Are We Achieving Spatial Transformation In South Africa?
Can Sub-City Spatial Indicators Make a Contribution?

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Abstract:

With the advent of a democratic order in South Africa in 1994 a number of policy frameworks have seen the light. All of these have indicated the need to spatially transform cities and settlements – to break from the pre-1994 apartheid city. Over time these frameworks change, new ones are developed which often state the same objectives. A major focus has also been placed on tracking their impact through spatial outcomes as set out in the Spatial Planning and Land Use Managemnet Act (SPLUMA), Act 16 of 2013 (Republic of South Africa, 2013) and also internationally through the recently introduced UN Sustainable Development Goals (SDGs) (United Nations Sustainable Development, 2016). A key question that remains is whether cities are succeeding in reinventing and restructuring the past. Vital in exploring progress regarding spatial transformation is investigating how the landscape within cities has changed spatially. To assess the progress made by South African cities in the last 20 years, the CSIR has embarked on developing a number of standardised repeatable sub-city level spatial indicators and/or indices to illustrate specific components of spatial change or transformation. This paper provides an overview of some of the innovations in spatially and temporally aligned sub-city indicator development within a data-scarce context. It also reflects on lessons learned, in the process providing some examples of spatial transformation analyses for a number of cities using the indicators developed. These Indicators have been developed partly in collaboration with the South African Cities Network (SACN) to support the 2016 State of Cities Report's (SACN, 2016) theme on spatial transformation.

Keywords:
Apartheid city, spatial transformation, spatial justice, spatial indicators, sub-city, indicators.

1. Introduction

Given South Africa's Apartheid past and the impact of planned segregation on South African cities (illustrated diagrammatically in Figure 1), the need to address socio-economic inequalities, racially divided cities and the transformation of cities to provide equal opportunities and sustainable means of living for all citizens has been on the political and planning agenda since 1994 (See Oranje, 2000; Oranje, 2011; Turok, 2015; National Planning Commission, 2012 and UNDP, 2014). Apartheid city design, especially the fact that many township areas are placed on the periphery of cities, results in inefficiencies and unequal access to economic and service opportunities (Du Plessis, 2013:70).
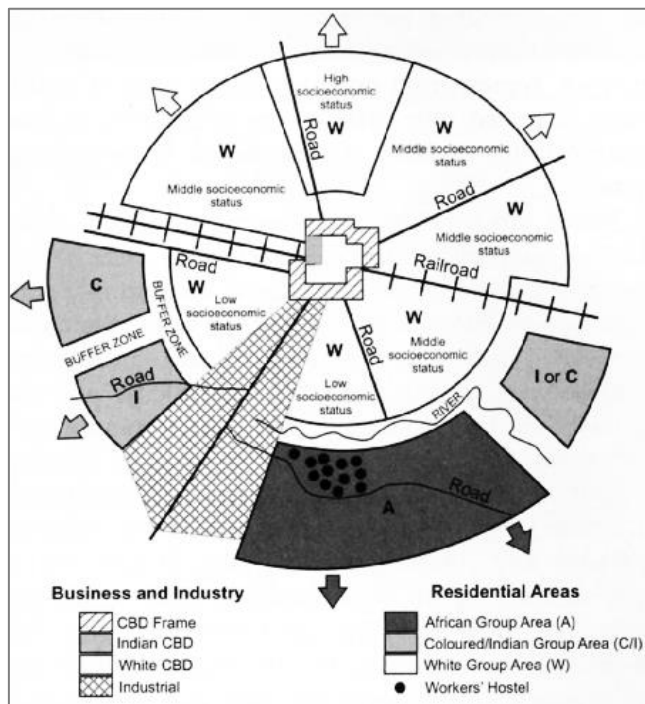

Figure 1: The Apartheid city diagrammatically illustrated (Cole & De Blij, 2007)

Presently, South Africa like many other African countries is experiencing rapid urbanisation. The United Nations estimates that in 2030, 71 per cent of South Africa's population will be living in urban areas, reaching nearly 80 per cent by 2050 (COGTA, 2014:12). This places more emphasis on the need for cities to be liveable, inclusive, sustainable and resilient places. Cities have to track this growth in order to adequately respond to and guide (infrastructure) investment decisions. In the past, cities would develop this data for their own use, however, this makes comparison between cities difficult, if not impossible. Developing consistent comparable data allows cities to learn from the experience of other cities and efficiently use their resources to build sustainable cities.

Given the realities of urbanisation and development pressures experienced by South African cities, there is the continued need to improve efficiency, entice growth and investment, whilst spatially transforming cities. Since the creation of the new democratic order, the extent to which cities have been successful in their spatial transformation has been a priority for local and national government. Even though a number of urban growth and development policies and strategies have been formulated since 1994, all stating the need to address transformation, the view is that South African cities "remain[s] amongst the most inefficient urban environments in

the world" (Du Plessis & Landman, 2002:55).

A major emphasis has *inter alia*, been placed on creating socially-just cities and towns through the implementation of spatial justice as part of the highly cited set of spatial outcomes as set out in SPLUMA (Republic of South Africa, 2013). Within this context two key questions are being asked: Firstly, how can spatial planning, land use management and government investment support cities in making progress in restructuring the apartheid space economy, creating a more equitable and sustainable future? Secondly, as raised by Turok (2015), how can place-specific progress and challenges related to the highly complex goals of integration, transformation and densification be explored? Exploring and tracking place-specific progress and spatial transformation is, however, a major challenge, not only in South Africa but in many other fast growing cities in the world and especially in the Global South (Amindarbari & Sevtsuk, 2013:4). Challenges to adequately measure (detect) changes and explore implications thereof include not only identifying and developing relevant spatial-specific indicators, but also issues related to data availability, exploration, temporal and place-based comparisons, resources and the capacity to track change (Bickford, 2014).

It is in relation to this **second set of challenges that this paper aims to make a contribution**. Spatially-specific indicators are critical, not only i) in investigating how the landscape has changed and how much progress has been made with spatial transformation in South African cities during the last 20 years, but also, ii) to contribute towards driving and monitoring just and sustainable spatial outcomes in cities moving forward. As set out by Harrison and Todes (2015:160), the South African experience of spatial change and efforts at tracking and 'directing' spatial transformation is something that is not incomparable to that of other countries, such as China, Russia and Canada. The challenge to create relevant and trackable spatial-specific and localised indicators is not only a South African challenge, but has also been prevalent (especially in developing country context) within the discourses about the recently introduced set of Sustainable Development Goals (Osborn, Cutter, & Ullah, 2015).

