GEOSPATIAL ANALYSIS PLATFORM AND TOOLS: SUPPORTING PLANNING AND DECISION MAKING ACROSS SCALES, BORDERS, SECTORS AND DISCIPLINES

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Abstract

Much has been said and written over the last couple of years on the daunting development challenges facing South and Southern Africa and efforts in this region at reaching the millennium goals, posing a sometimes equally daunting challenge for decision makers and planners to cope with and take advantage of the future. The value of harmonised and aligned decision making and territorial cohesion in this quest and on impact in the lives of people, have also been stressed by various academics and practitioners internationally and especially within the context of inter-regional planning in the European context. This implies *inter-alia* shared visions of the future and understanding of current challenges, trends and trajectories, influencing joint decision making between multi-level agencies, thus requiring a connection and cooperation not only between disciplines and sectors, but also across scales and beyond borders.

In South Africa a number of studies and projects over the last number of years, such as the assessments of Provincial Growth and Development Studies (2006) and the National Hearings on Integrated (municipal) Development Planning (2005), clearly highlighted the need and challenge for taking regional dynamics and the interconnectedness between functional regions into account and the practical difficulties in actually effecting joint prioritisation, resource allocation and implementation across borders and between different scales, sectors and spheres. In response to this, projects such as the development of the ESpace model to analyse and simulate regional development dynamics (2007), the update of the National Spatial Development Perspective (NSDP, 2006), the development of the draft Regional Industrial Development Strategy (RIDS, 2006) and the Contextualisation of the NSDP in 13 Districts (2007) have started to illustrate the value of analysing and understanding patterns and inter-regional dynamics at regional and local scales and made some strides towards putting in place some platforms to facilitate the sharing of spatial and other data on which to build shared understandings of the space economy and socio-ecological systems for decision making.

One of the key tools utilised in answering key questions of understanding the space economy and especially questions related to not only ‘what happens where’, but also to ‘how much happens where’ and to ‘what are the relations, connections and interaction possibilities and costs between various places’ is the Geospatial Analysis Platform (GAP2). The GAP2 platform and set of tools and methodologies in support of decision making across borders and scales and between sectors and disciplines, was developed in a collaborative effort between the CSIR, Department of Trade and Industry and the Presidency of South Africa and further enhanced to include modelling and simulation methodologies at

regional and local scales in partnership with Department of Science and Technology, and the Limpopo Provincial Government.

The paper will (1) build an argument for the importance and challenges of connecting across scales and borders and between sectors, (2) provide a brief overview of GAP2 in terms of its geo-spatial analysis platform, the way in which it facilitates and provides disaggregation of data, as well as the accompanying sets of tools and methodologies, (3) illustrate some of the innovative applications and value thereof in enabling inter-regional and across scale analyses, pattern recognition and synthesis of regional dynamics and connections in the South African context, and (4) suggest some possibilities for utilisation in the broader Southern African context.

Key words

Relational spatial analysis, relational modelling, Geospatial Analysis Platform (GAP), SA Mesoframe, intergovernmental collaboration, strategic planning, regional development, cross-border planning, multi-scale analysis and planning, multi-agency planning, inter-disciplinary planning

Introduction

Despite rapid advances in earth observation and geospatial analysis technologies, as well as the associated need for spatially explicit and sectorally integrated growth and development plans (including plans that deal with multi-scale or cross-border issues), the required statistical, analytical and planning support capabilities are generally still poorly developed. The paper explores the possibility of addressing this problem by shifting beyond the prevailing “island and silo approaches” (to spatial profiling, development assessment and planning) to much more relational and interactive approaches. It also discusses some of the progress that has been made in this direction – referring here specifically to the development and application of the South African Geospatial Analysis Platform (GAP) and associated tools.

Strategic intergovernmental, inter-regional, inter-sectoral and multi-agency alignment and coordination

The value of harmonised and aligned decision making and territorial cohesion in achieving accelerated and sustainable development have been stressed by various academics and practitioners internationally (e.g. within the context of inter-regional planning in Europe such as by Faludi, 2002, 2003a and 2003b; de Rooij, 2002; Faludi and Waterhout, 2002; Albrechts *et al.,* 2003). This implies, *inter alia*, shared visions of the future and a shared understanding of current challenges, trends and trajectories, influencing joint decision making between multi-level agencies.

Some of the key concerns in the above discourses are also echoed by questions around the level at which appropriate analyses can be done and interventions in economies be made, highlighting ‘the region’ as a possibly appropriate and more capacitated level of sub-national economic planning that could facilitate connection and cooperation not only between disciplines and sectors, but also across scales and beyond borders (see Boyle, 2000; Lechner and Dowling, 1999; Gualini, 2003; and Lazerzon and Lorenzoni, 1999).

Similarly, much has been said and written on the daunting development challenges facing South and Southern Africa and efforts in this region at reaching the millennium goals. Locally, a number of studies and projects over the last number of years, such as the assessment of Provincial Growth and Development Strategies by The Presidency (2006) and the National Hearings on Integrated (municipal) Development Planning by Department of Provincial and Local Government (2005) clearly highlighted the need and challenge for taking regional dynamics and the interconnectedness between functional regions into account.

These studies also brought to the fore the practical difficulties in effecting joint prioritisation, resource allocation and implementation across borders and between different scales, sectors and spheres. This challenge of "a *lack of a spatial dimension in the pursuit of intergovernmental coordination, integration and alignment* and the powerful role that space can play as an integrator between the developmental actions of different actors" (Oranje and Van Huyssteen, 2007:12) is one being faced internationally (see Faludi, 2003a and 2003b: and Albrechts *et al.*, 2003) and locally (see Harrison, 2002; MCA Planners and Oranje, 2002: and Meiklejohn and Coetzee, 2007). In South Africa, amongst other things, this challenge also points to the limited impact of strategic spatial planning in the preparation and especially prioritisation and resource allocation that happens in many integrated development plans (IDPs) and Provincial Growth and Development Strategies (PGDSs) in South Africa (Oranje and Van Huyssteen, 2007:12).

This is the case in spite of many efforts by the SA Government (faced by a complex constitutional and spherical governance system) during the past couple of years to align the various spheres' strategic planning instruments (IDP, PGDS, NSDP and the Planning Framework). It is recognised, on the one hand, that the scale at which interventions are targeted varies for most of these planning instruments, and on the other that they do "share the same set of progressive development objectives, i.e. the eradication of past disparities and absolute poverty through basic service provision, human skills development, sustainable economic growth and the deepening of democracy … there often is very little if any indication of strategic and context-specific initiatives and options" (Oranje and Van Huyssteen, 2007: 12). These planning instruments often display different and even conflicting readings and interpretations of the local, regional and macro-political space economies and social-ecological systems in which they operate, resulting in a *fundamental lack of coordinated strategic direction and interventions.*

