MAPPING GREEN INFRASTRUCTURE IN THE GAUTENG CITY-REGION

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Introduction

Green infrastructure (GI) has emerged as an alternative approach (or partner) to traditional infrastructure in light of the growing demand for infrastructure and services, and the negative impacts associated with traditional approaches. In order to adopt this new approach it is critical for decision makers to understand the extent and distribution of green assets that make up the GI network. Mapping using geographical information systems and remote sensing are thus critical for informing decision-making. GI mapping can provide information on inter alia which areas have inadequate access to GI and ecosystem services, and where GI investments could help address infrastructure needs or reduce disaster risk.

Over a number of years the Gauteng City-Region Observatory (GCRO) has used spatial analytics as a key component of the Green Assets and Infrastructure project to build the argument for incorporating GI into urban and infrastructure planning in the Gauteng City-Region (GCR). This poster tracks the GCRO's GI mapping and how our spatial analytics has evolved over time to better inform policies and decision-making.

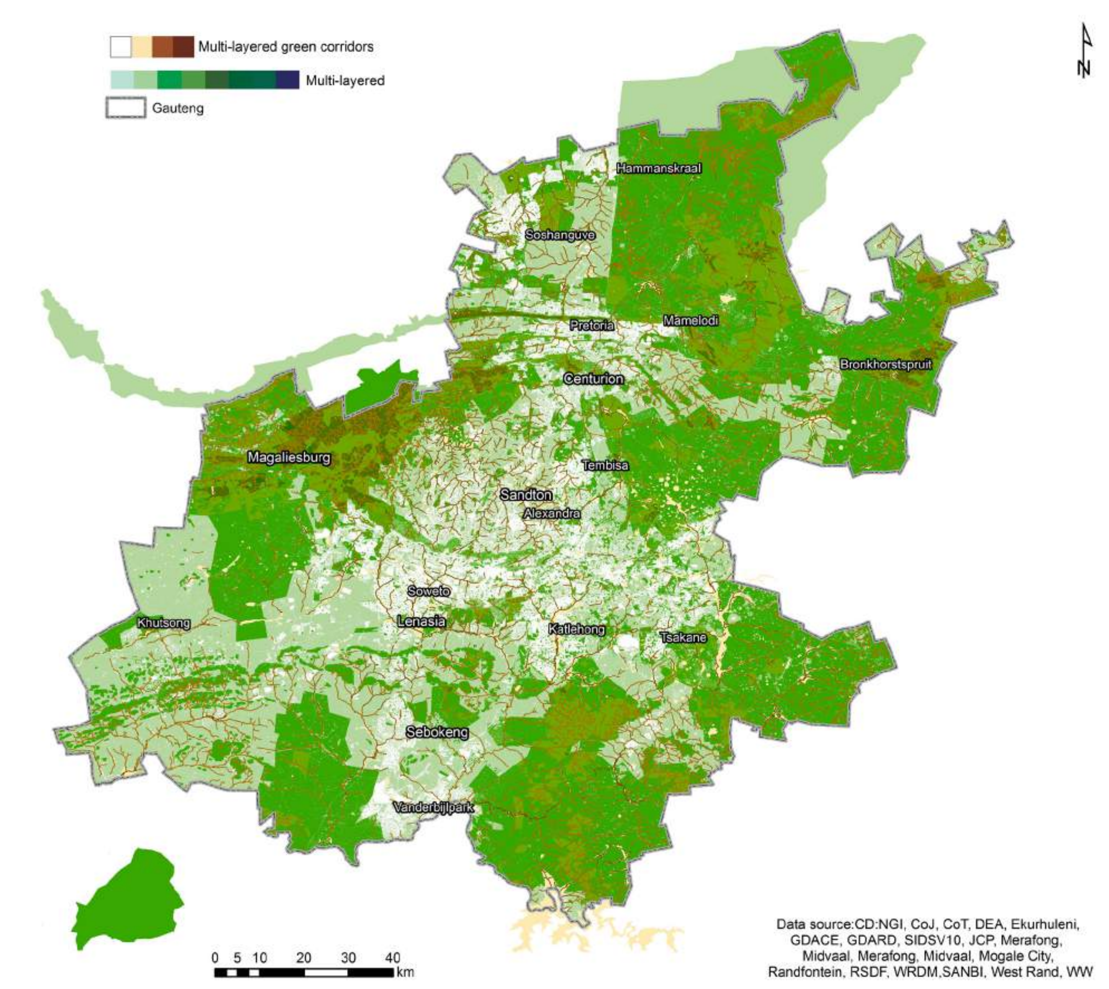
Green Infrastructure (GI)

