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Advances in Spatial Analysis to Support a more Nuanced Reading of the South African Space Economy

Elsona van Huyssteen · Sharon Biermann · Andries Naudé · Alize le Roux

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Abstract This paper illustrates how advances in spatial analysis contribute not only to an enhanced understanding of the complex dynamics of social and economic spatial patterns, but also to exploring the implications thereof for development policies. The paper reflects on a set of incremental advances in spatial analysis achieved recently in South Africa, illustrating the value to a project undertaken to inform national urban policy development. The unique challenge of the project was to conduct a more nuanced, national level spatial analysis, moving beyond administrative boundaries, to enable the identifying, describing, and comparing of a range of settlement types in South Africa in terms of key characteristics and functional roles. The paper illustrates how recent advances in spatial analysis have enabled identifying and defining the wide range of densely settled clusters, local towns and service centers, regional service centers, cities, and bigger city-region areas, all forming part of a polycentric network (or backbone) of towns and cities. In conclusion, it is argued that advances in spatially nuanced and relational analysis are not only invaluable in generating a more nuanced understanding of the space economy, but also in enabling commensurate and context-specific investment and policy responses, contributing to development and urban management discourses.

Introduction and Purpose

The importance of a spatial dimension in the planning objective of achieving aligned and coordinated decision-making regarding infrastructure investment and development spending has been stressed both internationally (Faludi 2003a,b; Harris and Hooper 2004; Healy 2004) and locally (Harrison 2002; Oranje and Van Huyssteen

E. van Huyssteen (✉) · S. Biermann · A. le Roux
CSIR, Built Environment, Planning Support Systems, Pretoria, South Africa
e-mail: EvHuyssteen@csir.co.za

A. Naudé
CSIR, Built Environment, Planning Support Systems, Stellenbosch, South Africa

E. van Huyssteen
Department of Town and Regional Planning, University of Pretoria, Pretoria, South Africa

2007). Incorporating a consideration of space into the resource allocation decision-making process requires rigorous spatial analysis in support of obtaining a shared understanding of inter-regional, inter-scalar, and inter-sectoral patterns and dynamics (Naudé et al. 2008b). While spatial planning is re-emerging in the integrated planning landscape of South Africa after a hiatus following the 1994 political change (Watson 2002; GTZ 2002), it has been widely acknowledged that spatial planning initiatives conducted at national, provincial, and local levels have often been inadequate in terms of, among other factors, informing spatial analyses (Meiklejohn and Coetzee 2003; Republic of South Africa 2006a; Oranje and van Huyssteen 2007). It has also been suggested that spatial planning in South Africa requires a stronger engagement with and understanding of the complex dynamics of social and economic spatial patterns (Mohamed 2006; Pillay 2008; Republic of South Africa 2005; Todes 2008).

In response to this call, a number of significant advances have been made in the spatial analysis environment in South Africa. These advances have evolved largely along two axes, namely:

- improving the *granularity of analysis* which has enabled much more nuanced and detailed comparable spatial analysis. This has been achieved mainly through the development of a set of mesozone units of analysis [mesoframe[1]; Council for Scientific and Industrial Research (CSIR) 2006; Naudé et al. 2008c] and microzones (developed for more rural applications) for South Africa (Maritz et al. 2008; CSIR 2006); and,
- enhancing the ability to conduct *relational spatial analysis*, through innovations in linking the mesoframe with the road and transport network. This "relational" view of space is in line with international calls to move from the treatment of space predominantly as "absolute" to include a more "relational" handling of space (Harris and Hooper 2004; Brand and Gaffikin 2007).

The South African policy and planning environment has, in more recent years, been characterized by a renewed focus on the need for aligned, collaborative, as well as spatially coordinated and targeted investment. In order to contribute toward enhanced quality of life and sustainable development, and for government to achieve the development objectives set in this regard in South Africa, various policy and planning initiatives such as the National Spatial Development Perspective (NSDP) (Republic of South Africa 2006a), the Draft Regional Industrial Strategy (RIDS; Republic of South Africa 2006b), numerous provincial development strategies and perspectives and a plethora of regional and municipal Integrated Development Plans, have called for and indeed started to incorporate, some of the aforementioned innovations in nuanced and relational spatial analysis. Advances in increased granularity as well as in relational spatial analysis have already made significant contributions within the South African policy and planning arena, following a renewed impetus in their development since 2005 (Naudé et al. 2008c). The analysis undertaken as part of the revised NSDP was considerably enhanced through the use

[1] These advances and terms such as *mesoframe* are explained in more detail in the background section of the paper.

of the mesoframe and thus allowed for a more refined granularity in the depiction of the patterns of need and economic potential, enabling analysis beyond mere administrative boundaries[2]. Spatial relational analysis advances have also been taken further in the development of a functional typology of spaces (by combining mesozones with a movement network), as part of an initiative to develop a science-based platform for enhanced integrated planning, called the Toolkit for Integrated Planning (Republic of South Africa 2008).

This paper is intended to describe and illustrate the nature and value of advances in spatial analysis, with a specific focus on the more recent incremental advances in spatial analysis as necessitated by the unique requirements of a specific project undertaken to inform the development of the Draft National Urban Development Framework[3]. The challenge in this National Spatial Trends Overview project was to conduct an analysis—not only by moving beyond administrative/municipal or regional analysis—but also by *identifying*, *comparing*, and *describing* the range of settlements in South Africa in terms of key characteristics and functional roles (South African Cities Network et al 2008).

This not only contributed toward identifying critical areas to be targeted in planning and policy development but also in raising questions and challenging perceptions around traditional definitions of particular spaces, such as the "urban–rural" divide and commensurate urban management responses.

In order to achieve the above aims, the paper is structured to:

- provide a brief background of (1) the need for enhanced spatial analysis; and (2) the consequential development of the South African geospatial analysis platform and range of innovative associated spatial relational tools over the last decade;
- introduce the project specific challenges and need for conducting an even more nuanced analysis of spatial trends and challenges at a settlement specific level in the country;
- explain how the existing platform has been utilized and which methodologies have been employed in order to identify, describe, and compare the range of settlements in the country within the project context;
- illustrate the value of the above by providing a brief overview of project findings, especially relating to the description and enhanced understanding of the functional character and role of the range of settlements (ranging from city-region areas to small towns and dispersed rural settlements); and
- in conclusion, reflect on the value of such spatially nuanced and functional analysis for practice, policy, and research purposes.

