12

Evidence of Island Effects in South African Enterprise Ecosystems

Daan Toerien and Maitland Seaman
Centre for Environmental Management,
University of the Free State, Bloemfontein
South Africa

1. Introduction

Living organisms and business enterprises (hereafter the term *enterprise* will be used to refer to a business enterprise) exhibit certain similarities. Beinhocker (2006) stated that: "Economic wealth and biological wealth are thermodynamically the same sort of phenomena, and not just metaphorically. Both are systems of locally low entropy, patterns of order which evolved over time under the constraint of fitness functions. Both are forms of fit order." He added that organisms and business enterprises are both subjected to Darwinian-type competition. Based on the foregoing reasoning we proposed that there should be similarities between natural ecosystems and enterprise ecosystems as described by Toerien & Seaman (2010).

Natural ecosystems have been defined as biotic communities or assemblages and their associated physical environments in specific places (Tansley, 1935). A basic structural requirement is that an ecosystem encompasses a biotic complex, an abiotic complex, interaction between them and a physical space. Natural ecosystems can be of any size as long as organisms, the physical environment and their interactions can exist within them. 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 (Pickett & Cadenasso, 2002).

The relationship between enterprises and towns meets the above norms for ecosystems, and towns should be considered enterprise ecosystems (Toerien & Seaman, 2010), a hypothesis tested in studies of the enterprise structures of selected South African towns by employing techniques often used in ecological studies (Toerien & Seaman, 2010, 2012a, 2012b). Towns could be clustered on the basis of their enterprise structures and the groups such identified made sense (Toerien & Seaman, 2010). Proportionalities in enterprise structures observed in more than a hundred South African towns lent further credence to the hypothesis (Toerien & Seaman, 2012a). In addition, enterprise diversity followed patterns observed for biodiversity in natural ecosystems (Toerien & Seaman, 2012b).

The *Theory of Island Biogeography (*MacArthur & Wilson, 1967) marked the coming of age of ecological science as a discipline with a theoretical/conceptual base (May, 2010). It is the dominant symbol of a transition which took place four decades ago from descriptive to analytical approaches in ecology and biogeography (Losos & Ricklefs, 2010). Islands are ecological systems and many ecological systems have island attributes (Losos & Ricklefs, 2010).

Whittaker et al. (2010) stated that: "The MacArthur-Wilson model recognizes that, for a discrete and isolated biological system, the number of species at any point in time must be a function of the number previously occurring there plus those gained through immigration and/or speciation… minus those having gone locally extinct. Their theory proposes that these three fundamental processes should vary in a predictable fashion in response to time since system initiation, and in relation to two principal controlling geographical/ environmental influences: isolation and area." These ideas could be used to test hypotheses about enterprise ecosystems.

Begon et al. (1990) stressed that there are many types of islands because the term does not only encompass islands of land in a sea of water but lakes are 'islands' in a 'sea' of land, mountain tops are high-altitude 'islands' in a low altitude 'ocean', clearings in forests are 'islands' in a 'sea' of trees, etc. Can South African rural towns (as enterprise ecosystems) also be considered islands? We think that the enterprise structures of towns should also exhibit island effects. If correct, this would extend our original hypothesis that towns are enterprise ecosystems (Toerien & Seaman, 2010) to one that states that towns are enterprise ecosystems that also exhibit island effects. If correct the finding might have socio-economic consequences for South African towns.

The specific null hypothesis posed in this chapter is that South African towns (enterprise ecosystems) do not exhibit island effects as predicted by the Species Equilibrium Model of MacArthur & Wilson (1967).

1.1 Logic of chapter

The following part of the chapter provides a conceptual argument as to why rural South African towns could be considered enterprise islands. This is followed by a brief overview of the Species Equilibrium Model of natural ecosystems (MacArthur & Wilson, 1967) and its possible use in tests of hypotheses about enterprise islands. A brief overview of the history of the Karoo, South Africa's arid heartland, and an explanation of why a part of this region is suitable for use as a case study follow. Next there is an overview of the twelve towns of the Karoo midlands of the Eastern Cape province of South Africa which have been selected as a case study for the purposes of this chapter. It includes previous research done on this region and its towns. The next section deals with six different ways in which the null hypothesis was tested. This is followed by an analysis of the relationship between town age and enterprise development in the towns of the case study. The results are then discussed and this is followed by our conclusions.

2. Island biogeography and enterprise ecosystems

2.1 South African towns as islands

Before 1652 the south-western part of South Africa had been occupied for more than 70 millennia by hunter-gatherers (Henshilwood et al., 2002; Marean et al., 2007). About two millennia ago herders arrived in south-western Africa (Giliomee & Mbenga, 2007). Neither the hunter-gatherers nor the herders established permanent villages or towns. In 1652 the

Dutch East India Company established a victualing station at what is now Cape Town and from here European farmers spread into the inland areas over time, replacing the hunter-gatherers and herders (Giliomee & Mbenga, 2007). The need of these farmers for household goods e.g. cloth, salt and sugar were largely met by travelling pedlars who visited individual farms to barter their goods for items such as livestock, skins and home-made soap (Fransen, 2006; Giliomee & Mbenga, 2007; Van Waart, 2001; Wickins, 1983). Because the basic needs of the farmers and their families were met, there were few, if any, commercial reasons for the establishment of towns in inland South Africa (Fransen, 2006).

The actual establishment of inland South African towns arose from two other needs: (i) authorities (firstly the Dutch East India Company and later the British government) needed effective control and administration of rural communities, which in turn led to the establishment of administrative towns, called drostdys (Fransen, 2006; Giliomee & Mbenga, 2007), and (ii) the need of farmers and their families for religious services over time led to the establishment of new parishes and the building of churches in the vicinity of which first villages and later towns developed (called 'church towns' by Fransen, 2006). How then did the enterprises of these towns develop?

Entrepreneurs create enterprises. Entrepreneurs had to move from elsewhere to these towns to use the 'entrepreneurial space' that had become available. The pedlars mentioned before were the initial entrepreneurs that supplied the goods needed by the farmers and their families. Many of them were Jews with experience of trading, immigrants from Lithuania, Poland, Russia or Germany. Once they made enough money, many set up shops in the towns where Jewish communities played an important commercial role, also providing valuable contact with Jewish communities elsewhere in the world (Van Waart, 2001). The immigration of knowledgeable entrepreneurs thus formed an important part of the establishment of the commercial functions of rural South African towns. This process is akin to the colonisation of island by biota from elsewhere.

Conceptually it is possible to think about the establishment of the drostdys or the building of churches as the equivalent of volcanic activity forcing a new island to rise above the sea and becoming available to be colonised, e.g. Surtsey Island (Lindroth, 1973). Once an administrative centre was established or a church built in a specific location, people came to use the services on offer and it became possible for entrepreneurs to conceive possible business opportunities and to react to them. These proto-towns were thus 'islands' in a sea of farms through which entrepreneurs bringing much-needed entrepreneurship had to pass in order to 'colonise' the towns. The question, however, is whether these 'enterprise islands' responded similarly to colonisation than natural islands?

