# The enterprise ecology of towns in the Karoo, South Africa

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## ABSTRACT

Two concepts, (1) companies are 'living' entities and (2) 'company ecology', stimulated our hypothesis that towns are 'enterprise ecosystems'. This hypothesis cannot be tested directly. However, if it is correct, application of clustering and ordination techniques used frequently in studies of natural ecosystems, should reveal clusters of towns that are statistically significantly different ($p < 0.05$). A dataset of 47 towns in the Karoo, South Africa served as study material and their enterprise assemblages were profiled through the use of a simple method based on the examination of telephone directories. Clustering and ordination techniques revealed six different clusters of towns at a correlation coefficient level of 0.65 and the clusters differed significantly ($p < 0.05$) in some respects. The agricultural products and services, the tourism and hospitality, and the trade sectors were particularly important in defining these clusters. We concluded that enterprise ecology is a valid concept and towns are 'ecosystems' that also cluster together in larger groupings. An array of potentially important techniques and approaches for the study of business development in towns now provide support to, and intriguing questions confront, academic and practical researchers of enterprise development in towns.

## INTRODUCTION

### Towns as enterprise ecosystems

Similarities between business enterprises and living organisms have, over the past decades, been mentioned from time to time. For instance, researchers agreed that information about the past could be stored in organisations, giving rise to the concept of organisational memory.[1] Learning at organisational level was recognised as a constantly repeated cyclic process of doing, reflecting, thinking and deciding,[2] similar to the way in which humans learn.[3] The central question posed in the book *The living company*[4] is whether companies can be thought of as living beings.[5] Beinhocker[6] stated:

> Economic wealth and biological wealth are thermodynamically the same sort of phenomena, and not just metaphorically. Both are systems of low entropy, patterns of order that evolved over time under the constraint of fitness functions. Both are forms of fit order. And the fitness of the economy ... is fundamentally linked to the fitness function of the biological world – the replication of genes. The economy is ultimately a genetic replication strategy.

Like each living organism, each individual enterprise is in a constant competition for survival and only the fittest survive. The number of enterprises, therefore, matters in enterprise development.

Ecology is the scientific study of the interactions between organisms and their environment.[7] It can be divided into three levels: the individual *organism*, the *population* (consisting of individuals of the same species) and the *community* (consisting of a number of populations).[7] The number of organisms, therefore, also matters in ecology.

Can the similarities between living organisms and enterprises be extended further? De Geus[4] hinted at the 'ecology' of companies but he did not investigate this aspect rigorously, in particular, he did not examine the similarities between natural ecosystems and the systems within which enterprises function.

Tansley[8] defined an ecosystem as a biotic community or assemblage and its associated physical environment in a specific place. A basic structural requirement is that ecosystems encompass a biotic complex, an abiotic complex, the interaction between them and a physical space.[8] A natural ecosystem can be of any size as long as organisms, the physical environment and their interactions can exist within it. Therefore, natural ecosystems can be as small as a patch of soil supporting plants and microbes, or as large as the entire biosphere of the Earth.[9]

Similar ecosystems tend to have similar assemblages or communities of organisms. This fact provides the basis for the study of communities of organisms in many divergent ecosystems (e.g. estuaries,[10] forests,[11] oceans[12] and soils[13]), as well as the detection of the effects of disturbances on ecosystem dynamics.[14]

Villages, towns and cities meet all the criteria set to define natural ecosystems. They contain 'biotic' (*sensu* De Geus[4]) complexes (i.e. groups of enterprises) occurring within 'abiotic' complexes, such as houses, streets, business districts, supplies of water (or lack thereof), electricity and so on, contained in specific physical spaces (urban areas or regions). There are also interactions between these 'biotic' and 'abiotic' complexes and spaces. Based on the above, we hypothesise that villages, towns and cities are 'ecosystems' that house 'living' enterprises; they are 'enterprise ecosystems'.

However, the above hypothesis cannot be tested directly. One way to test it is to determine if towns, like natural ecosystems, can be clustered together in larger groups that make sense. For this purpose, the techniques that have been used for decades to study the biotic assemblages or communities of natural ecosystems can be applied.

Clustering and ordination of samples have been successfully used to investigate different biotic assemblages.[15] For example, marine macrobenthic communities in a tropical environment,[16] microbes in soils,[17] river macroinvertebrates[18] and nematode communities[19] have all been studied in this way.

If South African villages and towns are enterprise ecosystems, these clustering and ordination techniques should be useful in delineating groups of towns with similar enterprise communities or structures, which would be indicative of similar enterprise evolutionary paths.

In order to apply the selected ecological techniques it was necessary to enumerate the number of enterprises in a selection of South African villages and towns. A rapid method to determine the enterprise structures of South African towns was developed and is described more fully later.

To prevent confounding the testing of the hypothesis unnecessarily, the selection of towns for testing of the hypothesis should preferably be based on towns with similar origins. A selection of towns from the semi-arid to arid Karoo regions of South Africa (Figure 1) was used. These towns fall largely within Fransen's definition[20] of 'church towns', that is, towns that followed upon the establishment of new church parishes during the expansion of European colonist farmers into southern Africa.[20]

The null hypothesis was that the Karoo towns are not enterprise ecosystems and the selected group of towns would not show any clusters that differ from one another at $p < 0.05$. Clustering should then only yield a single large cluster of towns because the same factors would, over time, have driven a similar process of enterprise development in all of the towns (as a result of their similar beginnings). However, if differences at $p < 0.05$ were detected between clusters of towns, the null hypothesis could be rejected. Karoo towns would then have behaved in a similar manner to natural ecosystems.

## The Karoo

The Karoo, the arid interior heartland of South Africa, has a long and fascinating history that will not be repeated here. Suffice it to say that at one stage in the 19th century, wool production, the majority of which was produced in the Karoo, was the economic driver of the Cape Colony and was linked to industrial activities in the United Kingdom (UK).[21] The result was prosperity in the Karoo and its towns.[22] However, this prosperity did not last and the economic modernisation of the Karoo in the late-20th and early 21st centuries has been slow.[22] Consequently, the structure of small towns and extensive sheep- and goat-farming operations still bear the imprint of the mid-19th century[23] and the Karoo has become an economic backwater in South Africa.[22] The Karoo now faces major development challenges, which include urbanisation resulting from east–west migration from more populous regions, the restructuring of agriculture, a changing profile and function of towns, economic marginalisation, the onslaught of HIV/AIDS and severe structural poverty.[23]

## METHODS
### Towns selected for the study

Forty-seven villages and towns (Table 1) covering a large part of the Little and Great Karoo (Figure 1) were selected.