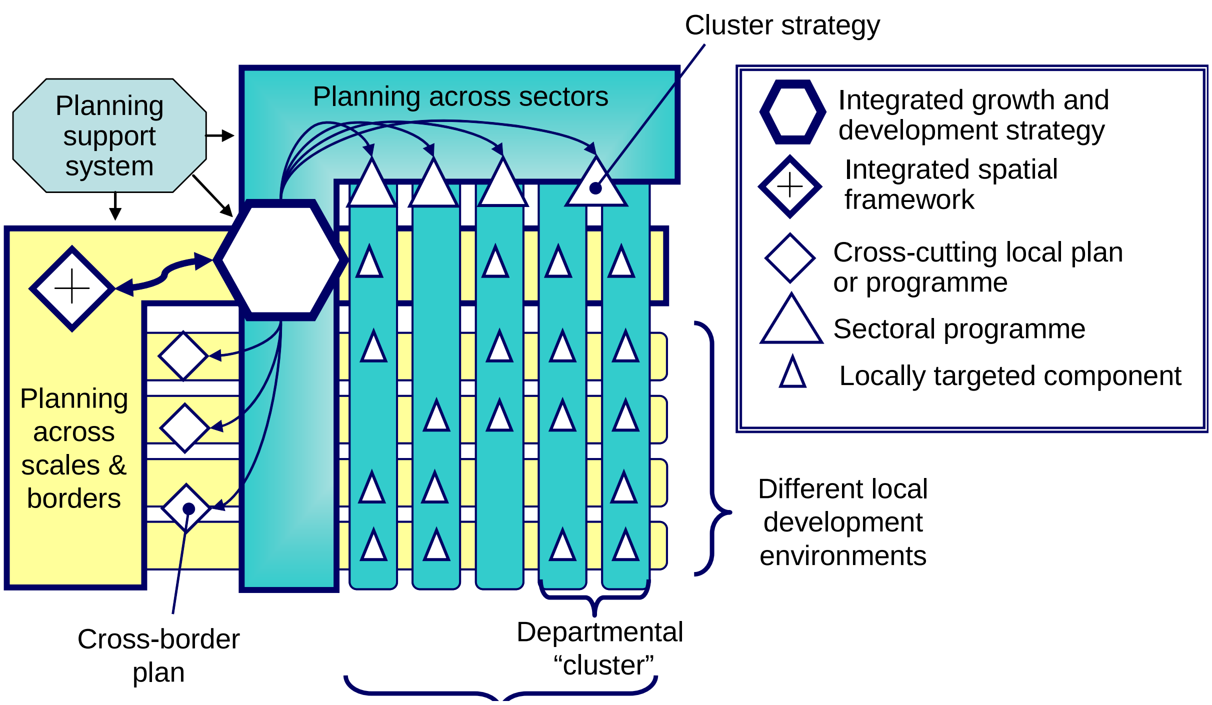
The aforementioned challenges of strategic multi-level and multi-agency planning and implementation, *inter alia*, calls for spatially explicit and sectorally integrated planning. This requires planning and analysis that can (1) facilitate the sharing of spatial and other data, (2) deal with multi-scale or cross-border issues, as well as can (3) support the understanding of patterns and inter-regional dynamics at regional and local scales. In support hereof, five key themes and capabilities for strategic planning support, and especially relational spatial analysis and modelling can be highlighted (see Diagram 1), namely:

- **Planning across borders:** Because a high proportion of human activities and interactions occur beyond local area boundaries (which can be defined as a walking distance range) there is a need to analyse and plan for spatial interdependencies across a range of borders.

- **Planning across scales:** This refers to the ability to "zoom in and out" – i.e. switch between less detailed, synoptic and more detailed, localised perspectives. *Synoptic* scales of analysis and planning – such at the level of a functional region – are needed not only to explore cross-border interdependencies, but also to compare 'how much is where' and identify hot spots to be targeted. *Localised* scales of analysis and planning are needed to deal with heterogeneity of local development environments and the associated need to adapt plans in accordance with local idiosyncrasies and bottom-up stakeholder inputs.

- **Planning across sectors:** In the South African context, this is related particularly to the need for integrated development planning and service delivery whether through municipal or district level IDPs (strategically coordinating municipal and provincial line department priorities and expenditure for a specific area), provincial growth and development strategies, the range of integrated Sector Plans (such as Integrated Transport plans, Integrated Water Service Plans, etc.) or even cluster strategies, such as an Infrastructure Master Plan.

Diagram 1: Key themes and capabilities for strategic relational planning support



- **Planning across disciplines:** Although there are many ways to look at this, and there is overlap with the need for inter-sectoral planning, this refers particularly to the need to accommodate and work across the worldviews, preferred spatial data models and other 'comfort zones' associated with: a) the natural and engineering sciences and b) the human/economic sciences, as well as the call for trans-disciplinary focus in developing sustainability.

- **The need for different modes of planning and planning support:** This is required to achieve the above – referring here specifically to the need to shift from the prevailing 'island and silo approaches' (to spatial profiling, development assessment and planning) to much more *relational and interactive approaches.*

Limitations of the container view of space and associated development statistics and maps

Cutting across all of the above, and as a general motivation for the need to investigate ways of enhancing capabilities to plan across scales, borders, sectors and disciplines, it is important to recognise the extent to which current development assessment and planning practices are still generally characterised by so-called *island or silo approaches*. Broadly speaking the 'island approach' to development assessment and planning refers to the compilation of development indicators and the tendency to use these for the planning and management of sub-national territories as if these territories are isolated, internally homogenous 'islands'. (See Couclelis, 1991.) Assuming that one is dealing with a homogenous island makes it easy to compile aggregate statistics or averages and make comparisons with other areas, but it ignores or 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 (such a very poor neighbourhood surrounded by fairly affluent, well-served areas).

Consistent with this 'island approach' to develop assessment and planning, most official development indicators and associated thematic maps tend to portray the geography of development and inequality in terms of an absolute, 'container' view of space (Couclelis, 1991). Some of the associated challenges and limitations can be summarised as:

- **Uncritical use of GIS and related tools to 'colour by numbers':** It has become deceptively easy to use GIS and related tools to produce a wide range of pattern or thematic maps, and use these to profile and compare the relative needs or potentials of different areas. In a critical, outspoken article on the subject, Openshaw has drawn attention to the inadequate understanding and consideration of the geography of the data (Openshaw, 1996), resulting in the development of biased, oversimplified or wrong area profiles. Stated in his words, the problem is that "large amounts of public funds are often allocated on the basis of simple minded indices used to rank areas. Simple minded technology is clearly attractive to end users, because the results are easy to understand, but they can also be wrong!" (Openshaw, 1996, p 63-64).

- **The modifiable area unit problem:** One reason for the above is that thematic maps of 'container statistics' are often highly subject to the so-called *modifiable area unit problem* (MAUP) (Openshaw and Taylor, 1981). Stated very simply, MAUP refers to distortions or wholly different pictures (e.g. different pictures of the apparent hot spots, or high magnitude areas) caused by: a) varying sizes and demarcations of statistical analysis units; and/or b) changes in the scale of analysis.

- **Small area statistics as only a partial solution:** A related reason is the difficulty of having to differentiate on the basis of between-area differences, but then sometimes disregarding within-area differences (heterogeneity) this typically leads to the inadequate targeting of pockets of deprivation (or other types of minority need) in small towns or areas, which in total, may only constitute one ward or district.