2.2 A brief consideration of the species equilibrium model for islands

The Species Equilibrium Model was first presented as a graph of gross extinction and immigration rates against the number of species present on an island (Schoener, 2010). It was based on two assumptions: (i) the rate of immigration of new species (those not yet present on the island) decrease monotonically with an increasing number of species already present. It reaches zero when all species in the source area are on the island, and, (ii) the rate of extinction of species increases monotonically as the number of species increases. These two assumptions imply that equilibrium between immigration and extinction would eventually occur, at which time the immigration and extinction rates will have the same value, called the turnover rate at equilibrium.

In-depth studies of the re-colonisation by biota of different islands after catastrophic events such as hurricanes, however, have shown that equilibrium can be steady (a constant number of species), cyclical (a regular fluctuation in the number of species), or moving directionally (a slow unidirectional change in the number of species brought on by a systemic change in immigration and/or extinction rates, e.g. due to climate change) (Schoener, 2010).

The Species Equilibrium Model also predicts that that species lists will vary in composition even after equilibrium is reached (Schoener, 2010) because some species may become extinct or emigrate. At the same time immigration of species would still occur and consequently there would be a turnover of species. This prediction was shown to be true by calculation of the relative turnover rates of different island biotas, e.g. for birds of the Channel Islands (Jones & Diamond, 1976).

The Species Equilibrium Model also makes predictions about the effects of distance between islands and their sources of immigrants and about the effects of the area of islands. Near islands of similar size should have more species and large islands at the same distance as small islands should have more species (Schoener, 2010). These predictions have also been verified by numerous studies of island biota (Lomolino et al., 2010).

2.3 The species equilibrium model and enterprises in rural South African towns

The Equilibrium Model provides insights into ways of testing the hypothesis that South African towns are enterprise islands. Whilst ecologists study the presence/absence of species, our studies have focused on individual enterprises in towns. If towns are enterprise islands one can expect evidence that the rate of establishment of new enterprises and the rate of disappearance of previously established enterprises would even out and that enterprise equilibrium would be established in the enterprise islands.

A first test of the null hypothesis, therefore, is a comparison of the enterprise lists [determined as described by Toerien & Seaman (2010)] of selected towns and for different years in order to determine: (i) whether enterprise equilibriums exist, and, (ii) if there is significant turnover of enterprises under condition of enterprise equilibrium. Number balances based on the enterprises at time t_1, enterprises which disappear between times t_1 and t_2, enterprises which appear between times t_1 and t_2, and the enterprises at time t_2, of selected towns would indicate whether there are equilibriums and if these are linked to enterprise turnover as predicted. Answers in the affirmative would contribute to the rejection of the null hypothesis. This exercise is described more fully later.

To examine the question of whether enterprise islands also respond to the proximity of a source of immigrant entrepreneurs is a more complex task. In the case of enterprises, proximity would have to refer to the sources of entrepreneurs who bring business ideas to towns from elsewhere. This is not a property that could be easily deduced from an examination of the names of enterprises in telephone directories and this question could only be dealt with obliquely. Toerien (2012), however, noted that gentrification of Prince Albert, a Karoo town, brought new entrepreneurial skills and development to the town, which suggests that proximity to entrepreneurs might be important.

A larger island that is as far from a mainland than a smaller island should according the Species Equilibrium Model, house more species than the smaller island (Schoener, 2010). If this statement is extended to towns, the challenge is to find appropriate surrogate measures of island or town size. The simplest way to estimate this is from resident numbers. However, for a long time the dominant theory about the roles and functions of South African towns was based on Christaller's Central Place Theory (Christaller, 1966, as cited in Van der Merwe & Nel, 1975). The theory was developed in 1933 after Christaller considered economic relationships between cities and their hinterlands (Van der Merwe & Nel, 1975). Christaller asserted that settlements (towns) functioned as 'central places' providing services to surrounding areas. The general usefulness of the theory has, however, been questioned (e.g. Fujita et al., 2005). Nevertheless, the implications of Christaller's theory should be considered, i.e. if a town is an 'enterprise island', the number of enterprises in a town should be related to the area of its surrounding district and/or the population size of that district. Prudence, therefore, required that the null hypothesis be tested against a number of indicators of town (and hence enterprise island) size: (i) the resident population (or urban population) numbers of towns, (ii) the total population of town and district, (iii) the rural population numbers of the districts surrounding towns, and (iv) the areas of the districts surrounding the towns. This exercise will be described more fully later.

In the case of rural South African towns, and in contrast to many towns in Europe and Asia, the founding dates of towns are precisely known. This provided a useful adjunct to the ideas derived from the Species Equilibrium Model, namely the possibility that older towns might have first-comer benefits. This aspect was also investigated.

The selection of towns to test the null hypothesis required consideration. Ideally the towns should be located in places with fairly similar climates, and the reasons for the founding of the towns and the governmental/regulatory systems under which they resorted should have been similar. Towns in parts of the Karoo of South Africa meet these requirements, as explained later.

3. A brief overview of the history of the Karoo, South Africa

The Karoo is a semi-arid area of approximately 400,000 km^2 situated in the central and western interior of South Africa (Nel & Hill, 2008). It is a single ecosystem, sub-divided into a winter rainfall and a summer rainfall area (Cowling, 1986). Khoikhoi herders moved some 1600 to 2000 years ago from the north into south-western South Africa (Boonzaaier et al., 1996; Giliomee & Mbenga, 2007). The Khoikhoi herded sheep and cattle, also in the Karoo. Their animals were rarely slaughtered. Herds expressed personal wealth rather than commercial utility and land was communally owned (Boonzaaier et al., 1996). To find good pastures tribes of herders moved around according to climate and season.

In 1652 the Dutch East India Company established a victualing station at the Cape of Good Hope to provide fresh produce and meat to the crews of their ships. Thereby a permanent European presence in the south-western Cape was established (Giliomee & Mbenga, 2007; Guelke, 1979). Their limited capacity to raise stock soon meant that cattle and sheep had to be sourced from the Khoikhoi (Giliomee & Mbenga, 2007). The Company's thrust into the more distant domains of the Khoikhoi consisted of three distinct, though overlapping, phases (Elphick, 1979).

A 'trading frontier' to obtain livestock from the Khoikhoi expanded steadily until about 1700. However, the ability of the Khoikhoi to supply enough livestock also became limited (Elphick, 1979). Secondly, the Dutch East India Company started allocating land that had traditionally fallen under Khoikhoi control and allowed free farmers to settle there (Wickins, 1983). The third frontier was one of semi-nomadic European pastoralists (called 'trekboers') who moved inland (Elphick, 1979). The farmers adopted the agricultural technologies of the Khoikhoi, i.e. the herding of fat-tailed sheep and cattle adapted to local conditions. The 'trekboers' supplied livestock to the Dutch East India Company but were more subsistence than commercial farmers. They were not historically or otherwise inclined to be commercial entrepreneurs.