This is a descriptive paper, largely based on the authors' experiences and reflections emanating from their involvement not only in the recent National Spatial Trends Overview Project, but also in the continuous development of a platform of more nuanced spatial analysis data and tools.

[2] See the description of GAP2 in the next section.

[3] Analysis conducted by CSIR, Built Environment in collaboration with Econrise, HSRC and the African Centre for Cities (ACC) for the South African Cities Network (SACN), Department of Provincial and Local Government (DPLG), and The Presidency.

Background to the South African Geo-spatial Analysis Platform and Associated Spatial Relational Tools

The purpose of this section is to (1) provide an indication of some of the needs for enhanced and more widely used spatial analysis as identified internationally, and often echoed even more acutely in developing countries; and (2) briefly describe the platform and range of tools that have been developed in response to these needs in South Africa over the last 5 years, enabling further and more nuanced spatial analysis.

The Need for Enhanced and more Widely used Spatial Analysis

Challenges of data availability and comparability, increased calls for integrated planning by government, and the need to collate and present socioeconomic and demographic data not only on the basis of administrative boundaries, have resulted in an increasing demand for more detailed mapping in South Africa.

Despite the increasing availability of GIS and other data relating to settlement patterns and trends together with advances in technology such as online mapping services, the required statistical, analytical, and planning support capabilities seem generally still poorly developed and used (particularly in so-called developing countries). One of the reasons is that official development indicators and the usual portrayal of these via GIS-generated thematic maps tend to portray the geography of development and need in terms of an absolute, "container" view of space (Couclelis 1991)—where maps typically merely reflect information per administrative or other area, regardless of differences in area sizes, character, or population densities and merely because these areas are the units/"containers" in terms of which the data was gathered. Reliance on container statistics is typically associated with the tendency to use these for the planning and management of subnational territories as if these territories are isolated, internally homogenous "islands," with little regard for cross-border functional areas or influences. Such an approach, however, downplays the existence of:

- important cross-boundary effects, including potentially accessible "cross-border" jobs, services, and other livelihood resources (i.e., what might exist in the next ward or municipality); and
- internal heterogeneity—such as "structurally different" types of local environments or dissimilar local pockets (for example a very poor neighborhood surrounded by fairly affluent, well-served areas).

There are obviously also a number of other general shortcomings of conventional approaches to the profiling and analysis of settlement systems. Some of the other most frequent lamentations in the literature on settlement systems and, in particular, rural–urban classifications is the outdated and ongoing use (by the UN and most national statistical agencies) of overly simplified urban–rural dichotomies and indicators (Champion and Hugo 2004) thus disregarding: (1) the existence of intermediate zones described for example as peri-urban, semi-urban, or ex-urban (Brown and Cromartie 2004); and (2) the wide variety of "structurally different" urban and rural settlement types.

Related to this, another general complaint is that most official statistics on urban populations are based on counts within administrative boundaries rather than on the boundaries of built-up areas and/or functionally linked peri-urban zones (Champion and Hugo 2004; Hugo et al. 2003; Coombes 2004). Predictably, this has led to many proposals, work, and discussions about more appropriate spatial analysis units as well as methods to convert and integrate data in terms of common or specifically customized analysis units.

Over the past 5 years, significant progress has been made in the South African context to meet these gaps and demands through the development of a platform of spatial planning data and relational analysis tools.

Innovations in Refined Granularity and Relational Spatial Analysis: the Geospatial Analysis Platform and other Recent Advances made in South Africa

Innovations in terms of the platform for spatial planning data and analysis tools have largely been developed by the CSIR in support of comparative and collaborative socioeconomic analysis in collaboration with The Presidency, Department of Trade and Industry (DTI), Department of Provincial and Local Government (DPLG), the Development Bank of South Africa (DBSA), and GTZ. The outcomes hereof have largely been packaged for utilization in planning practice in the form of a Geo-Spatial Analysis Platform in 2006 (GAP1) and 2007 (GAP2).

The Geo-Spatial Analysis Platform (GAP)[4] can be described as a common, meso-scale geospatial platform, developed for the assembly, analysis, and sharing of strategic geospatial information. In very simple terms, this can be translated as providing spatially nuanced information about (a) what is where? (b) how much is where? (c) where are the main concentrations/hot spots to be targeted? and (d) what can be reached from where? (Naudé et al 2007).

The three main components of GAP are illustrated in Fig. 1. The primary component of GAP is the meso-scale "geoframe" for South Africa (SA Mesoframe)—a demarcation of South Africa into a "grid" of more than 25,000 "mesozones," each approximately 50 km^2. These mesozones have been defined in such a way that they are nested within municipalities (administrative boundaries) and other significant geo-economic and historical area demarcations (such as the former Bantustan boundaries) and that the zone boundaries correspond with major travel barriers (such as rivers) as well as with "break lines" between sparsely populated areas, and areas with medium to high levels of human activity (Naudé et al 2007).

The mesozones are also linked to each other via the strategic national road network and to a geo-referenced dataset of South Africa's towns and villages, forming the second main component. This can be used to:

- estimate quantities of economic and other human activities within specified distance or travel time ranges; and,
- calculate a range of accessibility and related measures (including "functional urban accessibility measures" based on measured distances or travel times to the nearest town of a specified hierarchical order).

[4] For a detailed technical overview of the development of the Geospatial Analysis Platform for South Africa see Maritz et al. 2008; Naudé et al 2007 and CSIR 2006.

