Enterprise richness as an important characteristic of South African towns

AUTHORS:
Daan F. Toerien[1]
Maitland T. Seaman[1,2]

AFFILIATIONS:
[1]Centre for Environmental Management, University of the Free State, Bloemfontein, South Africa
[2]Strategic Cluster: Water Management in Water-scarce Areas, University of the Free State, Bloemfontein, South Africa

CORRESPONDENCE TO:
Daan Toerien

EMAIL:
Toeriend@ufs.ac.za

POSTAL ADDRESS:
Centre for Environmental Management, PO Box 339, Bloemfontein 9300, South Africa

DATES:
Received: 16 Jan. 2014
Revised: 05 Mar. 2014
Accepted: 24 Mar. 2014

KEYWORDS:
enterprise diversity; enterprise architecture; enterprise proportionality

HOW TO CITE:
Toerien DF, Seaman MT. Enterprise richness as an important characteristic of South African towns. S Afr J Sci. 2014;110(11/12), Art. #2014-0018, 9 pages. http://dx.doi.org/10.1590/sajs.2014/20140018

Towards the end of the 20th century there were almost 500 small towns of fewer than 50 000 persons in South Africa, accommodating about one tenth of the country's population. Little was known or said in national debates about the future of these places. A decade later this situation had changed and many studies have been or are being undertaken on small towns. For instance, the South African Government recognised that to stem the continued migration from rural to urban areas, a different approach was needed to economic development in rural municipalities and a 'Small Towns Regeneration Project' was initiated. Concerns about a perceived decline of rural towns also stimulated a quest to develop or find methods and/or measures to monitor the well-being of towns. Elsewhere in the world, small and medium enterprise 'observatories' were established to study and report on all aspects of small and medium enterprises, an approach recently followed in South Africa. New ways are needed to improve our understanding of the enterprise dynamics of South African towns. In this contribution, we examine the potential utility of the enterprise richness (i.e. the number of enterprise types) of South African towns and show that enterprise richness has a strong and fully quantifiable relationship with the total number of enterprises in the towns. This contribution adds a new dimension to the capability to make predictions about the enterprise structures of South African towns.

Introduction

The role of lower-order urban centres in regional development constitutes an important subject of debate[1] both internationally and in South Africa, which has seen a dramatic rise in scholarship on small town geographies since 2000.[2] A large number of empirical case studies form part of this scholarship. Two broad strands of enquiry related to small towns in South Africa have dominated recent writings.[3] The first focused on small town growth and development potential, particularly local economic development, and the second strand focused on various new rural and small town activities relative to debates on post-productivist landscapes.[3]

A third strand of investigation originated from ideas about the similarities between economic wealth and biological wealth. Beinhocker[4] is adamant that economic wealth and biological wealth are thermodynamically the same sort of phenomena. He stated that both are systems of low entropy and patterns of order that have evolved over time under constraint of fitness functions. Like each living organism, each individual enterprise is also in constant competition for survival and only the fittest survive. The similarities between living organisms and enterprises offer the opportunity to transfer lessons learnt from natural ecology to enterprise development in towns. The third-strand studies built on these possibilities.

The latter studies followed two broad themes. Firstly, they explored the interface between natural ecology and regional geography. It was concluded on the basis of norms set for natural ecosystems that towns are 'enterprise ecosystems'.[5] Based on the similarities between biological species and enterprises and consideration of the well-known species equilibrium model[6] of natural ecology, it was concluded that towns in the Karoo can conceptually be viewed as islands in a sea of farms, and the extent to which entrepreneurs successfully crossed the sea and established enterprises in available entrepreneurial spaces in the towns, determined the enterprise architectures of the latter.[7]

Secondly, a large number of business sector proportionalities (i.e. statistically significant correlations between the enterprise numbers in specific business sectors and total enterprise numbers of towns) were reported for a large group of South African towns[8] as well as for Karoo towns[9]. Such proportionalities also occurred in the tourism sector of towns in arid and semi-arid South Africa.[10] These studies revealed additional ways in which the enterprise dynamics of South African towns could be understood and predicted.

A logical conclusion of Beinhocker's[4] views is that the organisms that survive the competitive forces in natural ecosystems determine their biological diversity. Likewise, surviving enterprises determine the enterprise diversity, and hence the enterprise architecture, of towns. Examination of the utility of diversity concepts used in natural ecology could, therefore, be useful in developing an understanding of the enterprise diversity of South African towns.

The biological diversity of the earth has, ever since Wallace and Darwin, been a source of amazement and curiosity, and an area of formal inquiry. Tilman[11] remarked:

> *We still do not know, for example, how hundreds of plant species and thousands of insect species coexist on a hectare of rainforest or prairie, or how millions of species coexist on earth.*

This lack of understanding is also broadly true for the coexistence of enterprises in towns.

There are basically three reasons for natural ecologists' interest in ecological diversity and its measurement: (1) it is a central theme in ecology, (2) measures of diversity are often used as indicators of the well-being of ecological systems and (3) considerable debate surrounds the measurement of diversity.[12] Magurran[12] stated that biological diversity is like an optical illusion: the more it is looked at, the less clearly defined it appears to be.

There is, however, a simple explanation for why biological diversity is so hard to define, which consists of two components: (1) the variety of and (2) the relative abundance of species.[12] Biological diversity is, therefore, measured by recording the number of species, by describing their relative abundances or by using a measure that combines the two components.[13] The term 'species richness' should be used to refer to the number of natural species in a given area or in a given sample.[14] The equivalent term in economic geography is 'enterprise richness', which is used in this contribution.

In the context of enterprise dynamics, questions can be raised about how enterprises coexist in towns. In pursuing this issue we can build on the knowledge and experience of natural ecology. A number of natural ecological diversity indices have been derived using some combination of the number of biological species recorded in natural ecosystems (= species richness) and the total number of individuals summed over all species.[12] A widely used diversity index is the Margalef (D_{Mg}) Index[13]:

$$DMg = (S - 1)/\ln N \qquad \text{Equation 1}$$

where S is the number of different species observed and N is the total number of individuals recorded.

The Margalef Index simply states that in natural ecosystems the species richness is a function of the natural log of the total number of individuals present. An ecosystem that is able to carry more individuals will have a greater species richness than ecosystems that can carry fewer individuals and the differences are totally quantifiable. If the same is true for the enterprise richness of South African towns and the relationship can be quantified, a powerful predictor of the link between the total number of enterprises of South African towns and their enterprise richness could be gained.