To overcome some of the shortcomings of large-area statistics, infrastructure availability or service access indicators can be broken down by district, suburb, ward, postal code or any other small area. This will improve the homogeneity of the analysis zones and – with this – the validity of inter-area comparisons and rankings. The main disadvantage, however, is increased susceptibility to *boundary problems*. Formally stated, these occur because geographical study areas are usually bounded in ways that do not correspond with the effects of spatial processes (Macquire, 1995).

Shift to relational concepts of space and associated analysis methods

There are, however, a number of conceptual frameworks and empirical analysis methods that can be used to address this apparent scale-related dilemma – needing to ‘zoom in’ so as to recognise important local variations and needing to ‘zoom out’ in order to consider cross-boundary effects and other so-called wide area linkages. Linking back to the early distinction between *absolute* and *relative* conceptions of space, the common denominator of all these frameworks and tools is a renewed emphasis and acceptance of the *relational characteristics* of space – referring here both to the historic relations or *path dependence* of spatial patterns, and the *relative positions and other relational attributes* that (local) spaces have within various types of networks and hierarchies (including central place hierarchies). An important further aspect of the concept of ‘relational space’ that ultimately came to fruition in the 1990s (Harvey, 1996; and Thrift, 1996) is how human action and interaction actively ‘create’ space. Following Evans *et al.* (2006), one way of interpreting this is to appreciate the extent to which human agents (who might differ in terms of their relative mobility and connectivity) are able to transform *physical networks* (such as road or telecom connections) into *relational networks* (such as social networks or economic supply chains).

In order to implement a relational approach and undertake, what we may call, *a relational spatial analysis*, it is thus necessary to shift from, or supplement information about places (or areas), with information and estimates about *relationships between places* (e.g. as captured by accessibility indicators), activities and *interactions among activities*. This is illustrated in Table 1.

Table 1: Range of variables to profile as part of a relational spatial analysis
(based on Hopkins, 1998)

Intra-locational variables		Inter-locational variables	
Category	**Variables/examples**	**Category**	**Variables/examples**
CATEGORY 1 Places (local areas)	Shapes and sizes Field parameters Geographic location Area attributes	*CATEGORY 3 Relationships among places**	Network connectivity Network capacities Accessibility Surface impedance
CATEGORY 2A People and activities	Types of actors & activities Numbers & attributes of each type	*CATEGORY 4A Wide area relationships among people**	Translocal social networks Interregional supply chains
*CATEGORY 2B Local relationships and interactions**	Local social networks Local supply chains Local flows of ecosystem services	*CATEGORY 4B Wide area interactions among people and activities**	Types and quantities of people and commodity flows 'Pipelined' flows of ecosystem services

* Shaded blocks indicate variables that are not usually profiled as part of basic area statistics or GIS applications

Introducing the Geospatial Analysis Platform (GAP) platform, dataset and tools

In an attempt at addressing the above mentioned challenges, the CSIR (through a collaborative analysis and mapping project) started exploring statistical, analytical and planning support capabilities, that could move from the prevailing 'island and silo approaches' to spatial profiling, development assessment and planning to much more *relational and interactive approaches (CSIR, COSAMP Initiative, 2004).* As part of this initiative it was recognised that tools are required which could assist in answering key questions of understanding the space economy and especially questions related to not only 'what happens where', but also to 'how much happens where' and to 'what are the relations, connections and interaction possibilities and costs between various places'. In response, the South African Geospatial Platform (GAP) was developed specifically to address the problem of spatially incompatible 'large area statistics' and other limitations associated with indicators and associated maps that portray the geography of development and inequality in terms of an absolute, 'container' view of space.

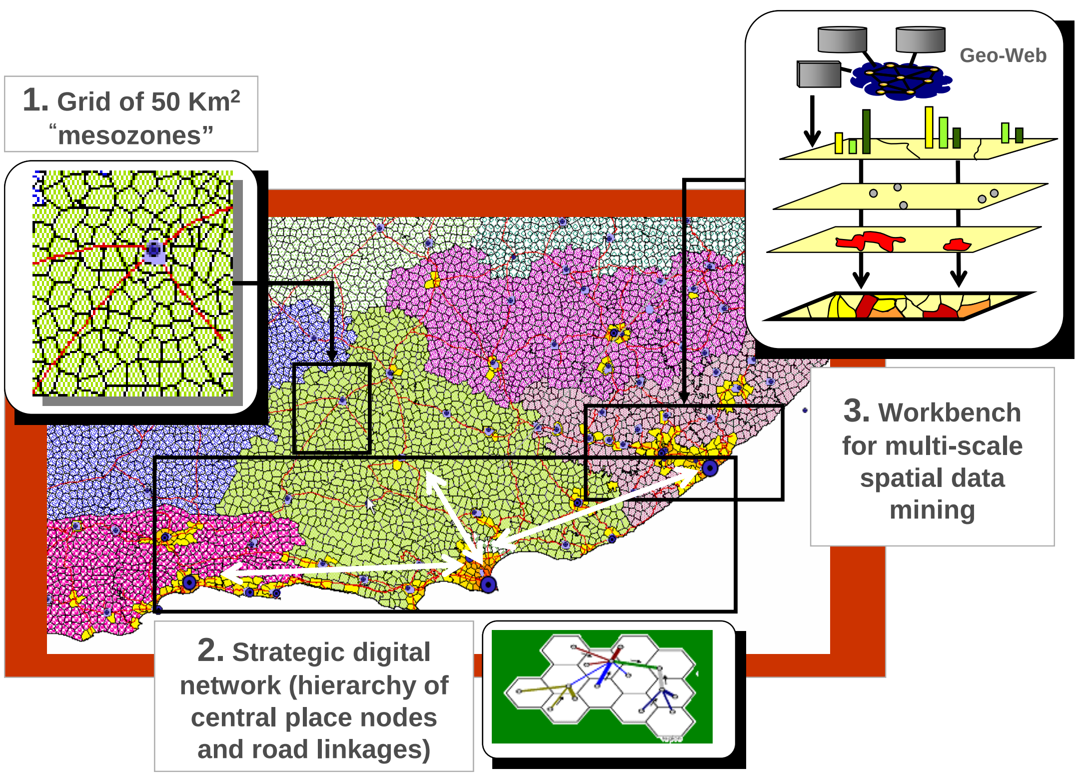
Background, substantive scope and functional description

The initial impetus for the development of GAP was a two-year research project that the CSIR undertook (from mid-2004 to mid-2006) in terms of its statutory mandate – which *inter alia*, requires it to undertake research and development in response to national socio-economic development, infrastructure management, service delivery and environmental challenges (Naude *et al.,* 2007). This CSIR project, however, quickly evolved into a more collaborative initiative involving the Presidency and the dti (the Department of Trade and Industry). Although the initial requirements from both these departments were to focus on an improved basis for mapping of South Africa's spatial economy, consultation with other actors – such as the Department of Local and Provincial Government (DPLG) – led to a broadening of the substantive scope. As GAP evolved (GAP1 was produced in mid-2006 and GAP2 in mid-2007) other data and indicators on relevant development and demand magnitudes (such as poverty levels, accessibilities to markets and services, land cover and economic potentials) were added; together with a digital road network and a new geo-referenced dataset of South Africa's towns.

