and limited access to higher education is evident in the gaps identified in the AARP spatial analysis.

AARP is one of the steps in the admissions' process of students, and taking the AARP test is becoming a general entry requirement. AARP results are employed differently in various academic faculties at UCT. The use of GIS and spatial analysis in this dissertation demonstrates how pre-planning can assist faculties to achieve their specific enrolment targets for a particular academic year or a series of years. GIS can be used to spatially overlay the factors with the geographic components of the different missions and targets, without overlooking the conventional methods in recruiting a quality and diverse student body. For example, the following may be combined in the spatial overlay: the Faculty of Science's targeting Black female students, AARP's identifying previously-disadvantaged students in general and the aim of UCT to increase the diversity of the student body. From maps such as those depicted in Chapter 5, faculties are able to strategise in order to meet their targets as well as to fulfil the mission of the university.

There is an interesting observed pattern of the proportion and geographic distribution of Indian students. Nationally, the majority of Indians reside in the KZN province and the WC. Furthermore, Indians do not dominate any one of the municipalities (see Figure 5.13a). However, in assessing applications for enrolment to UCT in 2008 for all provinces (Figure 6.1), Indian students are somewhat over-represented relative to their expected enrolments in relation to national and provincial demography. Black and Coloured students have had similar educational backgrounds but three times fewer Coloured applicants than Black students apply to UCT.

The White population in the WC is greater than the Coloured population. This is reflected in the admissions' pattern, in that the number of White candidates and applicants, recommended and registered, also exceeds that of the Coloured population group within the WC Province.

Patterns emerged when data was mapped by academic faculties. The differences in geographic distribution of students applying to various faculties reflect different recruitment strategies and different placement opportunities within academic faculties. As mentioned, the isolated schools in Figure 6.2b are mainly located in rural areas. However, according to the AARP project manager (Van der Ross, pers. Comm., 2008); few isolated areas are receiving special attention, where tests are taken into the remote areas. Although the remote test centres are not mapped, their increase would result in more schools being displayed on those participating in the AARP tests. Thus accessibility to UCT / AARP test centres could be rated accessible to all who wish to write the tests.

Literature shows that it is recommended to analyse student data, as in this dissertation, using the smallest spatial unit, such as the enumerator area (Herries and Marble, 2006). Large spatial units tend to generalise data where substantial detail, usually contained in small units, is necessary. In addition to race, gender and language; socio-economics analysed at the enumerator area spatial unit are essential in the selection of students, but most importantly, in the allocation of resources.

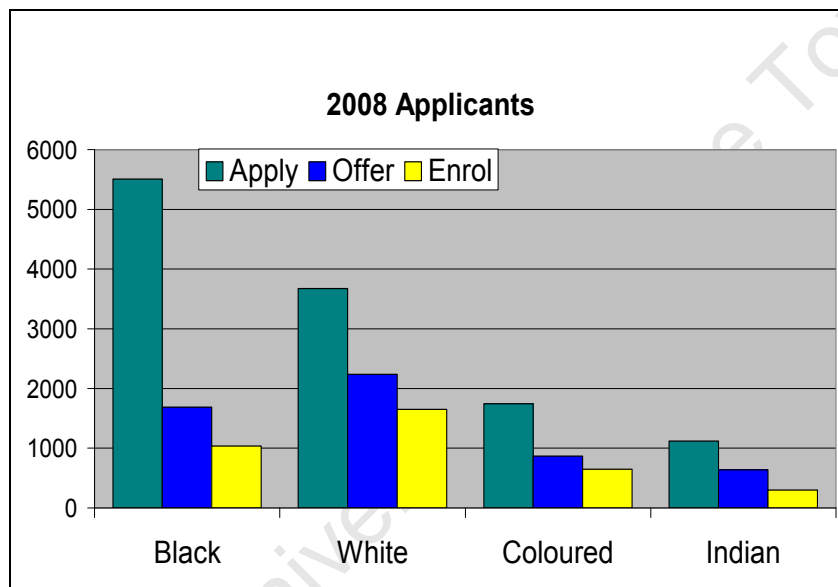
The use of maps reflecting population dynamics would considerably enhance the university's recruitment strategies to ensure coverage of the whole country, thus promoting diversity of the student body in many ways. This could also help in ensuring that the ex-DET schools are increasingly represented in the pool of applicants and, ultimately, in those who are accepted as registered students at UCT. To a certain extent this shows that the mission for UCT is gradually being fulfilled – ensuring the attraction of a diverse student body, particularly Black students.