GI is the interconnected set of natural and manmade ecological systems and green spaces that can provide services in a similar way to traditional infrastructure. A GI network includes ecological features (e.g. trees, plants, grasses, wetlands) and constructed features such as green roofs, rain gardens and bioswales.

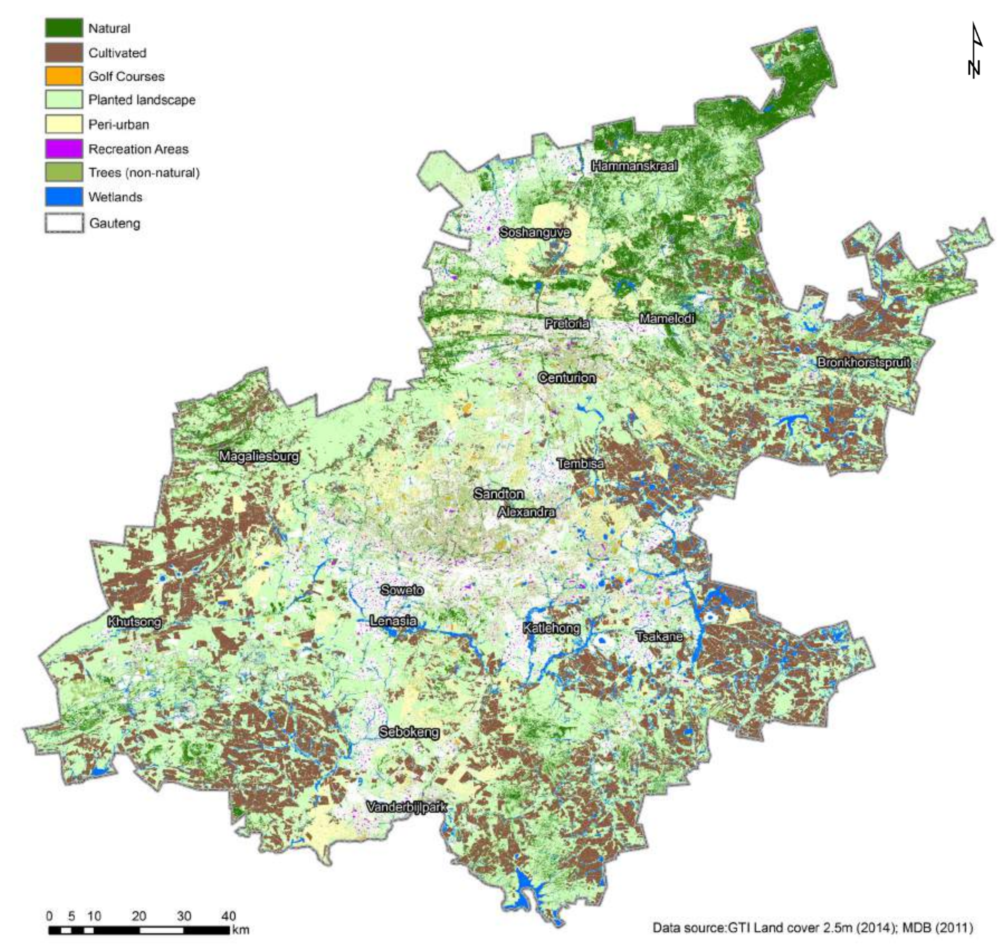
GI provides a range of services such as flood attenuation, air and water purification, erosion control, temperature regulation, noise reduction, and aesthetic and recreational values. Through providing these services GI can help build urban resilience, improve quality of life, reduce negative impacts of urban development, and mitigate and adapt to climate change.