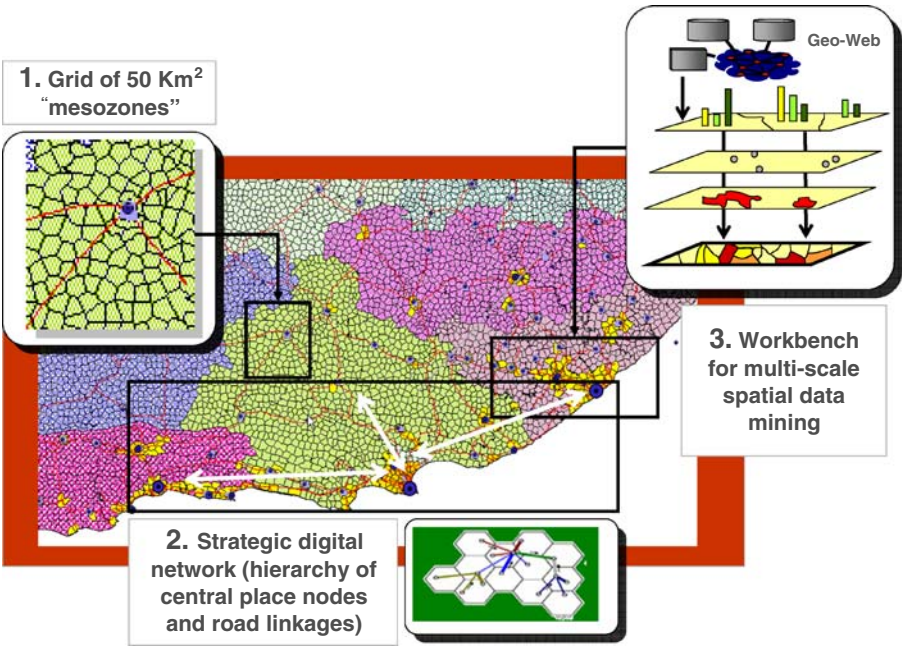

Fig. 1 The three main components of the SA GAP (Source: GAP2 (CSIR 2006))

The third main component of GAP is a multiscale spatial data mining workbench, used principally to disaggregate *large area data* and assemble this together with *small area*, *field*, *and point data* (e.g., town data).

The main national sphere applications have been a series of spatial profiles developed for the 2006 update of the National Spatial Development Perspective (NSDP) (Republic of South Africa 2006a) and the draft Regional Industrial Development Strategy (RIDS) (Republic of South Africa 2006b). An example of the improved granularity that has been achieved is illustrated in Fig. 2. This map shows the spatial distribution of economic activity, developed specifically in response to a widely felt need to improve the mapping of South Africa's spatial economy.

An example of relational spatial analyses, made possible as GAP contains a digital road network and a new geo-referenced dataset of South Africa's towns, is the analysis of urban accessibility/remoteness—compiled by calculating the weighted travel time from all places (i.e., each of the 25,000 mesozones) to the nearest village, small town, medium-sized town, large town, and metropolitan area (see Fig. 3).

Applications within regional and local economic development and integrated development planning have also been refined and explored further in the NSDP District Application Project (Naudé et al 2008c), as well as with the Department of Science and Technology (DST) in the Toolkit for Integrated Planning (TIP).

As part of this process and among a range of innovative outcomes, a "Functional Urban and Rural Typology" was developed. In itself, the spatial analysis culminating in the "Functional Urban and Rural Typology" already exhibited advances in terms of its relational approach (see Naudé et al. 2008a; Republic of South Africa 2008). Rather than the simple classification of spaces into either urban or rural as is the case with

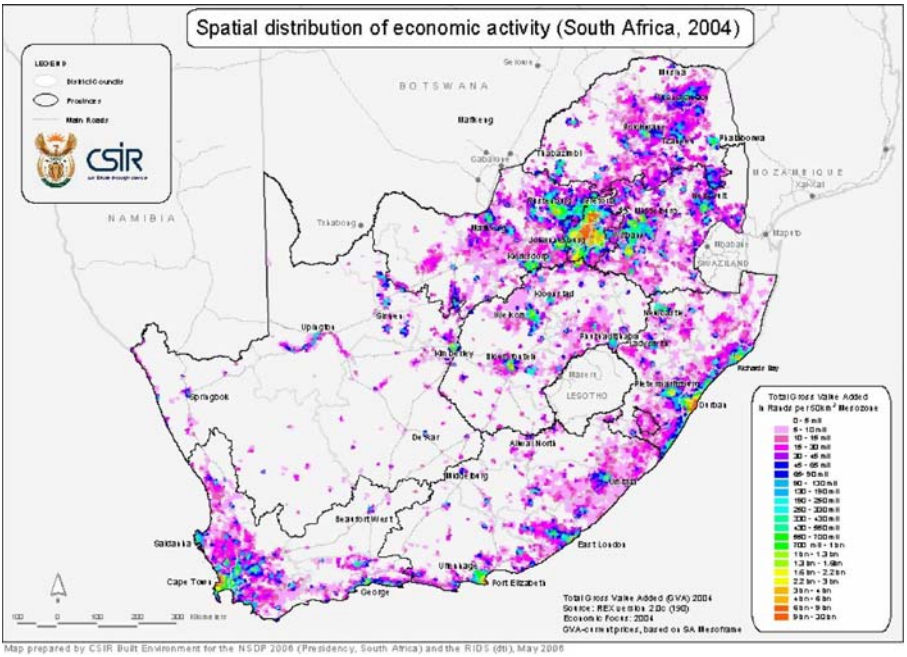

Fig. 2 Spatial distribution of economic activity for South Africa, 2004 (Republic of South Africa 2006b)

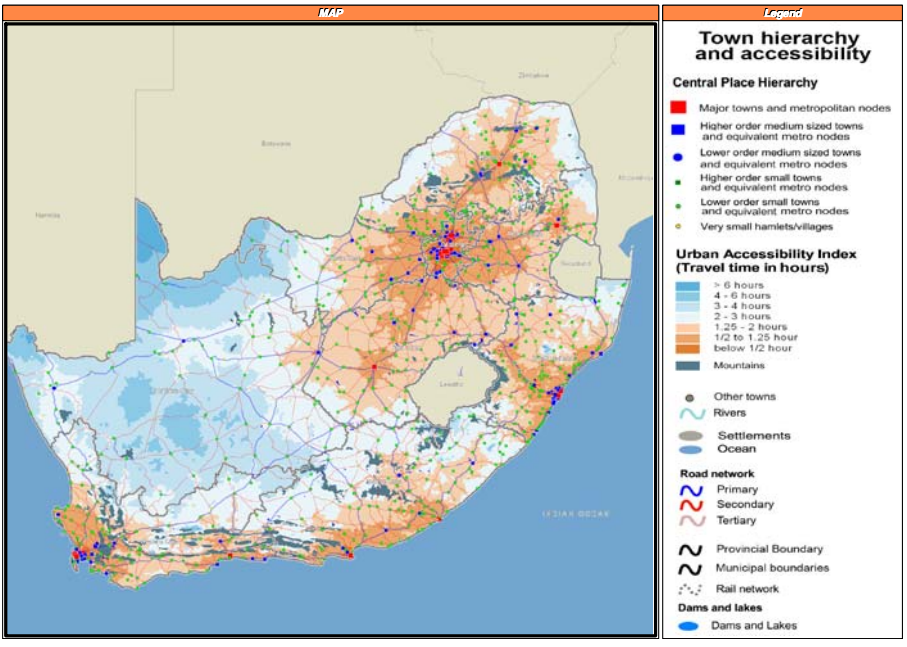

Fig. 3 Relative accessibility or remoteness in terms of a weighted sum of travel times to each tier in the national central place hierarchy (Source: GAP2—CSIR 2006)