Various spatial patterns have been identified in the AARP candidates and UCT admissions' data. For example, the admission office has categorised students geographically (UCT Admission Report, 2008 – unpublished) and the identification of admissions' targets,

geographically, demographically and administratively, may facilitate more astute planning and faster progress in addressing issues of transformation and diversity in terms of student admissions to UCT.

#### 6.4 Enrolment at UCT and Spatial Analysis

As noted earlier, the vision of AARP is to conduct meaningful research and testing initiatives which contribute to a greater understanding of access and success issues in higher and further education at UCT, South Africa and internationally (Cliff, 2007b). AARP was introduced at UCT to improve admission equity to all applicants. As identified in the results, the issues of race and gender are explicitly considered in the UCT admissions' process.



**Figure 6-1: Applications, offers and enrolments for entering and transferring undergraduates in 2008**

The majority of applicants to UCT are Black students. However, it can be seen that Black and Coloured students receive proportionately far fewer academic offers than do White and Indian students (Figure 6.1). According to AARP, because the majority of Black and Coloured students that continue to take the AARP do not meet the necessary standard, this reveals the under-preparedness of such learners for higher education. This shows that, even though the face of national education (at school level) may have changed in terms of integrating the curriculum, making it national, there are still many Black and Coloured schools that produce learners that fail to meet university entrance requirements. Naturally, this is an impediment

to transforming the institution of higher education. However, this would be an alternative strategy to focus on particular geographic regions: AARP could engage other responsible education stakeholders to focus on certain geographical areas in terms of academic development so that applicants that will meet university requirements may be further identified.

Spatial analysis facilitates the identification of geographic areas that require intervention through illustrating the spatial patterning in the data. When schools are classified by the former education department (using this as a proxy for under- and well-resourced schools), the spatial pattern showing all candidates compared with those that were recommended for admission changes remarkably (see Figure 6.2, All AARP Candidates vs. Recommended). The sparse distribution of the schools shown in Figure 6.2b indicates that there are many municipalities that annually produce candidates with little or no chance of success. Areas such as these may require a different approach in addressing the access issues of higher education institutions.

