The strategically located land index support system for human settlements land reform in South Africa

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Abstract

Creating sustainable human settlements is fundamental in fostering spatial and socio-economic integration in South Africa. Policy makers are often faced with the problem of identifying strategically located land for human settlements land reform in South Africa. To date there is no tool or standard framework that assist the government to identify land that is strategically located for land reform. This study proposes the use of geographic information systems (GIS), earth observation (EO) data and multi-criteria decision making (MCDM) to develop a strategically located land index (SLLI) deployed in a web viewer to identify land that is smart for human settlements land reform. The study demonstrates that using the GIS and EO and the GIS webserver are invaluable tools in facilitating streamlined, coordinated, standardised and evidence-based decisions for human settlements land reform. However, there is need for capacity building in government departments responsible for land reform and development planning

Keywords: GIS-MCDA, land reform, located, AHP, human settlements, South Africa

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1.1 Overview of land reform in South Africa

Historical land dispossession including the discriminatory laws enacted by in the past South Africa such as the infamous 1913 Natives Land Act had a profound effect on marginalization of the majority of the population, particularly blacks in access and ownership of land. Various programs such as Settlement Land Acquisition Grant (SLAG) (1996 – 1999) in which beneficiary groups pooled their grants to acquire land then farm as a group, Land Redistribution for Agricultural Development (LRAD) (2000 – 2009) amongst others seeking to create a significant class of black commercial farmers, and Proactive Land Acquisition Strategy (PLAS) since 2010 which switched from demand-driven land acquisition approach to a supply-driven one have sought address and correct this legacy through land restitution and redistribution. Although PLAS has only recently been introduced, it has had the largest impact. Notwithstanding these efforts Land Reform has had difficulties in achieving the three broad thrusts of the Programme that it sought to address in 1994, which include the strengthening of tenure rights for the rural poor, to facilitate land redistribution to those who had been dispossessed under apartheid and to redistribute 30% of agricultural land to the poor with only 6 million hectares of the 25 million targeted for resettlement being achieved. Moreover the land reform had a rural bias without making a significant impact in improving spatial integration in urban areas.

The development of cities and nations is underpinned by the existence of sustainable human settlements. The quality and aesthetics of housing as well as its proximity to other related urban amenities such as schools, road networks, places of worship and open spaces, and economic opportunities form the bedrock of sustainable human settlements. In building houses, land becomes 'an up-front component'(Huchzermeyer, 2003, Harrison et al., 2003). The availability and accessibility of land as well as its proximity or distance from other supporting physical, social and environmental infrastructure determines both the functionality as well as the desirability of housing.

In South Africa, the colonial and apartheid spatial planning practices deliberately created cities, towns and homelands fragmented on racial and ethnic lines (Harrison et al., 2003). As a result of these practices, non-whites, particularly black Africans were located in townships as well as hostels far removed from the needed urban amenities such as water, electricity, schools and places of entertainment. The so-called 'white cities' (i.e. where white people resided) on the other hand were well positioned spatially, and well serviced with all the amenities needed for a fulfilled urban life. The fact that black townships were located far from areas with economic potential rendered them not strategically located from a service delivery point of view. Put succinctly, the current housing challenges in South Africa have its roots in the history of land dispossession and policies. Therefore there is a strong need to identify land that is strategically located to make to ensure spatial and social integration.

South Africa's skewed land ownership patterns are further complicated by the global and local calls for sustainable environmental planning. The realities of climate change and the subsequent threats to food security and development at large, requires the state and its developmental partners to preserve natural capital. South Africa therefore finds itself in a space where demands for social justice at times compete with international obligations for protecting environmental assets. As Crane (2006: 1036) posits the balancing the tensions between relationships between poverty, inequitable access to resources, and the protection of biodiversity, remains a challenge to the government. The creation of biodiversity and mega-reserves on one hand and the demands for developments in the built environment requires a scientific approach that can assist the state to ascertain the best-possible land for these competing activities. Hence the significance of a geographic multi-criteria approach to land identification proposed here.

1.2 Decision support systems and GIS

To make rational decisions for complex problems planners often employ decision support systems (DSS). A decision support system is a set of solution mechanisms that help decision makers to assess complex decision making processes and to solve problems with the help of information and communications technology tools (Dur et al., 2009, Keenan, 2006). This definition incorporates two main properties; polices which involves making decisions and secondly technology with computational problem solving tools. Spatial planning requires a special DSS commonly called a Spatial Decision Support System (SDSS). Using SDSS to identify land suitable for various purposes is well entrenched in literature.