This paper showcases the results and methodologies used in developing a number of explorative, standardised and replicable sub-city level spatial indicators which were developed to track spatial change and progress with transformation at sub-city scale over the last 20 years in South African cities. The paper is structured firstly, in the Background section (Section 2), to examine: (i) the need to track and evaluate spatial change and spatial transformation in cities in developing countries, with specific reference to South Africa; and, (ii) the challenges and key principles associated with the development of appropriate spatial-specific indicators (development, data, etc.) to track spatial change. The second part of the paper provides an overview of the endeavour to develop appropriate, simple and practical spatial indicators to track spatial change and contribute towards the discourse of spatial transformation in 9 cities in South Africa. Specific emphasis is placed on the sub-city indicators selected and developed to identify major spatial patterns and changes with regards to concentrations of population and formal economic activity. The methodology adopted, as well as innovations and challenges within the process and results, is highlighted. In the last part of the paper the authors reflect on some of the most prominent contributions and lessons emanating from this endeavour. The paper aims to contribute to the ongoing drive towards more just and sustainable spatial outcomes and tracking of spatial change and transformation in South African cities. It also strives to highlight aspects that might also be of relevance to other developing countries.

2. Background

2.1 Tracking spatial transformation as an international priority

The term 'spatial transformation' is often used to refer to far-reaching urban change or urban restructuring. It is also a descriptive term to encapsulate the idea that cities have changed greatly over time due to urbanization (See Turok, 2014; Gülersoy & Gurler, 2011; Harrison & Todes, 2015). Urban spatial structures reflect socio-economic and institutional conditions and embedded histories, with transformation (as defined above) occurring through the adaptation of spatial form to new conditions and developments. At the same time urban spaces across the world are transforming in the midst of political, social and economic change and are also required to adapt to become more just, sustainable, efficient and viable spaces as set out by Edward Soja in his 2009 presentation on "The city and spatial justice", the notion of spatial justice brings with it the "intentional and focussed emphasis on the spatial or geographical aspects of justice and in-justice" (Soja, 2009). In order to improve and track spatial transformation initiatives, a renewed focus on evidence-based spatial policies and the development of indicators and monitoring systems is needed (Daly and González, 2013:84).

As part of a drive to promote spatial justice and a more cohesive and balanced territory the concept of 'territorial cohesion' has been identified as a core objective within the Europe 2020 Strategy together with economic and social cohesion. Territorial cohesion can be understood as a broad process of reducing socio-economic spatial imbalances, promoting environmental sustainability, improving governance processes and establishing a more balanced and polycentric urban system (Medeiros c.f. Daly and Gonzalez, 2013:78). As part of the EU cohesion policy country-specific targets, priorities and policy objectives were identified to monitor the effectiveness of policy interventions.

2.2 Spatial Transformation within the South African planning context

Within the South African context, Oranje (2014) indicates that spatial transformation relates mostly to those efforts aimed at ***addressing the physical manifestations of Apartheid planning***. Since 1994 there have been several policy instruments, Acts and Programmes that aimed to set a planning direction (implied spatial transformation) including the Reconstruction and Development Programme (RDP), Development Facilitation Act, Act 67 of 1995 (Republic of South Africa, 1995) and associated Land Development Objectives, followed by the Local Government: Municipal Systems Act, Act 32 of 2000 (Republic of South Africa, 2000) providing for integrated municipal-led integrated planning and spatial development (Oranje, 2007 and Oranje, 2014). Recently this effort has found expression in the National Development Plan (National Planning Commission, 2012) with specific focus on 'transforming human settlements' and in spatial principles and spatial outcomes as set out the Spatial Planning and Land Use Management Act (Republic of South Africa, 2013).

Within the National Development Plan (NDP), spatial transformation includes the focus on spatial justice, sustainability, and resilience, as well as spatial equality and efficiency, i.e. productive places with efficient circulation of people, goods and other resources.

According to Turok (2014) spatial transformation includes several dimensions, namely:
- Social integration and racial mixing – referring to a greater inclusion of different racial groups thus overcoming the segregated nature of SA cities (still apparent), thus also the tern racial-

inclusion.

- City structure – referring to the overall structure of the city/metropolitan area as well as to the texture of the urban fabric. Both of these have a bearing on the cities' functional efficiency, economic productivity, the life-chances of its inhabitants, and its impact on the environment.
- Local texture – referring to a range of finer scale qualitative built environment features that affect the lived experience of households and businesses. This also relates to the design of the city and if it is functional, supportive and appealing (to households and those that can invest in its business opportunities).

Spatial transformation requires a 'programmatic, plan-oriented, project-directed effort to change the unequal access to and occupation/ownership of socio-politically differentiated space in South Africa – a multi-dimensional, open-ended, fluid process of change, organically linked to the past, present and future' (Williams, 2000:180). It requires not only a development agenda that moves beyond project implementation and service delivery (Oranje, 2011) but also pragmatic support to analyse, track and improve progress in support of this long-term agenda to fundamentally reconfiguring inequality in society and space.

2.3   Challenges in developing indicators to track spatial change in South Africa

In 2014, a 'Spatial Transformation of Cities' Conference was held in Johannesburg. It explored a number of key themes to understand what transforming urban space means in practical terms (SACN, 2014). It served to interrogate the work undertaken by various cities, to gain knowledge and insight at the city scale, and deepen the understanding and learning concerning challenges and strategies for spatial transformation. The event reaffirmed that in order to gauge if actions to transform are manifesting actual change, evidence needs to be tracked. Thus there is a need to identify/develop a suite of suitable indicators to track transformation. Kusek and Rist (2004:65) define indicators as "the quantitative or qualitative variables that provide a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of an organization against the stated outcome". Before creating any indicator it is important to know what objective needs to be achieved. Indicators are only appropriate "when they are measured against an objective" (Kusek & Rist, 2004:57). It is the outcomes that will in the end produce the sought benefits.

