

Fracking into the Karoo Economy:

The main question that this research explores is what is the current economic and demographic profile of the small Karoo towns of Carnarvon, Victoria West and Williston and what will the short-term economic and social affects be on these towns be in the event of the development of a shale gas industry in the Karoo? Additionally, the research has identified numerous studies that show that shale gas exploration and production would cause damage to the natural environment and have long term negative ecological impacts. The thesis describes these briefly but does not attempt to assess these in relation to the short term impacts, although it is clear from these studies that a comprehensive study of the costs and benefits of shale gas exploration and production would have to take these into account.

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Abstract

With the potential for shale gas extraction in the Karoo region of South Africa, every effort must be undertaken to understand what the effects this transformative industry may have. This paper attempts to explore what effects the industry may have on “small” Karoo towns by creating a demographic and economic baseline for three towns in the region and compares this with a shale gas extraction future. This was grounded in sociological research based on the “Boomtown Model”, which attempts to understand the effects extractive industries have on small towns. The thesis finds that small Karoo towns are particularly vulnerable to the negative effects of the Boomtown Model, in light of their current profile which shows the rural economy has been declining for many years, which is coupled with a number of social issues that affect towns such as alcohol abuse and inter-personal violence. This paper concludes that a new shale gas industry will not benefit the residents of the Karoo unless a suitable policy framework is in place that ensures long term beneficiation and mitigates the environmental costs.

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Glossary

CCGT	Closed cycle gas turbine
CSP	Concentrated solar power
EIA	Energy Information Administration
FAS	Foetal Alcohol Syndrome
GW	Gigawatt
Igneous (Sill)	Igneous rock is one of three main rock types, the others being sedimentary and metamorphic. A sill is a horizontal formation of rock.
IPP	Independent power producers
IPV	Intimate partner violence
IRP	Integrated Resource Plan
LNG	Liquid natural gas
MW	Megawatt
MPRDA	Mineral and Petroleum Resources Development Act
NDP	National Development Plan
NLSA	National Library of South Africa
NPC	National Planning Commission
OCGT	Open cycle gas turbine
PASA	Petroleum Agency of South Africa
SKA	Square Kilometre Array
TCF	Trillion cubic feet
UNFCCC	United Nations Framework Convention on Climate Change

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Chapter 1: Introduction

Problem statement

The Karoo is a semi-arid region located in the central and western interior of South Africa and covers an area of approximately 400,000km². The region could potentially see the rapid development of a shale gas (fracking) industry in the near future, which will certainly have an impact on resident communities. This could lead to an industrial boom in a regional economy based on small stock pastoralism for the past century and a half. The resource boom in the United States in the 1970's and 80's, in response to the 1973 oil crisis, saw rural, isolated towns undergo a similar transformation. This transformation was both positive and negative and generated an entire body of literature devoted to the "Boomtown Model" (Krannich & Greider 1984; Summers & Branch 1984; Little & Lovejoy 1979; Gramling & Brabant 1986; Gopalakrishnan & Klaiber 2013; Muehlenbachs et al.. 2015). South Africa can draw on these experiences and attempt to mitigate the negative economic and social effects of a shale gas boom in the Karoo. Before this is possible, one needs to determine what effects shale gas extraction may have on the region.

Background

South Africa is currently in the midst of an energy crisis that has affected demand sectors since 2008. The electricity sector is in the process of expanding generation radically over the course of the next 36 years until 2050. This is based on the Integrated Resource Plan (IRP), which highlights a number of technologies and scenarios whereby generation is suitably expanded. Each scenario that is modelled in both versions of the IRP, returns the optimal outcome in terms staying below the targeted GHG emissions levels and obtaining the lowest possible cost. This document favours a nuclear option that has seen favour recently in South Africa and would provide a large portion of the country's baseload power needs. In a later iteration that has not yet been systematically taken up by government, shale gas is proposed as a mid-merit generation option. Further to electricity production, gas has a number of applications in industry and for commercial use, that the development of local shale gas would certainly stimulate. The specific technology used to extract unconventional gas resources, known as high-volume (HV), slick water hydraulic fracturing, was first used in 1999 in the Barnett Shale in Texas (Schafft et al.. 2013, pg.145). This is a large geological formation in the

United States where vast quantities of unconventional natural gas can be found deep underground. Fracking technology made enormous energy reserves such as the Barnett and Marcellus Shale in the USA accessible where previously they were not (IHS Global Insight 2012). While globally, many would like to see a rapid shift away from the use of hydrocarbon energy, shale gas looks likely to delay this shift. The industry rhetoric claims it is a “stepping stone” to a more renewable based generation because it is a less intensive emitter of greenhouse gases (GHG) than oil and coal.

South Africa made its own climate change commitments in response to international pressure and supposed legal obligations from the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol (Department of Environmental Affairs n.d.). Through these commitments, South Africa proposes to increase emissions at a reduced rate, such that they peak at 34% below a “Business as Usual” trajectory in 2020 and 40% in 2025, whereby emissions will remain stable for around a decade and then decline in absolute terms. As energy generation makes up a significant portion of GHG emissions, the mitigation of the effect of the generation sector has become a priority. The Integrated Resource Plan for Electricity (Department of Energy 2013) outlines a number of possible future trajectories for the electricity generation sector, with shale gas being one option. The shale gas scenario allows South Africa to stay within its climate change commitments while offering the cheapest avenue for new generation.

The commencement of shale gas exploitation, said to begin in 2017 (Pressly 2014), will see rapid development of the Karoo region in South Africa which is guaranteed to have noticeable impacts, economically, socially and environmentally. As the Karoo economy has been primarily geared towards small stock pastoralism for the past one hundred and fifty years, there is currently little evidence on which to base assessments of how a new extractive industry might impact towns in the region. While there have been studies that examine Karoo towns (Toerien & Seaman 2010; Conradie et al. 2009; Conradie 2006; Nel & Hill 2011; Nel & Hill 2008; Pretorius & Blaauw 2004; Ingle 2013), they provide little evidence to suggest how these communities might react to, for example, having increased spending power, higher rents, housing shortages and higher crime rates (Krannich & Greider 1984; Summers & Branch 1984; Little & Lovejoy 1979). These are common correlations that are often associated with “Boomtown” activities.

Shale gas is not the only potential game-changer in the region. The town of Kathu in the Northern Cape recently ramped up production on an iron ore mine which has changed the economic and social landscape of the town completely. Mines are not comparable to hydraulic fracturing wells as they are situated in a single site with a very high concentration of labour and housing required to service their needs. Shale gas exploration may create a similar level of jobs, though these will be dispersed over a much wider region. Furthermore, the first stages of the Square Kilometre Array known as the MeerKAT, began in 2013. The MeerKAT is a 64-dish radio telescope under construction to the north of the towns of Carnarvon and Williston. The presence of the SKA will limit the area in which shale gas exploration may take place. Mining, the SKA and a shale gas industry

will have a huge impact on the region in the next few decades and will all be considered in this paper, with the primary focus on shale gas exploration. The following section shows the geographical setting of the study, followed by the aims, objectives, research question and methodology applied to the problem statement.

Setting of study

The setting of this study is in the central Karoo, in the Northern Cape province of South Africa. The three towns that form the basis for the case study are Carnarvon, Victoria West and Williston.



Figure 1: Area of study (Google 2013)



Figure 2: Location of study (Google 2013)

Aims

This thesis aims to explore the likely social and economic effects of shale gas extraction in the Karoo region of South Africa. There is limited literature dedicated to describing the state of the Karoo economy at different points in its recent history (Wentzel 1984; Conradie & Natrass 2013; Conradie et al. 2009; Nel & Hill 2011; Nel & Hill 2008; Pretorius & Blaauw 2004; Ingle 2013). The most recent works focus on declining total factor productivity, predator control, changing population trends, the growth of tourism and “counter-urbanisation” and the worsening state of social health in the region. There has been little attempt to collate these perspectives in an effort to understand the trajectory one might expect to see in the Karoo in the event of an economic boom related to the three most relevant events in the Karoo, namely: shale gas extraction, mining or the Square Kilometre Array (SKA).

To explore the changes that might come from shale gas extraction, this paper aims to identify an economic, social and demographic baseline for Karoo towns to use as a comparison against a potential shale extraction future. This baseline needs to encompass not only the present and future state of the town’s economies, but also the social health of the towns. This paper thus aims to compare the potential outcomes of a future with and without shale gas extraction.

Through the creation of a baseline which will establish what the state of Karoo economies and society is, one can compare these with futures if shale gas extraction is introduced. The first step in creating a baseline in the Karoo is to describe the current state of the economy and society. This thesis aims to describe such a baseline, following which a comparison can be made between the baseline and the potential impacts of shale gas extraction on Karoo towns. This comparison will consider a timeline that extends only through the anticipated period of the shale gas extraction itself. While it considers the lasting effects of shale gas extraction to be important, consideration of such effects would unfeasibly increase the scope of the study. Within this timeline, the performance of Karoo town economies will be explored, as well as negative social characteristics expected in the baseline and shale gas extraction futures respectively.

The Karoo region itself encompasses a large population, living within different contexts be it rurally, or in towns and cities. This thesis intends to focus on the impacts shale gas extraction will have on small Karoo towns.

Objectives

The objective of this thesis is to identify an economic and demographic baseline for Karoo towns, in order to compare to a future whereby shale gas extraction occurs. This thesis intends to focus on small Karoo towns that have similar economic and population profiles. Assisted by the definition set out in Hill and Nell's paper (2011) on demographic and economic change in Karoo towns, this paper considers towns with a population of less than 10,000 people to be "small", and intends to focus purely on towns in this category. Furthermore, while acknowledging the long-lasting effects that shale gas extraction may have, this paper intends to focus only short term effects, lasting the anticipated length of the industry's presence in the region.

In order to identify a baseline, this thesis will use telephone directories to identify the number and diversity of enterprises present in small Karoo towns over time. In support of this argument, the "Transfers of Rural Immovable Property" (Bureau of Statistics n.d.) Directory will be used to identify the relative value of land in the Karoo over time for the period 1971-1995. These two sources form the basis for determining the state of small Karoo town economies.

This data will be interpreted in parallel with demographic data obtained from national censuses to determine the changing nature of population growth and the growth and decline among different ethnicities.

Secondary sources will be used to highlight the negative social characteristics that affect small Karoo towns. Thus, a baseline of small Karoo towns will have been established that will comment on the economic performance, as well as the negative social characteristics associated with such towns. Following this, the paper will compare this baseline to a shale gas extraction future that will be explored through the "Boomtown" or "Social Disruption Hypothesis" theoretical framework. This framework is discussed in more detail in the Methodology section below.

Assumptions and limitations of the study

The assumptions and limitations of the study are as follows:

- The towns being examined are considered "small", meaning > 10'000 people under Hill and Nels definition (2008).
- Data collected from historical censuses and telephone directories are assumed to be sufficiently representative for the purpose of this study. Some key limitations entailed in this assumption are:

- Based on a field visit to Carnarvon and Williston in August, 2014, I noticed there were a number of informal businesses in the towns that were not accounted for in the telephone directories. These businesses were typically small convenience stores and occasionally a “payday” loan enterprise which in all likelihood, do not have a landline.
- The local authority areas in which the towns of Carnarvon, Victoria West and Williston changed between 1996 and 2001 (censuses). This will be explained in more detail in the section, “**Error! Reference source not found.**” in the following chapter.

Research Question

The primary research question for this thesis is as follows: **The main question that this research explores is what is the current economic and demographic profile of the small Karoo towns of Carnarvon, Victoria West and Williston and what will the short-term economic and social affects be on these towns be in the event of the development of a shale gas industry in the Karoo? Additionally, the research has identified numerous studies that show that shale gas exploration and production would cause damage to the natural environment and have long term negative ecological impacts. The thesis describes these briefly but does not attempt to assess these in relation to the short term impacts, although it is clear from these studies that a comprehensive study of the costs and benefits of shale gas exploration and production would have to take these into account.**

Chapter 2: Methodology

This study will firstly identify economic and social trends for three small Karoo towns, namely: Carnarvon, Victoria West and Williston. The researcher chose these towns based on the extensive primary data available for each of them, more so than other Karoo towns investigated. This was further complimented by a site visit to these towns in September of 2014. Therefore, the conclusions drawn in this thesis intend to apply to “small” Karoo towns, such as the three towns that were studied. “Small” in this respect refers to towns that are populated by less than 10’000 people, as per Hill and Nel’s (2008) definition which will be expanded upon shortly. The data on enterprises is complemented by population data obtained from national censuses, followed by an analysis of this data that explores economic and social trends in the Karoo over the past century.

From the existing literature and the discussions with advisors it was established that no baseline social and economic data existed for Karoo small towns and that this was needed to complement the growing research on fracking in South Africa.

The primary research is archival, extracting evidence from historic telephone directories and census data in order to create a demographic and economic profile of the case study towns. This paper applies the theoretical framework developed in the “Boomtown Model” - a theme that emerged in the USA in the 1970’s. This hypothesis focused on towns that experienced rapid economic and population growth, typically in association with resource extraction. As the research question for this thesis implies, this hypothesis will explore whether a similar transformation will take place in small towns in the Karoo in light of a shale gas extraction boom. Briefly, it is anticipated that certain small Karoo towns will undergo population growth and increased job opportunities, which will be associated with an increased strain on municipal services such as healthcare, education and law enforcement. Furthermore, one expects to see a decreased quality of life for long-term residents, decrease in other industrial activity as more resources are allocated to servicing the new shale industry and finally increased housing costs, which are a significant burden to the longer-term residents.

As mentioned previously, this thesis will only cover the temporal period when the boom is taking place and immediately after the industry packs up and leaves. The longer term economic effects of the hydraulic fracturing activities in the area are still very important, such as the effects on water sources and the potentially long-lasting effects of the social landscape but these items, while important, fall outside the scope of the current thesis.

Secondary literature

The use of secondary literature provided the basis for necessary context in answering the research questions asked by this paper. The secondary literature focuses on a few key different themes, namely: the historical background and economic and social makeup of the Karoo region; “boomtowns” and their characteristics; the SKA; the Kathu mine and shale gas extraction.

Primary literature

In order to create a baseline of the businesses that exist within the towns of Canarvon, Victoria West and Williston, telephone directories were used at approximately five year intervals from 1982, to the present. 1982 was the oldest available directory at the National Library of South Africa (NLSA). I was unable to source the 2002/2003 and 2007/2008 telephone directories, as the NLSA stopped collecting telephone directories after 1997. The 2009/2010 and 2012/2013 directories were sourced from a contact in the Karoo and used to extend the data set to the near present.

The telephone directories inventoried were:

- 1982
- 1987
- 1992
- 1997
- ~~2002~~
- ~~2007~~
- 2009
- 2012

Each business would be placed in 1 of 19 categories. These categories were taken from a paper by Toerien and Seaman (2010), which identified six primary sectors that brought money into Karoo towns, followed by 13 service sectors. The enterprises that fall under the latter group in Karoo towns develop as a response to the primary sectors. They are listed in order of importance. These categories were developed on the basis of a census of 47 Karoo towns to argue that towns were “enterprise ecosystems”. Toerien and Seaman’s categories are the following:

Economic drivers

- | | |
|---------------------------------------|-----------------------------------|
| 1. Agricultural products and services | 2. Processing sector |
| 3. Factory sector | 4. Construction sector |
| 5. Mining sector | 6. Tourism and hospitality sector |

Service sectors

- | | |
|--|--|
| 7. Engineering and technical services | 8. Financial services sector |
| 9. Legal services sector | 10. Telecommunications services sector |
| 11. News and advertising services sector | 12. Trade sector |
| 13. Vehicle sector | 14. General services sector |
| 15. Professional services sector | 16. Personal services sector |
| 17. Health services sector | 18. Transport and earthworks sector |
| 19. Real Estate sector | |

The data for each of the three towns was extracted from the telephone directories onto an MS Excel spreadsheet and allocated to one of the 19 categories. The types of businesses that fall under each section can be seen in Appendix 1. The enterprise categorization for each town can be seen in Appendix 2.

The second source of primary data were the national population censuses from 1951 to 2001. South Africa is made up of 9 provinces, which are further divided into 44 district municipalities. These are further divided into local municipalities. Previously, each town in South Africa had its own local government, but since 1996 their functions were absorbed by local municipalities. Therefore, from 1951 to 1996 the defined area of rural and urban areas remained constant for all three towns. After 1996 each town was incorporated into larger administrative areas comprising a number of towns. While this change does not affect the urban population count of the three towns, it does the surrounding rural population making the tracking of the rural population trend impossible after 1996. The more recent 2011 census was not included in the study as it did not aggregate data at the town level. The lowest level of aggregation was the local municipality level.

The final source was a directory compiled by the Bureau of Statistics of South Africa, known as "Transfers of Rural Immovable Property" (Bureau of Statistics n.d.). This directory captured every transfer of rural property within South Africa, the general size of the property and the price for which it was sold. For the purpose of this thesis, it was used to identify the relative value of land in the Karoo over time for the period 1971-1995. The exact method that was used to do so is explained in the section below.

Data collection and analysis

The following section explains how the data were analysed.

Analysis of Census Data

The census data was obtained through the UCT Government Publications department. Data from censuses prior to 1996 was extracted onto an Excel spreadsheet to facilitate analysis. The 1996 and 2001 census data was downloaded from online sources in the library and added to the spreadsheet. This data was then plotted as graphs to identify major trends. The previous collation of census data relating to the entire Karoo region by Hill and Nel (2011, pp.401-407) was used in the population analysis. The census data was used to identify population trends in Williston, Carnarvon and Victoria West over the past 50 years. South Africa's system of racial classification allows changes in population of different ethnic categories to be identified over the same period.