University of Cape Town

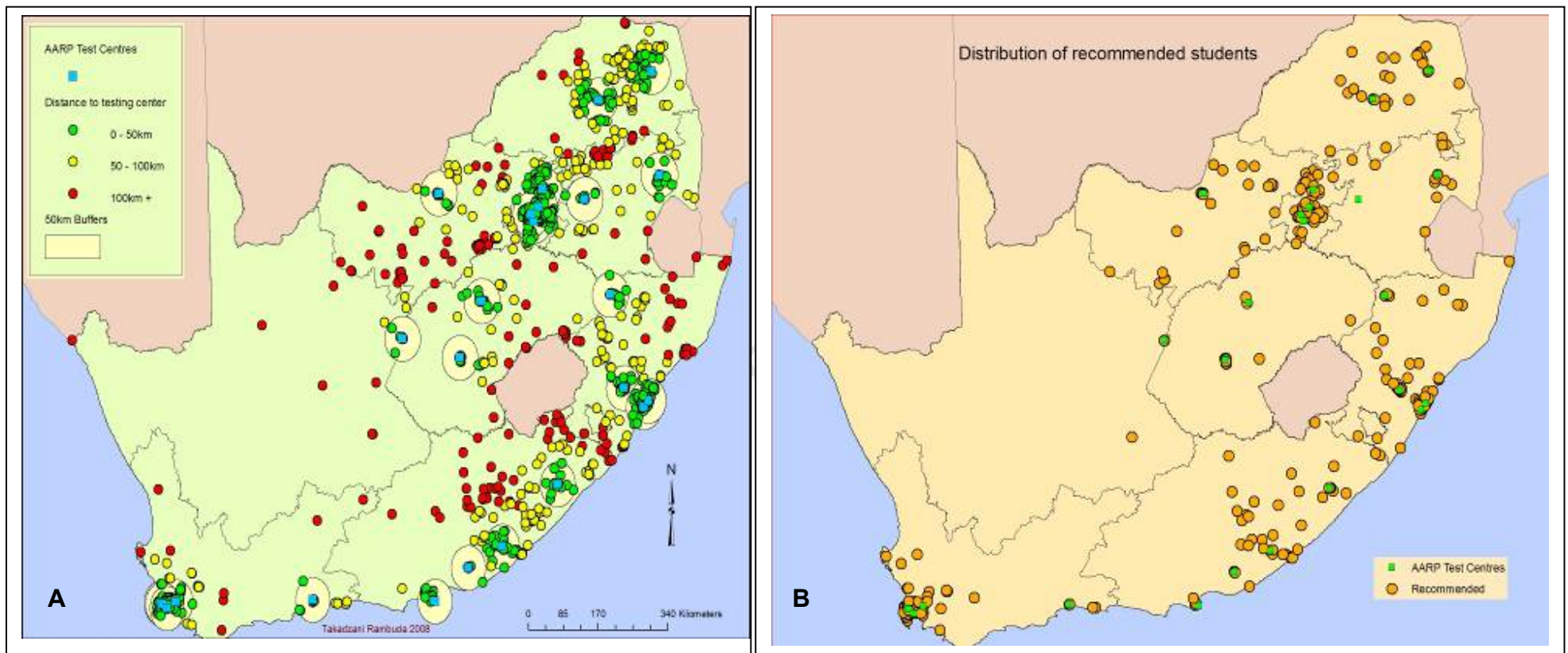


Figure 6-2: (A) Overview of all AARP schools and distance to test centres; (B) Distribution of recommended students relative to AARP test centres.

## **6.5 Issues and Questions Raised by Spatial Analysis**

Although there was no further detailed modelling using GIS techniques in this dissertation, the basic spatial analysis performed demonstrates the power of GIS in revealing questions that are related to recruitment strategies, distribution of resources and services and tracking the geographic diversity of the student body that has been and could be attained within the university. However, while GIS cannot provide direct solutions for higher education institutions' planning and admission, spatial analysis can assist in deepening an understanding of the various candidate constituencies and the way in which these areas can better be reached in order to achieve the vision and the mission of the university. This study demonstrates the value and potential use of visual analysis in a university admissions' process, and points to considerable further potential with more detailed data capture.

The geographic distribution or pattern observed on the maps reflects the population distribution, in the sense that there are larger populations, more and better schools in the metropolises and urban areas. Other factors, such as matriculants' having the exposure and opportunities to reside in urban areas when entering university, can contribute to the current spatial distribution of schools. Hugo (1998) discussed similar inequalities experienced in Adelaide, Australia, where most graduates came from high-income areas. In this dissertation, students further from the test centres may have less exposure to material and activities that assist them in accessing higher education. Thus learners would not apply to study at a university such as UCT. Spatial analysis would assist recruitment and AARP marketing officers in understanding the geographical gaps that have not been reached through AARP tests.

It has also been noted that distance to AARP centres could serve as a disincentive to many students (Cliff, 2007c). Some students may overlook or disregard writing the test (and consequently lack access to UCT) simply because they cannot reach the test centre. There are many factors, however, in addition to distance to writing centres that could deter a learner from writing the test. These factors may comprise the cost and time of travelling, including the length of time taken to travel as well as time of the day. For example, if someone has to travel very early in the morning for many hours, the likelihood of their being tired and having impaired concentration – and subsequently performing poorly on the test – becomes correspondingly high.

A significant and implicit criticism of the current AARP tests is that they are mainly administered in English (Swart, 1999). English is regarded as the medium of instruction in education in South Africa. This dissertation shows that only five of the 366 municipalities have English as their

dominant language. According to Swart (1999), using the University of Pretoria as an example, the potential diagnostic tests are still not adequate to identify academic potential in previously-disadvantaged schools; other tests still need to be devised. This is in terms of the poor quality education that still exists in the majority of Black schools and the use of English as the second language when writing the AARP tests or for any correspondence with the institution. However, an alternative could be to devise tests in vernacular languages and to examine whether the results would be significantly different for the Afrikaans first-language learners who might apply to the University of Pretoria. In the case of municipalities with high language diversity, learners could be required to make a choice of a language in which they have proficiency.