2.3.1   Standardised and other indicators?

When developing indicators it is also important to be aware of the latest approaches and whether any related international standards have been developed. In this current round of indicator development (CSIR-SACN project) international standards were not considered, largely due to the need to develop local indicators that reflect the local issues better (at sub-city scale). It is, however, important, for future reference, to be aware of the international drive to develop standardised indicators. Standardised indicators are "quantitative, qualitative or descriptive sets of measurements or metrics that can provide a globally standardised set of definitions and methodologies" (International Standards Organisation, 2014:2). It therefore allows cities to develop comparable indicators that can measure its performance on a number of themes over time, as well as to compare performance with other cities. These results can then assist in evaluating whether policies are achieving their desired outcomes. The World Council for City Data developed

a new standard; namely *ISO 371201: Sustainable development of communities, indicators for city services and quality of life*. This launches a set of standardized indicators that "provide a uniform approach to what is measured in the context of city indicators, and how that measurement is to be undertaken" (Korth, 2015:1). It sets out a common approach for collecting, assessing, and evaluating city data. Developing from the ISO 37120 standard, is the Global City Indicators Facility which is now the world standard for city metrics. It must be noted, however, that these items reflect the city-scale, as the intention is to compare city performance.

2.3.2   Reporting challenges and current initiatives in South Africa

According to the South African Statistical Quality Assessment Framework (SASQAF) of the National Statistical System (NSS), statistics become official when they are certified after going through the standard assessment procedure. To be certified, the data collected must meet user needs of a broad audience and form part of a longitudinal and sustainable process. Consequently, the data collected by many national agencies such as Statistics SA and the National Treasury can be considered to be official statistics. This includes their censuses and household surveys. Sources of data that are not collected by 'official' government agencies should follow a process of accreditation by going through the standard assessment procedure of SASQAF. Datasets that are not official statistics should not be used to report on any indicators (AfricaScope, 2013:26).

Metropolitan cities are legally obliged to report on outcome indicators as required by national departments and regulators. In addition, they also use these for purposes of internal analysis. They use registers and other sources to extract information and some cities also capture their own data. In addition, they are also requested to provide information to agencies such as Department of Performance Monitoring and Evaluation in the Presidency (DPME) and the South African Local Government Association (SALGA). During 2013, the South African Cities Network (SACN) commissioned the Urban Indicators Project to review the extent of indicators, data custodians, the methods used to collect and provide data (AfricaScope, 2013:9). An Indicators Reference group was established to provide inputs and share advice and guidance, to improve the inputs required from a range of indicators. Indicators would, for example, also be applied in various forms of requested performance reporting. A range of indicators was also used by the SACN for the latest State of Cities Report. When one considers the range of departments and institutions dealing with city statistics it is likely that some items could be duplicated or calculated by different parties.

Several studies have been undertaken since 2013 to review urban indicators. This included the 2013 Urban Indicators Project (AfricaScope, 2013) and the 2015 Open Data Almanac for Cities (KPMG, 2015) both commissioned by the SACN. The National Treasury Department's City Support Programme (National Treasury, 2015) has also developed a range of urban indicators to track city performance – all used the SACN thematic quadrants (Productive cities, Inclusive cities, Sustainable cities, and Well-governed cities). In addition, the other critical framework to mention is the Integrated Urban Development Framework developed by the Department of Cooperative Governance (2014), where strategic goals find implementation through policy levers, which would also measure spatial transformation, to greater or lesser extent. One of the main burdens for the South African metropolitan areas is reporting, as they are often required to submit a number of completed questionnaires to StatsSA, SALGA, DWA and National Treasury

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[1] This standard developed under the agenda of a technical committee for Sustainable development in communities (ISO/TC268)

(AfricaScope, 2013:22).

2.4   Developing spatial specific indicators – Challenges and Principles

2.4.1   Challenges when developing indicators

There are a number of challenges associated with the development of indicators. Some of the most noticeable challenges include the unavailability or incompleteness of data, difficulties collecting source data, methodological changes in the capturing of source data, incomplete time series data and inconsistent statistical methods used in the indicator-development phase. The spatial unit used when capturing data poses additional constraints, such as, (1) size variation, creating a statistical bias also known as the modifiable areal unit problem and (2) significant boundary changes between data collection periods (e.g census years).

The scalability of data (e.g South African voting districts which do not align to units such as sub-place or main place or even small area layers) also adds additional constraints in indicator development. It is also the objective to have indicators that are more spatially-specific or of a sufficiently fine resolution to allow the observation of localised changes in the data. This overcomes some of the generalisation that occurs when using administrative units such as local municipal boundaries.

2.4.2   Challenges of scale

It is important to note that although some of the information collected by various metros, departments and institutions might be collected at local sub-city level, the information presented in the various indicators is regularly aggregated and aimed at a broader scale and intended for a comparison of cities. The reporting units being used for city-level indicators are administrative units (mostly local municipal unit) which do not reflect the true spatial grain of features such as population distribution, land-use patterns, etc. (Hagenlocher, Kienberger, Lang, & Blaschke, 2014). Metropolitan areas, such as Gauteng, stretch across local municipal boundaries, yet are mostly reported within a particular local municipality (the seat of Metropolitan area).   The measurement of items is influenced by the scale that is used, when aggregating information, a measure of generalisation occurs (Fotheringham, 2005). This is particularly relevant when considering an item that is scale-dependant where the geographic extent is sensitive to the spatial arrangement (Blaschke, 2005:200). This begs the question – what is its usefulness in measuring spatial transformation? To enable sufficient pattern detection of spatial features it is necessary that the scale be sufficiently fine (for purposes of detecting spatial transformation for example). When the size of measurement unit changes the spatial variance or heterogeneity also decreases (McGarigal, 2013:2.18). Appropriate finer-grained information is more useful to grasp the spatially explicit realities which in turn can contribute to policy–relevant information. A constraint can, however, be in the computational complexity required if a completely new or unaligned[2] fine spatial unit is used.

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[2] Referring to alignment to existing units of data representation such as Sub-places, Small Areas, etc.

2.4.3   Principles for indicators:

In order to have indicators that provide value, they have to be clear, direct and unambiguous as possible. Indicators to be created or selected should be relevant to a desired outcome (Kusek & Rist, 2004:70) and comply with a set of criteria namely:

- Appropriateness/ Relevance – relevant to the desired outcome or the topic featured (National Treasury, 2015:26).
- Specific – To be clear on the focus and 'what' it attempts to measure.
- Verifiable - relating to the process of indicator creation, ensuring that the source of information is trustworthy. It should, if relevant or necessary, be independently verified.
- Statistical soundness – when an item is created using a statistical process to ensure it is defendable.
- Repeatable – Single/ once-off indicators provide limited value, as tracking change requires time series data. For this purpose, an indicator should, once created, be repeatable .
- Cost effective – Due to the costs involved and the likely expenses, indicators should be carefully selected/ created to provide as much value as possible. Exorbitant costs should be avoided and proxy indicators sought especially in the case of developing (poorer) countries.
- Comparable –The standardisation of indicators to allow for comparison (National Treasury, 2015:27).