### Determination of enterprise assemblages

The rapid method to determine the enterprise assemblages of South African towns was based on listings of enterprises in telephone directories. All enterprises listed in such directories form part of the formal economy of the towns in which they reside and their enumeration allows valid comparisons between towns. Telephone directories of the selected towns were scrutinised (Table 1) and all enterprises were listed in
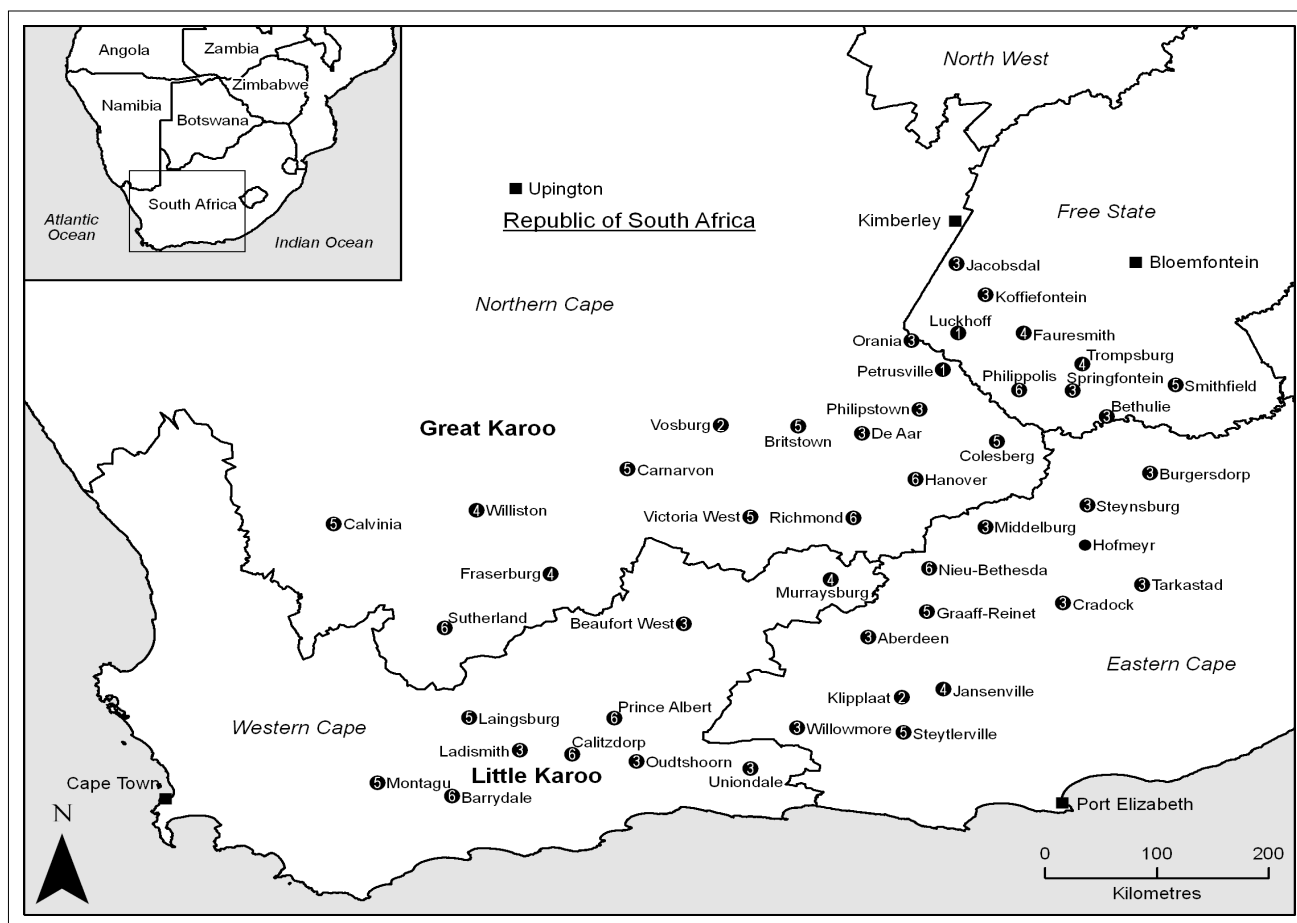


Numbers next to town names refer to cluster numbers – see Figure 2.

**FIGURE 1**
Location of Karoo towns used in the study

**TABLE 1**
The Karoo towns selected for the study, their numbers used in analyses (No.), their provincial location (Prov.) and the total number of their enterprises (Ent.)

| No. | Town | Ent. | Prov. |
|---|---|---|---|
| 1 | Petrusville† | 17 | NC |
| 2 | Luckhoff* | 16 | FS |
| 3 | Vosburg¶ | 16 | NC |
| 4 | Klipplaat* | 15 | EC |
| 5 | Jacobsdal* | 42 | FS |
| 6 | Tarkastad* | 42 | EC |
| 7 | Bethulie* | 43 | FS |
| 8 | Steynsburg* | 39 | EC |
| 9 | Willowmore‡ | 49 | EC |
| 10 | Ladismith§ | 88 | WC |
| 11 | Koffiefontein† | 43 | FS |
| 12 | Burgersdorp* | 115 | EC |
| 13 | Middelburg† | 161 | EC |
| 14 | Aberdeen* | 39 | EC |
| 15 | Uniondale† | 42 | WC |
| 16 | Springfontein* | 23 | FS |
| 17 | Philipstown† | 15 | NC |
| 18 | Beaufort-West* | 353 | WC |
| 19 | Oudtshoorn† | 897 | WC |
| 20 | Cradock* | 296 | EC |
| 21 | De Aar* | 223 | NC |
| 22 | Orania* | 26 | NC |
| 23 | Fraserburg* | 33 | NC |
| 24 | Fauresmith* | 22 | FS |
| 25 | Jansenville* | 47 | EC |
| 26 | Murraysburg‡ | 21 | WC |
| 27 | Trompsburg* | 38 | FS |
| 28 | Williston¶ | 26 | NC |
| 29 | Carnarvon* | 58 | NC |
| 30 | Smithfield* | 35 | FS |
| 31 | Graaff-Reinet‡ | 329 | EC |
| 32 | Montagu† | 224 | WC |
| 33 | Colesberg‡ | 144 | NC |
| 34 | Steytlerville* | 30 | EC |
| 35 | Calvinia* | 110 | NC |
| 36 | Victoria West¶ | 74 | NC |
| 37 | Britstown* | 27 | NC |
| 38 | Laingsburg* | 56 | WC |
| 39 | Prince Albert† | 72 | WC |
| 40 | Barrydale§ | 56 | WC |
| 41 | Calitzdorp§ | 54 | WC |
| 42 | Sutherland* | 35 | NC |
| 43 | Nieu-Bethesda‡ | 21 | EC |
| 44 | Philippolis† | 24 | FS |
| 45 | Hanover* | 22 | NC |
| 46 | Richmond¶ | 30 | NC |
| 47 | Hofmeyr* | 17 | EC |

Telephone directories used: *2008/2009; †2007/2008; ‡2006/2007; §2005/2006; ¶2000/2001.
EC, Eastern Cape; FS, Free State; NC, Northern Cape; WC, Western Cape.

spreadsheets and categorised using 19 major enterprise sectors, which included economic drivers and service providers (Table 2). When it was impossible to deduce the nature of an enterprise from its name in the telephone directory and/or from an Internet search via *Google*, the entry was not used in subsequent analyses. The identified enterprises in every enterprise sector of each town were counted to develop an enterprise assemblage profile for each town.

