ToDB: SIR/BE/SPS/ER/2019/0006/C

Profiling the Vulnerability of South African Settlements

Workstream 3 Methodology

2019

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Project partner

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Centre de recherches pour le développement international

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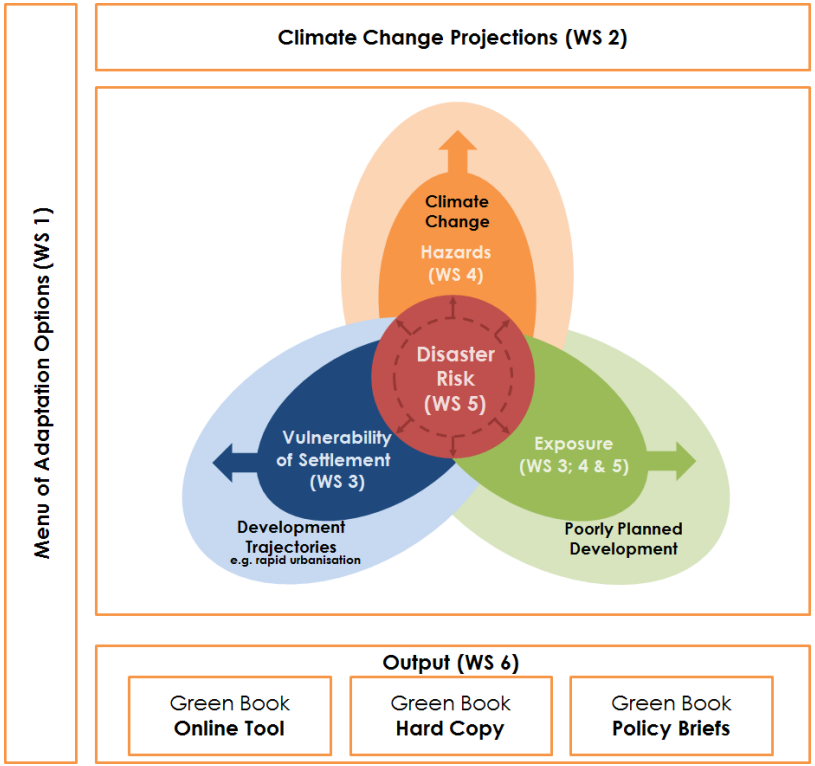
Background



Defining vulnerability is one aspect of understanding risk and should be understood in the broader context of climate change risk assessments.

The vulnerability profiling of cities, towns and settlements (WS#3) forms part of a larger risk analysis of settlements across South Africa (WS#4 and #5) and specifically focusses on the vulnerability of settlements with regards to their social, economic, physical, environmental and institutional make-up.

Measuring the vulnerabilities of settlements and monitoring and tracking their progress over time – gives insight into the changing dynamics or how these systems are responding to intervention strategies and policies.

Understanding what contributes to the vulnerability and coping capacity of neighbourhoods/settlements and local governments has been flagged as a National (Disaster Management Act no.16 of 2015) and International (Sendai framework for disaster risk management (UNISDR, 2015) ,SDG (UN, 2015)) priority.

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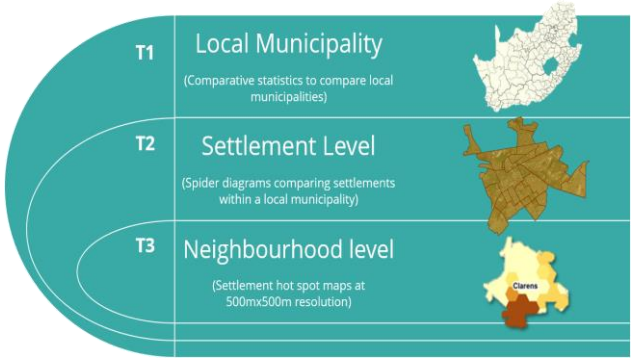
Research objectives

Profiling the vulnerability of SA settlements

- Profiling neighbourhoods, towns and municipalities according to their social, economic, physical, environmental vulnerabilities as well as the mechanisms in place to make these places more resilient.



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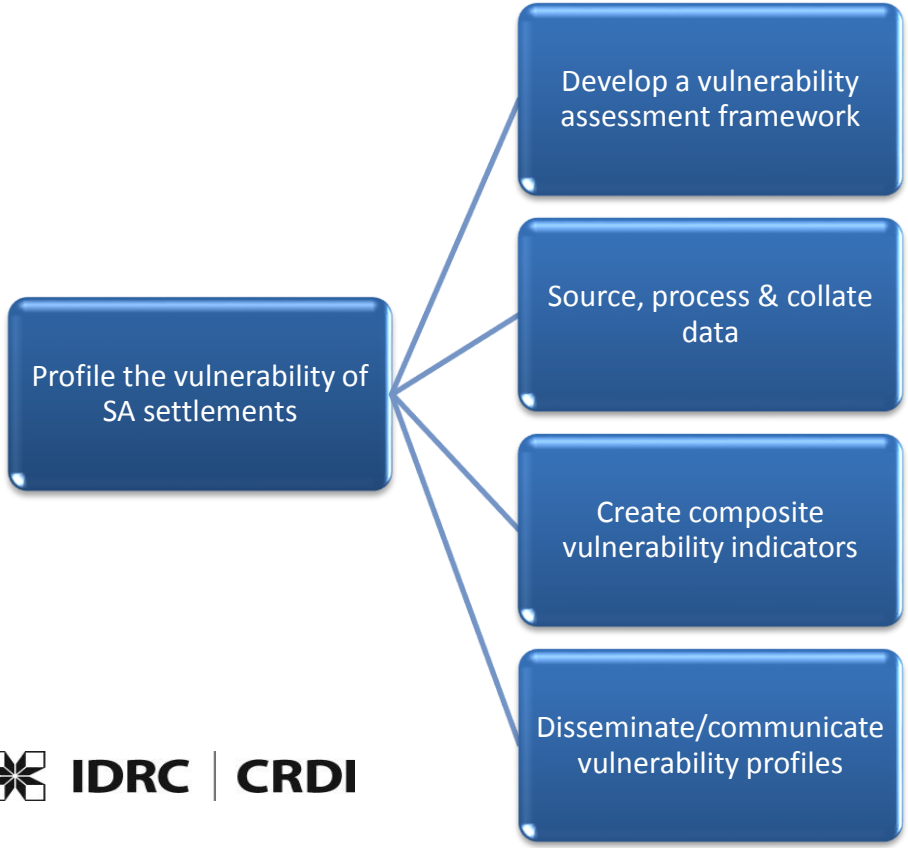
Research objective 1: Profiling the vulnerability of SA settlements



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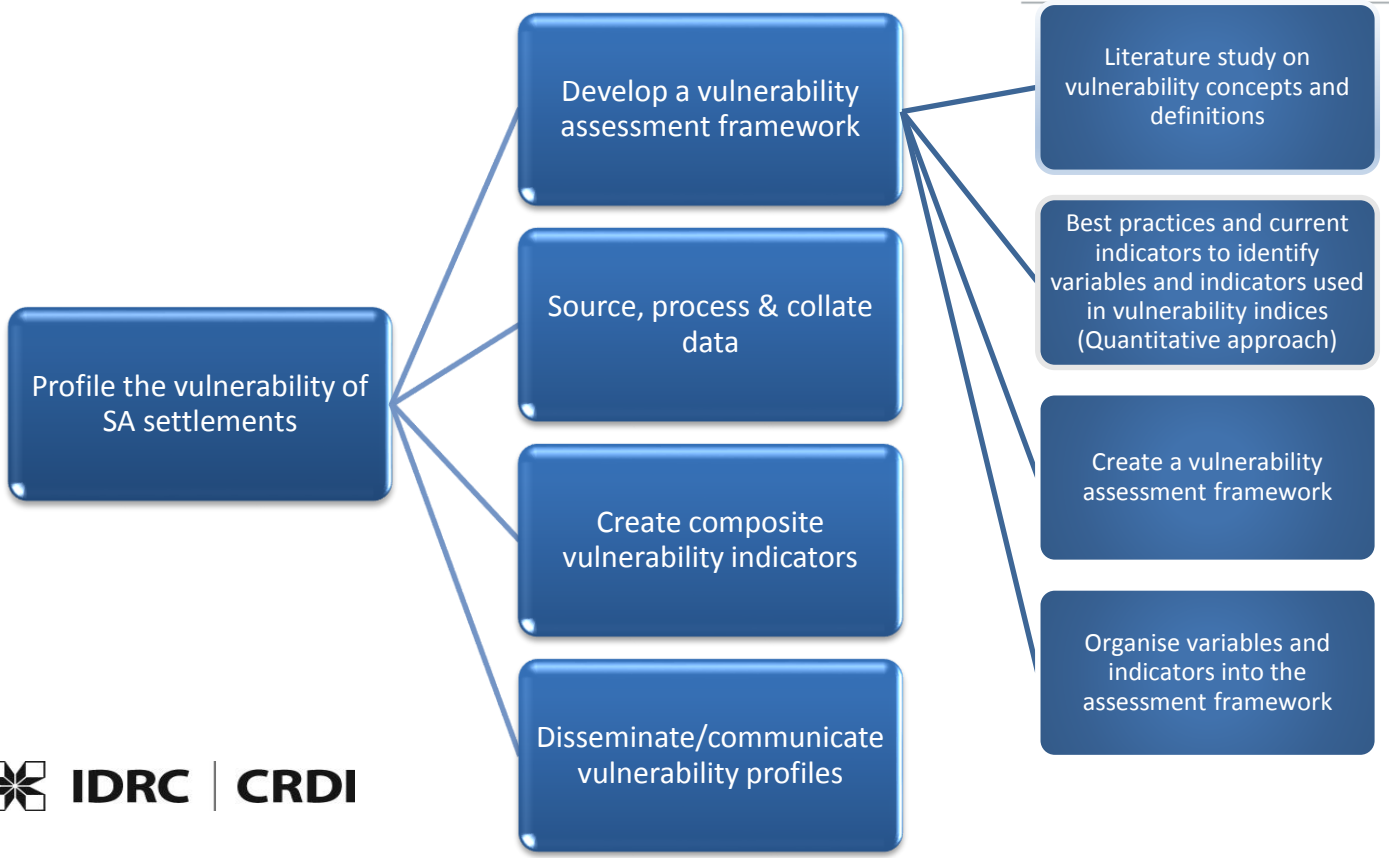
Developing a vulnerability assessment framework



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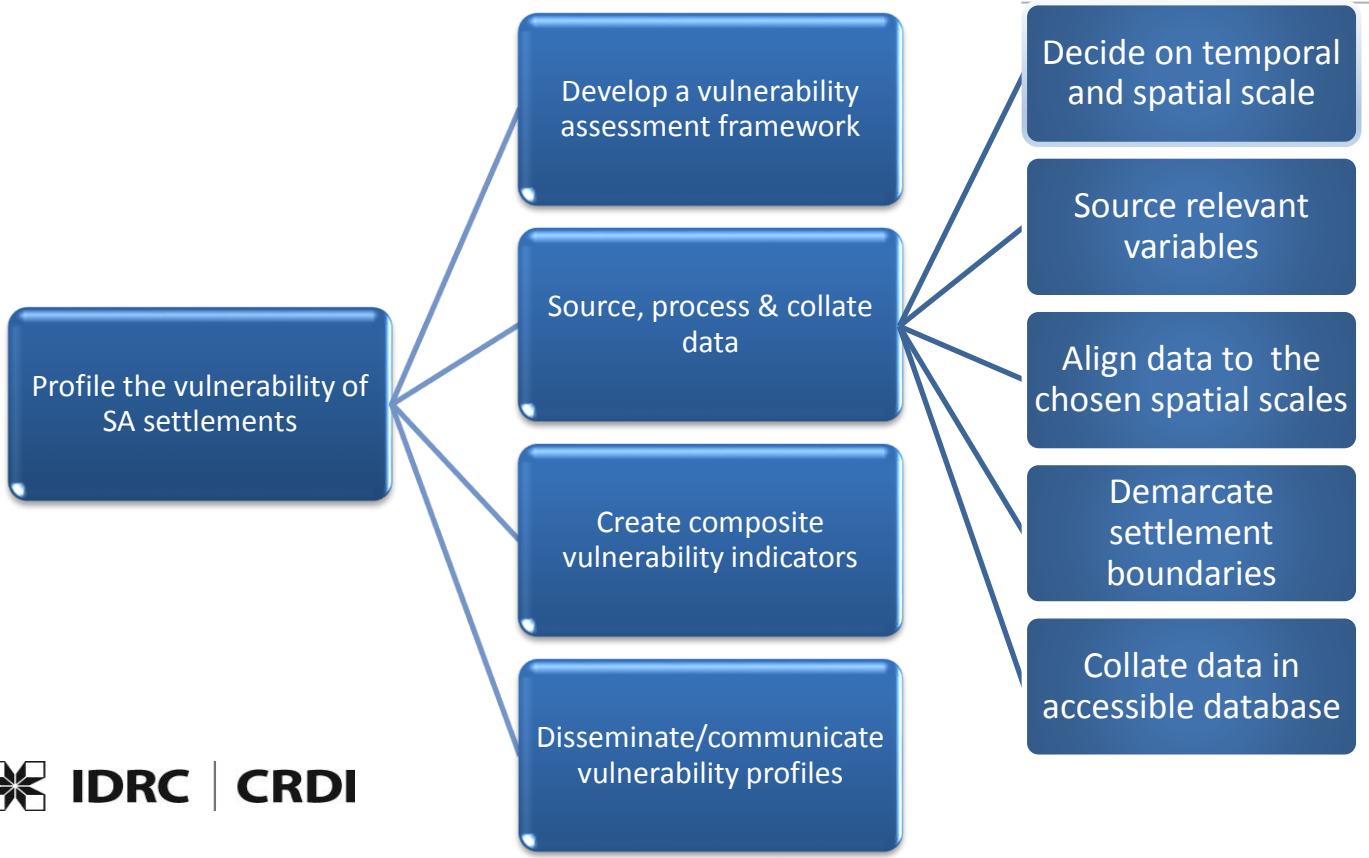
Source, process & collate data



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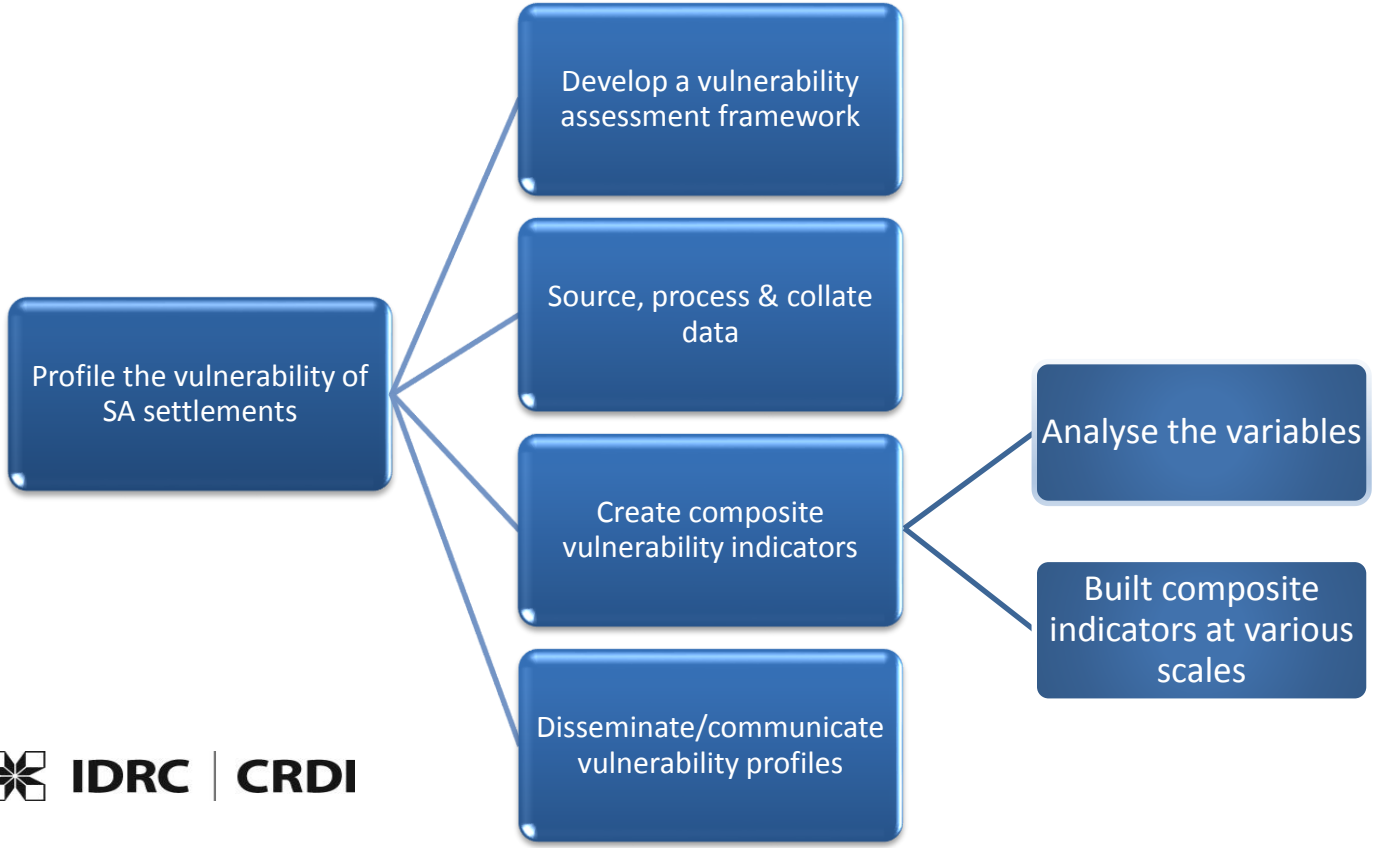
Create composite vulnerability indicators



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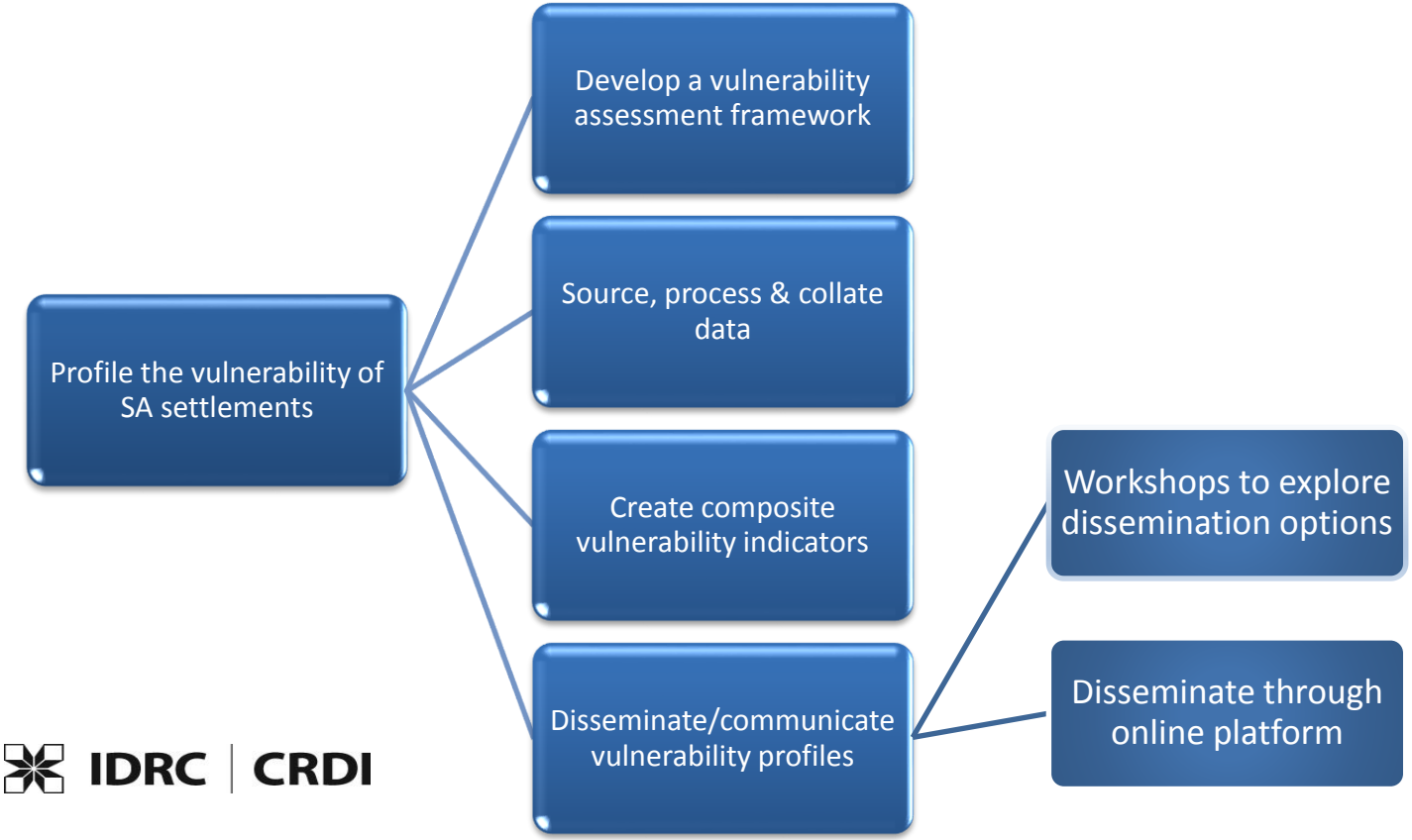
Disseminate/communicate vulnerability profiles



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Developing a vulnerability assessment framework

Literature study on vulnerability concepts and definitions

The term vulnerability is widely used and stems from multiple disciples. There are different definitions and dimensions to vulnerability, the concept generally refers to the potential to be unfavourably affected by a hazard or climate-related event.