Preference of higher education institution by students may also be taken into account, noting that there is competition amongst universities to attract a diverse student body while boasting the best performing students. For example, in WC, UCT competes with the University of Western Cape, University of Stellenbosch as well as the Cape Peninsula University of Technology. Even though the University of Western Cape may have more Coloured students than does UCT, it is also important to note that the admissions' targets, entrance scores and other prerequisites may be remarkably different, given that the University of the WC is a previously-disadvantaged higher education institution and that it does not have the same faculties and courses offered at UCT. Similarly, the University of Witwatersrand and University of Pretoria, both situated in northern South Africa, Gauteng, attract many students in the northern part of the country, particularly in Gauteng. The preference of an institution can slightly contribute to the fewer enrolled students at UCT; White students may still prefer to study at UCT than elsewhere because UCT is a previously White university.

In summary, spatial analysis raised the following questions:

- How does the university extract and assess, for admission, the highest achievers compared with those from previously-disadvantaged communities, in order to fulfil the mission of the university, as well as the vision for AARP?
- Are there several/many schools that have a high number of candidates writing the AARP tests annually from the same area, community, and region? If so, why? Are these learners being recommended for study at UCT?
- Do other universities in South Africa (e.g. Pretoria, WITS) show a different spatial distribution of the applicant and candidate pool? For example, would there be more writers from MP for these universities compared with those that sat the test for study at UCT?

- Given the distribution of the dominant languages, would the recommended AARP candidates aiming for admission to UCT show a different distribution were the test administered in the vernacular?
- Are UCT successful applicants or AARP candidates (and subsequent graduates) concentrated in English-speaking municipalities or in highly diversified areas of language and population?
- How can the urban clustering of AARP writers be comprehensively disaggregated in order to identify the previously-disadvantaged, but with academic potential to survive university studies?
- Is there a strong correlation between writers who score higher on the AARP tests with the distance travelled to the test centre?

While these questions undoubtedly fall beyond the scope of this dissertation, there are implications revealed by the data displayed and raised as a result of the maps through the use of GIS.

## **6.6 Conclusion**

As mentioned in the literature review, spatial analysis does not necessarily provide absolute solutions, especially in the social sciences' applications. However, GIS and spatial analysis offer the means to analyse visually data with a spatial component for enhanced decision making and admissions' planning. In a higher education application context, the data is annual and always current, thus the decision-making process will always be well informed and in 'real time'. For example, when applicants indicate their first choice course of study in the Science faculty, the recruitment officers could spatially locate each applicant. The areas that seem to have few or no applicants to the Science faculty may be identified in advance by recruitment officers and recruitment packages, or visits to such areas could be arranged. This is to avoid serving areas that are already well served or areas where UCT has already secured annual school feeders.

## **7 CHAPTER 7: FUTURE IMPLICATIONS AND CONCLUSION**

### **7.1 Future Implications**

#### **7.1.1 *Data for Spatial Analysis***

The analysis reveals that AARP and the UCT admissions' office would improve the selection process were they to collect and organise applicant data in a way that is GIS-compatible. When capturing application forms or AARP data, a unique national identifying code, such as the EMIS number of the school, would improve the data quality. The EMIS number can also be the standard for all South African universities, because it is then easier to merge different datasets and to perform data quality checks, because the EMIS number is unique to each school.

In 2006, AARP started collecting more biographical and geographical information on candidates as they underwent the test. This information includes the attributes of the schools, such as whether the school has computers for learners, library resources and other facilities. Other information is spatially relevant, such as the approximate distance a candidate travels from home and whether the school is situated in a rural or urban area.

Since not all students are required to write the test, additional biographical and spatial information on students who do not write may be gleaned, in addition to the already existing data on the 'Additional School Information Report' which is part of the application package sent to all applicants.

#### **7.1.2 *Questionnaires Distributed to Previous AARP Candidates***

An effective way to determine the reasons for candidates' writing in their chosen test centres and to substantiate some of the graphic displays would be to distribute a questionnaire to previous AARP candidates. Such a questionnaire may pose basic questions such as the name of the test centre one wrote in, which test centre would be the closest to the candidate both from home and school. The questionnaire may also help address questions as to candidate perceptions regarding the distance to the test centre and whether this affected their performance in any way.

#### **7.1.3 *AARP Test Scores***

Although many AARP candidates are clustered in urban areas in each province, it is still fundamental to identify the previously-disadvantaged schools within the urban areas using AARP test scores. AARP test scores, combined with the type of school a candidate attended, would give a better reflection of academic performance at school level. This would also assist the school-level

administration and further education improvement analysis to see which areas are underserved and under-performing.