GI networks can be designed to support, replace or be used in tandem with traditional infrastructure networks. Through deliberate planning, GI can be used to meet the demand for urban infrastructure and services through preserving, maintaining and investing in urban ecological systems.

1. VISUALISING GAUTENG'S GREEN INFRASTRUCTURE NETWORK



2. GREEN INFRASTRUCTURE IN GAUTENG MAPPED BY TYPE



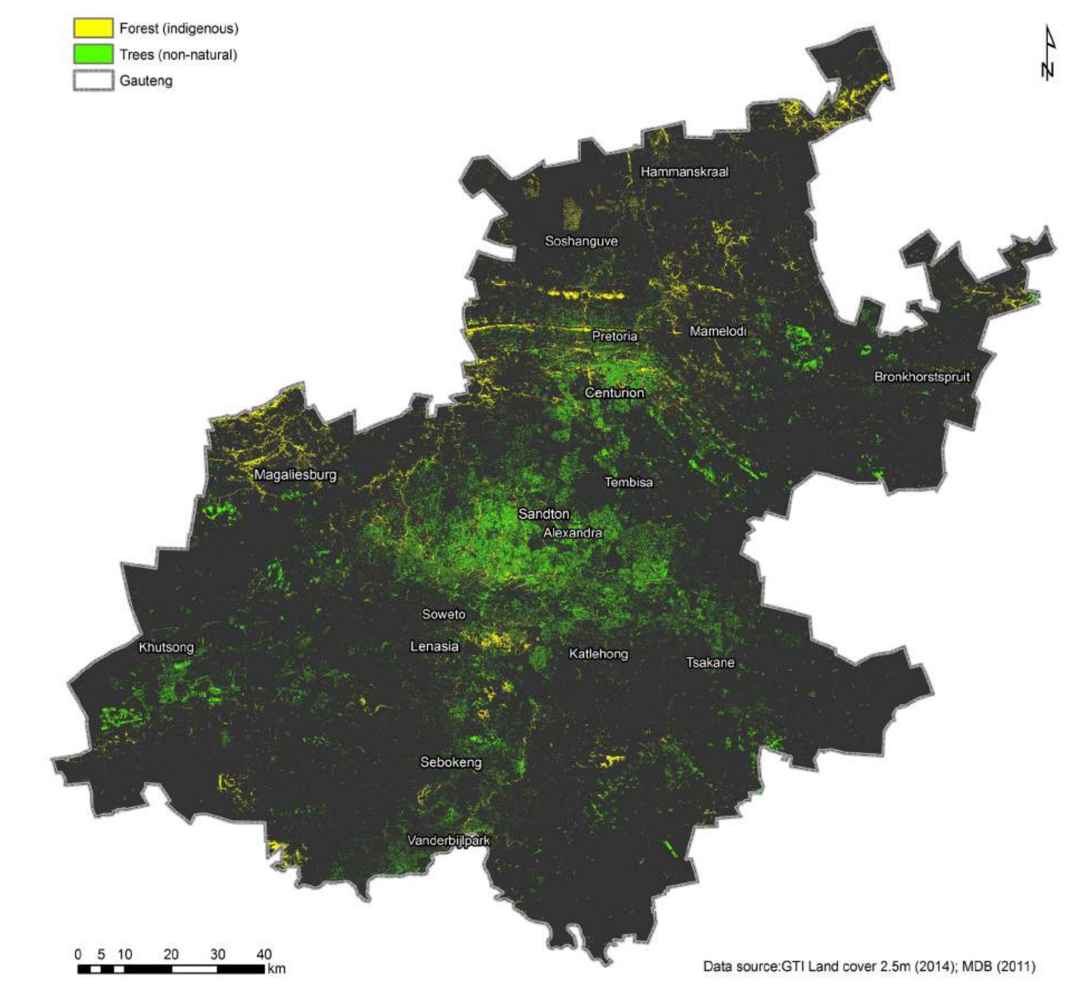
Early Mapping Work and its Challenges

The GCRO's initial work mapped distribution, connectivity and access to green assets in the GCR. Map 1 illustrates the multi-layered GI network, which combines a range of green asset datasets. This representation is suggestive of the interlacing of concepts including conservation, land development and man-made infrastructure planning that inform GI planning (Benedict & McMahon, 2006). While this map provides a sense of the extent of the GI network, the representation hides the