Spatial indicators should, apart from the abovementioned principles, also confirm to SDI 'good practice', it is especially relevant that such items conform to the South Africa data framework for geographic data and metadata. This is important to facilitate data sharing and distribution. Naturally proper referencing of such items is also a prerequisite.

3. Developing spatial indicators to track change in South African cities[3]

3.1   Introducing the research project

To assess the progress made by South African cities in the last 20 years in relation to development outcomes as well as to identify strategic problems and opportunities facing cities, the South African Cities Network (SACN) has produced the latest (2016) State of the Cities Report. As part of this project, a number of spatial indicators and or datasets have being explored by CSIR to identify key elements of change or transformation in South Africa's nine biggest cities (Maritz, 2015). The research also forms part of ongoing programmatic research conducted by the CSIR Spatial Planning and Systems team and various collaborators within the ambit of the StepSA initiative. This includes the development of socio-economic indicators at the "meso-zone" scale – a geo-spatial analyses platform and set of indicators to support regional development and analyses (see http://gap.csir.co.za/gap/about-gap-1 and http://StepSA.org). Also research focussed on identifying demographic change in South African cities and towns and population movement between them, undertaken as an input to the development of the Integrated Urban Development Framework (IUDF). Other items analysed (not featured in this paper) include tracking racial change (which is closely linked to South Africa's apartheid city past), as well as spatial transformation related to vulnerable communities within the city, using a measure called 'access to good services' (CSIR BE, 2015).

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[3] In addition to what is featured in this paper, the research project included the development of a range of added spatial indicators not featured here. These can be viewed on StepSa.org and some may feature in other papers presented at Planning Africa 2016.

One of the key contributions of the research project was thus to develop indicators to explore spatial change and levels of growth and spatial transformation. Particular indicators relating to bridging the data gap and exploring sub-city level changes were the focus. The intention was to identify spatial patterns and concentrations of people and activities, growth areas and attendant changes in urban structure, resource allocation and effectiveness of public services provision (e.g. public transport). It should be acknowledged that spatial change can be depicted on numerous levels and that no one indicator can provide a clear indication of spatial transformation, experiences of people within cities, etc. Indicators can, however, add value in providing some indication of embedded spatial patterns and the areas undergoing the biggest changes within cities (in terms of population density, concentration of economic activity), and also in addressing questions related to the spatial relationships between such changes.

3.2   Research approach and methodology

As mentioned previously the purpose of the research was thus to develop spatial specific sub-city level indicators to provide an indication of spatial change, not merely reflecting increases in number of people at sub-place or ward level (See example figure 2) or built-up area change (see http://stepsa.org/pdf/newsletter/stepSA_April16.pdf).
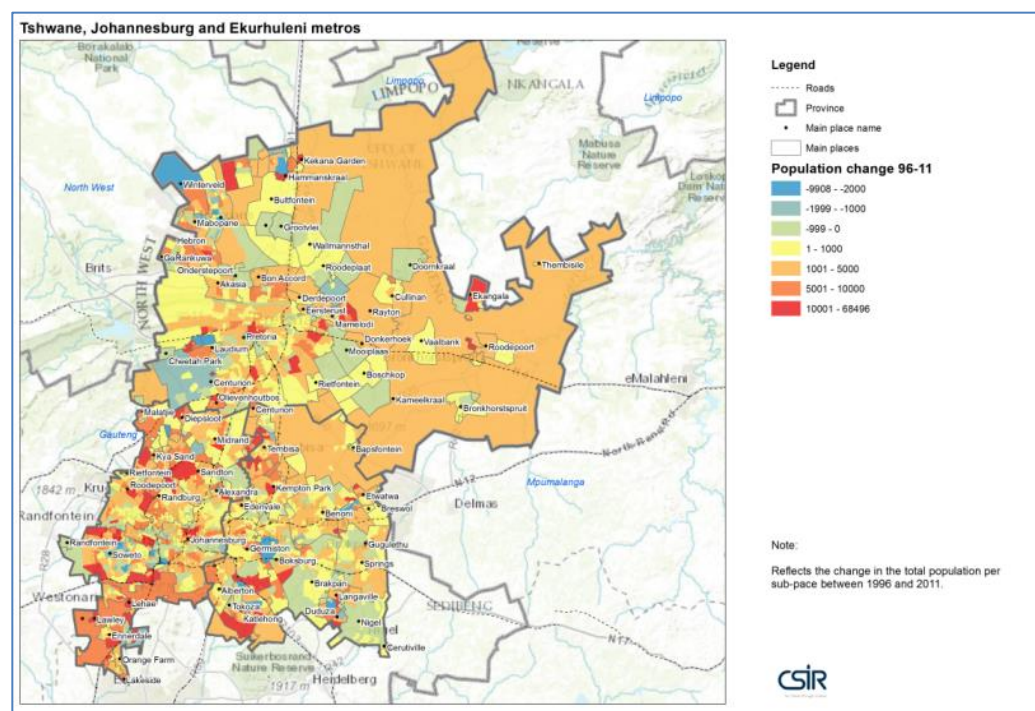

Figure 2: Change in total population per sub-place 1996-2011 (Maritz, 2015).

The intent was to spatio-temporally track aligned data to identify:
- spatial specific patterns of population concentration and growth;
- spatially embedded formal economic concentration, agglomeration and growth patterns ; and
- enable comparative analyses of fine-grained spatial patterns and changes in spatial patterns within cities – comparing place specific spatial change, as well as comparing spatial change and growth patterns between cities.

The development and exploration of sub-city indicators required several steps which included;

basic research into each item, data extraction (or update if already available), preparation, and calculation of the indicator, as well as considering and reflecting on the standards with respect to developing indicators (as set out in Section 2). However, it also required the development of a separate new uniform tessellation to correct for the spatial bias introduced by the sub-place boundaries.

To improve the spatial resolution of information at sub-city level, a single fine grained uniform tessellation (using 1 sqkm hexagons) was created for each city. Total population and economic information was assigned to this hexagon tessellation using a dasymetric mapping process, which is defined generally as the use of an ancillary data set to disaggregate coarse resolution data to a finer resolution (Eicher & Brewer, 2001). This was done for both population and total economic production.