Analysis of Telephone Directories

Telephone directories were obtained through the National Library of South Africa (NLSA) and a private person in Williston. The NLSA collected all national telephone directories up until 1997/1998. I relied on a private resident in Carnarvon for the 2009/2010 and 2012/2013 directories. I also visited the towns of Williston and Carnarvon in October 2014 to my own rough account of the economic make-up of the towns within the SKA area. While the trip was used to check the reliability of telephone directories, it did not directly contribute to the research. It did, however, reveal that the informal economy, particularly in the black townships adjoining each of these three towns, was unrecorded in the directories. There were informal sector enterprises that were not recorded, such as convenience stores known as Spaza shops and "payday loan" facilities. I consider these of secondary economic importance to the enterprises recorded as these types of businesses do not all under the "economic drivers" as described earlier.

Additionally, Google Maps was used to get a more complete understanding of the case study towns, in particular to assess the reliability of telephone directories as a data source. By accessing the "Street View" function on Google Maps, which was recorded in December 2010 for all three towns, I had visual access to the main streets in each town and could confirm the existence of each enterprise in the telephone directory. In this way, I could check the validity of the 2009/2010 directory.

Each telephone directory was examined thoroughly to pick out the businesses in the three towns town. Once these businesses were identified and recorded in a Word document, they were transposed into an Excel spreadsheet under one of Toerien and Seaman's nineteen enterprise classifications. A timeline of 30 years was used (1982/1983 – 2012/2013) with 5-year intervals. This allowed the data from the three towns to be compared with each other to identify the underlying structures and how that had changed over time. The analysis excluded government services.

Analysis of Rural Land Transfer Directory

The years 1965-1995 of the Transfers of Rural Immovable Property were obtainable through the UCT Government Publications department. From 1965 to 1970 the land measurement used was the morgen and thereafter hectare. For this reason the analysis began from 1971 and extended through until the final year available, 1995. From 1971-1979 I analysed the land transfers data from the Carnarvon and Victoria West rural area, in particular the average price (R) per hectare of land sold. Unfortunately the directory did not include the Williston rural area. From 1980 until 1995, the directory no longer included smaller towns such as Carnarvon and Victoria West, and so the area of Bo-Karoo was used as a substitute. This area is shown below:

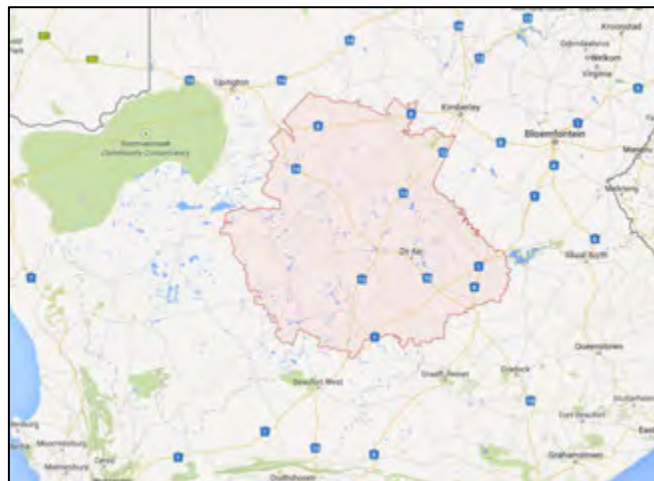


Figure 3: The Bo-Karoo (Google 2013)

As this area includes the towns of Carnarvon and Victoria West, including a wider ranging part of the Karoo whereby the type of agriculture practiced is similar, I felt it was appropriate to continue the analysis using this as the area.

The data was extracted and put onto an Excel spreadsheet for analysis. Using a consumer price index (CPI) for the years 1960-2014 obtained from Statistics South Africa (Statistics South Africa 2014), I was able to meaningfully compare the changing value of rural land in the Karoo, using December 2012 as the base year with an index value of 100. The data collated for analysis is shown in Appendix 5.

Chapter 3: Literature Review

The intention of this literature review is to cover the most pertinent points that will provide the reader with the necessary context to understand what effect new economic development will have on Karoo urban centres. The ultimate purpose of this thesis is to identify what the effects of fracking are likely to be on small Karoo towns by creating an economic and demographic baseline for these towns to compare against a potential shale gas extraction future. This research is the first of its kind, identifying the economic progress of three Karoo towns in the Northern Cape, over a 30 year period.

This literature review will begin by examining the “boomtown model”. It will start by discussing its roots in the USA in the 1970’s and 1980s, followed by a critical overview of the model and its limitations and finally how this model might inform future research in the Karoo context. It will draw on literature from the boomtown experience in the USA, literature that addresses the past and current economic status of the Karoo. This will be followed by a brief look at the potential negative social effects any new development may have on the towns. Finally, this review will examine literature from the USA experience of shale gas extraction, including what the potential economic and health implications for those affected by shale gas extraction.

Boomtowns

“Boomtowns are places that experience rapid economic and population growth, typically in association with mining or other types of resource extraction and occasionally in connection with other growth contexts involving rapid demographic change and economic change.”(Schafft et al.. 2013)

Energy development in the United States grew at an unprecedented level during the 1970’s, primarily in response to the 1973 oil embargo and the 1979 Iranian Revolution. (Jacquet & Kay 2014, pg. 4-6). Conventional fossil fuels such as coal, oil and natural gas were extracted in previously under-developed areas. Many of the new employment opportunities could not be filled locally which resulted in massive migration to these developing areas around the country.(Gramling & Brabant 1986, pg. 176) The number of manufacturing jobs in non-metropolitan areas in US Counties increased by 23.9% while in metropolitan areas, they rose by just 3.9%.(Summers & Branch 1984, pg.141) As the population increased, community resources become strained – one of the first problems was a shortage of housing. Following this, government services such as medical facilities, schools, law enforcement and public works all began to take strain. A number of sociological studies addressed the phenomenon in the early 1980s, which was named the “boomtown model” or “social disruption” hypothesis (Krannich & Greider 1984; Summers & Branch 1984; Little & Lovejoy 1979). The

hypothesis posits that increased population associated with energy related growth will cause disruptive change in small communities, notably with regards to; the overburdening of municipal services, an increase in housing costs, increased mental health caseloads and a decreased quality of life for long-term residents. Furthermore, the rapid growth in one sector, such as shale gas, results in a decline in industrial productivity – this occurs because the labour force attracted to the area is incapable of meeting the new population’s community and local business needs. This is because the new population is attracted to an area primarily in the interest of working on the boom-related activity and the service sectors are not able to grow as fast as the inflated population.

The boom period is followed by a “bust”. This bust is typically characterised by the completion of the extraction operation whereafter employment opportunities decline with a consequent out-migration of a large portion of the population. This thesis argues that the Karoo small towns are vulnerable to such changes, based on the nature of the industry and the isolation of the towns. . For the most part, the region has been reliant on small stock pastoralism.

The boomtown model has its limitations. Jacquet and Kay (2014, pp.6-12) challenge some of its assumptions to provide a more relevant model for the recent shale boom. The first of these is the assumption of rurality and isolation that is typically associated with boomtowns. The older model describes affected towns as rural and geographically isolated, without any prior development experience and that these “virginal” attributes are vulnerable to social and economic disruptions. This definition is particularly limiting in the 21st century due to the dispersed nature of the shale gas industry and improvements in technology and transportation, which have effectively reduced the isolation of these towns in every regard. In the case of the shale gas industry in particular, shale “plays” or areas whereby one can extract shale gas, are spread out over massive areas rather than concentrated in one area in particular. If it is the case that towns are far less isolated than the model assumes, then the negative impacts of major development as severe as the new population would be dispersed over a wider area. The burden on municipalities and the housing sector would be greatly reduced compared to if the impact were on a single small town.

This leads into the second limitation; the assumption of “spatial and temporal concentration”. Many previous boomtown studies involved a single resource set in a single fixed location. The length of time of the boom-bust cycle could vary, but the location would not. The shale gas boom is different in the spatially dispersed nature of the industry. Therefore, Karoo towns will not necessarily be the centres of development, just the nearest inhabited settlements of an expansive extractive industry. Furthermore, certain areas near to development could be very large urban centres, such as De Aar or Bloemfontein, however the effects of shale gas development on cities is not the subject of this thesis. As discussed in introduction, this thesis examines a predefined temporal period in the interest of a thorough investigation, however this will not cover the full period of the bust cycle.

Economic effects

The oil and gas industry have advertised a number of economic benefits from fracking, including: job creation, higher wages, natural resource royalties and increased demand for local businesses. This sort of reporting of the success of the shale gas industry tends to focus on macroeconomic benefits (Jenner & Lamadrid 2013, pg 443) and fails to hone in on the particular effects shale gas extraction may have on smaller towns.

A report published by Econometrix (Pty) Ltd. (2012) models a number of scenarios predicting such outcomes. This report consequently received a cold reception from a number of parties, claiming that critical elements of the modelling were not properly factored in, such as well-head cost and the infrastructural costs associated with a shale industry (Fakir 2014, pg.8)(Wait & Rossouw 2013, pg.6). Industry advertised benefits, as well as those highlighted in the Econometrix report may well be direct consequences of a shale gas extraction boom, though the boom experience will be different depending on the existing conditions in the towns affected. Furthermore, advocates of energy-related development in rural areas often argue for associated benefits that rest on a number of assumptions. Firstly, that rural residents will desire positions within the new industry, second that a large number of locals will apply for the available jobs, that local applicants will possess the requisite job skills and finally that the industry is willing and able to hire a substantial portion of the local applicants (Little & Lovejoy 1979, 170).

Hydraulic fracturing will create jobs primarily on the wells themselves. These jobs will come in the form of construction followed by the operation of the well. The USA has had an established oil and gas industry for over a century and as such, benefits from the local workforce and expertise. The labour required to meet the demands on site will have to be imported or trained in South Africa. On the other hand, a direct consequence of the influx of a skilled workforce. On the other hand, a direct consequence of this will be the creation of “induced jobs”, as many as 20-45% of jobs created (IHS Global Insight, 2012, pg. D2), in nearby towns. These jobs will service the requirements of people working in the industry, particularly in the accommodation and the trade sector. Once a place is characterised as a ‘boomtown’, the implication is that it has seen significant economic and population growth. Input-output (IO) models provide a quantitative measure of the impact of growth. These analyses are used to identify industry relations and how spending in one sector affects other sectors of the economy (Considine 2010). This type of analysis does well to explain the growth and decline of the various sectors within towns, though it fails to identify what the impacts of those changes were. Steck (2014) highlights the unprecedented levels of housing rents associated with the fracking boom in Pennsylvania as one such area of growth with negative side effects, particularly for long-term residents. In towns, higher rents will be accompanied by heavy truck traffic and an increased demand for local retail business.

Furthermore, government services will come under severe strain attempting to meet the increased needs of urban centres. In the Karoo, this issue might be particularly challenging. Van Rooy (2007, pg5) notes that the amalgamation of small town centres in the Karoo under a single local municipal authority has weakened smaller towns. On top of this, the local authorities are incapacitated by lack of finances and personnel, and the area has high levels of corruption among local government officials. Karoo local authorities will struggle to meet the development and maintenance needs of the region in the event of a sudden spike in economic activity.

Similarly to Karoo towns, the town of Kathu in the Northern Cape has recently experienced the enormous impact mining can have on the housing sector. The town was established in 1970 as a direct result of an iron ore mine and recent Chinese demand has resulted in renewed prosperity for the town. Employment at the mine increased to 8213 people in 2012 leading to a housing shortage and very high rentals in the area (Marais & Cloete 2009, pg.34)(Emuze & Hauptfleisch 2014). When the mine closes it will leave a large unemployed population and remove the largest source of local revenue. Most of the population will migrate away from the area, leaving an oversupply of housing. Furthermore, the town and local government will be left with the costs associated with the environmental and infrastructural degradation of the region.

The secondary literature focuses on the social consequences of “boom” and “bust”. Typical social consequences of booms include increases in rates of crime, marital instability, alcoholism, drugs, suicide, mental breakdown and other behavioural disruptions (Wilkinson et al.. 1982). The social consequences of “bust” are Just how susceptible Karoo towns may be to these consequences remains to be seen, though there are some indications that social costs may be exacerbated.

Social costs

Alcohol abuse is one such factor that warrants attention in the Karoo. Rehm *et al.* (2003), through their comparative study on global alcohol trends, identified Southern Africa as having relatively low absolute alcohol consumption per capita (7.1l of absolute alcohol/capita), though one of the highest consumptions per drinker in the world (16.6l/capita). Furthermore, 55% of adult males are considered drinkers while only 33% of females fall into the same category. In South Africa, one in four adult male drinkers experience symptoms of alcohol problems, compared to one in ten females (Society for the Study of Addiction, 2005, pg.426).

South African’s habit for drinking has detrimental side effects. Alcohol abuse is inextricably linked to violence and crime (Holtmann 2008, p.13). Violent crimes such as murder, rape, armed robbery and car hijacking typically occur with the perpetrators and often the victims being under the influence of alcohol or drugs.

Furthermore, the majority of these crimes are reported on Saturdays and Sundays, when victims and perpetrators are more likely to be under the influence (p.14). Statistically, 39% of all cases of interpersonal violence in South Africa are linked to alcohol consumption (Schneider et al.. 2007, pg. 21). Finally, Rehm *et al.* identified Southern Africa as having the second most detrimental alcohol pattern in the world as a consequence of the aforementioned factors with Karoo towns in particular manifesting these trends.

The cycle of alcohol and violence perpetuates itself and continues through generations. Alcohol abuse leads to the increased likelihood of teenagers falling pregnant, often resulting in absent fathers and consequently the increased likelihood of young children being exposed to violence or neglect early on. In South Africa, in particular in the Central Karoo, a condition referred to as Foetal Alcohol Syndrome (FAS) sees one of the highest rates in the world. Prevalence rates of FAS in high income countries are typically around 0.97/1000, while rates in Wellington, De Aar and Upington¹ are between 40.5 and 53/1000 (Urban et al.. 2008). Urban and Holtmann attribute this to a cycle of crime and violence, with its beginnings and ends coming from a dysfunctional family.



Figure 4: The cycle of crime and violence (Holtmann 2008, p18)

¹ Larger towns with the Karoo region

The origins of issues related to alcohol have their roots in the countries colonial history. Farmworkers in South Africa were often paid with alcohol, known as the “dop” system. This began in the Cape Colony, enticing indigenous people to work on farms with the promise of tobacco, bread and wine as payment. This tradition became institutionalized and this practice of social control continued over the next 300 years (London, 1999, pp 1408-1409). This is important for the Karoo as the legacy of this system has persisted to this day. Detrimental alcoholic trends are visible not only among farmworkers but also residents of towns drawn to do seasonal farm work.

Intimate partner violence (IPV) is yet another detrimental trend prevalent in South African society and shows a strong positive correlation with alcohol misuse (Peltzer 2013, pg.14) and the cycle described above. More women are killed by their current or ex-partner in South Africa than any other country in the world. Based on numerous studies of “boomtowns” and their consequences, it seems clear that a surge in economic growth is going to exacerbate social ills. In the case of the Karoo, one can expect an intensification of any existing alcohol trends and this would be accompanied by higher rates of crime, in particular IPV.

Detrimental trends related to alcohol and drug abuse are common in the Karoo (Holtmann 2008; Urban et al.. 2008; London 1999; Peltzer 2013). These issues are severe and have been prevalent for generations. A significant change to the economy of the region would do nothing to alter these trends, and one would expect they would be exacerbated.

Shale gas extraction considerations

Health implications

The shale gas extraction industry in the USA has seen a lot of negative publicity relating to the negative health implications of the practice. It is important to analyse these claims in order to understand what the implications may be in the Karoo. These effects of shale gas extraction can impact negatively not only on public health, but may also impact negatively on economic and social factors. The following section will examine such effects.

Certain negative health impacts that may result from shale gas extraction occur because the hydraulic fracturing fluid (fracking fluid) contains a number of potentially hazardous chemicals that the wells require. The process requires large volumes of water and sand, generating air pollution and large volumes of waste water, containing dissolved chemicals and contaminants (Adgate et al.. 2014, pg. 8307).

In the United States, houses that are nearby to points of shale gas extraction typically show higher than average levels of methane gas present in the drinking water. In a recent study by Jackson et al. (2013), the authors show that 82% of houses sampled within a >1km radius of a natural gas well were on average six times higher than water sampled from homes further away. Similar to the results on methane, ethane and propane were likely to be found in higher concentrations nearby to natural gas wells. It is clear from the study that natural gas is likely to be found in higher concentrations in drinking water nearer to natural gas wells, which increases the likelihood of illness among those affected.

Additional studies highlight the negative impacts natural gas well blowouts may have on nearby animal and human populations. One study identifies a case of leaked fracking fluid resulting in the death of 17 cows within one hour and another similar case resulting in reproductive issues for sheep exposed to fracking fluid over the course of two years from exposure (Bamberger & Oswald 2012, pg.59). In all cases studied, exposure to drilling fluid occurred after the fluid from wellhead blowouts leaked into nearby grazing areas. Furthermore, cases such as these could have been avoided had measures been in place to prevent the exposure of the animals to the fracking fluid, even in the event of a wellhead blowout. (Jenner & Lamadrid 2013, pg. 449).

Finally, literature relating to experiences of those living in shale gas extraction regions typically mention the increased volume of dust generated, most likely from the shale gas operations. Perry (2012, pg 87) highlights the collective negative experiences, who cite, among other things, dust as having significantly decreased residents quality of life and is perceived to have negative health consequences. Another paper (McKenzie et al., 2012, pg 86) notes that while the impact of dust has been considered for research, there is simply not enough data for meaningful study.

Economic implications

Aside from the negative economic implications associated with the detrimental health effects of shale gas extraction on nearby humans and animals, there are additional and more direct economic downsides to the activity. This section will review the negative economic implications associated with increase seismic activity that may result from high pressure drilling and the toll on road infrastructure as a consequence of the high truck traffic associated with shale gas extraction.