It is important to note that functional diversity in natural ecosystems differs from species diversity.[15] Functional diversity reflects the extent of functional differences among the species in a natural community. An enterprise diversity index, a functional index based on the relative presence of 19 different business sectors in South African towns, was inter alia used to examine functional differences between towns in water abundant and water poor areas of South Africa.[16] However, mathematical modelling of the enterprise richness (i.e. enterprise types) of South African towns has not been studied before – a situation which is addressed in this contribution.

The primary purpose of this study was to examine if there is a statistically significant relationship between the number of enterprise types (i.e. enterprise richness and not just functional types) and the total number of formal enterprises present in South African towns.

Over the past three decades, one of the more controversial issues in natural ecology has been the hypothesis that greater diversity and trophic complexity in natural ecosystems increase population and ecosystem stability.[17] This concept has been repeatedly challenged[18,19] but still remains a possibility.[11]

Are towns with a greater enterprise richness more stable than towns that are less enterprise rich? A possible answer could be derived from comparing different types of towns. Groups of South African towns have been identified based on their enterprise structures.[8] A secondary purpose of the study was, therefore, to examine the enterprise richness–enterprise number relationships of different groups of South African towns in order to determine whether such relationships, if they exist, could be used as indicators of town (i.e. enterprise ecosystem) stability.

Methods and results

Enterprise architectures and enterprise richness of towns

In total, 134 towns (Table 1) were examined in this study. There was no logic to the choice of the towns apart from the fact that they were, at the time of writing, part of a database of the enterprise architecture of South African towns. The selected towns were from eight South African provinces (Table 1) and represented a large subset of South African towns.

Town data was obtained as follows. A list of all enterprises in a specific town was prepared from telephone directories as described by Toerien and Seaman[5]. Each enterprise was allocated to one of 19 business sectors[5] (Table 2) by examining and/or 'Googling' its name. If it was impossible to determine the sector in which the enterprise functioned it was ignored in further analyses.[5] The enterprise type was then identified. For example, an enterprise with a name such as Union Wholesale Traders would be allocated to the trade services sector and the enterprise type would be recorded as a wholesaler. Salon Isabel would be allocated to the personal services sector and be identified as a beauty parlour. We previously identified more than 500 different enterprise types in our database of South African towns and these were used to allocate the enterprise types. For each town, we recorded: (1) a business profile consisting of the number of enterprises in each of 19 business sectors and the enterprises expressed as percentages of the total number of enterprises per town and (2) the number of different enterprise types (Table 1).

Statistical distribution of enterprise numbers

The selection of 134 towns contained many more small than large towns (Table 1). Statistica 12® software was used to examine the statistical distribution of the enterprise numbers of the selected towns. The median number (73 enterprises per town) was appreciably lower than the average number (138 enterprises per town) and the enterprise numbers were clearly not normally distributed. Further analysis showed that the enterprise numbers of the 134 towns had a log-normal distribution. This distribution suggested that, in order to test a hypothesis that enterprise richness is statistically related to enterprise numbers, an approach similar to that of Margalef could be followed.

Enterprise richness of a large group of South African towns

We related the number of enterprise types observed (as the dependent variable) to the $\log_{10}$ values of the total number of enterprises observed in towns (the independent variable) and then tested the statistical significance of the resulting equation(s). Enterprise richness increased as the enterprise numbers of towns increased (Figure 1); the best-fit relationship was statistically highly significant ($p < 0.01$ and $n = 134$) and 97% of the variance was explained:

$$\text{Enterprise types in town}_A = 1.8086\ (\text{number of enterprises in town}_A^{0.7164}) \qquad \text{Equation 2}$$

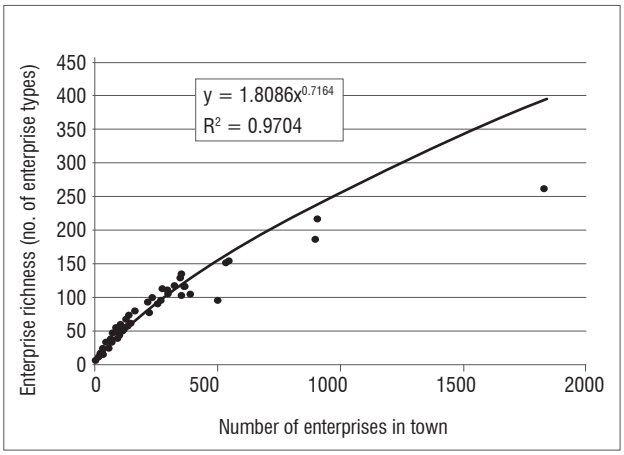

Figure 1: Enterprise richness as a function of the total enterprise numbers of 134 South African towns.

Bigger towns not only have more enterprises than smaller towns but also more enterprise types. The increase in enterprise richness is, however, not linear but moderates at higher enterprise numbers (Equation 2), similar to the Margalef Index in natural ecology. As towns grow, their 'entrepreneurial spaces'[9] increase in a predictable fashion (or vice versa).