## Economic drivers

We identified six sectors as economic drivers in rural South African towns (i.e. the principal sectors that bring money into towns; Table 2). Most rural towns in the Cape Colony depended on farmers to generate money that they would then spend in the town[24,25] and, thus, the *agricultural products and services* sector became very important. In time, some processors started

**TABLE 2**
Enterprise sectors used

| No. | Economic drivers |
|---|---|
| 1 | Agricultural products and services sector |
| 2 | Processing sector |
| 3 | Factory sector |
| 4 | Construction sector |
| 5 | Mining sector |
| 6 | Tourism and hospitality sector |
|  | **Service sectors** |
| 7 | Engineering and technical services sector |
| 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 |

adding value to local primary produce and the *processing* sector developed. Some entrepreneurs also realised that they could add value to materials from outside their regions and thus factories and the *factory* sector began to develop. Travellers also traversed rural areas and needed accommodation and food, which resulted in the development of a *tourism and hospitality* sector. The subsequent need to build homes, businesses and the like stimulated a *construction industry*, often dependent on investments from outside the region. The discovery of diamonds in 1866 and, subsequently, gold and other minerals, also stimulated the development of a *mining* sector in South Africa.

## Service providers

Thirteen different service sectors are active in the Karoo towns (Table 2). However, these sectors are probably more important for the circulation of money within the towns than for the generation of new money.

## Data analysis

The clustering and ordination of enterprise assemblages of differing sizes required normalisation of the data by expressing the numbers of enterprises in each enterprise sector as a percentage of the total number of enterprises in specific towns.

The computer software package PRIMER (Plymouth Routines in Multivariate Ecological Research) obtained from PRIMER-E Ltd, Plymouth, UK, was used to examine the (dis)similarity[26] of the enterprise assemblages of Karoo towns.

Pearson correlation coefficients based on the normalised data were calculated between each of the possible pairs of villages and towns, resulting in a correlation coefficient similarity matrix detailing the similarities between every possible pair of towns or villages.

## Cluster analysis

The aim of cluster analysis is to find 'natural groupings' of samples, such that samples within a group are generally more similar to one another than samples in different groups.[26] The most commonly used clustering techniques are hierarchical agglomerative methods that usually take a similarity matrix as their starting point and successively fuse the samples (i.e. towns in this study) into groups and those groups into larger clusters, starting with the highest mutual similarities and then gradually lowering the similarity level at which groups are formed.[27] The results can then be represented in a dendrogram.

The PRIMER software offers three linkage options when constructing dendrograms, namely single linkage (nearest neighbour), group-average and complete linkage (furthest neighbour) clustering.[26] The complete linkage option was used in this study. The correlation coefficient similarity matrix (see earlier explanation) was the input into the clustering process.

Clustering provided a first test of assessing the (dis)similarities of the enterprise assemblages of the selected towns and the question whether there are statistically different clusters of towns in the Karoo.

## Ordination analysis

An ordination is a map of the samples (towns in this study) usually in two or three dimensions in which the distances between the locations of samples reflect the (dis)similarities in community structures[27] (enterprise assemblages in this study). Shephard[28] and Kruskal[29] introduced non-metric multidimensional scaling (MDS) as an ordination technique in psychology. The purpose of MDS is to construct a 'map' of the samples in a specified number of dimensions that attempts to satisfy all the conditions imposed by a rank (dis)similarity matrix. The MDS analysis included in the PRIMER software[26] was used in this study.

Another input into the ordination process was the correlation coefficient similarity matrix based on normalised data. To ensure that a best fit was obtained in the ordination, 150 different repetitions were used whilst running the program.[26] It was inevitable that there would be a degree of distortion or stress between the similarity rankings and the corresponding distance rankings in the ordination plot,[27] therefore, the MDS program automatically calculated the stress value of an ordination.

The use of MDS provided a second test to assess the (dis)similarities of the enterprise assemblages of the selected towns and the question whether there are sensible clusters of towns in the Karoo.

## Testing the statistical significance of clusters

From previous experience, we were aware that the numbers of enterprises in different enterprise sectors of Karoo towns are not normally distributed and, hence, non-parametric statistical techniques were needed to test for the presence of statistically significant differences. The Mann–Whitney U-test, a non-parametric test,[30] was performed using WINKS SDA Software (6th edition) obtained from TexaSoft, Cedar Hill, United States of America, for this purpose. Clusters 1 and 2 were ignored in this comparison because of their small size (each having only two towns in the cluster). The rest of the analysis involved comparisons between Clusters 3, 4, 5 and 6 for all of the 19 enterprise sectors.

## RESULTS

### Clustering of towns

There were distinct clusters of towns at $r = 0.65$ in the dendrogram (Figure 2). Clusters 1 and 2 were small, each consisting of 2 towns only (Figure 2). Cluster 3 was the largest (18 towns) and had four distinct sub-clusters. Cluster 4 (6 towns) did not have sub-clusters, while Cluster 5 (8 towns) showed two sub-clusters. Cluster 6 did not have a sub-cluster. The town of Hofmeyr was an outlier that did not form part of any cluster defined at $r = 0.65$. The cluster analysis provided a one-dimensional analysis of the relationships between the different Karoo towns and showed clearly that there were clusters of towns in the Karoo.

The results of Mann–Whitney U-tests are presented in Table 3. Differences at $p < 0.01$ and $p < 0.05$ were registered for some enterprise sectors in each of the clusters, clearly indicating that the clusters at the $r = 0.65$ correlation coefficient level were stable and made sense. Because of these statistically significant differences the null hypothesis was rejected. Karoo towns behaved like natural ecosystems and could be clustered into larger enterprise ecosystems.

Three enterprise sectors, (1) the agricultural products and services, (2) the tourism and hospitality and (3) the trade sector, contributed the most to the significant differences between clusters (Table 3). These enterprise sectors, therefore, played an important role in defining the different clusters, as described later.