Water is a scarce and valuable resource in the Karoo, providing a foundation for the predominately agricultural and rural economy. Shale gas extraction is well known to be an extremely water intensive process (Kinnaman 2011; Jackson et al., 2013; Jenner & Lamadrid 2013; Department of Water Affairs 2013; Considine 2010). In the USA, shale gas extraction has relied primarily on local surface water sources. Mismanagement, poor practice and accidents can result in the contamination of nearby and downstream water sources.

Contamination threatens not only drinking water, but can destroy an economic resource that is vital to the functioning of nearby economies. This cost is external to the market and needs to be accounted through economic research tools such as hedonic pricing method, the contingent valuation method, or the travel-cost method (Kinnaman 2011, pg. 1248). Appropriate water management techniques need to be developed to minimise the risk of accidents and contamination, as well as to ensure best practice disposal methods for radioactive and toxic waste materials (Vidic et al.. 2013). Further to this, a problem with any industry use of potable water is that a portion of the used water is permanently lost – shale gas extraction being particularly water intensive will provide major challenges in this regard. (Fakir 2015, pg 15).

In recent years, increased seismic activity has been linked to shale gas extraction. Watson (Watson 2016) argues the case for hydraulic extraction to be considered an “abnormally dangerous” activity in legal terms. The paper identifies numerous lawsuits whereby plaintiffs have claimed injury and property damage from earthquakes that were allegedly caused by drilling activities on fracking wells. These claims are backed by recent scientific results (Rosen 2015) pointing to a direct correlation between increased seismic activity relating to wastewater pumped back into the ground by oil and gas operations.

Shale gas extraction is inextricably linked to the expansion of infrastructure assets such as roads, water treatment, gas pipelines and natural gas storage. This infrastructure is necessary at every phase of the development process, from upstream production to the end-users downstream. This infrastructure naturally comes at a high financial cost, but can also be environmentally detrimental (Rahm 2011, pg 2975), further increasing the economic cost. Furthermore, existing infrastructure may be insufficient for coping with the new stresses on it, such as water treatment facilities not being able to treat wastewater from frack sites. (Jenner & Lamadrid 2013, pg. 447). The USA benefitted greatly from having extensive oil and gas infrastructure in place before it began its shale boom, as well as a service economy that was very familiar with the industry. This gives the USA a fairly unique benefit that is not applicable to many new shale finds outside of the USA, which will push up costs for countries such as South Africa significantly (Fakir 2015, pg 10). Benefit, however, may be accrued for local communities through infrastructure development from the increased demand for unskilled labour (pg.41).

Finally, the shale gas extractive industry is unavoidably linked to tremendous increased volumes of truck traffic near the well sites. For each “frack”, an estimated 890 to 1340 truckloads of liquid is required. This provides one of the bigger opportunities for local employment as the position has a relatively low barrier to entry, however the costs of maintaining the existing roadways will rise. (Christopherson & Rightor 2012, pg. 11). Roadways are typically designed, within the USA, to different specifications depending on the anticipated usage of that particular road. Given the wide reach of shale gas operations, many roads that are not equipped to handle such excessive truck traffic often degrade at increased rates, which in turn place a burden on local government to repair and maintain these roads.(Hastak & Baim 2001) These burden of these costs could also

be passed through to the shale production companies. (Abramzon et al., 2014, pg 2). The effect of passing the cost through to local governments will in turn affect the ability to perform every other government service at the level that was achieved previously. The job creation will only be available throughout the production phase of the shale gas extraction, after which there will be no demand for those truck drivers in that industry.

Long-term implications

Finewood and Stroup (2012) argue that the true costs of shale gas extraction are never taken into account in cost-benefit analyses of the entire process. These cost-benefit analyses are viewed through a "neoliberal environments framework", whereby environmental consequences are viewed as how they affect directly affected stakeholders in the short-term. This does not consider the real impacts on not only future local populations, but the indirectly affected such as those affected by the altered hydrological cycle, climate change, displaced communities and innumerable other costs. In this sense, stakeholder concerns for water are shifted to a "fully economized benefit-cost analysis", rather than accounting fully for the costs to stakeholders.

One such example of a factor not accounted for in the economized cost-benefit analysis is the effect of new infrastructure, such as thousands of kilometres of tarred roads and animal fences, on animal populations. This is particularly pertinent for the Karoo. Du Toit, Rogers and Biggs (2003) examine the effect of anthropogenic influences on natural environments. While the Karoo is already developed to the extent that there are fences and roadways throughout the region, the development of a shale industry would see an explosion in fence and road construction, further impacting the livelihoods of animals native to the Karoo. Migration pathways (Conradie & Natrass 2013), breeding areas, noise pollution and water pollution are factors that will significantly impact wildlife in the area – these effects will not only impact animals in the exploration and production periods, but will very likely cause irreparable damage to the local environment.

In addition, much of the industry rhetoric has purported that shale gas extraction provides a "greener" fossil fuel alternative. When one considers the full life cycle from extraction to end-user with shale gas extraction, it is found that this is a misleading statement. For instance, the emissions reported in the 2011 EIA Annual Energy Outlook reported double the emissions for shale gas extraction than the 2010 report, given the same level of extraction (Wood et al. 2011). This highlights a severe lack of consensus of the carbon accounting for shale gas extraction. The economic costs of the impact of climate change on the Karoo region, given the neoliberal cost-benefit analyses as forwarded by Finewood and Stroup (2012), will not be accounted for by the shale industry in the Karoo, despite the inevitable effects on the region in the long term.

These factors mentioned provide a glimpse into the vastly unaccounted for, longer term effects of the shale gas extraction process. There are undoubtedly many more costs to consider which unfortunately fall outside of the scope of this dissertation, which do however warrant considerable further research that needs to be taken into account when assessing the impact of shale gas extraction on the region.

Conclusions

This section has examined the Boomtown Model, also known as the Social Disruption Hypothesis. It began by discussing the origins of the model in the USA in the 1970's and 1980s, its limitations and how this model might be valuable in understanding the effects a shale gas industry may have on the Karoo. It examined literature from authors who pioneered the research on the Boomtown model, to more contemporary work that sought to update the theory and retaining its relevance. This was then followed by an examination of the potential social costs that could be particularly detrimental to the Karoo region as a whole. These include drug and alcohol abuse, as well as IPV.

The second part of the literature review analysed the potential economic and social implications typically associated with shale gas extraction. This took into consideration a number of authors, touching on issues ranging from the health implications of water contamination of humans and animals, to the economic implications of increased seismic activity, increased truck loads and again, water contamination. The final consideration is that of the longer term consequences associated with shale gas extraction, the most important consideration here surrounding the fact that these impacts are not well accounted for in cost-benefit analyses of the activity. While these long term considerations are vital to the overall impact analyses of shale gas extraction in the region, they unfortunately fall outside the scope of this study.

This chapter intended to equip the reader with the necessary context through which to understand what effects one might come to expect from a rapid expansion of the shale industry in South Africa. The following chapter will examine the historical development of the Karoo region.

Chapter 4: The Karoo

Introduction to chapter

The Karoo is a semi-arid region located in the central and western interior of South Africa and covers a region of roughly 400,000km². The Karoo can be considered a single ecosystem that is subdivided into the winter rainfall Succulent Karoo and the summer rainfall Nama Karoo. The region is characterised by its “rangeland” agricultural economy and low population density (Nel & Hill 2008, pg.2268). The diamond trade began in the Karoo with the discovery of the Hopetown diamond in 1866. The diamonds soon became scarce and the region became reliant on small stock pastoralism as the primary economic driver. The agricultural sector flourished with subsidies generated by the mines, an extensive rail network throughout the country and tariff protection from the state (Wilson 2009, pg.68).

The figure below identifies the region within South Africa, as defined by the extent of the regional vegetation. Geologically, however, the region is much larger, extending as far north as the DRC. The Karoo in South Africa is not characterised strictly by its borders but rather by the type of climate and vegetation in the region and as such, therefore one should consider the borders below as only an approximate delimitation of the area. Furthermore, when this paper refers to the Karoo, it is referring to the inexact area shown below that is characterised by its climate and vegetation.

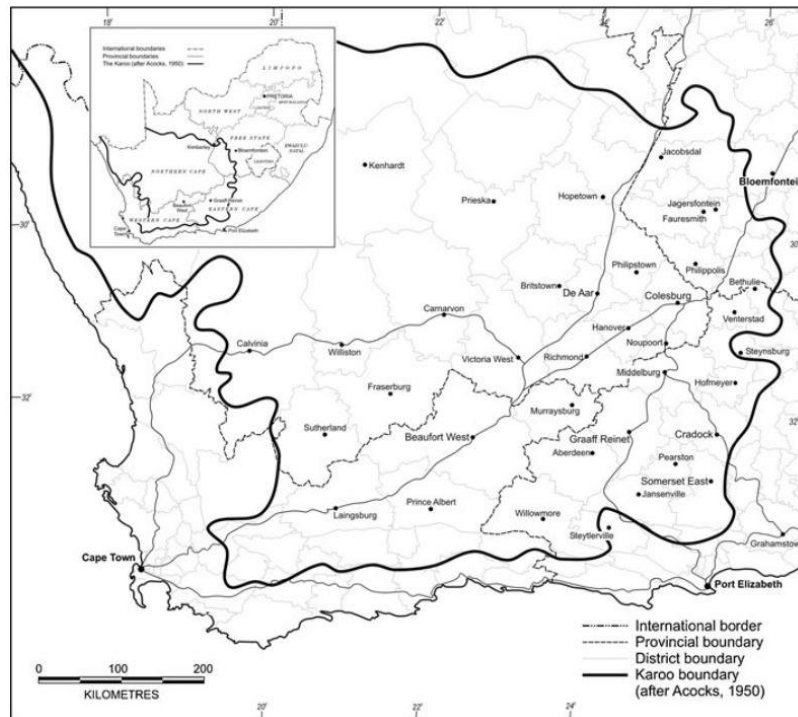


Figure 5: The Karoo region, South Africa (Nel & Hill 2011, pg. 400)

Urban settlements in the Karoo are widely dispersed and generally developed to serve the farming, religious and administrative needs of their rural hinterlands. The area's prosperity has varied over the course of the twentieth century, being subject to variable weather conditions, disease ecologies and global demand. Its traditional role has been the production of wool and mutton since the nineteenth century with production peaking in the 1950's following an extended period of unusually good rainfall and high market prices associated with the sheep industry. However, since then, as a r

esult of declining demand and production of these products, the economic viability of the Karoo towns has been impaired. Their decline coincided with the global modernization of agriculture affecting the market price for wool and mutton (Hoffman & Rohde, 2007, p. 649). Currently, the primary output of the Karoo is still livestock, though poultry farming has become increasingly popular (Statistics South Africa 2011a). The figure below shows the breakdown of activity for each agricultural household in the Northern Cape in 2011 (Statistics South Africa 2011a).

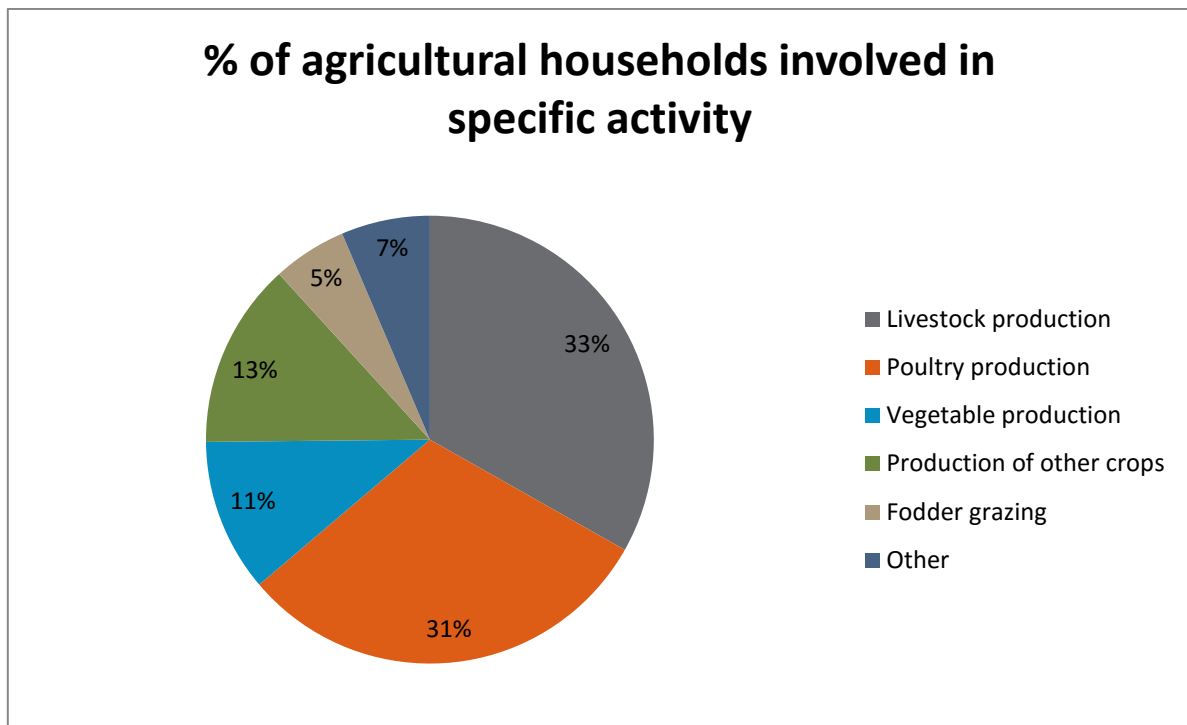


Figure 6: Breakdown of activity per agricultural household (Source data)

Today, the economy still relies heavily on agriculture, as well as community services and the tourism and hospitality industry. While there has been a drastic national trend towards urbanisation, as many as 50% of the country's population live in small towns. Poverty is a national issue – an estimated 19.7% of those living in cities live in poverty but that number is as high as 40.5% in small towns (van Rooy 2007, pg.2). The decline of small towns was noted in the 1980s, though there has been very little recognition of this on the policy agenda of the post-1994 government.

The decline of Karoo towns can be attributed to the decline in agricultural output, the redundancy of railway towns, advances in transport technology and changes in retail patterns. Furthermore, the North West Province (which is primarily made up of the Karoo region), is heavily reliant on exports. In 1996, 38.6% of its GDP came from exports, and 37.8% in 2001. The national average for provincial GDP sat at 13.84% and 19.93% in 1996 and 2001 respectively. Furthermore, the region has seen the lowest comparative growth in recent years with 2.8% between 1991 and 1996 and -0.3% between 1996 and 2001 (Pretorius & Blaauw 2004, pg. 8). The decline, however, is not ubiquitous. Some larger towns, such as Beaufort West and Queenstown (in the Eastern Cape Karoo), have absorbed the service functions of neighbouring smaller towns. This results in the loss of many formal-sector job opportunities, soaring poverty and the out-migration of skilled workers in the latter.

This change has created a dependence on state welfare in many Karoo small towns, while the loss of local government status has reduced revenue for the maintenance of local infrastructure. The new local municipalities are encumbered by a lack of finances and personnel, as well as high levels of corruption (pg.5)

Counter-urbanisation and tourism

A “post-productivist” economy describes the shift from the primary (agricultural) to the tertiary sector (Ingle 2013). This has occurred to varying degrees in Karoo towns and the tourism and hospitality sector, though still marginal, is the fastest growing sector in the Karoo attracting the most investment. The Karoo is branded as an untouched, pristine landscape that facilitates what Ingle describes as ‘counterurbanisation’, in which highly mobile professionals opt for rural living while continuing to earn urban-denominated incomes. This is made possible by the nearly universal presence of internet access throughout South Africa allowing certain professionals the freedom to work from anywhere. There have been no quantitative studies of how these individuals have affected the economy of Karoo towns, nor any analysis on their number or movement patterns, so the literature (Ingle 2013; McEwen 2013; Steyn & Ballard 2013) relies primarily on qualitative evidence and themes from literature on the British postproductivist countryside. The trend is visible to anyone, but further analysis is needed to understand the impact on Karoo towns and, in particular, what makes certain towns more popular than others.

Tourism is recognised as a key sector for economic growth (Rogerson & Visser 2007), hand in hand with the hospitality industry and thus closely linked to Ingle’s post-productivist influence on towns. This sector is a major source of foreign exchange, income and employment and particularly useful for facilitating an entrepreneurial environment (van Staden & Marais 2007, pg.233). Consequently, this has been highlighted by the South African government as an opportunity for poverty alleviation and job creation.

Population change

Urbanisation refers to the large-scale transition and centralization process of resources, industries and population in a certain area (Emuze & Hauptfleisch 2014, pg.884). Hill and Nel (2011) examine the changes in the Karoo over the course of the twentieth century, using census data to reveal interesting trends of urbanisation and the decline of small town service centres. The following table and graph demonstrates

racially based population change in the Karoo from the period 1911-2004, with key trends picked up in the graphs that follow.