Mapping of the AARP test scores is a potential indicator that may assist in identifying the previously-disadvantaged and under-performers within urban and township schools clustered around test centres. The test scores at AARP are analysed using four deciles denoting the above- and below-average scores. Students with below-average scores are regarded as less likely to perform well at university, although this is not always the case. Urban areas and townships have a diverse mixture of schools in terms of quality of education and resources even though the municipalities under which these schools fall have good socio-economic status in general. Clustering test scores by schools and then by larger spatial units may pinpoint schools that are under-performing so that further investigations could take place.

Further analysis may be conducted to see whether students who travelled longer distances to the test centres obtained lower AARP scores than those who were closer to the test centre. An appropriate distance or travel time will have to be determined as opposed to using the 50 km determinant of this analysis. The test scores of various students may be correlated with distance travelled, in order to ascertain academic competency.

#### **7.1.4 *Extension of the Study for Purposes of Comparison***

Overall, AARP seeks to identify the previously-disadvantaged students and to facilitate their access to UCT. Considering that AARP tests are used by most South African higher institutions for the same purpose, this study may be expanded to include other South African higher education institutions that make use of AARP tests, in order to compare the admission pools. Once all the institutions have indicated their admission pools geographically, areas that show low or no participation in higher education may more easily be targeted. The aim of South African education authorities is to make education accessible to all citizens. This would therefore be another way of identifying gaps or areas that are underserved by higher education institutions in South Africa.

## **7.2 Main Conclusion**

The main aims of the dissertation were to demonstrate the use of GIS and spatial analysis in various stages of the admissions' process through AARP at UCT, and to raise issues that are relevant for the recruitment and admission to the university using AARP candidates. Beyond the external services offered to candidates, resources within the university to address the range of academic needs may also be considered prior to admission, using GIS to understand patterns in schooling and socio-economic background. In this way, a more diverse student body may be

attained and sustained, thus meeting one of UCT's transformational goals. This diversity incorporates racial and gender composition of candidates, a well-balanced local, provincial, and national geographical distribution of candidates and a range of resourcing levels within the target schools.

AARP administers alternative admission tests for prospective UCT students, which are written throughout the country prior to their coming to university. AARP test centres are distributed across the country and are considered UCT services offered outside the university. AARP services contribute to the recruitment for universities in South Africa, but the data examined in this dissertation relates only to AARP students enrolled at UCT. Thus, in order to attract a higher proportion of previously-disadvantaged students (as noted in the AARP mission) and to build a diverse student body at UCT, the test centres need to be optimally located for easy access for all learners who wish to gain admission to UCT.

GIS and students' data in this dissertation revealed that maps simplify the process of geographically identifying areas that have not been reached by AARP or the university. It is in this instance that spatial analysis, based on the home address of candidates would have revealed socio-economic background at enumerator level as opposed to the current general analysis of the candidates at the municipal level.

It is evident that the diversity and transformation of the student body at a higher education institution is not independent of geography. In addition to elements that constitute diversity, as outlined in Carignan et al (2008), namely race, culture, language, religion, gender, disability groups, non-traditional roles, attitudes, beliefs, values and behaviour, geographic location is the base that fabricates these diverse factors. It is evident from the maps presented in this dissertation that, were all the diverse elements integrated and displayed, this would provide further and collective insight into the university admissions' process as well as in understanding issues of transformation within UCT. Overall, the geographic coverage of students interested in studying at UCT implies a relatively rich diversity within the candidate body.

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## 9 APPENDICES

### 9.1 Appendix A

**Table 9-1: List of Education codes and former education departments as used by AARP**

#### Old Education Departments

Ex-HOA Model C	NA	Natal Ed. Dept. (Old White)
	TR	Transvaal Ed. Dept.
	OF	Orange FSEd. Dept.
	CA	Cape Ed. Dept.
	NE	National Ed. Dept.
	IE	Independent Education Board
	FO	Foreign Education Board
	CL	Cambridge Education Board
IN	Indian	