The normalised contribution of sectors based on median numbers of each enterprise sector, is presented in Table 4. This information also helped to define the different clusters (see later).
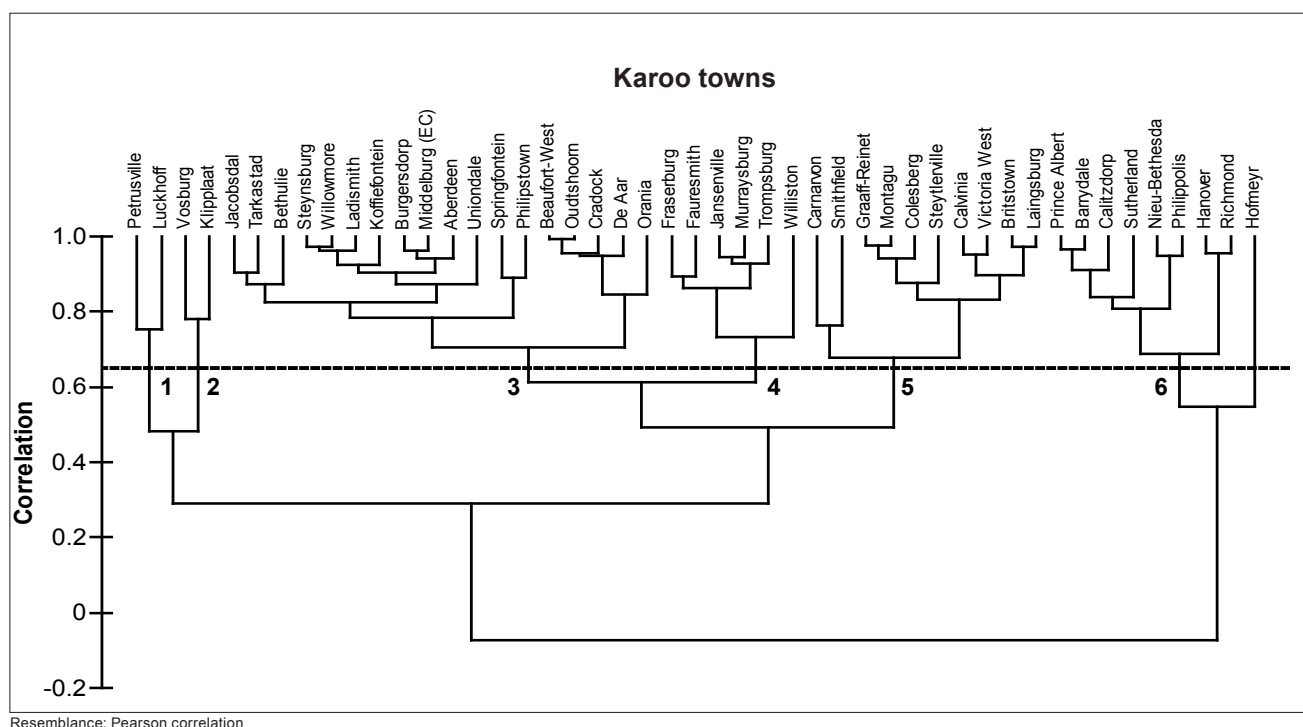


**FIGURE 2**
Dendrogram of 47 Karoo towns (based on normalised data) using a complete linkage clustering strategy

**TABLE 3**
Summary of statistical differences between enterprise sectors of the clusters of 47 Karoo towns

| Enterprise sector | Cluster 3 | | | Cluster 4 | | | Cluster 5 | | | Cluster 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cluster 4 | Cluster 5 | Cluster 6 | Cluster 3 | Cluster 5 | Cluster 6 | Cluster 3 | Cluster 4 | Cluster 6 | Cluster 3 | Cluster 4 | Cluster 5 |
| Agricultural products and services | HS | ND | ND | HS | HS | S | ND | HS | ND | ND | S | ND |
| Processing plants | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Factories | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Construction industry | ND | ND | S | ND | ND | ND | ND | ND | ND | S | ND | ND |
| Mining | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Tourism and hospitality | ND | HS | HS | ND | HS | HS | HS | HS | HS | HS | HS | HS |
| Engineering and technical services | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Financial services | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Legal services | ND | ND | ND | ND | ND | ND | S | ND | ND | ND | ND | ND |
| Telecommunications | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| News and advertising | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trade | ND | HS | HS | ND | S | HS | HS | S | S | HS | HS | S |
| Vehicle | S | ND | ND | S | ND | ND | ND | ND | ND | ND | ND | ND |
| General services | ND | ND | S | ND | ND | ND | ND | ND | S | S | ND | S |
| Professional services | ND | ND | ND | ND | S | S | ND | S | ND | ND | S | ND |
| Personal services | ND | ND | ND | ND | ND | HS | ND | ND | ND | ND | HS | ND |
| Health services | ND | S | HS | ND | ND | ND | S | ND | ND | HS | ND | ND |
| Transport and earthworks | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Real estate | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

Comparisons by way of Mann–Whitney U-tests.
ND, No significant difference between clusters.
S, $p < 0.05$ difference between clusters.
HS, $p < 0.01$ difference between clusters.

**TABLE 4**
Median enterprise sector percentages for the different clusters, where the sector median is expressed as a percentage of the sum of all medians

| Enterprise sector | Cluster 1 | Cluster 2 | Cluster 3 | Cluster 4 | Cluster 5 | Cluster 6 |
|---|---|---|---|---|---|---|
| Agricultural products and services | 12.1 | 29 | 7 | 18.8 | 6.4 | 8.9 |
| Processing plants | 2.9 | 0 | 1.4 | 0 | 0 | 1.7 |
| Factories | 0 | 0 | 0 | 0 | 0 | 0 |
| Construction industry | 2.9 | 0 | 4.5 | 0 | 4.1 | 0 |
| Mining | 0 | 3.3 | 0 | 0 | 0 | 0 |
| Tourism and hospitality | 2.9 | 9.6 | 12.2 | 10.8 | 20 | 30.7 |
| Engineering and technical services | 0 | 0 | 2.1 | 0 | 2.7 | 1.4 |
| Financial services | 15.1 | 3.1 | 7.7 | 7.8 | 7.3 | 6 |
| Legal services | 3.1 | 0 | 1.9 | 2.8 | 2.7 | 2.3 |
| Telecommunication services | 0 | 6.7 | 0 | 0 | 0 | 0 |
| News and  advertising | 0 | 0 | 0 | 0 | 0 | 0 |
| Trade | 21.1 | 19.4 | 29.9 | 29.2 | 21.2 | 15.7 |
| Vehicle | 15.1 | 9.6 | 4.9 | 3 | 9 | 3.3 |
| General services | 12.1 | 3.3 | 4.6 | 2.8 | 4.3 | 2.1 |
| Professional services | 3.1 | 3.3 | 1.8 | 4.4 | 2.7 | 0 |
| Personal services | 3.1 | 0 | 7.1 | 9.1 | 6.9 | 5.2 |
| Health services | 6.3 | 6.5 | 6.7 | 6.5 | 5 | 3.9 |
| Transport and earthworks | 0 | 3.1 | 2.2 | 1.9 | 0.9 | 0 |
| Real estate | 0 | 3.1 | 0.7 | 0 | 1.8 | 0.9 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** |

## Multidimensional scaling of towns

The stress level, a measure of the 'goodness-of-fit' of the MDS 'map', was 0.15, which is an acceptably low level.[27] A two-dimensional MDS plot of the towns is shown in Figure 3. The $r = 0.65$ contour defined in the cluster analysis (Figure 2) is shown and the groups it defines have little overlap in the two-dimensional MDS plot. MDS, therefore, also confirmed the presence of different clusters of Karoo towns.

The MDS software also allowed two-dimensional bubble plots of variables (i.e. enterprise sectors in this study) to be superimposed on the basic MDS plot. Three sectors, i.e. the agricultural products and services sector, the tourism and hospitality sector and the trade sector had the most significant differences between clusters (Table 3). Figures 4, 5 and 6 present bubble plots for these three sectors and help to visualise the differences between the clusters of Karoo towns.