national census statistics, this "Functional Urban and Rural Typology" classifies a continuum of space types ranging from functional urban nodes and long distance commuter areas to rural nodes and clusters and sparse rural production areas. The classification was based on a relational analysis of accessibility, including access to different levels of urban functionality, access to livelihood opportunities, markets and jobs, and even took into account relations with areas characterized by high levels of subsidized commuter transport (Republic of South Africa 2008). To ensure a continuous classification of space across the whole country, topographical, land cover, and conservation information was also included in the classification (See Fig. 4, as well as Naudé et al. 2008a).

The "National Spatial Trends Overview": Project Challenges and Demands for More Nuanced Spatial Analysis

In spite of widely acknowledged progress made in the development arena over the last 15 years, South Africa is still facing enormous challenges in terms of job creation, shared and inclusive growth, poverty alleviation, increased quality of life, and sustainable development. Within this context, the importance of aspects such as regional policy approaches, coordinated and planned action within a particular geographical space, the role of cities and regions as drivers of economic competitiveness and inclusion, as well as social equity and the potential impact of ongoing urbanization, is self evident (Republic of South Africa 2006a). Against this background, the South African government embarked on a process to develop a Draft National Urban Development Framework.

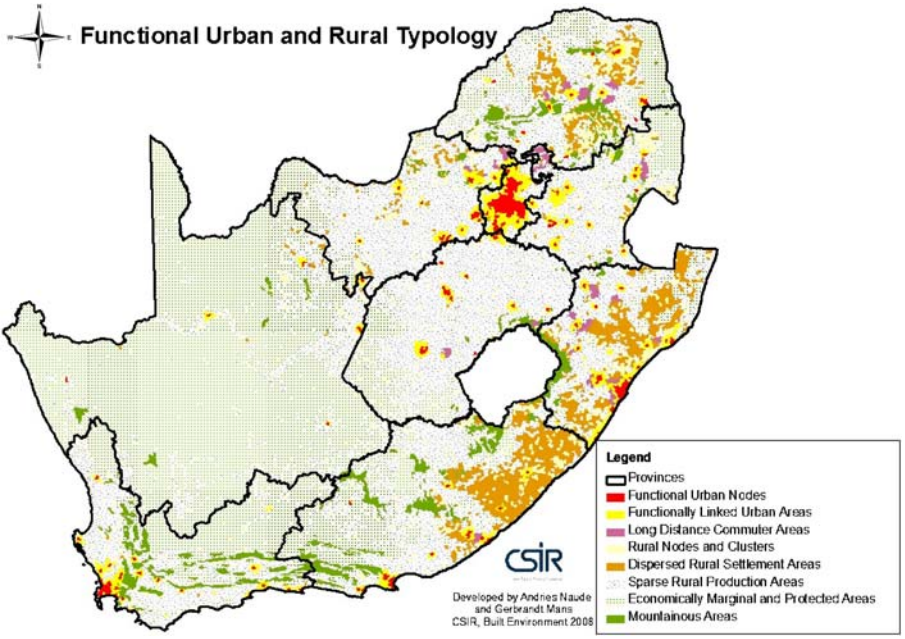

Fig. 4 Functional urban and rural typology (Source: Republic of South Africa 2008)

In support of this process, a project was commissioned to identify significant national demographic, economic, social, service, and environmental trends impacting on the national space economy and the growth and development of South Africa's towns, cities, and city regions (South African Cities Network et al. 2008).

Particular emphasis was placed on comparing and analyzing a range of data sets, trends, and patterns in terms of municipal boundaries, as well as more spatially refined functional urban and settlement areas.

One of the biggest challenges in conducting such a settlement-specific analysis was obviously to consider the range of specific settlements in South Africa, especially in such a way as to not fall into the trap of merely identifying and analyzing a hierarchy of cities and major towns. Owing to Apartheid history and the subsequent range of settlement types (where size of population, size and nature of the economy and the hierarchy of service functions do not correspond logically), a mere hierarchical categorization of settlements in South Africa would quite obviously not be ideal (South African Cities Network et al. 2008).

Development of a Settlement Classification: Technical Process and Advances in more Nuanced Spatial Analysis

This section deals specifically with the technical process that was followed to develop the six-category settlement classification as part of the project.

Limitations of Existing Settlement Classifications

Internationally, most classifications of towns or settlements are based on population sizes, while the boundaries between urban and rural areas are usually defined in terms of population or dwelling unit densities. The problem is that population size or density-based classifications are typically very sensitive to, and therefore distorted by, varying sizes of administrative or census area demarcations. Another problem—particularly relevant to developing countries, and even more so in South Africa with its Apartheid history of Bantustan development—is the existence of many populous settlements without any significant administrative or commercial functions.

A related issue is that conventional population-based measures and classifications are poor proxies for measuring relative accessibility to, or remoteness from markets, services, and jobs—factors which are highly relevant determinants of livelihood and development prospects both at intra-regional scales (such as might be defined by a commuter catchment area or local labor market area) and at inter-regional or national scales.

Demarcation and Classification Variables

In order to overcome the aforementioned shortcomings, the process to develop a suitable settlement classification for South Africa involved the consideration of the following classes of variables:

- *concentration or population density*—ranging from dense to sparse;
- *settlement size*—ranging from metropolitan to hamlet;

- number and range of services or "urban functions"; and
- relations between places, measured in terms of accessibility—ranging from close to distant; or functional linkages—ranging from strong to weak.