extent of the fragmentation due to land transformation and development that undermines the functioning of GI (Schäffler et al., 2013). In addition to this, map was derived by merging a range of data from various sources, each of which utilised different definitions, typologies and classifications of green assets, which significantly frustrated the ability to map and evaluate the datasets together. This is indicative of the fragmentation across the various data repositories, and the need for standardising data collection and storage practices (Culwick et al., 2016).

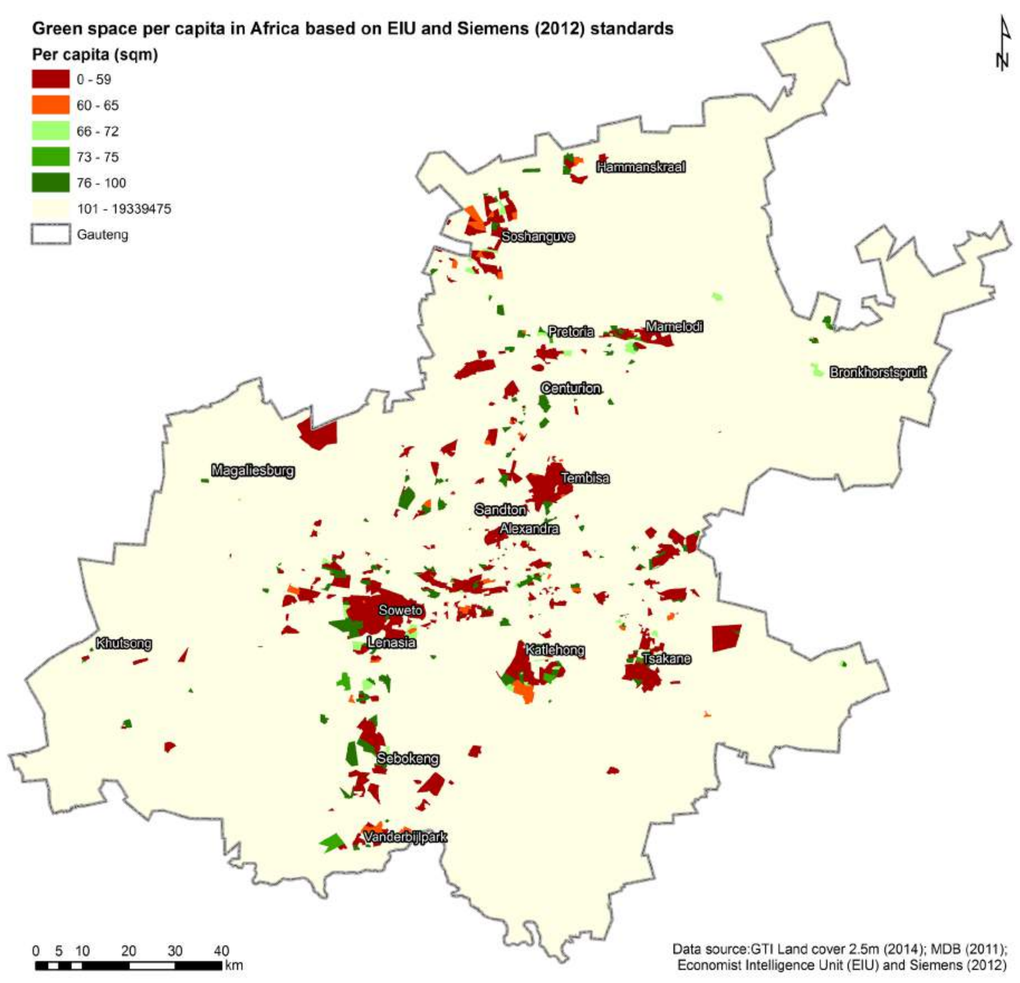
New Data Sources

In attempting to overcome some of these challenges, the GCRO considered alternative data sources, such as land cover data derived from satellite imagery. Map 2 demonstrates how this data provides a more refined and consistent image of GI in the GCR, which provides a more realistic sense of GI at both macro and micro scales.