Wool production in the south-western Cape was negligible up to the end of the 18th century. By 1804 fewer than 8,000 sheep out of a total population of 1,34 million were wool-producing merinos. Burrows (1994) commented: "During the next fifty years wool farming became the staple economy of the countryside. The merino sheep provided farmers with a secure and rising income, which released them from the poverty of subsistence stock farming." In 1830 the Cape exported 15,000 kg of wool and 22 million kg by 1872. By the mid-19th century the sheep farmers were firmly linked into the Colonial and global economies and wool was the Cape Colony's major staple export. Sheep farmers in the Karoo were part of the wool production system and their need for religious services as well as the government's need for administrative control drove the establishment of new parishes and drostdys followed by the development of villages and towns (Fransen, 2006). The sheep farmers' need for household and other goods were initially satisfied by itinerant pedlars and later by traders in towns.

4. The towns of the Karoo midlands of the Eastern Cape

In South Africa there are areas within which: (i) the founding reasons and dates of towns are well documented (Fransen, 2006), (ii) where other reasons for town evolution such as the exploitation of minerals are absent, and, (iii) in which at any time a single authority has always governed the whole of the region. The Karoo midlands of the Eastern Cape Province is one such area and provides an opportunity for studying possible 'island' effects in enterprise development in South African towns. The twelve towns (Table 1, Figure 1) of the region have also been studied in reasonable detail before (Nel & Hill, 2008). This contributed to the potential of the area and its towns to serve as a suitable case study for the purposes of our study.

The twelve towns were established to serve rural communities in a pre-industrial era. The three towns of drostdy origin (Cradock, Graaff-Reinet and Somerset East) are the oldest (Table 1) with ages (in 2011) that varied from 186 to 226 years. The younger towns are all 'church towns' and their ages in 2011 varied between 135 and 157 years (Table 1). Over their history the towns and/or their hinterlands have at all times fallen under the same authorities/governments: the Dutch East India Company until 1795, the British and Batavian governments in turn until 1806, then the British government until 1910, the Cape Provincial government of South Africa until 1994, and thereafter the Eastern Cape Provincial government of South Africa. Differences in enterprise structures and dynamics should, therefore, not be ascribed to different government systems, policies and practices.

Towns	Year Founded	Total population (2004)*	Enterprises (2006/07)
Aberdeen	1858	8670	46
Cradock	1814	39296	303
Graaff-Reinet	1785	42208	356
Hofmeyr	1873	5243	18
Jansenville	1854	11452	50
Middelburg	1852	23786	166
Pearston	1859	5182	20
Somerset East	1825	30459	199
Steynsburg	1872	8437	41
Steytlerville	1876	5632	35
Ventersburg	1875	5243	18
Willowmore	1862	12358	55

* After Nel & Hill (2008)

Table 1. Selected Karoo towns of the Eastern Cape Province, South Africa.

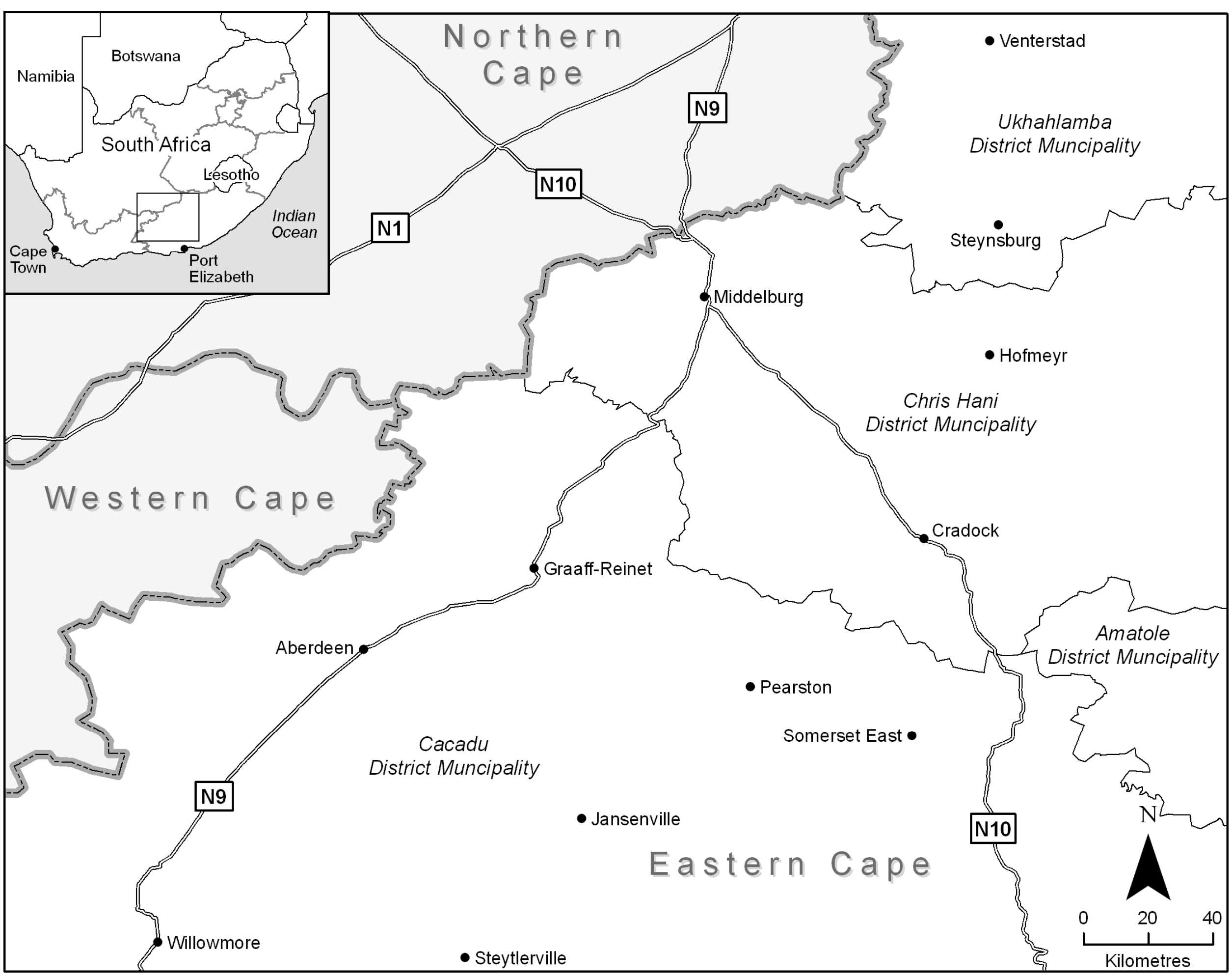


Fig. 1. A map of the selected Eastern Cape Karoo towns.