Ex-HOR	CO	Dept. of Education and Culture (Coloured)
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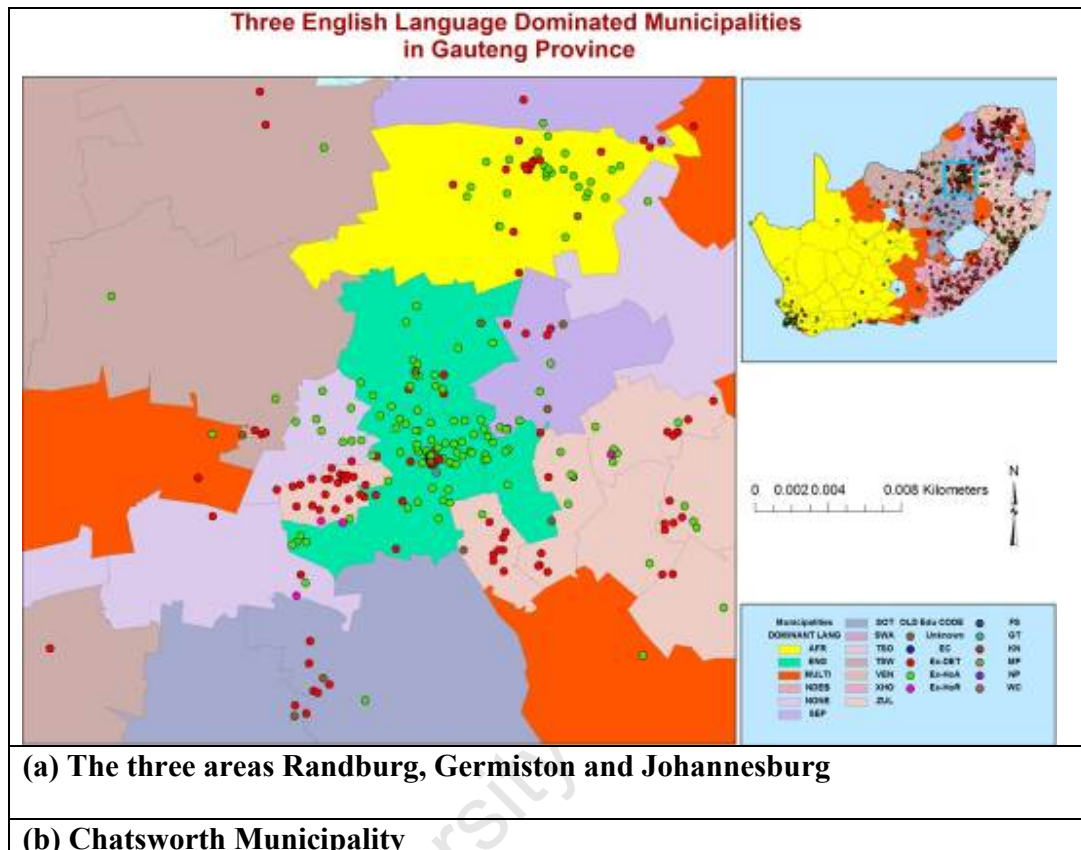
Ex-DET	TK	Transkei Ed. Dept. (SA Black)
	ET	Dept. of Education and Training

