Spatial measures of socio-economic inequality in South Africa

Spatial exposure to inequality: Methods

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Background and rationale

- The South African government now lists inequality alongside poverty and unemployment as the three core economic challenges facing the country.
- Both the New Growth Path (NPG 2010) and the National Development Plan (NDP 2012) adopt inequality reduction as a core priority.
- International (but largely northern hemisphere) evidence that inequality may be an important driver of social problems such as violent crime and social unrest.
- Strong imperative to broaden and deepen the empirical evidence base concerning inequality in South Africa.

Two research projects

'***Exploring the relationships between spatial inequality and attitudes to inequality in South Africa***' (UK ESRC & SA NRF funded):

1. Analyse the unequal spatial configuration of deprivation at small area level as a measure of people's lived experience of inequality.
2. Analyse people's attitudes towards inequality and towards policy options for redress.
3. Test whether people's attitudes are influenced by (or associated with) their lived experience of inequality.

'***Social cohesion: the missing link in overcoming violence, inequality and poverty***' **in South Africa and Brazil** (Canadian IDRC & UK DfID):

1. Analyse spatial patterns and trends in violent crime and potential explanatory factors – including inequality – at relevant spatial levels.
2. Explore relationships between these factors, including examining the role of social cohesion, drawing upon both quantitative and qualitative work.

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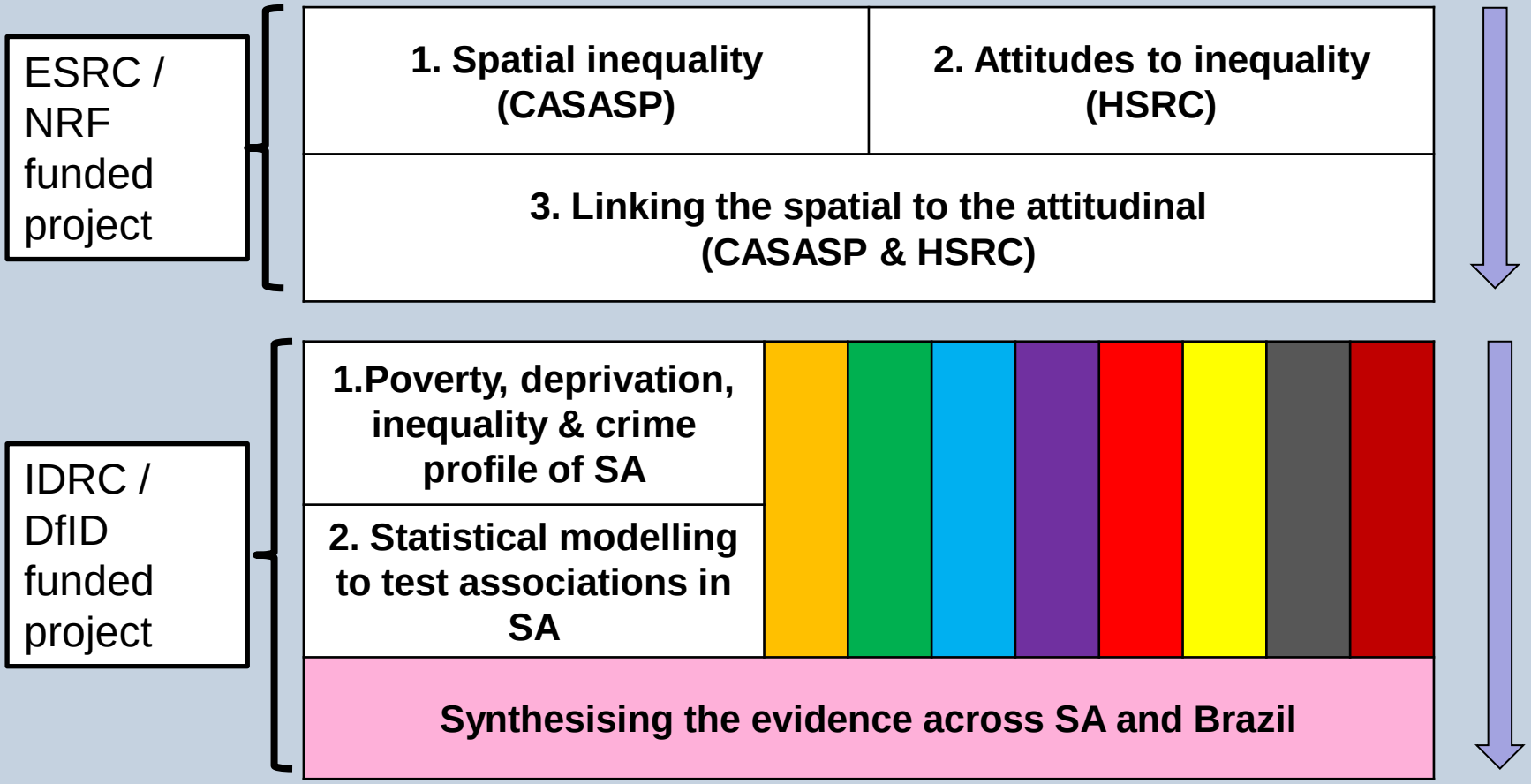
Structure of the two projects



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Spatial Inequality

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Why measure spatial inequality?

- Much of the existing quantitative research concerning inequality in South Africa utilises the ‘classical’ measures of (income) inequality such as the Gini coefficient, General Entropy measures, or the Atkinson index, and is expressed at high spatial levels (e.g. national or provincial).
- These measures say little about people’s ‘lived experience of inequality’ and how this varies *geographically* within a country.
- We argue that people’s experience of inequality is contoured by the geographical settings in which they live, work and travel.
- Requires a neighbourhood-level approach.

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Spatial inequality: residential segregation

- Residential segregation indices measure the degree to which two (or more) population sub-groups live separately from one another, at small area (i.e. neighbourhood) level. Utilise categorical data.
- We applied and developed a range of these indices to measure segregation between the 'poor' population and the 'non-poor' population (i.e. dichotomous classification) across the whole of South Africa.
- Our aim was to develop a measure of residential segregation that reflects people's lived experience of inequality in South Africa.
- Required a dataset that counts the number of 'poor' people and the number of 'non-poor' people for each neighbourhood across the whole of South Africa.

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South African Index of Multiple Deprivation 2001 (SAIMD 2001) at Datazone level

- The SAIMD 2001 consists of five dimensions or 'domains' of deprivation, each of which is measured separately at Datazone level:
  - Income and material deprivation (% population deprived)
  - Employment deprivation (% population deprived)
  - Education deprivation (% population deprived)
  - Living environment deprivation (% population deprived)
  - Health deprivation (age/sex standardised mortality)

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South African Index of Multiple Deprivation 2001 (SAIMD 2001) at Datazone level

- The SAIMD 2001 consists of five dimensions or 'domains' of deprivation, each of which is measured separately at Datazone level:
  - Income and material deprivation (% population deprived)

- In the SAIMD people are classified as suffering income and material deprivation if they meet one or more of the following criteria:

  (i) living in a household that has a household income (need-adjusted using the modified OECD equivalence scale) that is below 40% of the mean equivalent household income; or

  (ii) living in a household without a refrigerator; or

  (iii) living in a household with neither a television nor a radio.

South African Index of Multiple Deprivation 2001 (SAIMD 2001) at Datazone level

Datazones are a statistical geography covering the whole of South Africa. Datazone populations range from 1,000 to 3,000 with a mean of 2,000. There are approx 22,000 Datazones across South Africa as a whole.

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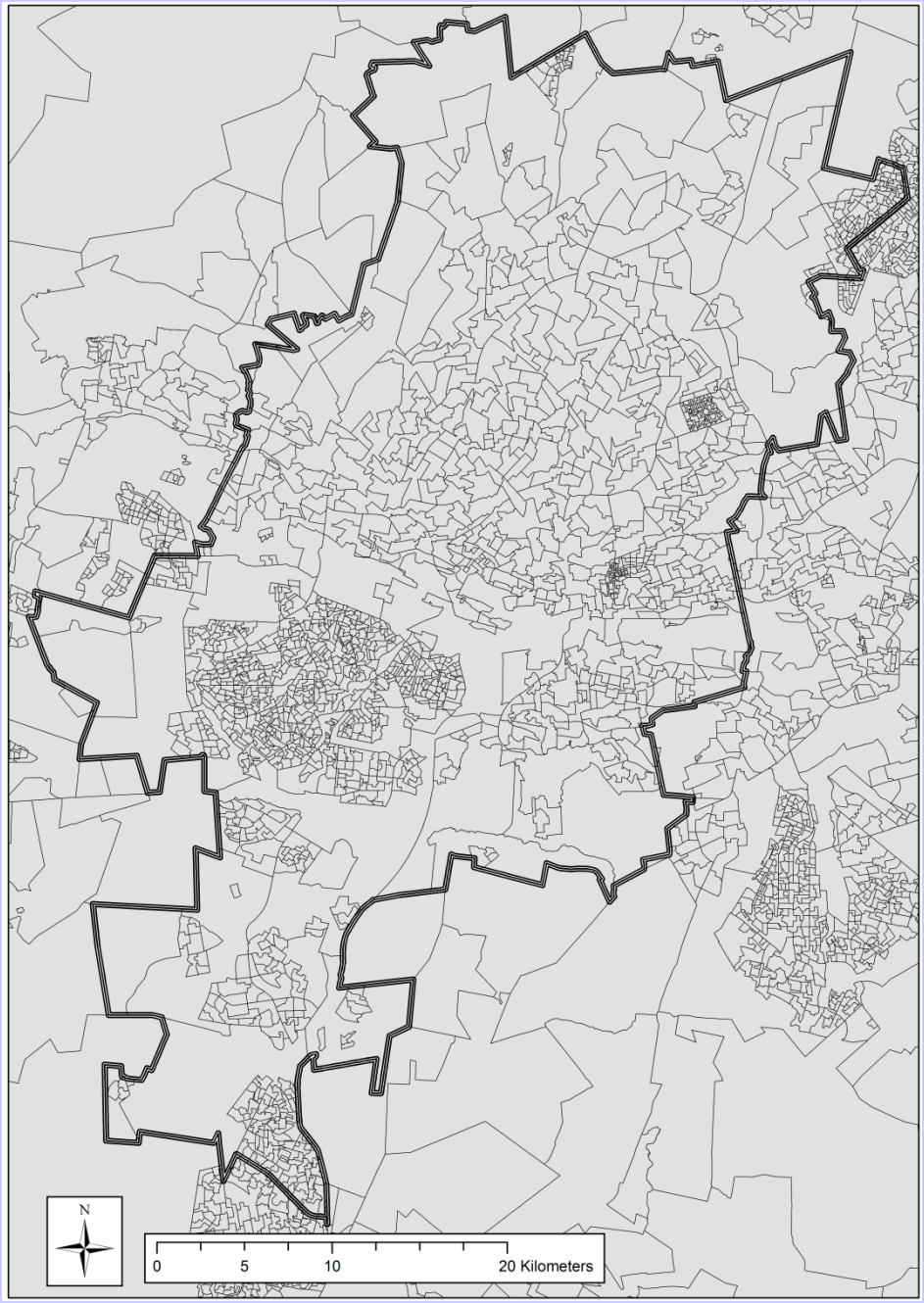
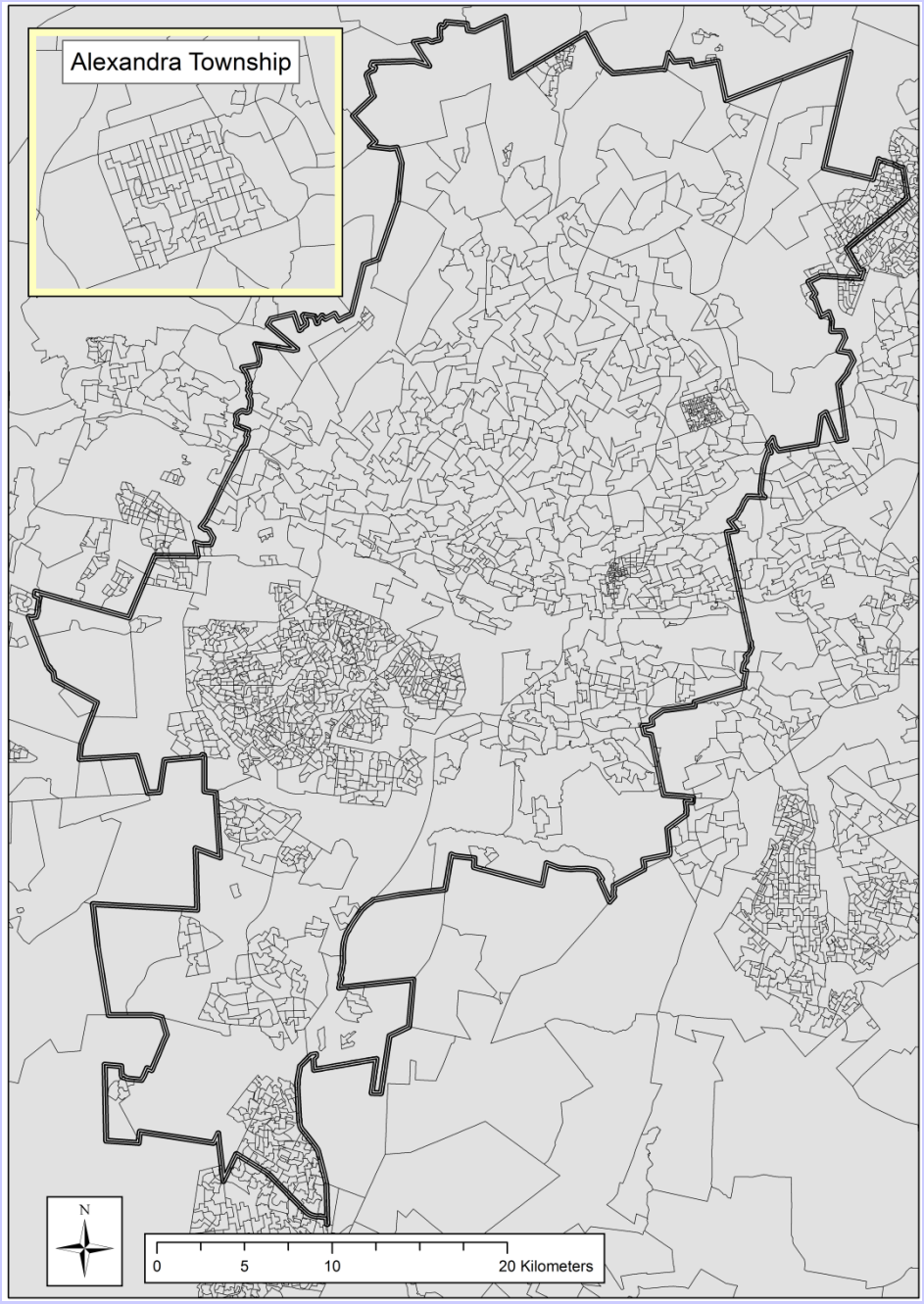
City of Johannesburg