Seen from a functional perspective, GAP can now be described as a common, meso-scale geospatial platform for the assembly, analysis and sharing of strategic geospatial information – i.e. 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? (Naude *et al.,* 2007).

The three main components of GAP are illustrated in Diagram 2. 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 and other significant geo-economic and historical area demarcations (such as the former homeland boundaries), and that the zone boundaries correspond with major travel barriers (such as rivers) as well as the 'break lines' between sparsely populated areas (such as mountains), and areas with medium to high levels of human activity (such as fertile valleys or built-up areas) (Naude *et al.,* 2007).

Diagram 2: The three main components of the SA GAP



The mesozones are also linked to a strategic national road network and – via the road network – to each other 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.
- 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).

The third main component is a multi-scale 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).

GAP2 was recently (2007-2008) further enhanced to include modelling and simulation methodologies at regional and local scales in partnership with Department of Science and Technology and the Limpopo Provincial Government.

Key applications and contributions to date

Since its development, GAP has filled a huge vacuum in successfully supporting strategic, relational spatial analysis in support of strategic development planning in the last two years in South Africa. Recent prominent projects, which were based on and also illustrate the value of relational spatial analysis, include the update of the National Spatial Development Perspective (Republic of South Africa: The Presidency, 2006), the development of the draft Regional Industrial Development Strategy (RIDS) by the Department of Trade and Industry (2006), the Contextualisation of the NSDP in 13 Districts by The Presidency (2007) and the development of the eSpace model to analyse and simulate regional development dynamics (CSIR for Department of Science and Technology, 2007). In this section some reflections are raised on the value of GAP in addressing the challenges and needs for strategic, relational spatial analysis and modelling.

Reflecting on GAP (1): Its role as a platform for interactive planning across scales, borders and sectors

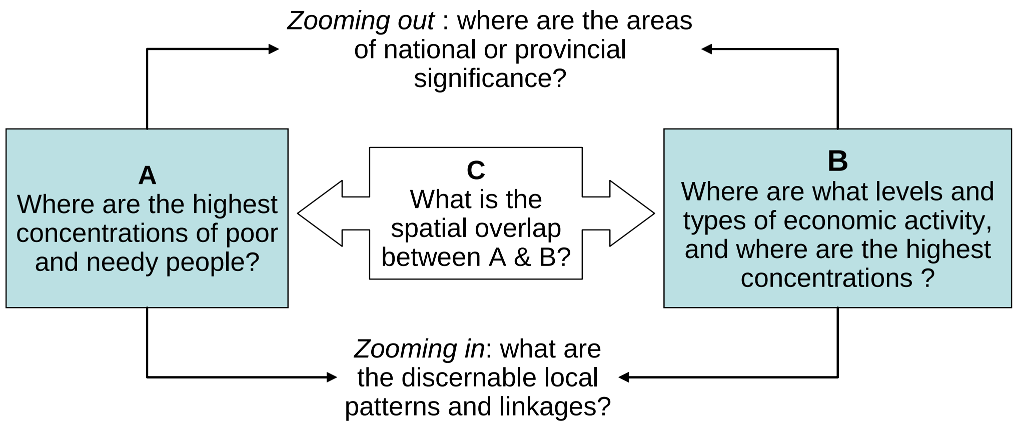
This section deals with the value and contribution of GAP in terms of strategic spatial planning across scales and borders and between disciplines and sectors. It refers in particular to the process of updating the NSDP, and its subsequent application at a district level in thirteen pilot districts. This assessment is based on *inter alia*, interviews conducted with participants in the respective projects, reflecting on personal experiences and involvement from authors in the projects under review, as well as feedback from clients and key role players in the respective projects.

A platform for focussed spatial analysis and spatial policy formulation

GAP has been used as spatial analysis platform in both the compilation of RIDS and the update of the NSDP in 2006. Three key policy and derived analysis questions (see Diagram 3) emerged during the update of the NSDP and interactions with inter-departmental provincial and municipal stakeholders, namely:

A. Where are the highest concentrations of poor and needy people?
B. Where are what levels and types of economic activity, and where are the highest concentrations?
C. What is the spatial overlap between A and B?

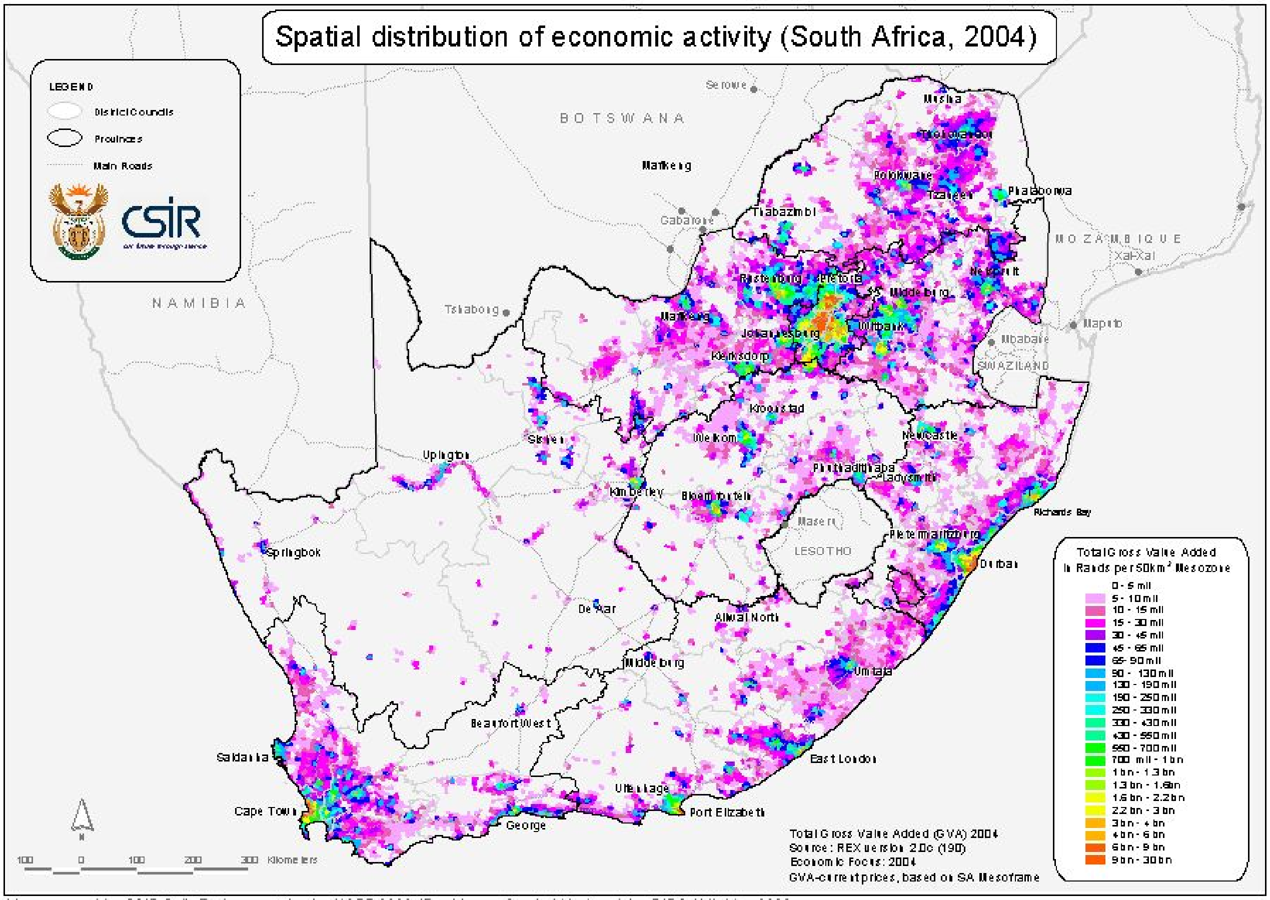
Diagram 3: Spatial analysis at national and district scale