Numerous studies have been carried out that shows that the lack of carrying out of land suitability analysis especially for human settlements can result in degradable land and settlements not being smart (Hanashima, 2002). Scholars within the field consider that giving land that is not suitable for such use will result into environmental cost (Sikor et al, 2009). Feizizadeh et al. (2013) stated that land suitability is also important as every portion of the landscape is characterised by different set of features that render it more suitable for certain uses than the other uses. This concept of land evaluation or land suitability uses efficient tools in evaluating land capabilities and the next sections below will discuss them in details.

1. 2. 1 Multi Criteria Decision Analysis (MCDA)

MCDA is regarded as a powerful approach to land suitability and in terms of decision of allocation of land for certain uses. According to Belton et al. (2002) it is a suite of methodologies that can assist decision makers to choose between competing factors. It is a family of techniques that aid decision makers in structuring multi-facet decisions formally and also evaluating the alternative (Greene, 2003). Malczewski (2006) defined MCDA as a collection of techniques for analysing geographic events where the results of analysis depend on the spatial arrangements of the events. Furthermore Greene (2003) stated that MCDA is mostly concerned with how to combine information from numerous criteria to a single index of evaluation.

1.2.2 GIS in decision making and spatial planning

Individuals tend to make decisions that tend to require additional information such as how to allocate strategic land for human settlements reform programme. According to Breytenbach (2005) some of those decisions are simple while others require considerable related information before the decisions can be made. Decision-making in this context can be defined as the process of evaluating the alternative and choosing a course of action in order to solve a problem (Cowlard, 1990). GIS has been used to develop land use suitability models to facilitate in decisions in land use planning (Zhu et al 1998). GIS is also used to solve complex spatial problems by employing its software and hardware systems that allow it to manipulate, manage, model, represent and display geo-referenced data used to solve such problems (NCGIA, 1960).

However there have been arguments that the current GIS technology is inadequate in decision-making capabilities (Malczewski, 1999; 2003). Furthermore its isolation application cannot fully address complexities associated with resource management in this case it will be managing how strategic land for human settlements is allocated for land reform (Laskar, 2003). There are also various limitations associated with GIS in this context such includes its incapability of representing judgements, values, arguments, (Laskar, 2003). According to Eldrandaly (2007) GIS has limited competences of combining the decision maker's preferences and heuristics into the problem-solving process but it can be regarded, as is a great tool for handling physical suitability analysis. In other words GIS can assist decision makers with spatial information and it is incapable of provide decision maker with information for decision support. For GIS to assist fully in spatial decision making it needs to be able to facilitate the following spatial analysis concepts, namely: selection, manipulation, expropriation and confirmation. As a result there is need of combining GIS with other approaches used during land suitability analysis to create smart human settlements.

1.3Problem statement

A number of frameworks including legislation have been introduced since 1994 to support government developmental strategies including land restitution and redistribution. To accelerate the rate of land redistribution and restitution in South Africa, the government seeks to follow a structured approach to land acquisition. Cabinet decided in 2009 to implement the Comprehensive Rural Development Programme (CRDP), and use it as a blueprint for land development and use. It was determined that quality of land and its location are critical when acquiring land. The DRDLR does not have a guideline or framework that clearly outlines what land we refer to as "strategically located" for human settlements. Moreover according to the national Development Plan, there is a strong desire to create smart and sustainable human settlements. Therefore the aim of this paper is to develop a strategically located land index (SLLI) that can be used by decision makers to identify land that that is considered smart for human settlements land reform.

1.4 Approach and Methodology

This section provides a step-by-step approach on how the SLLI for human settlements land reform was developed. Identifying land suitable for land reform is a complex process. The approach taken to develop the SLLI involved using GIS-MCDA. A consultative, participatory, anticipatory and collaborative approach was employed to improve user acceptance within the DRDLR (Figure 1).