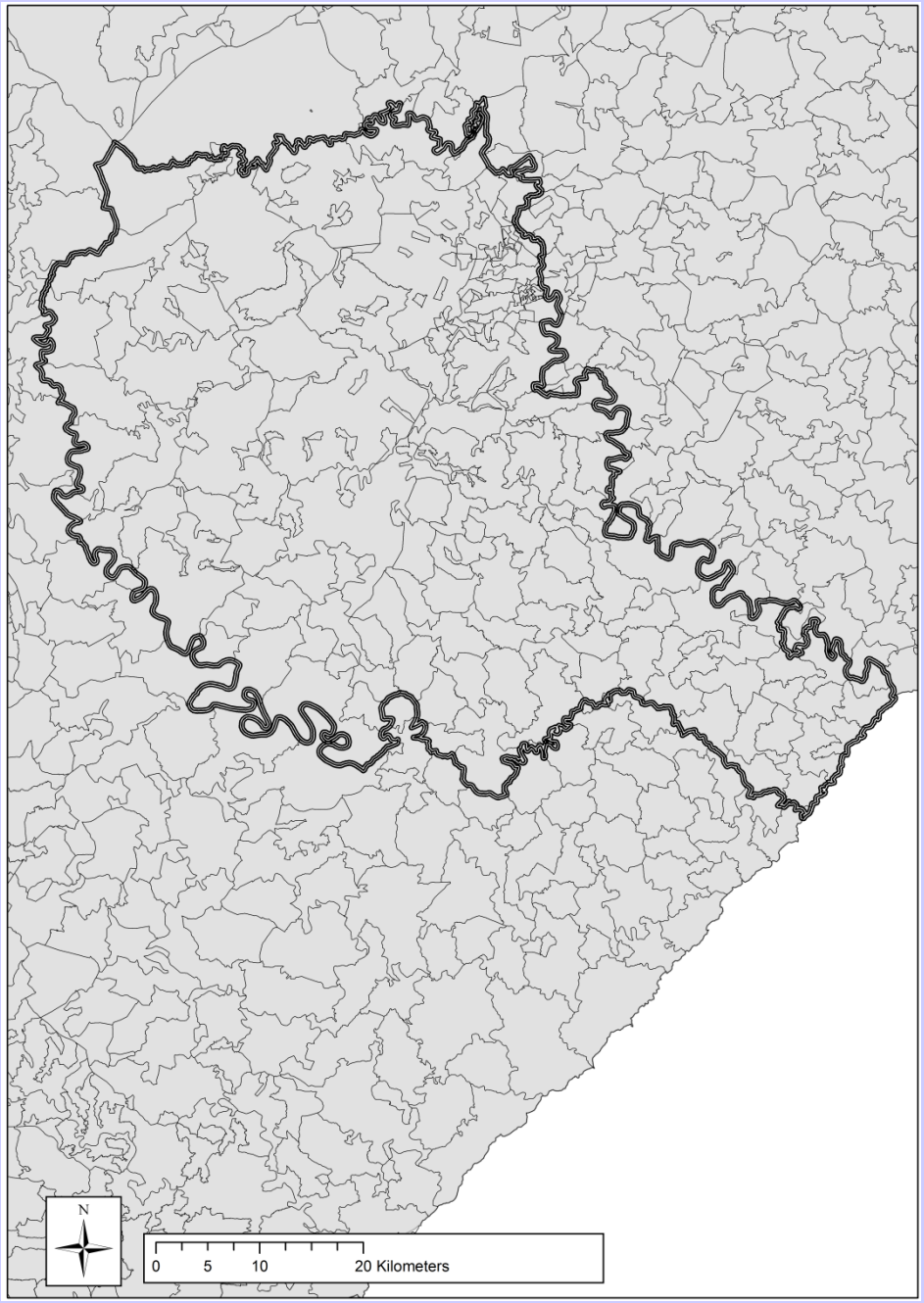
City of Johannesburg



City of Johannesburg

City of Johannesburg

King Sabata Dalindyebo



City of Johannesburg

King Sabata Dalindyebo

Measures of Residential Segregation

- Massey & Denton (1988) identified five dimensions of residential segregation and gave a number of statistical measures of each dimension:
  - Evenness
  - Exposure
  - Concentration
  - Centralisation
  - Clustering

Exposure Indices

- The *P** exposure indices measure the extent to which members of one population sub-group are exposed to members of another sub-group.
- For our purpose, we are interested in the extent to which:
  a) the ‘poor’ are exposed to the ‘non-poor’
  b) the ‘non-poor’ are exposed to the ‘poor’
- These measures represent the likelihood that individuals will be exposed to people from the other end of the socio-economic spectrum as they go about their daily lives. May be regarded as proxies for an individual’s ‘lived experience of inequality’.
- Different variants: ‘global’, ‘geographically weighted’ or ‘local’.

How and where are people exposed to socio-economic inequality?

- Personal interactions with family / friends / colleagues / neighbours / strangers.
- Visual appreciation of differences in wealth and opportunities (e.g. seeking work; driving along a highway).
- Local, national and international media.

- For our purpose, we assume exposure is primarily contoured by people's routine daily activities.

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Routine daily activities

For a given person living in a given neighbourhood:

1. How do we set the spatial bounds within which we assume people carry out their daily routine activities and within which they may therefore be exposed to inequality?
2. How do we estimate the likelihood of that person actually visiting each separate constituent neighbourhood within the specified spatial bounds?

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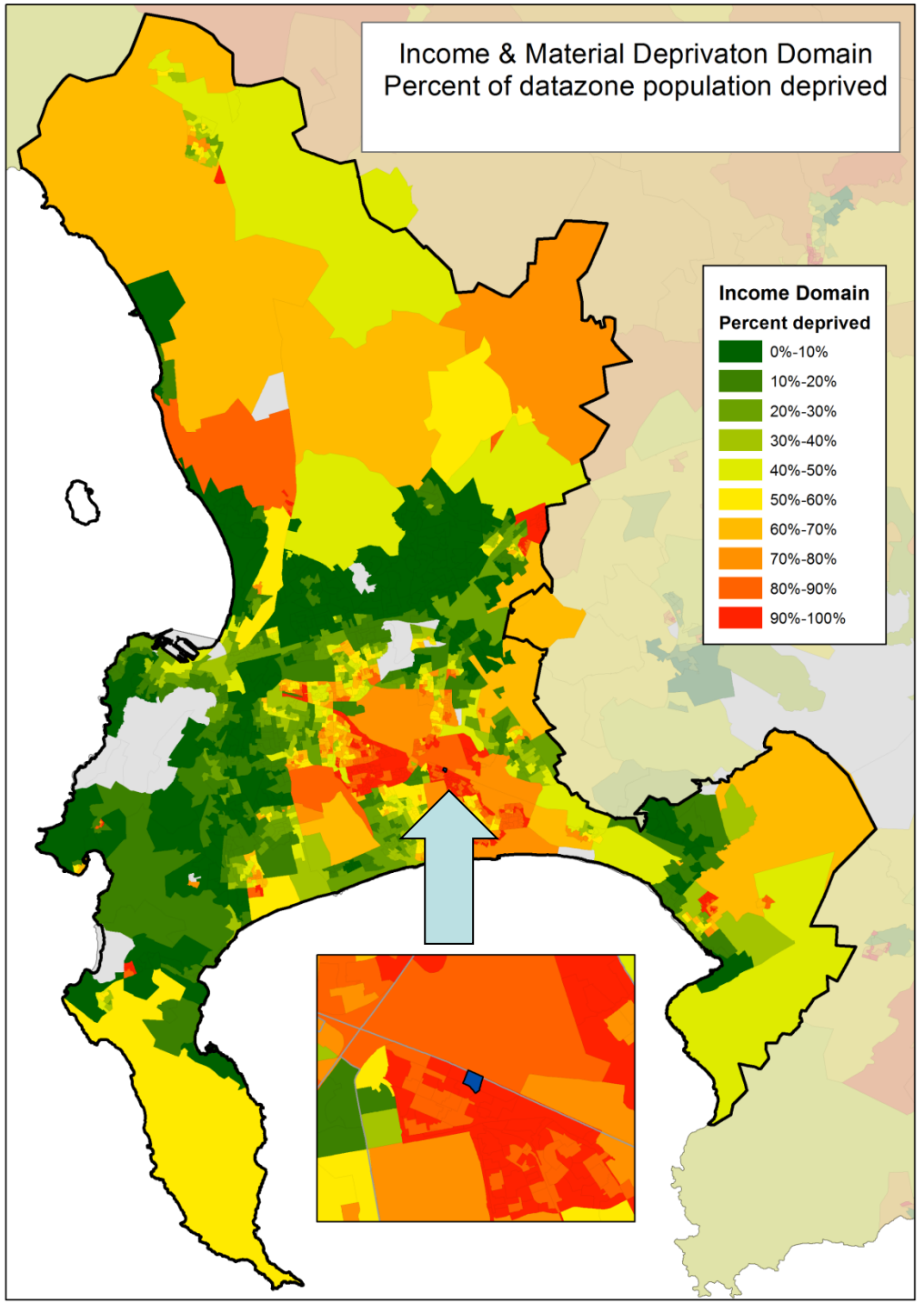
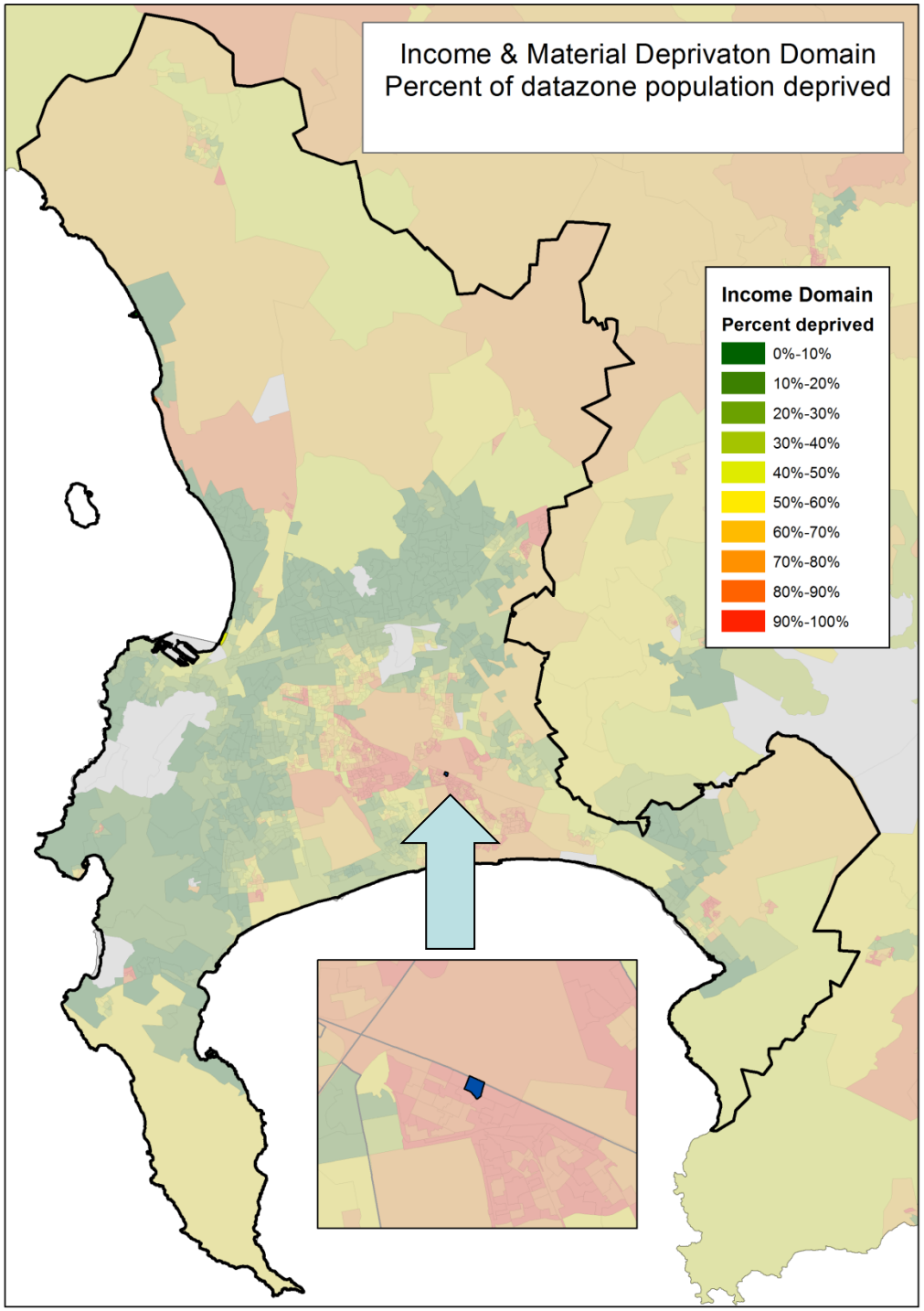