Table 1: South African towns used in this study

Town	Province	Source†	No. of enterprises	No. of types	Town	Province	Source†	No. of enterprises	No. of types	Town	Province	Source†	No. of enterprises	No. of types
Aberdeen	EC	g	39	31	Hartswater	NC	g	295	107	Prieska	NC	g	108	56
Albertinia	WC	d	93	49	Heidelberg	WC	d	115	51	Prince Albert	WC	h	82	42
Alexander Bay	NC	g	55	34	Hobhouse	FS	h	10	10	Richmond	NC	b	30	17
Aliwal-North	EC	e	266	95	Hofmeyr	EC	g	17	13	Riversdal	WC	d	232	99
Allanridge	FS	f	22	16	Hopetown	NC	g	70	49	Riviersonderend	WC	c	67	40
Ashton	WC	c	73	41	Jacobsdal	FS	g	42	33	Robertson	WC	c	323	116
Augrabies	NC	g	41	22	Jagersfontein	FS	g	28	21	Rosendal	FS	g	11	9
Barkly-West	NC	g	77	43	Jan Kempdorp	NC	g	121	61	Rouxville	FS	g	32	19
Barrydale	WC	d	56	26	Jansenville	EC	g	47	28	Sannieshof	NW	a	84	57
Beaufort-West	WC	g	353	104	Kakamas	NC	g	138	69	Schweizer-Reneke	NW	a	224	92
Bethulie	FS	g	43	30	Kathu	NC	g	135	71	Senekal	FS	g	132	63
Bloemhof	NW	g	120	64	Keimoes	NC	g	101	53	Smithfield	FS	g	35	23
Bonnievale	WC	c	122	53	Keimouth	EC	g	35	16	Springfontein	FS	g	23	19
Boshof	FS	h	39	27	Kenhardt	NC	h	29	23	Steynsburg	EC	g	39	28
Bothaville	FS	f	241	94	Kleinmond	WC	c	210	93	Steytlerville	EC	g	30	23
Botshabelo	FS	f	223	78	Klipplaat	EC	g	15	11	Stilbaai	WC	g	199	93
Brandfort	FS	h	91	50	Koffiefontein	FS	g	43	34	Struisbaai	WC	d	103	45
Brandvlei	NC	h	22	16	Komga	EC	e	52	31	Strydenburg	NC	h	17	14
Bredasdorp	WC	d	274	113	Ladismith	WC	d	88	42	Stutterheim	EC	e	152	79
Britstown	NC	g	27	17	Ladybrand	FS	h	252	91	Sutherland	WC	f	35	21
Bultfontein	FS	g	102	47	Laingsburg	WC	g	56	30	Swellendam	WC	h	342	120
Burgersdorp	EC	g	115	66	Lime Acres	NC	g	42	31	Tarkastad	EC	g	42	32
Caledon	WC	c	245	94	Loeriesfontein	NC	h	29	22	Taung	NC	g	91	45
Calitzdorp	WC	d	54	27	Loxton	NC	h	7	7	Thabazimbi	LIM	f	323	118
Calvinia	NC	g	110	56	Luckhoff	FS	h	16	14	Thohoyandou	LIM	f	499	95
Carnarvon	NC	g	58	37	Lutzville	WC	c	72	48	Trompsburg	FS	g	38	23
Christiana	NW	g	137	59	McGregor	WC	g	38	23	Tulbagh	WC	c	158	72
Clarens	FS	g	126	51	Middelburg (EC)	EC	f	161	79	Uniondale	WC	f	42	28
Clocolan	FS	g	90	50	Montagu	WC	d	224	93	Upington	NC	g	906	216
Colesberg	EC	g	144	58	Mookgophong	LIM	f	227	87	Vanderkloof	NC	g	18	15
Cradock	EC	g	296	111	Mtubatuba	KZN	g	362	116	Vanwyksvlei	NC	h	8	7
De Aar	NC	g	223	89	Murraysburg	WC	e	21	16	Venterstad	EC	e	18	14
Douglas	NC	g	127	70	Napier	WC	f	63	36	Victoria West	WC	a	74	43
Dullstroom	MP	d	101	44	Nieu-Bethesda	EC	e	21	9	Viljoenskroon	FS	f	131	72
Fauresmith	FS	g	22	15	Nieuwoudtville	NC	h	30	19	Vosburg	NC	a	16	14
Ficksburg	FS	g	299	105	Norvalspont	FS	e	8	6	Vredendal	WC	c	351	134
Fraserburg	NC	g	33	22	Orania	NC	g	28	23	Wakkerstroom	MP	d	30	20
Gansbaai	WC	c	254	91	Oudtshoorn	WC	f	897	186	Warrenton	NC	g	90	52
Gariepdam	FS	g	21	14	Parys	FS	h	532	152	Welkom	FS	f	1830	262
Garies	NC	g	26	16	Petrusville	NC	f	17	14	Williston	NC	a	26	21
Graaff-Reinet	EC	e	329	130	Phalaborwa	LIM	f	543	154	Willowmore	EC	e	49	25
Great Brak River	WC	f	148	71	Philippolis	FS	f	24	15	Winburg	FS	f	73	35
Greyton	WC	c	59	36	Philipstown	NC	f	15	13	Winterton	KZN	h	117	63
Griekwastad	NC	g	31	23	Phuthaditjhaba	FS	f	387	105	Yzerfontein	WC	c	52	29
Hanover	NC	g	22	13	Porterville	WC	c	93	52					

EC, Eastern Cape; FS, Free State; LIM, Limpopo; MP, Mpumalanga; NC, Northern Cape; NW, Northwest; WC, Western Cape.

†Year of telephone directory: a = 2000/2001; b = 2002/2003; c = 2004/2005; d = 2005/2006; e = 2006/2007; f = 2007/2008; g = 2008/2009; h = 2009/2010

For example, should (for whatever reason) the total number of enterprises of a town increase from 100 to 200, Equation 2 predicts that the enterprise richness will increase from 49 to 81, an increase of 32 types. Similarly, if a town degenerates and its total enterprises reduce from 200 to 100, the enterprise types present will decrease from 81 to 49 types. However, if a town's total enterprises rose from 200 to 300, the change in enterprise types would be from 81 to 108, a mere increase of 27 types (or vice versa). As towns get bigger, the enterprise richness grows at a slower rate than the total enterprises. In other words, the 'entrepreneurial space' for similar enterprise types increases, increasing the likelihood of heightened competition between peer group enterprises. The contrary is also true – if a town degenerates, it sheds entrepreneurial space and enterprises in a predictable fashion.

Close examination of Figure 1 indicates that at higher enterprise numbers the best-fit line does not fit the data very closely. Because smaller towns dominate the group of selected towns (Table 1), it is possible that their influence might have introduced a degree of spuriousness in the enterprise number–enterprise richness response of Figure 1. To test this possibility we divided the selected towns into two groups: Group 1 – small towns (88 towns with fewer than 115 enterprises per town) and, Group 2 – large towns (46 towns with 115 or more enterprises). The relationship between enterprise richness and the enterprise numbers of each of these groups was determined as described earlier and the results are presented in Figures 2 and 3.