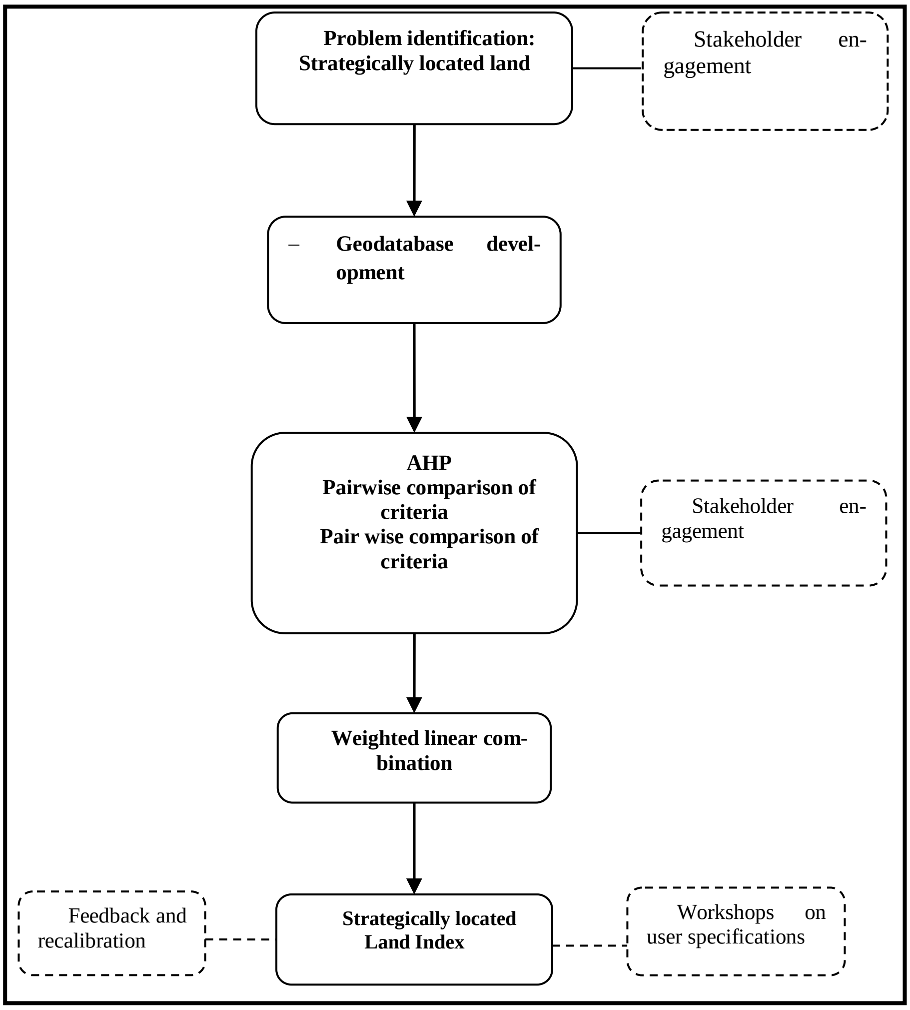

Figure 1: Procedures for developing the Strategically Located Land Index

Criteria identification was carried out through participatory planning workshops. An initial workshop was conducted in September 2013, which consisted of professional experts in government departments, consultants, and policy makers. Most of these were officials from various sector departments such as Rural Development and Land Reform, Economic Development, Human settlements, Agriculture and Cooperative Governance and Traditional Affairs. Selection of the criteria was guided mainly by national policy documents and legislation such as the National Development Plan. The workshop resulted in criteria which were group into seven broad themes namely proximity to economic development corridors (EDCs), proximity to strategic infrastructure projects (SIP), proximity to infrastructure, linkages to social amenities and markets, land with unique resources features that provide a competitive advantage, vital infrastructure for social and economic development. These themes produced over 30 criteria, which would make it impossible and complex to develop a GIS tool. Accordingly, a core team was appointed to streamline the criteria. Literature and human settlement guidelines were also consulted extensively in criteria selection. Consequently, the number of criteria was kept as low as possible (15) for human settlements criteria (Table 1) to make a well-informed decision and also to reduce complexity and/or redundancy. Similarly, the criteria have to be logically sound and consistently relate to the objective and problem as well as being realistic, transparent, simple and minimal.

Table 1: Criteria weights for human settlements

Criteria	**Weight**	**Rank**
Proximity to cities and towns	22.8	1
Proximity to roads	14.4	2
Proximity to mining deposits	9.9	3
Proximity to EDC	8.9	4
Elevation	8.5	5
Proximity to SIP	8	6
Proximity to informal settlements	7.2	7
Soil classes	5.1	8
Proximity to railway line	4.7	9
NDVI (Vegetation)	2.8	10
Annual temperature max	2.5	11
Average annual rainfall	2.2	12
Proximity to rivers and dams	1.35	13
Dolomite	N/A	N/A

Table Footnote: NDVI-Normalized difference vegetation index
SIP-Strategic Infrastructure Projects.
EDC-Economic Development Corridors

Workshop participants engaged in an Analytical Hierarchy Process (AHP) for weighting each criterion using a pair wise comparison matrix for the 15 criteria (Satty, 1980; Malczewski, 2006). These participants were experts on land reform such as planners, project managers, academics, NGO's and personnel from relevant government departments. The pair wise comparison matrix asks how important one criterion is relative to another based on a 1-9 scale (Table 2).