Datazone within Khayelitsha, where > 95% of the pop. is deprived on the Income Domain


Income & Material Deprivaton Domain
Percent of datazone population deprived
Income Domain
Percent deprived
0%-10%
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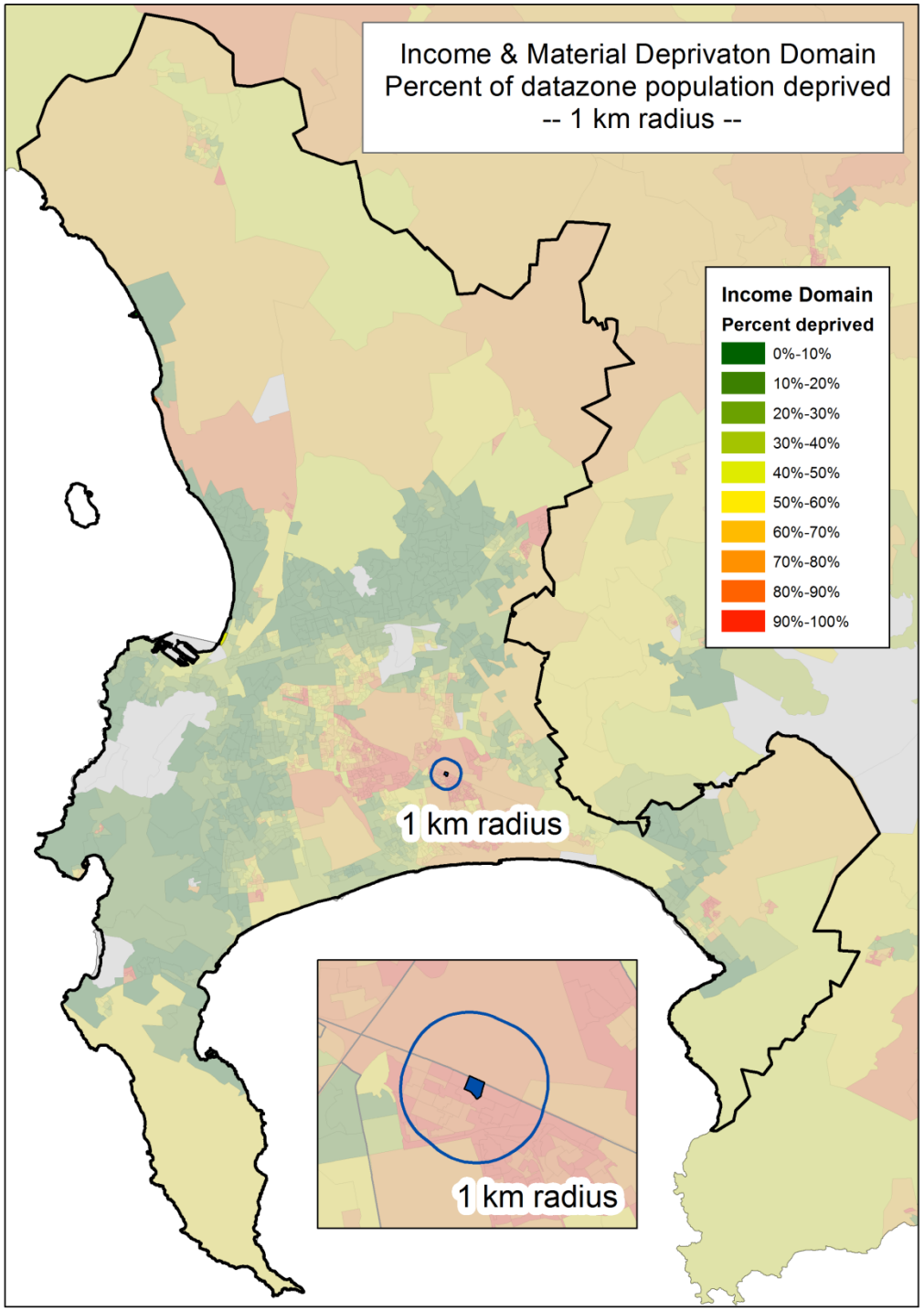
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 1 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
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40%-50%
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60%-70%
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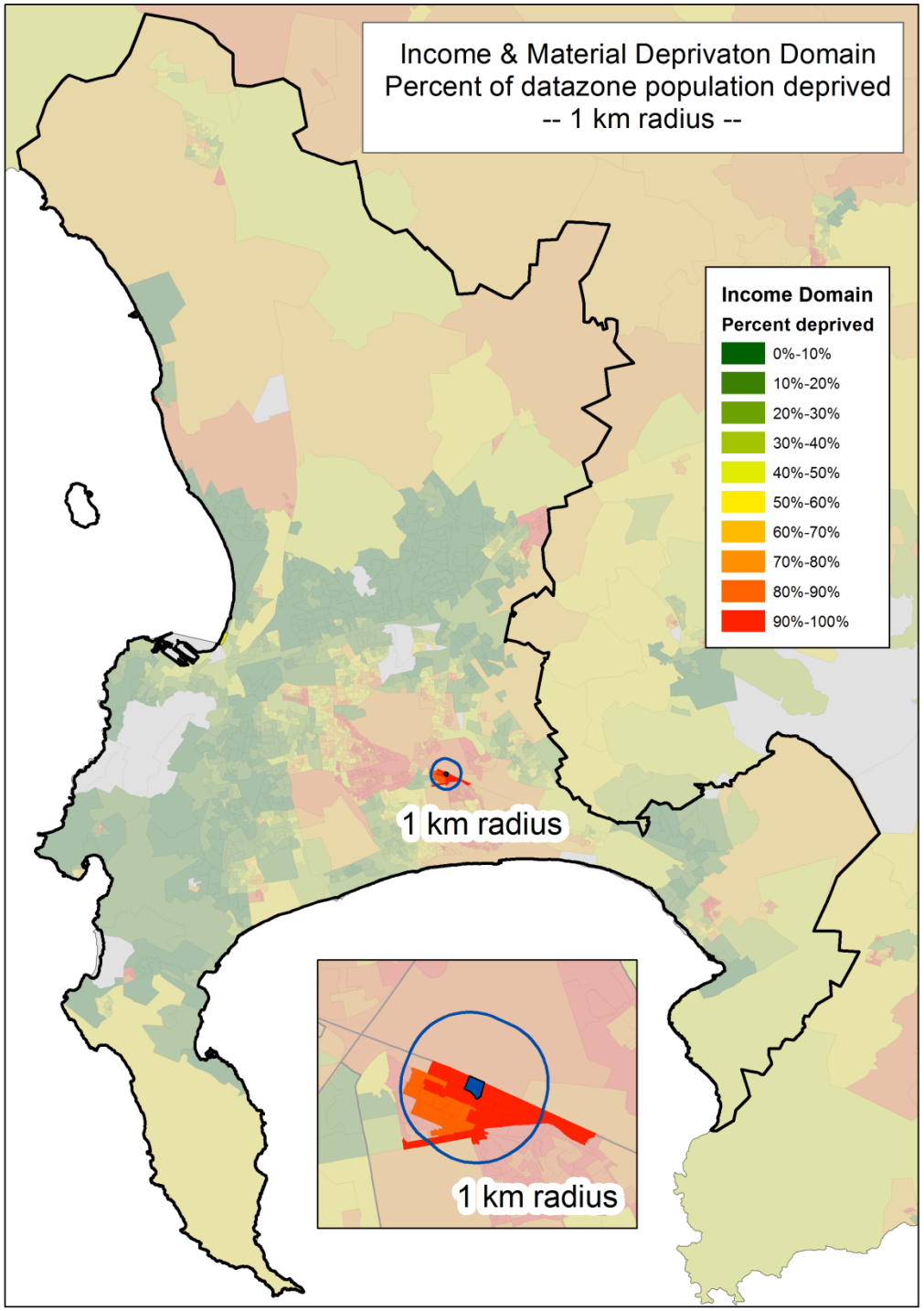
90%-100%
1 km radius
1 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 1 km radius --
Income Domain
Percent deprived
0%-10%
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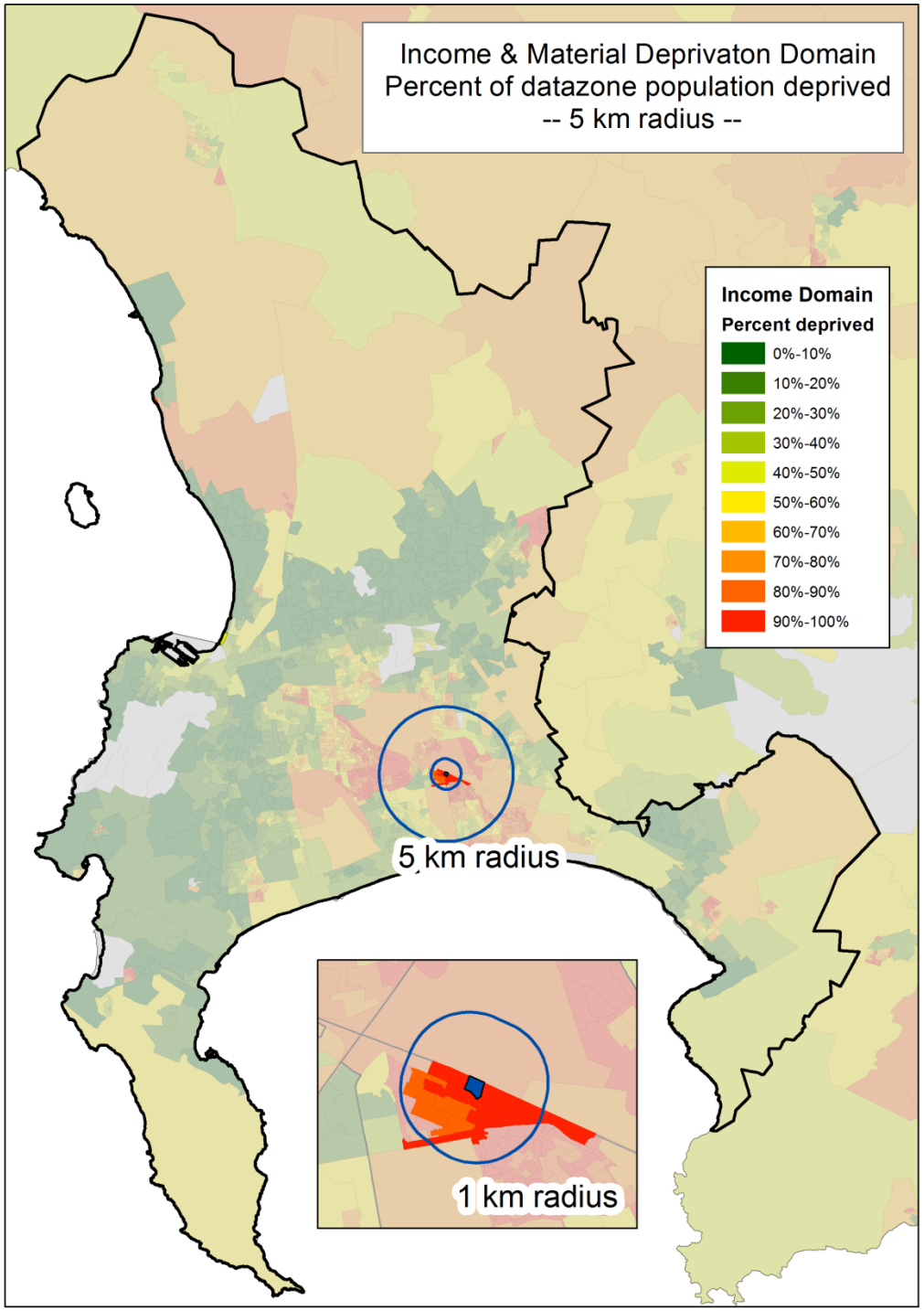