Geographic location, physical condition, urban design and management all play vital roles in the losses experienced in a region. Climate change will change the magnitude and intensity of hazards & changing physical and socio-economic characteristics will influences the sensitivity of settlements & households against these impacts (e.g unmanaged or poorly managed urbanisation and population growth, changes and pressures on terrestrial areas, poor land use planning and regulations, changing demographic structures, economic and institutional stability, public infrastructure maintenance and retrofitting, interconnectivity, natural resources dependency etc.).

The United Nations in their International Strategy for Disaster Reduction (ISDR, 2007) define vulnerability as the conditions or processes that are driven by different economic, social, physical and environmental factors and that have the potential to increase a system's exposure to the impact brought on by a hazard. The National Disaster Management Centre in South Africa also adopts this definition of vulnerability as is outlined in the Disaster Management Act (16 of 2015). These factors referred to in this definition would normally include the characteristics of the built environment, a community, or an individual (humans), as well as environmental, agricultural and economic elements that are exposed to natural hazards and risks.

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Developing a vulnerability assessment framework

Inherent vulnerability approach

The contextual approach takes vulnerability as a starting point and looks at the state that exists within a system before it encounters a hazard. This approach focuses on the context and underlying economic, social, political, technological, institutional, environmental and cultural conditions that influence a system's exposure, sensitivity and adaptive capacity. The approach considers future biophysical changes, but only after the vulnerability of a group or place has been assessed (O'Brien & Wolf, 2010).

Developing a vulnerability assessment framework

Best practices and current indicators to identify variables and indicators used in vulnerability indices (Quantitative approach)

There is no single definition that seems to capture both the complexity and multi-dimensionality of vulnerability.

There has been an increase in the number of both global and local initiative over the past couple of years to measure vulnerability and risk using sets of indicators and indices.

The complexity of vulnerability can't be measures with a generic set of criteria. It is also evident that measuring and understanding vulnerability should be considered in a framework were preference is given to complexity by including various temporal and spatial dimensions/scales, multiple dimensions of vulnerability as well as the numerous actors involved.

An indicator-based risk method entails reducing a complex problem into key factors, identifying variables that characterise those factors and using mathematical and decision theoretic techniques to quantify and aggregate the variables into measurements that are intuitive, holistic and descriptive of the settlement's make-up as well as very descriptive of the households occupying these spaces.

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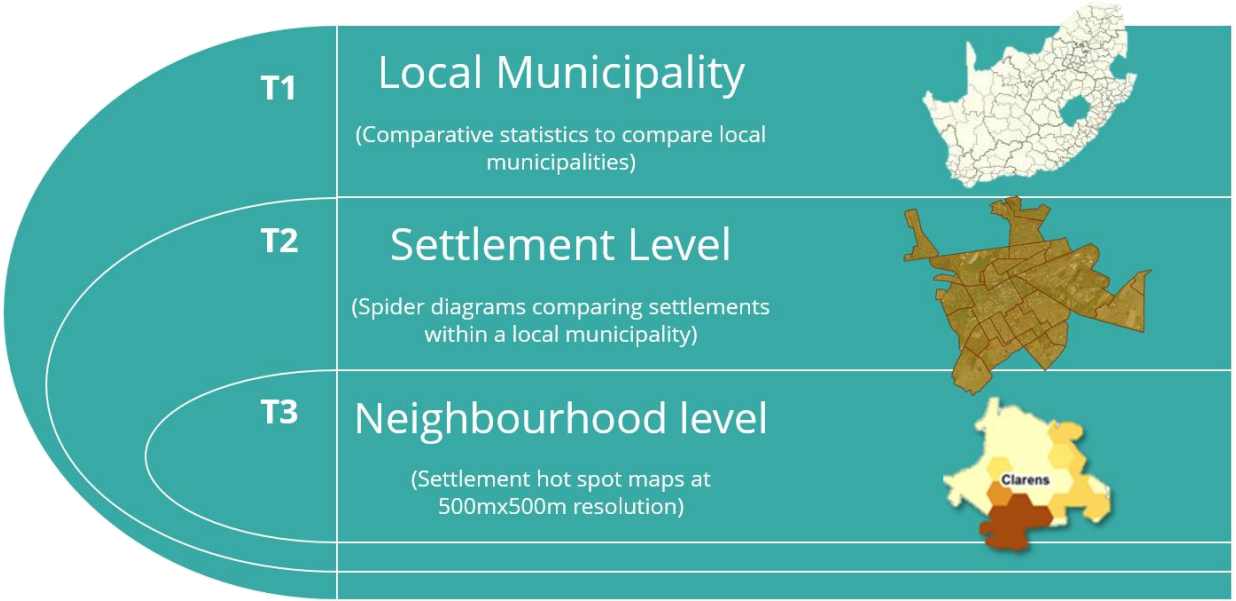
Developing a vulnerability assessment framework

Create a vulnerability assessment framework



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Multiple scales, multiple dimensions = multiple actors involvements to intervene

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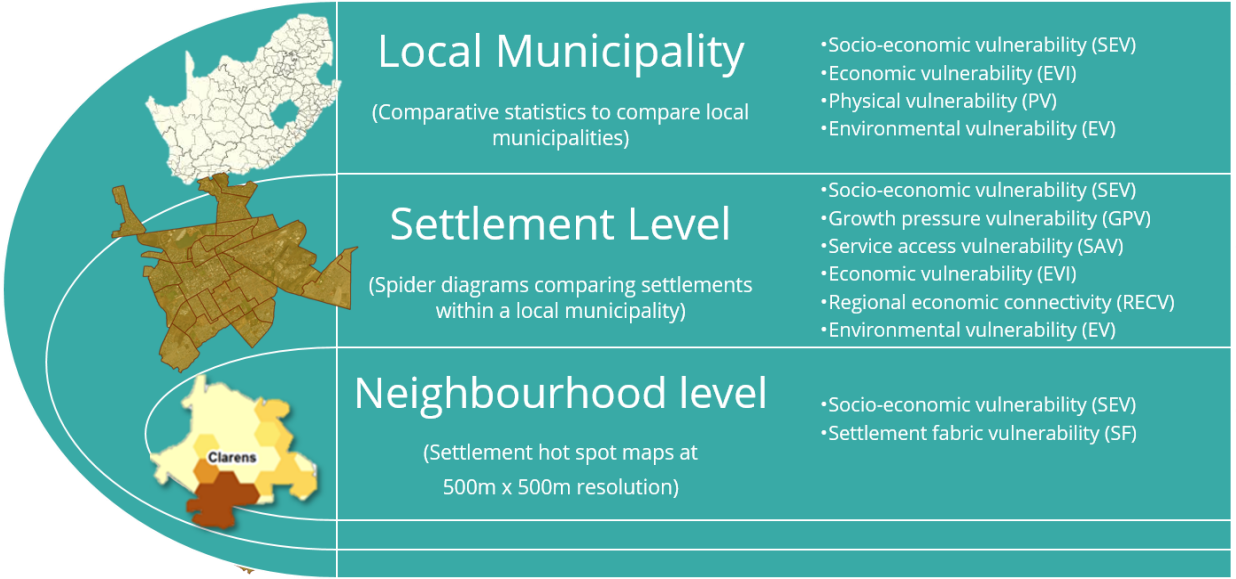
Developing a vulnerability assessment framework

Organise variables and indicators into the assessment framework



Local Municipality

(Comparative statistics to compare local municipalities)

- Socio-economic vulnerability (SEV)
- Economic vulnerability (EVI)
- Physical vulnerability (PV)
- Environmental vulnerability (EV)

+- 56 variables grouped into 24 indicators and 4 composite indicators

Settlement Level

(Spider diagrams comparing settlements within a local municipality)

- Socio-economic vulnerability (SEV)
- Growth pressure vulnerability (GPV)
- Service access vulnerability (SAV)
- Economic vulnerability (EVI)
- Regional economic connectivity (RECV)
- Environmental vulnerability (EV)

+- 31 variables grouped into 16 indicators and 6 composite indicators

Neighbourhood level

(Settlement hot spot maps at 500m x 500m resolution)

- Socio-economic vulnerability (SEV)
- Settlement fabric vulnerability (SF)

+- 13 variables grouped into 6 indicators and 2 composite indicators

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Source, process & collate data

Decide on temporal and spatial scale

Source relevant variables

Align data to chosen spatial scales

Input datasets with differing demarcations

StatsSA

GTI

AfriGIS

CSIR

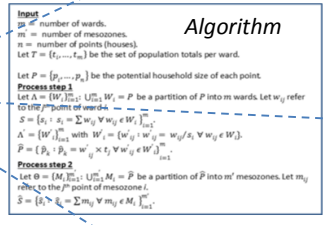
Knowledge Factory

ISS

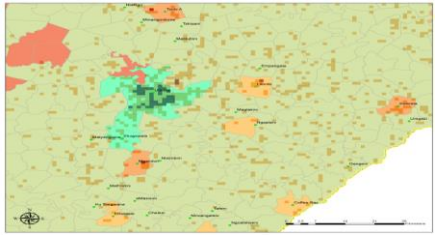
Use hybrid method: dasymetric mapping and areal interpolation

Data alignment

Algorithm



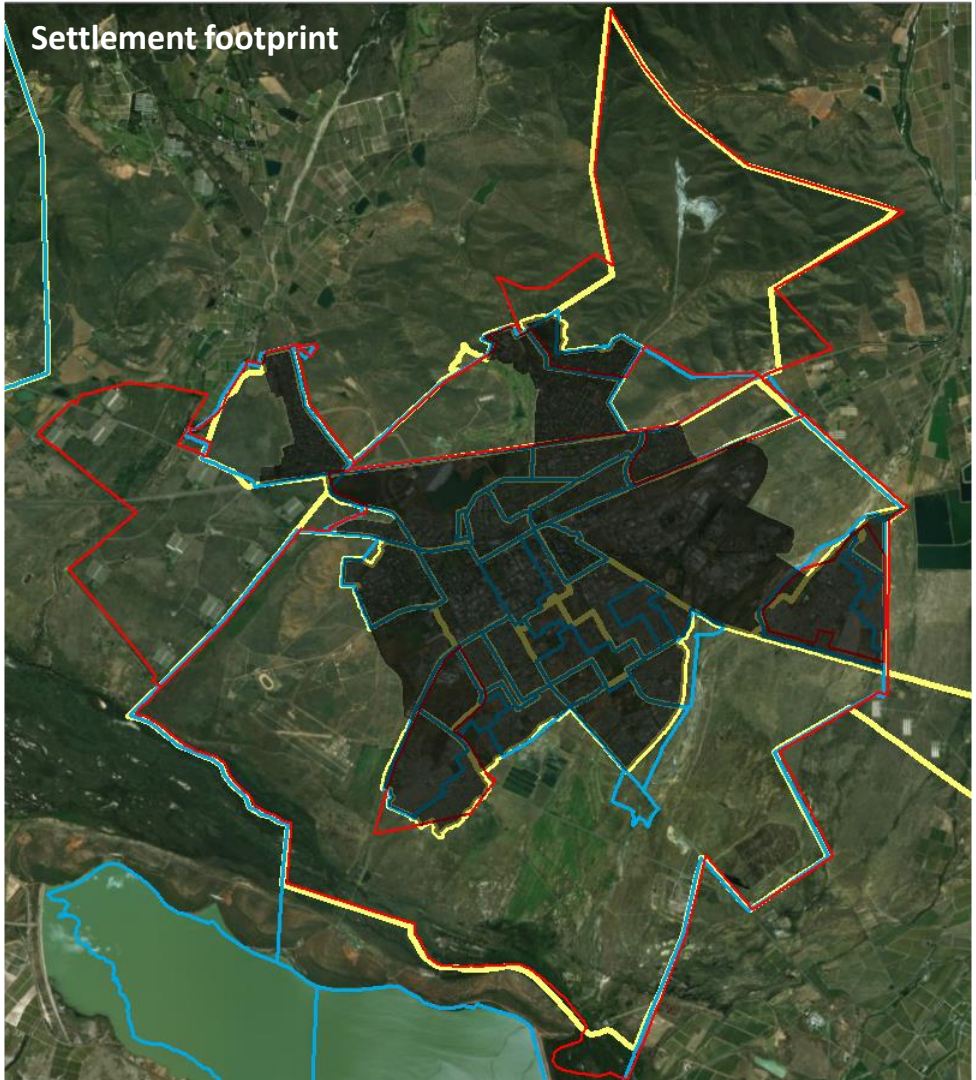
Proxy for underlying statistical surface



Raster grid

Settlement footprint

Municipality



Demarcate South African settlement

EA_2011

GB_EA_Class

* Formal settlement / Rural split

Formal settlement
- Nature Reserve Urban
- Parks and recreation
- Formal residential
- Collective living quarters
- Informal residential
- Commercial
- Industrial
- Vacant
- Small holdings

Traditional settlement
- Traditional residential
- Vacant Traditional
- NU Traditional
- Farms Traditional

Rural
- NU
- Farm
- National Park
- Parks Other
- Nature Reserve
- Reserve
- Forest Reserve
- State Forest

**Note: that these classes were split based on whether it was more than 2/3rds surrounded by built-up areas*

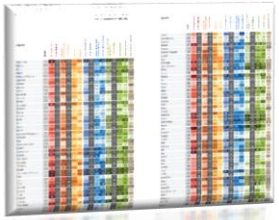
Example of data now available on grids, settlement footprints and municipalities

Source data	Data set	Years
AfriGIS	General insurance	2016
StatsSA	Age in 5 year categories for male and female	1996;2001;2011
StatsSA	Access to water	1996;2001;2011
StatsSA	Access to electricity for lighting	1996;2001;2011
StatsSA	Level of education	1996;2001;2011
StatsSA	Income categories	1996;2001;2011
StatsSA	Population group	1996;2001;2011
StatsSA	Type of dwelling	1996;2001;2011
StatsSA	(Un)employment	1996;2001;2011
StatSA	Refuse removal	1996;2001;2011
StatSA	Type toilet	1996;2001;2011
StatSA	(Un)employment for male and female	1996;2001;2011
StatSA	Age head of household (0-14; 15 and older) for male and female	2001; 2011
StatSA	Mode of travel	2001
StatSA	Disability	2001; 2011
Quantec	Total population	All years 1996 to 2016
StatsSA	Total population	1996;2001;2011
Quantec	GVA (SIC1,2,3,4,6,7,8,9)	All years 1996 - 2013
Quantec	GVA based employment (place of work)	All years 1996 - 2013

Indicators to disseminate showing multiple dimensions and scales of vulnerability

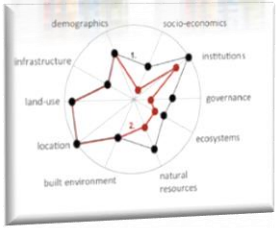
T1 Local Municipality

(Comparative statistics to compare local municipalities)



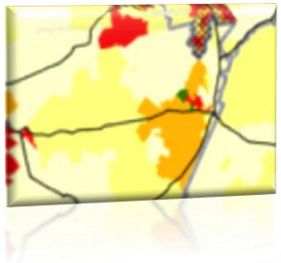
T2 Settlement Level

(Spider diagrams comparing settlements within a local municipality)



T3 Neighbourhood level

(Settlement hot spot maps at 500mx500m resolution)



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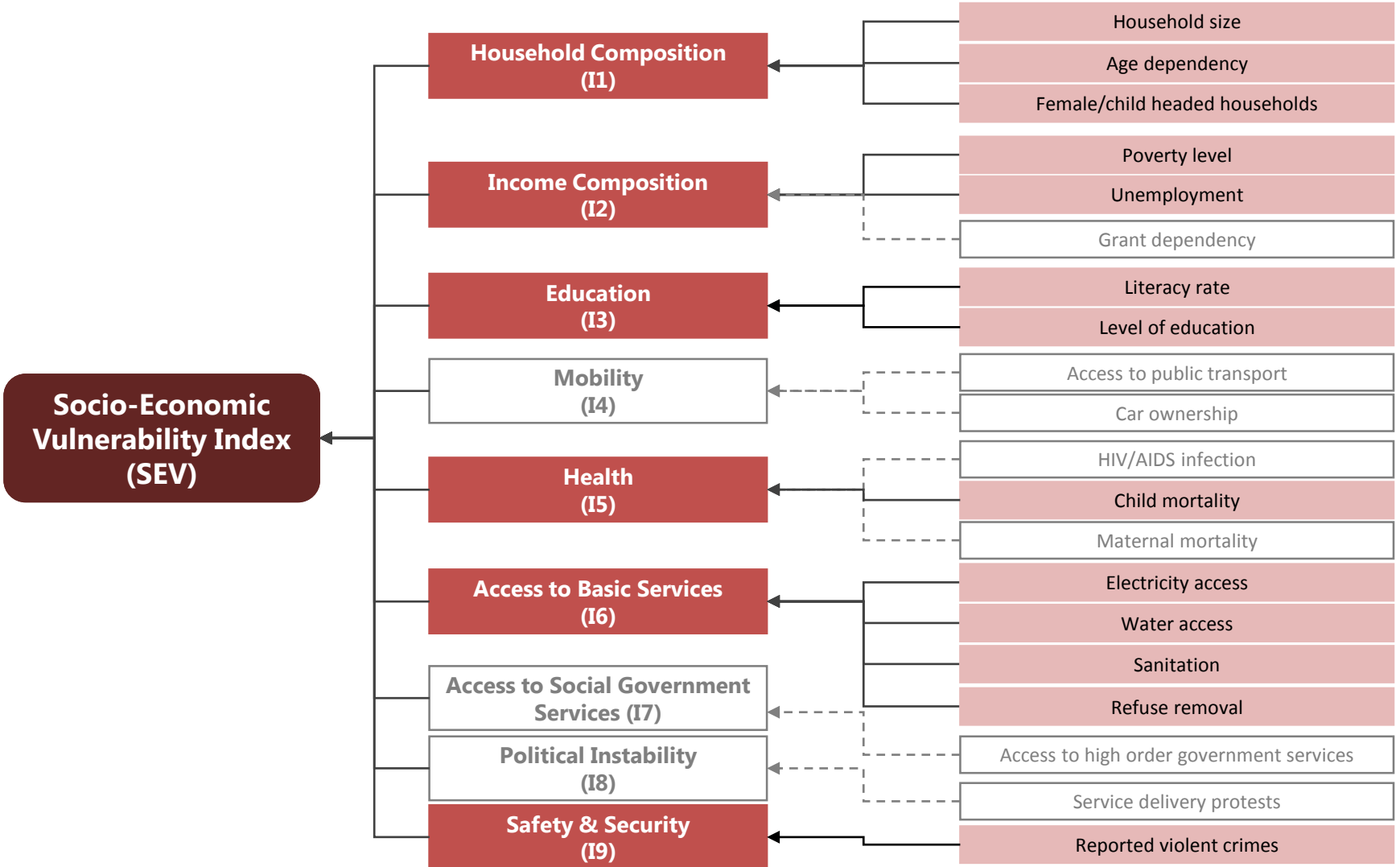
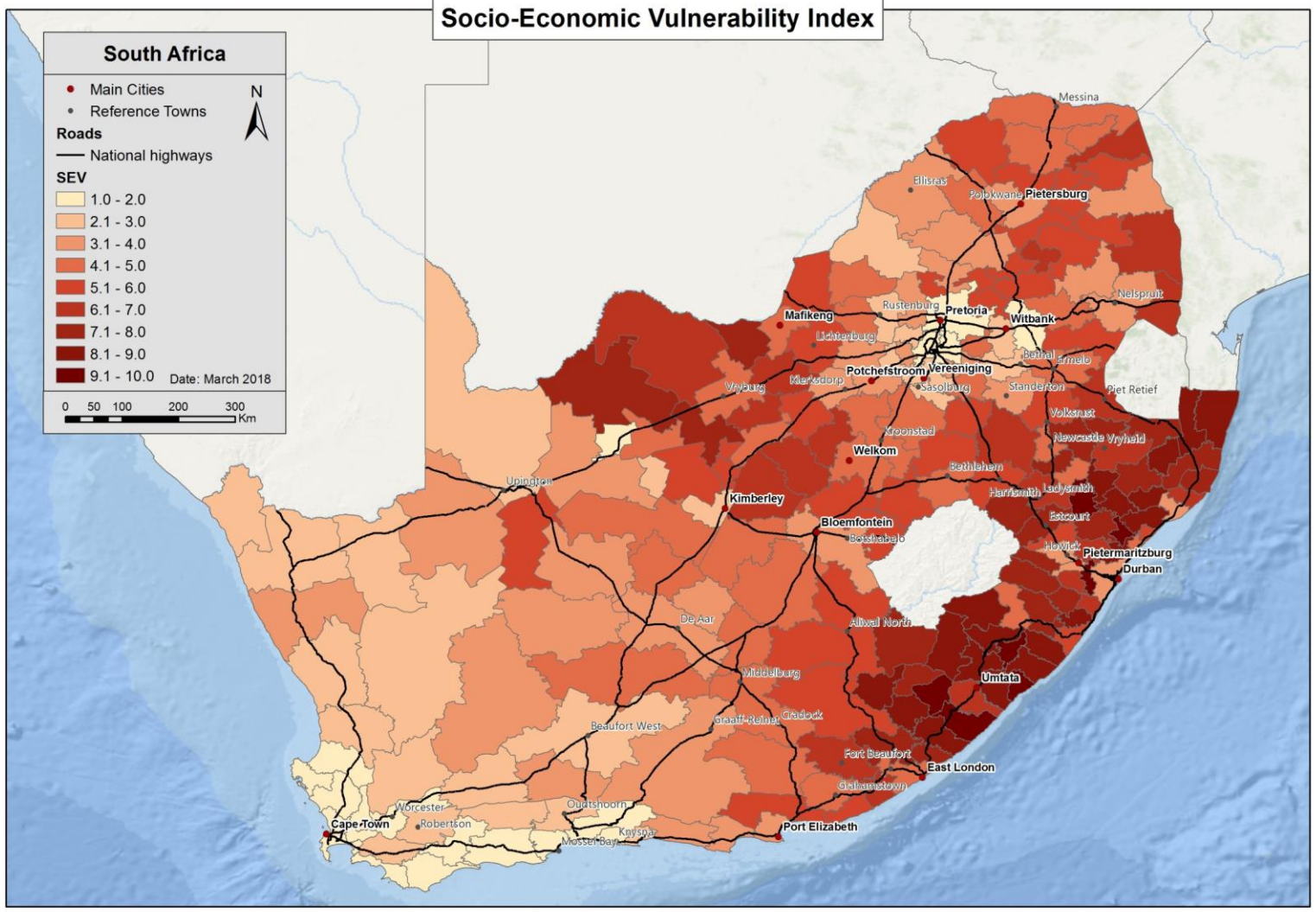