In response to the above questions, some of the critical challenges were to address the lack of disaggregated and compatible population data and to enable concentration mapping and 'overlay mapping' of areas identified as areas of need and areas of potential.

The first step in addressing these questions was to compile compatible meso-scale datasets and maps of the spatial distribution of population and economic activity, thereby addressing the lack of disaggregated and compatible economic and population data.

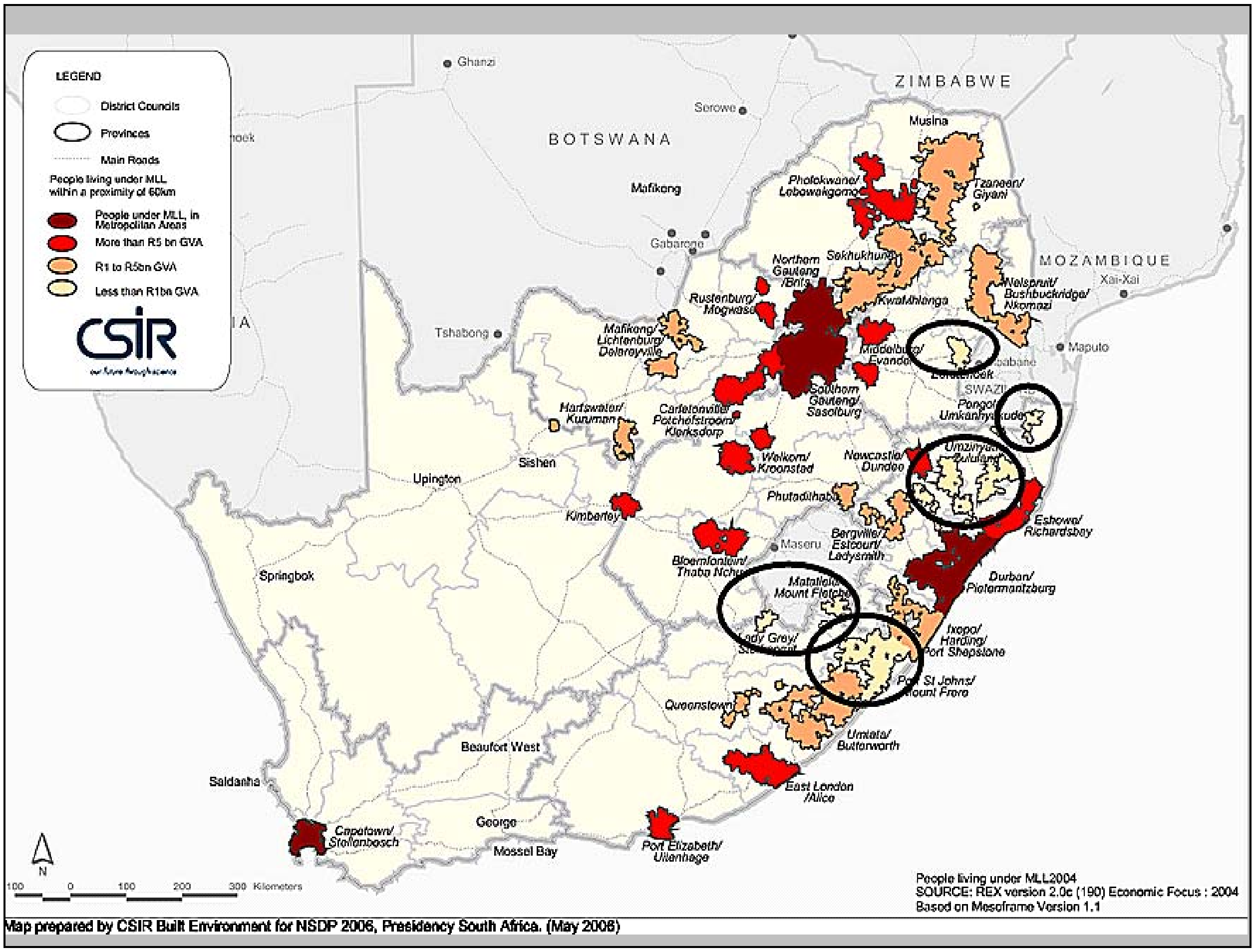
Map 1: Spatial distribution of economic activity 2004 – produced by GAP1 (2006)



Map prepared by CSIR Built Environment for the NSDP 2006 (Presidency, South Africa) and the RIDS (dti), May 2006

Using the capability of GAP to estimate magnitudes of economic activities, population and other variables within specified distance or travel time ranges, it was possible to identify and map nationally significant concentrations of a) persons below the minimum living level (i.e. areas of need) and b) economic activity (i.e. areas of demonstrated economic potential) (see Map 1). Map 2 gives the results of undertaking the further step of comparing the degree of spatial overlap. Using this type of map it is then possible, for example, to identify areas with low levels of demonstrated economic activity, but high numbers of people living below the minimum living level (Republic of South Africa: The Presidency, 2006) – see areas highlighted with circles in map below.

Map 2: Spatial overlap between areas of need and areas of potential, with highlighted circles indicating area with high needs but low levels of demonstrated economic activity. Source Republic of South Africa: The Presidency (2006)



A platform for strategic dialogue and shared understanding

In the application of the NSDP principles and methodologies in thirteen pilot district in 2007 by The Presidency, the use of GAP as a common platform for strategic and comparative analysis of the space economy contributed greatly to (1) facilitating a strategic dialogue about the development of the district among stakeholders from different sectors and different spheres of government and (2) the stakeholders reaching a shared understanding of the district's development trajectory.

The challenge in this particular project was to enable multi-scale analysis on a shared data platform, to enable role players to engage on contextual regional space-economy and social-environmental analysis, as well as bring local and sector specific knowledge into account. This was done through preparing interpretative maps for different scales, being able to analyse and represent broader contextual as well as district and specific municipal and local (settlement level) readings, as well as to enable stakeholder engagement through sketch-planning and interactive perception mapping (utilising smart board technology). GAP, in this context, provided an innovative ability to zoom in and out through various scales, as well as provide spatially represented data of various sectors on the same platform.