90%-100%
1 km radius
1 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 5 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
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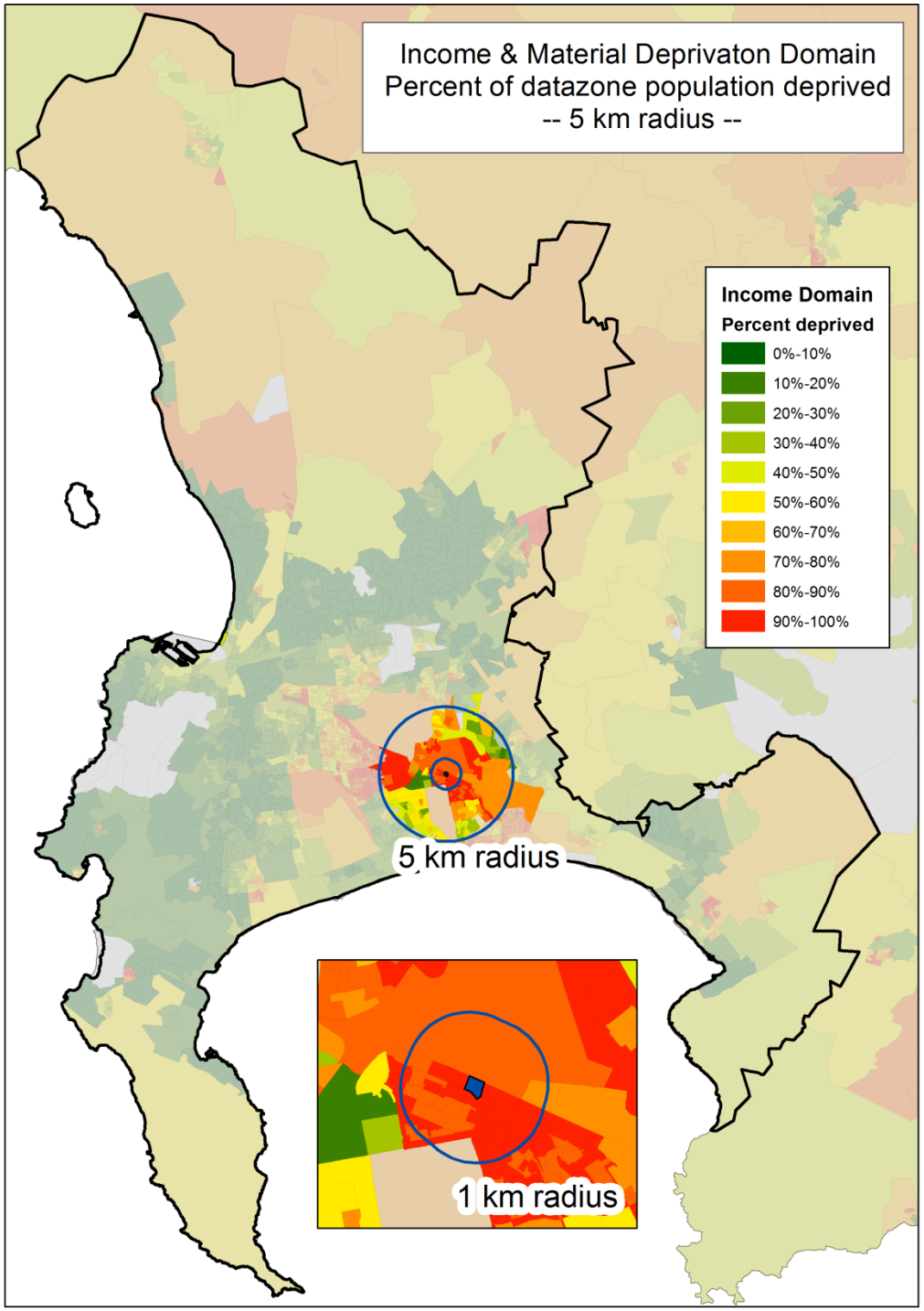
80%-90%
90%-100%
5 km radius
1 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 5 km radius --
Income Domain
Percent deprived
0%-10%
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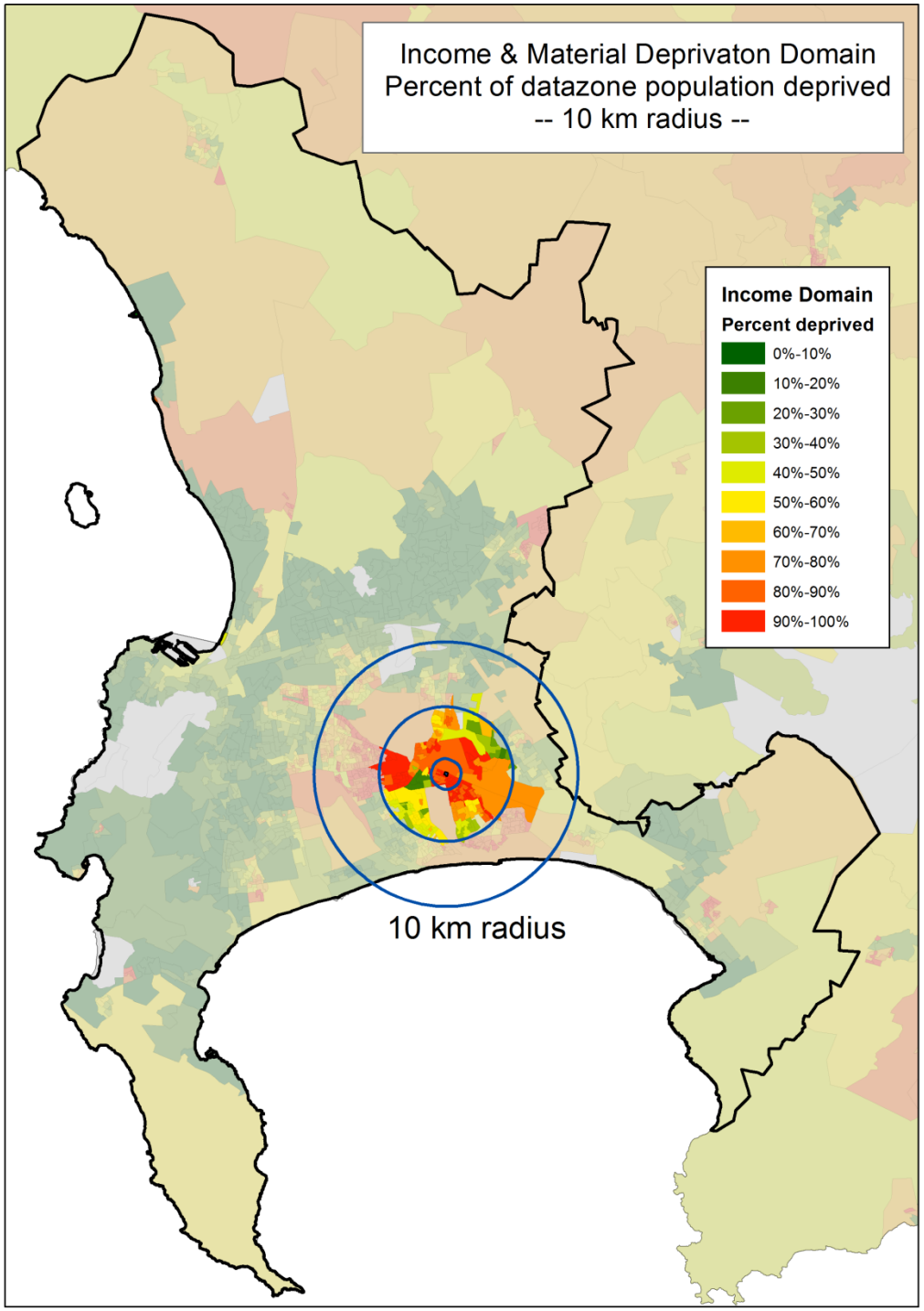
90%-100%
5 km radius
1 km radius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Percent of datazone population deprived
-- 10 km radius --
Income Domain
Percent deprived
0%-10%
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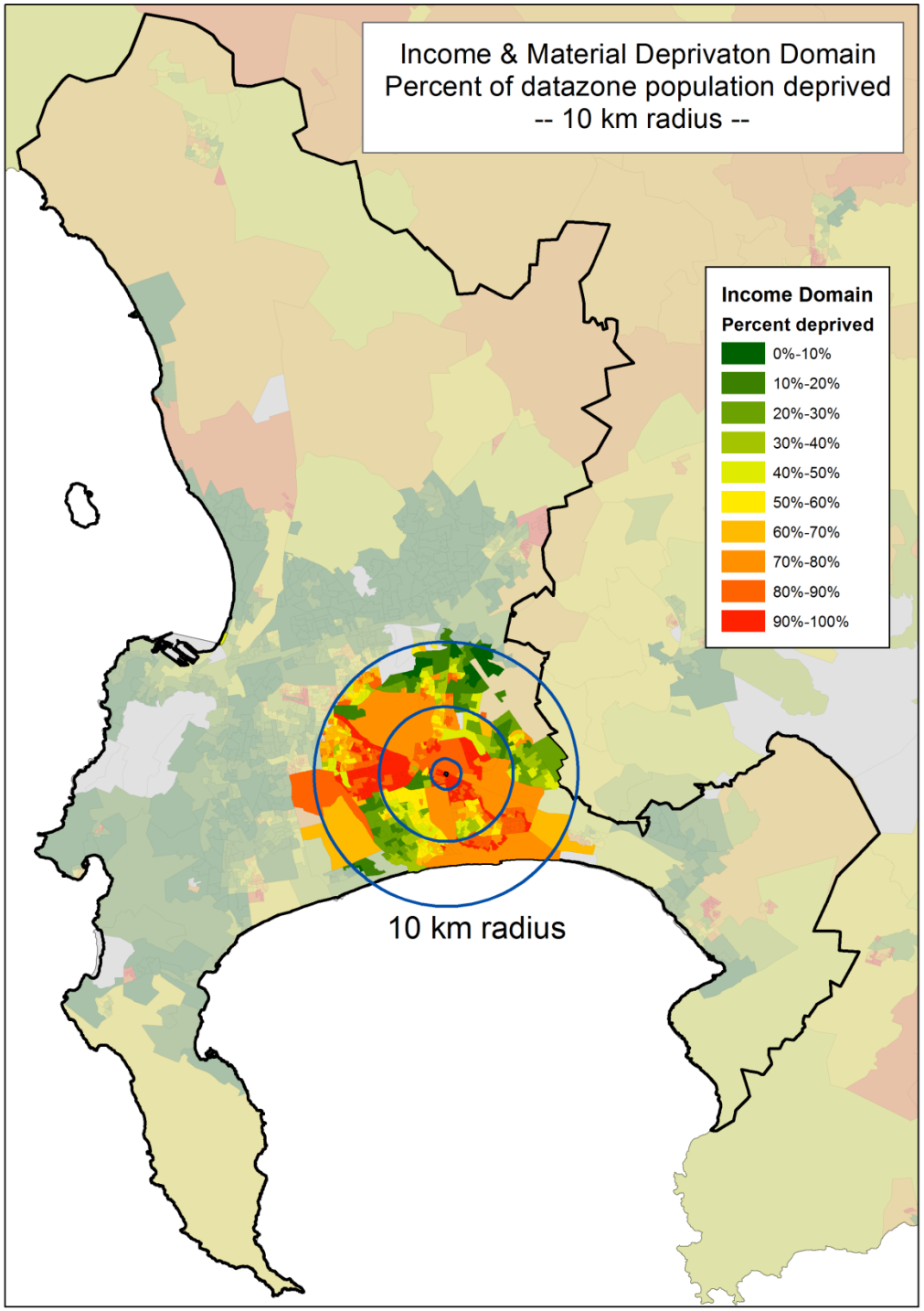
90%-100%
10 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 10 km radius --