There were visible 'gradients' or vectors in the MDS plots of the three enterprise sectors. The agricultural products and services sector had a vector towards the top of the graph in the MDS plot (Figure 4). Higher values occurred towards the top, even within specific clusters. The tourism and hospitality sector had a vector towards the left of the MDS plot (Figure 5) and the vector of the trade sector was towards the bottom right of the MDS plot (Figure 6). These vectors were helpful in delineating possible enterprise evolution patterns of the different clusters (see below).

## Definition of the different clusters
### Cluster 1

With its two towns, Petrusville and Luckhoff (Figures 1 and 2), Cluster 1 is quite distinct from the other clusters (Figure 3). Its closest neighbours are Clusters 3 and 4 (Figure 3). Its agricultural products and services sector is relatively weak (Figure 4, Table

**47 Karoo towns**
**Multidimensional scaling (2D Stress: 0.15)**
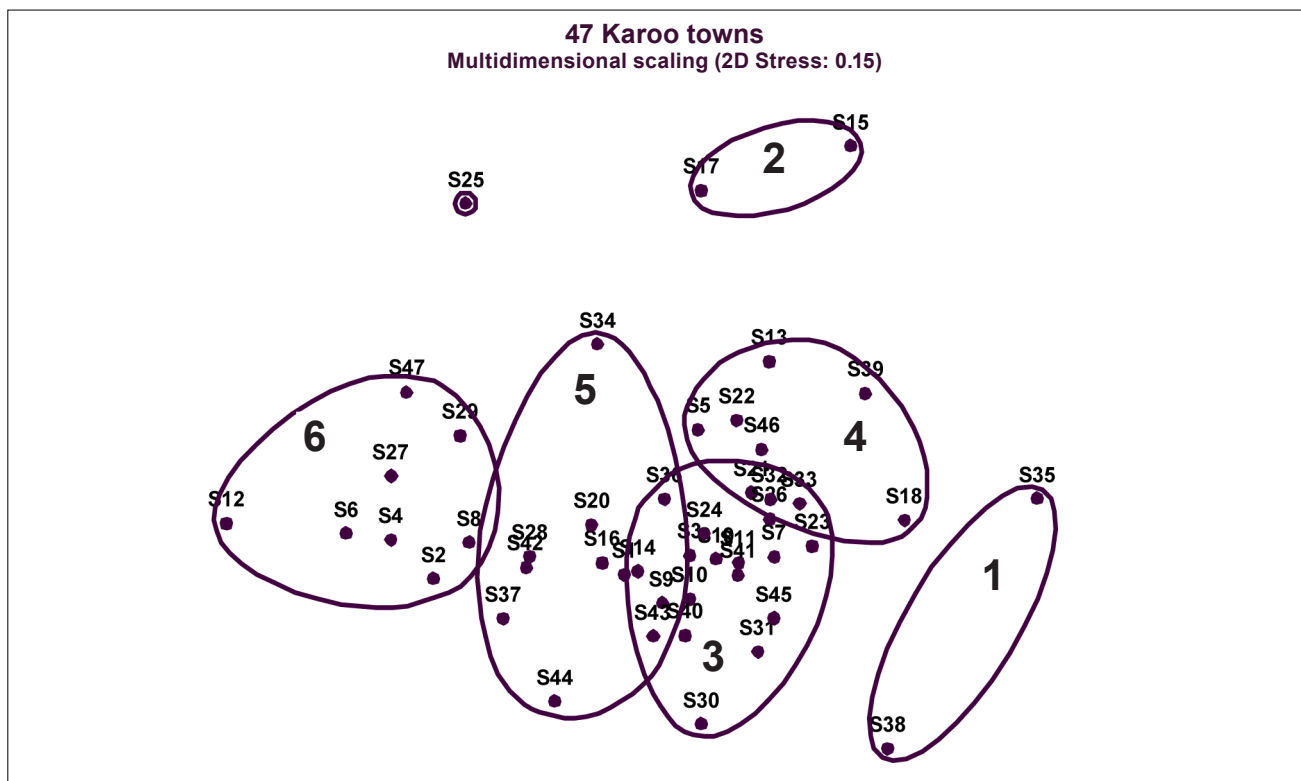
Numbers preceded by 'S' are those used for the towns, given in Table 1.
Resemblance: Pearson correlation
Key: ——— 0.65 Correlation

**FIGURE 3**
Ordination of the six clusters of 47 Karoo towns by means of multidimensional scaling

4), which is perhaps reflective of intense competition in this sector from the nearby cities of Bloemfontein and Kimberley. The cluster's tourism and hospitality sector is also weak (Figure 5; Table 4), while its trade sector is of medium strength (Figure 6). Cluster 1 has an average of 17 enterprises per town (Table 5), which suggests that the amount of money flowing into, or circulating within, the two towns is severely limited.

The weakness in the three important enterprise sectors (Table 5) suggests that this cluster might represent a regressive variant of the original church towns of rural South Africa (Figure 7). In these towns, the town was dependent on agriculture and vice versa,[20] a situation that no longer seems to be true for this cluster. Agricultural products and services are no longer the main driver of the towns' economies, except that farmers might still be dependent on financial and legal services (Table 4). Neither the tourism and hospitality sector nor the trade services sector became important in these towns (Table 4), which probably reflects an increasing dependence of the enterprise sectors of these towns on welfare and pension payments by government, for which these towns compete. The reasons for this cluster's relative strengths in the vehicle and general services sectors are obscure.

## Cluster 2

With its two towns, Vosburg and Klipplaat (Figure 2), Cluster 2 is also quite distinct from the other clusters (Figure 3); its closest neighbours being Clusters 4 and 5 (Figure 3). It has a very strong agricultural products and services sector (Figure 4), while its tourism and hospitality sector is weak (Figure 5) and its trade sector is of medium strength (Figure 6). It is the only cluster that engages in mining activities (Table 4). Its average of 16 enterprises per town (Table 5) suggests that the amount of money flowing into, or circulating within, the towns is also severely limited. The drivers of the local economy are, therefore, a strong agricultural products and services sector, a tourism and hospitality sector that has grown more pronounced, a trade

sector of medium strength and a minor mining sector. This cluster is probably a modern variant of the original church towns that were only strongly dependent on the agricultural sector.[20]

## Cluster 3

With 18 towns (Figure 2), Cluster 3 has some overlap with Clusters 4 and 5 (Figure 3). This cluster contains a number of the larger Karoo towns but also some smaller ones. A strong trade sector (Figure 6), a medium strength agricultural products and services sector (Figure 4) and a medium strength tourism and hospitality sector (Figure 5) primarily define this cluster, suggesting that the economies of this cluster are fairly well balanced (Table 4). The average of 141 enterprises per town (Table 5) suggests that there are reasonably strong flows of money into, or circulating within, the towns of this cluster. Two of the towns (Cradock and Beaufort West) were early administrative centres in the Cape Colony[20] and the rest, located in what was formerly the Cape Colony, are church towns.[20] The economic drivers of these towns are more varied than those of Clusters 1 and 2 and the agricultural products and services and tourism sectors are important. However, the strong trade sectors of these towns suggest that they act as regional trade centres with reasonably well-balanced local economies. This cluster probably represents a positive evolutionary form of the old drostdy/administrative and church towns[20] in the sense of having developed fairly well-balanced economies that draw upon the buying power of wider areas.