Socio-Economic Vulnerability Index (SEV)
Household Composition (I1)
Household size
Age dependency
Female/child headed households
Income Composition (I2)
Poverty level
Unemployment
Grant dependency
Education (I3)
Literacy rate
Level of education
Mobility (I4)
Access to public transport
Car ownership
Health (I5)
HIV/AIDS infection
Child mortality
Maternal mortality
Access to Basic Services (I6)
Electricity access
Water access
Sanitation
Refuse removal
Access to Social Government Services (I7)
Political Instability (I8)
Access to high order government services
Service delivery protests
Safety & Security (I9)
Reported violent crimes


Socio-Economic Vulnerability Index
South Africa
Main Cities
Reference Towns
Roads
National highways
SEV
1.0 - 2.0
2.1 - 3.0
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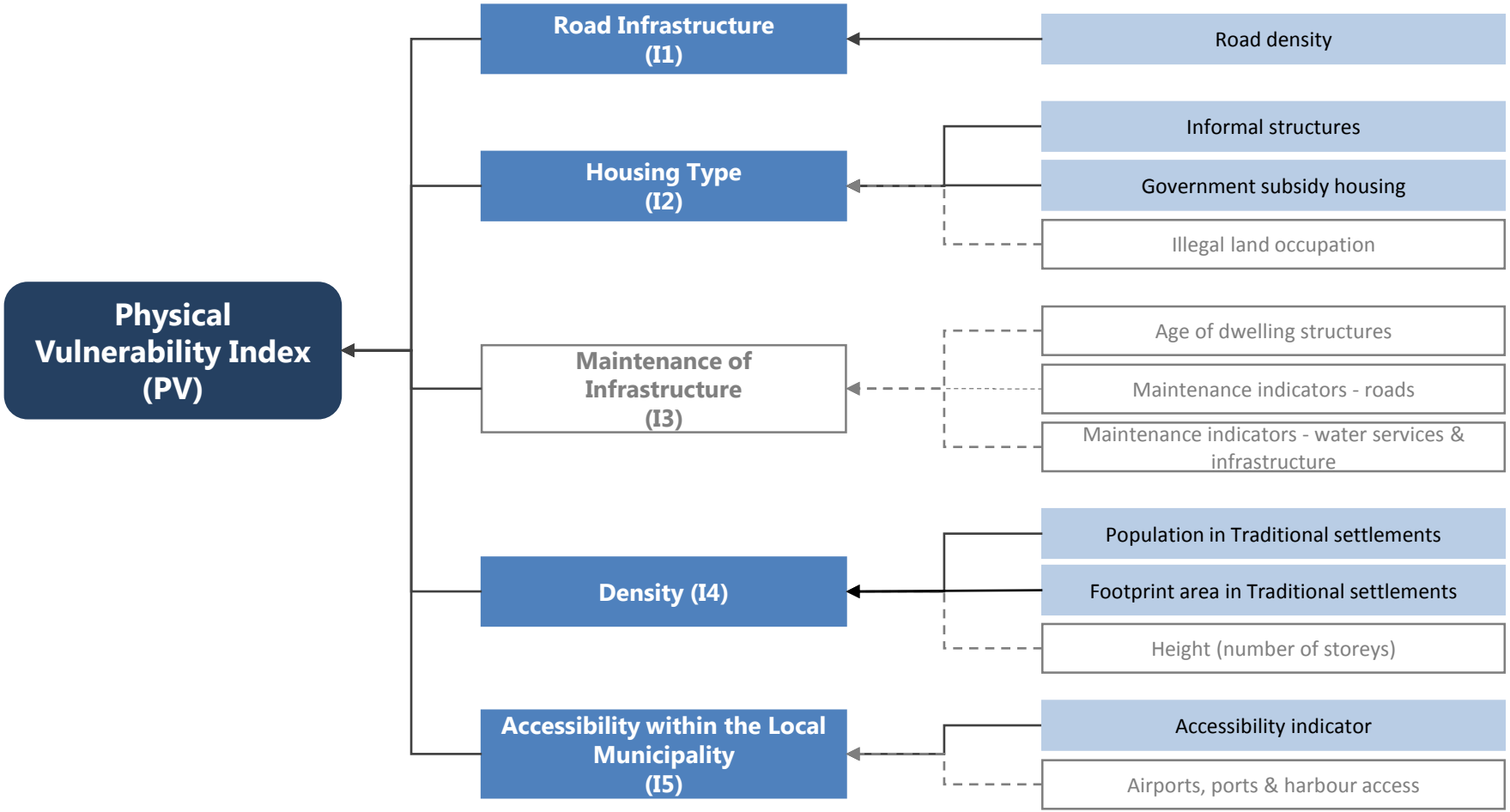
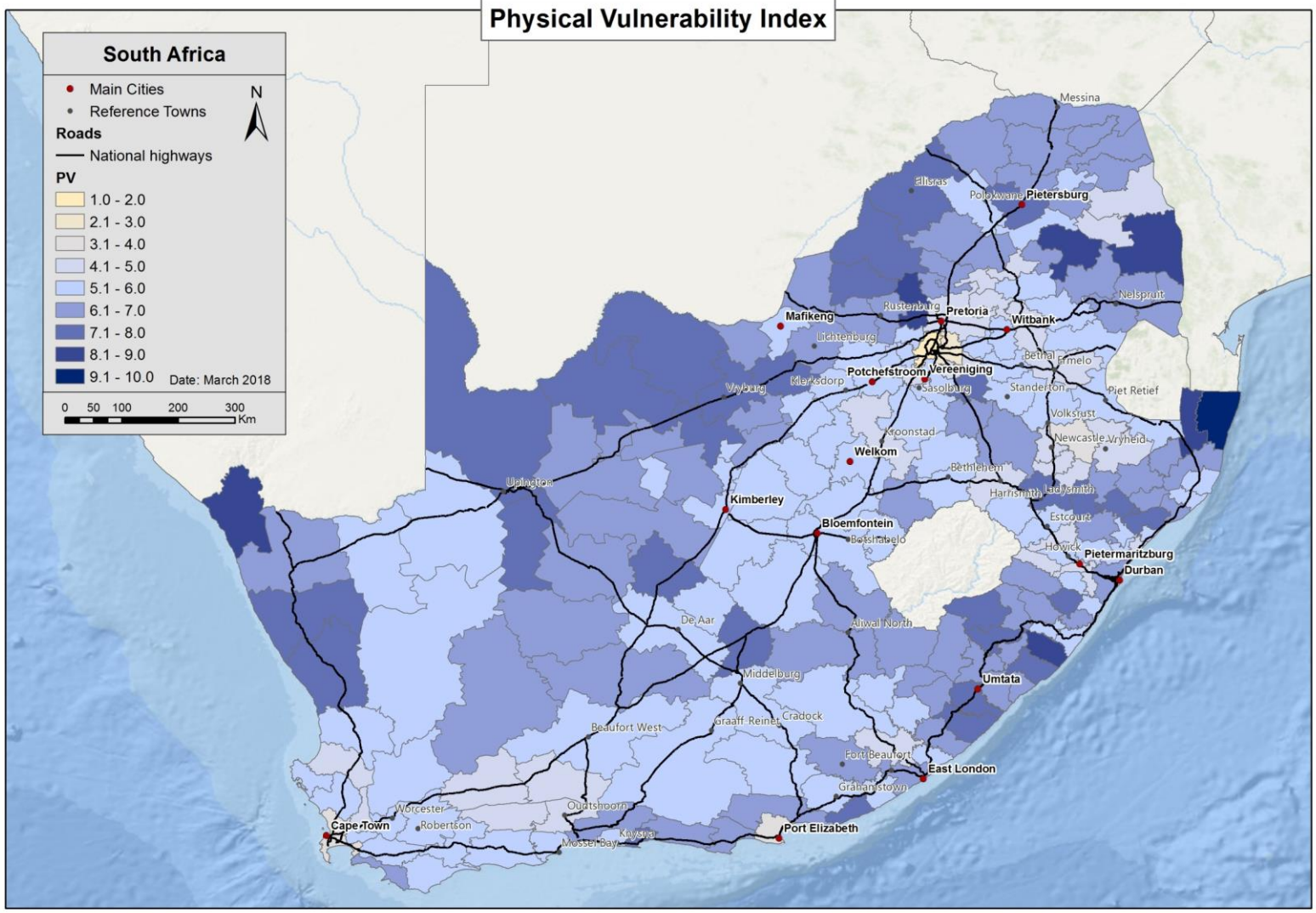
Cape Town
Knysna
Mossel Bay
Port Elizabeth


Physical Vulnerability Index (PV)
Road Infrastructure (I1)
Road density
Housing Type (I2)
Informal structures
Government subsidy housing
Illegal land occupation
Maintenance of Infrastructure (I3)
Age of dwelling structures
Maintenance indicators - roads
Maintenance indicators - water services & infrastructure
Density (I4)
Population in Traditional settlements
Footprint area in Traditional settlements
Height (number of storeys)
Accessibility within the Local Municipality (I5)
Accessibility indicator
Airports, ports & harbour access


Physical Vulnerability Index
South Africa
Main Cities
Reference Towns
Roads
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PV
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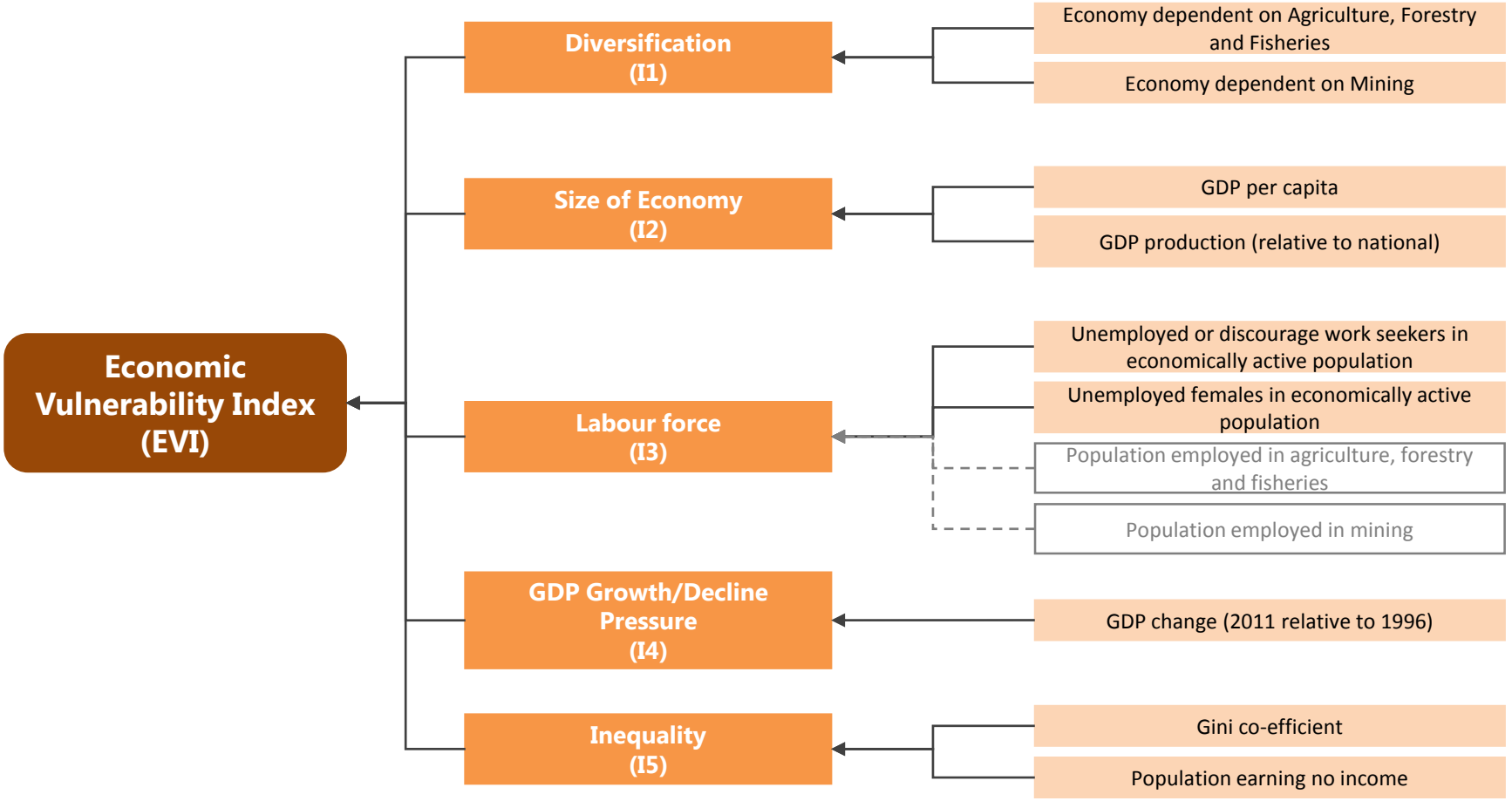
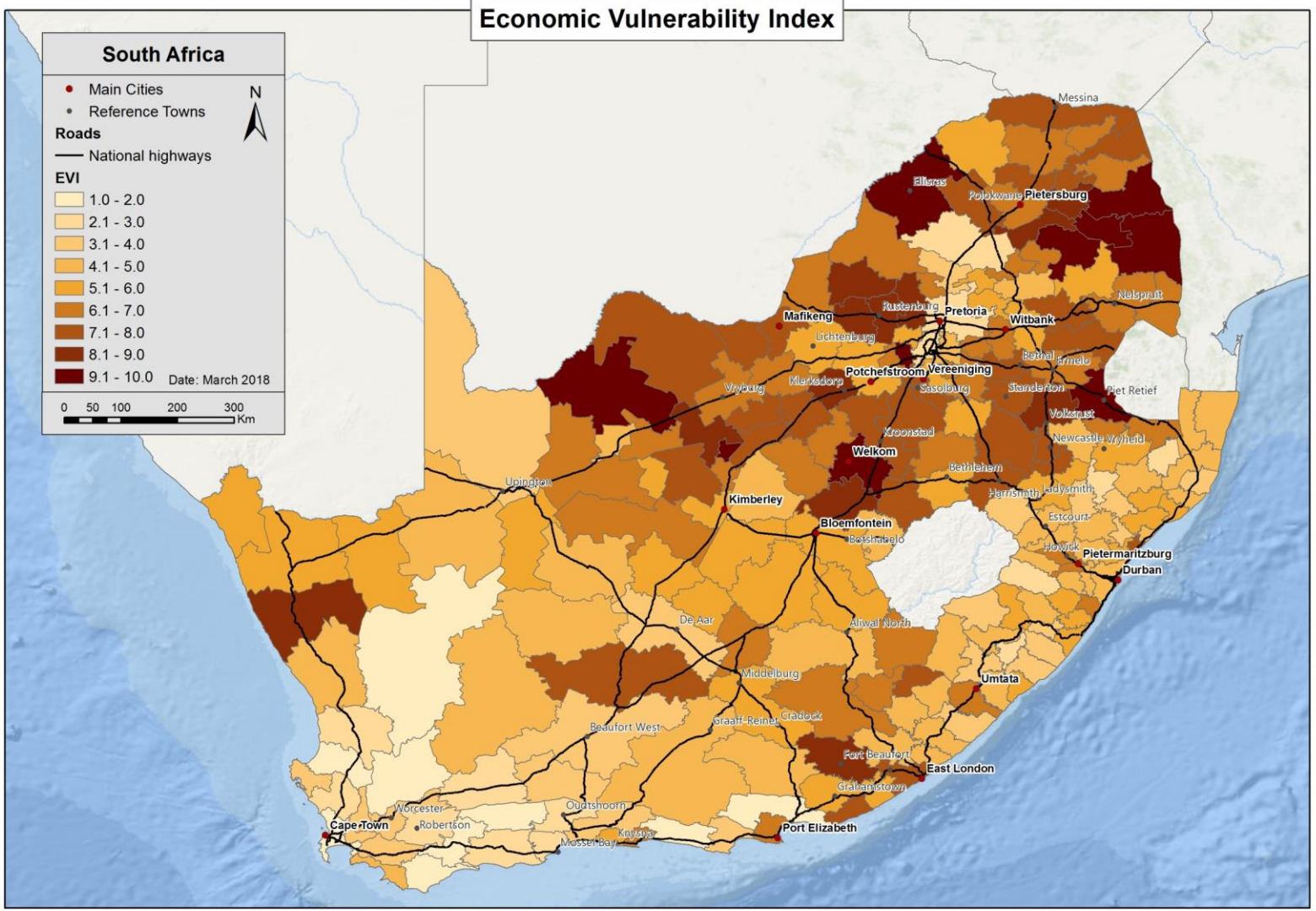