In feedback received from project participants (CSIR, 2007a), it was indicated that these abilities of GAP was very useful for relative comparisons and contextualisation and provided a common platform for discussion for stakeholders from a variety of backgrounds. For example, having spatially quantified data challenged prevalent perceptions among participants – e.g. the perception in the Vhembe District that the Makhado area had the highest levels of economic activity (the main area in the district with significant economic activity) and should be the focus for infrastructure investment in support of economic growth. However, by interrogating this perception and exploring the space economy deeper with the help of quantified, spatially referenced indicators of economic activity, it became evident that the Thohoyandou area, had in fact, higher levels of economic activity and was located in close proximity to/had overlapping areas of high need.

GAP did not only fill a data and spatial 'sense-making' vacuum, it was also noted to have made a crucial contribution in directing the discussion towards the district as shared area of jurisdiction of all spheres of government. It facilitated discussions regarding investment and impact in space and time in all participating districts. It also played an important role in ensuring balance, in the dialogue and eventual decision making, between what is locally relevant and nationally/regionally significant.

A platform for discussing and strategising about links between issues, sectors and areas

In the district application of the NSDP it was found (CSIR, 2007a) that structuring strategic dialogue around a specific geographic area, supported by GAP, was extremely valuable in gaining insights into development dynamics, socio-economic and environmental interdependencies between localities, settlements and municipal areas, and also in highlighting sector interdependencies. Participants were given the opportunity to make links between the district, regional, provincial, national and even international areas. The process resulting from the NSDP application project seemed to be more outward looking than the normal IDP processes. Examples of drawing connections between areas and issues include:

- In Ilembe District, discussion was facilitated about ways of addressing blockages and provide services that could 'unlock economic development' in a context of conflicting needs and interdependencies between the coastal strip (with many development pressures) and the 'lagging' hinterland areas.
- In Umkhanyakude and Thabo Mofutsanyane Districts (both border-regions), the lack of engagement with border-issues was opened up, e.g. sharing cross-border functional economic regions, and cross-border migration and pressures on service delivery.
- The regional planning perspective proved very useful, especially its contribution to contextualising local municipality priorities (e.g. in Umkhanyakude a serious discussion was held around the regional importance of the Jozini Dam for basic services and economic opportunities, and the need for Provincial support in this regard).

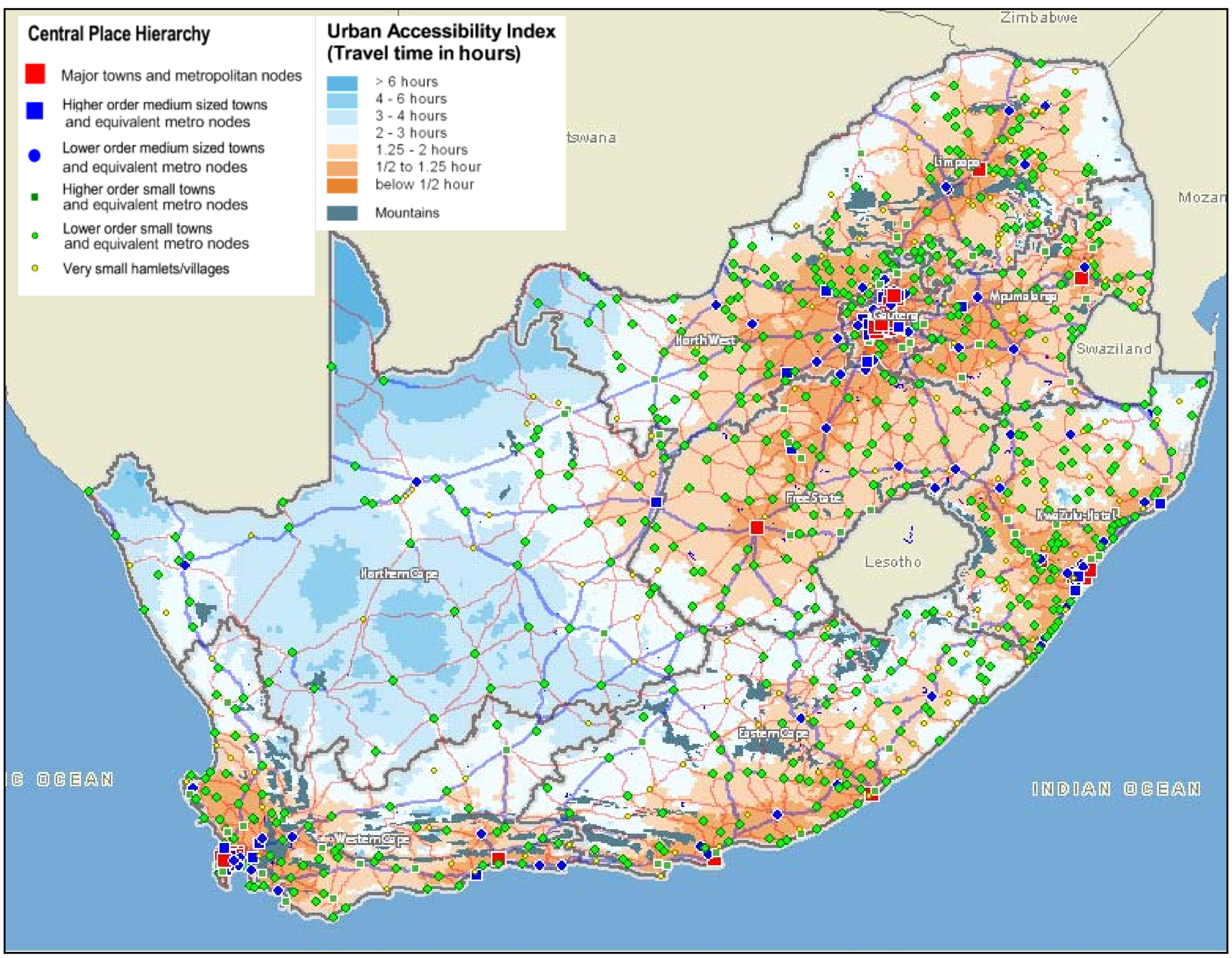
Reflection summary

In conclusion, the availability of compatible meso-scale data on a range of development indicators made it possible to undertake analysis and planning both at the national scale and at sub-national scales. In this section we indicated how – as part of the update of the NSDP – the use of GAP made it possible to identify nationally significant areas of need and potential. This formed an important basis for formulating the NSDP principles and guidelines regarding infrastructure investment and development spending. At the same time, the mesozone data and maps provided enough detail at district level to facilitate the application of NSDP principles at intra- and inter-district scales, and to explore the nature and spatial distribution of the district economic base in the context of broader functional economic regions.

Reflecting on GAP (2): Its role as a platform for modelling spatial accessibility, interaction and dynamics

Because GAP contains a digital road network and a new geo-referenced dataset of South Africa's towns, it can be used to produce a variety of distance, travel time or transport cost maps. One example is an urban accessibility/remoteness map, 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 Map 3). Another is a logistics cost map of South Africa (Havenga and Naude, 2006).