Table 2: The business sectors used for determining the enterprise architectures of the selected towns

No.	Economic drivers
1	Agricultural Products & Services
2	Processors
3	Factories
4	Construction Services
5	Mining
6	Tourism & Hospitality Services
	Service sectors
7	Engineering & Technical Services
8	Financial Services
9	Legal Services
10	Telecommunications Services
11	News & Advertising Services
12	Trade Services
13	Vehicle Services
14	General Services
15	Professional Services
16	Personal Services
17	Health Services
18	Transport & Earthworks Services
19	Real Estate Services

The statistical relationships of the two groups, i.e.:

$$\text{Enterprise types in small town}_{ST} = 1.44\ (\text{number of enterprises in town}_{ST}^{0.7789}) \quad \text{Equation 3}$$

and

$$\text{Enterprise types in large town}_{LT} = 4.1293\ (\text{number of enterprises in town}_{LT}^{0.5661}) \quad \text{Equation 4}$$

were statistically highly significant ($p<0.01$) and in excess of 90% of the variance of both groups was explained.

To understand the differences among Equations 2, 3 and 4, we used the equations to predict the enterprise richness of towns of different sizes (Table 3). For lower enterprise numbers, the predictions of the 'all town' (Equation 2) and 'small town' (Equation 3) models were very similar. From 100 to 200 enterprises, the 'all town' model lagged behind the other two models but at higher values it exceeded the 'large town' model considerably. From about 200 enterprises, the 'small town' model started exceeding the 'large town' (Equation 4) model. Below 100 enterprises, the predictions of the 'large town' model exceeded those of the two other models. Taken together, it is clear that town size has some effect and it is advisable to use the small town model for predictions of the enterprise richness of towns with up to 150 enterprises. For predictions for towns with more than 150 enterprises, the 'large town' model should be used.

Table 3: Predictions of enterprise richness for towns with different enterprise numbers

	Derived from model		
Number of enterprises	All towns†	Small towns††	Large towns†††
10	9	**9**	15
50	30	**30**	38
100	49	**52**	56
150	66	**71**	**70**
200	81	89	**83**
300	108	122	**104**
1200	291	360	**229**
1800	389	494	**288**
2500	492	638	**346**

†From Equation 2; ††from Equation 3; †††from Equation 4

Numbers in bold indicate the recommended models for town size and number of enterprises.

Clusters of towns and enterprise richness

Although the small town data in Figure 2 clearly shows a strong relationship between enterprise numbers and enterprise types, it is also evident that there is quite a bit of data variation around the best-fit line. The earlier detection of so-called 'proportionality-in-proportionality' phenomena in the enterprise architectures of towns in arid and semi-arid South Africa[10] raised the question of whether the above variability could be a result of differences in the enterprise architectures of different groups of towns. The proportionality-in-proportionality term refers to a phenomenon in which a selection of South African towns exhibited an overall statistically significant correlation between town size (measured by the number of enterprises) and the number of enterprises in specific business sectors.[10] In these cases, specific regression coefficients defined the proportion of the total number of enterprises that sector enterprises constitute. Yet if the larger group was separated into sub-groups of towns with similar enterprise architectures, the above relationships were more clearly defined and distinct differences between the regression coefficients were observed. There was not only proportionality at an overhead level but also proportionality at lower levels; thus proportionality-in-proportionality.

To detect the possible presence of a proportionality-in-proportionality phenomenon in the overall enterprise numbers–enterprise richness relationship established here (Equation 2), the 134 towns were clustered on the basis of their enterprise architectures as described elsewhere.[5] Use was made of PRIMER v.6 software[20] and a complete linkage clustering strategy was used. Eight clusters (groups) with at least three member towns were identified at a correlation level of 0.55 (Figure 4 and Table 4). To identify differences between the clusters, the enterprise architecture of each cluster was calculated from the total enterprises for

Table 4: Towns in each of the clusters

Cluster 1	Cluster 2	Cluster 3			Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8
Brandvlei	Kenhardt	Aberdeen	Jan Kempdorp	Robertson	Ashton	Aliwal North	Albertinia	Augrabies	Barrydale
Britstown	Klipplaat	Allanridge	Kakamas	Sannieshof	Bethulie	Beaufort West	Gansbaai	Sutherland	Calitzdorp
Colesberg	Loxton	Barkly West	Kathu	Schweizer-Reneke	Bothaville	Bonnievale	Great Brak River	Vanwyksvlei	Clarens
Hanover	Vosburg	Bloemhof	Koffiefontein	Senekal	Brandfort	Calvinia	Kleinmond	Winterton	Dullstroom
Laingsburg		Boshof	Ladismith	Steynsburg	Bultfontein	Carnarvon	McGregor		Gariepdam
Richmond		Botshabelo	Ladybrand	Stutterheim	Christiana	Graaff-Reinet	Napier		Greyton
Vanderkloof		Bredasdorp	Lime Acres	Tarkastad	Clocolan	Griekwastad	Orania		Keimouth
		Burgersdorp	Loeriesfontein	Taung	Fauresmith	Komga	Stilbaai		Nieu-Bethesda
		Caledon	Lutzville	Thabazimbi	Fraserburg	Montagu	Struisbaai		Nieuwoudtville
		Cradock	Middelburg (EC)	Thohoyandou	Heidelberg	Mookgophong			Norvalspont
		De Aar	Mtubatuba	Upington	Hopetown	Oudtshoorn			Philippolis
		Douglas	Parys	Vredendal	Jansenville	Philipstown			Prince Albert
		Ficksburg	Phalaborwa	Warrenton	Keimoes	Rosendal			Wakkerstroom
		Garies	Phuthaditjhaba	Welkom	Luckhoff	Smithfield			Yzerfontein
		Hartswater	Porterville	Williston	Murraysburg	Springfontein			
		Jacobsdal	Prieska	Willowmore	Petrusville	Steytlerville			
		Jagersfontein	Riversdal	Winburg	Riviersonderend	Swellendam			
					Rouxville	Tulbagh			
					Trompsburg	Uniondale			
					Viljoenskroon	Venterstad			
						Victoria West			

each of the 19 business sectors expressed as a percentage of the total enterprises of each cluster (Table 5).