Analysis Platform and Input Data

The process was based on the use of GAP, as discussed earlier as an analysis platform and source of input data. The relevant input data included the following:

- the "basic" 2004 mesozone dataset (containing information on population, economic activity, income, land cover, etc.)
- a geo-referenced dataset of South Africa's towns and villages '[each with an urban function index (UFI) value], linked to a subset of "nodal mesozones";
- a strategic national road network (with link distances and travel speeds), connecting all the mesozones;
- previously developed urban–rural typologies[5], overlaid with the mesozone dataset.

Demarcation Process

Following a rule-based methodology (Coombes 2004), the first step in the demarcation process was to identify and classify all "nodal mesozones" based on their urban function index (UFI)[6]. The UFI is a service index, calculated for each node in the country (with metropolitan areas obviously having multiple nodes), based on the number, nature, and order of government and economic services, ranked between 0 and 100.). The result of this process is shown in Fig. 5.

The second step was to develop measures of likely functional linkages between nodal mesozones and demarcate functionally linked groups of mesozones (identifying areas that are functionally linked in a settlement). Groupings were defined as:

- groupings of more than one nodal mesozone, typically indicating a multinodal urban or metropolitan settlement area or region;
- multinodal areas linked with interstitial and surrounding (non-nodal) mesozones, typically indicating the spatial extent of a functionally linked settlement area that may contain significant pockets of nonresidential land uses (such as conserved open spaces, industrial areas, airports, etc.);
- mono-nodal areas linked with surrounding mesozones, typically indicating an isolated town and surrounding areas with high to moderate levels of accessibility or functional linkage to the town; and

[5] See Mhlongo et al. 1999, as well as Naude et al. (2008a)

[6] The underlying UFI database on urban and other nodes (which now forms part of GAP) is based on a study and database developed for Stats SA (Republic of South Africa 2003) and further work (undertaken by CSIR) which involved: (1) the checking of place names and the geo-location of nodes; (2) the adding of nodes in metropolitan areas and around major towns (where suburban or outlying zones might contain a shopping centre, etc.); and (3) the re-interpolation of the original UFI values based on commercial land use and/or nearness to central business districts and other major nodes (Naudé et. al 2007).

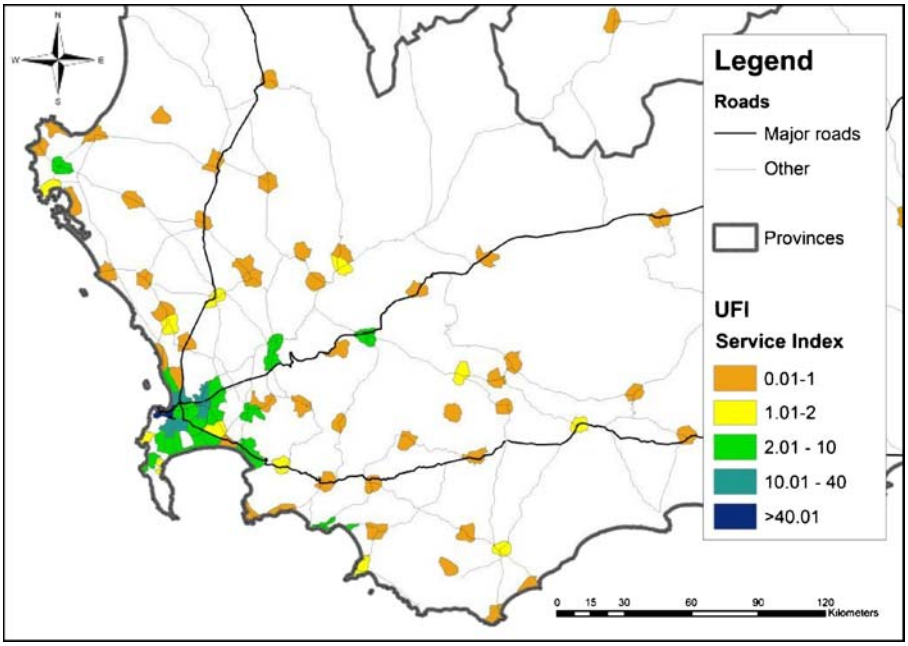

Fig. 5 Identification and classification of nodal mesozones based on their UFI values (zoomed-in view of part of the Western Cape Province)

- mono-or multinodal areas linked to a noncontiguous satellite or commuter settlement[7].

Against this background, the demarcation of functionally linked groups of mesozones was undertaken by calculating indices of urban-related *markets* and *services* that can be reached within a given travel time, weighted by the effort in terms of distance, time or cost (in this case time)[8]. This type of index belongs to the family of gravity-based *geographic potential measures*, and has also been extensively used in other processes, inter alia, to *calculate* indices of spatial interaction potential, market potential (cf. Hanson 2005), and accessibility to urban services (cf. ESPON 2004).

The result of the settlement demarcations derived in this way is illustrated by Fig. 6. On this map it is clearly shown how functionally linked urban areas have been defined around larger towns (with a UFI index larger than 1) and the Cape Metropolitan Area. In the latter case, the map also indicates the boundaries of the grouping of mesozones

[7] Commuter areas in this context refers to settlements (as reminiscent of the Apartheid legacy) dependant on government subsidies sustaining daily commuting from dormitory towns to areas of employment.

[8] Two geographic potential indices and associated area demarcations were calculated within the project context. The first index was designed to identify areas that have above a certain "market threshold" of local and nearby job opportunities or purchasing power. To implement this, a travel time discounted measure of local and nearby household income (a proxy for purchasing power) was calculated. The second index focused on identifying areas with more than a defined minimum level of accessibility to services, measured in terms of a travel-time discounted function of the services at local and nearby nodes (within a maximum range of 40 min travel time). As in the case of delimiting nodal mesozones, the Urban Functional Index (UFI) was used as a composite measure of the range and quantity of services.

that were selected to define the Cape Town city-region area (The criteria for the demarcation of city regions are discussed in the following two sections.).

The total number of settlements identified as a result of the first two steps totaled 694, ranging from very large groupings of mesozones to individual mesozones (such as most of the nodal mesozones with UFI values smaller than 1 shown in Fig. 6).