3.3   Results

Using this uniform spatial unit enables users to see a less distorted picture of the information. Because the information does not result in zone size distortions and is sufficiently fine grained. It can also be displayed in different ways, primarily aimed at the identification and comparison of:

- Spatial patterns of concentration and growth of a particular trend i.e. population density within a city, and also across boundaries – highly useful in discussions regarding nodes, corridors, identification of growth areas in and on border areas, etc. (See Figure 3 and 4);
- An indicator across time between cities, i.e. increase and change in population density across different cities to explore possible patterns, i.e. increased densities and development on the outskirts of cities (See Figure 5 and 6);
- Spatial concentrations and changes/embeddedness of patterns of population and economic growth within a city across time (See Figure 7).
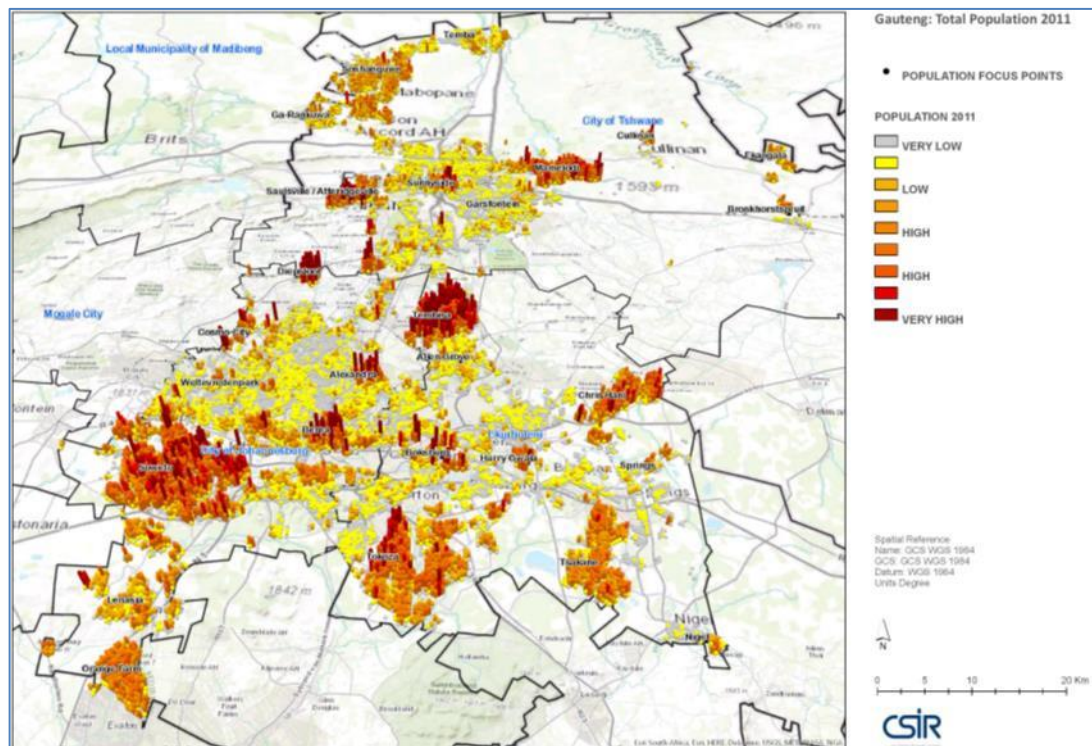

Figure 3: Spatial patterns of population concentration (Maritz, 2015).

Using a uniform fine-grained analysis surface as depicted in Figure 3 enables a comparable depiction across space. Using GIS software a 3D-bar landscape map is created with the extruded values representing the value of the attribute (population or total economic production). Looking at the 3D tessellation of population further assists in 'reading' the values. The advantage is that the areas of largest growth or highest value can be easily observed more clearly. Dense versus less-densely populated areas are clearly visible. Taking the same spatial surface but comparing only the change in population (figure 4) helps to visualize whether the growth that materialised was aligned with development objectives such as 'not developing township type settlements on the periphery of cities', etc.
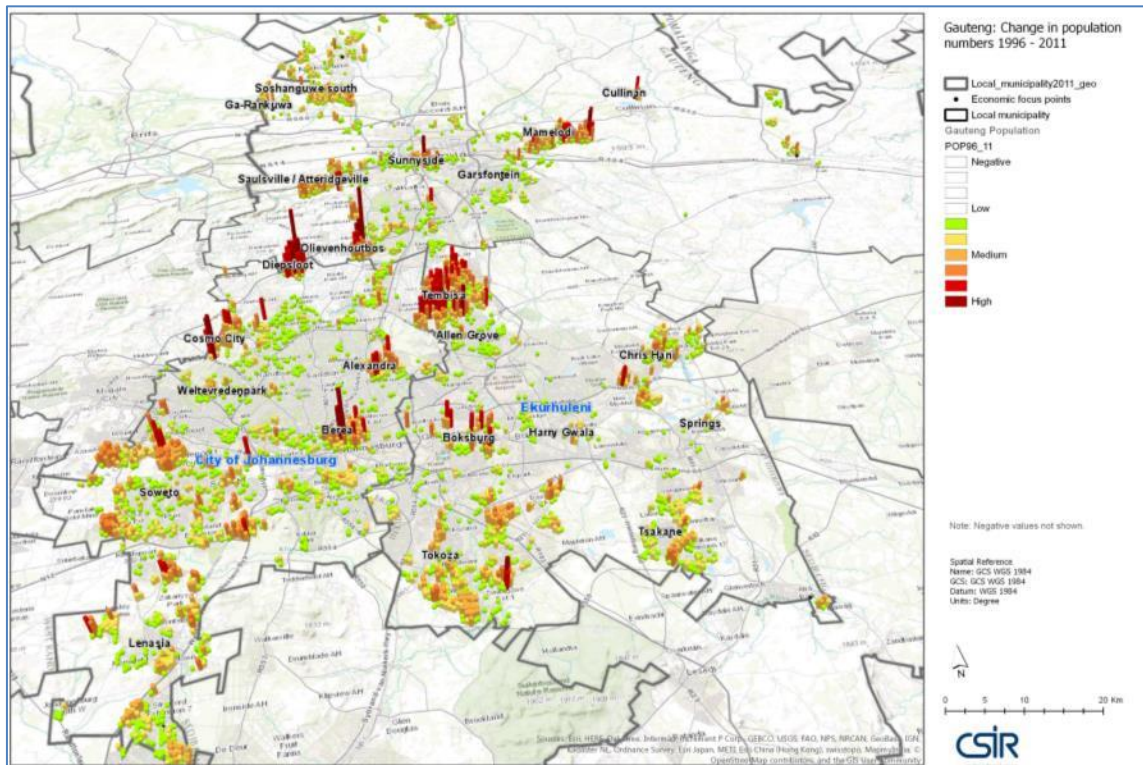

Figure 4: Spatial patterns of population growth (Maritz, 2015).