Table 2: AHP pairwise comparison

How important is A relative to B	Preference index assigned
Equally important	1
Moderately more important	3
Strongly more important	5
Very strongly more important	7
Overwhelmingly more important	9
Values in between	2; 4; 6; 8

The workshop participants were given a template with 105 pairwise comparisons of the 15 criteria to complete. The template was computed using the AHP calculator by Goepel (2014). Consequently, the participants used the AHP calculator software to create an overall weighting matrix. The pairwise matrix had a consistency ratio of 0.025, which implies that there were no logical inconsistencies in the matrix. The sum of the weight for all the criteria should add up to 1(one). Therefore, deriving the suitability (SLLI) was a summation problem where S_l total score of strategically located land for a land unit is calculated using the following equation (1).

$$S_l = \sum_{i=1}^{n} W_i \; P_i$$

Equation 1

Where W_i of each criterion is calculated using AHP, P_i represents value of each criterion based on corresponding standards and n is number of criterion. The final SLLI was a raster; however for ease of use the SLLI values where extracted to points and accompanying criteria justifying each point was attached using structured querying language. The points where also converted to theisen polygons containing the accompany criteria to improve visualization. Lastly these polygons where calibrated or reclassified to improve usability. Extensive, accuracy assessments was also carried out to determine if the SLI index and accompanying criterion corresponds. The theisen polygons where later plugged into the SLLI web viewer that mangers could use as a SDSS.

1.3.1 Mapping and criteria rule sets

Mapping was divided into two parts (1) data collection and geodatabase development and (2) using the model builder tool in ArcGIS to develop the strategically located index for smart human settlements land reform. All processing was done using ArcGIS 10.2. Data was collected from the DRDLR, the National Geospatial Inspectorate and other government departments. This data was stored into a geodatabase, which was dived into themes, namely environmental/physical and socio-economic GIS layers. This data was assigned Hartebeesthoek_1994 Geographic Coordinates Systems. Rule-sets for each criterion were identified from literature. Accordingly, maps for each criterion were created a using suitability scale of -1 to 2 were 2 is highly suitable, 1 moderately suitable, 0 marginally suitable and -1 unsuitable.

Table 3: Human settlements rule sets

Criteria	Highly suitable	Moderately suitable	Marginally suitable	Unsuitable
Average annual rainfall (mm)	601-800	201-600	801-1000	0-200 and > 1000mm
Annual temperature max	0 – 25 or 25.1 – 27	27.1 - 31	31.1 – 35	>35
Elevation	1200-2000m	200-400m	400-1200m or 2000-2500m	Sea level 200 or >2500m
Soil classes	Sandy soils	Clay soils	Silty or Silty clay	Peat or Muck
Dolomite	Boolean Analysis			
NDVI (Vegetation)	<0.25	0.25-0.49	0.5- 0.75	>0.75
Proximity to informal settlements	<5	5 – 10 km	11 – 15 km	>15 km
Proximity to rivers and dams	<5 km	5 - 7 km	8 - 10 km	>10 km
Proximity to roads	<3 km	3 - 6 km	7 - 10 km	>10 km
Proximity to railway line	<5 km	5 - 10 km	11 - 15 km	>15 km
Proximity to SIP	<15 km	15 - 30 km	30 - 45 km	>45 km
Proximity to EDC	<15 km	15 - 30 km	3 - 45 km	>45 km
Proximity to cities and towns	<7 km	7 - 14 km	14 - 21 km	>21 km
Proximity to mining deposits	<25 km	25 - 50 km	50 - 75 km	>75 km

The overlay-weighted method was used to derive the SLLI for human settlements using *equation 1*.

1.5 Results and discussion

Figure 2 shows the strategically located index for human settlements land reform while Figure 3 shows strategic location for human settlements land reform according to strategic (suitability classes). From Figure 2 it is clear that land strategic for human settlements is mostly located along activity corridors and close to urban areas. Gauteng and Mpumalanga provinces possess the majority of land; however they are also the two smallest provinces in the country. It is necessary for the DRDLR to identify land for human settlements so as to ensure that people are resettled where there are the necessary supporting services and also avoid mistakes of the past where people where settled far away from economic opportunities.