Economic Vulnerability Index (EVI)
Diversification (I1)
Economy dependent on Agriculture, Forestry and Fisheries
Economy dependent on Mining
Size of Economy (I2)
GDP per capita
GDP production (relative to national)
Labour force (I3)
Unemployed or discourage work seekers in economically active population
Unemployed females in economically active population
Population employed in agriculture, forestry and fisheries
Population employed in mining
GDP Growth/Decline Pressure (I4)
GDP change (2011 relative to 1996)
Inequality (I5)
Gini co-efficient
Population earning no income


Economic Vulnerability Index
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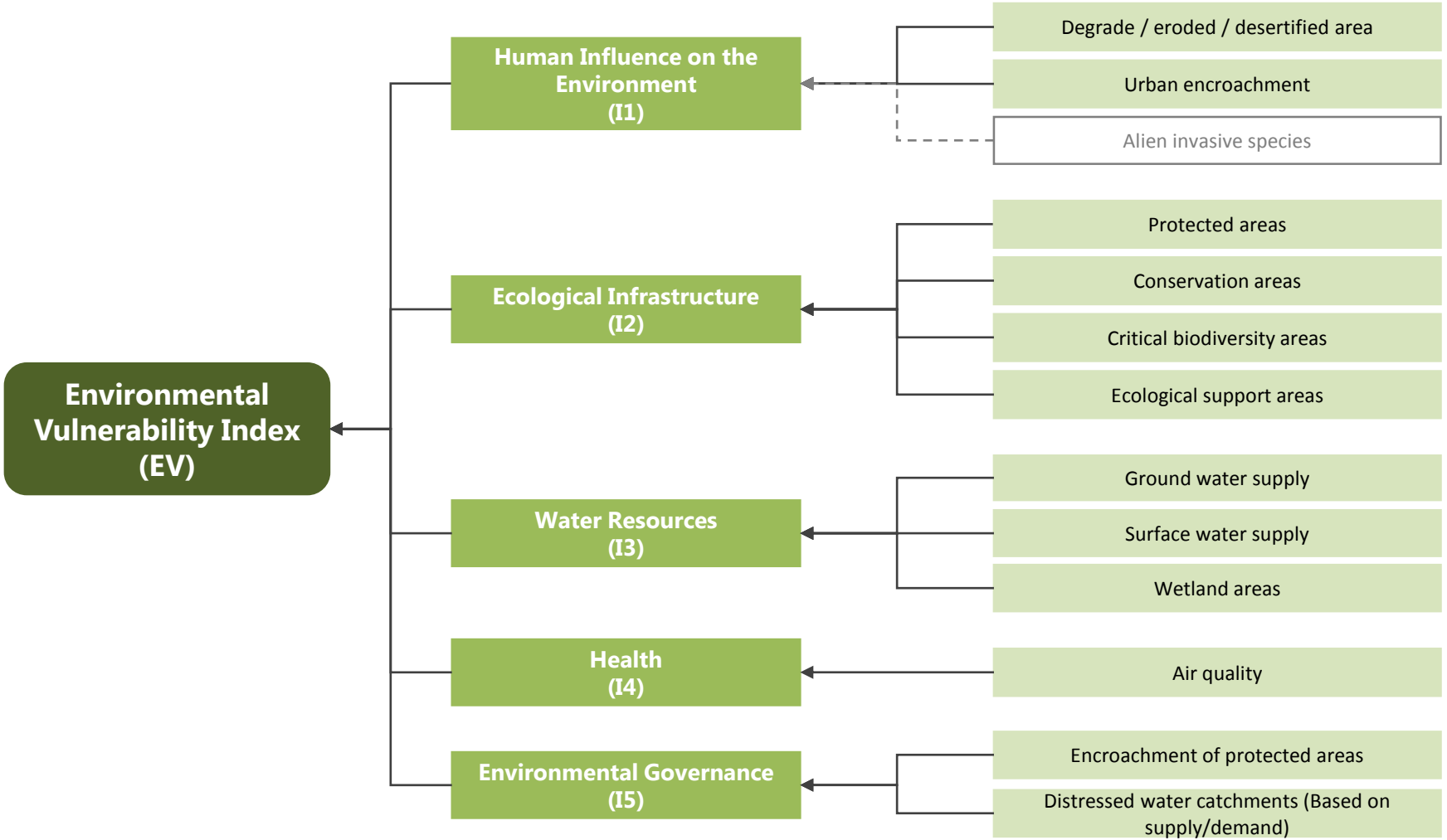
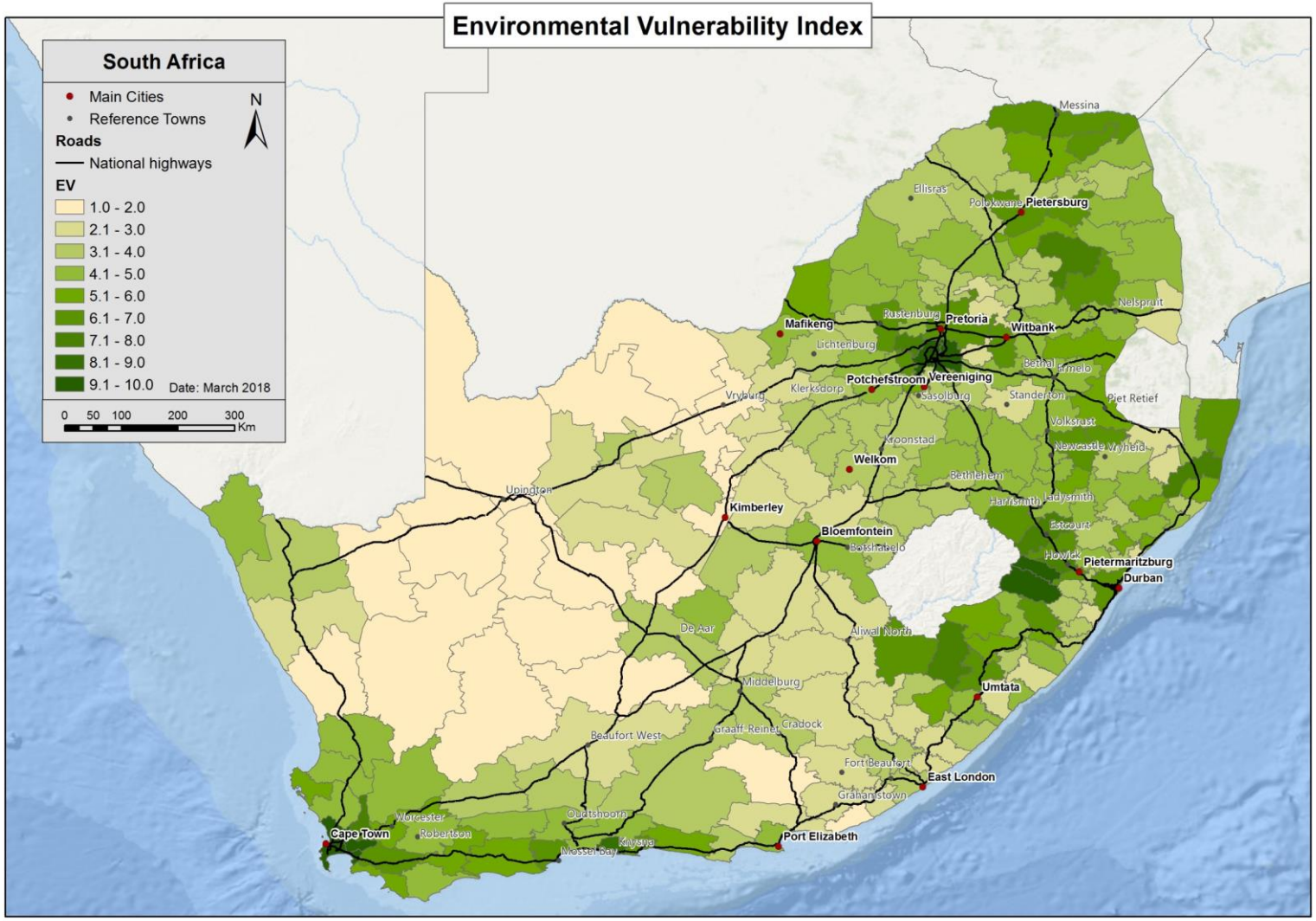

Environmental Vulnerability Index (EV)
Human Influence on the Environment (I1)
Degrade / eroded / desertified area
Urban encroachment
Alien invasive species
Ecological Infrastructure (I2)
Protected areas
Conservation areas
Critical biodiversity areas
Ecological support areas
Water Resources (I3)
Ground water supply
Surface water supply
Wetland areas
Health (I4)
Air quality
Environmental Governance (I5)
Encroachment of protected areas
Distressed water catchments (Based on supply/demand)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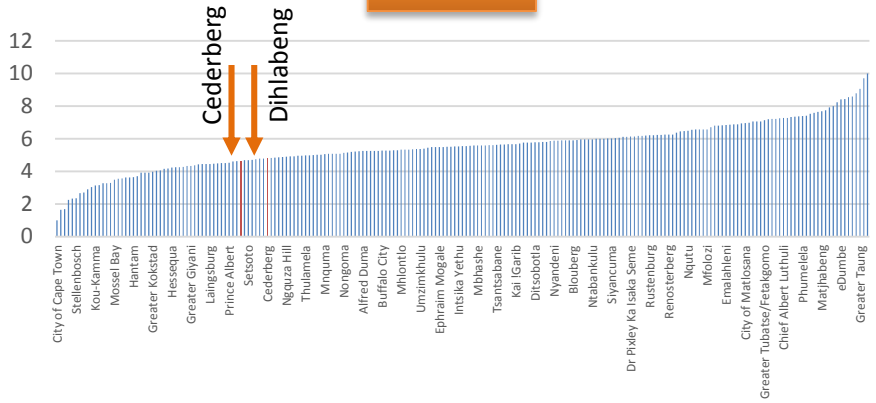
Port Elizabeth

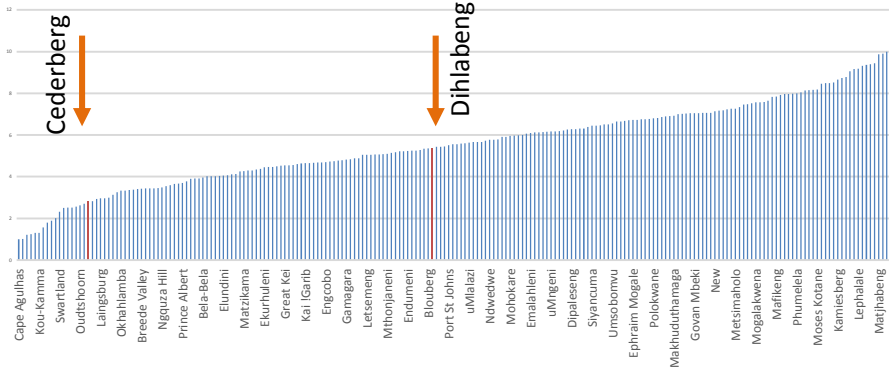
Local Municipality (T1) comparative Indicators and trends

MUNICIPALITY CODE	MUNICIPALITY	SEV	Trend	EVI	Trend	PV	Trend	EV	Trend
NC084	!Kheis	5.19	↘	5.78	↗	7.57	↗	1.00	No Trend
KZN263	Abaqulusi	6.43	↘	5.25	↘	4.77	↘	3.77	No Trend
KZN238	Alfred Duma	6.34	↘	5.59	↗	7.33	↘	4.99	No Trend
EC124	Amahlathi	7.24	↘	4.50	↘	4.88	↗	3.41	No Trend
LIM334	Ba-Phalaborwa	3.83	↘	10.00	↗	4.52	↘	4.48	No Trend
WC053	Beaufort West	2.90	↘	3.77	↘	5.83	↘	2.00	No Trend
LIM366	Bela-Bela	3.19	↘	3.97	↗	6.02	↘	3.57	No Trend
WC013	Bergrivier	1.23	↘	1.30	↘	4.33	↗	4.48	No Trend
KZN276	Big Five Hlabisa	7.99	↘	4.12	↘	6.74	↘	7.19	No Trend
WC047	Bitou	2.32	↘	6.50	↗	7.17	↗	6.84	No Trend
LIM351	Blouberg	5.93	↘	5.35	↘	6.63	↗	3.64	No Trend
EC102	Blue Crane Route	4.90	↘	4.47	↘	5.36	↘	1.90	No Trend
WC025	Breede Valley	1.81	↘	3.43	↘	5.40	↗	5.11	No Trend
BUF	Buffalo City	4.52	↘	7.52	↗	6.62	↘	3.32	No Trend
MP325	Bushbuckridge	6.65	↗	9.05	↗	8.25	↘	4.17	No Trend
WC033	Cape Agulhas	1.44	↘	1.00	↘	5.97	↗	4.27	No Trend
WC012	Cederberg	2.29	↘	2.82	↘	5.75	↗	4.75	No Trend
MP301	Chief Albert Luthuli	5.94	↘	7.01	↘	5.88	↘	5.27	No Trend
CPT	City of Cape Town	1.18	↗	1.22	↗	3.12	↗	10.00	No Trend
JHB	City of Johannesburg	1.26	↘	2.51	↗	1.00	↘	9.32	No Trend
NW403	City of Matlosana	3.35	↘	8.48	↗	5.06	↘	3.14	No Trend
MP326	City of Mbombela	3.92	↘	6.00	↗	6.78	↘	4.39	No Trend
TSH	City of Tshwane	1.07	↘	2.52	↗	4.48	↘	6.13	No Trend
KZN254	Dannhauser	7.15	↗	7.05	↘	4.98	↗	4.90	No Trend
NC087	Dawid Kruiper	2.58	↘	3.41	↘	7.66	↗	1.29	No Trend
FS192	Dihlabeng	4.30	↘	5.36	↗	5.19	↘	3.69	No Trend
NC092	Dikgatlong	5.44	↘	7.98	↘	6.99	↘	3.53	No Trend
MP306	Dipaleseng	5.00	↘	6.27	↗	7.24	↘	3.99	No Trend
NW384	Ditsobotla	5.35	↘	5.14	↘	6.45	↗	3.92	No Trend
EC101	Dr Beyers Naude	3.80	↘	4.74	↘	5.82	↘	3.65	No Trend
MP316	Dr JS Moroka	5.78	↗	5.18	↘	4.93	↘	2.98	No Trend
KZN436	Dr Nkosazana Dlamini Zuma	7.78	↗	2.94	↘	6.27	↗	9.34	No Trend
MP304	Dr Pixley Ka Isaka Seme	5.74	↘	8.17	↗	5.49	↘	4.06	No Trend
WC023	Drakenstein	1.24	↘	3.25	↘	4.43	↘	7.26	No Trend
KZN261	eDumbe	7.58	↘	6.15	↘	4.75	↘	6.61	No Trend
EKU	Ekurhuleni	1.94	↘	4.46	↗	2.62	↘	9.74	No Trend
LIM472	Elias Motsoaledi	5.63	↗	4.73	↘	5.61	↗	3.49	No Trend
EC141	Elundini	8.35	↗	4.06	↘	6.26	↘	7.91	No Trend
KZN253	Emadlangeni	7.80	↗	4.02	↘	3.87	↗	6.12	No Trend
MP314	Emakhazeni	4.24	↘	7.05	↗	5.36	↘	4.44	No Trend
EC136	Emalahleni	8.47	↗	6.27	↘	5.54	↘	2.93	No Trend
MP312	Emalahleni	2.55	↘	6.09	↗	5.13	↘	6.36	No Trend
GT421	Emfuleni	2.82	↗	7.96	↗	4.20	↘	5.95	No Trend
NC073	Emthanjeni	3.05	↘	3.45	↘	5.71	↘	3.88	No Trend
KZN241	Endumeni	4.11	↘	5.24	↘	4.83	↘	5.21	No Trend
EC137	Engcobo	9.48	↗	4.70	↘	6.49	↘	5.62	No Trend
EC139	Enoch Mgijima	5.78	↘	6.75	↗	5.60	↘	2.57	No Trend
LIM471	Ephraim Mogale	5.64	↗	6.72	↗	4.73	↘	3.36	No Trend
ETH	eThekwini	3.67	↘	4.02	↗	6.35	↘	6.26	No Trend
NC453	Gamagara	1.45	↘	4.82	↘	6.84	↗	3.70	No Trend
NC452	Ga-Segonyana	4.60	↘	6.82	↗	6.58	↗	2.72	No Trend
WC044	George	1.60	↘	3.38	↘	6.03	↘	4.36	No Trend
MP307	Govan Mbeki	2.55	↘	7.04	↗	5.97	↘	4.48	No Trend
EC123	Great Kei	7.56	↘	4.54	↗	5.27	↗	2.83	No Trend
LIM331	Greater Giyani	5.95	↗	6.46	↗	6.09	↘	3.03	No Trend
KZN433	Greater Kokstad	4.42	↘	5.44	↗	6.52	↘	4.39	No Trend
LIM332	Greater Letaba	5.78	↗	7.06	↗	5.60	↗	3.96	No Trend
NW394	Greater Taung	7.01	↘	8.52	↘	7.43	↗	1.92	No Trend
LIM476	Greater Tubatse/Fetakgomo	5.38	↘	9.44	↗	8.44	↗	7.41	No Trend
LIM333	Greater Tzaneen	5.04	↘	8.14	↗	6.19	↘	6.64	No Trend
NC065	Hantam	2.69	↘	1.89	↘	5.97	↘	1.68	No Trend
WC042	Hessequa	1.60	↘	2.96	↘	5.28	↗	5.12	No Trend
KZN224	Impendle	7.60	↗	4.38	↘	4.83	↘	9.44	No Trend
KZN237	Inkosi Langalibalele	7.31	↗	4.88	↘	5.17	↘	7.04	No Trend
EC135	Intsika Yethu	8.88	↗	4.04	↘	5.56	↘	2.71	No Trend
EC131	Inxuba Yethemba	4.23	↘	5.34	↘	5.39	↘	3.31	No Trend

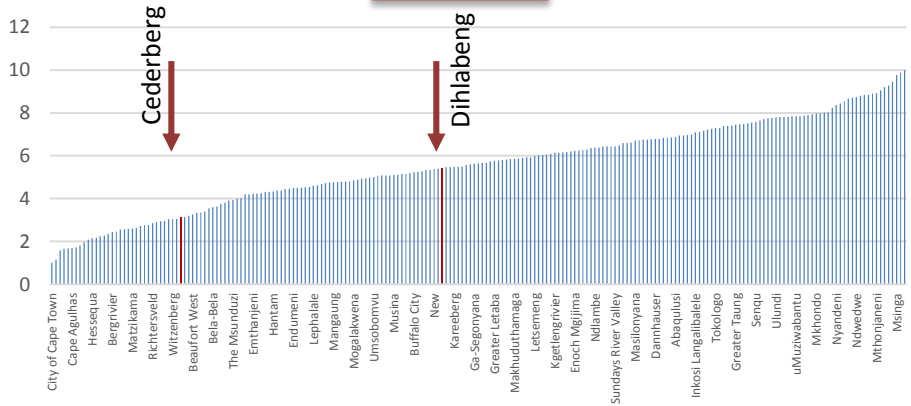
EVI 1996



EVI 2011



SEV 1996



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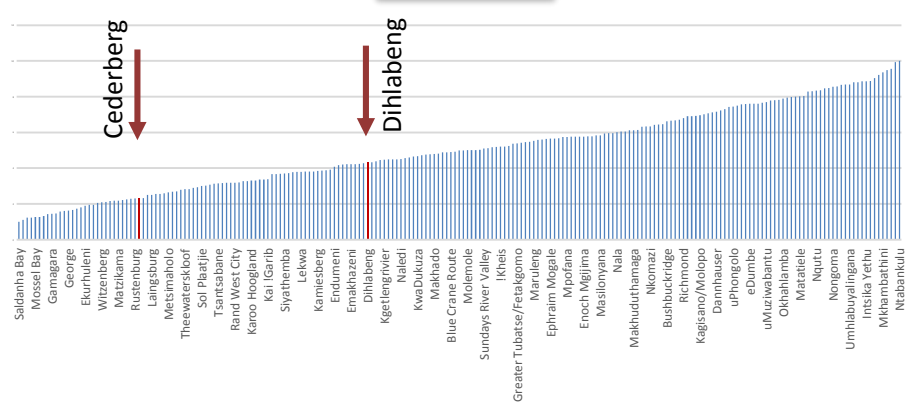
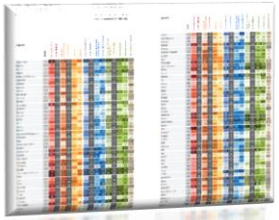


Indicators to disseminate showing multiple dimensions and scales of vulnerability