5. Testing the null hypothesis

5.1 Drawing up enterprise lists and constructing enterprise number balances

Telephone directories for Port Elizabeth and the Eastern Cape Country were used to identify the enterprises listed for the twelve towns (Table 1) for the years 2006/07 (Telkom Directory Services, 2006) and 2010/11 (Trudon, 2010). These enterprises were classified into 19 business sectors as described by Toerien & Seaman (2010). The lists were scrutinised to identify all enterprises which disappeared from or were new to the lists between 2006/07 and 2010/11. Through this process complete number balances (total enterprises as well as for each of the 19 business sectors) were constructed for each of the twelve towns. Turnover rates were calculated according to the following equation (Schoener, 2010):

$$\textit{Turnover rate} = \frac{(\text{No. of disappearences + No. of new enterprises) x 100}}{(\text{No. of enterprises in 2006/07 + No. of new enterprises in 2010/11})} \quad (1)$$

5.2 Enterprise equilibriums and turnover rates

The first test of the null hypothesis showed that enterprise development in the selected towns followed the predictions of the Species Equilibrium Model (see regional totals in Table 2). Not only were the total numbers of enterprises in the two different years for all of the towns almost identical, but this was also true for each of the towns. The reason was that the number of disappearances and new enterprises in each of the towns were in good balance. The turnover rates were high (Table 2) and reflected very competitive environments as predicted by Beinhocker (2006). Based on these results, the null hypothesis can clearly be rejected. South African towns are not just enterprise ecosystems (Toerien & Seaman, 2010) but also enterprise islands.

Town	2006/07	Extinct	New	2010/11	Turnover rate (%)
Aberdeen	43	5	8	46	14.6
Cradock	303	65	65	303	21.5
Graaff-Reinet	346	93	103	356	27.9
Hofmeyr	17	0	1	18	2.9
Jansenville	47	4	7	50	11.3
Middelburg	162	32	36	166	20.7
Pearston	21	5	4	20	22.0
Somerset East	198	42	43	199	21.4
Steynsburg	47	8	2	41	11.4
Steytlerville	30	8	13	35	32.3
Venterstad	20	4	2	18	15.8
Willowmore	54	9	10	55	17.4
Regional total	1288	275	294	1307	21.9

Table 2. Enterprise numbers and turnover rates for twelve Eastern Cape Karoo towns.

The same general picture emerged from number balances of different business sectors (Table 3). A few sectors showed some growth (e.g. the construction, health services, tourism and hospitality, and real estate sectors), most were very balanced and a few sectors showed some decline (e.g. legal services, processing, and the trade sectors). In general the adherence to the prediction of stable equilibriums by the Species Equilibrium Model was remarkable. These results also support the rejection of the null hypothesis.

Sector	2006/07	Extinct	New	2010/11	Turnover rate (%)
Agricultural Products & Services	106	16	15	105	14.7
Construction	43	5	15	53	20.8
Engineering & Technical Services	32	6	5	31	17.5
Factories	5	0	1	6	9.1
Financial Services	80	19	16	77	22.3
General Services	56	11	12	57	20.4
Health Services	101	21	38	118	26.9
Legal Services	21	9	5	17	36.8
Mining	0	0	0	0	0.0
News and Advertising	3	0	0	3	0.0
Personal Services	101	17	18	102	17.2
Processing	22	5	2	19	17.1
Professional Services	42	16	15	41	37.3
Real Estate Services	16	5	9	20	38.9
Telecommunications Services	14	8	5	11	52.0
Tourism and Hospitality	171	41	50	180	25.9
Trade	305	60	51	296	18.5
Transport & Earthworks	39	7	7	39	17.9
Unknown	31	13	11	29	40.0
Motor vehicles	100	16	19	103	17.2
Total enterprises	1288	275	294	1307	21.9

Table 3. Enterprise numbers and turnover rates between 2006/07 and 2010/11 of the different business sectors of twelve Eastern Cape Karoo towns.

The data presented in Table 3 allowed us to identify the business sectors that provide the 'momentum' for change in the enterprise structures of the selected towns. The 2006/07 numbers, the disappearances, new ventures and numbers for 2010/11 (Table 4) were normalised as percentages of the total enterprises given in Table 3.

Momentum for change was calculated as follows (equation 2):

$$\begin{aligned}&\textit{Sector's contribution to momentum for change} = \\ &(\%\ \textit{of disappearences} + \%\ \textit{of new})(\%\ \textit{of enterprises in}\ 2006 - 2007 + \\ &\%\ \textit{of enterprises in}\ 2010 - 2011)\ \textit{and expressed as}\ \%\ \textit{of total momentum}\end{aligned}$$

Business sector	2006/07	Disappear	New	2010/11	Momentum
Trade	23.7	21.8	17.3	22.6	44.7
Tourism and Hospitality	13.3	14.9	17.0	13.8	21.3
Health Services	7.8	7.6	12.9	9.0	8.5
Personal Services	7.8	6.2	6.1	7.8	4.7
Motor vehicles	7.8	5.8	6.5	7.9	4.7
Agricultural Products & Services	8.2	5.8	5.1	8.0	4.4
Financial Services	6.2	6.9	5.4	5.9	3.7
General Services	4.3	4.0	4.1	4.4	1.7
Professional Services	3.3	5.8	5.1	3.1	1.7
Construction	3.3	1.8	5.1	4.1	1.3
Unknown	2.4	4.7	3.7	2.2	1.0
Transport & Earthworks	3.0	2.5	2.4	3.0	0.7
Engineering & Technical Services	2.5	2.2	1.7	2.4	0.5
Legal Services	1.6	3.3	1.7	1.3	0.4
Real Estate Services	1.2	1.8	3.1	1.5	0.3
Telecommunications Services	1.1	2.9	1.7	0.8	0.2
Processing	1.7	1.8	0.7	1.5	0.2
Factories	0.4	0.0	0.3	0.5	0.0
Mining	0.0	0.0	0.0	0.0	0.0
News and Advertising	0.2	0.0	0.0	0.2	0.0
Total	100.0	100.0	100.0	100.0	100.0

Table 4. The contribution of the different business sectors to the momentum for change in the enterprise structures of the Karoo towns of the Eastern Cape.

More than 80% of the momentum for change in enterprise structures was contributed by only six business sectors: trading, tourism and hospitality, health services, personal services, the motor vehicle sector and the agricultural products and services sector. It seems as if an 80/20 rule (Pareto Principle) applies.

5.3 Urban population size and number of enterprises

The Species Equilibrium Model predicts that larger islands should have more species than smaller islands because they offer more space for colonisation by different species (Schoener, 2010). The first test - whether this prediction is also true for enterprise islands - was to compare total enterprise numbers and urban populations of the twelve towns, with urban populations serving as surrogate for the size of the 'islands'. In this regard we were fortunate that population and enterprise numbers had been determined for specific years over a period of about a century for the twelve towns (Nel & Hill, 2008) and we had received permission to use their data. This allowed us to extract 11 different data pairs for the same year or close together years of urban population sizes and enterprise numbers for the twelve towns. To test if enterprise numbers (dependent variable) for the twelve towns showed the same patterns of variance than urban population numbers (independent variable) Pearson correlation coefficients and regression equations were calculated with the use of Microsoft Excel software (Table 5).

Highly significant ($P < 0.01$) correlations were established for every data pair. With the exception of 1904, more than 80 and often more than 90 per cent of the variance (R^2) of the data pairs was explained. The urban populations and the number of enterprises in towns followed similar patterns. Over a period of a century larger enterprise islands housed more enterprises and vice versa; the towns as enterprise islands fitted the predictions of the Species Equilibrium Theory. Based on these results the null hypothesis could also be rejected.