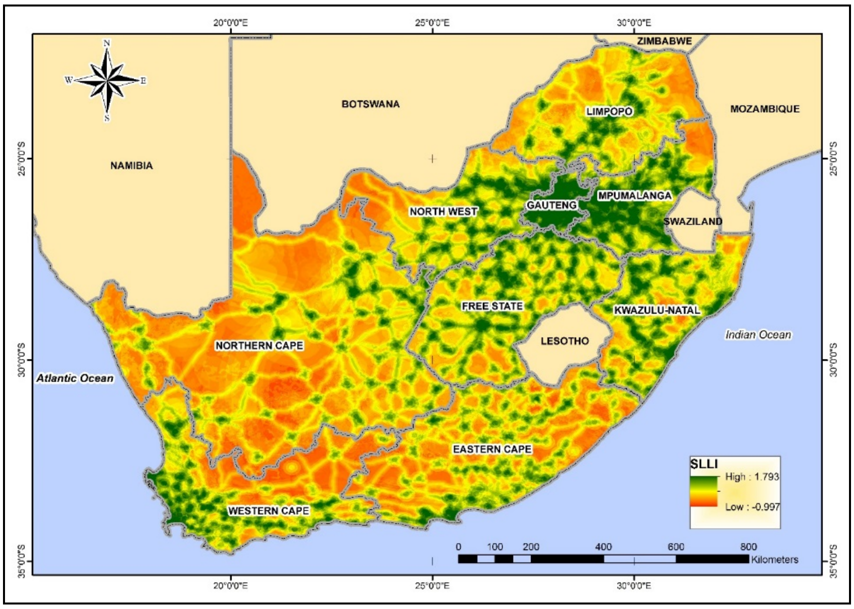

Figure 2: SLLI for Human Settlements

In Kwa-Zulu Natal (KZN) the highly strategic land in a dark green shade is along development corridors. Likewise, in the most strategic land in the Eastern Cape is in the central Eastern Cape. Similarly in the Western Cape the most strategic land is on the Western Cape seaboard and in the South Western Cape as well as the Cape wine lands.

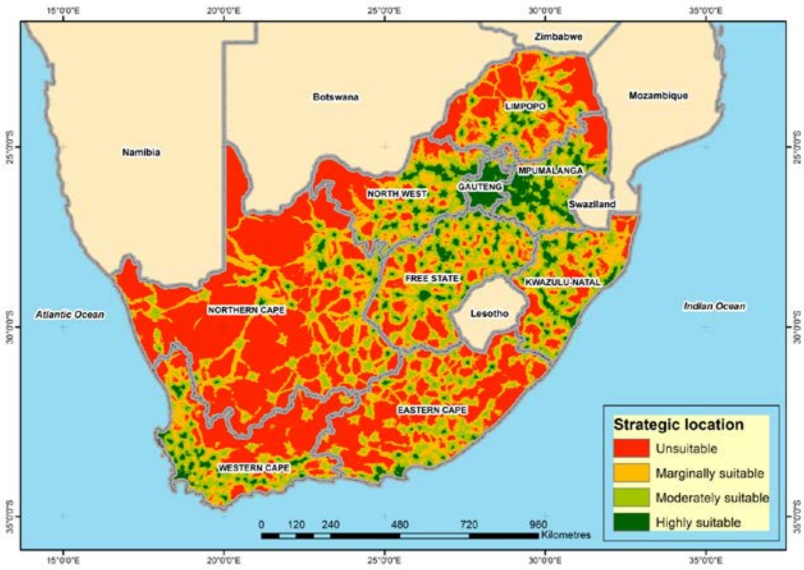

Figure 3: Suitability classes for human settlements

Meanwhile Table 4 gives an overview of the amount of suitable land in the country. Only 7% of the country is highly suitable for human settlements and 18% moderately suitable. These areas have to be targeted, as they are highly accessible, already contain infrastructure and services and supporting land uses. This will most likely lead to further densification and congestion in already established areas which can ultimately lead to inability to promote sustainability. It is also important to note that 46% of the country is largely unsuitable for human settlements. This poses a challenge in distribution of resources and can have implications in migration patterns as well as hampering plans of creating smart cities.

Table 4: Human settlements suitability in South Africa

Suitability	Area (ha)	% Area
Highly suitable	1 659 475.63	7.30
Marginally suitable	44 852 902.42	28.07
Moderately suitable	28 920 911.77	18.10
Unsuitable	74 329 015.65	46.52
Total	159 762 305.47	100

It should be note that suitability for land human settlements land reform is not evenly distributed across the provinces (Table 5).

Table 5: Distribution of agricultural suitability per province

Suitability	Gauteng (% Area)	Limpopo (% Area)	KZN (% Area)	Mpumalanga (% Area)	North West (% Area)	Free State (% Area)	Eastern Cape (% Area)	Western Cape (% Area)	Northern Cape Y (% area)
Highly suitable	69	9	30	21	21	16	2	6	1
Marginally suitable	8	32	23	26	26	36	29	22	21
Moderately suitable	20	13	27	19	19	31	15	15	7
Unsuitable	2	47	20	34	34	17	53	57	70