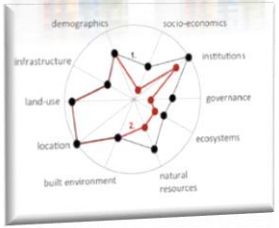
T1 Local Municipality

(Comparative statistics to compare local municipalities)



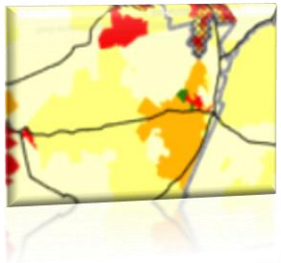
T2 Settlement Level

(Spider diagrams comparing settlements within a local municipality)



T3 Neighbourhood level

(Settlement hot spot maps at 500mx500m resolution)



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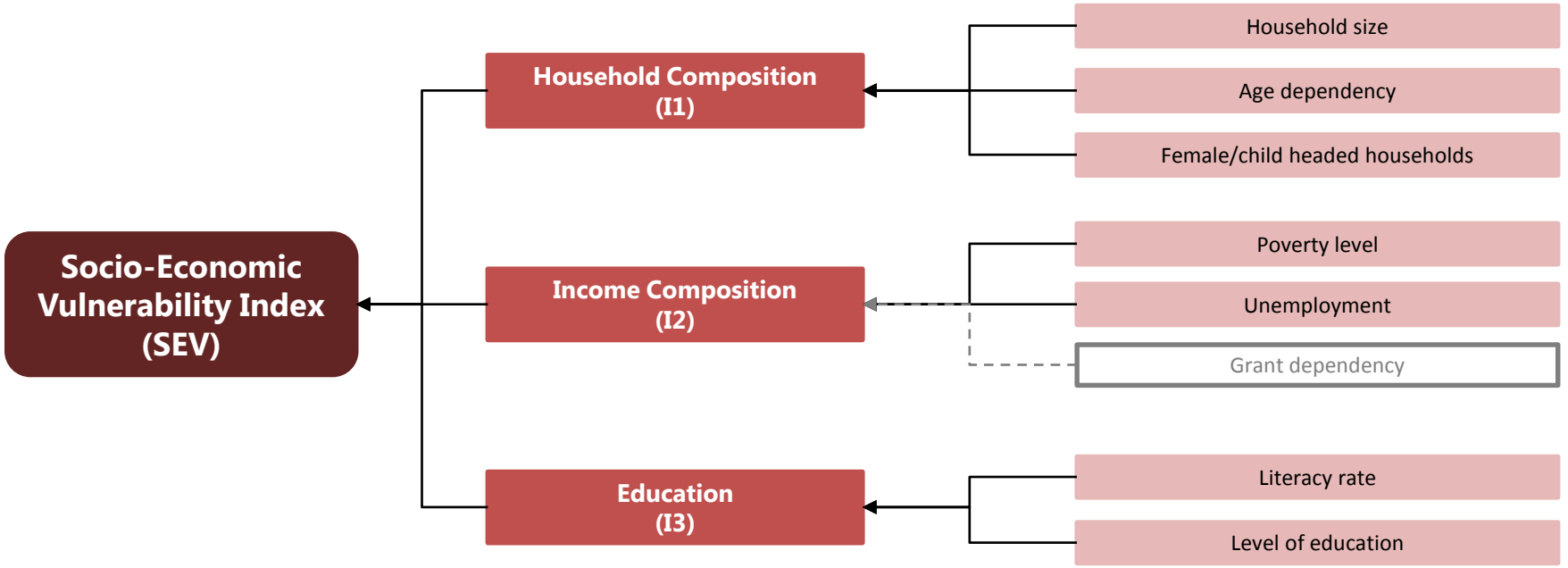

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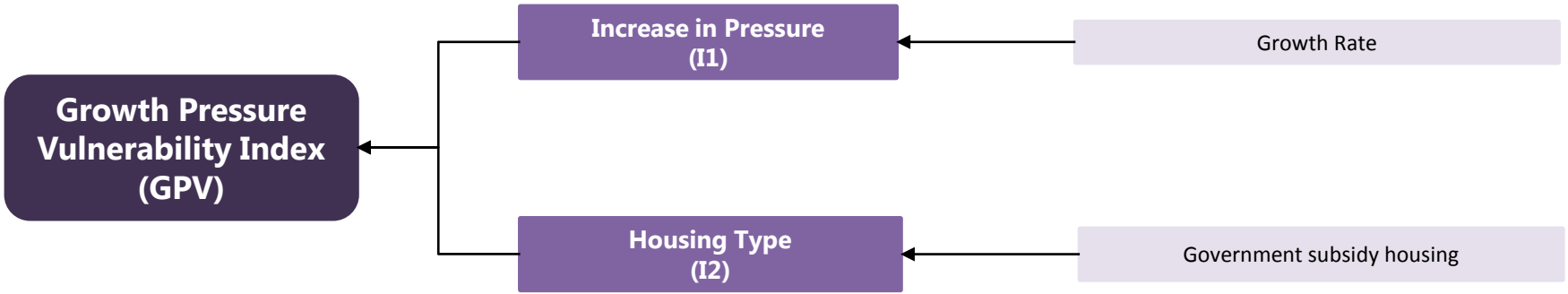

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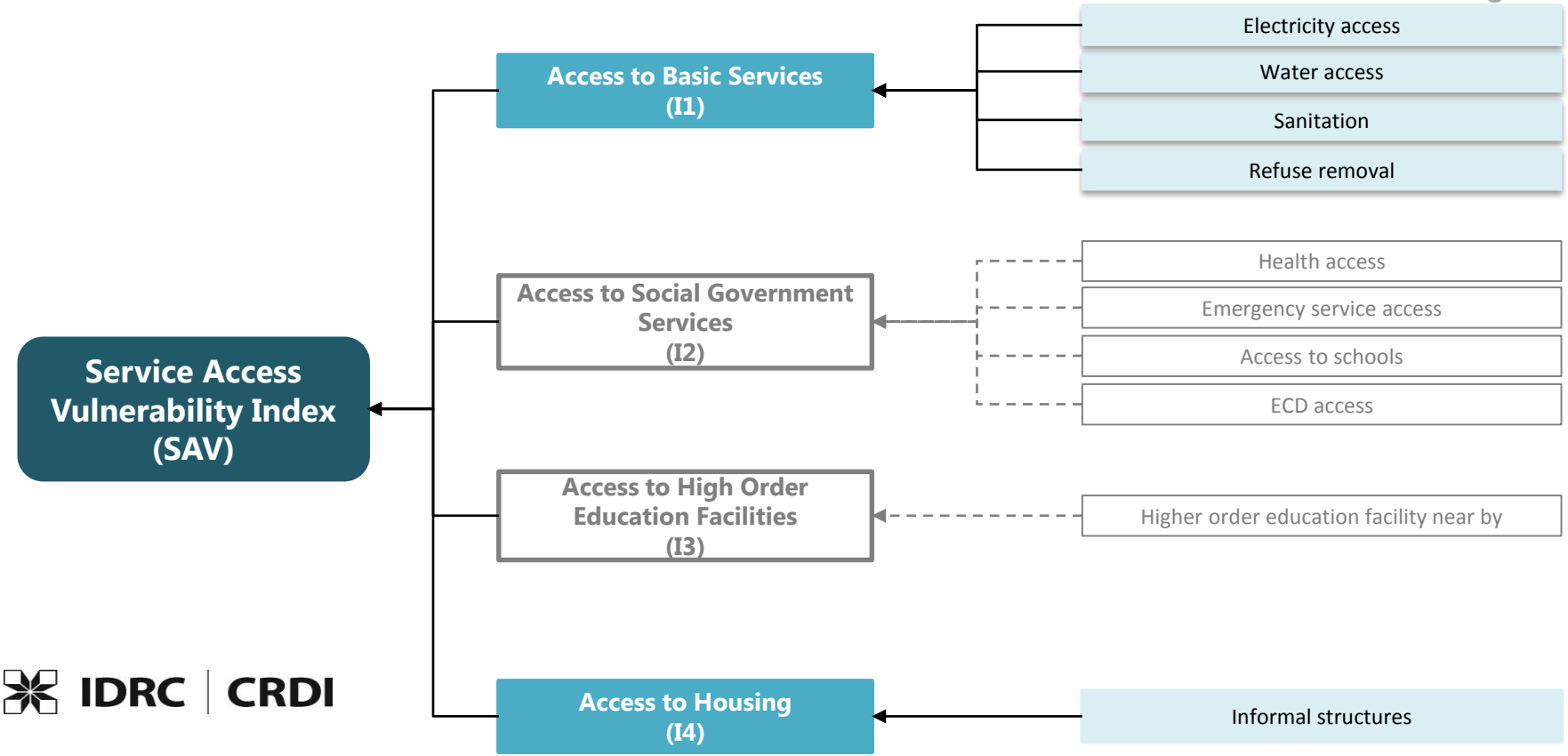
Service Access Vulnerability Index (SAV)
Access to Basic Services (I1)
Electricity access
Water access
Sanitation
Refuse removal
Access to Social Government Services (I2)
Health access
Emergency service access
Access to schools
ECD access
Access to High Order Education Facilities (I3)
Higher order education facility near by
Access to Housing (I4)
Informal structures

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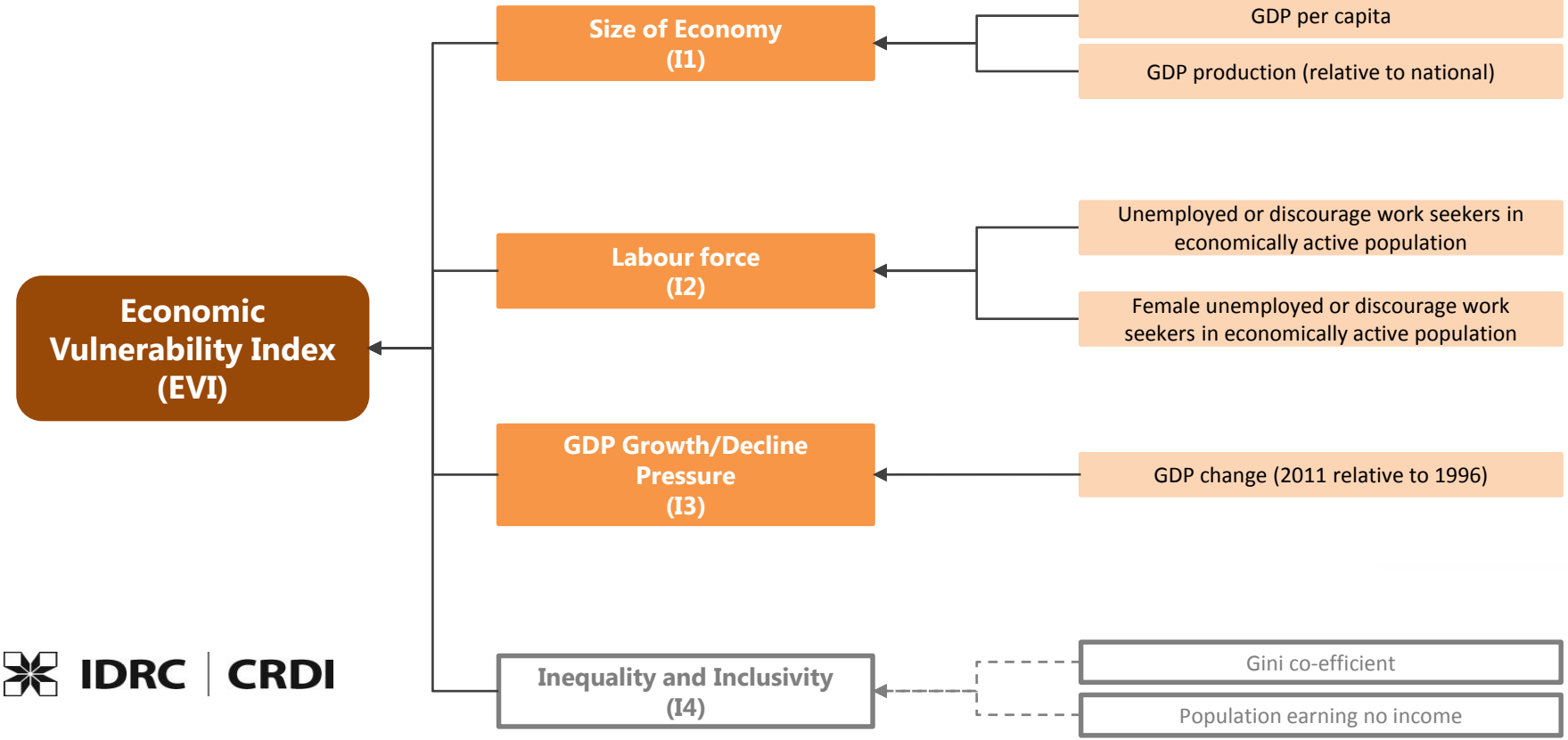
Economic Vulnerability Index (EVI)
Size of Economy (I1)
GDP per capita
GDP production (relative to national)
Labour force (I2)
Unemployed or discourage work seekers in economically active population
Female unemployed or discourage work seekers in economically active population
GDP Growth/Decline Pressure (I3)
GDP change (2011 relative to 1996)
Inequality and Inclusivity (I4)
Gini co-efficient
Population earning no income

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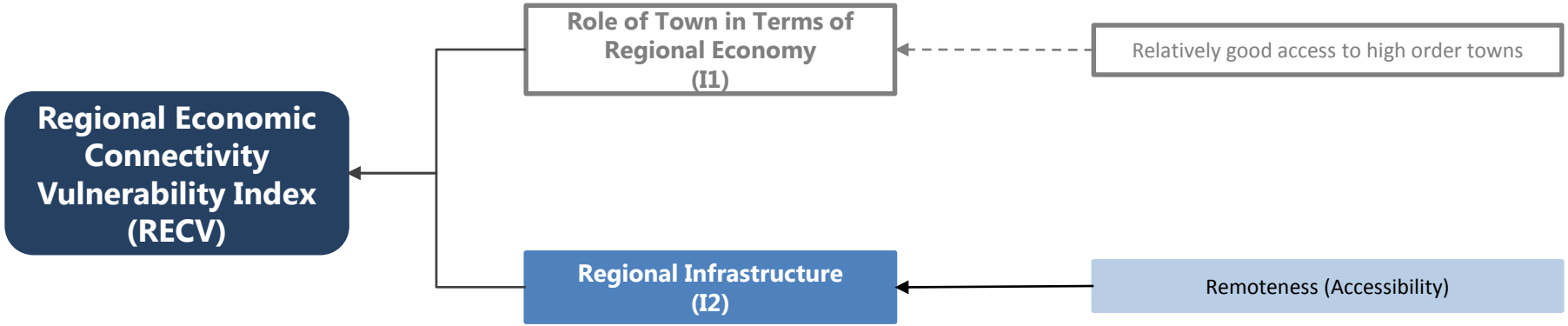

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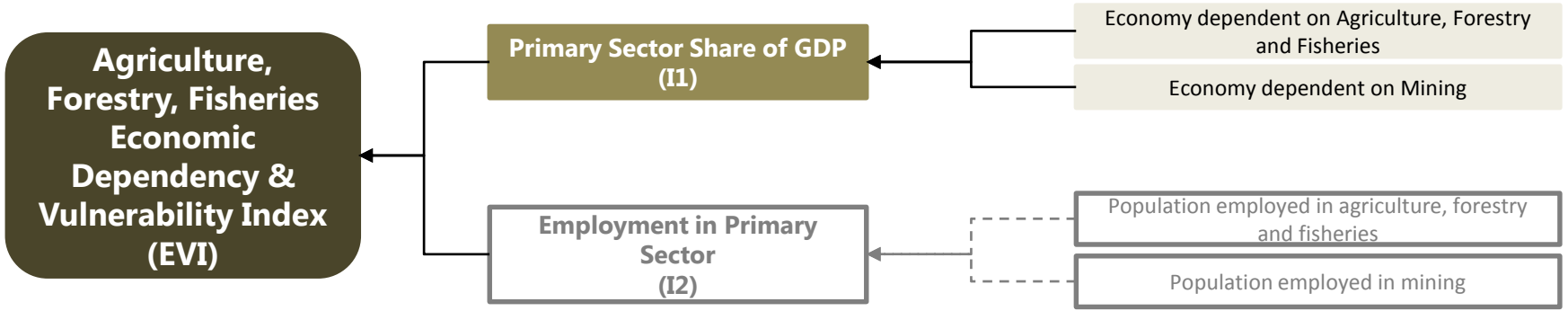

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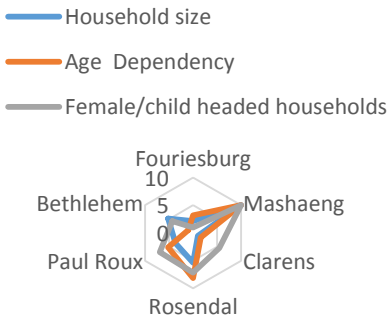
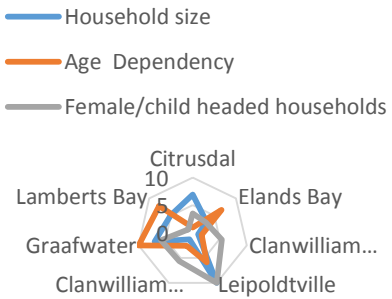
Socio-Economic Vulnerability

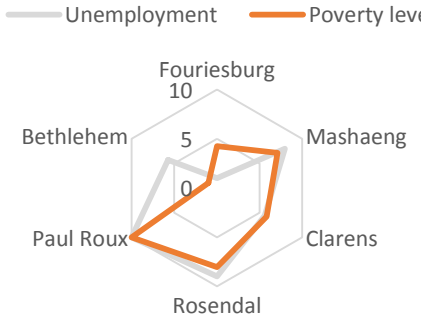
Dihlabeng Household Composition



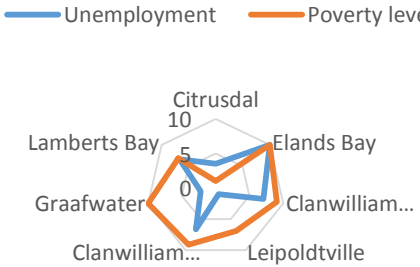
Cederberg Household Composition



Dihlabeng Income Composition



Cederberg Income Composition



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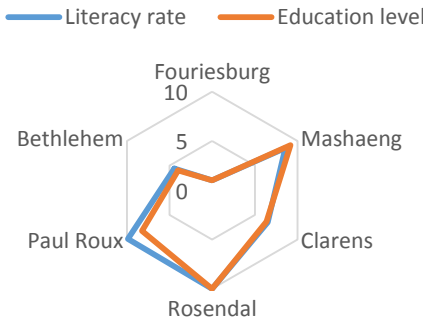
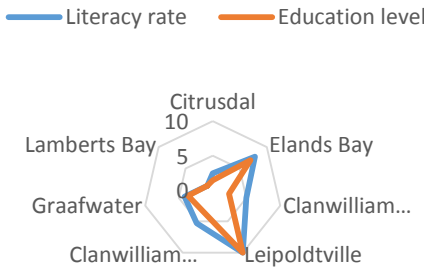
Socio-Economic Vulnerability