Population change in the Karoo, 1911-2004							
	1911	1936	1951	1970	1980	2004	Percentage change
Total population	287 118	314 525	352 222	468 870	454 516	504 159	76%
White	125 518	115 427	106 955	84 611	71 565	62 614	-67%
Coloured	87 390	109 522	137 618	216 856	225 850	275 063	669%
Black	74 048	93 395	110 145	167 404	163 941	164 247	463%
Total urban	89 885	119 600	160 311	264 426	280 627	365 959	307%
Urban white	40 012	53 316	61 219	57 821	50 516	44 820	12%
Urban coloured	25 920	36 492	55 572	116 976	131 762	188 880	629%
Urban black	22 011	30 095	42 497	88 210	98 349	132 417	502%
Total rural	199 013	198 575	194 810	206 418	108 729	133 790	-33%
Rural white	85 506	62 111	45 736	26 790	21 049	17 794	-79%
Rural coloured	61 470	73 030	82 046	99 880	94 088	86 183	40%
Rural black	52 037	63 300	67 648	79 194	65 592	31 830	-39%

Source: Hill, Nell (2011)

Table 1: Population change in the Karoo, 1911-2004 (Source data)

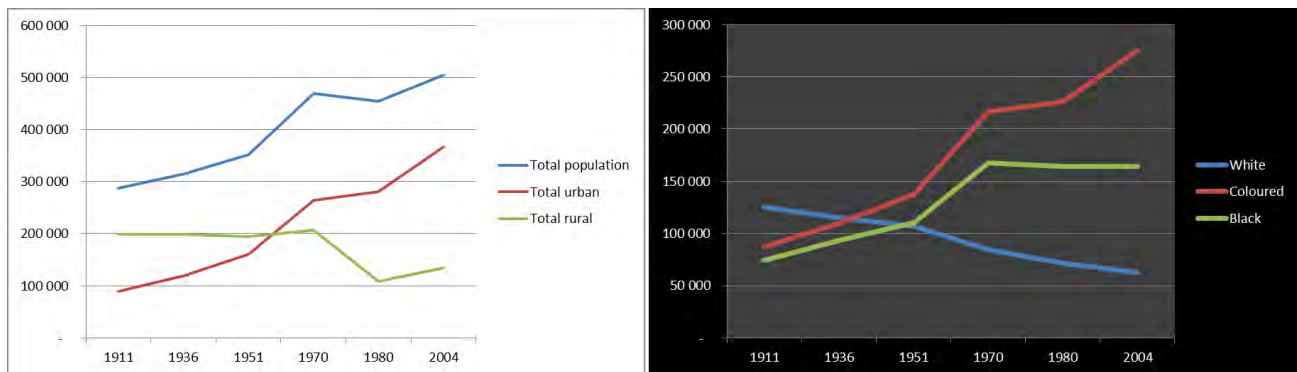


Figure 7: Population change in the Karoo, 1911-2004 (Source data)

Pertinent trends include urbanisation within the Karoo region, and in particular the steady migration of the white population out of the Karoo. To put this trend in context, one needs to understand that the Karoo's agricultural sector, primarily consisting of livestock and poultry farming, experienced mixed fortunes throughout the twentieth century with a significant downturn in the 1960s that permanently affected the economy. The period between 1951 and 1971 as indicated on the table above, shows the most significant decline in the total white population from 84,611 to 71,565, reflecting the global downturn in the wool and

mutton price as mentioned above. Even more telling is the decline in the rural white population over the same period from 45,736 to 26,790; a decline of 41.5%. The rural white population represented the land owners thus their significant decline over that period indicates the incorporation of smaller farms into larger ones while struggling families moved to larger towns or cities (Nel & Hill 2008, pg.2270).

Karoo towns, however, do not form a homogenous grouping from which a researcher examining economic impacts can make overarching predictions. Hill and Nell examine economic and demographic change in small Karoo towns and identify different trajectories that certain towns have followed. In Hill and Nels study, they define a small town as one which has a population of less than 50,000. This is then split into large and small “small towns” with the former having populations of over 10,000 and the latter having less than 10,000. The general trend shows larger town centres such as Graaf-Reinet, Middleberg and Cradock experiencing relative growth demographically and economically while smaller towns like the three towns considered in this study have experienced a marked decline. The larger towns (<10,000) saw continuous growth over the period, while smaller towns became economically less important, as reflected by their declining populations. This trend is visible in the table and graph below.

The changing population of certain Karoo towns, 1911-2004							
	1911	1936	1951	1970	1980	2004	Percentage change
Graaf-Reinet	19 396	23 133	25 585	33 749	30 871	42 217	118%
Cradock	20 765	20 839	26 785	35 915	38 827	39 261	89%
Beaufort West	11 982	15 409	18 642	26 948	28 417	38 846	224%
De Aar	4 105	9 045	11 318	20 324	23 319	31 406	51%
Calvinia	12 225	9 965	19 578	20 783	12 259	18 430	665%
Williston		5 738	5 054	6 427	4 742	4 177	-27%
Fraserberg	8 059	5 572	4 548	5 528	4 768	4 546	-44%
Aberdeen	9 536	7 911	8 380	8 711	8 325	8 588	-10%
Jansenville	11 167	9 707	9 413	11 802	11 375	11 449	3%
Britstown	5 489	5 182	5 997	6 853	6 346	6 530	19%

Table 2: Changing population of small Karoo towns, 1911-2004 (Conradie et al. 2009)

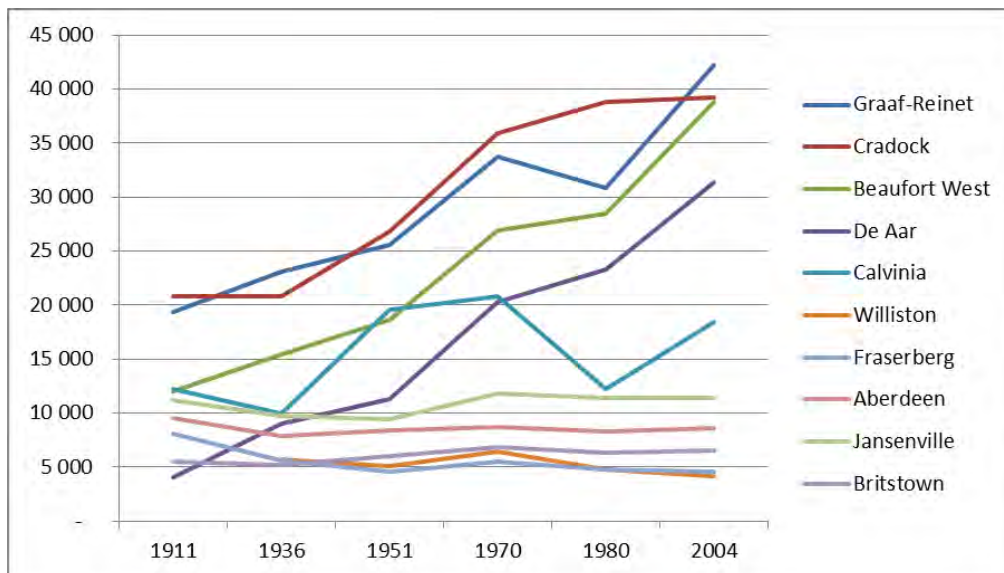


Figure 8: Changing population of small Karoo towns, 1911-2004 (Source data)

While the previous set of graphs showed the urbanisation trends over the twentieth century in the Karoo, this graph shows that this was not to the same in all towns in the region. The data set consists of 10 towns. Graaf-Reinet, Cradock, Beaufort West, De Aar and Calvinia all had populations over 10,000 in 1911, categorising them as larger “small towns” that show an upward growth trend. The remainder of the towns had populations of <10,000 in 1911 and experienced a downward growth trend. The only exception in this case is Jansenville, though considering its proximity to Cradock it is clear that the area only required one larger town, while Jansenville followed the trend of Williston, Fraserberg, Aberdeen and Britstown as reflected above.

Graaf-Reinet, one of the largest towns in the Karoo shows a positive growth trend over time with a particularly steep rise in the 1951-1971 period again from 25,585 to 33,749 (31%). The inverse is true of the smaller Karoo towns, which typically manifest a negative or very low positive growth trend below natural population growth. This confirms that these towns are reliant on the agricultural sector for their survival while the larger towns that have experienced growth have more diverse economies thus attracting migrants. These changes are not merely economic, but can also be attributed to the increasingly mobility of people. Smaller towns, such as those listed above, were established in an era that required all necessary services to be locally accessible but this is no longer a necessity since the advent and prevalence of automated transportation. Furthermore, the diminishing rural white population suggests that farms were being consolidated into larger units to create economies of scale. Despite this, small stock farming has remained the primary economic activity in the Karoo, though a continually strengthening tourism and hospitality sector has emerged in recent years (Hoffman & Rohde 2007), which will be the final point of consideration for the thesis. The following section will explore the historic economic change in the Karoo over the last century.

Economic change

Conradie, Piesse and Thirtle (2009) examine district level, disaggregated total factor production in the Western Cape, South Africa through 1952 -2002. Typically, one could gauge productivity by measuring output in relation to a single input, such as labour or land. This would place preference on a single factor as the determining measure of output. Furthermore these measures do not take into account non-farm outputs and therefore prove to be inadequate measures of overall efficiency (Conradie pg266). Total factor productivity (TFP) is a variable that accounts for output not explained by the amounts of inputs used. Indices of TFP in agriculture “measure aggregate output per unit of aggregate input, providing a guide to the overall efficiency of agricultural production.”(Conradie et al.. 2009, pg.266) Therefore, TFP is determined by how efficiently and intensely the inputs are utilized in production (Comin 2006). The theory is explained in Conradie *et al.* and in more in-depth in articles such as Thirtle et al.. (1993) and Chambers (1988). In Conradie *et al.*'s paper, they illustrate that aggregating TFP on a national level could lead to misleading results regarding performance at the district-level. The paper examines the performance of 31 magisterial districts from 1952-2002. An index is constructed to interpret change over time. This is accomplished by taking the proportional changes for succeeding years, weighted by the average share of that input over the two periods. The aggregate productivity for the Western Cape is used as the benchmark for the first period, beginning with the index number 100. The table below shows the change in TFP in the Karoo region over the period 1952-2002.

	1952	1956	1960	1965	1971	1976	1981	1988	1993	2002	Growth rate
TFP index values	61	73	73	80	73	65	64	70	70	53	-0.33%

Table 3: Change in total factor production in the Karoo, 1952-2002 (Conradie et al. 2009)

The starting value of the 9 regions in the Western Cape was calculated as the ratio of value of outputs to inputs, with the aggregated Western Cape starting at 100. The Karoo started at 61, as seen above, primarily because a lack of water results in productivity that is two-thirds lower than the aggregate. That said, the first period in the time-series was during a wool-boom in the Karoo and the area has not seen such agricultural productivity since. The graph below shows the TFP for all 9 regions in the study with the Karoo and the Western Cape being increased in size to highlight their trends. One can notice immediately that the Karoo stands apart from the other regions as the only one to experience a negative growth trend. This is the result of three of its district municipalities decreasing agricultural intensification. The strategy in many parts of the Karoo has been

to survive by reducing costs but this has not proved sufficient to increase TFP. The only region to experience positive productivity growth is Prince Albert. It is in the advantageous position of being near two medium sized rivers which have been developed to irrigate almond groves, olive orchards and small vineyards. Furthermore, Prince Albert has benefitted over time from the counterurbanisation of professionals as discussed earlier. (Ingle 2013; McEwen 2013)

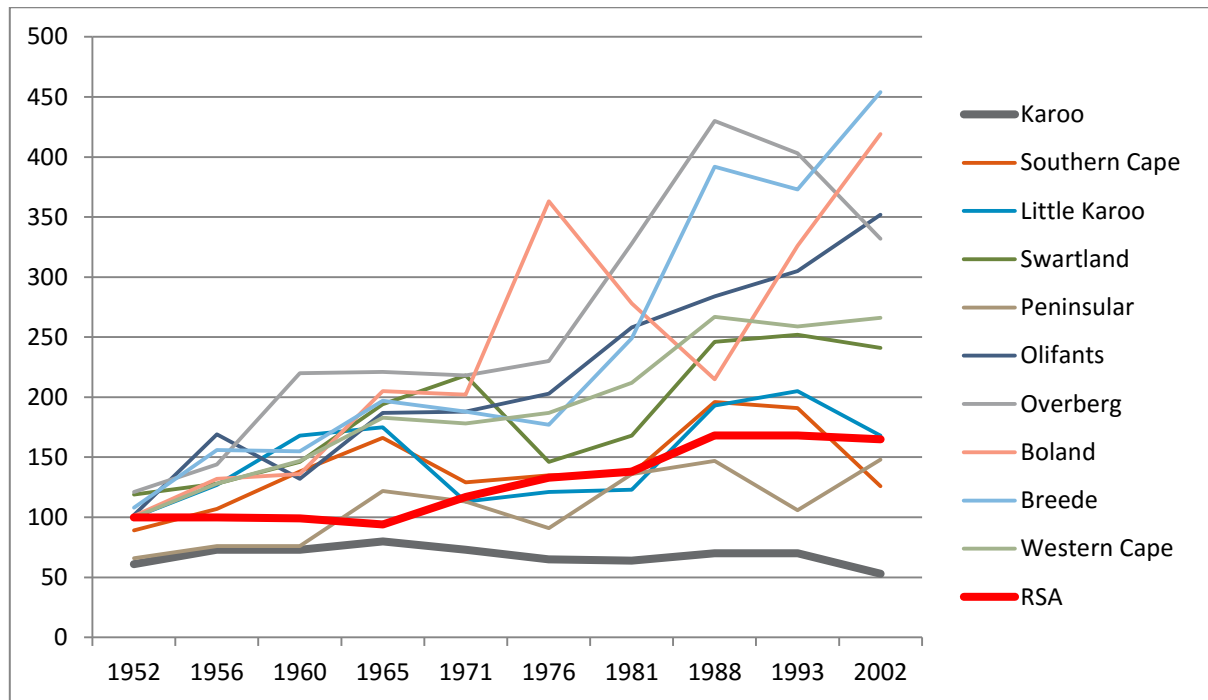


Figure 9: Change in total factor production in the Karoo, 1952-2002 (Conradie et al. 2009)

From population data extracted and analysed from national censuses, this thesis was able to pick up valuable trends between rural population and TFP. The focus of the analysis was on the three Karoo towns that are the subject of this thesis: Carnarvon, Williston and Victoria West. Before this section discusses population change in relation to TFP in the Karoo, it is important to note that the research undertaken by Conradie *et al.* focused on the Karoo in the northern parts of the Western Cape. Carnarvon, Victoria West and Williston are in the Northern Cape. The reason the towns were appropriate for analysis is due to the similarity in the nature of the economy and climate. Conradie *et al.* highlight in their paper that aggregating TFP in winter rainfall areas of the Western Cape and summer rainfall areas across the rest of the country that produce different outputs is not a useful exercise because the aggregation can disguise significant differences between component parts. In the same way, it could be said that the Karoo in the northern Western Province can be used as a proxy for TFP in the Northern Cape as they experience very similar climatic conditions. The agricultural sectors are also focused on meat farming - albeit the Northern Cape focuses on game while the Karoo on sheep and poultry. The global and national trend throughout the course of the twentieth century has been one of urbanisation

and by extension, the de-population of rural areas. South Africa has seen a significant decline in rural population from 75.3% of total population in 1911, to 38% in 2011. The number of commercial farms has decreased from 112,453 in 1946 to 39,966 in 2007 suggesting the incorporation of smaller farms into larger ones for the sake of efficiency. Additionally, the average size of farms has increased from 837 ha in 1946 to 1427 ha in 1993.

Through the examination of government “Transfers of Rural Immovable Property” from 1971-1995 (Bureau of Statistics, 1971-1995) the declining relative value of the property becomes clear. The following two graphs shows the price per hectare of land (2012 ZAR) in Carnarvon and Victoria West from 1971-1979. Williston was not included in the Bureau of Statistics document.

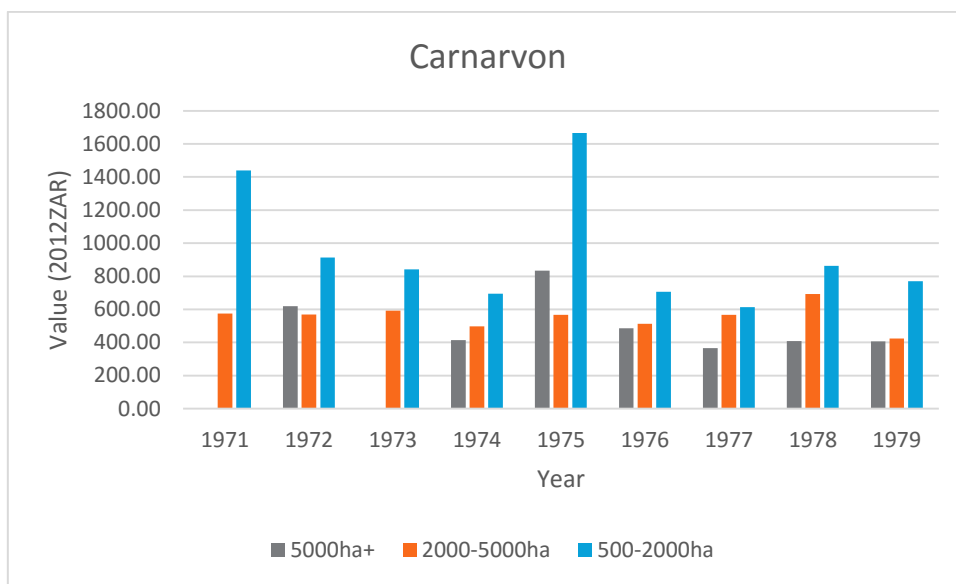


Figure 10 Carnarvon: Price of land per hectare (1971 – 1979) (Source data)

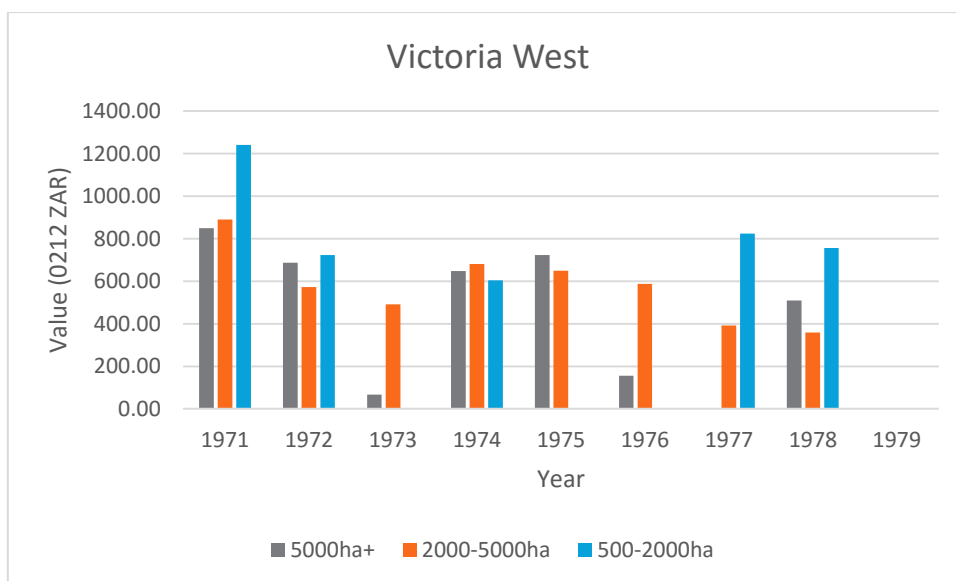


Figure 11 Victoria West: Price of land per hectare (1971 – 1979) (Source data)

The next graph is a continuation of the previous graphs, though expanded to the broader region known as the Bo-Karoo as the towns of Williston and Carnarvon were no longer included in the Bureau's study. The data extracted from the records is included in Appendix 5 below.