Income Domain
Percent deprived
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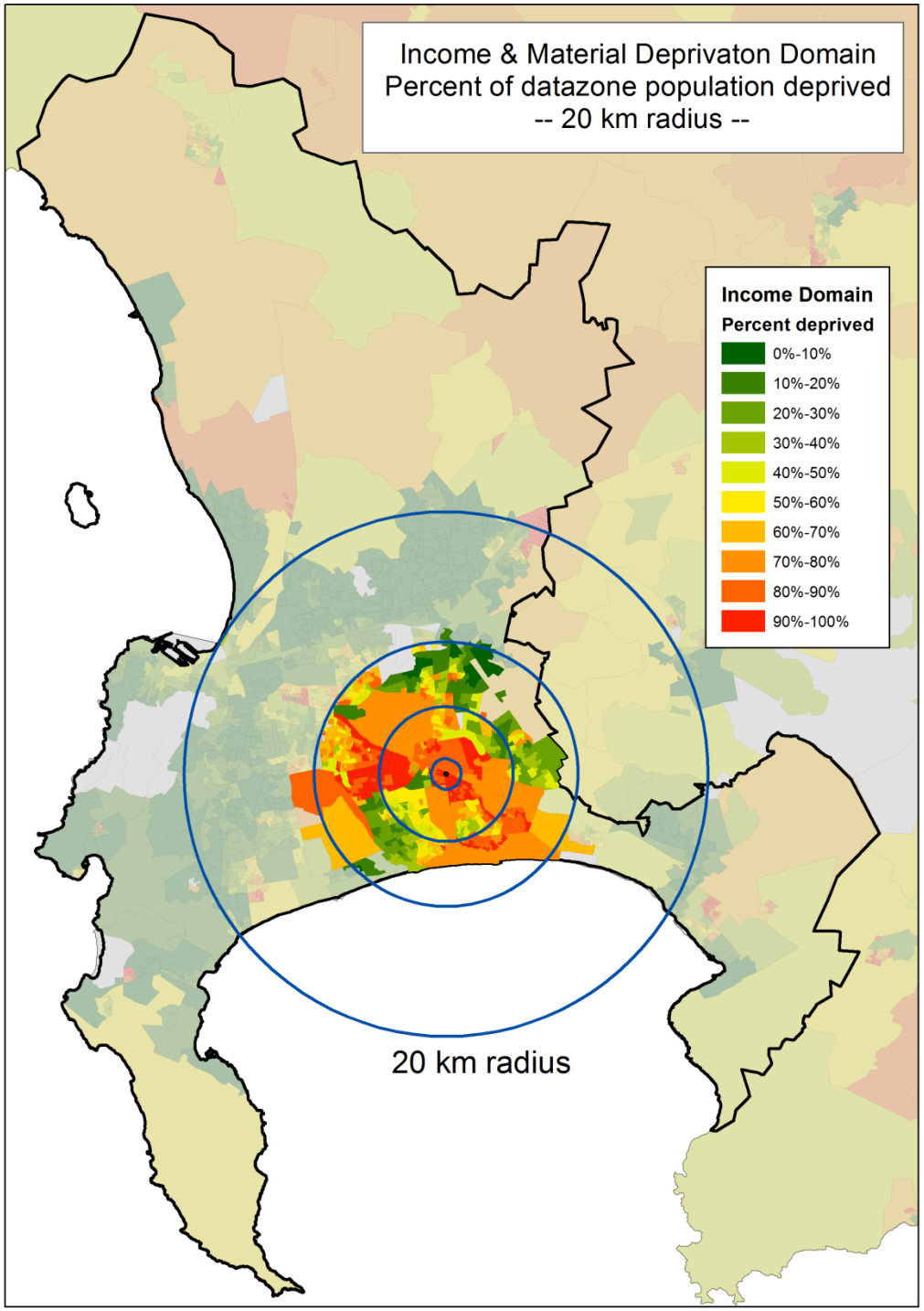
90%-100%
10 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 20 km radius --
Income Domain
Percent deprived
0%-10%
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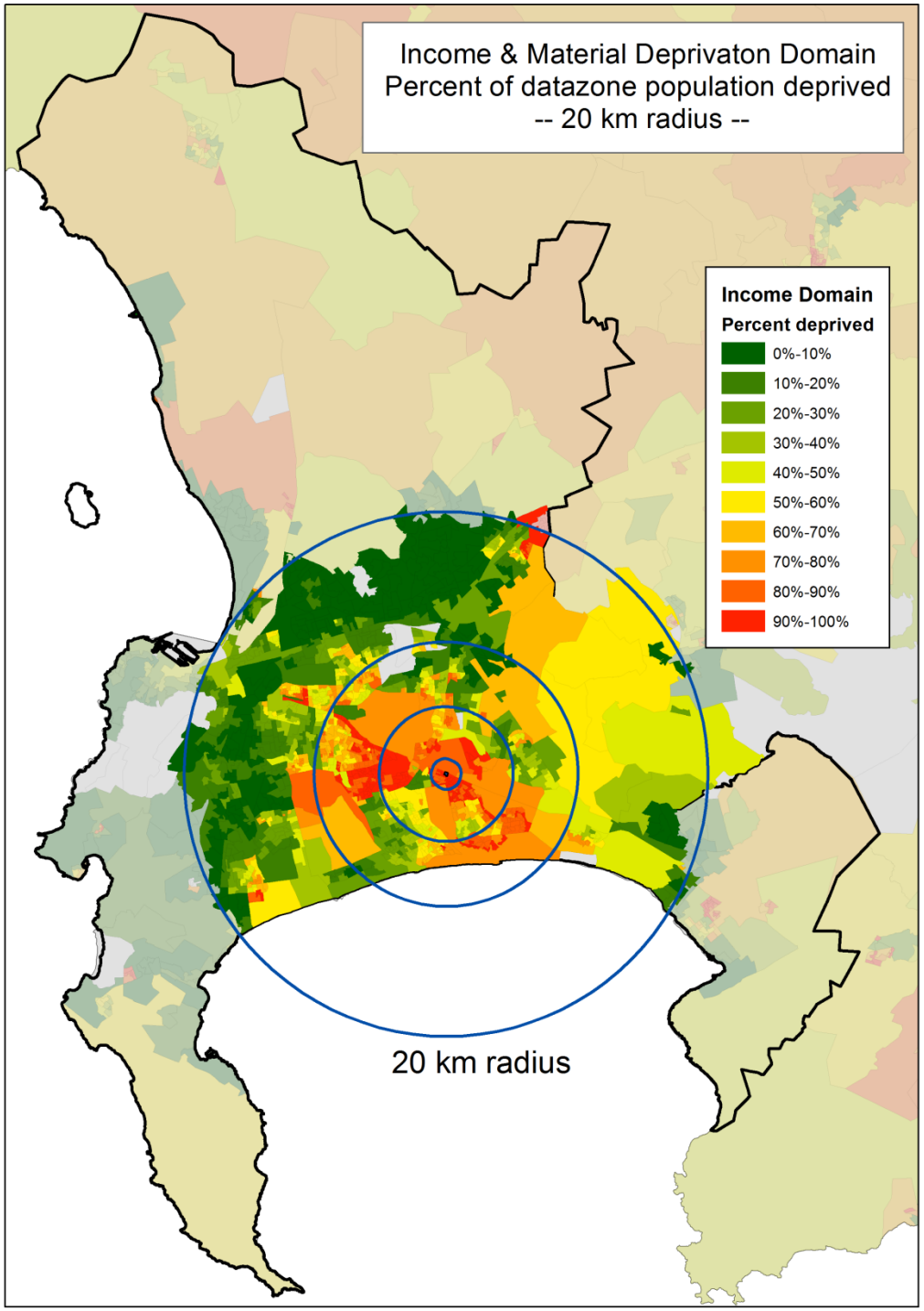
90%-100%
20 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 20 km radius --
Income Domain
Percent deprived
0%-10%
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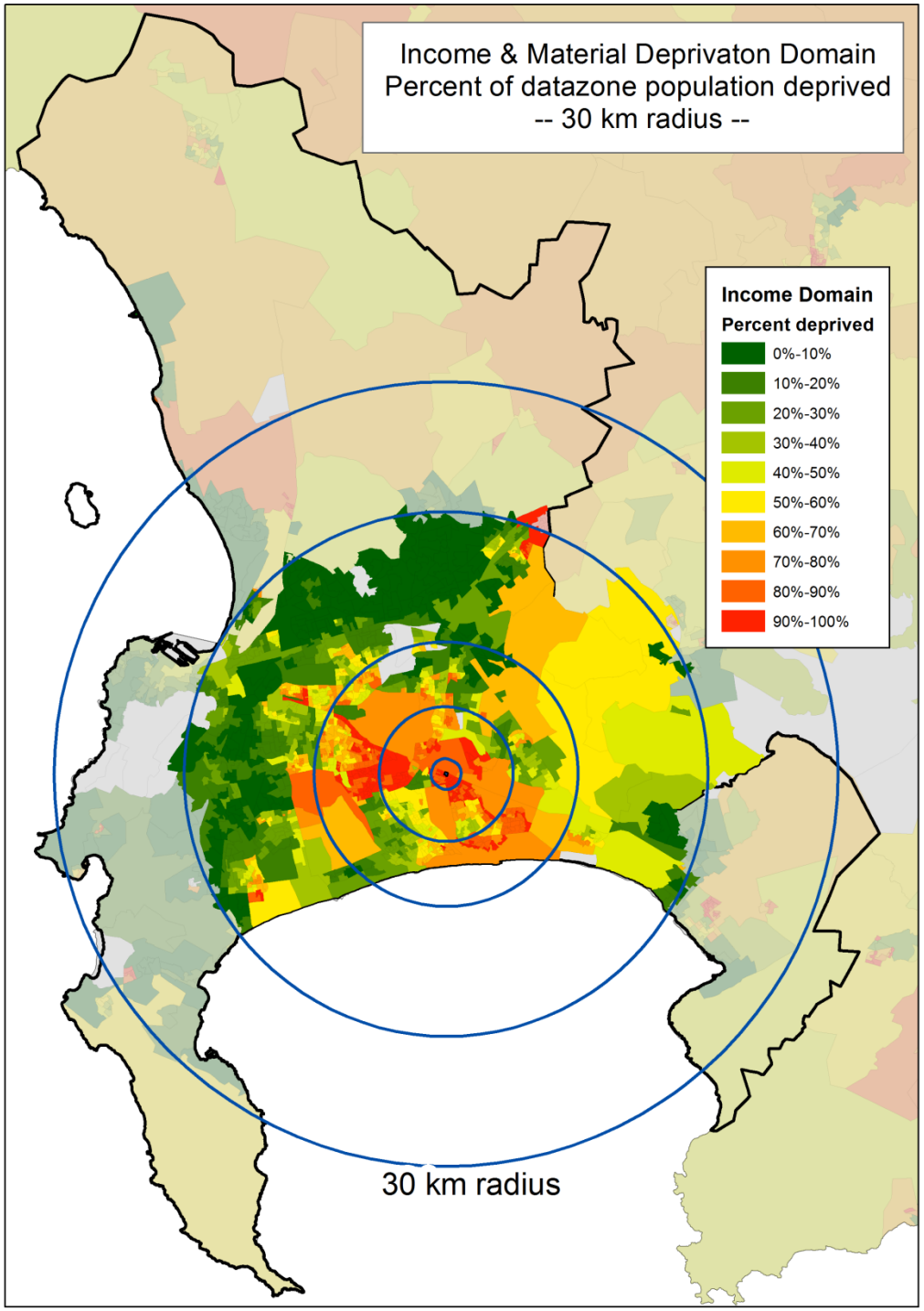
80%-90%
90%-100%
20 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 30 km radius --
Income Domain
Percent deprived
0%-10%
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20%-30%
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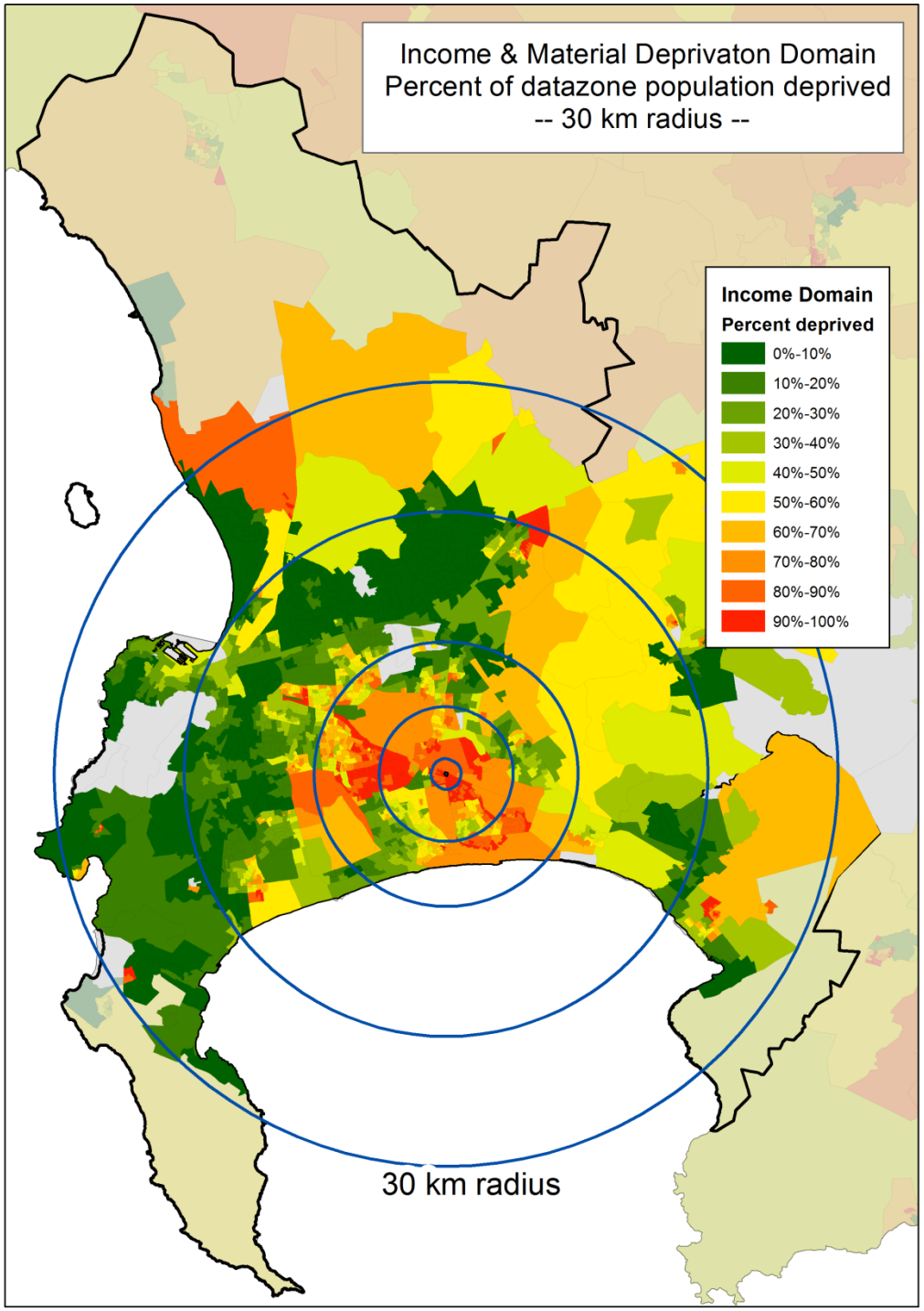