The third and final step of the demarcation process was to demarcate an additional range of settlement areas with fairly high (semi-urban) densities but no UFI value, nor linked to any nearby nodal areas. The criterion for selecting these areas was simply that the gross (mesozone) population density should be equal to or higher than 40 persons per km^2.

Classification Process and Results

The process of classifying the demarcated range of settlements can be described as an *iterative clustering procedure* involving: (a) the statistical analysis of a range of correlated variables (including population size, UFI value, and economic activity) and (b) the application of context- and policy-relevant knowledge of South Africa's settlement patterns and dynamics. The result of this process is a six-category settlement classification set out in Table 1. The table also provides a summary of the main classification criteria and the defining characteristics of each of the categories.

For the present, it should suffice to briefly comment on the degree of correlation between the main classification variables, and the extent to which the settlement categories not only makes policy sense, but also form statistically distinct clusters. In

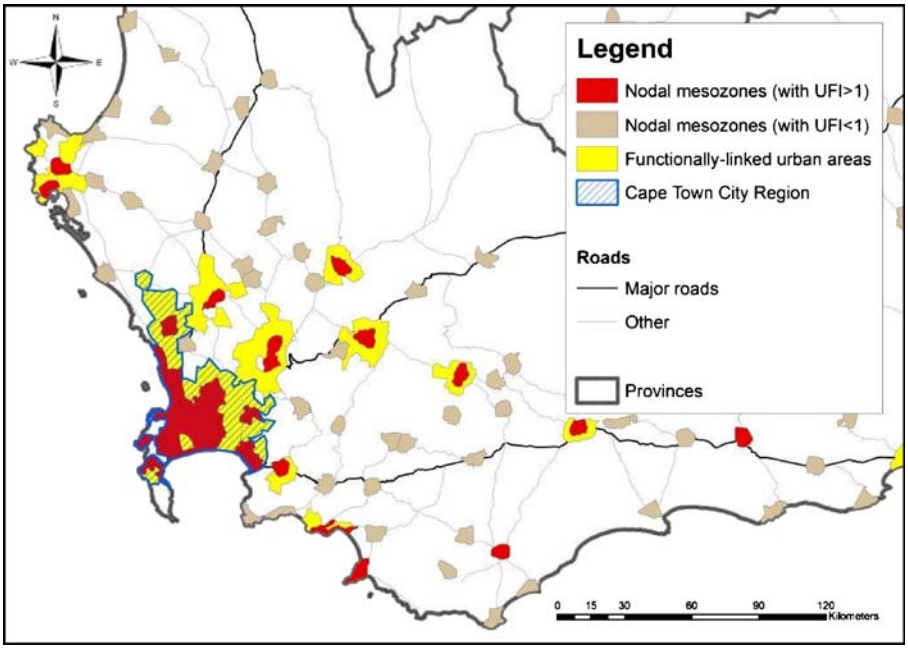

Fig. 6 Result of the first two stages of the settlement demarcation process (zoomed-in view of part of the Western Cape Province)

Table 1 National Spatial Trends Overview: Settlement classification and criteria

Category and number	Classification criteria	Examples	Percentage share of RSA	
			Pop[a] (km)	EA[b] (km)
City regions (4)	*UFI value*: above 40; *Size of population*: above 1 million; *Size and nature of the economy*: high level of economic activity in a diversified range of sectors; *Settlement structure*: multinodal	Gauteng, Cape Town, eThekwini, and Nelson Mandela Bay	38	64
Cities (5)	*UFI value*: between 11 and 40; *Size of population*: between 400 000 and 1 million, *Size and nature of the economy*; medium-high level of economic activity in a diversified range of sectors; *Settlement structure*: one dominant node	Bloemfontein, Nelspruit, East-London, Polokwane, and George	6	5
Regional Service Centres (41)	*UFI value*[c]: between 2 and 10; *Size of population* (three subclasses): (1) 300 k–400 k, (2) 100 k–300 k; (3) below 100 k; *Size and nature of the economy*: medium level of economic activity in a diversified range of sectors; *Settlement structure*:	Upington, Rustenburg, Thohoyandou	14	15
Service towns (44)	*UFI value*: between 1 and 2; *Size of population*[d]: between 10 k and 100 k; *Size and nature of the economy*: medium-low level of economic activity mostly in the service sectors; *Settlement structure/function*: the principal node of a strong, predominantly agricultural or subsistence-focused local region	Estcourt, Malmesbury,	4	3
Local and niche settlements (600)	*UFI value*: between 0.1 and 1; *Size of population*[e]: under 100 k; *Size and nature of the economy*: medium-low level of economic activity mostly in the service sectors; *Settlement structure/function*: nodes that provide: (1) a limited range of services to a small or sparsely populated hinterland; or (2) specific niche services (such as tourism)	Acornhoek, Clarens, Prince Albert	9	5
Clustered and dispersed settlements	*UFI value*: zero; *Population density*: (two subclasses): (1) above 150 persons per km^2; (2) between 40 and 150 persons per km^2; *Size and nature of the economy*: mostly low–level subsistence activity; *Settlement structure/function*: non-nodal areas with a significant spatial footprint	Sub-places such as Mapate, Sinakanaka, Tamboekievlei	21	2
Total of all settlements (excluding farms, nature reserves and other areas with no urban functions or less than 40 persons per km^2)			92	94

[a] Population

[b] Economic activity

[c] A few nodes with UFI values of less than 2 (e.g., Thohoyandou) were included in this category because of their large population hinterlands (more than 130 000 people)

[d] Applicable to 95% of settlements classified as service towns

[e] Applicable to 95% of settlements classified as local and niche settlements

Fig. 7, the top three categories of settlements are graphed in terms of three variables, namely: (1) urban functional index (UFI); (2) central place rank (determined in terms of population size); and (3) economic activity (measured in terms of Gross Value Added (GVA)). This analysis clearly illustrates identifiable clusters and general positive correlation between the chosen classification variables.

An Overview of the South African System of Settlements: Application of more Nuanced Spatial Analysis

In conducting a more nuanced reading of spatial and temporal data and information, the analysis attempted to identify trends that could potentially (and most probably already do) have significant impacts on settlements and the respective governance and service delivery challenges within them. In this section, a very brief, generalized, and comparative indication of such characteristics per type of settlement is provided (see Table 2 and Fig. 8). It should be kept in mind that the characteristics as set out generically, are in reality, significantly influenced by particular regional and local contexts and thus only form a starting point for further and more detailed analysis.