## Cluster 4

With its six towns (Figure 2), Cluster 2 has some overlap with Cluster 3 and is adjacent to Cluster 1 (Figure 3). The cluster contains primarily old church towns[20] and is defined by fairly strong agricultural products and services (Figure 4) and trade (Figure 6) sectors. However, its tourism and hospitality sector (Figure 5) is weak (Table 4). Its enterprise assemblages appear to be more balanced than those of Clusters 1 and 2, but much less so than those of Clusters 3 and 5. The average of 31 enterprises per town (Table 5) suggests that the amount of money flowing
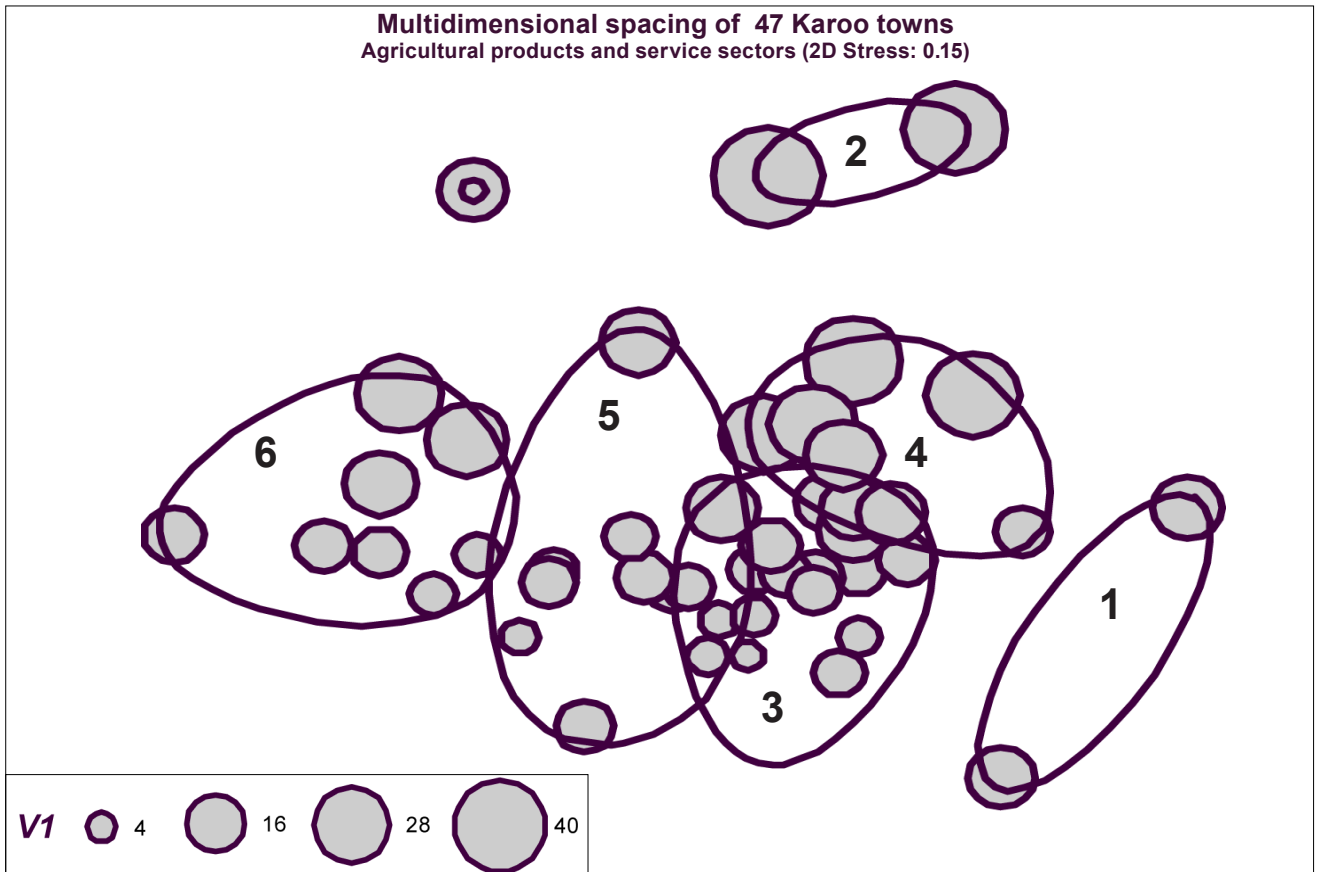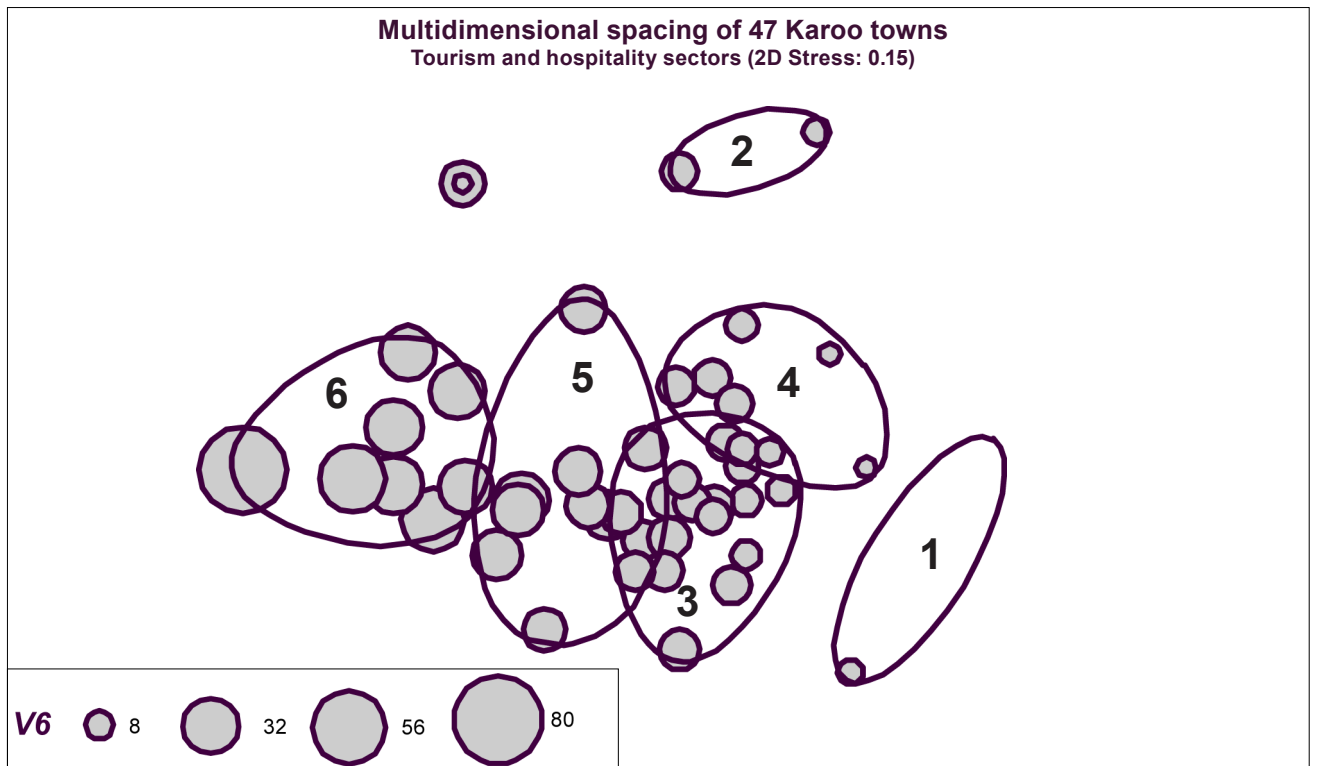
**FIGURE 4**
Multidimensional spacing plot of the agricultural products and services sectors of the different clusters