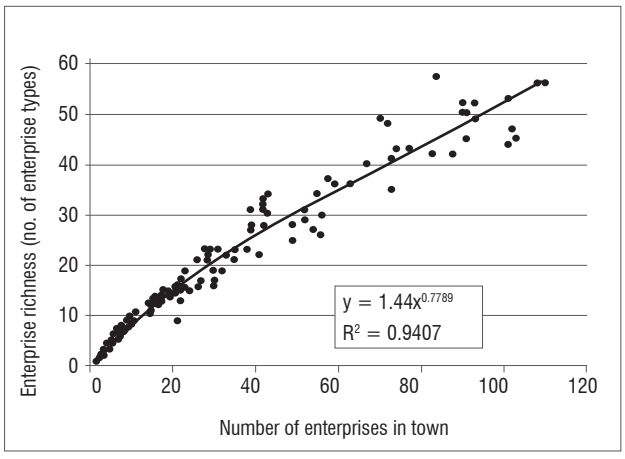

Figure 2: Enterprise richness as a function of the total enterprise numbers of 88 smaller (<115 enterprises per town) South African towns.

Each cluster received a designation based on the identity of towns clustered in it. 'Highway' towns (Cluster 1) are located on major routes and have strength in the tourism and hospitality, trade and vehicle services sectors. They differ from 'Tourism' towns (Cluster 5) mainly by way of a weaker construction sector but stronger tourism and hospitality and trade sectors. Three clusters have strength in the agricultural products and services sector. 'Small Agri' towns (Cluster 2) differ from 'Large Agri' towns (Cluster 4) and 'Agri Tourism' towns (Cluster 6) in terms of greater strength in the agricultural products and services and vehicle sectors. Large Agri towns are weaker in the agricultural products and services sector and in the tourism and hospitality sector, but have strength in the financial services, trade and vehicle sectors. Agri Tourism towns (Cluster 7) are strong in agricultural products and services and the tourism and hospitality sectors, but weaker in the trade, financial services and vehicle services sectors. Cluster 3 contains a large group of towns that are weak in the agricultural products and services sector, strong in the trade sector and have mostly well-balanced enterprise architectures – they are called 'Trade' towns. Cluster 8 towns are exceptionally strong in the tourism and hospitality sector as well as the real estate services sector but weaker in the trade sector; they are called 'Gentry' towns because gentrification is a significant factor in these towns (e.g. Clarens[21] and Prince Albert[22]).

The clusters differed greatly in their enterprise architectures (Table 5). As a consequence, the clusters met the requirement that different groups of towns could be used to test for proportionality-in-proportionality phenomena in enterprise number–enterprise richness relationships. These relationships and other characteristics were determined for each cluster through the use of Microsoft Excel (Table 6).

Table 5: The enterprise architecture (percentage composition) of Clusters 1 to 8. The top three sectors for each cluster (four in the case of Cluster 4) are shown in bold.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8
Agricultural Products & Services	6.9	**25.4**	4.9	**16.6**	4.9	1.5	**17.9**	4.6
Processing Plants	1.3	0.0	1.5	2.8	2.8	2.5	5.0	3.6
Factories	0.0	0.0	0.8	0.6	0.5	1.7	1.0	0.4
Construction	0.9	0.0	5.5	2.5	6.3	**12.2**	4.0	2.9
Mining	0.3	3.0	1.4	0.2	0.2	0.2	0.0	0.6
Tourism & Hospitality	**26.0**	9.0	**7.7**	6.0	**15.8**	**17.5**	**25.9**	**36.6**
Engineering & Technical Services	2.2	1.5	3.4	1.9	1.9	1.3	1.0	0.1
Financial Services	7.2	6.0	7.6	**9.2**	7.3	3.9	4.0	3.6
Legal Services	1.6	1.5	2.0	2.3	2.0	2.1	1.5	1.3
Telecommunications	0.6	4.5	1.1	0.3	0.7	0.6	0.0	0.3
News & Advertising	0.0	0.0	0.2	0.1	0.2	0.5	0.0	0.4
Trade	**20.7**	**17.9**	**27.2**	**26.2**	**25.0**	**23.1**	**18.9**	**20.1**
Vehicle industry	**12.9**	**10.4**	**9.2**	**9.2**	**7.7**	4.1	3.0	2.1
General Services	3.8	3.0	6.0	3.7	5.2	5.1	4.0	3.1
Professional Services	1.3	1.5	3.5	1.7	2.6	1.8	3.0	4.0
Personal Services	7.2	6.0	6.6	7.0	6.4	7.7	2.5	3.7
Health Services	4.7	7.5	7.1	5.6	5.9	4.5	2.0	4.9
Transport & Earthworks	1.3	1.5	2.4	2.4	2.1	2.1	2.0	1.7
Real Estate	1.3	1.5	1.8	1.7	2.6	7.6	4.5	**6.0**
Total	100	100	100	100	100	100	100	100
Designation	Highway	Small Agri	Trade	Large Agri	Tourism	Second Home	Agri Tourism	Gentry

Table 6: Cluster relationships between enterprise richness and enterprise numbers and other characteristics

Characteristic	Cluster							
	1	2	3	4	5	6	7	8
Model: y =	$1.667x^{.7105}$	$1.317x^{0.8353}$	$2.681x^{0.6436}$	$1.631x^{0.7486}$	$2.063x^{0.6891}$	$1.94x^{0.7077}$	$1.227x^{0.8084}$	$1.068x^{0.8178}$
Correlation	0.98	0.98	0.98	0.99	1.00	0.99	1.00	0.98
Variance explained (%)	96.7	96.5	96.1	97.4	99.0	97.7	98.9	95.2
No. in cluster	7	4	51	20	21	9	4	14
Enterprises in smallest town	18	7	22	16	11	28	8	8
Enterprises in largest town	144	29	1830	241	897	254	117	126
Median no. of enterprises	27	15.5	127	68.5	74	103	38	41

With the exception of Cluster 2, which has only small towns, all clusters contained a range of different-sized towns (Table 6). The composition of the enterprise architectures (Table 5) rather than the magnitude of enterprise development in towns defined specific clusters of towns. The statistical significance of the relationships between enterprise numbers and enterprise richness of the different clusters was highly significant in all cases and in no case was less than 95% of the variance explained. Figure 5 shows the enterprise number–enterprise richness relationship of Cluster 4 as a visual example of the goodness of fit obtained when cluster-level analyses were done. There is clearly some proportionality-in-proportionality within the enterprise number–enterprise richness relationship of the 134 towns (Equation 2), which could be discerned by examination at cluster level.

