

## **MAF08 PN 09**

### **Presenter**

Stuart Martin  
Director: Business Development  
GeoTerralmage (Pty) Ltd

**Mailing Address:** Po Box 295  
Persequor TechnoPark  
Pretoria  
0020

**Email Address:** [Stuart.martin@geoterraimage.com](mailto:Stuart.martin@geoterraimage.com)

**Fax Number:** +27 (12) 349 0055  
+27 (12) 349 0051

### **Brief Biography**

Stuart Martin has been involved in the geospatial industry for over 15 years, where he has been involved in all levels of GIS implementation. His involvement in the industry covers areas such as the establishment of corporate databases through to the sales, marketing and consulting in the implementation of GIS.

Stuart works at GeoTerralmage (Pty) Ltd, where he is tasked with business development in the fields of remote sensing and image interpretation.



Stuart is passionate about GIS and his involvement with GISSA and many school initiatives has allowed him to grow the awareness of geography and GIS to the community at large.

## **Abstract**

### **Spatially Enabled Datasets characterizing the urban Landscape**

In the urban context, one typically finds a diverse landscape with many physical and human influences. This landscape is also highly dynamic as it changes in response to pressures and influences, whilst trying to provide a harmonious environment for people to live and carry out their day-to-day activities. In between all these human influences, natural systems are also trying to adapt and survive, which results in major land use conflicts.

In this day and age, a large proportion of South Africa's population lives in urban or large metropolitan areas and this focuses a significant proportion of government and industries attention on these areas. Ironically, the urban environment could be described as lacking adequate data, which characterizes this complex dynamic. The metropolitan municipalities do have extensive datasets which describe the areas and provide data for town planning, engineering, development and housing; however these datasets are not always applicable for all applications and are not presented in an appropriate fashion.

The challenge is to be able to develop cost effective datasets which fulfill these data requirements. The paper will discuss the ability to use remote sensing and image interpretation to collect appropriate datasets through a predominantly desktop exercise. The primary users of this data will be Insurance Companies, Banking Institutions, Telecommunication Service Providers, Market Research Companies, all tiers of Government and Retailers.

The datasets highlighted include Land Cover, Land Use, Wireless Telecommunication and Human Settlement, specific datasets. These datasets are complimentary as they are all based on a common foundation; however provide specific and significantly different classifications or spatial representations of the phenomena being mapped. These various datasets each have a distinct application area, where they provide valuable inputs in the decision making process.

Land-cover is defined as the physical properties of the earth's surface, for which there can only be one component at any point on the earth's surface, e.g. water. Land-use on the other hand is defined as the human activity or activities associated with that particular land-cover. There can be many land uses associated with a specific land cover and in the case of the urban landscape, the land use categories focus on the socio-economic land use activities.

- Land Cover

In typical land cover mapping exercises where extensive and diverse provinces such as the North-West Province are mapped, it is necessary to have in excess of 45 classes to represent and classify the landscape adequately. This detail is however not always necessarily in an urban context and a simplified land cover classification could be used which is very cost effective to capture whilst providing the necessary level of detail. Table 1 illustrates such a simplified urban land cover legend.

Table 1: Simplified Urban Land Cover Classification

<b>Class</b>	<b>Sub-Class</b>
<b>Non Vegetated</b>	<b>Non-Urban</b>
	<b>Urban</b>
<b>Grass</b>	<b>Irrigated Grass</b>
	<b>Non-Irrigated Grass</b>
	<b>Veld Grass</b>
	<b>Veld Grass (Urban)</b>
<b>Bushes</b>	<b>Bushes</b>
<b>Tall Trees</b>	<b>Tall Trees</b>
<b>Cultivated</b>	<b>Cultivated</b>
<b>Water</b>	<b>Water</b>

One of the applications of this simplified data is the mapping of sealed, hardened or impervious surfaces. This allows the storm water engineers to model the amount of runoff from an area. The dataset also highlights the open spaces in the urban areas and quantifies the conservation status of these small pockets of vegetation which occur within the urban edge. This data has recently been used to assist with wetland delineation and the modeling of habitat suitability within an urban context.

A comprehensive Land Cover product can also be developed, which would contain in excess of 30 Land Cover classes, which would be required to classify the urban landscape in detail. Figure 1 illustrates the land cover for the area around Cape Town International Airport.