Map 3: Relative accessibility or remoteness in terms of a weighted sum of travel times to each tier the national central place hierarchy (Source SA Geospatial Analysis Platform, Version 2, 2007)

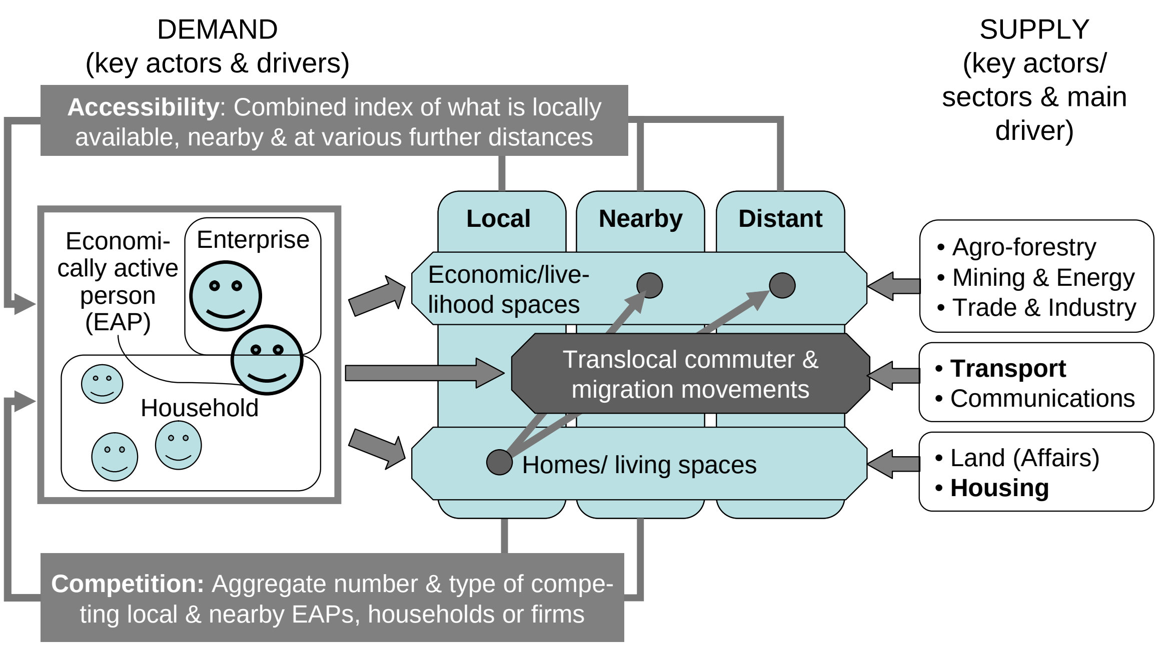


GAP's network modelling component and its associated relational spatial analysis capability have also made it possible to construct models of spatial interactions and dynamics. As part of an ongoing demonstration project (undertaken on behalf of the Department of Science and Technology), the CSIR has been using a variety of GAP-based products to develop and test the eSpace development profiling and simulation workbench. Summarised very briefly, eSpace is an electronic workbench aimed at modelling: 1) how economically active persons, households and enterprises position themselves in, link across, or move between local, nearby and distant economic, livelihood and living spaces; 2) how this influences the place, quantum, rate and type of land, housing, transport and other infrastructure demands; 3) how and to what extent this is influenced by a range of sector-specific supply trends and policies; and 4) what the impacts (such as changes in spatial development patterns) might be, given alternative macro-economic, demographic and delivery policy scenarios.

As indicated in Diagram 4, a key feature of the eSpace model is the (GAP-based) capability to calculate and use (as model variables) indicators that are not only based on local magnitudes, but also incorporate what might be accessible (or perhaps spill over as competing demands) from nearby and distant spaces.

Hence, it is possible to, for example, calculate and use accessibility indicators (such as shown graphically in Map 4) to model how economically active persons (or the SMMEs to which they might belong) will: a) gravitate towards locations or spaces with relatively higher levels of accessibility, and/or b) be pushed further, checked, or diverted by the extent of local and nearby competition (for jobs or consumption expenditure).

Diagram 4: Simplified design of the eSpace development profiling and simulation model



Provisional application of the *eSpace inter-regional model* (to the whole of South Africa) has been strongly informed by evidence about spatial variations in economic growth and unemployment rates, as well as the pervasiveness of oscillating migration, long distance commuting and other so-called translocal livelihood patterns (Lohnert and Steinbrink, 2005). The current modelling focus is on trying to simulate how local job competition and (possibly) over-traded local (informal sector) markets induce economically active people either to opt out of the workforce, or seek access to distant economic spaces, leading to phenomena such as long-distance commuting; oscillating migration or permanent migration.

eSpace also contains a *regional living space allocation and a (linked) transport model*. Since the these two (sub)-models are used to profile options and simulate processes (such as choices of different types of housing or transport modes) that occur at intra-regional rather than inter-regional scales, the GAP mesozones have been divided into smaller, more homogenous units (provisionally defined as 'microzones'). A variety of *conversion tables* have been constructed to facilitate data transfer between the mesozone, microzone and other data layers.

As the eSpace modelling project has not been completed (with considerable model calibration, validation and interfacing remaining to be done) it is too early to discuss the findings or draw firm conclusions about its efficacy as model of developmentally significant spatial interactions and dynamics. But as this review is not primarily about eSpace, but rather about the use of GAP as a supporting platform (e.g. for deriving relevant explanatory variables such as accessibility) it is possible to at least reflect upon and draw a number of conclusions in this regard. These are dealt with in the next section, together with a number of more general conclusions relating to the other themes addressed in this paper.

Conclusion

This paper has dealt extensively with the need for enhanced capabilities to analyse and plan for phenomena or issues that cross the boundaries of, or lie at the interface between different geographic scales, levels of decision making, territories, sectors and/or disciplines.

Focussing first on the need for a capability link across scales and levels of decision making, the evidence presented in this paper would seem to indicate that the development and use of the *SA Mesoframe* – the primary component of GAP – has indeed made positive contributions, if only to facilitate: a) the assembly and rescaling of a variety of macroscopic and microscopic data layers; and b) the sharing of information and the results of analysis between planning stakeholders at national and sub-national scales.

Moving onto the capability to link across territorial borders or boundaries, evidence was presented to indicate that the development and use of the second main component of GAP – *the strategic hierarchy of (central place) nodes and (road) linkages covering the whole country* – is also starting to make useful and potentially significant contributions. Although some of the uses and potential contributions – such as providing a robust basis for modelling how economically active persons, households and enterprises position themselves, link across, or move between local, nearby and distant economic/livelihood spaces – still need to be verified; the accessibility, remoteness and logistics cost maps that have been produced point to an emerging potential to undertake what was described as the ideal to strive for: *a fully relational spatial analysis capability*.

Turning thirdly to the need for capabilities to link across sectors and disciplines, the biggest contribution of GAP has probably been to create a common strategic basis for profiling people and their associated (human) activities, not only at their place of residence (such as has been the focus of population census geoframes and associated statistics) but also where they work or might extract water, minerals and other ecosystem goods and services. Instead of the official set of 'population counting containers' with extremely varying sizes (often cutting across important natural features such as mountains, dams and lakes), the GAP mesozones offer a much more robust basis for the strategic profiling, analysis and mapping of South Africa's economic and human geography, as well as for exploring a variety of spatially complex human-ecosystem, core-periphery and/or poor-rich relationships and interactions. As has been found through exploratory CSIR research on these issues (Naude, *et al.,* 2008), a promising avenue for addressing many of the remaining challenges is not only to continue building a relational spatial analysis platform, but start thinking specifically about and working on ways to build effective *multi*-relational analysis capabilities.