To test if the proportionality-in-proportionality phenomenon would introduce distortions that would have to be considered, the predictive powers of the cluster equations were examined by comparing predictions for a range of town sizes (expressed as the total number of enterprises in towns) and what was limited to the range of town sizes included in each cluster (Table 7). This exercise showed that the predictions stemming from the different cluster equations did not differ by much, particularly for larger towns (see Clusters 3 and 5 in Table 7). The relationship between enterprise richness and total enterprise number seems to hold for whatever group of towns is considered and seems to represent a general property of the enterprise dynamics of South African towns. Although there are subtle differences between clusters, at this time, Equations 3 and 4 should rather be used for predictive purposes.

Discussion and conclusions

There clearly is a quantitative link among the factors that control the growth or decline of towns, the total number of enterprises and enterprise richness. On the basis of the results presented, the hypothesis that the relative abundance of enterprises (= enterprise richness) in South African towns offers no or little potential to serve as a potential indicator of business well-being of towns can be rejected. Enterprise richness is

Table 7: Predictions of enterprise richness of the different town clusters at different enterprise numbers (predictions are limited to being close to the minimum and maximum enterprise numbers recorded in any town of a cluster)

No. of enterprises	Enterprise richness (no. of enterprise types)							
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8
10		9		9	10		8	7
40	23	29	29	26	26	26	24	22
80	38		45	43	42	43	42	38
120	50		58	59	56	57	59	54
200			81	86	79	82		
300			105		105			
900			214		224			
1500			297					
2000			357					

one of the tools that may be useful in assessing the economic health of towns.

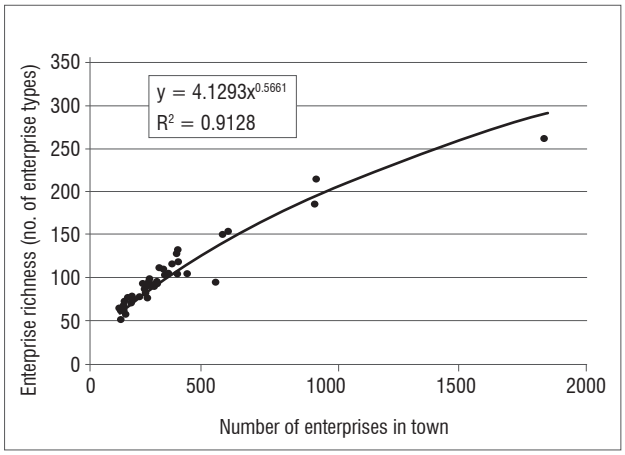

Figure 3: Enterprise richness as a function of the total enterprise numbers of 46 larger (>115 enterprises per town) South African towns.

The fact that the enterprise richness of South African towns increases with increased town size is not unexpected and could be inferred from earlier studies of South African towns.[23,24] In the 1960s and 1970s, the fashion (largely driven by a belief in central place theory[23]) was to construct town classification hierarchies based on the levels of services provided. For instance, Davies and Cook[24] identified eight different orders among 601 settlements in South Africa. However, Figures 1 to 3 and Figure 5 indicate that the increase in enterprise richness, and hence the level of business services provided in South African towns, is a continuous rather than a stepwise phenomenon (which the hierarchy approach of Davies and Cook seemed to infer). Our results caution against simply categorising towns on the basis of service levels.

Toerien and Seaman[25] applied systems thinking to enterprise dynamics in South African towns. They provided proof that the gross domestic products (GDPs) of towns drive the available money, which drives the number of people in the towns, which drives the total number of enterprises in the towns. Toerien and Seaman[8] showed that there are strong proportionalities between the total number of enterprises and the enterprise numbers of a wide range of business sectors in South African towns. This study now adds the fact that the enterprise richness of towns is distinctly and quantitatively linked to the total number of enterprises, which increases our predictive capabilities. The underlying reasons for the observed regularities in the numbers of enterprise types in South African towns are still obscure and deserve further research.

To illustrate the potential value of our results we turn to the burning issue of the potential use of hydraulic fracturing ('fracking') of shales in the Karoo for the exploitation of shale gas.[26] The potential benefits or detriments of such exploitation are being strongly debated,[27] but without any indication of what Karoo towns may gain or lose in terms of enterprise development. Toerien and Seaman[25] quantified some of the expected impacts and Table 3 provides further guidance. For instance, should fracking activities in the vicinity of a Karoo town with 100 existing enterprises result in an increase of 50 new enterprises, the enterprise richness would increase by 19 additional enterprise types. In other words, 31 of the new enterprises would enter business sectors that are already served by one or more existing enterprises. In addition to expanding the business services in the town there would be increased business competition in some business sectors. However, should pollution of groundwater as a result of fracking activities result in a loss of economic activities and 50 enterprises from a town of 150 enterprises, the contrary picture would emerge. Apart from 50 enterprises, 19 enterprise types would disappear, probably to the detriment of the residents. This predictive capability should be factored into considerations of the application of fracking in South Africa.

What views have guided the thinking about the developmental roles of small towns? In 1950 to 1970, small towns were seen as centres for innovation and modernisation in rural areas.[28] The concept of 'urban functions in rural development' suggested that a rational rural spatial strategy is to develop a well-articulated, integrated and balanced urban hierarchy.[29] Rural development would be promoted by locating more service supply points for a variety of services, agricultural inputs and consumer goods to the rural areas.[29] However, this approach was criticised on the grounds that low rural consumption is caused by social inequality and low incomes rather than by access difficulties.[30] Southall[31] suggested that small towns contribute to rural impoverishment in Africa because they are 'vanguards of exploitation' of the rural poor by external forces which, depending on the case, may be colonial powers, multinational enterprises, central national government, local administrators and élites and, in some cases, international donors. However, Hardoy and Satterthwaite[30] cautioned against universal generalisations and prescriptions and suggested that attention should be given to the social dimensions of small towns including the complexity of social networks, kinship and family ties. Later Hinderink and Titus[1] also challenged optimistic assumptions about the developmental role of small towns. They suggested that the divergent character of different contexts and differential impacts of regional conditions made generalisations about the role of small towns difficult.