**FIGURE 5**
Multidimensional spacing plot of the tourism and hospitality sectors of the different clusters

into, or circulating within, its towns is fairly limited but greater than for Clusters 1 and 2.

There are similarities between Clusters 3 and 4, but Cluster 4, which has a smaller average number of enterprises per town, has maintained a focus on its agricultural base (Figure 4); similarly to Cluster 3, it has failed to develop a strong tourism and hospitality sector (Figure 5). The economic drivers of the towns in this cluster are the strong agricultural products and services sector, strong vehicle sector and some tourism and hospitality activities (Table 4). Cluster 4 is possibly a modern variant with a somewhat unbalanced local economy of the old church towns.[20]

### Cluster 5

Cluster 5 comprises 10 towns (Figure 2) and has some overlap with Cluster 3 and a slight overlap with Cluster 6 (Figure 3). Similar to Cluster 3, it contains large towns (e.g. Graaff-Reinet and Montagu) and smaller towns (e.g. Britstown and Smithfield) (Figure 2). The towns of this cluster are of different origins. Graaff-Reinet is an old drostdy/administrative town and Montagu was founded as a speculative venture.[20] The rest of the cluster comprises old church towns.[20] A strong tourism and hospitality sector (Figure 5), a weaker trade sector (Figure 6), a weak agricultural products and services sector (Figures 4) and some strength in many of the service sectors (Table 4) define this cluster. The average number of enterprises per town in this cluster is 109 (Table 5) suggesting that reasonably large amounts of money must be flowing into, or circulating within, its towns. Tourism appears to be the main local economic driver of this cluster, but, overall, the cluster has strength in many enterprise sectors. The economies of its towns appear to be fairly well balanced. Similar to Cluster 3, this cluster represents a positive evolutionary form of the old drostdy/administrative and church towns[20] and illustrates the value of developing a strong tourism and hospitality sector and an overall well-balanced economy.

### Cluster 6

With eight towns (Figure 2), Cluster 6 has a little overlap with Cluster 5, its nearest neighbour (Figure 3). With the exception of Philippolis, the constituents of this cluster are all old church towns of the Cape Colony.[20] The cluster's principal strength is a very strong tourism and hospitality sector (Figure 5), but it also has a reasonably strong agricultural products and services sector (Figure 4). Its trade sector (Figure 6) and most of its other service sectors are rather weak (Table 4). The average number of enterprises per town is 39 (Table 5), suggesting that the inflow, or circulation, of money in the towns of this cluster is limited, but not as low as that of Clusters 1, 2 and 4.

The economies of these towns are less well balanced than those of Cluster 5. The economic driver of these towns is quite clearly the tourism and hospitality sector (Figure 5), but the agricultural products and services sector still provides some strength (Table 4). This cluster illustrates the extent to which old church towns have evolved in the Karoo. Whilst maintaining their links to their agricultural past, the cluster's towns have focused strongly on the tourism and hospitality sector, perhaps in some cases overly so. Consequently, their economies might not be as robust as those of towns in other clusters.

### Business evolution of Karoo towns

Based on the development vectors deduced from Figures 4 to 6, the identification of important enterprise sectors (Table 4) and the definition of clusters (previous section), it is possible to propose evolutionary development paths of Karoo towns (Figure 7). Initially all of the Karoo towns, despite having been founded for different reasons,[20] would have had very similar business environments: some traders buying farm produce and providing supplies, some providers of accommodation, some transporters, a few manufacturers (e.g. wagon builders) and some providers of specialised services.[20,24,25] Some towns have remained strongly, perhaps overly, focused on the agricultural
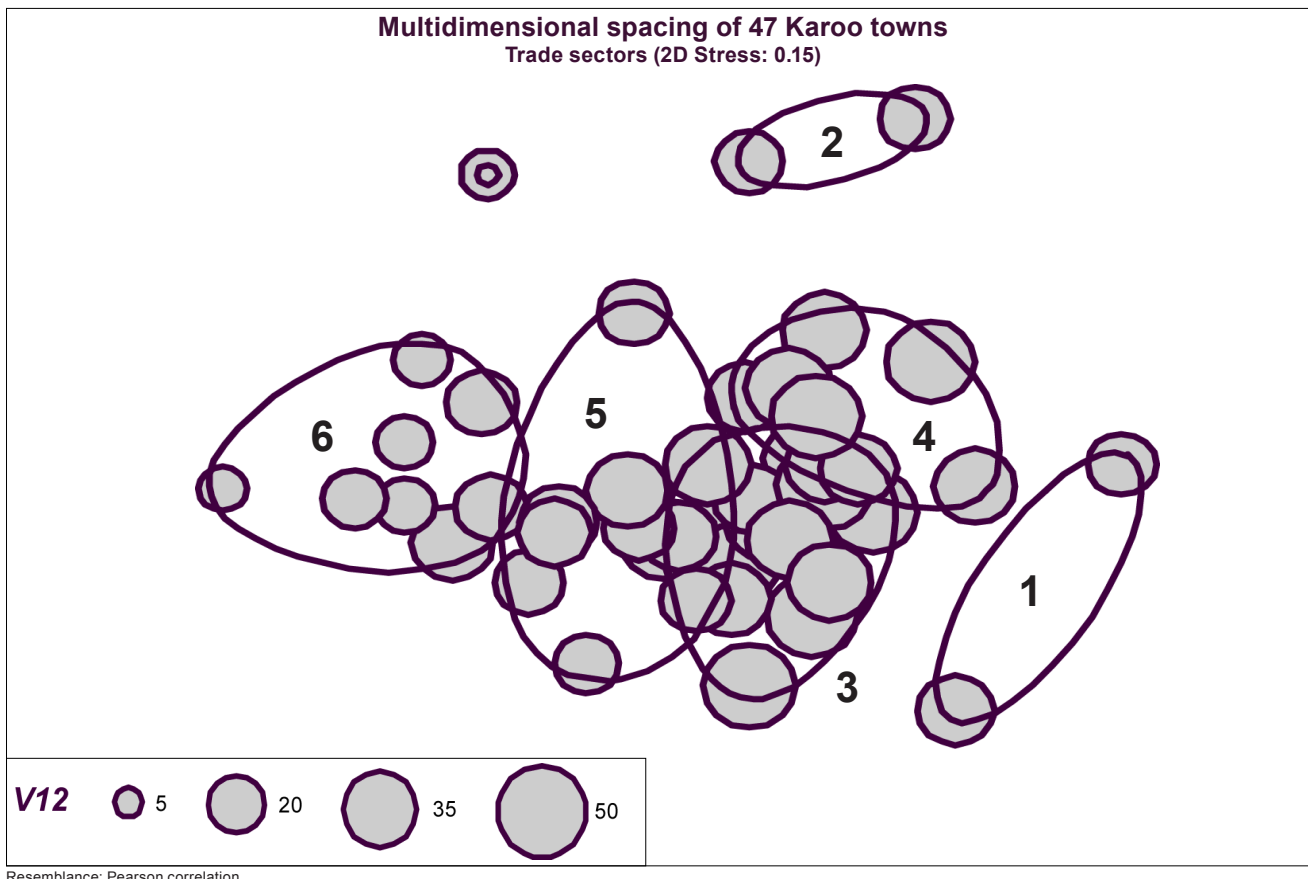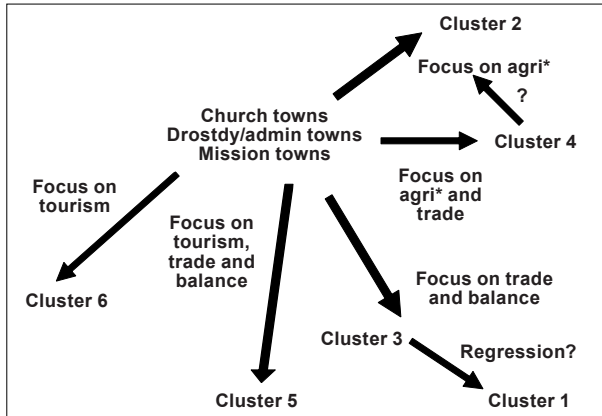