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%
30 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 30 km radius --
Income Domain
Percent deprived
0%-10%
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60%-70%
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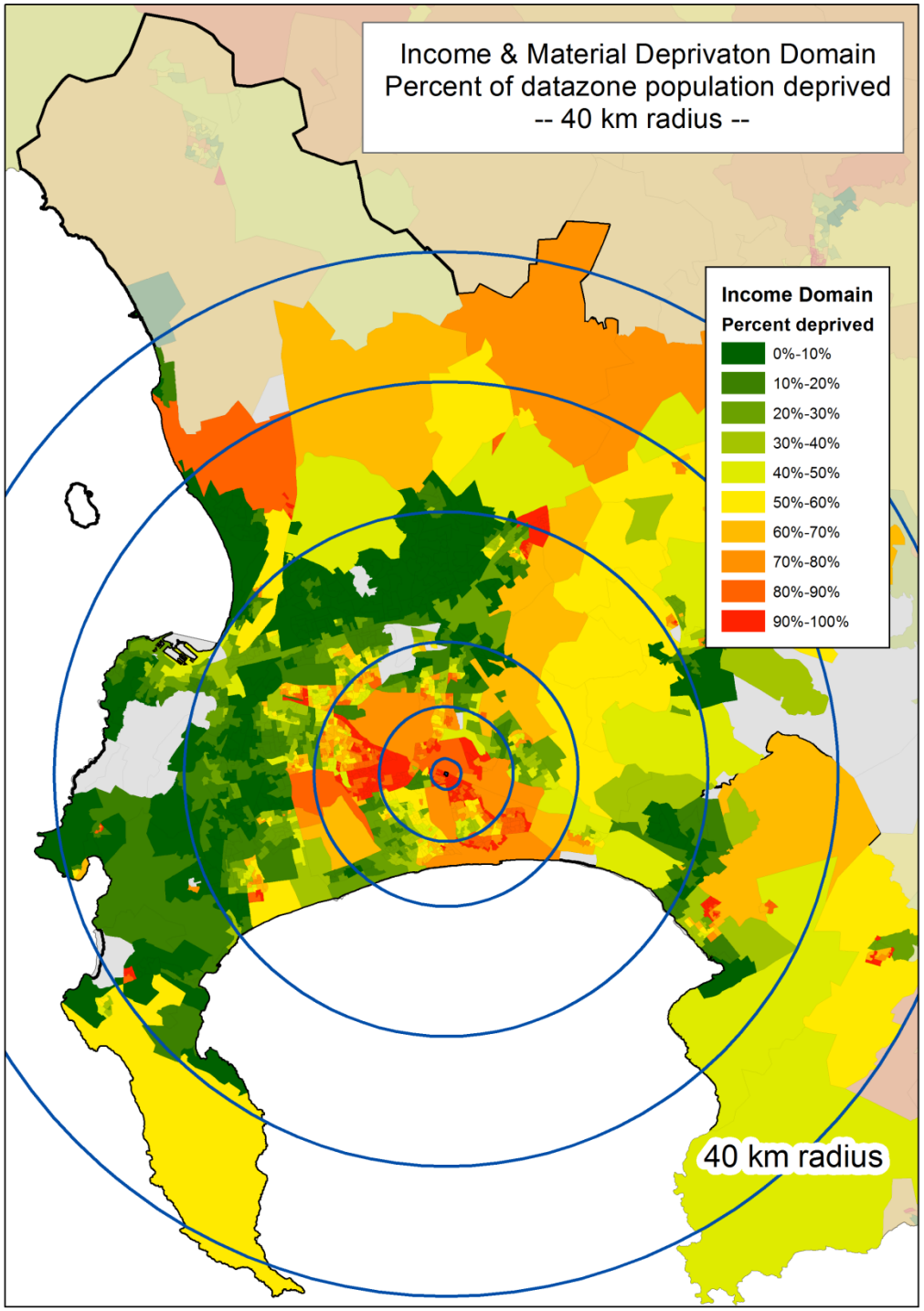
80%-90%
90%-100%
30 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 40 km radius --
Income Domain
Percent deprived
0%-10%
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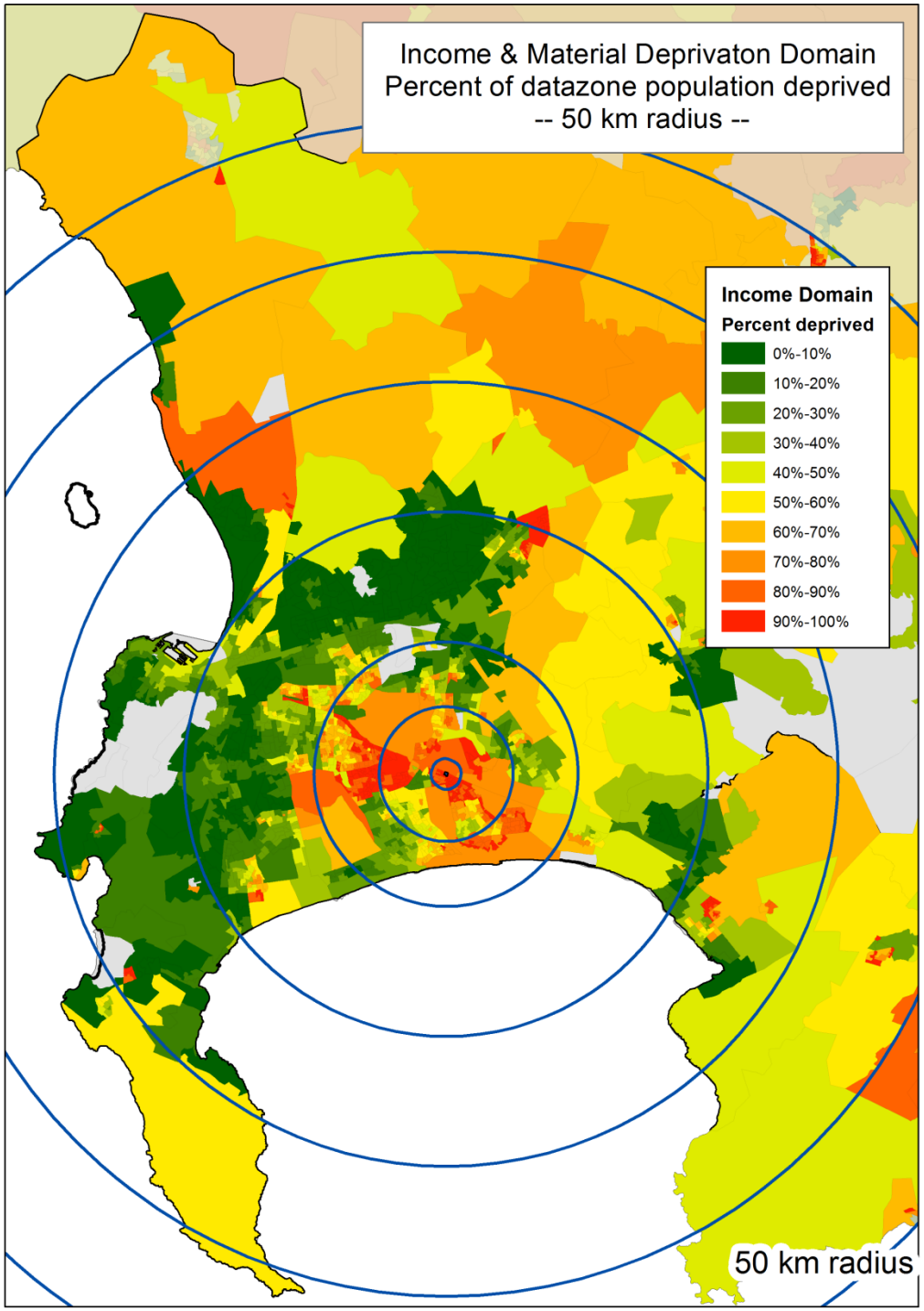
80%-90%
90%-100%
40 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- 50 km radius --
Income Domain
Percent deprived
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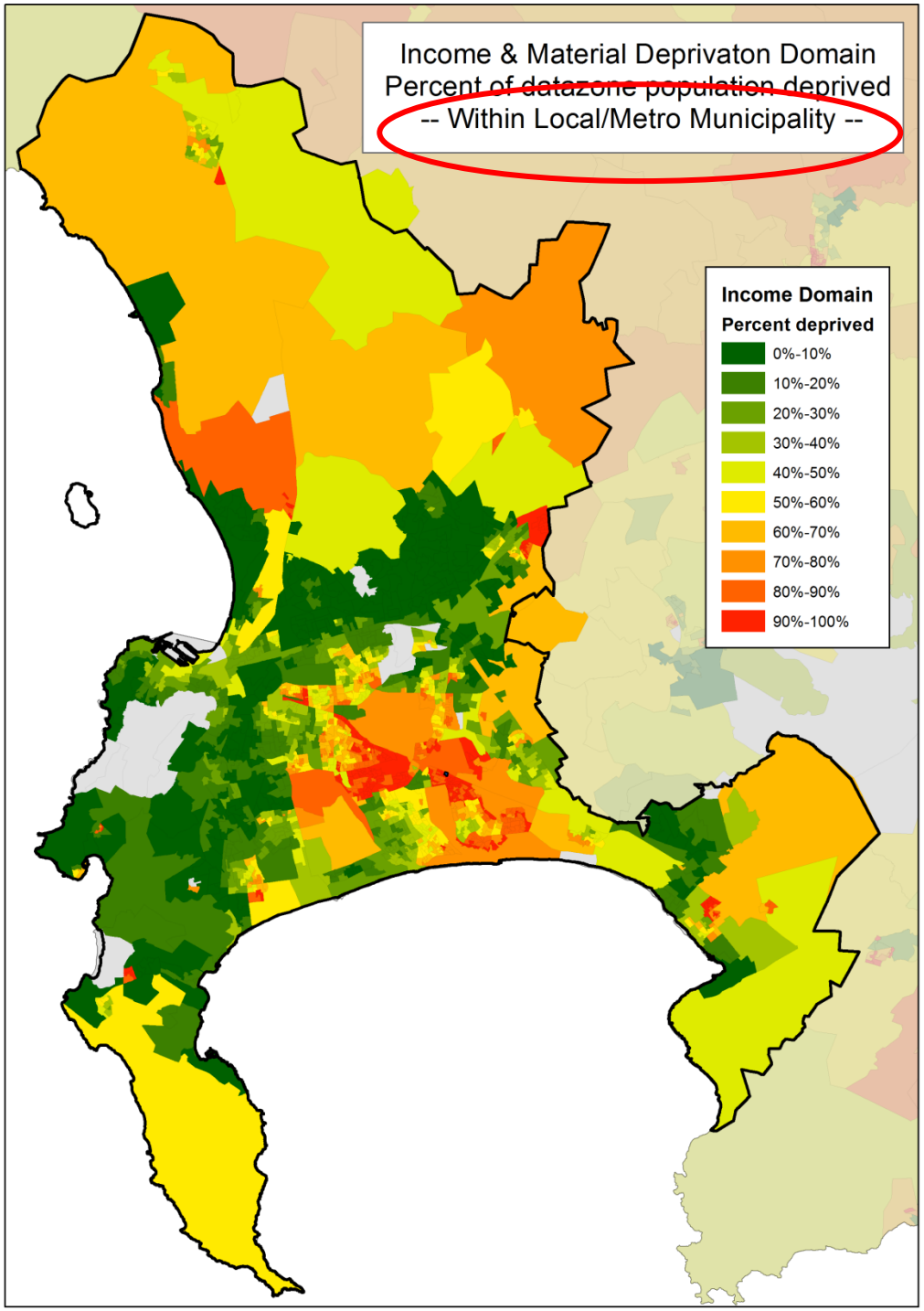
80%-90%
90%-100%
50 km radius