Year(s)	Correlation	Slope	Intercept	% Variance explained (R^2)	Significance
1904	0.73	0.0090	32.2	54.0	P < 0.01
1911	0.97	0.0116	16.6	94.9	P < 0.01
1921	0.92	0.0091	26.8	85.5	P < 0.01
1935/36	0.90	0.0077	17.6	81.2	P < 0.01
1951	0.98	0.0072	16.6	95.9	P < 0.01
1960/61	0.98	0.0094	3.5	95.5	P < 0.01
1970	0.98	0.0076	-1.0	96.0	P < 0.01
1980	0.96	0.0094	1.0	93.1	P < 0.01
1990/91	0.98	0.0076	-7.8	96.9	P < 0.01
2000/01	0.99	0.0080	-19.4	97.3	P < 0.01
2004/06	0.99	0.0091	-29.6	97.8	P < 0.01

Table 5. A century of urban population-enterprise relationships of twelve Eastern Cape Karoo towns.

5.4 Rural population size and number of enterprises

The support in South Africa for the Central Place Theory (e.g. Van der Merwe & Nel, 1975) necessitated an investigation of the relationship between the number of enterprises in the selected towns and rural population sizes. The data of Nel and Hill allowed us to extract 11 different data pairs of rural population and enterprise numbers for the same year combinations used for the urban population-enterprise analysis. Pearson correlation coefficients and regression equations were also calculated with Microsoft Excel software (Table 6).

The rural populations and enterprise numbers of the region were with the exception of 1904 highly significantly ($P < 0.01$) correlated and from about 50 to more than 70 per cent of the variance was explained (Table 6). Larger towns were associated with larger rural populations. It is noticeable that the correlation coefficients in this exercise were generally lower than those for the urban populations (Table 5). Nevertheless the prediction of the Species Equilibrium Model about the impact of island size on species richness (Schoener, 2010) also applied to this surrogate of island size and it served to reject the null hypothesis.

Year(s)	Correlation	Slope	Intercept	% Variance explained (R^2)	Significance
1904	0.52	0.0086	1.7	26.6	Not significant
1911	0.79	0.0078	-2.2	63.0	P<0.01
1921	0.79	0.0097	-1.2	62.5	P<0.01
1935/36	0.78	0.0090	-0.8	60.2	P<0.01
1951	0.81	0.0082	3.2	66.4	P<0.01
1960/61	0.75	0.0111	-9.8	56.3	P<0.01
1970	0.81	0.0120	-16.3	65.2	P<0.01
1980	0.70	0.0161	4.8	48.7	P<0.01
1990/91	0.79	0.0202	-9.8	61.8	P<0.01
2000/01	0.81	0.0276	-28.8	65.9	P<0.01
2004/06	0.88	0.0242	-45.9	77.2	P<0.01

Table 6. A century of rural population-enterprise relationships for twelve Eastern Cape Karoo towns.

5.5 Total population size and number of enterprises

The fact that enterprise numbers in the selected towns were significantly correlated to both the rural and the urban populations (Tables 4 and 5) suggested that they should also be correlated with total population numbers for the districts in which the towns are located. This was indeed the case and, for all data pairs except for one (1904), more than 80 per cent of the variance was explained (Table 7). This analysis also supports the rejection of the null hypothesis. The results also question the modern applicability of the Central Place Theory to South African towns because enterprise numbers are not only correlated with the rural populations (Table 6), but more strongly with the total and urban populations (Tables 5 and 7).

Year(s)	Correlation	Slope	Intercept	% Variance explained (R^2)	Significance
1904	0.84	0.0070	-8.59	70.2	P<0.01
1911	0.94	0.0054	-2.20	88.4	P<0.01
1921	0.92	0.0061	2.53	83.8	P<0.01
1935/36	0.89	0.0050	2.68	78.6	P<0.01
1951	0.90	0.0042	7.30	80.5	P<0.01
1960/61	0.92	0.0056	-9.99	85.1	P<0.01
1970	0.98	0.0053	-16.74	95.6	P<0.01
1980	0.93	0.0067	-8.76	86.5	P<0.01
1990/91	0.97	0.0060	-15.18	94.4	P<0.01
2000/01	0.97	0.0065	-26.51	94.9	P<0.01
2004/06	0.97	0.0070	-36.95	94.9	P<0.01

Table 7. A century of district population-enterprise relationships for twelve Eastern Cape Karoo towns.

5.6 Island size and turnover rates

The Species Equilibrium Theory also predicts that the turnover rate in species richness is a function of island size: larger islands have larger turnover rates and vice versa. To examine this prediction, we calculated Pearson correlation coefficients between the average number of enterprises for 2006/07 and 2010/11 (surrogate for 'island size' and independent variable) and the turnover rates (dependent variable) for the different towns. This correlation was not statistically significant (P = 0.05) (Figure 2). However, an examination of the data suggested that two outlier towns (Hofmeyr and Steytlerville, see arrows in Figure 2) were primarily responsible for the negative result. When these towns were excluded in a correlation analysis, a statistically significant (P < 0.01) correlation coefficient of 0.76 was obtained (as suggested by the trend line in Figure 2). This suggests that the prediction of the Species Equilibrium Model might be correct, but that it requires further investigation. In this test the null hypothesis cannot be rejected.

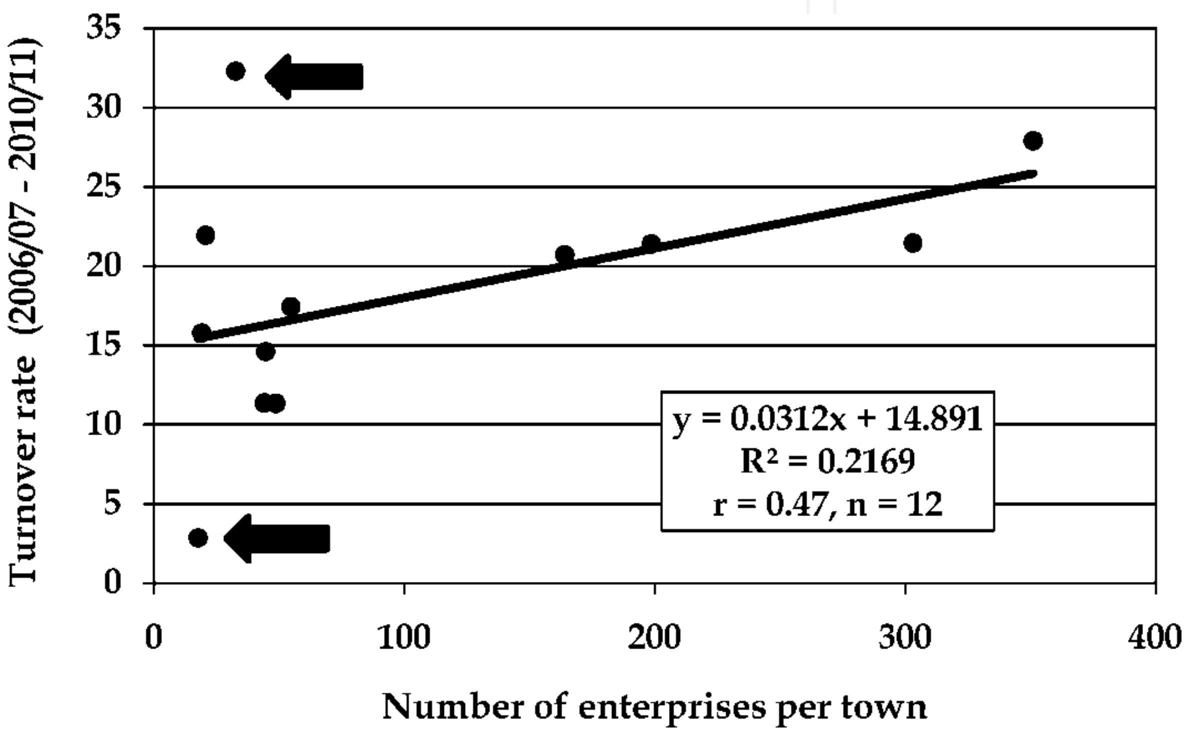


Fig. 2. Turnover rate as a function of the size of enterprise structures of towns.