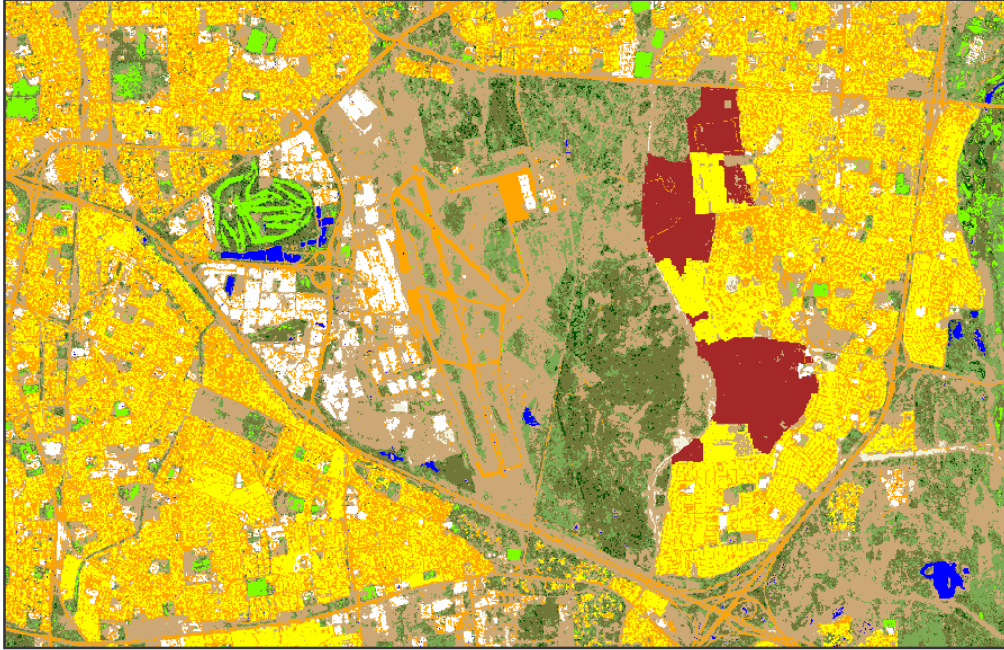


Figure 1: Urban Land Cover around Cape Town International Airport

Land cover data is captured through traditional remote sensing and image segmentation techniques. Utilizing the multi-spectral capabilities of a sensor such as SPOT 5, one can extract information which is verified and where necessary refined manually. It will be possible to repeat this process on a regular basis to model changes.

- Land Use

The socio-economic land use of an area is the interpretation of the human activity which is influencing the land cover. As the urban landscape is already divided into cadastral land parcels, which typically infer a single land use activity, the urban land use data is developed to link to this cadastral fabric.

Where the land parcels are large and do represent multiple land use activities, these can be reported separately. The interpretation of the land use activities is a manual process which is carried out by image interpretation specialists utilizing high resolution imagery and other supplementary data. The land parcels are classified into the following land use classes as illustrated by Table 2:

Table 2: Urban Land Use Classes

Class	Sub-Class	Description
Commercial	Commercial	Commercial, retail and offices
	Industrial	Manufacturing and storage
	Mining	All mining activities
Community	Community	Place of worship, museums, community halls etc
	Education	Schools, colleges, university, etc
Government	Government	Military, etc
	Services	Health, cemetery, waste disposal, substations, reservoirs, sewage works
Open Area	Open space	Includes agriculture and other non defined land uses
	Park	Urban parks, conservation areas, etc
	Recreation	Golf, race tracks, stadiums, sport grounds, etc
Residential	Cluster housing	Town and cluster housing
	Formal housing	Formal housing
	High Rise	High rise flats
	Informal housing	Areas where the majority of the housing structures are informal
	Small holding	Agricultural and residential smallholding
Transportation	Air	Airfield, airports, other
	Other	Railway stations, taxi ranks, etc
Unknown	Unknown	Land use unknown

In most cases, historical imagery is available and it is possible to build up a temporal dataset which illustrates land use change over a period of time. This allows users to understand and visualize the dynamics of an area.

When integrating Land Cover and Land Use, one can use the changes in Land Cover as an indication of changes in the land use activities which are occurring over an area. This ability to map or model these potential changes illustrates the complimentary nature of the datasets.

- Telecommunications Planning Data

The telecommunications companies typically require a dataset which, in conjunction with an accurate digital terrain model, allows for the modeling of wireless signal propagation across space. This dataset represents a combination of land cover and land use as classified according to signal propagation, specific requirements.