3. TREE COVERAGE IN GAUTENG



4. GREEN SPACE PER CAPITA



Using High-Res Imagery

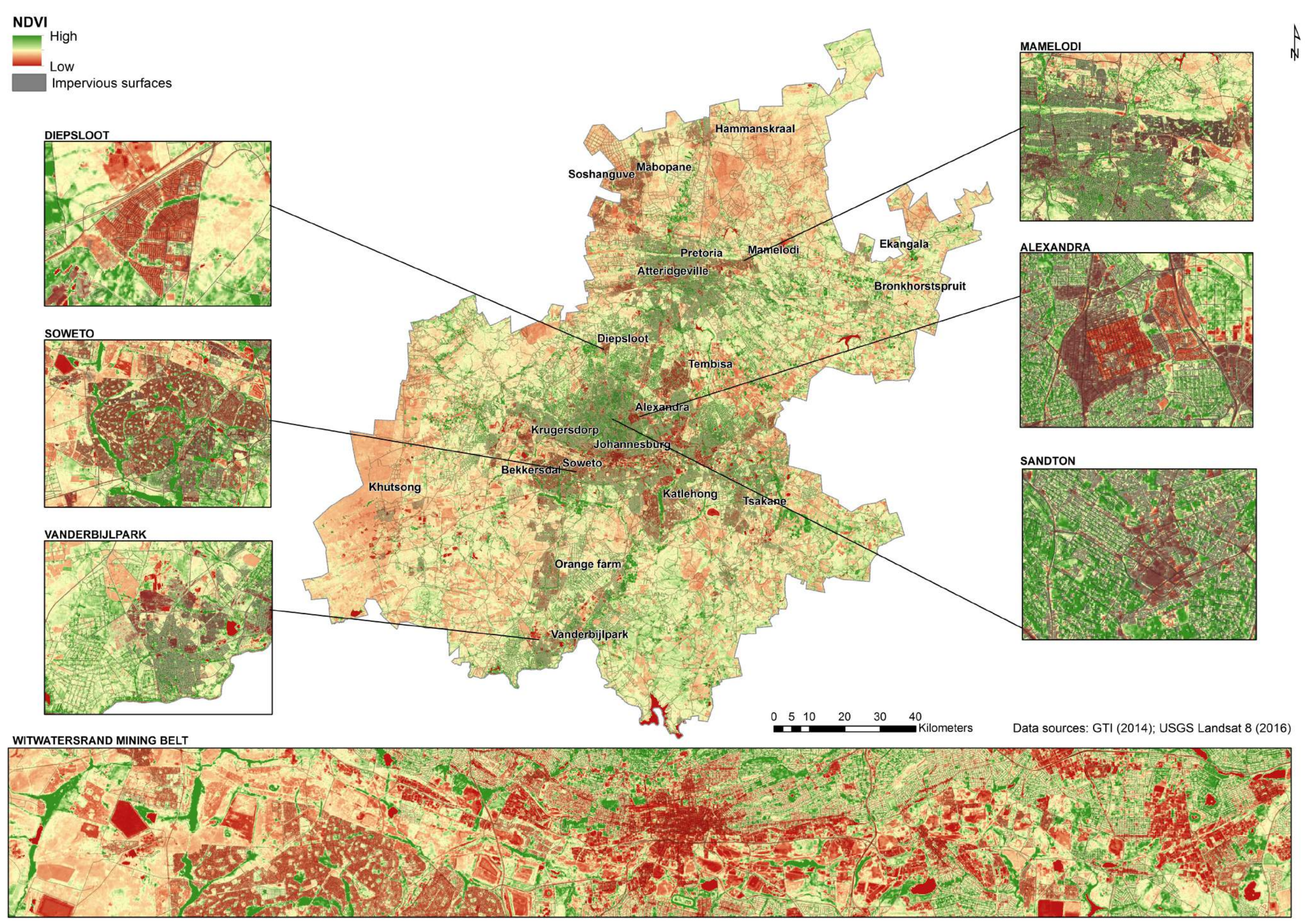
Map 3 illustrates the power of this high resolution satellite imagery in mapping individual assets, such as trees. This map shows both indigenous and planted tree, and importantly reveals the extent of tree cover within the urban core. Trees provide a range of ecosystem services, and these urban trees, although the majority are planted and non-indigenous, provide important services such as shade, air purification and erosion control. Map 2 and 3 demonstrate the potential for satellite imagery to represent more accurately existing green assets than collected data can. The use of remote sensing techniques in GI digitisation also provides the opportunity to create new data and conduct further analysis that can assist with policy development and decision-making.