5.7 District area and the number of enterprises in the selected towns

The Central Place Theory suggests that towns are very dependent on their rural hinterlands (Christaller, 1966 as quoted by Van der Merwe & Nel, 1975). District area could possibly also serve as a surrogate for 'enterprise island' size and could be used to test the null hypothesis. The data of Nel and Hill contained three different estimates (for 1938, 1981 and 1993 respectively) of the district areas surrounding the selected towns. This allowed us to examine the relationship between district area and the enterprise numbers for the closest years to the years identified above: (i) 1935 and 1938, (ii) 1980 and 1981, and, (iii) 1990 and 1991.

The district areas and enterprise numbers were significantly (P< 0.05) correlated and 40 to 48% of the variance was explained (Table 8). The use of this surrogate for 'island size' also supported the prediction of the Species Equilibrium Model about the impact of island size on species richness, here measured as enterprise richness, and serves to reject the null hypothesis.

Area – enterprises	Correlation	Slope	Intercept	% of variance explained (R^2)	Significance
1935-38	0.69	0.00015	-7.57	47.9	P<0.01
1980-81	0.67	0.00028	-37.20	44.3	P<0.05
1990-91	0.64	0.00026	-35.62	40.4	P<0.05

Table 8. The relationships of enterprise numbers of the twelve Eastern Cape Karoo towns and district areas at three separate times.

5.8 The impact of town age on enterprise numbers

In the case of rural South African towns, and in contrast to many towns in Europe and Asia (e.g. Braudel, 1979), the founding dates of towns are precisely known. This provided an opportunity to assess if older towns have first-comer advantages as far as enterprise development is concerned. This was indeed the case (Table 9) and for the eleven different years during the past century that were analysed there were statistically significant ($P < 0.01$) positive correlations. The first-comer advantages stayed in place for more than a century. The steady increase with time of the slopes and the decreases in the intercepts of the regression equations (Tables 7 and 9) suggest that the larger (and older) towns of the Eastern Cape Karoo have in modern times grown their enterprise numbers more rapidly than smaller towns.

Year	Correlation	Slope	Intercept	Variance explained (%)	Significance
1904	0.81	1.22	-6.4	65.8	P<0.01
1911	0.93	1.03	-9.9	86.4	P<0.01
1921	0.94	1.27	-25.7	88.6	P<0.01
1935	0.84	1.15	-39.6	69.9	P<0.01
1951	0.92	1.28	-70.8	84.9	P<0.01
1961	0.94	2.12	-163.0	88.7	P<0.01
1970	0.92	1.92	-165.5	85.0	P<0.01
1980	0.95	2.75	-266.8	90.1	P<0.01
1990	0.93	2.46	-266.9	86.6	P<0.01
2000	0.94	3.00	-369.2	87.8	P<0.01
2006	0.95	3.32	-438.9	90.3	P<0.01

Table 9. The relationships of enterprise numbers (dependent variable) and town ages (independent variable) of the twelve Eastern Cape Karoo towns.

6. Discussion

Veblen (1898, as cited in Witt, 2008) introduced the notion of evolutionary economics, an approach that would attract much support later. However, there is still little agreement among the researchers in the field when it comes to deciding what is specific about evolutionary economics (Witt, 2008). Some interpretations of evolutionary economics consider the Darwinian theory of evolution relevant for understanding economic behaviour and the transformation of economic institutions and technology. Other interpretations do not embrace, or even explicitly reject, that idea (Witt, 2008). He stressed that at the core, this is a controversy about the basic (ontological) assumption about the structure of reality. It relates to the question of whether evolutionary change in nature and in the economy represent connected spheres of reality, making them likely to mutually influence each other, an issue important to this study. In addition there is the issue of whether evolutionary theorising in economics can profit from borrowing analytical tools from evolutionary biology, e.g. models of selection processes and population dynamics (Witt, 2008).

Witt (2004) cautioned that one should be careful to accept that evolution in the economy and evolution in nature are similar or even identical. Beinhocker (2006) belongs to the school of belief of the similarities between biological and economic evolution and he discussed these in great detail in his book, *The Origin of Wealth*. His views, briefly presented earlier, will not be further examined here, except to state that Toerien & Seaman (2010) built on them by examining and accepting the hypothesis that towns are enterprise ecosystems.

The Species Equilibrium Model (MacArthur & Wilson, 1967) marked the transition of ecology from a descriptive to an analytical science (Losos & Ricklefs, 2010). On the other hand town studies in South Africa had already by the 1960s involved some quantitative approaches, e.g. applied by Davies & Cook (1968) and extensively discussed by Van der Merwe & Nel (1975). At that time the hierarchical order of towns was the primary focus (e.g. Davies & Cook, 1968). There was little or no appreciation of the analogy between the systems in which organisms compete, survive or die and the systems wherein enterprises compete, survive or die, as discussed by Beinhocker (2006).

We believe that the analogy provides a new way of thinking about and analysing South African towns. To do this we first conceptually developed the hypothesis that many South African towns (i.e. enterprise ecosystems) could also be viewed as enterprise islands in seas of farms. If the contention is correct, the Species Equilibrium Model (perhaps in modified form) could be applied in analyses of town enterprise structures. We posed a null hypothesis that the towns are not enterprise islands. Overwhelming evidence was obtained that the null hypothesis could be rejected. As suggested by the model, quantification of enterprise numbers for 2006/07 and 2010/11 for selected case study towns indicated stable equilibriums in regional as well as individual town enterprises despite high turnover rates (Table 2). The same general picture emerged for enterprise numbers of different business sectors (Table 3). In addition some evidence, not statistically significant, were obtained that the magnitude of turnover rates is higher in larger enterprise islands (Figure 2).

The Species Equilibrium Model also predicts that larger islands will have more species than smaller islands when equidistant from a mainland (source of immigrants). Different surrogates of island size (or town size) were used in statistical examinations of this prediction for enterprise numbers in towns and all of the comparisons supported the rejection of the null hypothesis (Tables 5 to 8). In fact, it was demonstrated that some of these relationships or proportionalities have existed in the case study towns for a period of more than a century. In addition, there is a positive link between the number of enterprises and the ages of towns (Table 9), indicating fist-comer advantages.