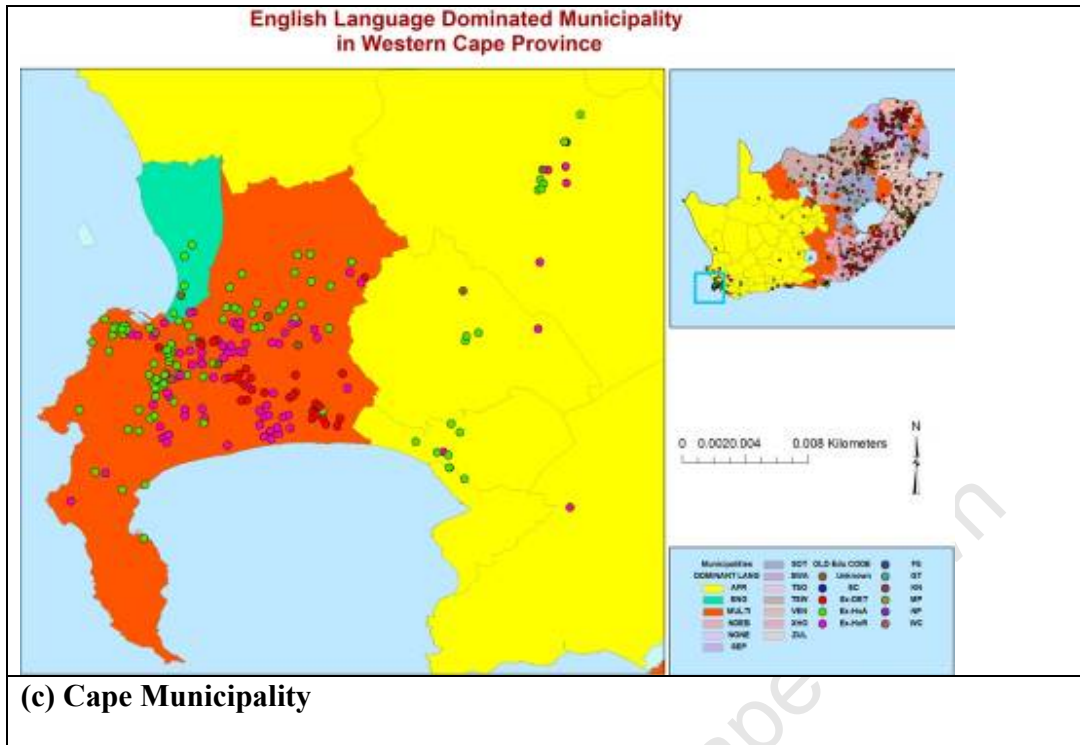
#### New Education Departments

AE	Associated Examining Board
CA	Cape Ed Dept.
CL	University of Cambridge Local Examinations
CO	Education and Culture: House of Representatives
ET	Department of Education and Training
FO	Foreign Examining Authority
IE	Independent Examination Board
IN	Education and Culture: House of Delegates
JM	Joint Matriculation Board
NA	Natal Education Department
NB	Ministry of Education / Culture / Youth / Sport, Namibia
NE	Education and Culture: House of Assembly
NN	Authority not known
OF	Orange FSEducation Department
TK	Transkei Education Department
TR	Transvaal Education Department

## 9.2 Appendix B

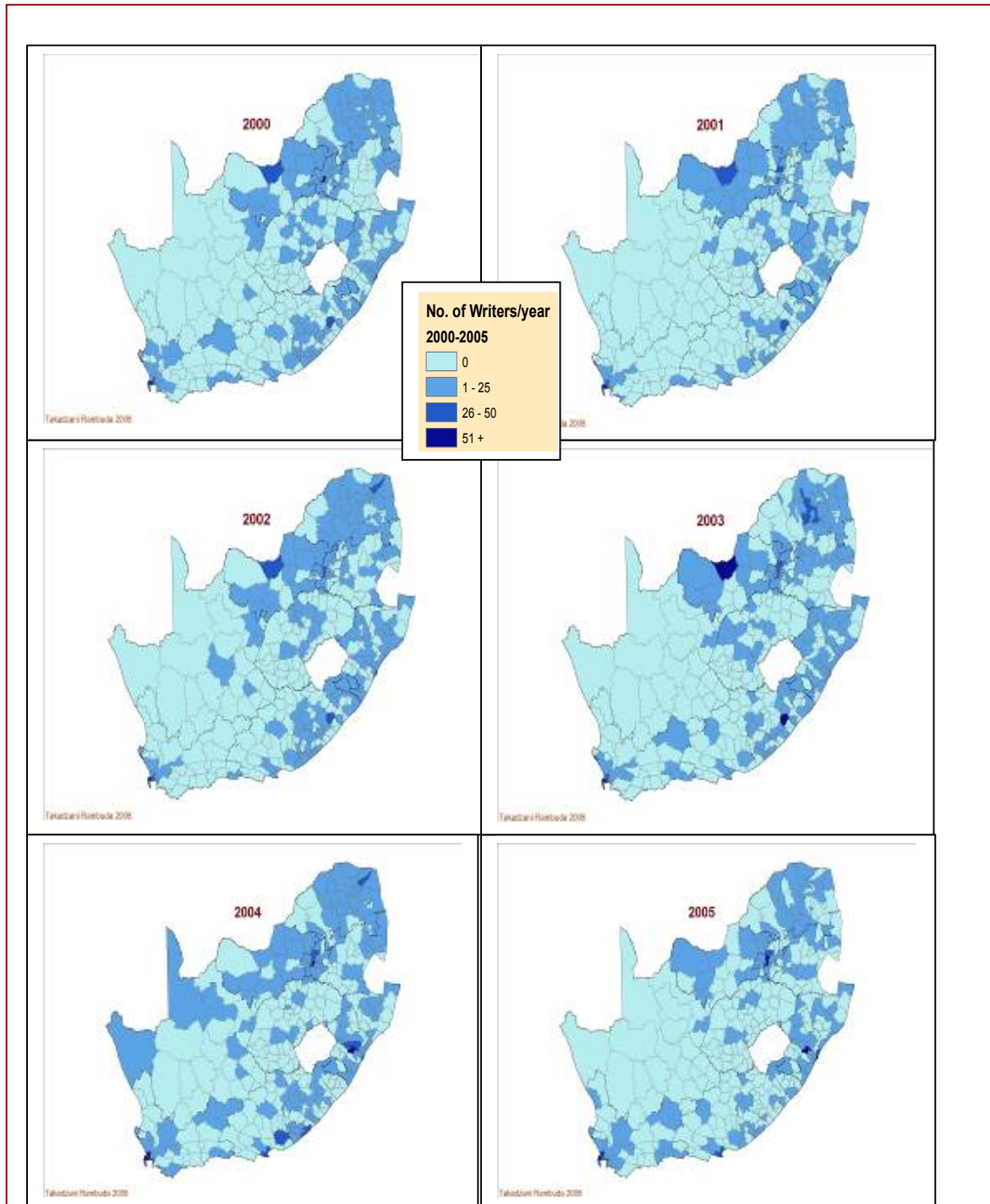
English language dominated municipalities (shaded in medium apple green)