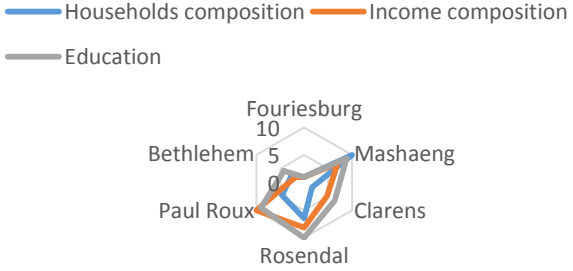
Dihlabeng Education



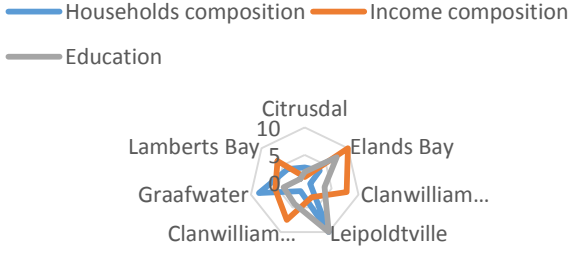
Cederberg Education



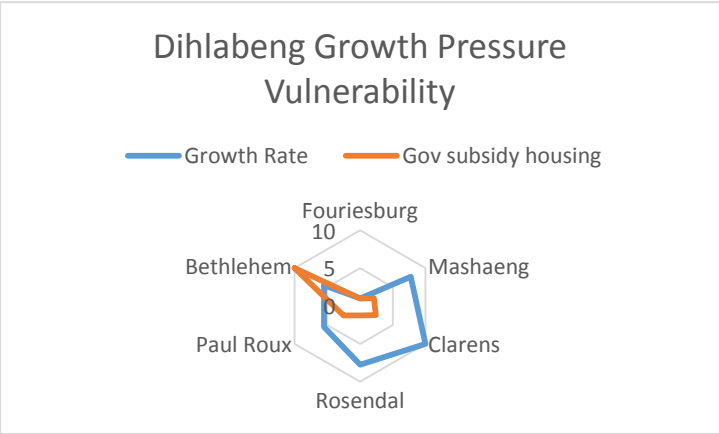
Dihlabeng Socio-Economic Vulnerability

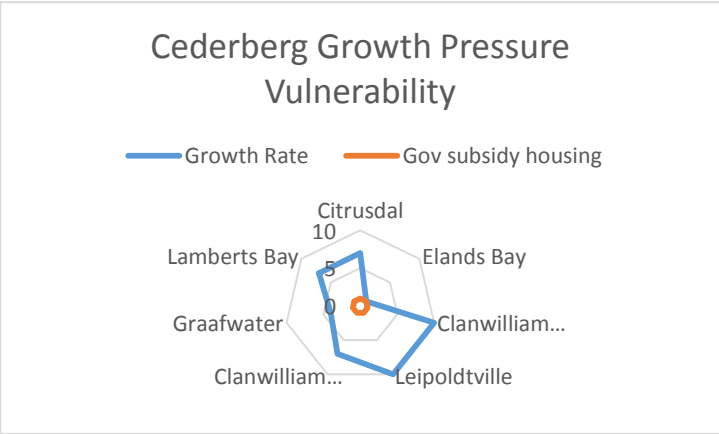


Cederberg Socio-Economic Vulnerability



Growth Pressure Vulnerability





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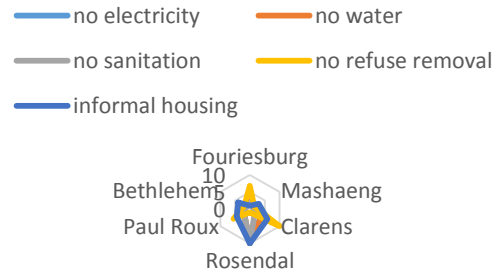
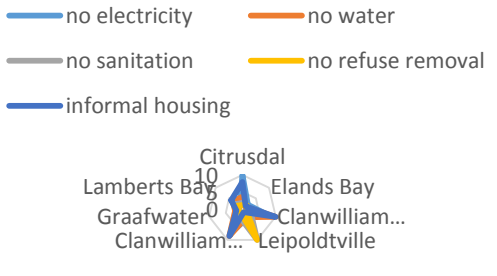
Service Access Vulnerability

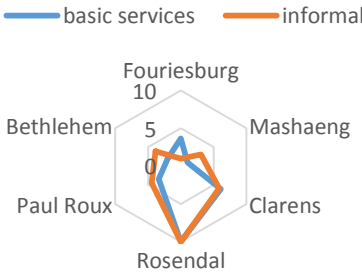
Dihlabeng Access to Basic Services and Housing



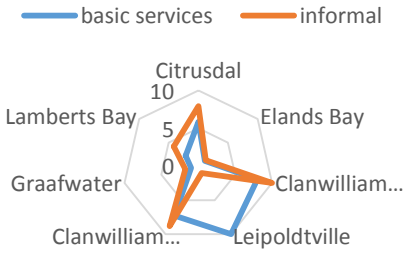
Cederberg Access to Basic Services and Housing



Dihlabeng Service Access Vulnerability

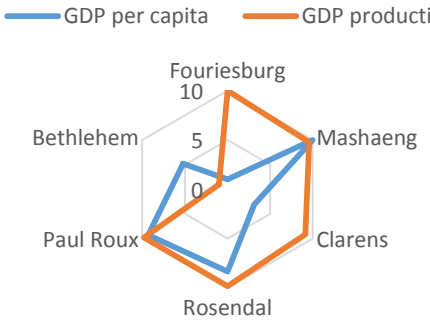


Cederberg Service Access Vulnerability

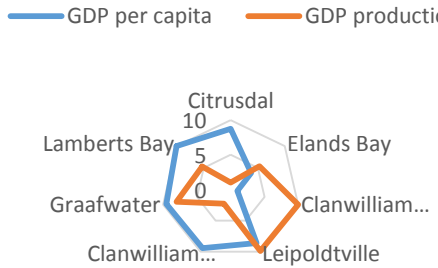


Economic Vulnerability

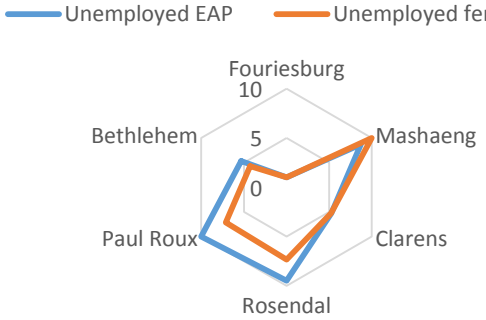
Dihlabeng Size of Economy



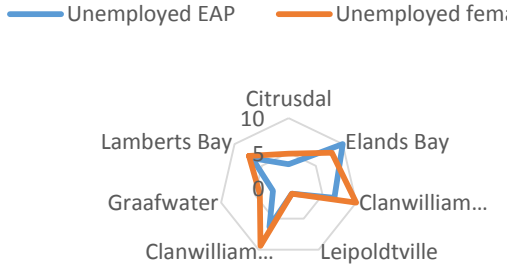
Cederberg Size of Economy



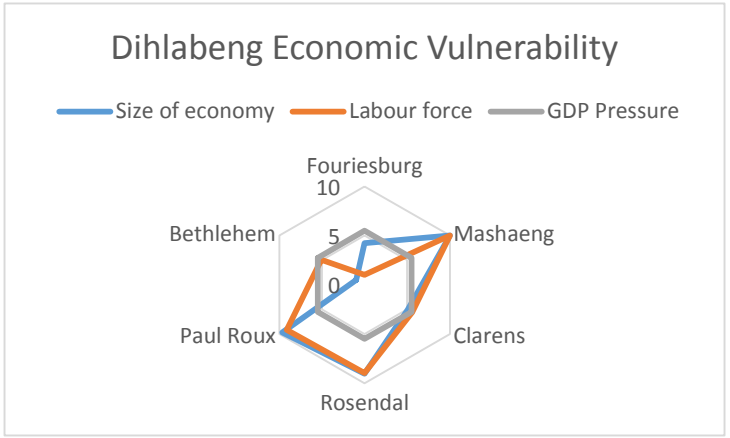
Dihlabeng Labour Force

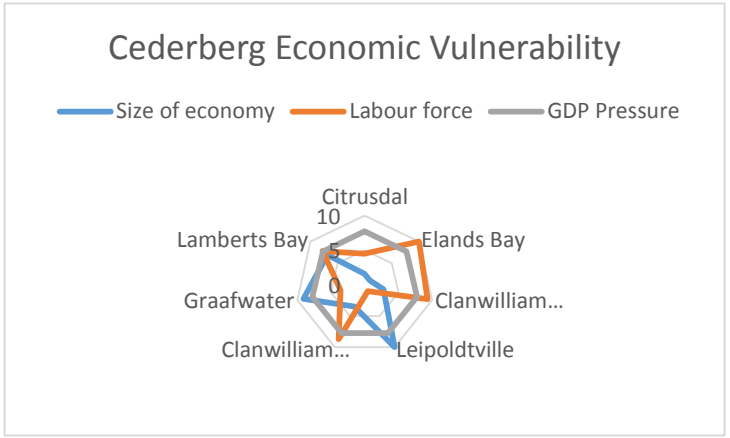


Cederberg Labour Force



Economic Vulnerability





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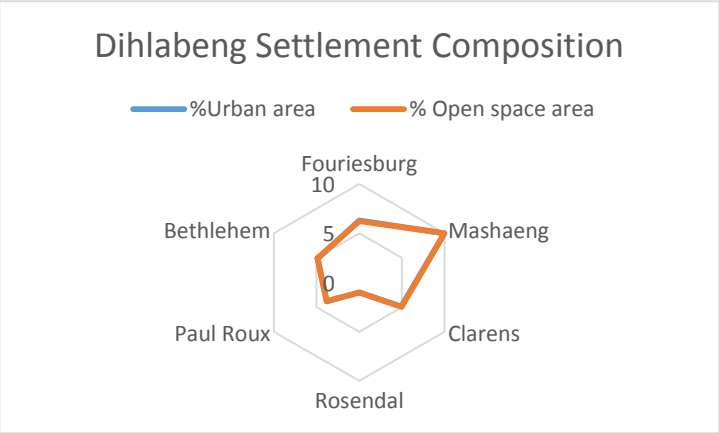
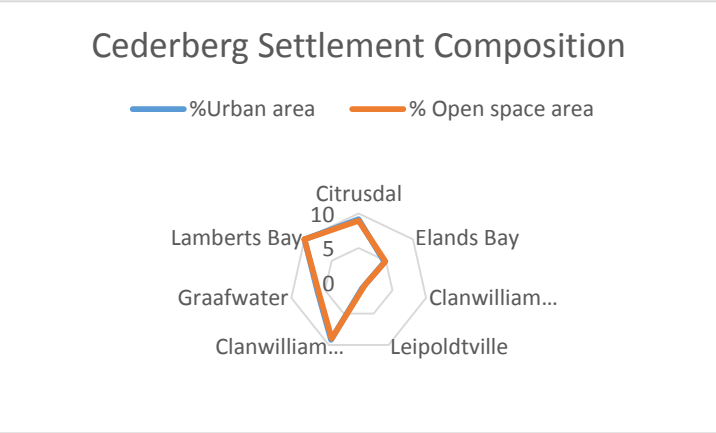
Environmental Vulnerability





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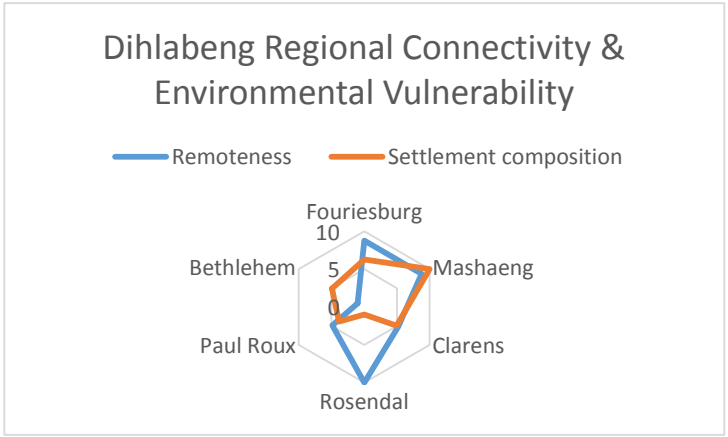
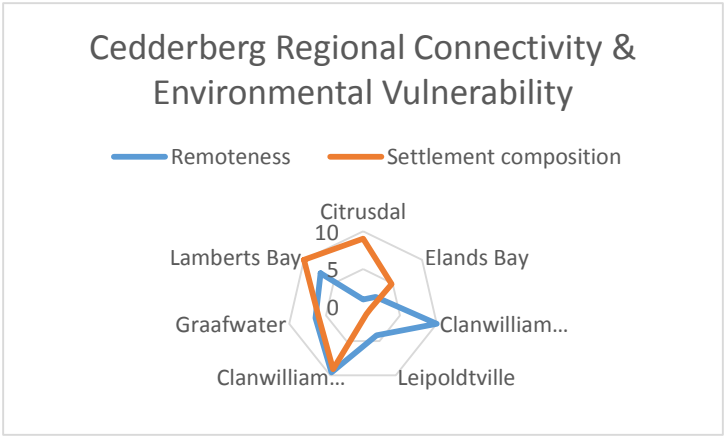
Regional Economic Connectivity & Environmental Vulnerability





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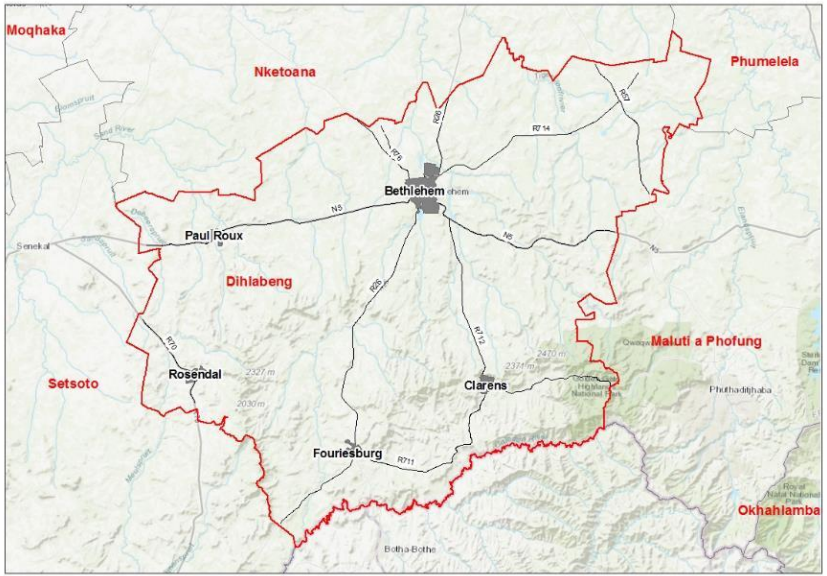

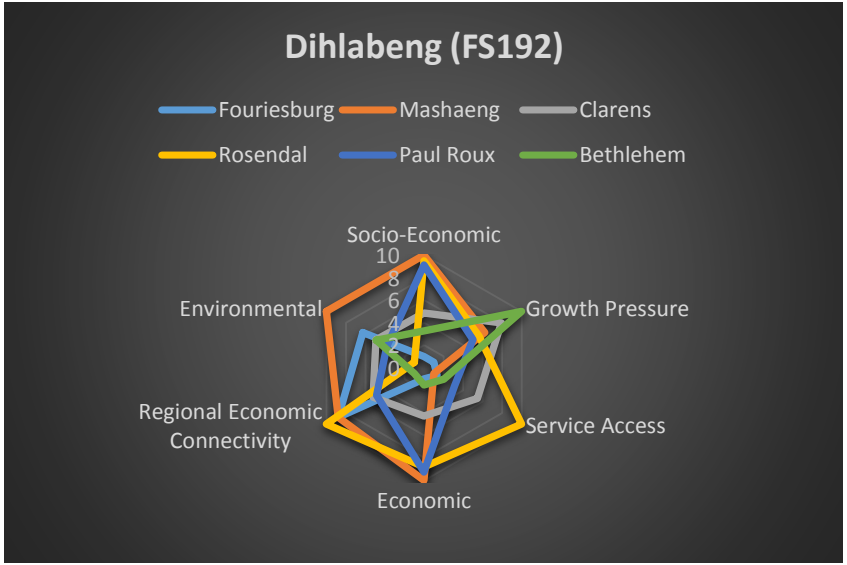

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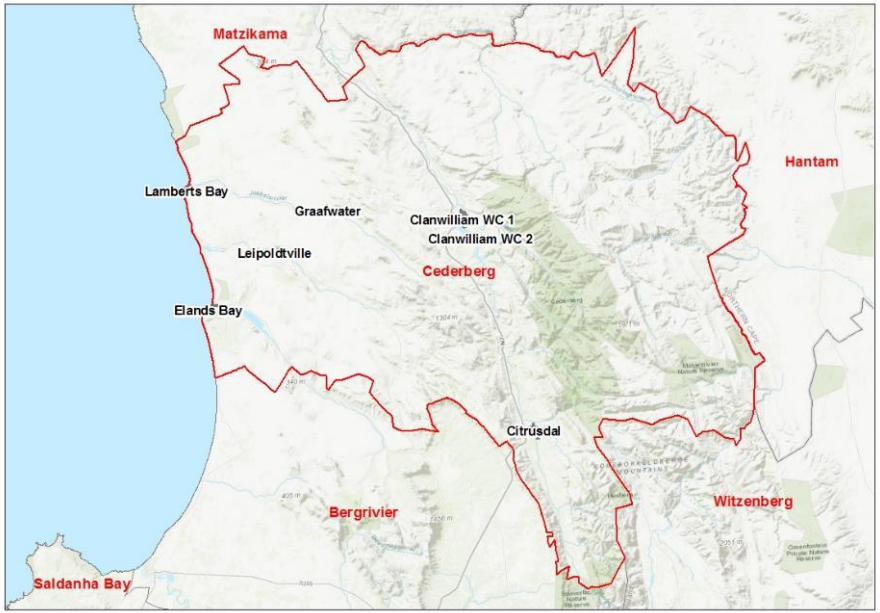

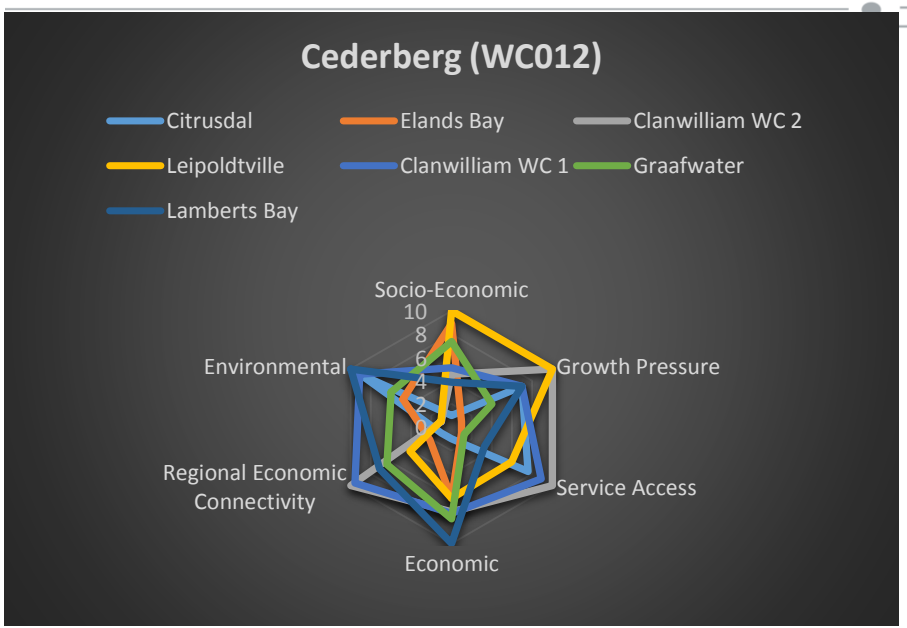

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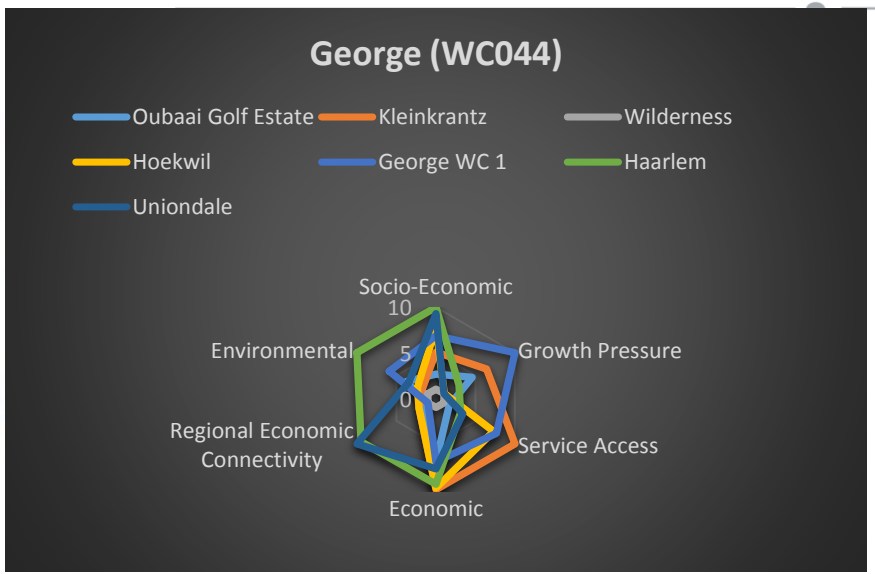