Based on the evidence presented as well as on the Species Equilibrium Model it is possible to think of an Enterprise Equilibrium Model for towns that could explain the enterprise proportionalities observed in the enterprise structures of 140 South African towns (Toerien & Seaman, 2012a) or the century-long proportionalities between different population group and enterprise numbers in the Eastern Cape (Tables 5 to 7).

Acceptance of such a model would be dependent on an understanding of what the units of evolutionary selection in economic evolution are or, in other words, what the economic equivalent of a gene is. Beinhocker (2006) expounded on this issue. He stated that businesses are the interactors that struggle in survival-of-the-fittest competition in economic evolution but they are not the units of selection (similar to organisms in biology). Modules (developed by entrepreneurs or managers) are components of business plans (explicit or implicit) that provide a basis for the differential selection between businesses in competitive environments. They are the units of selection in economic evolution as genes are in biological evolution. Successful genes increase in frequency in biological populations and successful business plan modules extend their influence over resources over time (Beinhocker, 2006). In other words, these successful modules are repeated more often in business plans as more and more entrepreneurs/managers apply them.

The Species Equilibrium Model recognises that three fundamental processes, i.e. species gained through immigration and/or speciation minus those having become extinct locally, determine the number of species at any point in time and result in species equilibriums. In addition, two principal controlling geographical/environmental influences, isolation and area, contribute to the magnitude of the equilibriums achieved (Whittaker et al., 2010). this study showed that enterprise equilibriums are also determined by significant turnover rates resulting from the appearance of new ventures and the disappearance of existing enterprises. The resulting equilibriums are proportional to the size of the respective towns (enterprise islands).

Two of these natural processes deserve further comment: isolation and speciation, especially in terms of what their equivalents may be in economic evolution. In the case of towns new ventures depend, if only in part, on their proximity to (or isolation from) entrepreneurs, whilst the ability of managers to adopt their business plans to change business operations might be the equivalent of speciation on natural islands. Isolation and speciation are, albeit in modified form, probably also important in economic evolution.

An important difference in this regard needs to be noted. Whereas with natural islands it would be impossible to physically change isolation, the same is not true as far as isolated enterprise islands are concerned. Local authorities and development agencies can use (and have used) different tactics to bring entrepreneurs in contact with existing or potential business opportunities in cities/towns. The familiar view of job creation is that business location is largely a function of traditional economic values such as tax structure and cost of doing business. However, Johnson & Rasker (1995) found that positive economic growth also resulted from the maintenance of a high environmental quality. This suggests some level of entrepreneurial activity may be encouraged through efforts which maintain local environmental and quality of life amenities. There are probably many different creative ways by which towns can expose their entrepreneurial opportunities to entrepreneurs from elsewhere. In addition existing enterprises use tactics such as training and consulting to improve the skills of their staff and their abilities to strategize and compete more effectively.

Finally, one further issue raised by Beinhocker (2006) deserves attention. He noted that as complex adaptive open systems the natural world as well as the economic world is subject to entropy. In open systems there is a never-ending battle between energy-powered order creation and entropy-driven order destruction. Enterprise ecosystems, therefore, are driven by energy, which costs money. Toerien & Marais (2012) argued that the money that flows to or circulates in a town determines: (i) the number of businesses that can be supported, and, (ii) the number of people that can exist in the town. Therefore population numbers serve well as surrogate measures (Tables 5 to 7) of such money flows. The entrepreneurial spaces of enterprise islands ultimately probably depend on money.

7. Conclusions

The rejection of the null hypothesis that towns are not enterprise islands because of the good fit of rural South African towns to predictions derived from the Species Equilibrium Model supports contentions: (i) that natural and economic systems are very similar, and, (ii) the ecology and the economy can learn from each other (Beinhocker, 2010). Rural South African towns are not just enterprise ecosystems (Toerien & Seaman, 2010) but also enterprise islands.

We believe that the similarities between biological evolutionary systems and evolutionary economic systems, as pointed out by many including Beinhocker (2006), result in the possibility of applying methods and approaches used in the one successfully in the other. For instance, this study has shown that it is possible to develop new insights about entrepreneurship in rural towns by applying the Species Equilibrium Model developed for island biogeography. As a consequence it is possible to think about the development of an Enterprise Equilibrium Model for towns and its application in decisions about local economic development.

8. Acknowledgements

We thank Ettienne Nel, Trevor Hill and Doreen Atkinson for permission to use their population, enterprise and area data of the case study towns. Frank Sokolic was responsible for the map of the study area and helped with table outlays and Figure 2. Annamarie du Preez provided library support, Marie Toerien analytical support and Max Döckel valuable comments about the manuscript. Marilie van der Walt of Indigo Language Solutions provided language editing. Financial support was received from the Centre for Environmental Management, University of the Free State, Bloemfontein, South Africa.

9. References

Beinhocker, E.D. (2006) The Origin of Wealth: Evolution, Complexity, and the Radical Remaking of Economics. Harvard Business School Press, ISBN 1-57851-777-X, Boston.

Begon, M., Harper, J.L., & Townsend, C.R. (1990) Ecology: Individuals, Populations and Communities, 2nd Edition, Blackwell Science, ISBN 0-86542-111-0, Cambridge.

Boonzaaier, E., Malherbe, C., Smith, A. & Berens, P. (1996) The Cape Herders: A History of the Khoikhoi in Southern Africa, David Philip, ISBN 0 86486 311 X, Cape Town.

Braudel, F. (1979) Civilization and Capitalism. 15th–18th Century. Volume 1. The structures of Everyday Life: The Limits of the Possible. Translation from the French revised by S. Reynolds, University of California Press, ISBN 0-520-08114-5, Berkeley.

Burrows, E.H. (1994) Overberg Outspan: A Chronicle of People and Places in the South Western Districts of the Cape, Facsimile Edition, Swellendam Trust, ISBN 0 620 12930 1, Swellendam.

Cowling, R.M. (1986) A Description of the Karoo Biome Project. South African National Scientific Programmes Report No. 122, Foundation for Research Development, ISBN 0 7988 3803 5, Pretoria.

Davies, R.J. & Cook, G.P. (1968) Reappraisal of the South African urban hierarchy, South African Geographical Journal, Vol. 50, No. 2, 116-132.

Elphick, R. (1979) The Khoisan to c. 1770. In: The Shaping of South African Society, 1652–1820. Ed. by R. Elphick & H. Giliomee, pp. 3–33, Maskew Miller, ISBN 0 636 00516 X, Cape Town.

Fransen, H. (2006) Old Towns and Villages of the Cape: A Survey of the Origin and Development of Towns, Villages and Hamlets at the Cape of Good Hope, Jonathan Ball Publishers, ISBN 1 86842 227 5, Johannesburg.

Fujita, M., Krugman, P. & Venables, A.J. (2005) The Spatial Economy: Cities, Regions, and International Trade, MIT Press, ISBN 978-0-262-06204-6, Cambridge.

Giliomee, H. & Mbenga, B. (2007) New History of South Africa. Tafelberg, ISBN-13: 978 0 624 04358 4, Cape Town.