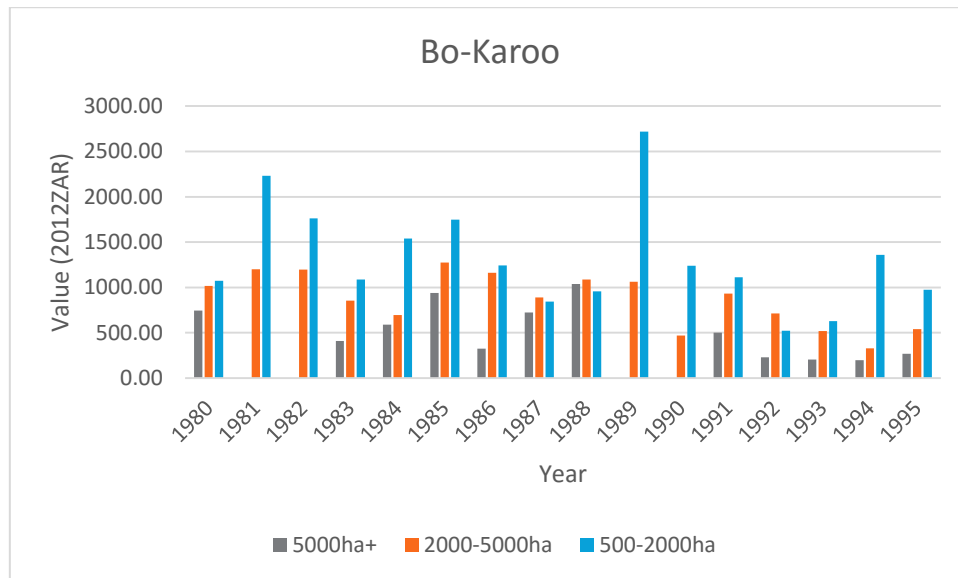


Figure 12: Bo Karoo: Price of land per hectare (1980 – 1995) (Source data)

What the above graphs show is the slow decline of the value of large agricultural property. These tables only included the largest scales of agricultural land, namely those between 500-2000ha, 2000-5000ha and 5000ha+. The occasional spike in the average value/hectare can typically be attributed to only a single property being sold in that year for an abnormally high price. This slow decline in the value of rural property, in particular that of the large property's (5000ha+), is in line argument for the rural decline of agriculture.

Finally and more specific to the Karoo region, the wool, lamb and mutton output as a percentage of agricultural output has dropped from 15.2% in 1948 to just 3.7% in 2011 (Conradie & Natrass 2013). This can be attributed to, among other things, the volatile and generally unfavourable climatic conditions of the region and the decline of the wool price after the 1950's -60's. The change in price of wool and mutton over time (1911-2011) are reflected in in the graph below. (Conradie & Natrass 2013)

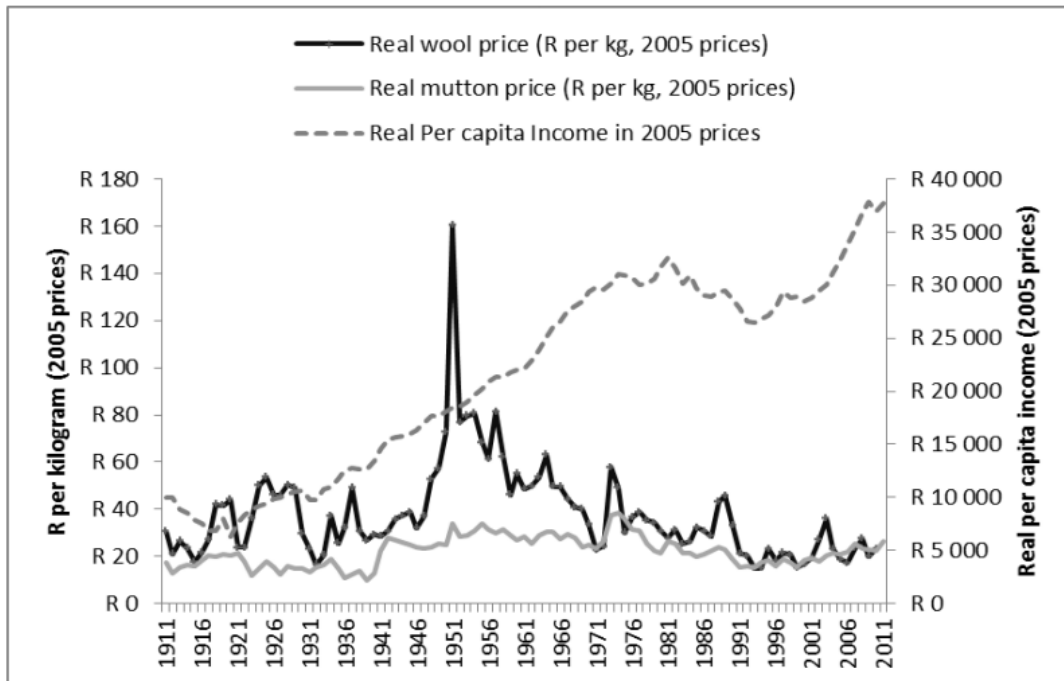


Figure 13: The changing price of wool and mutton (1911 – 2011) (Conradie et al. 2009)

Conclusions

This chapter has attempted to provide an overview of the Karoo region by examining pertinent historical themes such as the historical role of the region, to a more detailed look at population change and finally an examination of the economic history. It explored themes of urbanisation and counterurbanisation, the continual shrinking of the agricultural sector as explained through total factor productivity and the different population changes experienced over time by different sized towns, seeing “small” Karoo towns becoming less relevant over time.

This leads into the crux of the paper; that is, the creation of a demographic and economic profile of the towns of Carnarvon, Victoria West and Williston and the comparison thereof against a shale gas extraction future. Through the examination of the Boomtown literature, the determination of the likelihood of a new shale gas industry and the examination of the Karoo region, the reader has now been temporal window to provide a focused but necessary framework through which to understand what changes may occur in the small Karoo towns. It is important to understand that this coverage of fracking is within a very particular frame of reference, which does not consider water, air, soil, faun and flora and the natural ecology. Furthermore, this paper does not attend to predictions regarding the larger Karoo towns.

Chapter 5: Town Profiles

This section creates a demographic and economic baseline for the towns of Carnarvon, Victoria West and Williston. As discussed earlier, it made use of data collected about the nature of the enterprises in these three towns from telephone directories (1982-2013) and the national censuses. This information was analysed against a number of secondary sources. This section will begin with an analysis of rural population change against TFP index numbers in the region.

Carnarvon, Victoria West and Williston were no exception to the national and global urbanisation trends. The surrounding rural areas which the towns were originally established to service saw a steady population decline over the course of the second half of the twentieth century. The graph below plots the population from each of the three towns from 1951 to 1996. This is plotted on the same graph as the TFP for the Western Cape Karoo, discussed earlier. The points captured on the time scale for the census data were 1951, 1961, 1970, 1980, 1985, 1991 and 1996 while the remainder of the years on the graph were points from the TFP data. A full timeline was used to include all of these dates, while the population numbers and TFP index numbers that were missing were interpolated in excel and used in the analysis.

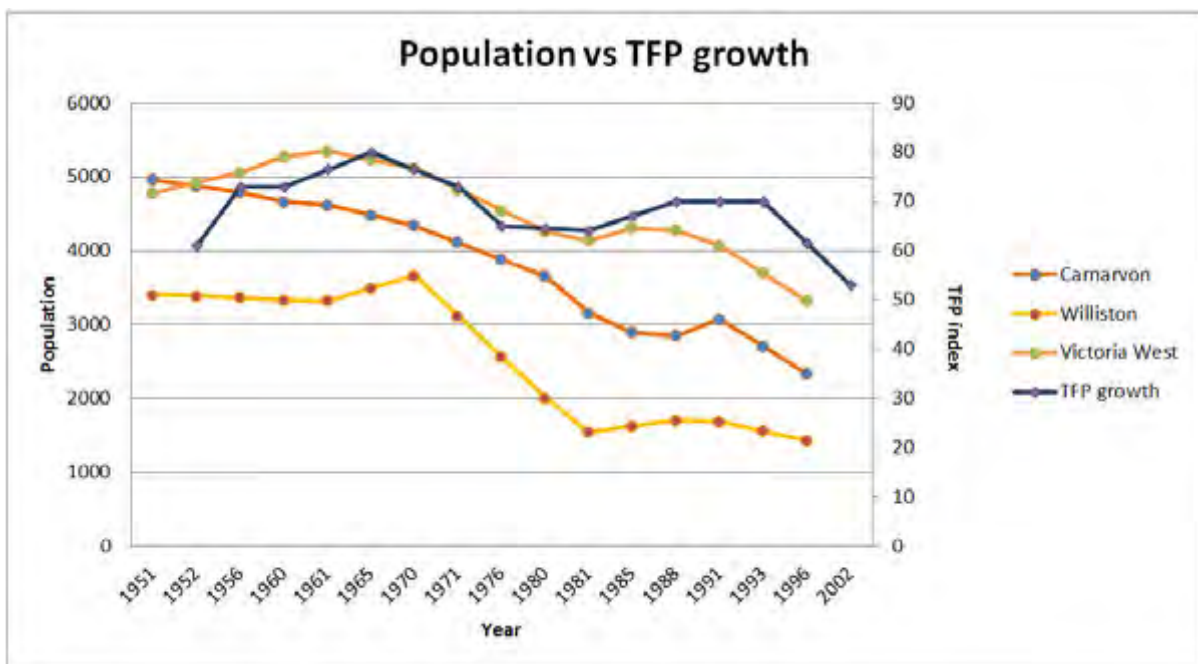


Figure 14: Population versus TFP growth (1951 – 2002) (Source data)

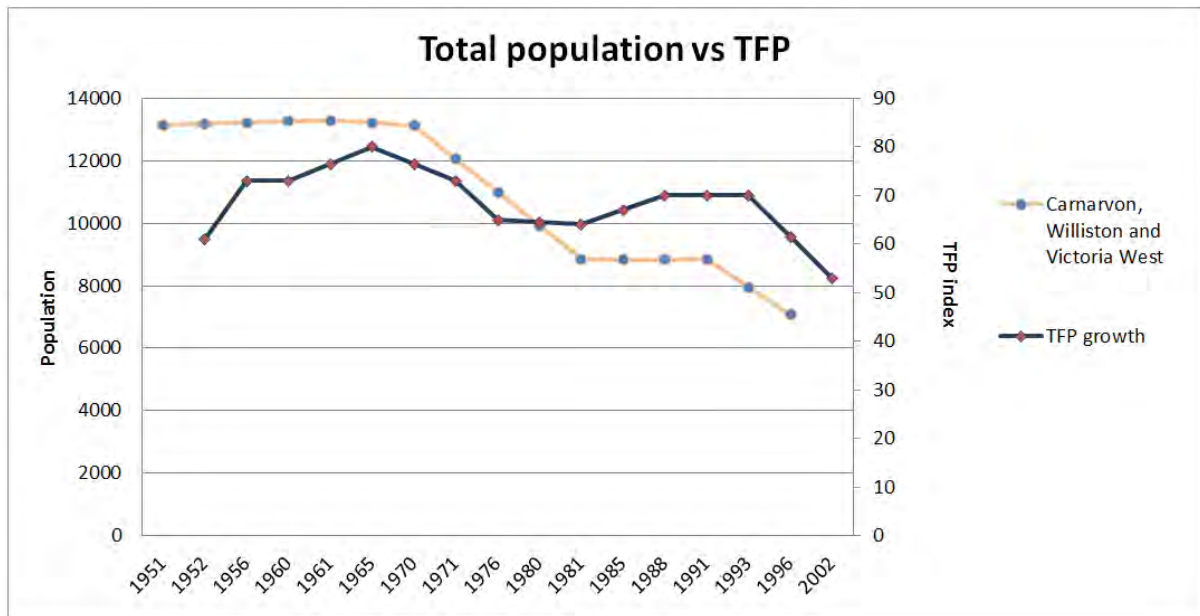


Figure 15: Population versus TFP growth (1951 – 2002) – Aggregated (Source data)

The decline in rural population suggests that this is a response to the declining TFP, given the dependence of the region on the wool and mutton industry. A spike in the price of wool in 1951, largely related to the Korean War (Conradie & Natrass 2013), led to a short period of growth in TFP and thus relatively stable population levels. It was towards the end of the wool spike in the early 1960's that TFP began to decline and, following a short lag, migration from the rural areas increase. This rural decline was prominent in all three towns, though the urban population stayed relatively constant in Carnarvon and Williston. In Victoria West, there was a more significant increase in urban population that was most likely the result of a slightly bigger, more diversified economy. As discussed in the methodology section, enterprises for each town were extracted from telephone directories and allocated to one of 19 categories. The top six of these categories are listed below in order of importance – these constitute the economic drivers:

Agricultural services and products

1. Processing sector
2. Factory sector
3. Construction sector
4. Mining sector
5. Tourism and hospitality sector

The next graph show urban population change in Carnarvon, Victoria West and Williston against the number of “economic drivers” in each town from 1982 – 2011. From the 2011 census data was no longer provided at town, but rather at local municipality level. Therefore in order to estimate the local population the urban

population growth from 2001-2011 for the respective municipalities was calculated and applied to each town. The estimated population growth for each town is shown below (Statistics South Africa 2011b):

- Carnarvon, Kareeberg Municipality – 23.03%
- Victoria West, Ubuntu Municipality – 13.59%
- Williston, Karoo Hoogland Municipality – 19.75%

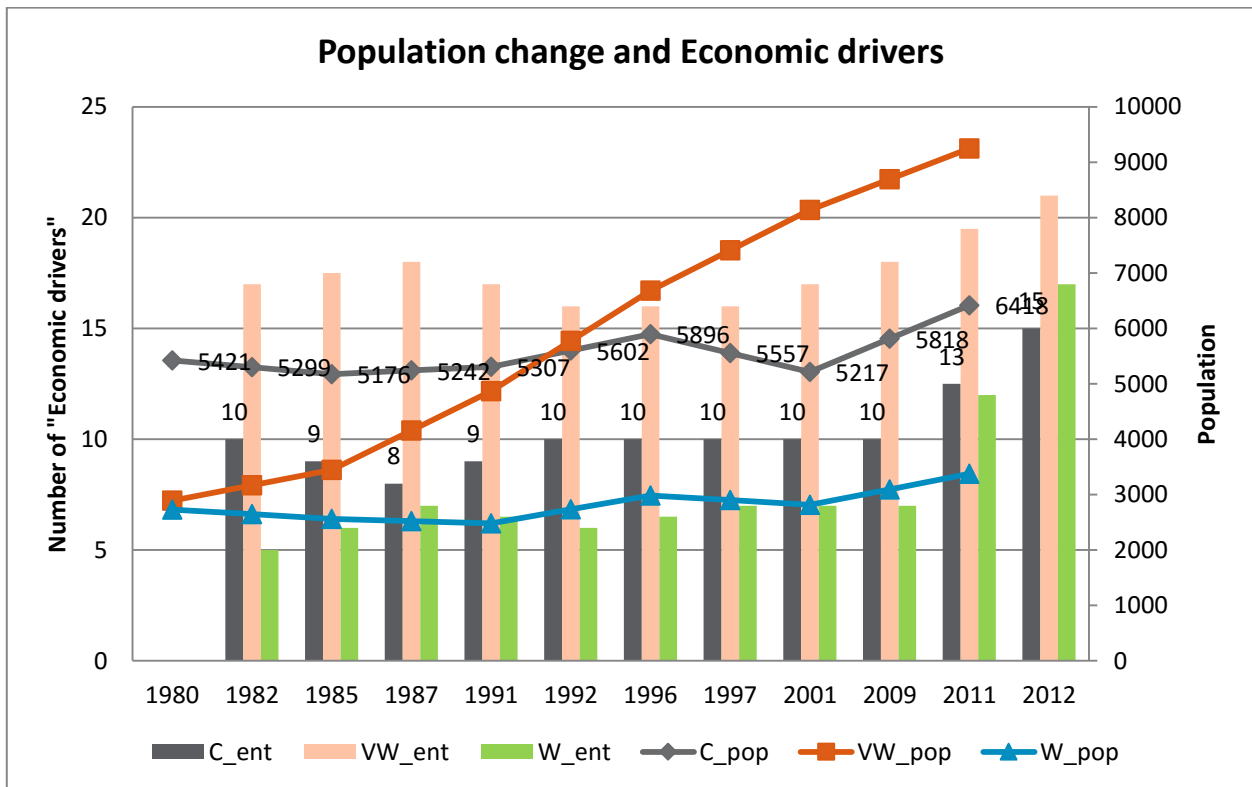


Figure 16: Population change and economic drivers (1980 – 2012) (Source data)

The dataset in the above graph used time-series data from both population and the recorded enterprises. As the time-series for each did not align, missing values were interpolated in excel in order to interpret the results. What the graph highlights is the stagnant population growth and the slow growth of the towns, “economic drivers”. A detailed look at individual towns follows. The stagnant population growth trend is characteristic of “small” Karoo town growth, as discussed in the “Population change” section above. Carnarvon, Victoria West and Williston experienced an annual average population growth of -1.34%, 13.48% and 2.24% respectively.