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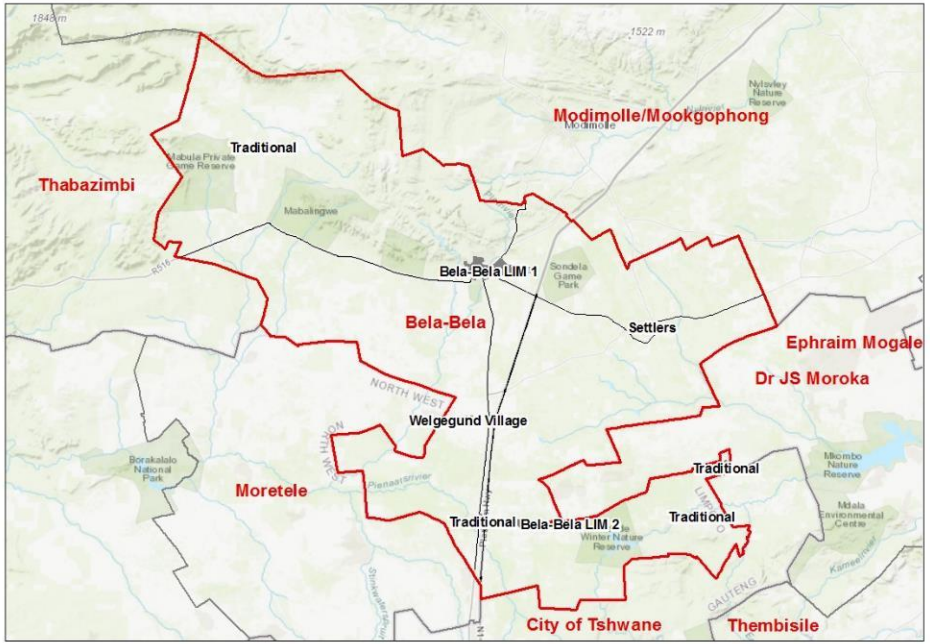

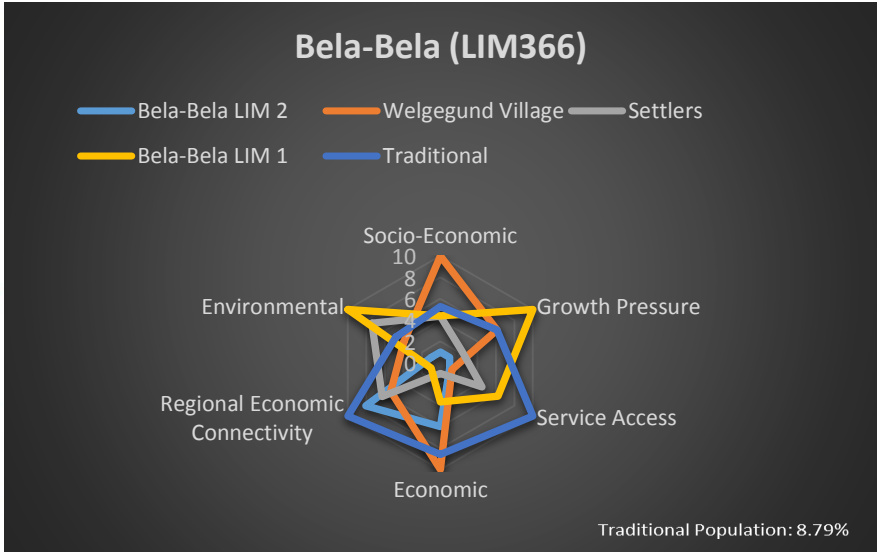

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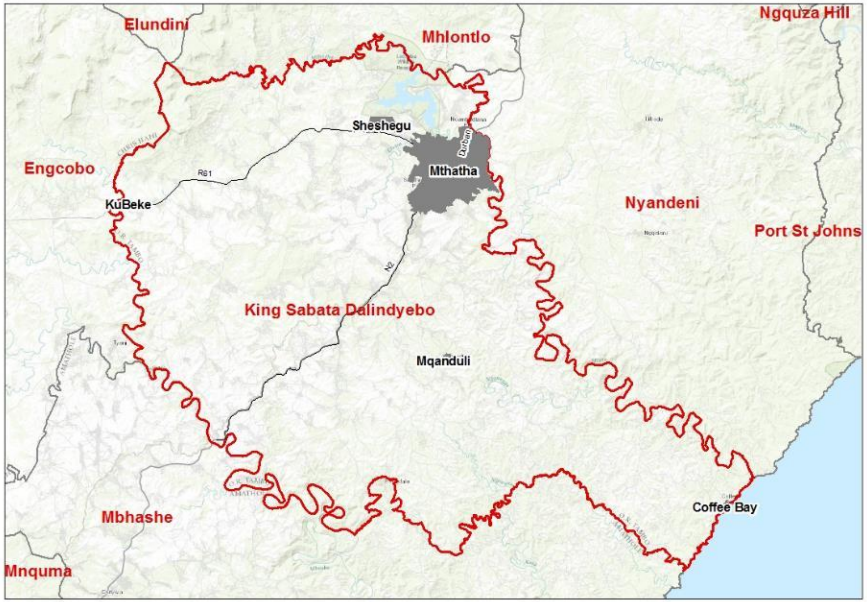

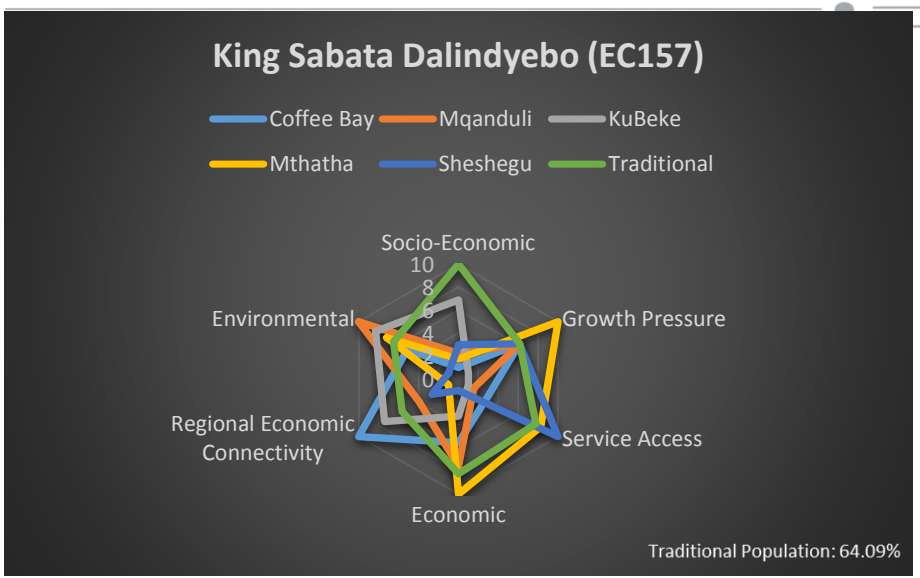

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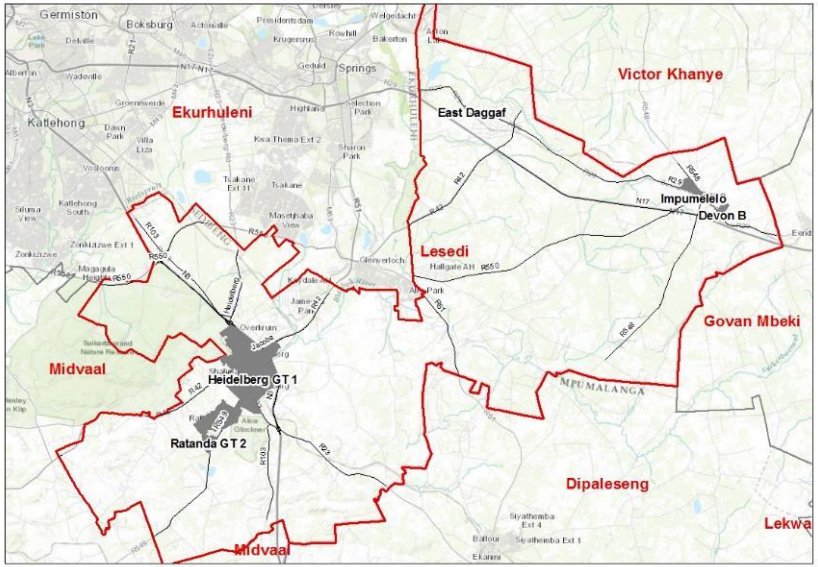

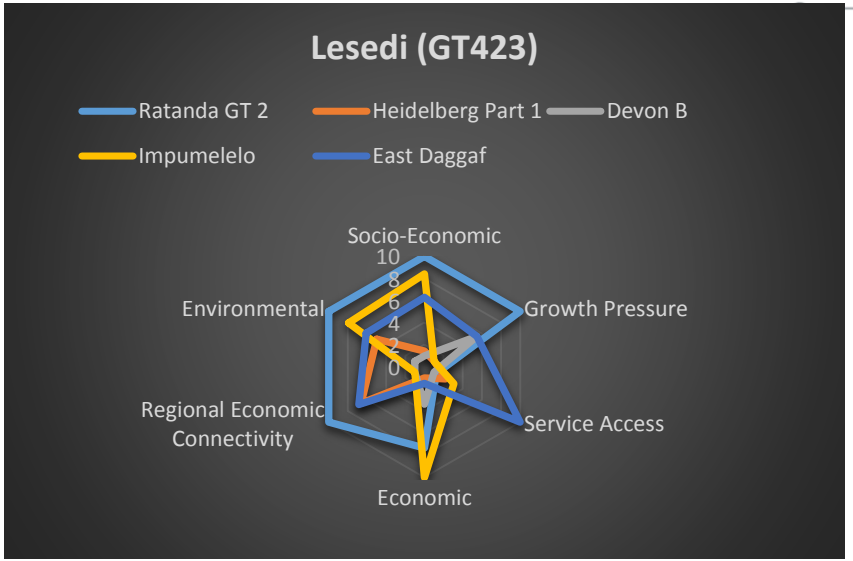

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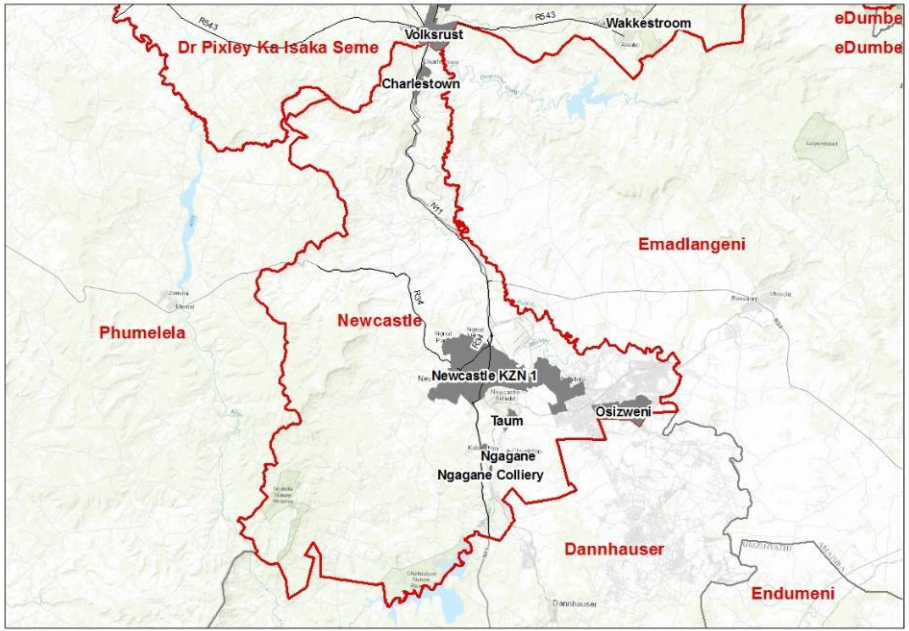

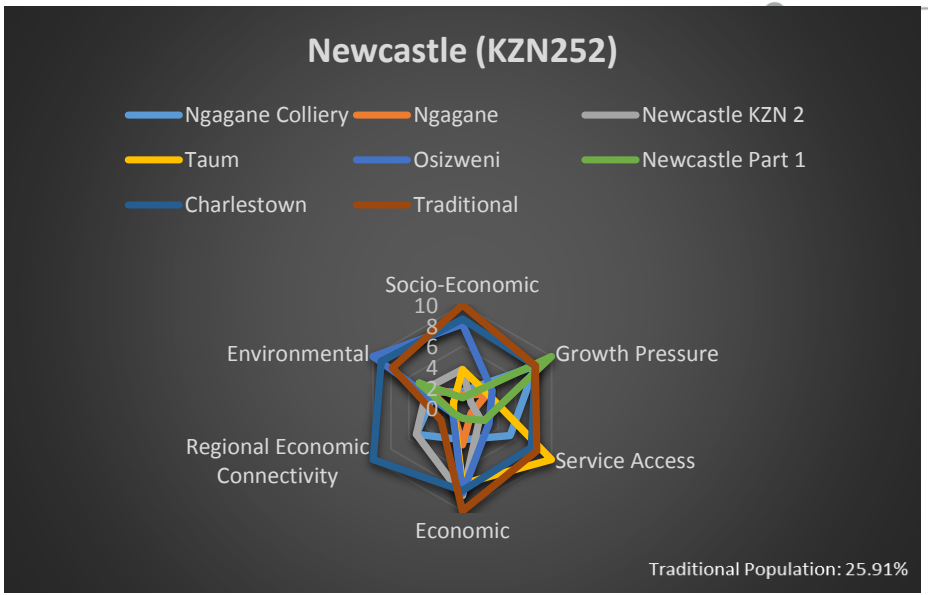

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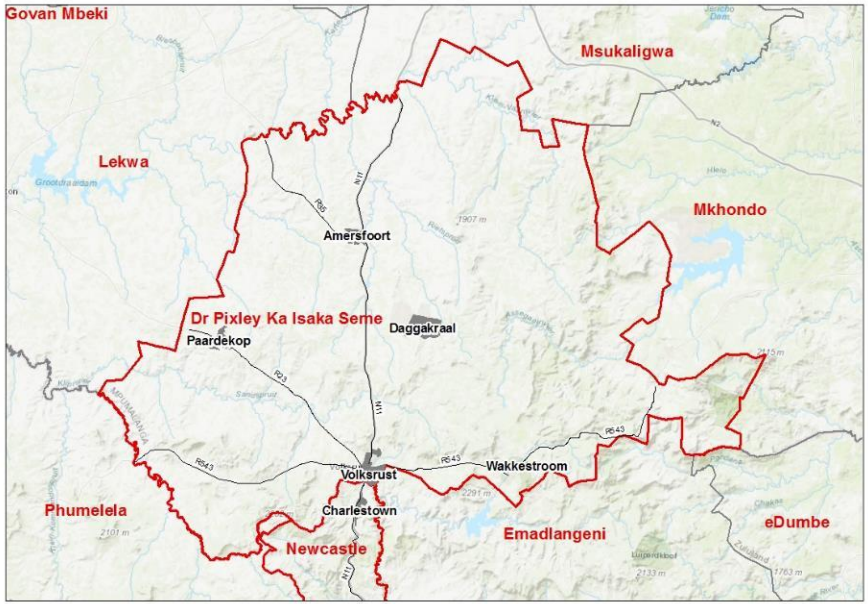

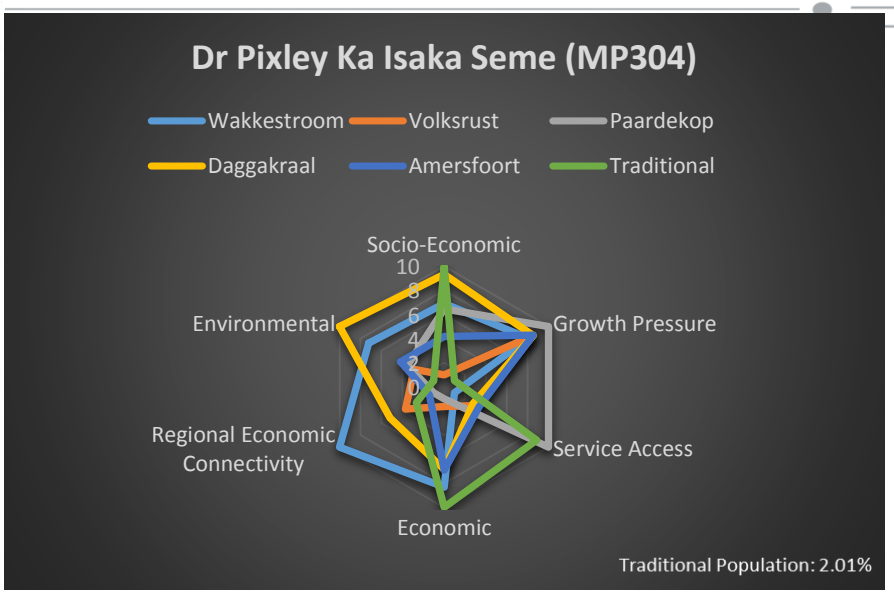

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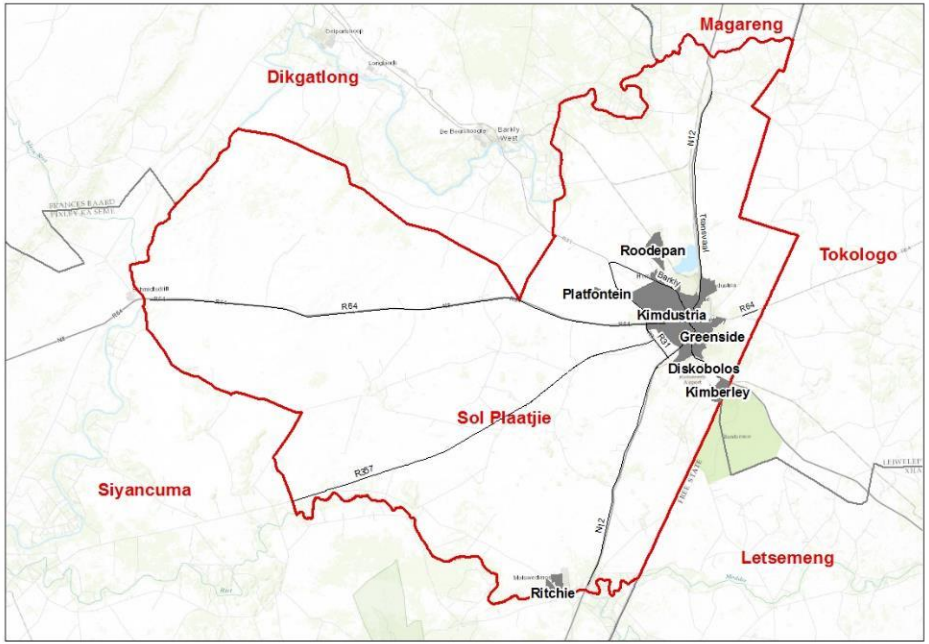