Guelke, L. (1979) The white settlers, 1652–1780, In: The Shaping of South African Society, 1652–1820. Ed. by R. Elphick & H. Giliomee, pp. 41–74, Maskew Miller, ISBN 0 636 00516 X, Cape Town.

Henshilwood, C.S., d'Errico, F., Yates, R., Jacobs, Z., Tribolo, C., Duller, G.A.T., Mercier, N., Sealy, J.C., Valladas, H., Watts, I, & Wintle, A.G. (2002) Emergence of modern human behavior: Middle Stone Age engravings from South Africa, *Science,* Vol. 295, No. 5558, 15 February 2002, 1278–1280.

Johnson, J.D. & Rasker, R. (1995) The role of economic and quality of life values in rural business location. Journal of Rural Studies, Vol. 11, No. 4, 405-416.

Jones, H.L. & Diamond, J.M. (1976) Short-time-base studies of turnover in breeding bird populations on the Californian Channel Islands, The Condor Vol. 78, No. 4, 526–549.

Lindroth, C.H. (1973) Surtsey, Iceland: The Development of a New Fauna, 1963-1970. Terrestrial Invertebrates. Munksgaard, Copenhagen.

Lomolino, M.V., Riddle, B.R., Whittaker, R.J. & Brown, J.H. (2010) Biogeography, 4th ed. Sinauer Associates, ISBN-10: 0878934944, Sunderland.

Losos, J.B. & Ricklefs, R.E. (eds.) (2010) The Theory of Island Biogeography Revisited, pp. xi–xiv, Princeton University Press, ISBN 978-0-691-13653-0, Princeton.

MacArthur, R.R.H. & Wilson, E.O. (1967) The Theory of Island Biography, Princeton University Press, ISBN 0-691-08836-5, Princeton.

Marean, C.W., Bar-Matthews, M., Bernatchez, J., Fisher, E., Goldberg, P., Herries, A.I.R., Jacobs, Z., Jerardino, A., Karkanas, P., Minichillo, T., Nilssen, P.J., Thompson, E., Watts, I. & Williams, H.M. (2007) Early human use of marine resources and pigment in South Africa during the Middle Pleistocene. Nature, 449, 18 October 2007, 905-908.

May, R.M. (2010) Foreword, In: The Theory of Island Biogeography Revisited, Ed. by Losos, J.B. & Ricklefs, R.E., pp. vii-ix, Princeton University Press, ISBN 978-0-691-13653-0, Princeton.

Nel, E.L. & Hill T.R. (2008) Marginalisation and demographic change in the semi-arid Karoo, South Africa. Journal of Arid Environments, Vol. 72, No. 12, 2264-2274.

Pickett, S.T.A. & Cadenasso, M.L. (2002) The ecosystem as a multidimensional concept: meaning, model, and metaphor. Ecosystems Vol. 5, No. 1, 1–10.

Schoener, T.W. (2010) The MacArthur-Wilson equilibrium model: A chronicle of what it said and how it was tested. In: The Theory of Island Biogeography Revisited, Ed. Losos, J.B. & Ricklefs, R.E., pp. 52-87, Princeton University Press, ISBN 978-0-691-13653-0, Princeton.

Tansley, A.G. (1935) The use and abuse of vegetational concepts and terms. Ecology Vol. 16, No. 3, 284-307.

Telkom Directory Services (2006) Port Elizabeth & Eastern Cape Country 2006/2007, Telkom Directory Services, Johannesburg.

Toerien, D.F. (2012) Prince Albert: A fourth economic bubble or sustainable development? In: Small Town Geographies in Africa in press, Ed. Donaldson, R. & Marais, L., Nova Science Publishers, Hauppauge, N.Y.

Toerien, D.F. & Marais, L., (2012) Classification of South African towns revisited. In: Small Town Geographies in Africa, in press, Ed. Donaldson, R. & Marais, L., Nova Science Publishers, Hauppauge, N.Y.

Toerien, D.F. & Seaman M.T. (2010) The enterprise ecology of towns in the Karoo, South Africa. South African Journal of Science, Vol 106, No. 1, 24–33.

Toerien, D.F. & Seaman M.T. (2012a) Proportionality in enterprise development of South African towns. South African Journal of Science (in press).

Toerien, D.F. & Seaman M.T. (2012b) Enterprise diversity in selected South African towns. South African Journal of Science (submitted).

Trudon, (2010) Port Elizabeth & Eastern Cape 2010/2011. Trudon, Bruma.

Van der Merwe, I.J. & Nel, A. (1975) Die stad en sy omgewing: 'n studie in nedersettingsgeografie (in Afrikaans), Universiteitsuitgewers, Stellenbosch.

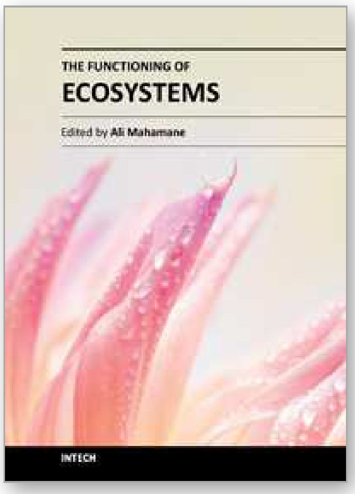
Van Waart, S. (2001) Swartberg en Sy Mense & Paleise van Pluime (in Afrikaans), Lapa, Pretoria.

Whittaker, R.J., Triantis, K.A. & Ladle, R.J. (2010) A general dynamic theory of oceanic island biogeography, In: The Theory of Island Biogeography Revisited, Eds. Losos, J.B. & Ricklefs, R.E., pp. 88-115, Princeton University Press, ISBN 978-0-691-13653-0, Princeton.

Wickins, P.L. (1983) Agriculture. In: Economic History of South Africa, Ed. Coleman, F.L., pp. 37-85, HAUM, Pretoria.

Witt, U. (2004) On the proper interpretation of 'evolution' in economics and its implications for production theory, Journal of Economic Methodology Vol. 11, No. 2, 125–146.

Witt, U. (2008) What is specific about evolutionary economics? Journal of Evolutionary Economics Vol. 18, No. 5, 547–575.



The Functioning of Ecosystems
Edited by Prof. Mahamane Ali

ISBN 978-953-51-0573-2
Hard cover, 332 pages
Publisher InTech
Published online 27, April, 2012
Published in print edition April, 2012

The ecosystems present a great diversity worldwide and use various functionalities according to ecologic regions. In this new context of variability and climatic changes, these ecosystems undergo notable modifications amplified by domestic uses of which it was subjected to. Indeed the ecosystems render diverse services to humanity from their composition and structure but the tolerable levels are unknown. The preservation of these ecosystemic services needs a clear understanding of their complexity. The role of the research is not only to characterise the ecosystems but also to clearly define the tolerable usage levels. Their characterisation proves to be important not only for the local populations that use it but also for the conservation of biodiversity. Hence, the measurement, management and protection of ecosystems need innovative and diverse methods. For all these reasons, the aim of this book is to bring out a general view on the biogeochemical cycles, the ecological imprints, the mathematical models and theories applicable to many situations.