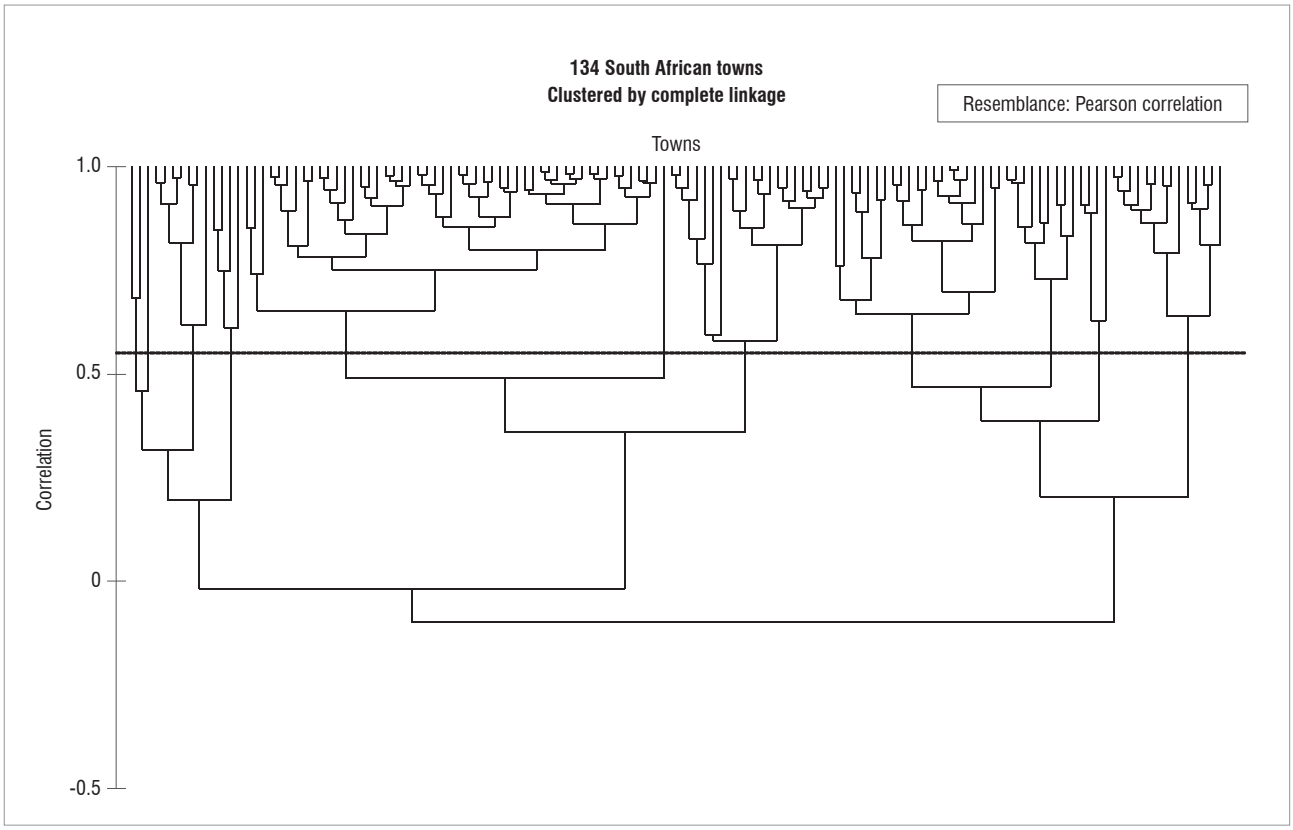

Figure 4: The enterprise architecture similarity dendrogram of 134 South African towns. Clusters 1 to 8 with four or more towns per cluster are identified at a correlation coefficient level of 0.55.

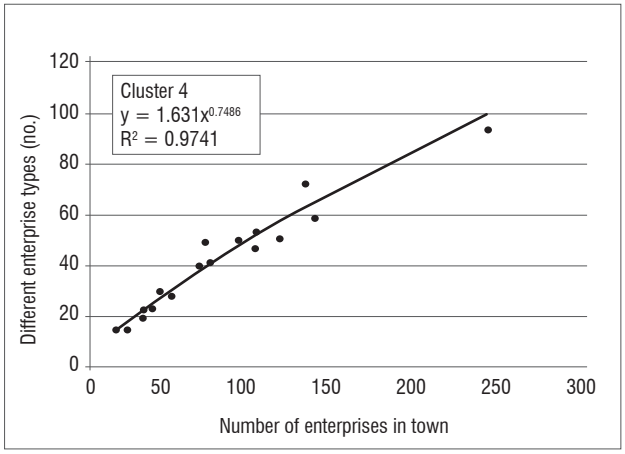

Figure 5: Enterprise richness as a function of the total enterprise numbers of Cluster 4 towns, illustrating the closeness of fit of cluster data.

Two core themes in modern literature are relevant in small town development dynamics in South Africa: locality-based development and post-productivism.[3] The former has its roots in locality theory and endogenous development theory and indicates that local resources, human assets and partnerships are important. This theme contributed to an emphasis on local economic development strategies.[3] This study raises questions about certain assumptions that seem to permeate thinking about local economic development, namely that training of entrepreneurs and promotion of entrepreneurship could solve many developmental problems. Our results emphasise the systemic nature of business development. The degree to which economic value is added through products and services that have a distinct external market is the foremost limiting factor. Entrepreneurial spaces have limits, and unless these limits are expanded, little success will be achieved. To paraphrase a comment made[25]: you cannot expect champagne outcomes from beer systems. The right leverage points must be sought to achieve success and the quantified insights developed here might be helpful tools in this regard.

The declining role of agriculture in South Africa as shown by a decline in the number of farmers and agricultural workers has contributed to an erosion of traditional livelihoods and the displacement of thousands of people.[3] A rise in post-productivist activities in rural South Africa such as the development of farm tourism, game farming and production of products for niche markets (e.g. olive products) have helped to bridge the decline of traditional agriculture[3] – a conclusion which is supported by the results presented in Table 5. Nevertheless, the dynamics of enterprise richness of South African towns remain overall the same irrespective of whether towns are productivist or post-productivist (Table 7). The usefulness of the application of the post-productivist label to South African towns needs further elucidation.

A question was posed about enterprise richness in and the stability of South African towns. The fact that enterprise richness is a function of all town clusters identified and that small and large towns clustered together (Table 7), suggests that fewer enterprise types do not necessarily indicate the potential for greater instability. The stability question needs further investigation, perhaps by a greater focus on the functional diversity of enterprises in South African towns.

Acknowledgements

The financial support of the Centre for Environmental Management, University of the Free State, the help of Marie Watson with the use of PRIMER, help by Falko Buschke, the library support of Annamarie du Preez and Estie Pretorius, and the analytical support of Marie Toerien are gratefully acknowledged.