Figures 5 and 6 repeat the same analysis for different cities, allowing for visual comparison between different cities because the tessellated units used were the same size. The scale of change (population growth) as well as its spatial extent is depicted more clearly and in a comparable fashion.
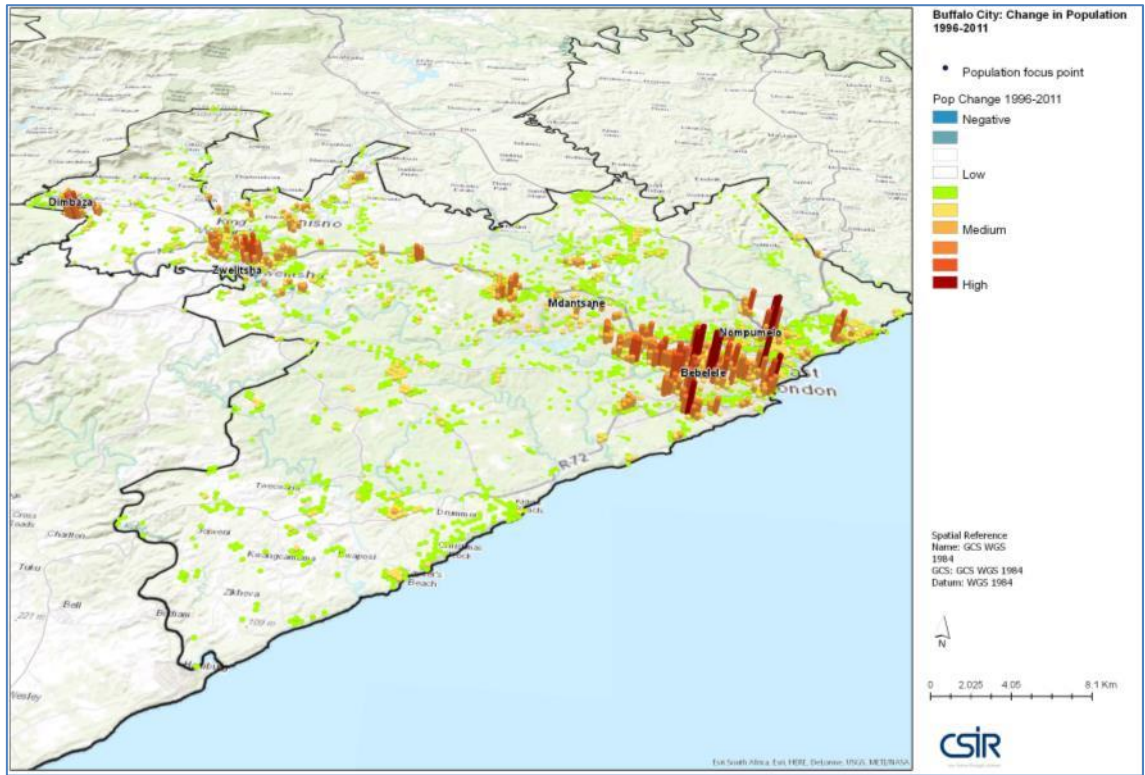
Figure 5: Population growth 1996-2011 - East London (Maritz, 2015).

Using this approach, different items can be depicted for the same area – Figure 7 depicts the change in population as well as in economic production. Although the actual numbers cannot be compared one-to-one, the change when reflected along a relative scale can be useful when comparing change in population versus economic production.
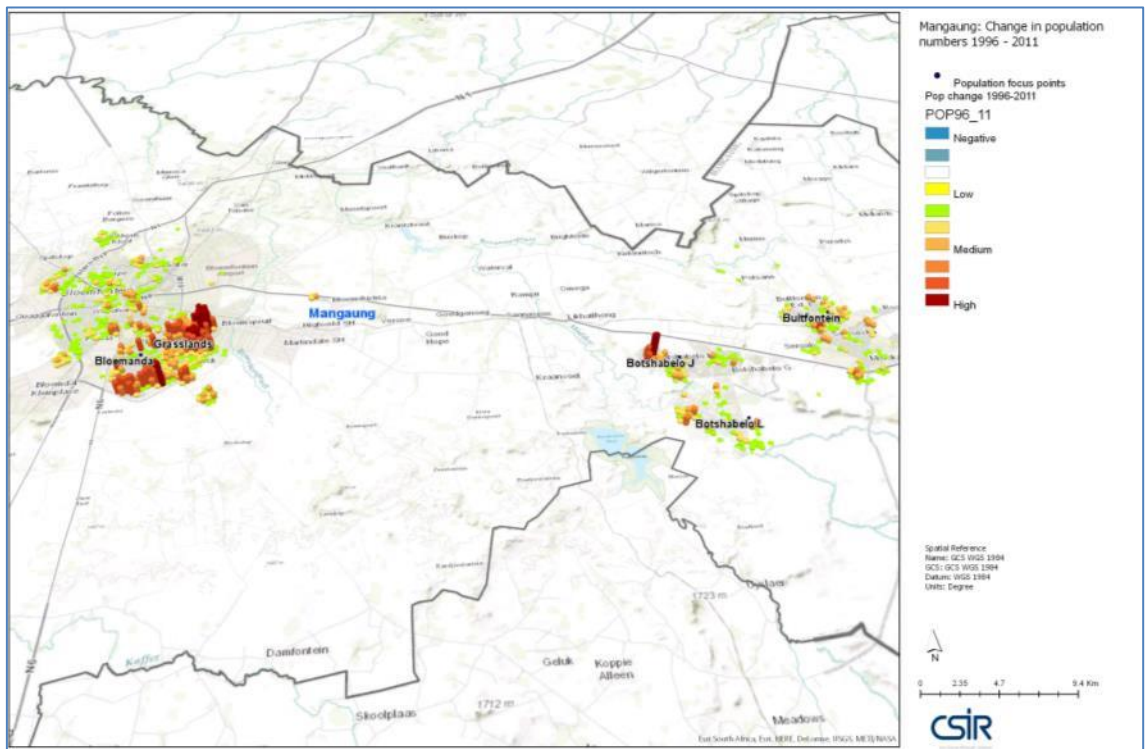