Gauteng contains the largest (69%) of highly suitable land for human settlements per province, because it is the country's economic hub, highly urbanised area and yet it is the smallest province in land size Statistics SA, 2011). Continued resettling of people in Gauteng is less costly as Gauteng contains infrastructure and services suitable for human habitation. However, there should be caution as pressure on Gauteng will result in congestion, overcrowding, and damage to the environment and strain on services which can lead to reduced carrying capacity if necessary improvements and adjustments are not made. Interestingly, Gauteng is also identified as highly suitable for agriculture (Musakwa et al 2014); therefore there is conflict between resettling for agriculture and or human settlements. Kwa Zulu-Natal contains 30% of highly suitable land and offers a better solution to Gauteng as it is much larger and also contains infrastructure and services particularly along the coast necessary for human habitation. The Eastern Cape, Western Cape and Northern Cape are generally harsh environments mainly due to climatic reasons as they have 53%, 57% and 70% of unsuitable land. The highly suitable land in the Cape provinces is mostly along activity corridors and already established towns along the coastline. For example the City of Cape Town and literature supports that people form the Cape provinces migrate to Cape Town as a result of its suitability and strategic location (HSRC 2010). This is mainly because the neighbouring provinces (Northern Cape and Eastern Cape contain only 1% and 2 % of highly suitable land. Perhaps there is need to attract investment in these areas to improve suitability for human settlements and minimise migration to other provinces. However given the fiscus constraints and economic downturn it is less feasible.

It is important to note that the above statistics and maps are indicative of where to target areas for land reform to establish human settlements. The SLLI therefore provides a scientific procedure of targeting land for human settlements as opposed to the current ad Hoc systems (Hall 2013). Recall the objective of this study is to propose a using GIS-MCDA a technique that is scietificaly grounded in systematically identifying land for human settlemnst. This is unlike the current sysms available at the Housing Development Agency (HDA) which doont emply a stucted MCDA. It should be recognised however that deciding on a piece of land is an optimising procedure, as other factors have to be taken into account. For example the carrying capacity, land uses, dolomitic status, conservations, spatial targeting and issues of global climatic changes. Accordingly, the SLLI was deployed on an ESRI based Server to aid in decision-making.

1.6 SLLI viewer

The SLLI viewer is a web application, developed in Adobe Flex and works across all browsers that have a flash plugin. This is the first step in centralising and coordination of information within the DRDLR. Unlike the raster based information it is vector based and it is meant to simplify information to facilitate decision making and increase usability. Moreover most mangers at provincial level are familiar and work with vector (cadastral data) in their day-to-day activities. The SLLI viewer consists of two main layers containing both the agricultural index (Musakwa et al 2014) and human settlements index with supporting criterion. The purpose of the SLLI viewer is to simplify the daunting task of searching relative information on what land can be best used for. The solution makes available answers to key questions to be asked in order to make the decision on land use.

The landing page for the SLLI viewer is shown in figure 4

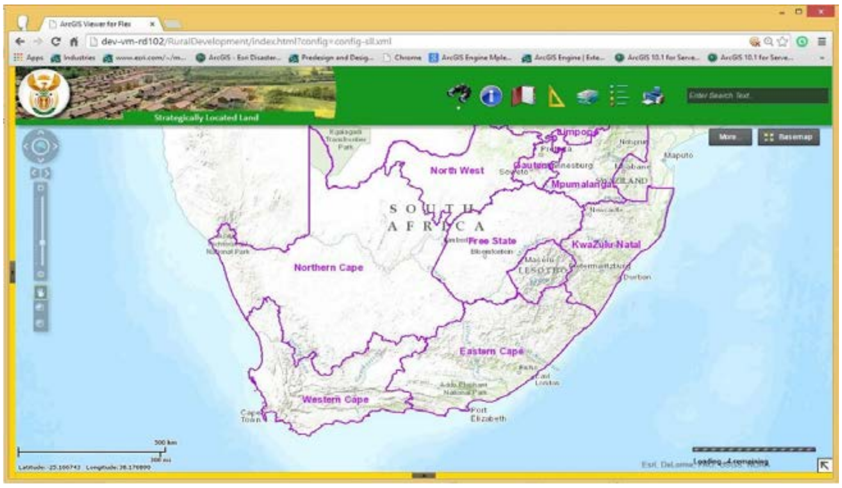

Figure 4: SLLI viewer

The main functionality of the SLL viewer is the search function and reporting function. There are two main functions namely the search by parcel key and detailed search (Figure 5). For this function land mangers can search for the index overlaid on national cadastre wherein decision makers can search for a land parcel using the unique land parcel key known as the 21 digit code (Figure 4). Once the search is complete it collates the average index for that particular parcel as well as accompanying criteria. The viewer also has a reporting functionality that allows users to generate pdf reports and Excel list file for further analysis (Figure 7).