Carnarvon

Findings

The population of Carnarvon has seen very minor growth from 2985 in 1946 to 5217 in 2011 given the size of the town and the length of time that passed. The relevance of small Karoo towns was called into question in the 1960's during the global downturn in the wool price. The economy of Carnarvon was a lot more diversified fifty years ago with a number of car dealerships, a theatre, restaurants, lawyer's offices, accountants, an abattoir and a factory. In the 1990's the dealerships closed, the agricultural output of the region continued to decline and the town's population stagnated. The town does, however, sport at least three windmill repair enterprises, possibly indicating the reliance on borehole water sources for urban dwellers as well as the local farmers.

Since 1946, Carnarvon and surrounding areas have witnessed much of the white population migrate out of the area. 1249 white people lived in the town in 1946 and 1333 in the rural areas. These numbers have shrunk to 436 and 229 in 2001. In contrast, the poorer coloured population have migrated internally from the rural areas into town over the past 68 years. In 1946 there were 1613 coloured people in town and 3348 in rural areas, whereas in 2001 this was reversed to 4652 in town and 1229 in the countryside respectively. The black population in Carnarvon and Williston was so small over this period as to be negligible.

This confirms that the Karoo agriculture sector has been in steep decline for the past four decades. The out-migration of the white population over the past 68 years from urban and rural Carnarvon shows not only that the previous level of farming was unsustainable, but also that small Karoo urban centres did not provide an attractive destination for emigration. The story of the coloured population tells a more desperate story; one where work on surrounding farms became difficult to find and only slightly less so than in urban centres it seems. The current unemployment rate in the Carnarvon's Kareeberg Local Municipality is 25%², with a dependency ratio of 59.9. This ratio refers to the ratio of dependents to the working age population and in this case is exceptionally high, especially when considering the large portion of the population unemployed. The implications for such social conditions will be discussed in as these issues are pertinent for most of the Karoo.

² Strict definition: According to the strict definition only those people who take active steps to find employment, but fail to do so, are regarded as unemployed. The expanded definition, on the other hand, includes everyone who desires employment, irrespective of whether or not they actively tried to obtain a job. (South African Reserve Bank 2015)

The development stages of the SKA provided the most economic growth Carnarvon has seen since the South African War. The town is currently developing the MeerKAT – a 64 dish array, 80 kilometres north-west of the town. This was preceded by KAT 7 between July 2008 to August 2010, which was a 7-dish array. The KAT 7 created 618 temporary jobs for local residents (Department of Science and Technology 2014). Between April 2013 and June 2013 the MeerKAT created a total of 196 job opportunities. It is not clear how many of these jobs accrued to local residents such as those from Carnarvon, Williston or neighbouring Vanwyksvlei, though what was clear is that the SKA development is certain to impact nearby communities. The picture below shows an aerial view of the MeerKAT development as of June 2013 and the completed KAT 7 array.



Figure 17: MeerKAT development near Carnarvon (SKA Africa 2013)

As with any development on this scale, labour will be continuously required until the project's completion around 2028, particularly in low-skilled, temporary work. It is unclear how many permanent positions will exist after this date. Furthermore, the SKA project has committed to active participation in the schooling system in Carnarvon, including a community knowledge centre and bursaries for scholars from surrounding areas. In terms of the "Astronomy Geographic Advantage Act 21 of 2007" (Department of Science and Technology 2007), the SKA area has been deemed the area protected to ensure the lowest possible levels of optical and radio frequency pollution. For the potential shale industry and SKA development to co-exist, this will require the attention of, and communication between the Department of Science and Technology and Department of Mineral Resources.

Baseline trajectory

- Given the established trends, we can identify a declining agricultural economy, growing unemployment and high levels of dependency. This trend, given no shale gas extraction, could see some disruption from the development of the SKA. As discussed in the previous section, South Africa has already built seven dishes and the construction of MeerKAT is already underway, with some

benefit for the local community already accrued. The full development of the SKA project will be completed in the following stages until 2030:2014 – 2017: Building the 64-dish MeerKAT array

- 2018 – 2023: Construction of SKA Phase 1
- 2023 – 2030: Construction of SKA Phase 2 (Department of Science and Technology 2014)

There is no research that investigates what the economic effects of the development of the SKA will be. Given the size of the development, one can reasonably expect that employment opportunities will be created for the local residents in Carnarvon, though what impact this may have on the current economic, demographic and social trends in the town is unclear.

Given the current population trend, the town may see very low overall population growth. The SKA itself will not attract migrants as the data from the facility is analysed remotely in Cape Town, leaving only employment opportunities for construction and maintenance of the facility (SKA Africa 2013; Department of Science and Technology 2014).

The low growth trend will see likely see the increased out-migration of whites from both rural and urban settings. The coloured population will probably continue to rise in urban settings, while the black population remains so small as to be negligible. Economically, one can anticipate a trend of slow economic growth that correlates to the low population growth. Carnarvon, as with other case study towns, sees a trend of decreasing diversification as people move towards larger urban centres for job opportunities.

Victoria West

Findings

The population of Victoria West evidences a very different trend to Carnarvon and Williston since the 1980s. From a population of 2535 in 1950 to 2890 in 1980, the growth rate over the period was very low. This changed drastically thereafter with the urban population spiking at 8693 in 2001 for a staggering growth rate of 13.48% since 1980. The table below shows the urban and rural trends of the most important population groups.

	1951	1960	1970	1980	1985	1991	1996	2001
White urban	1041	1125	785	920	757	886	863	466
White rural	864	665	584	480	481	379	305	Not available
Coloured urban	903	1884	2461	2060	2663	3943	5760	5781
Coloured rural	3203	3640	3693	3420	3568	3559	2629	Not available

Black urban	583	775	624	0	22	137	60	1956
Black rural	728	1042	841	360	259	29	387	Not available

Table 4: Urban and rural trends of different ethnic groups in Victoria West (1951-2001) (Source data)

While the urban growth is inversely proportional to the rural population decline as with Carnarvon and Williston, it is still abnormally high for the region. The majority of this growth came from the coloured population, with the white population staying relatively constant over the period. That being said, between 1996 and 2001 the black urban population jumped from 60 to 1956. There is no indication as to where these migrants came from or why they moved to Victoria West.

Looking back to the “Population Change and Economic Drivers”) figure on page 38, it reveals that the populations of Williston and Victoria West were very similar in 1980, while Carnarvon was almost double the size of both towns. By 1992 the population of Victoria West had overtaken that of Carnarvon. The most noticeable difference between the towns is the higher number of “economic drivers” in Victoria West compared to Carnarvon and Williston providing opportunities in a region where most economic indicators reflect an ailing future.

A number of businesses in the town have been in existence since 1982, such as a joinery known as Grib en Vos; Smit, Vlok en Kie – the accounting firm; and until recently, a Bokomo depot. The most common economic driver in all towns are the agricultural supply stores, such as the KVB Co-op, of which Victoria West had five in 1982; and more recently B&B’s. The tourism and hospitality industry has seen fast growth since 1982.

Apart from the stronger economy of the town, the only other significant difference between Victoria West and the other case study towns is their geographical location. While Carnarvon and Williston are located on the R63 and R384, between the towns of Calvinia and Vosburg, Victoria West is far more favourably placed on the N12, a national road. Furthermore, the intersection between the N12 and N1 is not far from the town, with the N1 being the busiest road in the country as the primary road connection between Cape Town and Johannesburg.

The economy of Victoria West in the 1980s and early 1990’s, like Carnarvon, was far more diverse than today. In 1982 the town boasted two processing businesses, a budding hospitality sector, engineering and construction services, insurance brokers and even a distribution company. In 1987/88, the region apparently needed the services of an advertising agency! Of the 41 enterprises recorded in the town in 1982, 17 were classified as “economic drivers” and were not exclusive to the agricultural products and services line. The economy of the town was stronger than nearby Carnarvon’s, as well as retaining a diverse range of services throughout the period of measurement. These features could have contributed to the sharp population growth in the town.

Baseline trajectory

As with Carnarvon, the town of Victoria West has seen a steady decline in rural population and a stagnation of rural property prices over the past few decades. However, given the town's geographic location and recent population growth, the current trend suggests that the town's population will continue to grow moving into the future. It is the largest town in the municipality in which it is situated. (Statistics South Africa 2011b)

The diversity of the enterprises in the town shows the same trend as Carnarvon and Williston, that is, a decreasing level of diversification. Given the increasing population, low levels of enterprise diversification and high levels of unemployment, one is likely to see the continuation of social problems associated with this combination. These social problems include alcohol abuse and violent behaviour, accompanied by high levels of HIV infection. Such issues will place strain on local law enforcement and healthcare systems.

Williston

Findings

Williston is the smallest of the case study towns in every regard. The urban population has seen a miniscule average growth rate of 2.24% between 1911 and in 2001, and at the latter date amounted to 2818 inhabitants.

The economic drivers of the town have been primarily agriculture-related with the exception of three car dealerships in 1982/83. The available accommodation and options for eating out increased from a single restaurant and hotel in 1982/83 to a number of B&Bs as well as delis and cafes in 2012/13. Furthermore, the town offers a select few tourist attractions. Typically, the most common enterprises in all towns were in the "trade" sector. This includes all general stores, clothing outlets, bottle stores, furniture stores and other retailers. In Williston, these make up the only noticeable feature of the economy outside of agricultural services and hospitality (which are limited). A search using Google Maps (Google Maps 2010) reveals the prevalence of liquor stores and smaller shops that do not appear in telephone book such as Spaza shops and occasionally businesses that offer "payday loans". Spaza shops are small, informal convenience stores with a low barrier to entry. Payday loans are small, high-interest loans taken out over a short period of time. In South Africa, this is growing problem among consumers (Fin24 2013) and the existence of such an institution in Williston is an indication of a credit poor and highly vulnerable population. The unemployment rate in the Karoo Hoogland Local Municipality is 14.6% with youth unemployment at 20%.

Baseline trajectory

Williston sees trends of high unemployment, a small population with a very low growth rate and a town economy that is almost solely reliant on agriculture and the hospitality sector. Given the current trends and small population, it is likely that the town will continue in decline, serving only as a service town for nearby farms and a destination for those seeking Karoo tranquillity.

The SKA may provide similar employment opportunities as mentioned under Carnarvon, though Williston is not quite in the same proximity to the telescope development and as such, residents may see less of the benefit.

Shale gas extraction future

A shale gas extraction future will see a sharp initial rise in population. This population growth will come largely from skilled migrant workers from abroad (Wait & Rossouw 2013, pg 14), but given the need for infrastructure associated with shale gas extraction there will be a large indirect demand for local unskilled labour. South Africa has a scarcity of skilled labour and a surplus of unskilled labour (Wait & Rossouw 2013, pg. 18). Furthermore, shale gas extraction is skill and capital intensive and uses relatively little unskilled labour. Regardless, the labour force of Carnarvon and Williston is rather limited, so this labour will need to be attracted from elsewhere. Victoria West has seen slightly higher population growth in recent years but will likely also require an influx of unskilled labour. One may assume this kick-off period will result in local job creation in the towns themselves, to service new residents, truck drivers for transportation of fracking fluids and building materials and construction jobs relating to infrastructure and new wells (Fakir 2015; Jenner & Lamadrid 2013; Rahm 2011). In addition to this growth, it is likely that there will be growth in the hospitality sector, particularly to service the short term skilled migrant labour coming into the country from abroad. This, based on the data, is the only sector that saw growth in the past twenty years. The benefits accrued from such job creation will, however, will be accompanied by a number of issues.

The rise in population will necessitate a rise in housing. Given that the population of the town has seen such a steady incremental population growth for the past century, there will not be enough housing available to meet demand. This will result in new developments to meet demand, as well as residents leasing spare rooms and housing to the incoming residents. This will lead to inflated rents which in turn will make life far more difficult for longer-term residents, possibly pushing out locals to make way for migrant workers who can afford

higher rents. Such change will likely breed resentment towards the migrant workers (Krannich & Greider 1984; Summers & Branch 1984; Gramling & Brabant 1986; Little & Lovejoy 1979).

Local municipality resources will come under strain from the increased population. The children of new migrant workers will need to go to local schools, which will be forced to absorb the new intakes, further straining the municipal budget (Summers & Branch 1984). Given the existing social issues of high crime rates, IPV alcohol abuse, one expects local law enforcement to come under strain from the increased population (Rehm et al.. 2003; Schneider et al.. 2007; Peltzer 2013). Furthermore, given the extremely high volumes of truck traffic that are anticipated, the local municipal public works departments will take on the burden of maintaining all new and existing infrastructure that will be affected by shale gas extraction traffic daily (Rahm 2011; Jenner & Lamadrid 2013). Many Northern Cape municipalities are already incapacitated by lack of personnel, finances and high levels of corruption and have been further weakened by the recent amalgamation of small town centres under a single municipality, thus weakening their political autonomy (Van-Rooy 2007). The additional factors mentioned will only serve to exacerbate existing problems, especially if shale gas rents are not accrued to those municipalities affected.

In addition, the increased population will put strain on local healthcare resources. The South African healthcare system struggles to service its existing population as is (Coovadia et al.. 2009; Rowe et al.. 2005; Myburgh et al.. 2005) and the increased population in such an outlying area will require additional medical support, particularly given the shale gas extraction is typically associated with a number negative health costs. The negative health implications will affect both the human population as well as livestock and wildlife as a result of contaminated ground water supplies from migrated methane and well blowouts. (Adgate et al.. 2014; Bamberger & Oswald 2012; Vengosh et al.. 2014)

In the event that drilling activities trigger seismic activity, local residents and businesses would be a risk of incurring costs relating to damages from these earthquakes. This would likely result in legal action against the responsible oil and gas companies, though the costs of damages would have to be borne by residents and business, at least initially. (Watson 2016; Rosen 2015)

With the town increasingly moving to support the functions of the shale gas extraction industry, whatever limited local industrial productivity there was may see a decline (Wait & Rossouw 2013). This will occur because overheads such as rent and other basic services will become more expensive and their competitive advantage will be lost. On the other hand, local industrial productivity may increase if the activity sees an opportunity in the larger market of new migrant workers, but this will depend on the type of industrial activity and its ability to meet demand.

Finally, we encounter issues of shale gas extraction detrimentally contaminating some water sources relied upon by farmers, businesses and residents in the water scarce region (Nel & Hill 2008; Adgate et al.. 2014;

Bamberger & Oswald 2012; Vengosh et al.. 2014). This could lead to agricultural failure and thus a loss of productivity, but also a further increase in the urban population as the farm workers from failed farms migrate away from the rural area towards the urban area. Furthermore, as mentioned previously, this could place additional strain on local healthcare services as a result of all those suffering from shale gas related ailments. Another potential issue these towns may face is the burden of increased management of water sources as a result of high usage of the shale industry. Mismanagement can lead to ecological, economic and health catastrophes (Kinnaman 2011) and given the strain on resources one would already see during the production phase, this would be a high risk area.

As one can see, the boom period of the shale gas extraction carries with it a number of negative disruptions based on the application of the social disruption hypothesis. These negative disruptions occur in the time of purported prosperity, yet the bust period would not yet have arrived. Once the shale gas extractive industry has run its course and all economically feasible reserves have been exhausted, the local towns will be left with the infrastructure, housing and businesses suited to service a much larger population with specific needs relating to the local industry, but without the population itself.

Schools and clinics will close, the housing market will recede drastically and unemployment will be rife. Permanent residents will either migrate away from the “busted” town or remain, some of whom may fall back into or continue with patterns of alcoholism and intimate partner violence. Ecologically, it is likely that a number of wells throughout the Karoo would have contaminated water sources, damaging them irreparably. The future opportunity costs of the loss of this economic resource will be need to be borne by locals. Furthermore, given the extensive new infrastructure, the landscape will bear the scars of the extraction which may affect animal populations as well as the aesthetic of the Karoo, a key selling point to those in the hospitality industries.

Chapter 6: Findings and Conclusions

Findings

The primary research question that this thesis sought to address was as follows:

The main question that this research explores is what is the current economic and demographic profile of the small Karoo towns of Carnarvon, Victoria West and Williston and what will the short-term economic and social affects be on these towns be in the event of the development of a shale gas industry in the Karoo? Additionally, the research has identified numerous studies that show that shale gas exploration and production would cause damage to the natural environment and have long term negative ecological impacts. The thesis describes these briefly but does not attempt to assess these in relation to the short term impacts, although it is clear from these studies that a comprehensive study of the costs and benefits of shale gas exploration and production would have to take these into account. The following chapter will summarize the findings of this thesis, as discussed in the preceding chapters. It will begin by identifying the demographic and economic baselines of the towns of Carnarvon, Williston and Victoria West. This summary will be followed by a comparison between the baseline and the shale gas future that Karoo towns may experience in the event that shale gas extraction takes place.

The Karoo is characterised by its low population density and small stock farming economy. Livestock and poultry production are the primary outputs for the region. The urban centres throughout the Karoo used to provide essential services to agricultural communities but with advances in global transportation and declining demand for the region's output, these towns have declined. Hill and Nel (2011) showed the different population trends for small and big Karoo towns, with small towns (those with a population of <10000) experiencing very low population growth for most of the twentieth century. In contrast, some of the larger towns absorbed the service functions of smaller towns and expanded, such as Queenstown and Beaufort West. These towns diversified to the extent that they no longer relied on surrounding agricultural areas to sustain them.