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Within Local/Metro Municipality --
Income Domain
Percent deprived
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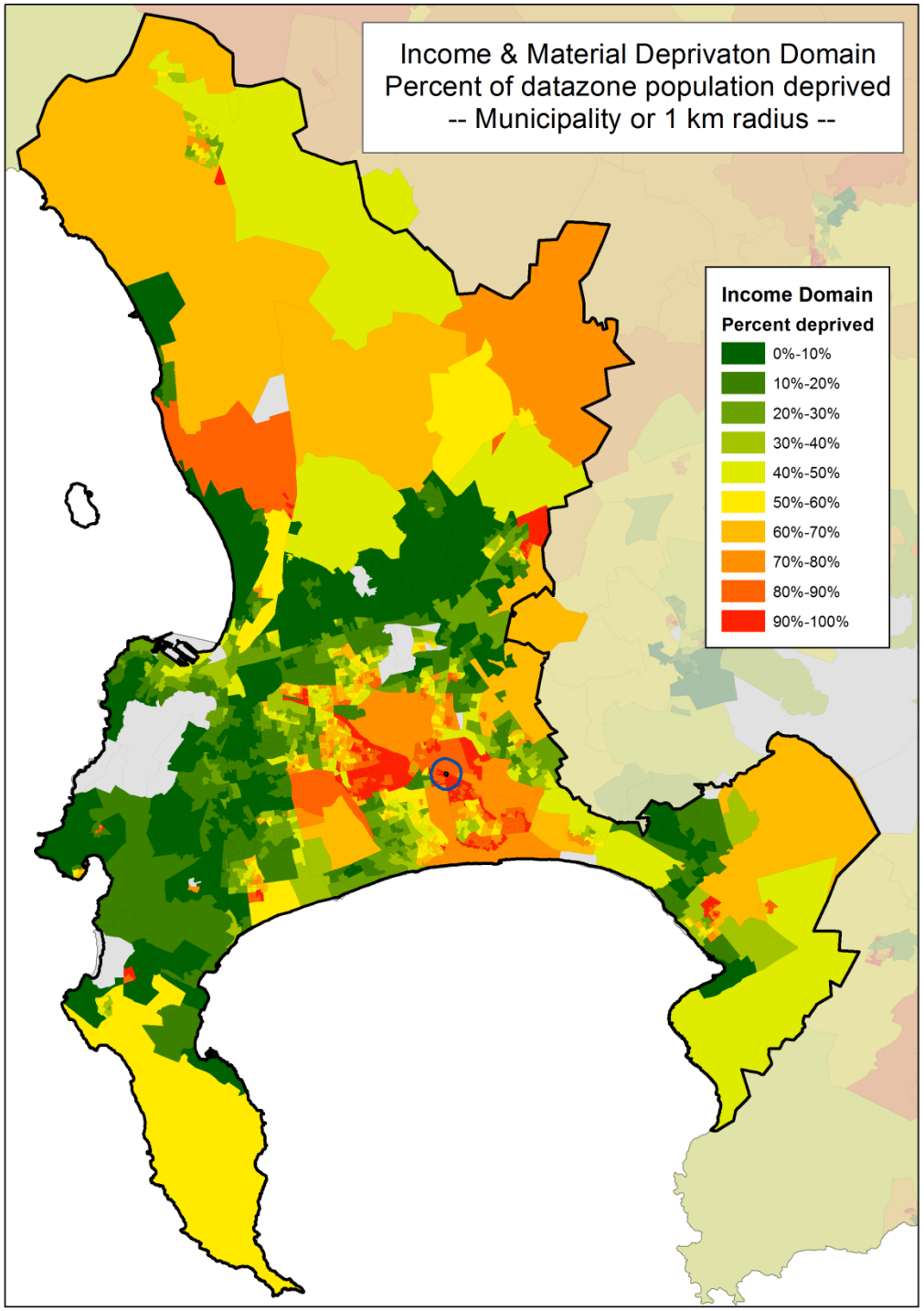
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 1 km radius --
Income Domain
Percent deprived
0%-10%
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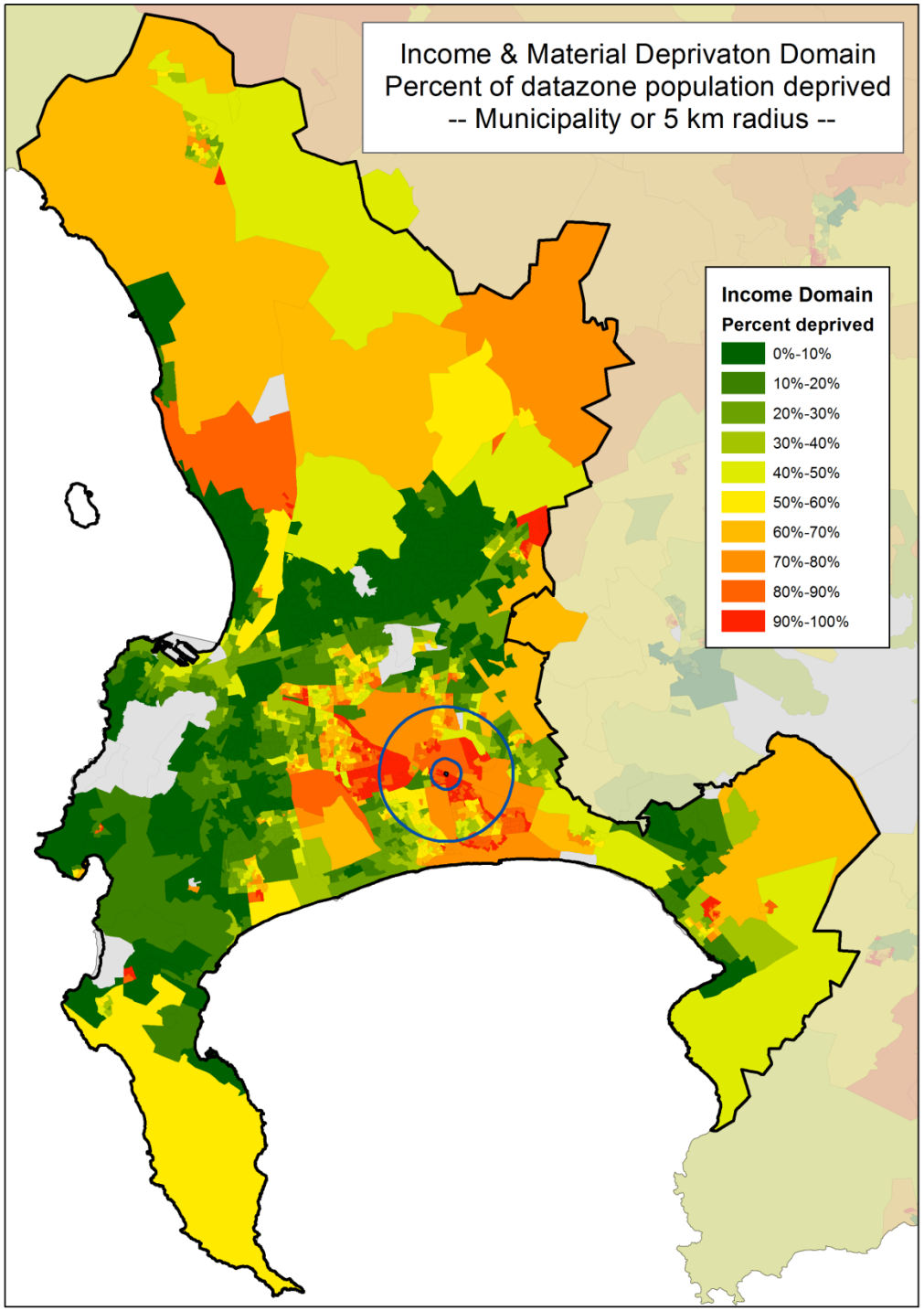
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 5 km radius --
Income Domain
Percent deprived
0%-10%
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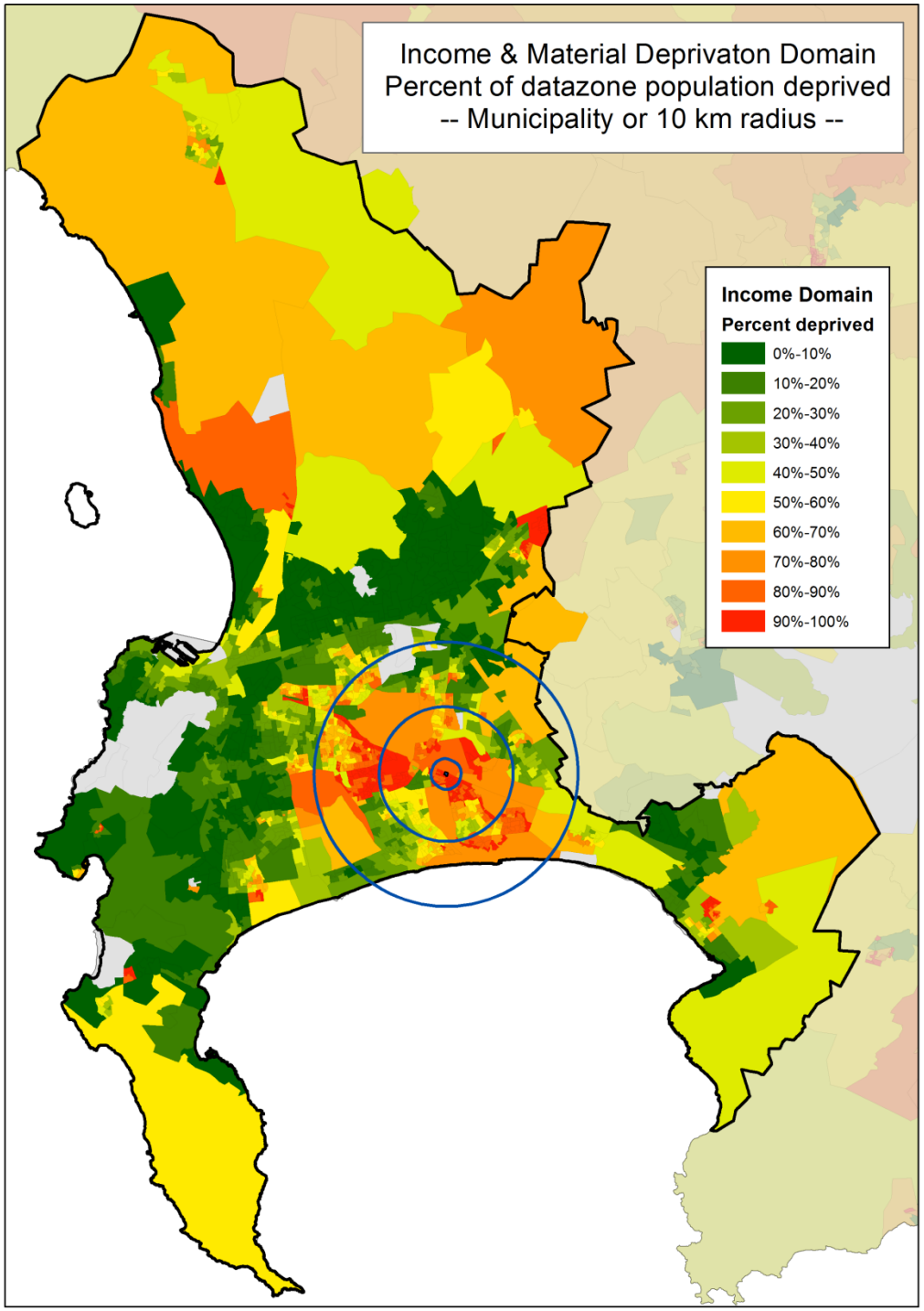
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 10 km radius --
Income Domain
Percent deprived
0%-10%
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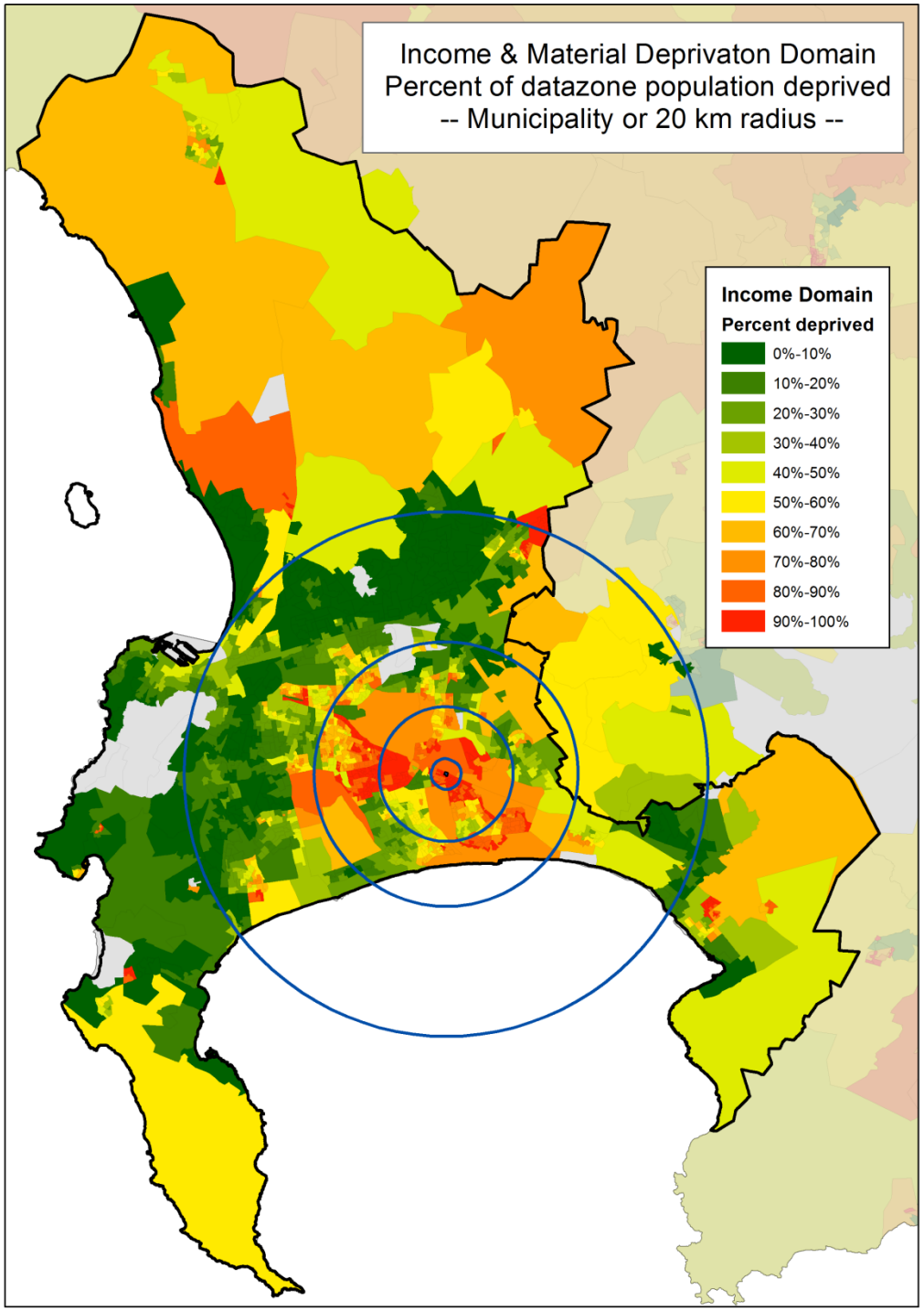
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