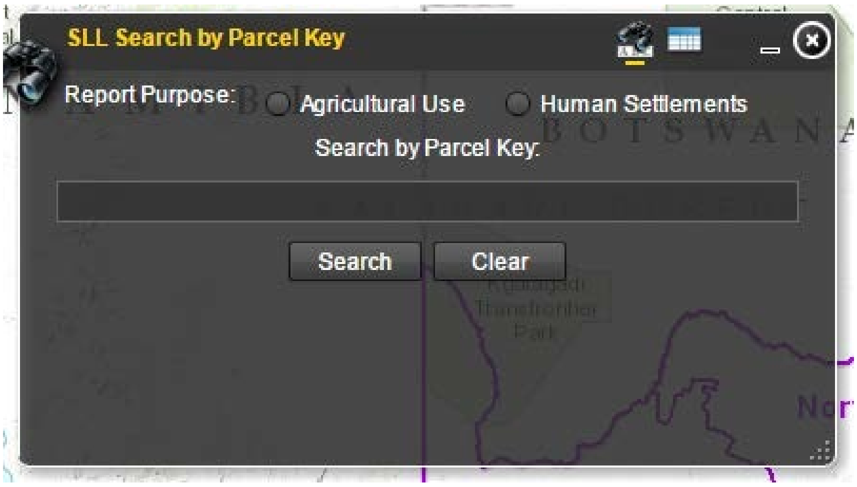

Figure 5: Search by parcel key

On the other hand the detailed search allows users to search for SLLI for human settlements using attributes that are used to filter to the necessary land parcel. This also allows minimizing the results to be returned for reporting and to improve performance on the viewer. Province, District Municipality, Local Municipality are compulsory fields to select before a user can search. These fields are also used to narrow the search to a subset of data and zoom into the area selected.

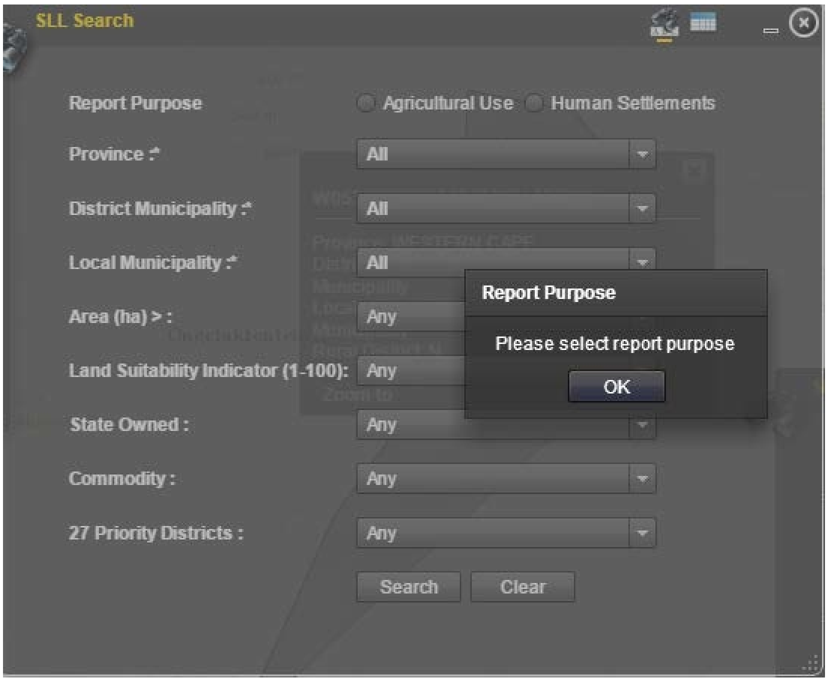

Figure 6: Detailed search

Land Suitability Indicator: -0.27

PARCEL KEY:	W053C00900000000026100020
PROVINCE:	Western Cape
DISTRICT MUNICIPALITY:	Central Karoo District Municipality
27 PRIORITY DISTRICTS:	N
LOCAL MUNICIPALITY:	Beaufort West Local Municipality
WARD:	10503007
STATE OWNED:	N
COMMODITY:	Sheep
AREA (IN HACTARES):	1016.35

NDVI (VEGETATION)	< 0.25
SOIL PH	7.5 - 8.4
PROXIMITY TO DAMS	> 10 km
AVERAGE ANNUAL RAINFALL(mm)	0 - 200 or > 1000
ELEVATION (meters)	200 - 800
AVERAGE MINIMUM TEMPERATURE	0.1 - 4 Degree Celcius
AVERAGE MAXIMUM TEMPERATURE	31.1-35 Degree Celcius
PROXIMITY TO ROADS	> 10 km
PROXIMITY TO CITIES AND TOWNS	7 - 14 km
PROXIMITY TO EDC	> 45 km
GROUND WATER QUALITY	70 - 300
PROXIMITY TO RAILWAY LINE	> 15 km
PROXIMITY TO SIPS	> 45 km
PROXIMITY TO MINING DEPOSITS	> 90 km
SOIL TEXTURE	Soil structure favouring arable land use scarce or absent

Figure 7: Search report.