**FIGURE 6**
Multidimensional spacing plot of the trade sectors of the different clusters

*agri, agricultural products and services.

**FIGURE 7**
Multidimensional spacing map and possible evolutionary
development paths of Karoo towns

**TABLE 5**
Average number of enterprises of the different town clusters

| Cluster | Average number of enterprises |
|---------|-------------------------------|
| 1 | 17 |
| 2 | 16 |
| 3 | 141 |
| 4 | 31 |
| 5 | 109 |
| 6 | 39 |

sector (e.g. Cluster 1) resulting in potentially unstable local economies as a result of competitive pressures in agriculture. Others towns maintained a focus on agricultural products but also grew their trade sectors (Cluster 4). A large group of towns focused on agriculture and trade but also developed a number of other sectors resulting in well-balanced local economies (Cluster 3). However, they have not developed strong tourism and hospitality sectors.

Cluster 2, which is less focused on tourism and hospitality, could be a possible regressive variant of Cluster 4. Within Cluster 5, there are several towns that have well-balanced economies, but which have focused strongly on tourism and hospitality. They are prime examples of Karoo towns that have significantly shifted their enterprise focus and balance. The final small group of towns (Cluster 6) is very strongly, and perhaps overly, focused on tourism and hospitality. The economies of these towns may have become prone to economic shocks linked to tourism cycles.

## DISCUSSION

This study examined the hypothesis that towns are enterprise ecosystems grouped in larger ecosystems. Forty-seven Karoo towns were used to test the hypothesis and their enterprise assemblages were analysed by clustering and ordination techniques. Statistically significant patterns of dissimilarities were detected between clusters of towns. The null hypothesis that there were no statistically different clusters of towns was, therefore, rejected. De Geus[4] was correct in his use of the term 'company ecology'. However, the latter concept should be extended to 'enterprise ecology' to indicate that all enterprises, not only companies, form part of enterprise ecosystems.

The Karoo towns clustered into six statistically different ($p < 0.05$) clusters at $r = 0.65$ (Figures 2 and 3; Table 4), indicating that different groups of towns have followed different survival and growth strategies, primarily involving three enterprise sectors: the agricultural products and services sector, the tourism and hospitality sector and the trade sector (Table 3; Figures 4, 5 and 6). As a consequence, the suggested evolutionary paths followed by the clusters of towns differed substantially (Figure 7).

Clustering of towns on the basis of their enterprise structures provides a new way of classifying towns in South Africa, but how does this compare with previous town classifications?

Four levels of towns were earlier identified for the Eastern and Central Karoo,[31,32] (1) country towns (Cradock, Graaff-Reinet, Middelburg, Beaufort-West), (2) minor country towns (Carnarvon, Victoria-West, Willowmore, Sutherland, Laingsburg, Fraserburg, Prince Albert), (3) local service centres (Aberdeen, Jansenville, Murraysburg, Noupoort, Pearston, Steytlerville, Richmond) and (4) lower-order service centres (Klipplaat, Nieu-Bethesda, Rosmead, Loxton, Van Wyksvlei, Vosburg, Merweville, Rietbron, Hutchinson). The results of this study do not support the above classification because towns supposedly of the same type were clustered in different groups in this study. This questions the applicability of the earlier classification of Karoo towns, an area of investigation that needs further exploration.

The growth potential and rank of 131 towns and villages of the Western Cape were previously determined by using a set of multidimensional criteria.[33] Eighty-two variables for which information could be obtained for each of the 131 towns were identified. Ten compounded indices were quantitatively combined to produce three composite indices, (1) resource potential, (2) the state of infrastructure and (3) economic potential. This is a complex procedure that does not lend itself to regular monitoring exercises. The present study suggests that a simple analysis of the enterprise structures of towns followed by clustering and ordination techniques may provide a much quicker and cheaper way of determining the growth potential of South African towns.

Such an approach has worked elsewhere. Aquatic scientists have developed a rapid and cheap monitoring system of the health of South African rivers,[34] now called SASS 5 (which incidentally inspired the approach used in this study). The applicability of this study's approach to monitoring the 'business health' of towns also needs further exploration.

The positive results obtained whilst studying the towns of the Karoo in South Africa bring the promise of utility in studies of enterprise structures of towns both within South Africa and elsewhere.

The results of this study also have implications for authorities concerned with issues such as local economic development. Local economic development plans and their implementation might benefit from the monitoring technique used here.

The results and conclusions of this study also raise academic questions. For instance, what serves in enterprise ecosystems as the equivalent of the gene in biological evolution?[35] New enterprises arise out of decisions by entrepreneurs. The quality of their decisions determines the quality of the business plans and the ability of enterprises to be successful. 'Communities' of enterprises, and hence collections of entrepreneurs, determine the economic success of towns. The nature of entrepreneurship of South African towns also needs further exploration.

## ACKNOWLEDGEMENTS

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