However, the focal point of this thesis has been small Karoo towns. Population trends for Carnarvon and Williston confirmed the hypothesis of Hill and Nel; that the rural population of small Karoo towns has been in decline, almost since the beginning of the century. This population decline coincides with the falling TFP of the region, discussed by Conradie *et al.* (2009). This population decline is not exclusive to rural areas but also inclusive of 'small' Karoo towns, *i.e.* those with a population of less than 10,000 people. The population of Carnarvon and Williston was reflective of this trend, further highlighted by Hill and Nel (2011) in their paper on the marginalisation of small towns in the Karoo. Since the 1950's, the economic viability of the region has been impaired. This decline coincided with the global modernization of agriculture and the area has seen a growth in poultry farming in response to the weakened state of the wool and mutton industry. (Hoffman &

Rohde 2007). This paper highlighted the declining state of the Karoo region by through an examination of the existing literature on the Karoo. These trends were supported by the evidence for declining rural population of the area and declining population in small Karoo towns. The Rural Land Transfer Directory confirmed that the relative price of property in the Karoo has been declining, strengthening the hypothesis that larger farms have been forced to incorporate smaller farms because of economies of scale. The primary sector in small Karoo towns is still agriculture, though the tourism and hospitality sector has been the fastest growing sector for a number of years. In particular towns, a trend of “counter-urbanisation” has been prevalent. This trend describes professionals moving from urban areas to rural towns in search of a non-conventional lifestyle, thus affecting the economic make-up of those towns. This trend, however, was not apparent in Carnarvon, Victoria West or Williston.

The following paragraphs focus on the Carnarvon, Victoria West and Williston more specifically in order by examining the economic change in these towns from 1982-2012.

Since the beginning of the period of analysis for the enterprises in the town, it was shown that the economy of Carnarvon is much less diversified today than it was in 1982 (see Appendix 2). The economy of the town has grown slightly, though economic indicators for the region paint a bleak picture, with high levels of unemployment, particularly among youth. The areas surrounding the town have seen the majority of the white population migrate away from the area while the coloured population has moved into the town itself from the rural areas. The value of rural land around Carnarvon has been in decline since 1971, further supporting the notion that the rural areas surrounding Carnarvon are in decline. Williston shares similar trends in all regards with its neighbour, though data on the average price of rural land was not available for Williston.

Victoria West proved an outlier among the small towns in the Karoo because of its unusual population spike beginning in 1980. The black and coloured groups contributed to the growth of the town from 2890 people in 1980 to 8140 in 2001. The economy of the town is much larger than Williston and Carnarvon and geographically it is better situated, sitting on the N12 national road. Other than this there is little evidence of the source of Victoria West’s population growth spurt. Large rural properties surrounding the area are seen to have declined in value over the period 1971-1995, highlighting again the rural decline in the area. The following paragraphs will discuss a summary of what one might expect from the development of shale gas in the region.

It is likely that, given that nature of the shale gas extraction that widely dispersed towns in the Karoo region will form a base for shale gas extraction operations. The towns provide housing and an established area whereby necessary services can be sourced. In the event of shale gas development in the region, one would expect towns such as Williston, Victoria West and Carnarvon to be susceptible to detrimental change on a number of levels. The United States’ experience of shale gas experience has provided a number of experiences

to be considered for a potential shale gas extraction future in the Karoo. This includes damage to property and health relating to the potential for increased seismic activity; increased medical costs for residents and local businesses as a result of dangerous chemicals polluting the air, soil and water as a result of shale gas extraction; decreased viability of local businesses in light of the higher overheads such as rent; the potential for agricultural failure as a result of contaminated air, water and soil resources; high volumes of dust pollution affecting health and quality of life; the overutilization of the limited water resource; and finally the financially ruinous and environmentally damaging impact of new infrastructure that will be required for any shale gas extraction development.

Furthermore, The Boomtown Model (Krannich & Greider 1984; Summers & Branch 1984; Little & Lovejoy 1979; Gramling & Brabant 1986; Gopalakrishnan & Klaiber 2013; Muehlenbachs et al. 2015) suggests that the increased stress of a rapidly inflated population is a direct consequence for social ills to affect such towns. These include an increase in mental health caseloads, decreased quality of life for long-term residents, increased chances of drug and alcohol related incidents and marital instability, which in the South African case can transfer into inter-personal violence. Furthermore, the shale gas industry is sure to attract an influx of road traffic. Trucks delivering building materials, fracking fluid and water will inundate Karoo roads that have been designed to accommodate farmland traffic. This traffic will serve to provide an economic boost (Christopherson & Rightor 2011, p.11) to the towns as well as an increased burden on the already underfunded and underperforming local municipalities.

In addition to the factors listed above, which are shorter term economic and social effects as they apply to the exploration and production phases of shale gas extraction, there are significant long term considerations. This includes the permanent damage to the local hydrological cycle (Finewood & Stroup 2012), displaced communities, the ecological effects of thousands of kilometres of tarred roadways and fencing (Conradie & Natrass 2013; du Toit et al. 2003) and the immense amounts of hydrocarbon energy released that would contribute to climate change (Wood et al. 2011). There are undoubtedly many more factors to consider when dealing with the post-production phase of shale gas extraction that have not yet been identified - these factors will also be accompanied by economic, environmental and social costs that will have to be borne by future generations. These factors require further study in order to properly assess the all relevant costs and benefits, though it is clear that shale gas extraction in the Karoo will have effects that permeate through South African society long after the industry has left.

That being said, there is a significant unemployment issue that is ubiquitous throughout the region that may be relieved through shale gas development. Employment opportunities will be created in both the upstream and downstream sectors of the business, increasing the populations of smaller towns and potentially diversifying their economies through the accompanying growth in the service sectors. Furthermore, there will be infrastructural requirements necessitating significant labour as well as 'induced jobs' that will be created

in response to the industry in all facets of the economy. Increased government revenues acquired through royalties could be used to ease the financial burden on local municipalities in the region, thus addressing poverty challenges in the area. Furthermore, extractive industries may be required to contribute to community development through their projects, the extent of which will be decided on in the event that prospecting begins.

Conclusions

The research question that this thesis set out to answer asked what the current demographic and economic profile of the small towns of Carnarvon, Victoria West and Williston and what will the short-term economic and social affects be on these towns in the event of the development of a shale gas extractive industry in the Karoo. It began by grounding the literature in the sociological Boomtown literature that analyses the effects extractive industries have on rural towns. This literature has undergone a revival in the USA in the wake of the shale boom and given the rurality and isolation of the Karoo, this seemed the most appropriate foundation through which to continue. The paper highlighted some of the pertinent issues one encounters in a boomtown case and later outlined how Carnarvon, Williston, Victoria West and other towns of a similar profile may be susceptible to these issues.

This paper then moved to examine the Karoo region as a whole. It explored the theme of urbanization and how this has seen the steady decline rural populations over the last century, including a population decline in small Karoo towns – those being of a population less than 10,000 people. This decline can be attributed to the stagnation of the wool and mutton industry, the global mechanisation of agriculture, improving transportation and technology reducing the need for remote “service towns” and less intensive farming of the land. A new trend was explored, that of counterurbanisation. This describes the movement of high-earning professionals away from large urban areas in search of an alternate lifestyle which is made possible by wide-reaching internet access and improved transportation. This trend is very noticeable in certain South African towns and expected to continue to grow over time. Finally the chapter examined the economic situation of the Karoo with the aid of Conradie *et al.*'s work on total factor productivity, further solidifying the notion that the economy of the Karoo is shrinking and has been doing so for quite some time.

These preceding sections lay the necessary groundwork through which this paper could create the demographic and economic profiles of the towns of Carnarvon, Victoria West and Williston. This formed the basis for the creation of a baseline trajectory that these towns might follow in the event that no shale gas extraction occurs and compares this with a shale gas extraction future. The baseline trajectories of Carnarvon and Williston confirmed the findings of the analysis of the Karoo, discussed in the previous paragraph. The

decline of these small rural towns have less diversified economies than they once used to, high levels of unemployment and high levels of alcohol abuse. These towns, including Victoria West, will see a number of changes from shale gas development, many of those detrimental to the well-being and quality of life of small town Karoo residents.

The entire process and severity of its positive and negative effects is subject to the regulatory environment. This will control the attractiveness of the opportunity to business interested in the resources, as well as mitigate or leave the likely negative social effects to go unchecked. The government has an enormous responsibility to consider every aspect of shale gas development to ensure that communities are not irreparably affected and that the benefits of the development are managed to maximise the benefits accrued to the people of the region and South Africa as a whole. If shale gas development does go ahead, it is the duty of policy makers to learn lessons from the USA experience of shale gas extraction, in conjunction with careful consideration of the economic and social realities that exist in the Karoo today.

Furthermore, the integrity of the local environment and underground water resources will need active and conscientious monitoring and regulation. There are a number of likely environmental consequences associated with hydraulic fracturing, including the contamination of shallow aquifers, surface water and shallow ground water. Even more concerning is the immense volume of water required to frack a single well, which begs the question as to where this water might come from in such a water constrained country.

One hopes that with the lives and livelihoods of so many people at stake that responsible and rigorous research is undertaken at all levels to ensure the development of shale gas in South Africa is beneficial to everyone, and not just for some.

Appendix 1

Business Categories

Enterprise sectors used	Types of business
Agricultural products and services	General agricultural stores (Koöperasie), auctioneers
Processing sector	Abattoirs, processing enterprises
Factory sector	Manufacturing and factory businesses
Construction sector	Construction businesses
Mining sector	Mining businesses
Tourism and hospitality sector	Restaurants, hotels, B&B's, guesthouses, bars, theatres
Engineering and technical services	Engineering businesses
Financial services sector	Accountants, banks
Legal services sector	Legal advisors
Telecommunications services sector	Not applicable to study
News and advertising services sector	Not applicable to study
Trade sector	General stores, furniture stores, supermarkets, food stores, liquor stores, clothing outlets
Vehicle sector	Mechanics, Car dealerships
General services sector	Hair dressers, cell phone repair shops
Professional services sector	Security companies, insurance companies
Personal services sector	Funeral services, old age homes,
Health services sector	Pharmacies, private healthcare
Transport and earthworks sector	Distribution companies
Real Estate sector	Real estate agents
Excluded government services	Post office, courthouse, police station, health clinics, social services

Appendix 2

Enterprise categorization

1982/1983		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	2	2	5
2	Processing sector		2	2
3	Factory sector			1
4	Construction sector		2	
5	Mining sector			
6	Tourism and hospitality sector	3	4	9
Service Sectors		5	10	17
7	Engineering and technical services sector			1
8	Financial services sector	2	1	4
9	Legal services sector	2	3	2
10	Telecommunications services sector			
11	News and advertising services sector			
12	Trade sector	2	8	9
13	Vehicle sector	4	8	4
14	General services sector	2	3	1
15	Professional services sector		1	1
16	Personal services sector		2	1
17	Health services sector	1	1	1
18	Transport and earthworks sector			
19	Real Estate sector			
TOTAL		18	37	41

1987/1988		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	3	3	5
2	Processing sector		1	
3	Factory sector			1
4	Construction sector			1
5	Mining sector			
6	Tourism and hospitality sector	4	4	11
Service Sectors		7	8	18
7	Engineering and technical services sector			
8	Financial services sector	1	3	6
9	Legal services sector	1	4	1
10	Telecommunications services sector			
11	News and advertising services sector			
12	Trade sector	2	5	9
13	Vehicle sector	4	7	3
14	General services sector	1	4	1
15	Professional services sector		1	1

16	Personal services sector		2	1
17	Health services sector			2
18	Transport and earthworks sector			
19	Real Estate sector	2	1	
TOTAL		18	35	42

1992/1993		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	4	4	4
2	Processing sector	1	1	1
3	Factory sector			1
4	Construction sector		1	1
5	Mining sector			
6	Tourism and hospitality sector	1	4	9
Service Sectors		6	10	16
7	Engineering and technical services sector			
8	Financial services sector	2	4	3
9	Legal services sector		2	2
10	Telecommunications services sector		1	
11	News and advertising services sector			
12	Trade sector	2	13	11
13	Vehicle sector	2	5	3
14	General services sector		4	4
15	Professional services sector	2	2	
16	Personal services sector	2	2	1
17	Health services sector		1	1
18	Transport and earthworks sector			3
19	Real Estate sector	1		
TOTAL		17	44	44

1997/1998		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	2	2	4
2	Processing sector		1	1
3	Factory sector			1
4	Construction sector		1	
5	Mining sector			
6	Tourism and hospitality sector	5	6	10
Service Sectors		7	10	16
7	Engineering and technical services sector			
8	Financial services sector	2	4	4
9	Legal services sector	1	1	3
10	Telecommunications services sector			
11	News and advertising services sector			
12	Trade sector	6	12	14

13	Vehicle sector	2	5	3
14	General services sector		4	4
15	Professional services sector	2	1	2
16	Personal services sector	1	1	1
17	Health services sector		1	1
18	Transport and earthworks sector			
19	Real Estate sector	1		
TOTAL		22	39	48

2009/2010		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	1	2	2
2	Processing sector		1	
3	Factory sector			1
4	Construction sector		2	
5	Mining sector			
6	Tourism and hospitality sector	6	5	15
Service Sectors		7	10	18
7	Engineering and technical services sector			
8	Financial services sector	2	5	6
9	Legal services sector	1	1	2
10	Telecommunications services sector			
11	News and advertising services sector			
12	Trade sector	7	13	12
13	Vehicle sector	3	4	6
14	General services sector	1	2	3
15	Professional services sector	3	2	
16	Personal services sector			3
17	Health services sector		1	1
18	Transport and earthworks sector			
19	Real Estate sector		1	
TOTAL		24	39	51

2012/2013		Williston	Carnarvon	Victoria West
Economic drivers				
1	Agricultural products and services sector	2	5	1
2	Processing sector	2	1	1
3	Factory sector			1
4	Construction sector		1	1
5	Mining sector			
6	Tourism and hospitality sector	13	8	17
Service Sectors		17	15	21
7	Engineering and technical services sector			
8	Financial services sector	1	3	5
9	Legal services sector	1	2	2

10	Telecommunications services sector			
11	News and advertising services sector			
12	Trade sector	10	15	11
13	Vehicle sector	2	3	3
14	General services sector	2	4	4
15	Professional services sector	1		2
16	Personal services sector			1
17	Health services sector		2	1
18	Transport and earthworks sector			
19	Real Estate sector			
TOTAL		34	44	50

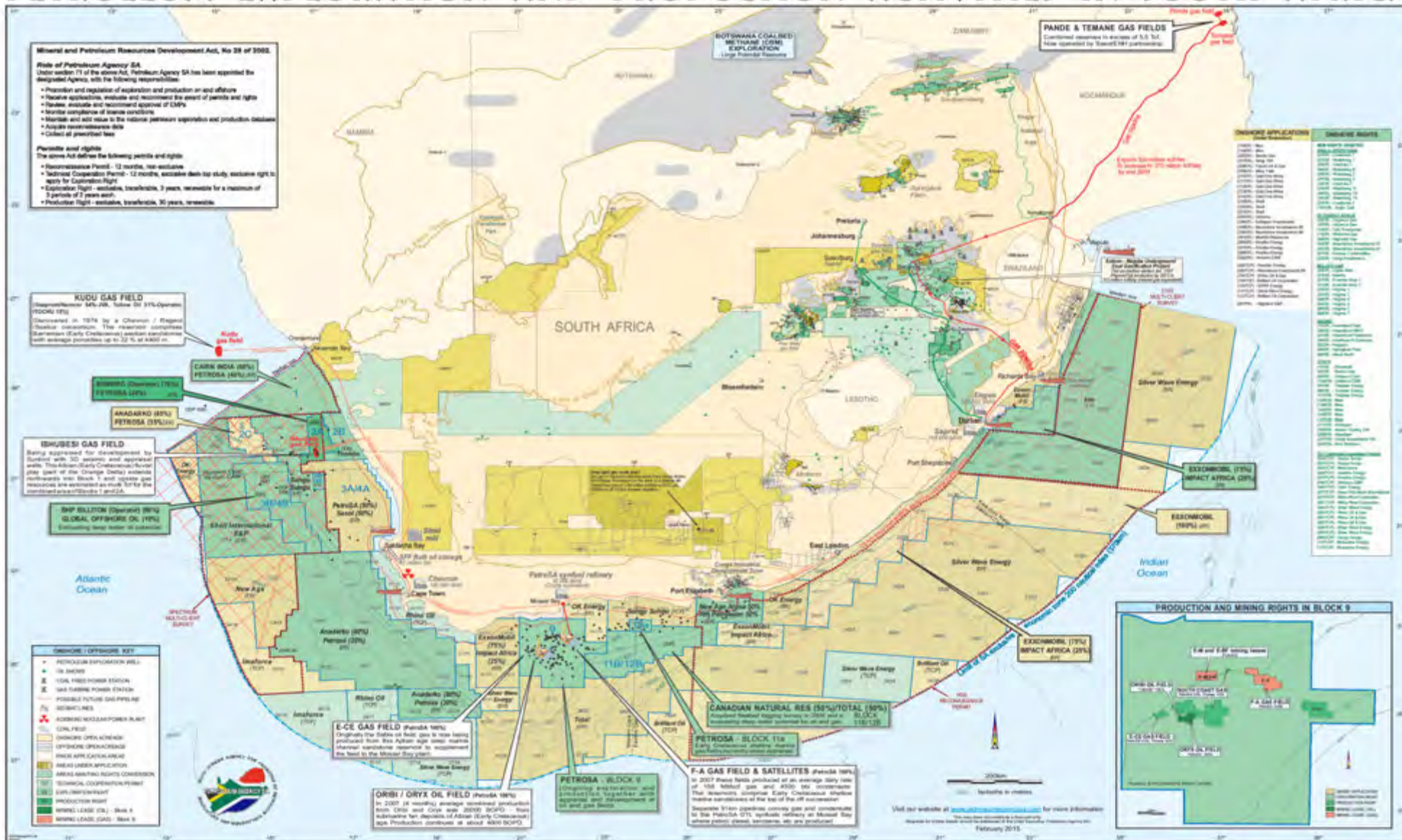
Appendix 3

Location of towns

Town	Province	District	Municipality	Location
Carnarvon	Northern Cape	Pixley ka Seme	Kareeberg	30°58'S 22°08'E
Victoria West	Northern Cape	Pixley ka Seme	Ubuntu	31°24'S 23°07'E
Williston	Northern Cape	Namakwa	Karoo Hoogland	31°21'S 20°55'E