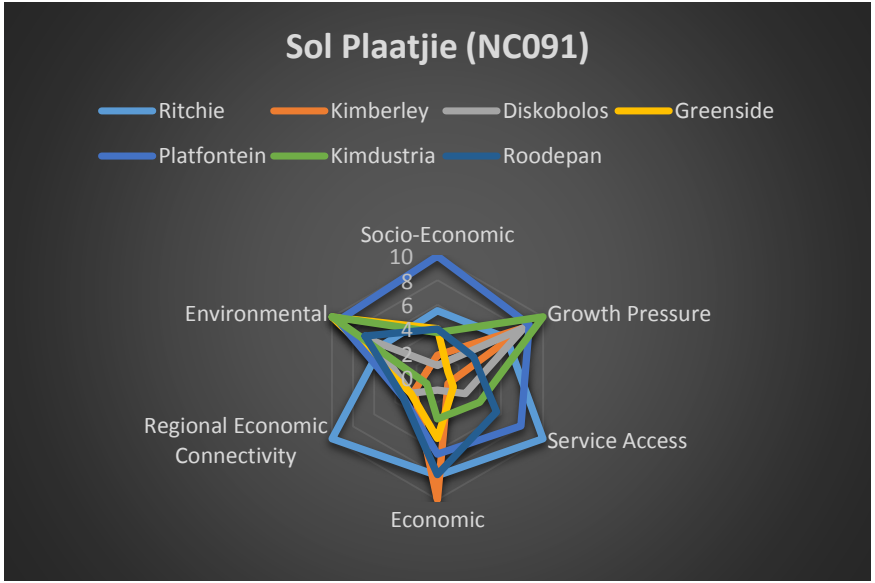

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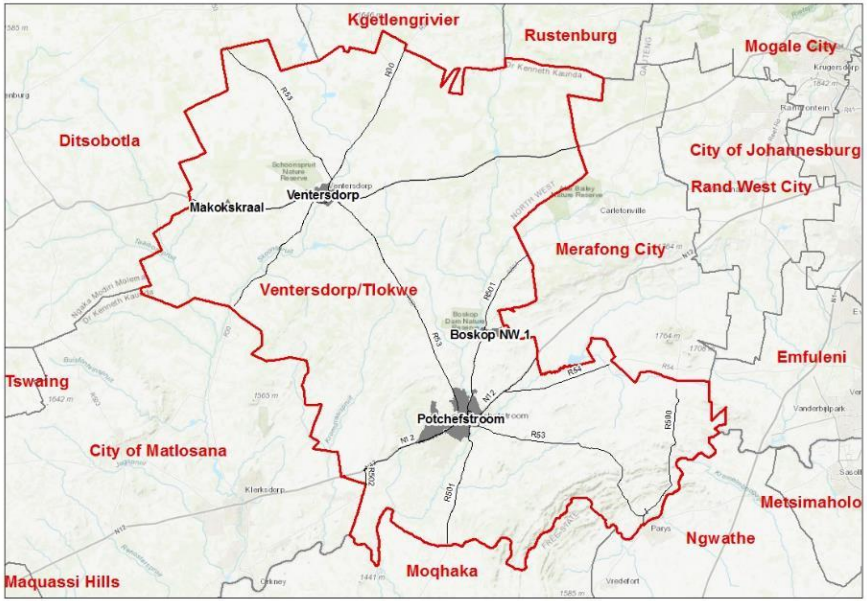

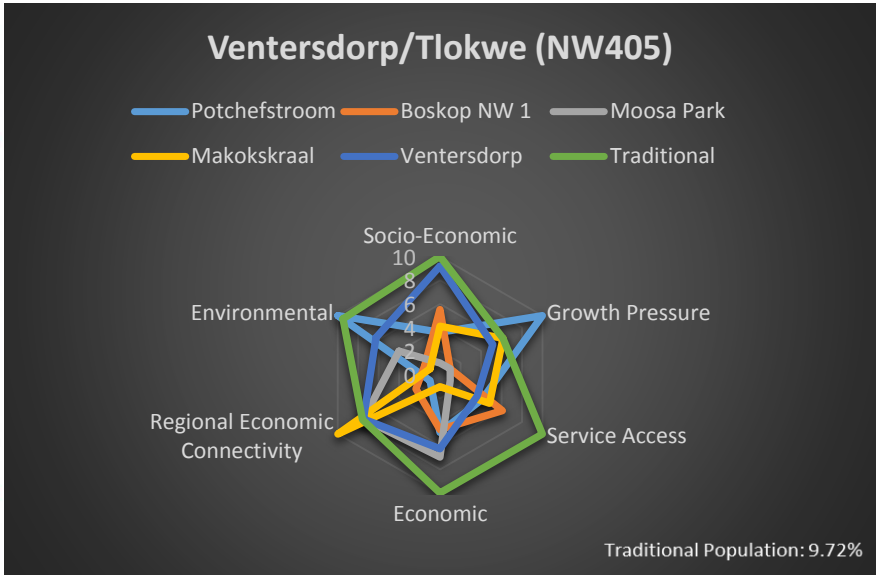

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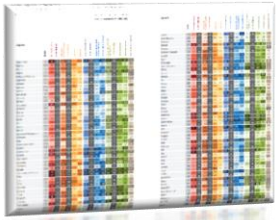
Indicators to disseminate showing multiple dimensions and scales of vulnerability

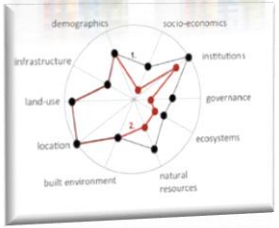
T1 Local Municipality

(Comparative statistics to compare local municipalities)



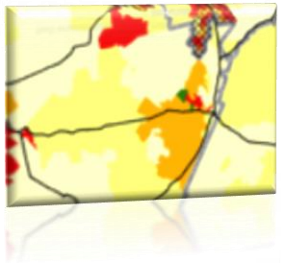
T2 Settlement Level

(Spider diagrams comparing settlements within a local municipality)



T3 Neighbourhood level

(Settlement hot spot maps at 500mx500m resolution)



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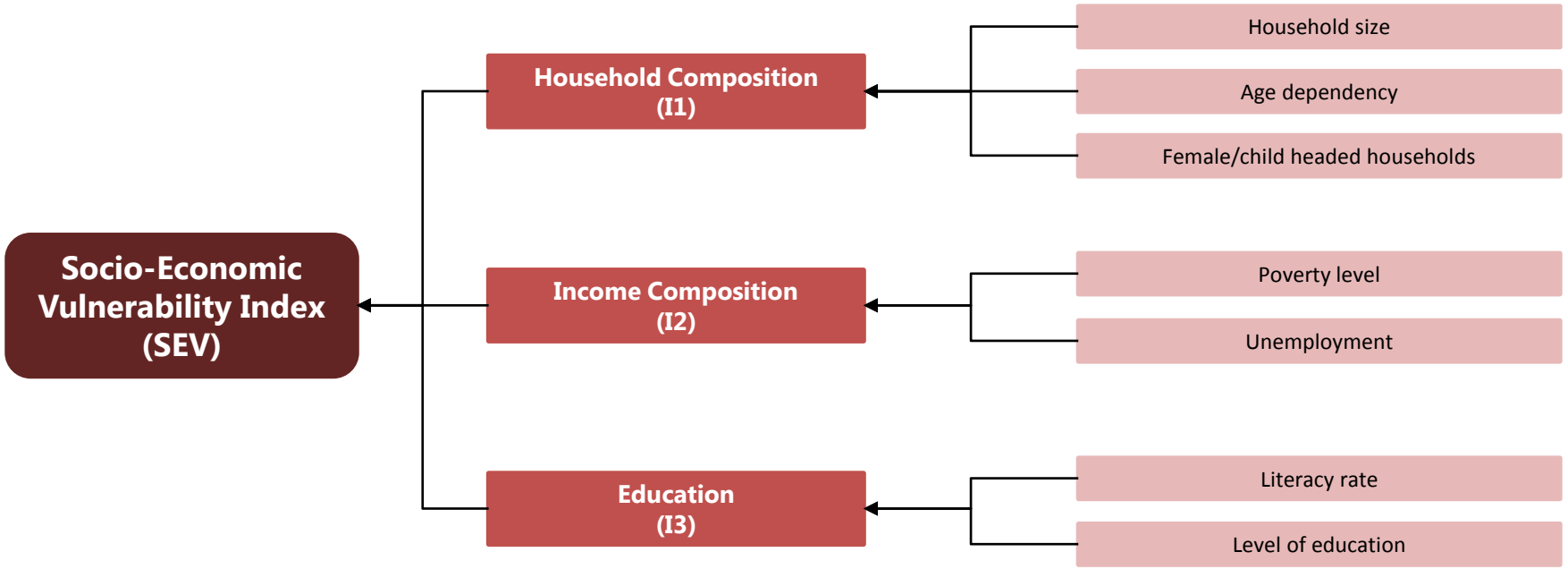

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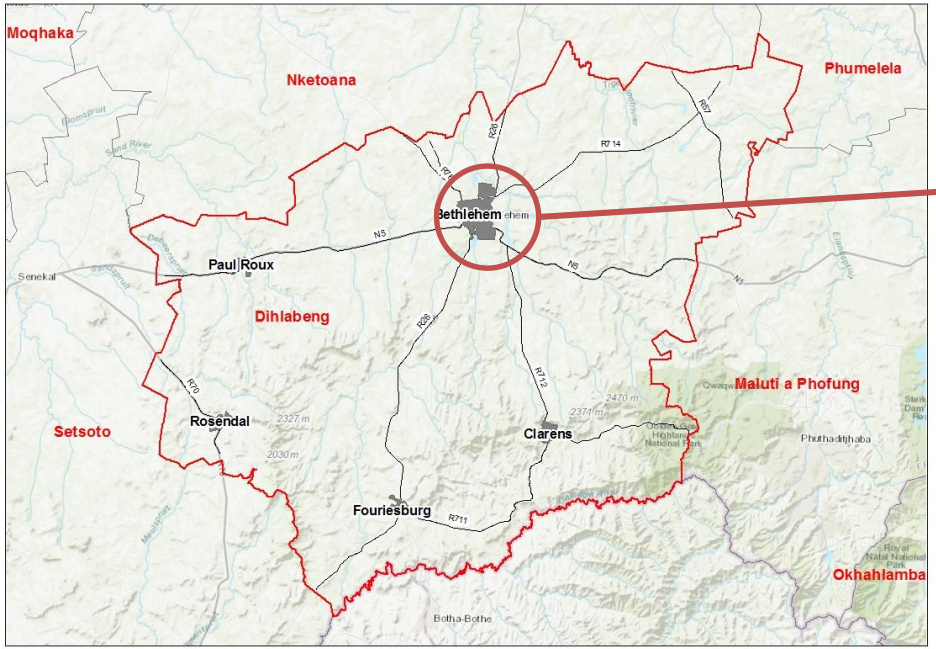
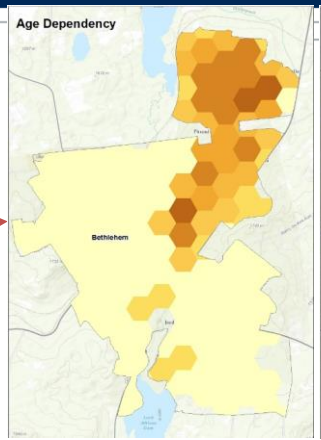
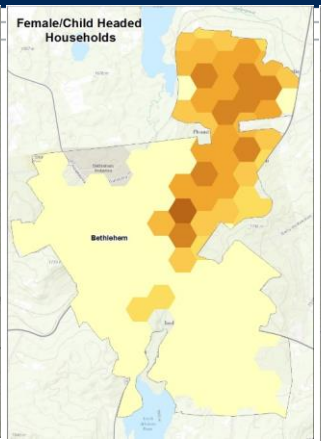
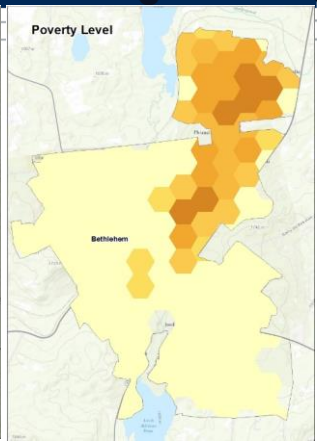
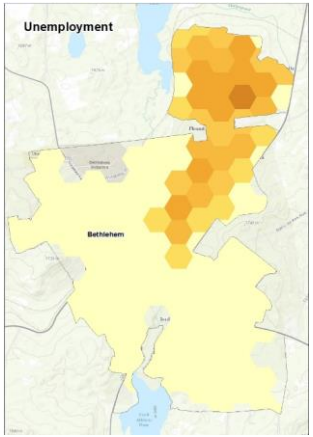
Neighbourhood/precinct (T4) comparative indicators

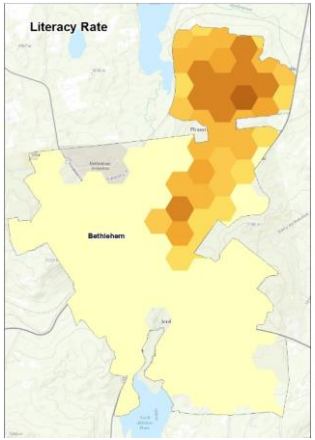


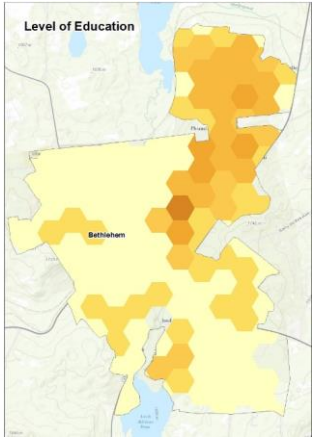












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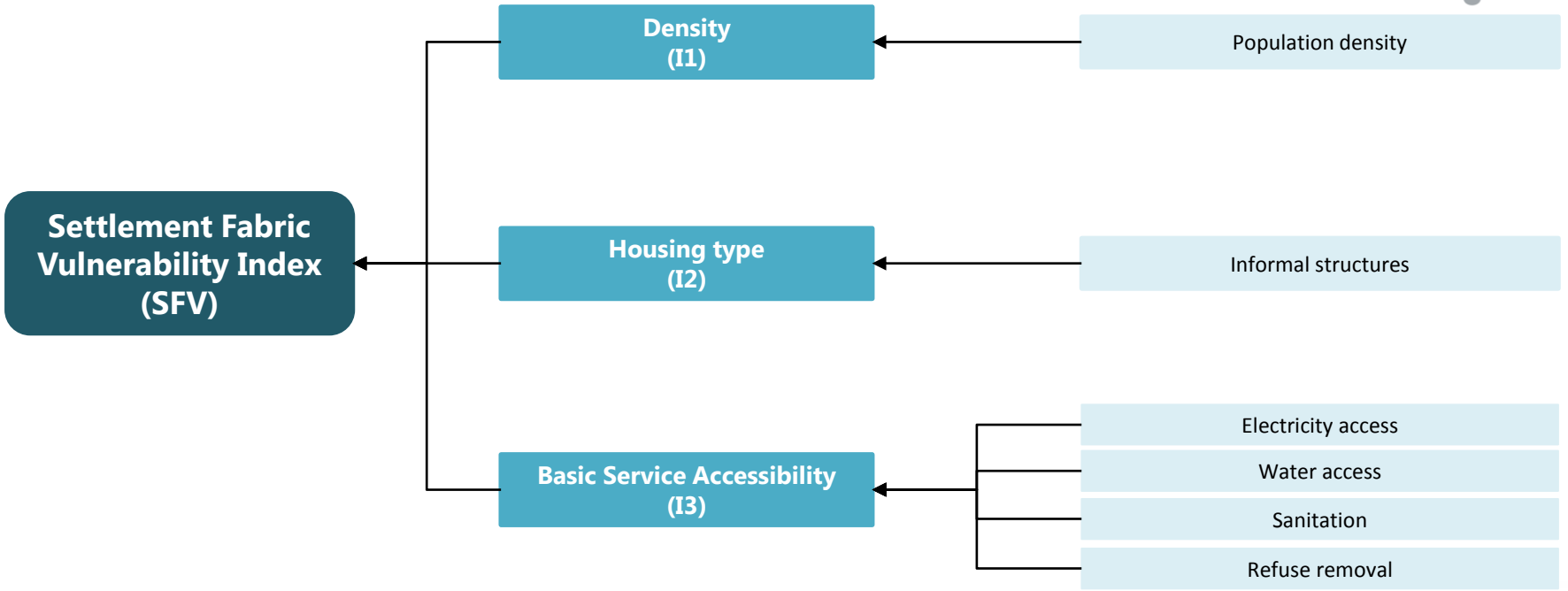

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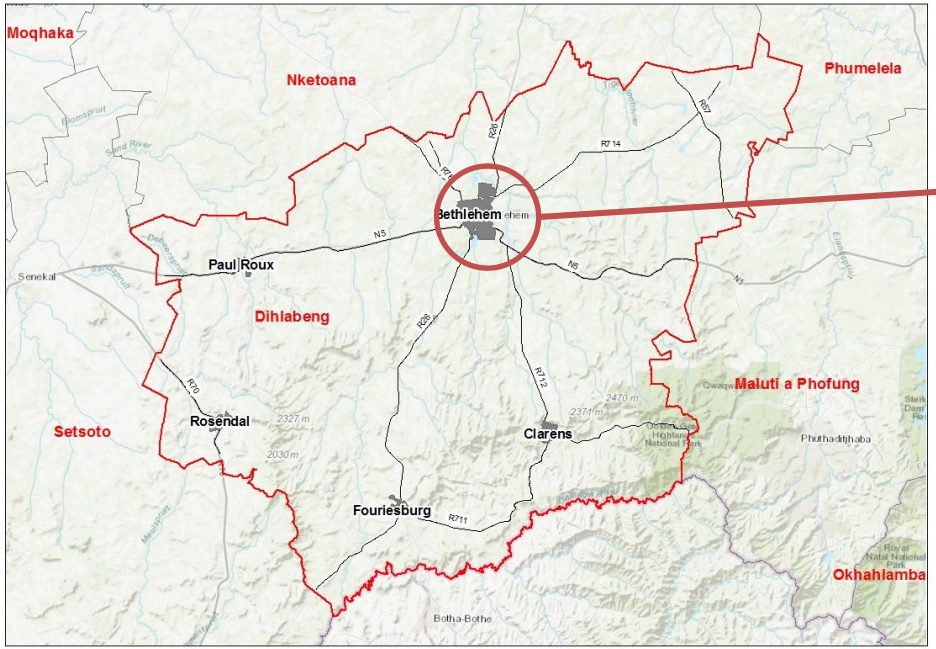
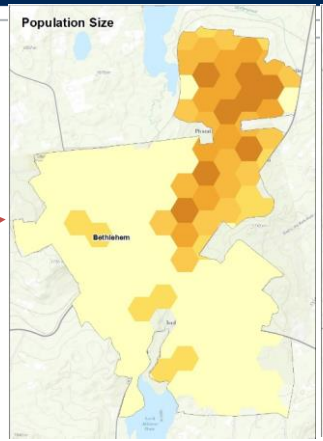
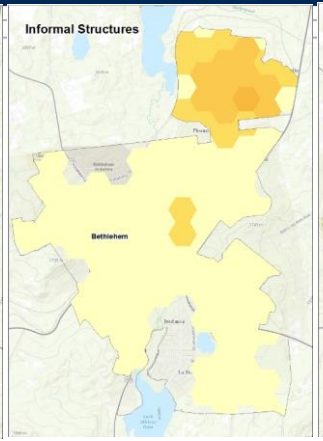
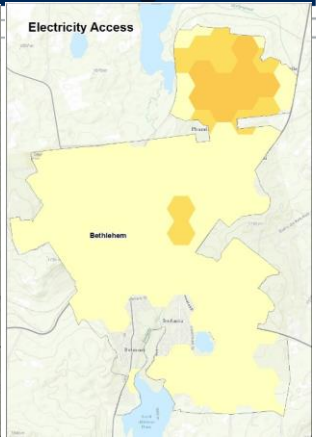
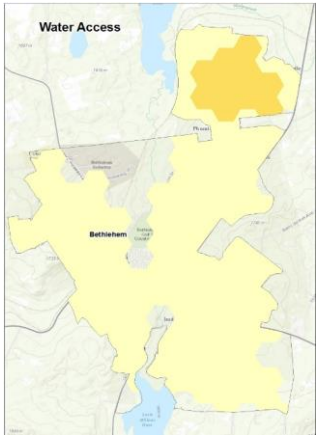
Neighbourhood/precinct (T4) comparative indicators

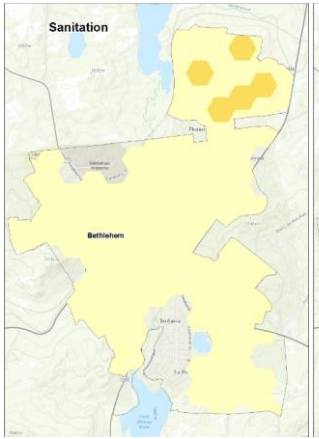


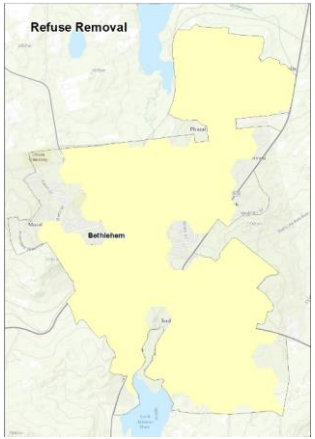












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Deliverables

- Open settlement layer (GB_STLMNTS_V1.gdb) Downloadable from
- Local Municipality spatial variables, indices and composite indictors (LM Vulnerability Indices.gdb)
- Final 4 LM CI and 15year trend data (LM_Indicators Trend Table_20180224.xlsx)
- Settlement comparative spatial indictors (.gdb)
- Settlement comparative indicators (.xlsx)
- Grid base vulnerability indicator
- Article submitted to the JAMBA