Mapping Green Space Standards

Ensuring access to GI not only ensures access to recreational space, but also the range of services that GI provide. As such, GI provision is an important component of delivering services and infrastructure, particularly to areas that were historically under-served. Map 4 shows the green space per capita in Gauteng. The green space per capita was calculated using data on the area of some GI types (natural areas, golf courses, school grounds, recreational areas, wetlands, planted landscapes and land types consisting of non-natural trees) derived from land cover data, together with population data at the subplace level. All the green spaces per subplace were added together and divided by the population within that subplace.

Standards have been established both internationally and locally prescribing the minimum amount of green space required per person. Although these standards differ over time and space (Schäffler et al., 2013), they provide an opportunity to compare and benchmark access to GI. The African Green City In dex (Economist Intelligence Unit and Siemens, 2012) recommends a minimum of 60 square metres (sqm) of green space per person. Map 4 and highlights in red the areas that fall below the African Green City Index threshold. Although these maps suggest that residents living on the periphery have greater access to green spaces than those living in the urban core, many green spaces on the periphery have restricted access (e.g. private small holdings, farms and protected areas).

5. VEGETATION AND IMPERVIOUS SURFACES IN GAUTENG



Mapping Vegetation & Impervious Surfaces

Beyond being able to assess the distribution of GI, satellite imagery and remote sensing techniques provide the potential to investigate the state of GI to provide insight into the quality of green assets. Map 6 uses the Normalized Difference Vegetation Index (NDVI) to highlight vegetation and impervious surfaces in Gauteng. Green, on the one end of the scale, indicates healthy vegetation and red, on the other end of the scale, indicates unhealthy or limited vegetation. The areas mapped in grey reflect impervious surfaces.

In many of GCRO's previous maps, minimal green assets were visible in core urban areas. However, this map shows a concentration of healthy vegetation in these areas. This map reveals further that areas such as Alexandra and Diepsloot (see map insets) have virtually no healthy vegetation and instead have extensive impervious surfaces. These increase their risk and vulnerability to flooding disasters. This map demonstrates the importance of investing in GI to reduce disaster risk, and improve quality of life.

This type of mapping can also serve as a powerful indication of the impact of past land use practices such as mining activities on the surrounding environment (see the zoomed-in section of the mining belt). Most importantly, this map provides clear evidence for decision-makers on where investment in GI should be targeted, and demonstrates the consequences of excluding GI from urban planning decisions.

Value in Mapping Green Infrastructure

From a planning perspective mapping of green infrastructure is beneficial as it can provide the following information:

- Which needs are being met and assess whether that is likely to be sustained.
- Where needs are not being met, what can be done through green infrastructure planning and implementation.
- Identify which needs can be addressed using existing green infrastructure and influencing policy and strategies.

Ongoing Projects

- Using Lidar data to digitise tree coverage and extract information on tree height. Trees typically provide more functionality than other green infrastructure and a wider range of ecosystem services.
- Investigate the different ecosystem services and the functionalities provided by different tree species.
- Calculate GI per capita at the Small Area level (SAL).
- Percentage of green infrastructure cover at ward level (already done), next would be to investigate green assets at the land parcel level, look at GI and ecosystem services provided by gardens – and the paving over which poses a problem.
- Investigate different ecosystem valuing tools to find one which is most applicable to the Gauteng context ongoing.
- Investigate the use of Participatory GIS (PGIS) in the mapping of green assets. Also important for getting an insight as to how these communities use the green assets and infrastructure available to them.

References

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