The SLLI viewer also contains standard functions such as identify and measuring tools that can enhance the decision-making experience. The SLLI viewer compares with planning support systems such as the What if? in that it is built for planners and that it can depict various scenarios.

Moreover both systems (SLLI and What If are policy oriented and collaborative systems,

1.7Lessons learnt and challenges

The SLI viewer has several limitations. Firstly it is a web based application, therefore it has to be hosted centrally wherein other provinces will access it. This system is currently not in place and it can lead to the SLLI not being readily used. A solution is packaging all the data used, the SLLI grids, and supporting data that can be used for querying into a geodatabase digital video disk (DVD). This can then be distributed to managers at provincial level to start using the SLLI tool to assist them in identifying strategically located land. Moreover, the geodatabase requires only ArcGIS software that is available within the DRDLR, which will mean minimal capital outlay. This will mean that the SLLI will be employed more for day-to-day decision-making, as it will not be dependent on the viewer, and it also requires minimal capital outlay. Further training perhaps is needed to train particularly non-GIS experts on how to navigate and query the SLLI geodatabse. Distributing, training and usage of the SLLI geodatabase will mean decentralisation of functionally and it will also be part of capacity building. Managers will be able to make quick decisions instead of relying on the head office. It should also be noted that for optimum performance the SLLI should only be used within the geodatabase without importing and exporting material.

Potential users of the SLLI pointed out that the criteria are broad as they are to be utilised for a national geospatial tool to identify strategically located land for land reform for human settlements. However, it was established that there is potential to develop specific sub-criteria for various land uses in cities such as industrial and recreation. Consequently there would be need to develop new tools or viewers that are context specific such as industry. Nevertheless there was broad consensus that the SLLI was a huge step towards improving identification of strategically located land. Another challenge is that a land parcel may be both suitable for human settlements and agriculture. As a result there is a need to develop a new mechanism that assists managers in choosing the two using a new tool based on multi-objective criteria.

Another challenge common to developing countries is the access and availability of data. As a result users are advised not to alter the current state of the SLLI viewer or the desktop package. Users can only query and obtain results for use. However, with time when required the SLLI index can be updated using new data obtained. For example it is foreseeable that in the future data such as roads and towns are to change therefore it becomes critical that the index be updated using such data.

Similarly, it also emerged that there where over-expectations as some users deemed the SLLI as a tool that is supposed to make the decision for them. It should be cautioned that the SLLI viewer is supposed to aid/facilitate decision making not making the decision for the user. As a result many supporting datasets that enhances querying were included. The SLLI is not the panacea to land acquisition, however it goes a long way into making sure that correct, appropriate, smart and suitable, land parcels are acquired.

An additional challenge that was faced was realisation of a common ground as well as the need to provide a history of how the SLLI was developed, explaining what it can and what it cannot do. Overall the users as indicated accepted the SLLI during the training workshops. However, a key issue that has to be solved by the department is the issue of capacity and management constrains. Some users indicated that they are not familiar with spatial decision support systems and GIS. Consequently they found the system intimidating which may hamper its use. This scenario is not only common within DRDLR but in

Another issue that was identified is the issue of propriety where it was identified by users that the SLLI could be useful for various government departments. The SLLI viewer has been identified that it could be potentially useful for the Housing Development Agency (HDA). However at present functionality across government departments is not available as it is strictly a DRDLR project. However other departments can make arrangements, as this will greatly facilitate coordination and streamlining of decision-making, which will ultimately lead to efficient utilisation of resources and creation of smart cities.

Other key challenges worth mention are the slow processing speed of the SLL viewer that needs to be greatly improved.

1.7 Conclusion

The beginning point of this study was the need for developing a tool that help s the DRDLR in identifying land suitable for human settlements land.

A consultative and participatory process using MCDA and the AHP process were used to develop the SLLI for human settlements land reform. THE SLLI facilitates making decisions that require acquiring land suitable for creating smart cities. It will go a long way into streamlining and making decision with a scientific basis's. It should be noted that the SLLI viewer only guides not make the decision. Other factors such as government policy, human judgment and internal process have to be taken into cognisance. SLLI is still fraught with capacity challenges that need to be solved to realise full usage.

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