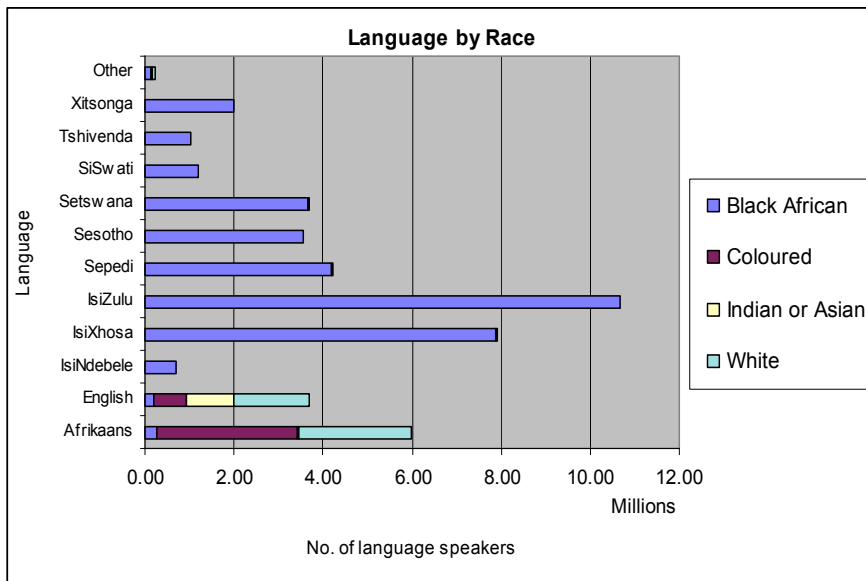


**Figure 9-1: English Language dominated municipalities (a, b and c)**

### 9.3 Appendix C



**Figure 9-2: Spatio-temporal distribution all AARP writers, 2000-2005**



**Figure 9-3: Language by population group in South Africa Source: Statistics SA, 2001**

**Table 9-2: Number of ordinary and independent schools by province (source: 2006 SNAP survey)**

Province	No. of Schools	No. of learners
KZN	5954	2,768,015
EC	5886	2,100,425
LP	4102	1,771,320
GT	2388	1,863,375
MP	2079	1,092,382
NW	1841	772044
FS	1818	685971
WC	1579	978517
NC	622	261736

**Table 9-3: Gender by first choice faculty of study for recommended students**

First Choice Faculty	Sex		Total
	F	M	
None	95	90	185
COM	89	149	238
ENG	25	51	76
LAW	29	16	45
MED	103	45	148
SCI	36	40	76
SSH	378	195	573
Total	755	586	1527