From this analysis (utilizing 2004 estimates), it is evident that more than 90% of all economic activity in the country was generated in this range of settlements, and more than 70% of the population is housed in the network of settlements. This suggests that the wide range of settlements, i.e., densely settled clusters, local towns, and service centers, regional service centers, cities and bigger city-region areas, in many ways appear to form the backbone of the South African space economy.

Making use of the nuanced analysis, *city-regions* (yellow on Fig. 8) can be described as multinodal city areas that, with their functional linked areas, are each home to more than one million people. This includes the Gauteng city-region area, as well as the coastal city-region areas of Cape Town, eThekwini, and Nelson Mandela. The term "city-region" used here describes the functional area and its

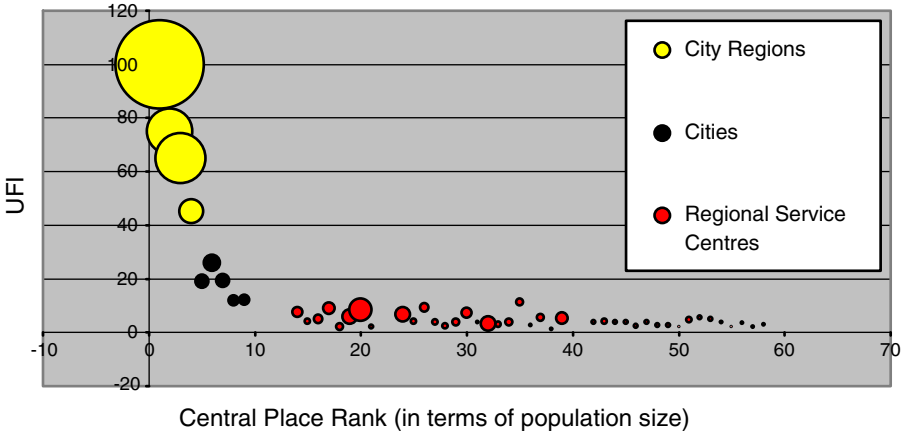

Fig. 7 Correlation between the main settlement classification variables

Table 2 Summary of the network of settlements in terms of selected indicators: population, number of people living below the minimum living level, and economic activity (2004)

	Number of settlements identified	Population (% of national)	Economic activity (% of national GVA)	People living under a minimum level of living (% of national)
Gauteng city region	1	22	39	14
Coastal city regions	3	16	25	10
Subtotal city regions		38	64	24
Cities	5	6	5	6
Regional service centers	41	14	15	14
Service towns	44	4	3	5
Local and niche settlements	600	9	5	12
Subtotal as a percent of National		71	92	61
Clusters and dispersed rural settlements	N/A	21	2	31
Farms/rest of SA		8	6	8
Subtotal as a percent of National		29	8	39

Source: South African Cities Network, et al. 2008

magnitude and not necessarily a particular administrative/policy unit. An interesting comparison is that when utilizing 2007 population figures based on the administrative borders of the respective metropolitan municipalities, it seems that an estimated 35% of South Africans live in the four metro areas, and 57% of economic output are generated in these areas. When using the functional urban boundaries (as defined for purposes of this analysis and as set out in Fig. 8), the analysis suggests that already in 2004, the four multinodal city-region areas significantly dominated the South African space economy. They housed more than 40% of the South African population and provide them with access to livelihood opportunities and services. They also produced more than 65% of national economic activity. A sector-specific analysis of the economies of these areas illustrated that these areas have significant and diverse economies, play a significant role in the national spatial economy, and provide key linkages for international collaboration and competitiveness. The analysis also highlighted the large number of people living in poverty in these areas (24% of the national population living under the minimum living level[9]). The Gauteng city-region alone plays a crucial role in that in 2004, it housed almost a quarter of the country's population (the analysis suggests more than 22%) and generated almost 40% of the national economy (CSIR 2006). The city-regions are areas marked by economic and population growth with a significant proportion of

[9] Given the fact that South Africa does not have a national income poverty line, the National Spatial Development Perspective (NSDP) used the 2004 Minimum Living Level (MLL) developed by the Bureau of Market Research at the University of South Africa, and this information has been spatially disaggregated using the mesoframe. The MLL has been criticized for making use of the lowest possible amount on which a household can live, thus painting a rather bleak picture of the amount of people living in poverty.

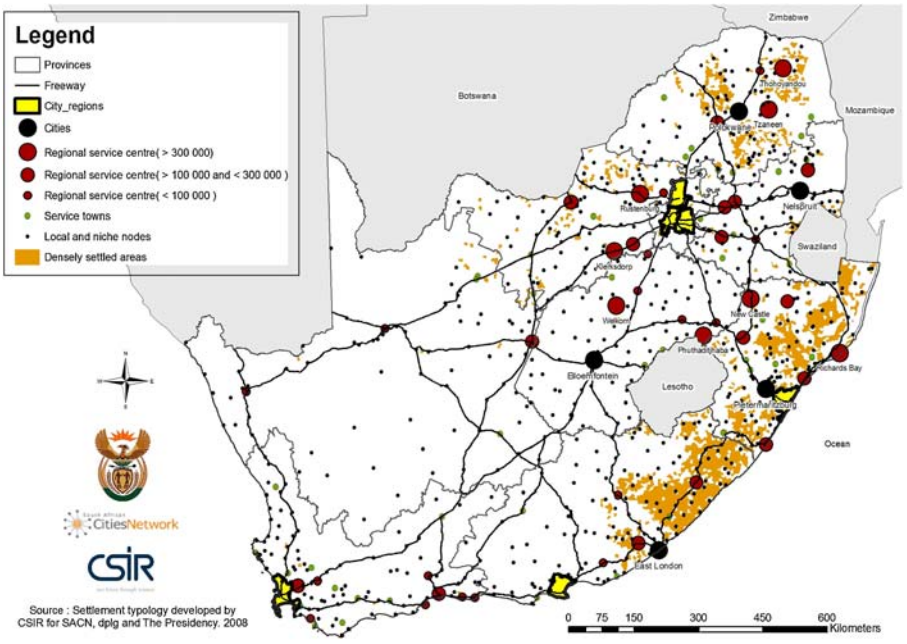

Fig. 8 Network of diverse settlements (Source: Adapted from South African Cities Network et al. 2008)

the national youth population, as well as of the economically active population (in categories of employed, unemployed, skilled, and unskilled). The city regions are also characterized by increasing service demands and significant environmental impacts.