Our final comments are based partly on the experience that was gained with the use of GAP-based maps and related products as means to facilitate dialogue and interactive planning. But they also relate more generally to the well-documented challenges that all developers of planning support systems (PSS) have been, and are still facing to cross what may be referred to as the *black box divide.* In essence, this divide exists because many spatial planners and other decision stakeholders still find it difficult to interact with, and/or trust the outputs of what they see as 'spatial analysis black boxes'. As noted by Vonk *et al.* (2005), planners mainly use simple information storage and retrieval systems for exploration tasks, whilst the majority of PSS are technically much more advanced and aim to support complex tasks. Against this background, CSIR has started to work with local economic planning stakeholders in the Limpopo project to develop user requirements for a much more interactive version of GAP (GAP3). But from preliminary results it seems a wider range of experimentation and user-centric research is called for, and that this should link up not only with the work of Geertman and Stilwell (2003, 2004) and others in the PSS field, but also draw from the accumulated knowledge on topics such as PSS-assisted *sketch planning* (Hopkins, 1998) and *participative GIS* (Elwood, 2001; Wood, 2005).

REFERENCES

Albrechts, L., Healey, P. & Kunzmann, K. R. (2003) Strategic spatial planning and regional governance in Europe. *APA Journal*, 69(2): 113-129.

Adam, A. & Oranje, M. (2002) *A report on engagements with District and Metropolitan Municipalities on the first round of Integrated Development Plans produced in terms of the Municipal Systems Act, 2000*. Prepared for the Municipal Demarcation Board and the Department of Provincial and Local Government, Pretoria.

Boyle, M. (2000) Euro-regionalism and struggles over scales of governance: The politics of Ireland's regionalisation approach to Structural Fund allocations, 2000-2006. *Political Geography*, 19: 737-769.

Couclelis, H. (1991) Requirements for planning-relevant GIS: a spatial perspective' in *Papers in Regional Science*, 70: 9-19.

CSIR. (2007a) *NSDP Application Project: Learning Database*. Unpublished set of records of interviews, questionnaires and observations.

CSIR. (2007b) *Geo-spatial Analysis Platform (GAP2) Viewer*. Pretoria: CSIR, Built Environment.

De Rooij, R. (2002) The impact of the European Union on Local Government in the Netherlands. *Journal of European Public Policy*, 9(3): 447-467.

Elwood, S. (2001) GIS and collaborative urban governance: understanding their implications for community action and power. *Urban Geography,* 22: 737-59.

Evans, T.S. & Rivers, R. (2006) *Physical and relational networks in the Aegean Bronze Age*. Report Imperial/TP/06/TSE/2. Preprint (accepted for ECCS 06 Conference, Oxford, Sept. 2006, to appear in *Complexity*). Imperial College, London.

Faludi, A. (2002) Positioning European Spatial Planning. *European Planning Studies*, 10(7): 897-909.

Faludi, A. (2003a) The application of the European Spatial Development Perspective: Introduction to the special issue. *Town Planning Review*, 74(1): 1-9.

Faludi, A. (2003b) Unfinished business: European spatial planning in the 2000s. *Town Planning Review*, 74(1): 121-140.

Faludi, A. & Waterhout, B. (2002) *The making of the European Spatial Development Perspective: No Masterplan*, London: Routledge.

Geertman, S., & Stillwell, J. eds. (2003) *Planning Support Systems in Practice*. Berlin: Springer-Verlag.

Geertman, S., & Stillwell, J. (2004) Planning support systems: an inventory of current practice. *Computers, environment and urban systems*, 28(4): 291-310.

Gualini, E. (2003) Challenges to multi-level governance: contradictions and conflicts in the Europeanization of Italian regional policy. *Journal of European Public Policy*, 10(4): 616-636.

Harrison, P. (2002) *Towards integrated inter-governmental planning in South Africa The IDP as a building block.* Unpublished report. DPLG, Pretoria.

Harvey, D. (1996) *Justice, Nature and the Geography of Difference*. Blackwell. Oxford.

Havenga, J.H. & Naude, A.H. (2006) Macro Freight Logistics' Legacy to the Second Economy. *The Third Annual State Of Logistics Survey For South Africa*: *2006*.

Hopkins, L.D. (1998) From sketch planning through commitment: Progress towards a Planning Support System for urban development. *Computers in Urban Planning and Urban Management,* 2: 679-691.

Lazerson, M. & Lorenzoni, G. (1999) Resisting organizational inertia: The evolution of industrial districts. *Journal of Management and Governance*, 3: 361-377.

Lechner, C. & Dowling, M. (1999) The evolution of industrial districts and regional networks: The case of the biotechnology region Munich/Martinsried. *Journal of Management and Governance*, 3: 309-338.

Maguire, D. (1995) Implementing spatial analysis and GIS applications for business and service planning. Longley, P. & Clark, G. eds. *GIS for Business and Service Planning*. Geoinformation International, Cambridge.

Naudé, A.H., Badenhorst, W., Zietsman, H.L., van Huyssteen, E. & Maritz, J., (2007) *Technical overview of the mesoframe methodology and South African Geospatial Analysis Platform.* Technical Report for the CSIR, Pretoria.

Naudé, A., Le Maitre, D., De Jong, T., Forsyth, G., Mans, G. & Hugo, W. (2008) Modeling of spatially complex human-ecosystem, rural-urban and rich-poor interactions. Paper submitted to *International Conference: "Studying, Modelling and Sense Making of Planet Earth"*; *1 - 6 June, 2008, Department of Geography, University of the Aegean.*

Meiklejohn, C.L. & Coetzee, M.J. (2006) *Preliminary Update on Spatial Development Frameworks in the Context of Provincial Growth and Development Strategies*. Report for PCAS, The Presidency.

Openshaw, S. & P.J. Taylor. (1981) The modifiable area unit problem. *Quantitative Geography: A British View*. London: Routledge.

Openshaw S. (1996) Developing GIS-relevant zone-based spatial analysis methods. Longley, P. & Batty, M., *Spatial Analysis: Modelling in a GIS Environment*. Geoinformation International, New York.

Oranje, M. & van Huyssteen, E. (2007) A brief history of intergovernmental development planning in South Africa. *Town and Regional Planning*, 51:1-15.

Republic of South Africa: The Presidency. (2006) *National Spatial Development Perspective,* Pretoria.

Thrift, N. (1996) *Spatial formations*. London: Sage.

Vonk, G., Geertman, S. & Schot, P. (2005) A SWOT analysis of planning support systems. *Environment and Planning A*, 39(7): 1699-1714.

Wood, J. (2005) How green is my valley? Desktop geographic information systems as a community-based participatory mapping tool. *Area,* 37(2): 159-170.