Appendix 4

PETROLEUM EXPLORATION AND PRODUCTION ACTIVITIES IN SOUTH AFRICA



Appendix 5

Changing value in rural property in the Karoo

Carnarvon rural land value (2012 ZAR)							
Size of property (ha)	1-4	5-19	20-99	100-500	500-2000	2000-5000	5000+
1971	0.00	152085.00	4125.00	0.00	1440.00	575.00	0.00
1972	0.00	11763.64	4577.27	713.64	913.64	568.18	618.18
1973	0.00	4537.50	3416.67	0.00	841.67	591.67	0.00
1974	0.00	4662.96	1351.85	0.00	694.44	496.30	414.81
1975	141666.67	2586.67	1603.33	2666.67	1666.67	566.67	833.33
1976	0.00	0.00	0.00	0.00	705.88	511.76	485.29
1977	0.00	13513.51	1689.19	486.49	613.51	567.57	364.86
1978	0.00	0.00	0.00	3378.05	862.20	692.68	407.32
1979	20925.53	2836.17	1921.28	0.00	769.15	423.40	406.38

Victoria West rural land (2012 ZAR)							
Size of property (ha)	1-4	5-19	20-99	100-500	500-2000	2000-5000	5000+
1971	167855.00	0.00	0.00	0.00	1240.00	890.00	850.00
1972	0.00	0.00	3600.00	0.00	722.73	572.73	686.36
1973	0.00	0.00	19408.33	0.00	0.00	491.67	66.67
1974	123455.56	0.00	0.00	0.00	603.70	681.48	648.15
1975	186466.67	0.00	0.00	0.00	0.00	650.00	723.33
1976	51470.59	0.00	18382.35	0.00	0.00	588.24	155.88
1977	184683.78	0.00	7883.78	0.00	824.32	391.89	0.00
1978	0.00	0.00	2260.98	402.44	756.10	358.54	509.76
1979	41757.45	0.00	134.04	444.68	0.00	0.00	0.00

Bo-Karoo value rural land (2012 ZAR)							
Size of property (ha)	1-4	5-19	20-99	100-500	500-2000	2000-5000	5000+
1980	37037.04	0.00	0.00	2068.52	1074.07	1018.52	746.30
1981	0.00	0.00	0.00	806.45	2230.65	1201.61	0.00
1982	0.00	0.00	0.00	0.00	1760.56	1195.77	0.00
1983	0.00	75721.25	18978.75	9755.00	1087.50	856.25	411.25
1984	0.00	0.00	20552.81	5120.22	1540.45	696.63	588.76
1985	0.00	0.00	58117.48	6934.95	1749.51	1274.76	939.81
1986	0.00	10452.85	0.00	16408.94	1243.90	1163.41	325.20
1987	0.00	0.00	0.00	7358.45	845.07	888.73	722.54
1988	93167.70	0.00	16244.72	15427.33	958.39	1087.58	1038.51
1989	20380.43	0.00	2443.48	1592.93	2720.65	1062.50	0.00
1990	0.00	0.00	31217.14	5248.57	1238.57	470.48	0.00
1991	0.00	0.00	11340.33	8243.21	1113.17	932.10	501.65
1992	0.00	0.00	9804.04	4738.42	523.90	713.97	231.25
1993	22277.23	0.00	26049.50	2640.26	630.36	518.15	204.62
1994	0.00	0.00	5990.91	14574.24	1360.61	330.30	196.97
1995	0.00	0.00	9459.61	1857.94	974.93	540.39	270.19

Bibliography

- Abramzon, S. et al., 2014. Estimating the Consumptive Use Costs of Shale Natural Gas Extraction on Pennsylvania Roadways. *Journal of Infrastructure Systems*, 20(3).
- Adgate, J., Goldstein, B. & McKenzie, L., 2014. Potential Public Health Hazards, Exposures and Health Effects from Unconventional Natural Gas Development. *Environmental Science and Technology*, 48, pp.8307–8320.
- Bamberger, M. & Oswald, R., 2012. Impacts of Gas Drilling on Human and Animal Health. *New Solutions*, 22(1), pp.51–77.
- Bureau of Statistics, *Transfers of Rural Immovable Property*, Pretoria.
- Christopherson, S. & Rightor, N., 2011. *A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus Shale*, Available at: http://greenchoices.cornell.edu/downloads/development/shale/Thinking_about_Economic_Consequences.pdf.
- Christopherson, S. & Rightor, N., 2012. How shale gas extraction affects drilling localities: Lessons for regional and city policy makers. *Journal of Town and City Management*, 2(4).
- Comin, D., 2006. Total Factor Productivity. , pp.1–5. Available at: <http://www.people.hbs.edu/dcomin/def.pdf>.
- Conradie, B., 2006. *Revisiting Labour Casualisation on Fruit Farms in the Western Cape*, Available at: <http://www.cssr.uct.ac.za/sites/cssr.uct.ac.za/files/pubs/wp177.pdf>.
- Conradie, B. & Natrass, N., 2013. *Jackal Narratives and Predator Control in the Karoo, South Africa*, Available at: http://www.cssr.uct.ac.za.ezproxy.uct.ac.za/sites/cssr.uct.ac.za/files/WP324_0.pdf.
- Conradie, B., Piesse, J. & Thirtle, C., 2009. District-level total factor productivity in agriculture: Western Cape Province, South Africa, 1952–2002. *Agricultural Economics*, 40, pp.265–280.
- Considine, T., 2010. *The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia*, Laramie. Available at: <http://www.api.org/~media/Files/Policy/Exploration/API-Economic-Impacts-Marcellus-Shale.pdf>.
- Coovadia, H. et al., 2009. The health and health system of South Africa: historical roots of current public health challenges. *The Lancet*, 374(9692), pp.817–834.
- Department of Energy, 2013. *Integrated Resource Plan for Electricity 2010-2030 (Update)*, Pretoria. Available at: http://www.doe-irp.co.za/content/IRP2010_updatea.pdf.
- Department of Environmental Affairs, South African Government's position on Climate Change. Available at: <http://www.climateaction.org.za/cop17-cmp7/sa-government-position-on-climate-change> [Accessed November 29, 2014].
- Department of Science and Technology, 2007. *Astronomy Geographic Advantage Act*, South Africa. Available at: http://www.saflii.org/za/legis/consol_reg/agaa21o2007rangnr90740.pdf.
- Department of Science and Technology, 2014. The SKA and MeerKAT projects.
- Department of Water Affairs, 2013. Proposed declaration of the exploration for and or production of unconventional oil or gas resources and any activities incidental thereto but not limited to hydraulic fracturing as a controlled activity. Available at: http://cer.org.za/wp-content/uploads/2013/10/Proposed-Declaration-of-Fracking-as-Controlled-Activity-under-NWA-23-Aug-2013-36760_gen863.pdf.
- Econometrix (Pty) Ltd., 2012. *Karoo Shale Gas Report: Special report on economic considerations surrounding potential shale gas resources in the southern Karoo of South Africa*, Johannesburg. Available at:

<http://cer.org.za/wp-content/uploads/2012/06/Econometrix-KSG-Report-February-2012.pdf>.

- Emuze, F. & Hauptfleisch, C., 2014. The Impact of Mining Induced Urbanization: A case study of Kathu in South Africa. *Journal of Construction Project Management and Innovation*, 4(2), pp.882–894.
- Fakir, S., 2015. *Framework to assess the economic reality of shale gas in South Africa*, Available at: http://awsassets.wwf.org.za/downloads/framing_the_economics_of_shale_gas_in_south_africa__report_web.pdf.
- Fakir, S., 2014. WWF Memo: Shell's Econometrix shale-gas study. Available at: http://awsassets.wwf.org.za/downloads/econometrix_economics_study_on_shale_final.pdf.
- Fin24, 2013. Consumers increasingly taking out pay day loans. *News24*. Available at: <http://www.fin24.com/Economy/Consumers-increasingly-taking-out-pay-day-loans-20131003>.
- Google, 2013. Google Maps. Available at: <https://www.google.co.za/maps>.
- Google Maps, 2010. Williston. Available at: <https://www.google.co.za/maps/@-31.341153,20.918319,3a,75y,107.41h,82.04t/data=!3m4!1e1!3m2!1saiptCF6rSciDIpMU2QNIQ!2e0>.
- Gopalakrishnan, S. & Klaiber, A., 2013. Is the shale energy boom a bust for nearby residents? Evidence from housing values in Pennsylvania. *Agricultural Economics*, 96(1).
- Gramling, B. & Brabant, S., 1986. Boomtowns and Offshore Energy Impact Assessment: The Development of a Comprehensive Model. *Sociological Perspectives*, 29(2), pp.177–201.
- Hastak, M. & Baim, E., 2001. Risk factors affecting management and maintenance cost of urban infrastructure. *Journal of Infrastructure Systems*, 7(67), pp.67–76.
- Hoffman, M.T. & Rohde, R.F., 2007. From pastoralism to tourism: The historical impact of changing land use practices in Namaqualand. *Journal of Arid Environments*, 70, pp.641–658.
- Holtmann, B., 2008. Why Law Enforcement Is Not Enough: Lessons from the Central Karoo on breaking the cycle of crime and violence. *SA Crime Quarterly*, 23, pp.13–20.
- IHS Global Insight, 2012. *The Economic and Employment Contributions of Unconventional Gas Development in State Economies*, Available at: http://www.anga.us/media/content/F7D4500D-DD3A-1073-DA3480BE3CA41595/files/state_unconv_gas_economic_contribution.pdf.
- Ingle, M., 2013. Counterurbanisation and the emergence of a post-productivist economy in South Africa's arid Karoo region, 1994-2010. *New Contree*, 66.
- Jackson, R. et al., 2013. Increased stray gas abundance in a subset of drinking water wells near Marcellus shale gas extraction. *Proceedings of the National Academy of Science*, 110(28).
- Jacquet, J. & Kay, D., 2014. The Unconventional Boomtown: Updating the Impact Model to Fit New Spatial and Temporal Scales. *Journal of Rural and Community Development*, 9(1), pp.1–23.
- Jenner, S. & Lamadrid, A., 2013. Shale gas vs. coal: Policy implications from environmental impact comparisons of shale gas, conventional gas, and coal on air, water, and land in the United States. *Energy Policy*, (53), pp.442–453.
- Kinnaman, T., 2011. The economic impact of shale gas extraction: A review of existing studies. *Ecological Economics*, 70, pp.1243–1249.
- Krannich, R. & Greider, T., 1984. Personal Well-being in Rapid Growth and Stable Communities: Multiple Indicators and Contrasting Results. *Rural Sociology*, 49(4), pp.541–552.
- Little, R. & Lovejoy, S., 1979. Energy Development and Local Employment. *Social Science Journal*, 16(2), pp.169–190.
- London, L., 1999. The 'dop' system, alcohol abuse and social control amongst farm workers in South Africa: a public health challenge. *Social Science & Medicine*, 48, pp.1407–1414.
- Marais, L. & Cloete, J., 2009. Mining and Housing: The case of the "Village under the trees" (Kathu – South Africa). *Town and Regional Planning*, (55), pp.31–38.

- McEwen, H., 2013. Deserting Transformation: Heritage, Tourism, and Hegemonic Spatiality in Prince Albert. *Diversities*, 15(2), pp.23–33.
- McKenzie, L. et al., 2012. Human health risk assessment of air emissions from development of unconventional natural gas resources. *Science of the Total Environment*, 424, pp.79–87.
- Muehlenbachs, L. et al., 2015. *The Impact of the Fracking Boom on Rents in Pennsylvania*, Durham.
- Myburgh, N. et al., 2005. Patient satisfaction with health care providers in South Africa: the influences of race and socioeconomic status. *International Journal for Quality in Health Care*, 17(6), pp.473–477.
- Nel, E. & Hill, T., 2011. Demographic and Economic Changes in Small Towns in South Africa's Karoo: Looking from the Inside Out. *Urban Forum*, 22, pp.395–410.
- Nel, E. & Hill, T., 2008. Marginalisation and demographic change in the semi-arid Karoo, South Africa. *Journal of Arid Environments*, 72, pp.2264–2274.
- Peltzer, K., 2013. The severity of violence against women by intimate partners and associations with perpetrator alcohol and drug use in the Vhembe district, South Africa. *African Safety Promotion Journal*, 11(1), pp.13–24.
- Perry, S., 2012. Development, Land Use, and Collective Trauma: The Marcellus Shale Gas Boom in Rural Pennsylvania. *Culture, Agriculture, Food and the Environment*, 34(1), pp.81–92.
- Pressly, D., 2014. Fracking likely to start in 2017. *Fin24*. Available at: <http://www.fin24.com/Economy/Fracking-likely-to-start-in-2017-20141205> [Accessed December 7, 2014].
- Pretorius, A.M. & Blaauw, P.F., 2004. An analysis of provincial economic growth in South Africa 1991–2001. *South African Journal of Economic History*, 19(1–2), pp.1–17.
- Rahm, D., 2011. Regulating hydraulic fracturing in shale gas plays: The case of Texas. *Energy Policy*, 39, pp.2974–2981.
- Rehm, J. et al., 2003. The Global Distribution of Average Volume of Alcohol Consumption and Patterns of Drinking. *European Addiction Research*, 9, pp.147–156.
- Rogerson, C.M. & Visser, G., 2007. *Urban Tourism in the Developing World: The South African Experience*, New Jersey: Transaction Publishers.
- Rosen, J., 2015. Pumped Up to the Rumble. *Science*, 1299(348).
- Rowe, A. et al., 2005. How can we achieve and maintain high-quality performance of health workers in low-resource settings? *The Lancet*, 366(9490), pp.1026–1035.
- Schafft, K.A., Borlu, Y. & Glenna, L., 2013. The Relationship between Marcellus Shale Gas Development in Pennsylvania and Local Perceptions of Risk and Opportunity. *Rural Sociology*, 78(2), pp.143–166.
- Schneider, M. et al., 2007. *Estimating the burden of alcohol abuse in South Africa in 2000*, Cape Town.
- SKA Africa, 2013. MeerKAT. Available at: <http://www.ska.ac.za/meerkat/>.
- Society for the Study of Addiction, 2005. South Africa: alcohol today. *Addiction*, 100, pp.426–429.
- South African Reserve Bank, 2015. Unemployment. Available at: <http://www2.resbank.co.za/internet/Glossary.nsf/0/9028ea9be02366d342256b43002f51f5?OpenDocument>.
- Van Staden, J. & Marais, L., 2007. The tourism potential of Beaufort West: a study based on visitor demand. *Development South Africa*, 22(2), pp.223–249.
- Statistics South Africa, 2011a. Agricultural households municipal data - Northern Cape.
- Statistics South Africa, 2014. P0141 - Consumer Price Index (CPI), December 2014. Available at: <http://www.statssa.gov.za/publications/P0141/CPIHistory.pdf>.
- Statistics South Africa, 2011b. Statistics by place. *Census*. Available at:

http://beta2.statssa.gov.za/?page_id=964.

- Steyn, M. & Ballard, R., 2013. Diversity and Small Town Spaces in Post-Apartheid South Africa: An Introduction. *Diversities*, 15(2), pp.1–4.
- Summers, G. & Branch, K., 1984. Economic Development and Community Social Change. *Annual Review of Sociology*, 10, pp.141–166.
- Toerien, D. & Seaman, M., 2010. The enterprise ecology of towns in the Karoo, South Africa. *South African Journal of Science*, 106(5–6). Available at: http://www.scielo.org.za/scielo.php?pid=S0038-23532010000300011&script=sci_arttext#tab2.
- Urban, M. et al., 2008. Fetal alcohol syndrome among Grade 1 schoolchildren in Northern Cape Province: Prevalence and risk factors. *South African Medical Journal*, 98(11).
- Van-Rooij, R.J., 2007. *Promotion of small-town development: the case of the Apollo Development Association*. Bloemfontein: University of the Free State.
- Vengosh, A. et al., 2014. A Critical Review of the Risks to Water Resources from Unconventional Shale Gas Development and Hydraulic Fracturing in the United States. *Environmental Science and Technology*, 48(15), pp.8334–8348.
- Vidic, R. et al., 2013. Impact of Shale Gas Development on Regional Water Quality. *Science*, 340.
- Wait, R. & Rossouw, R., 2013. *The economic benefits of shale gas extraction in the southern Karoo, South Africa*, Potchefstroom.
- Watson, B., 2016. Fracking and Cracking: Strick Liability for Earthquake Damage Due to Wastewater Injection and Hydraulic Fracturing. *Texas Journal of Oil, Gas, and Energy Law*, 1(11), pp.1–29.
- Wentzel, W., 1984. Hard times in the Karoo: Case studies and statistical profiles from five peri-urban residential areas. In *Second Carnegie Inquiry into poverty and development in Southern Africa*. pp. 1–140.
- Wilkinson, K. et al., 1982. Local Social Disruption and Western Energy Development: A Critical Review. *The Pacific Sociological Review*, 25(3).
- Wilson, F., 2009. *Dinosaurs, Diamonds and Democracy*, Cape Town: Umuzi.