With the incessant need for faster communication, the data requirements are increasing exponentially to respond to these demands. The positioning of cell phone towers is a good example, where the demand for wireless

communication needs to be fused with the potential environmental impacts to provide the necessary compromise.

This data is captured using a combination of remote sensing and image interpretation and is presented as a raster dataset which can be imported into a radio propagation planning tool. There is a strong overlap between the telecommunications planning data, land use and the land cover datasets. This allows one to derive some of the information from data which has already been captured, therefore reducing the costs.

As the communications industry continues to grow, these datasets will be complimented by three dimensional data representing buildings or land use, which will provide the necessary level of detail for the next generation of wireless communications. The data is not only useful for the cell phone or broadband service providers and can be used in point-to-point microwave applications where a municipality may want to link two or more buildings together.

- Human Settlement

For most applications, the demographics of an area are crucial to assist in planning, marketing and servicing of the area and its population. As it is not possible to determine population through a desktop exercise, a dwelling count is conducted on all household dwellings. For all residential cadastre, points are captured for each residential structure as visible on either high resolutions aerial photography or satellite imagery. The dwelling structures are classed into four classes as highlighted in Table 3.

Table 3: Residential Dwelling Classification

Description	Position		Classification	Name	Number of Units
	Point	Polygon			
Formal	X		X		
Informal	X	X	X		
Small Holding	X		X		
Cluster / Complexes	X		X	X	X

In the case of the cluster developments or complexes, the number of units and the development names are collected from a combination of Title Deed information and field surveys.

This data allows one to infer population numbers by applying a factor in calculating the number of households and therefore population of an area. The data as represented by a series of points, which can be used in GIS analyses to understand development trends, growth and the densification of areas. The data can be collected for multiple years, therefore providing a time series of dwelling growth and changes

These four derived spatial datasets provide a comprehensive suite of information which can be used for planning and decision making across a municipality. Figure 2 illustrates the various datasets for a given area and how they vary.

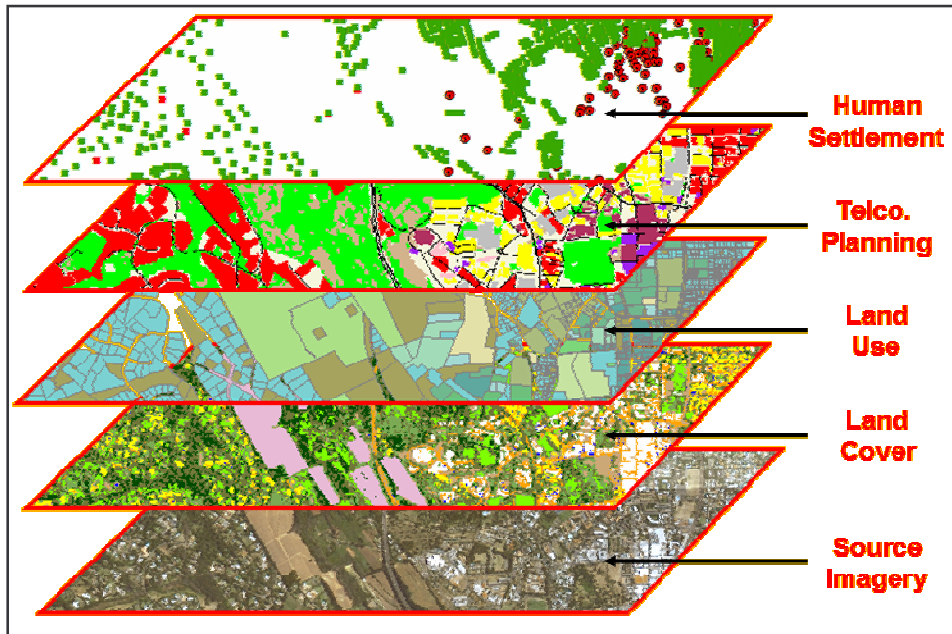


Figure 2: Spatial Datasets Characterizing the Urban Landscape

In summary these datasets can be captured effectively from high resolution imagery by skilled remote sensing and image interpretation specialists who understand the various application areas. This ability to produce consistent and up-to-date data across a municipality provides a valuable planning tool which can be applied at any level from a local retailer through to a national organization working across municipalities. The ability to model changes over time is also crucial as it allows one to understand the underlying dynamics of an area.

This presentation will discuss on the various datasets and their applications. Where applicable, the data capture methodologies and limitations will be discussed *in lieu* of enhancing the workflows and the development of other derived datasets.

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