Figure 6: Population growth 1996-2011 - Mangaung (Maritz, 2015).
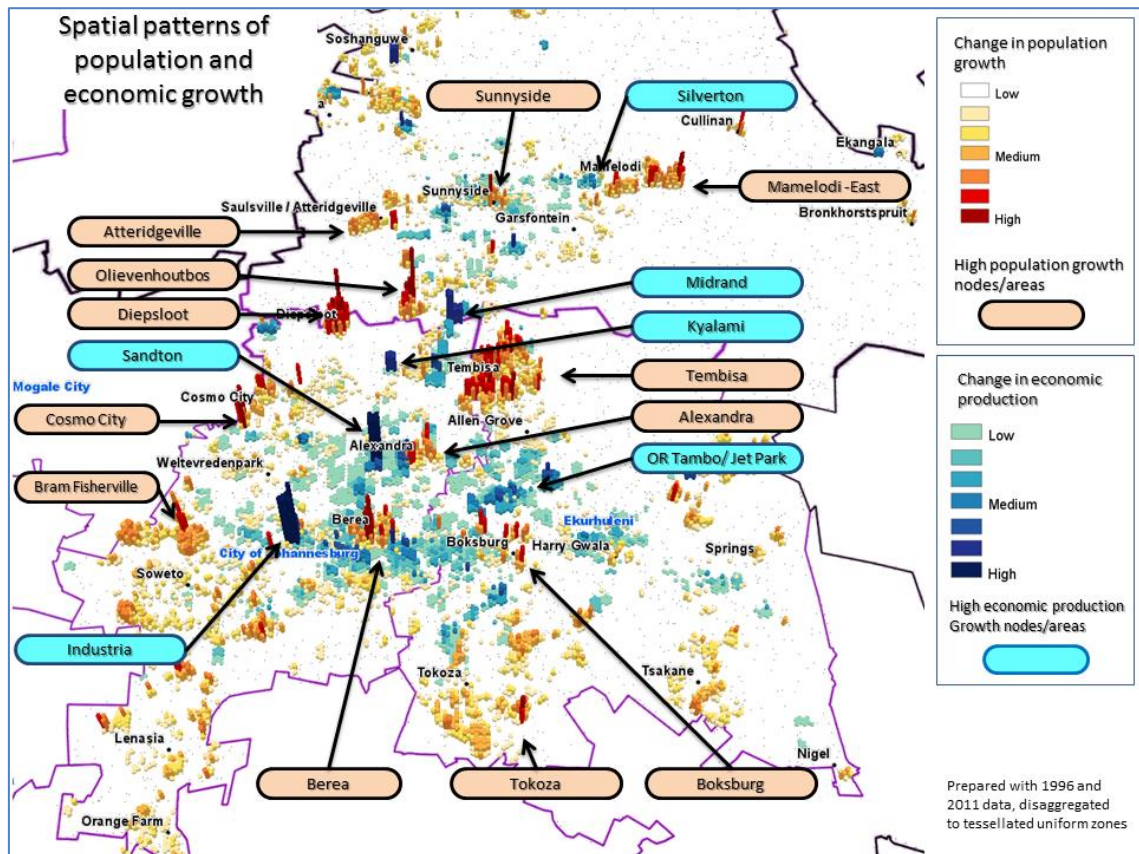
Figure 7: Comparing spatial patterns of population and economic growth (Maritz, 2015).

Considering the locational and strategic planning context it then becomes easier to judge the result of policies such as densification, corridor development or economic development growth points. Comparing planned with actual development can assist in informing planners and city managers whether their efforts in transforming cities, in line with their spatial plans, are succeeding or not. The contribution of the spatial concentration and growth indicator is, however, not merely in the identification of patterns as illustrated above, but even more so in enabling advanced spatial analyses related to comparison of patterns across distance bands and over time. An example of comparison of areas across different distance bands is done by developing line transects. See Figure 8 that uses uniform distance intervals, drawn from this newly developed socio-economic sub-city indicator dataset, where the values are truer when considering distribution and distance than datasets that vary in size. A statistically unbiased representation is created because the units along the transect are regular.
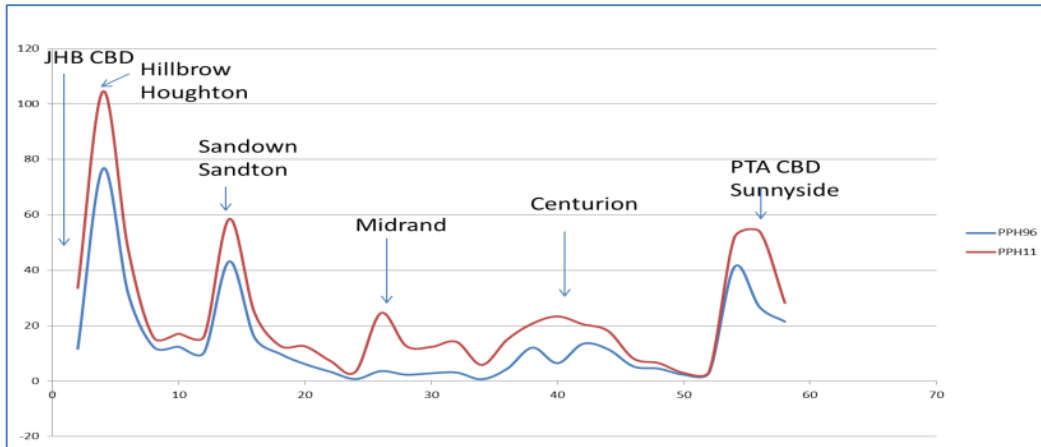
Figure 8: Linear transect from the JHB CBD to the PTA CBD reflecting the change in population comparing 1996 to 2011 (Napier, Le Roux, & Van Heerden, 2016).