Authors' contributions

D.F.T. was responsible for the conceptualisation of the study, the analyses of the enterprise diversity, the interpretation of the results and the write-up. M.T.S. refined some concepts and provided advice on ecological aspects of diversity.

References

1. Hinderink J, Titus M. Small towns and regional development: Major findings and policy implications from comparative research. Urban Stud. 2002;39(3):379–391. http://dx.doi.org/10.1080/00420980220112748
2. Donaldson R, Marais L. Preface: Small town geographies. In: Donaldson R, Marais L, editors. Small town geographies in Africa: Experiences from South Africa and elsewhere. New York: Nova Science Publishers; 2012. p. ix–xviii.
3. Hoogedoorn G, Nel E. Exploring small town development dynamics in rural South Africa's post-productivist landscapes. In: Donaldson R, Marais L, editors. Small town geographies in Africa: Experiences from South Africa and elsewhere. New York: Nova Science Publishers; 2012. p. 21–34.
4. Beinhocker ED. The origin of wealth: Evolution, complexity, and the radical remaking of economics. Boston, MA: Harvard Business School Press; 2006.
5. Toerien DF, Seaman MT. The enterprise ecology of towns in the Karoo, South Africa. S Afr J Sci. 2010;106(5/6):24–33. http://dx.doi.org/10.4102/sajs.v106i5/6.182
6. MacArthur RRH, Wilson EO. The theory of island biogeography. Princeton: Princeton University Press; 1967.
7. Toerien DF, Seaman MT. Evidence of island effects in South African enterprise ecosystems. In: Mahamane A, editor. The functioning of ecosystems. Rijeka: Intech; 2012. p. 229–248. http://dx.doi.org/10.5772/36641
8. Toerien DF, Seaman MT. Proportionality in enterprise development of South African towns. S Afr J Sci. 2012;108(5/6):38–47. http://dx.doi.org/10.4102/sajs.v108i5/6.588
9. Toerien DF, Seaman MT. Regional order in the enterprise structures of selected Eastern Cape Karoo towns. S Afr Geogr J. 2012;94(2):1–15. http://dx.doi.org/10.1080/03736245.2012.742782
10. Toerien DF. Enterprise proportionalities in the tourism sector of South African towns. In: Kasimoglu M, editor. Visions of global tourism industry: Creating and sustaining competitive strategies. Rijeka: Intech; 2012. p. 113–138.
11. Tilman D. The ecological consequences of changes in biodiversity: A search for general principles. Ecology. 1999;80(5):1455–1474.
12. Magurran A. Ecological diversity and its measurement. London: Crown Helm; 1988. http://dx.doi.org/10.1007/978-94-015-7358-0
13. Colwell RK. Biodiversity: Concepts, patterns and measurement. In: Levin SA, editor. The Princeton guide to ecology. Princeton: Princeton University Press; 2009. p. 257–263.
14. Spellberg IF, Fedor PJ. A tribute to Claude Shannon (1916–2001) and a plea for more rigorous use of species richness, species diversity and the 'Shannon–Wiener' Index. Global Ecol Biogeogr. 2003;12:177–179. http://dx.doi.org/10.1046/j.1466-822X.2003.00015.x
15. Petchey OL, Gaston KJ. Functional diversity (FD), species richness and community composition. Ecol Lett. 2002;5(3):402–411. http://dx.doi.org/10.1046/j.1461-0248.2002.00339.x
16. Toerien DF, Seaman MT. Ecology, water and enterprise development in selected rural South African towns. Water SA. 2011;37(1):47–56. http://dx.doi.org/10.4314/wsa.v37i1.64106
17. Elton CS. The ecology of invasions by animals and plants. London: Methuen; 1958.
18. May RM. Will a large complex system be stable? Nature. 1972;238(5364):413–414. http://dx.doi.org/10.1038/238413a0
19. McNaughton SJ. Diversity and stability of ecological communities: A comment on the role of empiricism in ecology. Am Nat. 1977;111(979):515–525. http://dx.doi.org/10.1086/283181
20. Clarke KR, Gorley RN. Primer v6: User manual/tutorial. Plymouth: Primer-E Ltd; 2006.
21. Marais L. From small town to tourism Mecca: The Clarens fairy tale. In: Rogerson C, Visser G, editors. Tourism and development issues in contemporary South Africa. Pretoria: Africa Institute of Southern Africa; 2004. p. 420–435.
22. Toerien D. Prince Albert: A fourth economic bubble or sustainable development? In: Donaldson R, Marais L, editors. Small town geographies in Africa: Experiences from South Africa and elsewhere. New York: Nova Science Publishers; 2012. p. 143–162.
23. Van der Merwe IJ, Nel A. Die stad en sy omgewing: 'n Studie in nedersettingsgeografie [The city and its surroundings: A study in settlement geography]. Stellenbosch/Grahamstown: Universiteits-uitgewers en Boek-handelaars; 1975. Afrikaans.
24. Davies RJ, Cook GP. Reappraisal of the South African urban hierarchy. S Afr Geogr J. 1968;50:117–132. http://dx.doi.org/10.1080/03736245.1968.10559439
25. Toerien DF, Seaman MT. Paradoxes, the tyranny of structures and enterprise development in South African towns. Presented at: Strategies to Overcome Poverty and Inequality: Towards Carnegie3; 2012 Sep 3–7; Cape Town, South Africa.
26. De Wit MJ. The great shale debate in the Karoo. S Afr J Sci. 2011;107(7/8), Art. #791, 9 pages. http://dx.doi.org/10.4102/sajs.v107i7/8.791
27. Treasure Karoo Action Group [homepage on the Internet]. No date [cited 2013 Dec 24]. Available from: http://treasurethekaroo.co.za/
28. Tacoli C. Rural-urban interactions: A guide to the literature. Environ Urban. 1998;10(1):147–166. http://dx.doi.org/10.1177/095624789801000105
29. Rondinelli D, Ruddle K. Urbanization and rural development: A spatial policy for equitable growth. New York: Praeger; 1978.
30. Hardoy JE, Satterthwaite D. Small and intermediate urban centres: Their role in regional and national development in the Third World. London: Hodder and Stoughton; 1986.
31. Southall A. Small towns in Africa revisited. Afr Stud Rev. 1988;31(3):379–391.