Within the specific analysis, *cities* (big black dots in Fig. 8) were identified as places that, with their functionally linked urban areas, accommodate populations of more than 400,000 people each, have significant multinodal economies, and play a significant role in their respective regions in terms of service delivery and the economy. These places all play a major role in government and commercial service delivery, have relatively high economic growth rates, and are attractors of population. This category includes the functional areas of Polokwane, Bloemfontein, Nelspruit, East London, and Pietermaritzburg. The comparative analysis enabled these places to be viewed in terms of their functional areas and not merely in terms of administrative boundaries. It illustrated that these areas face huge challenges arising from widespread poverty in their functional hinterlands. Although less so in terms of absolute figures, the challenge is that with 5.9% of the national population, the cities and their functional hinterlands also house 5.7% of the country's population living under the minimum living level, with associated challenges in terms of job creation and service delivery.

Major regional service centers (red dots in Fig. 8) comprise medium and higher-order towns that are characterized as such due to the role that they play as prominent service centers within particular hinterlands. These places are characterized by relatively high service indexes (between 2 and 10). In this case, the nuanced spatial analysis and spatial referencing also provides an indication of regional context-

specific nuances. The category typically includes large (in terms of population) towns in densely settled areas (such as Mthata and Toyando—often in former Bantustan areas) as well as towns in resource-rich areas that are relatively accessible (such as Rustenburg, Middelburg, and Secunda) or smaller towns playing key service functions within more isolated and less accessible areas (such as Upington and Springbok). Even though as a group these towns differ substantially in size of their population and economic activity, a strong correlation exists between their regional individual contexts, role, size of population, and economy.

Service centers (green dots in Fig. 8) are smaller towns that, from the analysis, seem to be fulfilling mostly the role of service centers within a local area or region. These towns are usually associated with a particular range of more local services. Outliers in this category are the former Bantustan towns of Bushbuckridge, Giyani, and Siyabuswa, towns with a service index below one, but with populations of more than 130,000 each—also clearly distinguishable because of their spatial relational contexts and large dispersed settlements in their immediate hinterlands. Towns in this grouping are fulfilling a service function for relatively large communities within their direct vicinity (e.g., Giyani) or for a relatively smaller community in sparsely populated areas on particular corridor/access routes (e.g., Estcourt or Malmesbury).

Local and/or niche towns (small black dots in Fig. 8) have been identified as small towns that fulfill local functions and/or perform a particular niche role such as tourism (i.e., Clarens). These settlements are typically smaller in terms of population and economic activity and are geographically much more evenly distributed through the country than settlements in the other categories. In some cases, they are characterized by high economic growth rates (even though from a small base, such as Prince Albert) or relatively high population growth (typically places on access routes such as Alice). In some areas, towns in this category also seem to exhibit evidence of decline (associated with economic stagnation/population decline in the surrounding area). An example of the latter could be Koppies in the Free State province.

The last category of settlements identified in the analysis is that of clustered and dispersed settlements (brown areas in Fig. 8). These include (1) rural nodes and clusters, which are typically clusters of settlements with very limited service roles; and (2) densely settled rural areas/dispersed rural settlements which are characteristic of the former Bantustan areas and are often under traditional land ownership. As in the case of the city-region areas, the findings provide a very strong case for the importance of specific intervention in these kinds of settlements, indicating that the clustered and dispersed settlements housed 21% of the South African population by 2004 and more than 32% of all people in South Africa living under the minimum living level (CSIR 2006). The analysis highlighted three prominent areas within this group. In the eastern coastal part of the country, the former Bantustan area of Transkei Ciskei in the Eastern Cape and the northern KwaZulu-Natal area are characterized by a complete lack of regional service centers, declining areas/regions in terms of the economy, natural population growth, out-migration trends, as well as high dependency ratios (South African Cities Network et al. 2008). In the northern parts of the country, these densely developed clustered and dispersed settlements are largely concentrated in the Limpopo province around the N1 and N4 access routes and the Gauteng-Sekhukune corridor, with relatively better access to regional services centers and areas of economic opportunity.

Based on the project analysis and findings (also see Table 2), it is clear that in considering the future of South Africa and its citizens and for government to deliver on its objectives, the range of settlements in South Africa needs serious consideration—especially in relation to their development and governance challenges, and their capacity to provide access to services, employment, and livelihoods.

Reflections and Conclusions: The Value of Advances in Spatial Analysis in Obtaining Nuanced and Settlement Specific Understandings

Advances in spatial analysis, as applied within the National Spatial Trends Overview project context, enabled a more nuanced (granular, relational) description of the spatial dynamics of changes and trends with regard to demographics (for example indicating the spatial distribution of migration trends), the economy, the built environment, infrastructure, as well as natural resources. It also enabled a range of spatial relational and accessibility analysis, such as accessibility to economic activities and accessibility to services.

The national level overview of key socioeconomic and environmental characteristics, trends, and challenges in the South African landscape, not surprisingly highlighted an increased concentration of population within an interconnected system/network of settlements and functional regions; increased population growth and associated pressures for service delivery in city-region areas and cities; continued urbanization; significant town-ward migration; the impact of the economic and labor market landscape on development; and increasing resource and energy pressures (South African Cities Network et al. 2008). These findings, it can be argued, contributed to acknowledging the increased challenges faced by the range of settlements and cities in South Africa.

More specifically, the recent and project-specific advances in more nuanced spatial analysis illustrated in the paper, have enabled (1) the identification of a range of settlement categories in the country, as well as (2) the subsequent descriptions of demographic trends, employment prospects, migration pressures, services demands and accessibility, as well as environmental impacts for the respective types/categories of settlements identified[10]. These descriptions pointed to increased pressures, opportunities, as well as development and governance challenges converging in these respective spaces.

It can be argued that these advances and findings, not only prompt an urgent consideration of diverse and context-specific government interventions and investment in respective settlements/regions in South Africa. It also calls, and provides a platform for, much more nuanced discourses in urban and rural development debates and policy approaches.

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[10] See South African Cities Network et al. (2008) for the extensive analysis

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