In the same vein, comparison of areas across different time scales can be done by developing 'heat contour' maps (see Figure 9) that also use uniform intervals, where this newly developed socio-economic sub-city indicator dataset enables comparison across time scales whilst data gathering and sub-place area boundaries have shifted.
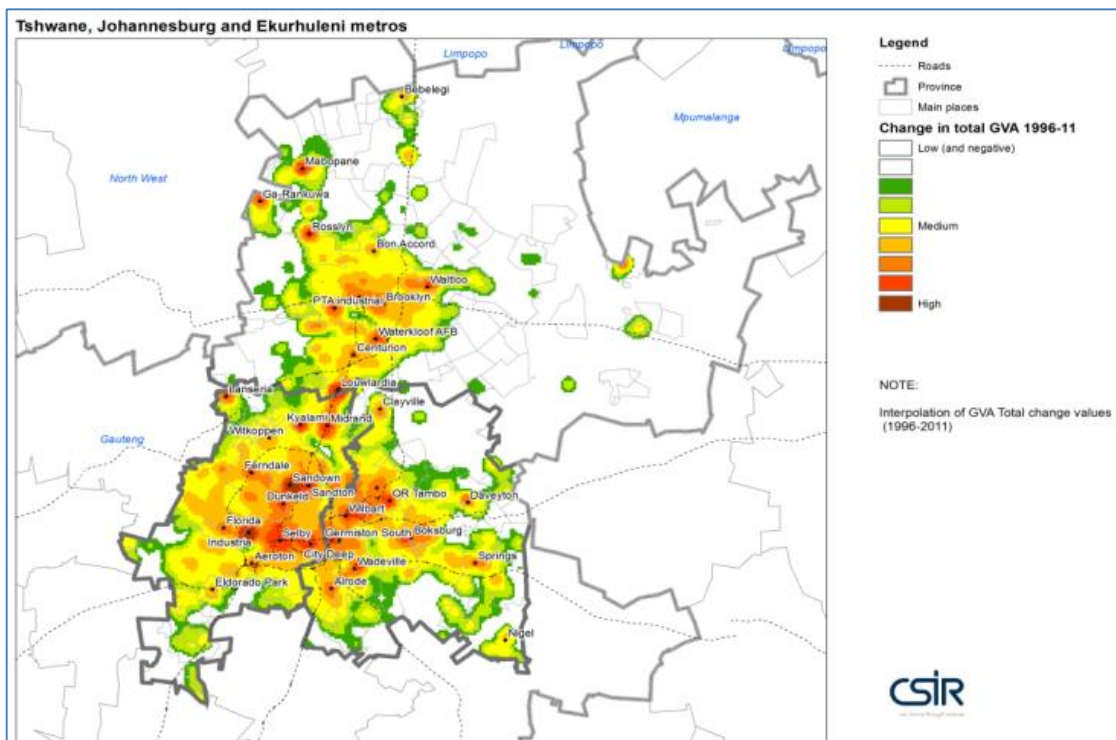

Figure 9: Economic nodes in the Gauteng city region, following the JHB CBD to the PTA CBD transect, reflecting embedded patterns of economic concentration between the time periods 1996 to 2011 (Maritz, 2015).

3.4   Value and contribution of the sub-city spatial change indicator, and possibilities going forward

Although there are numerous indicators aimed at measuring city performance, most utilise only city-level information. This does not reflect the spatial realities underlying change, development or even decay. We need to also apply more information at a sub-city scale. Such information

allows planners and researchers to investigate whether their policies/strategies are having the intended effect. Also critical is that when change is reflected, this also requires that spatial units remain constant (or alternatively it would require an adjustment process where spatial extent has changed). As indicated it is unlikely that a single indicator can measure spatial transformation.

A current reality is that several sub-city indicators exist but they are also based on different spatial units. This presents a problem when needing to combine them or to test for the correlation between indicators. The type of indicators used will differ. For example, the population and economic change can be seen as indicators of intensity, while items such as racial change will be an indicator of diversity.

By adding other information such as age-groups, household income, etc. more differentiated views can be created to depict the relative concentration of vulnerable groups, housing need, service requirements, etc.

4. Reflections and conclusion

Continued urbanisation and societal inequalities present a challenge in ensuring that spatial change and investment in South African cities are orientated towards achieving the outcomes of spatial transformation. To contribute towards achieving spatial transformation objectives, and tracking progress in this regard, the need for the development, extension and use of spatially and temporally aligned sub-city level indicators is evident.

It is crucial to support the wide range of ongoing indicator initiatives in South Africa and internationally, and to strive for the use of trustworthy official data. However, there is also a need to explore the benefits and improvement of spatially refined and aligned sub-city indicators that can provide spatially-specific views on place-specific progress and challenges in the endeavour towards spatial transformation.

The innovative approach and findings of the endeavour to develop spatio-temporally aligned sub-city level indicators does not only provide a solid baseline to track change in cities in South Africa, but also provides a basis to explore and improve the development and value of such spatial-specific indicators within the context of developing countries and fast growing cities. In reflecting on the research and development process, the team and authors identified a number of key considerations regarding the development, value and use of such indicators. These can be summarised as:

- The value of place-specific views on population increase and decline in specific parts of cities, and especially in city regions (moving beyond the metropolitan/city borders). An indicator built on a finer spatial granularity is more useful to grasp the spatial realities. It can provide a view of population change in the broader area, and not as an aggregate value.
- In order to create fine-grained socio-economic data it is critical to maintain proxy data sets that are used to assign values to such fine-grained spatial units with confidence, in order to create a representative picture.
- It enables spatial analyses and presentation of change in different ways to make comparative analyses possible. It allows for additional analysis - such as creating transects across city space. Keeping the unit type a constant size also makes for better comparison between cities. Should such tessellations be extended beyond the city boundary it will also indicate cross-border change.

- Although currently available only for nine of South Africa's largest cities, this can similarly be repeated for other cities or even regions. Currently the mesozone data layer provides (similar) information albeit to assist with coarser scale regional-level analysis. Moving beyond Local Municipal indicators provides for better inter- and intra-city views.
- Indicators are often the result of contained data combination or processing, as such it does not represent all realities. For example, depicting economic activity does not include the informal economy.
- There is merit in collaboration when it comes to developing sub-city level spatial indicators. Indicator development should involve the users/ beneficiaries to ensure appropriateness and relevance. Data reference- and working-groups are important to avoid duplication whilst ensuring that items are vetted and aligned to standards.
- Through the stepSA initiative opportunities are sought to enhance the use and sense-making of indicators to measure spatial change and changes in concentration of population and economic activity.

Can sub-city spatial indicators make a contribution (to measure spatial transformation)? This paper presented an approach which uses a fine-grained uniform spatial unit to present change and trend data. Given the importance of measuring change and reporting on spatial planning outcomes, the value of finer-grained information becomes obvious. Considering the examples used it is clear that this is useful in judging the extent of spatial transformation in our cities. Much work still needs to be done to test its application with city authorities and to expand information variables. In addition, the monitoring and evaluation space is filled with indicators often only presented at city-scale. Collaboration between institutions/departments can reduce the burden placed on municipalities and might even result in the provision of a range of comparable sub-city indicators being developed. Having a shared framework against which to measure spatial transformation will also be beneficial in answering this question.

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