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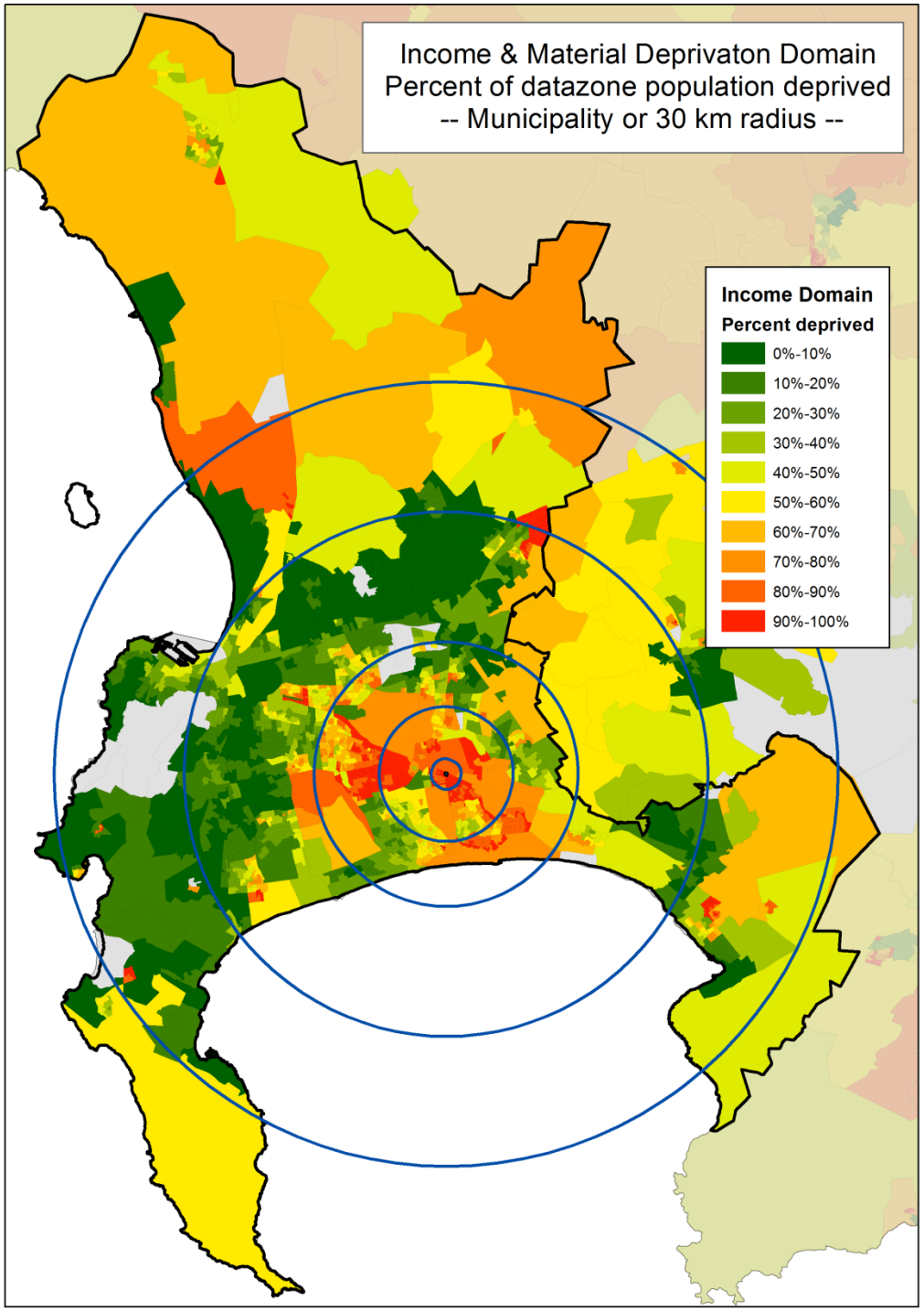
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 30 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
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50%-60%
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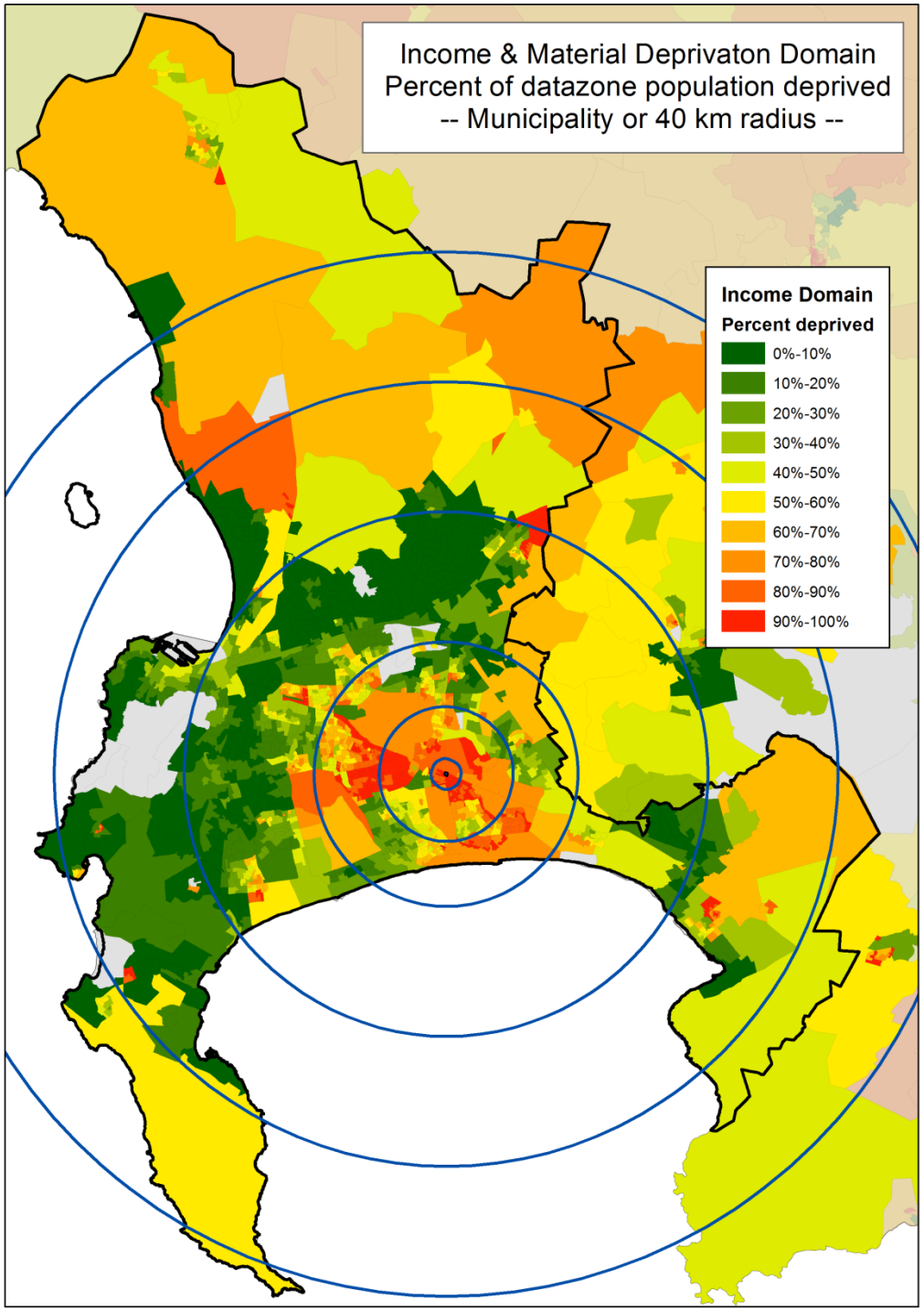
Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 40 km radius --
Income Domain
Percent deprived
0%-10%
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20%-30%
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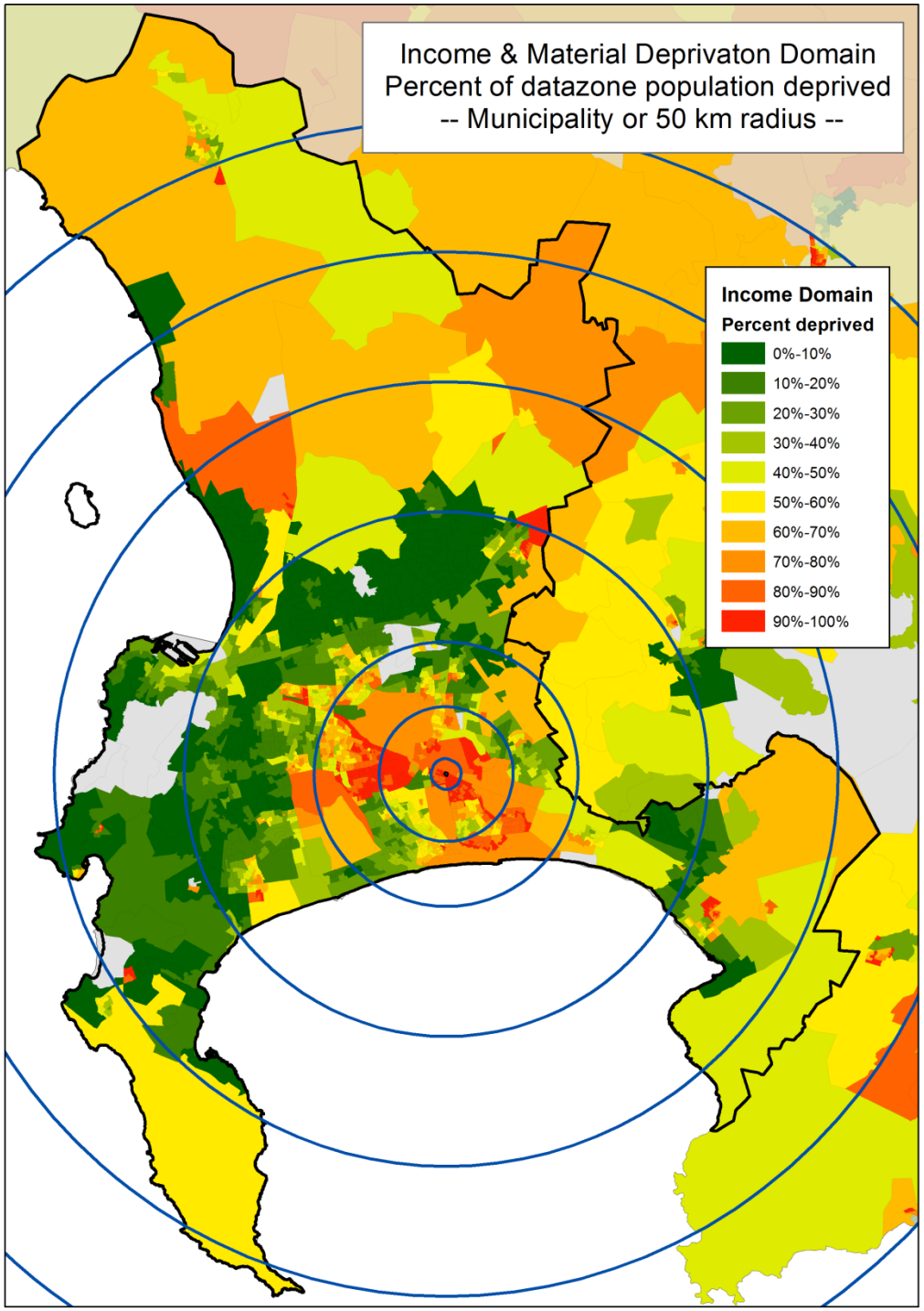
80%-90%
90%-100%


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 50 km radius --
Income Domain
Percent deprived
0%-10%
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20%-30%
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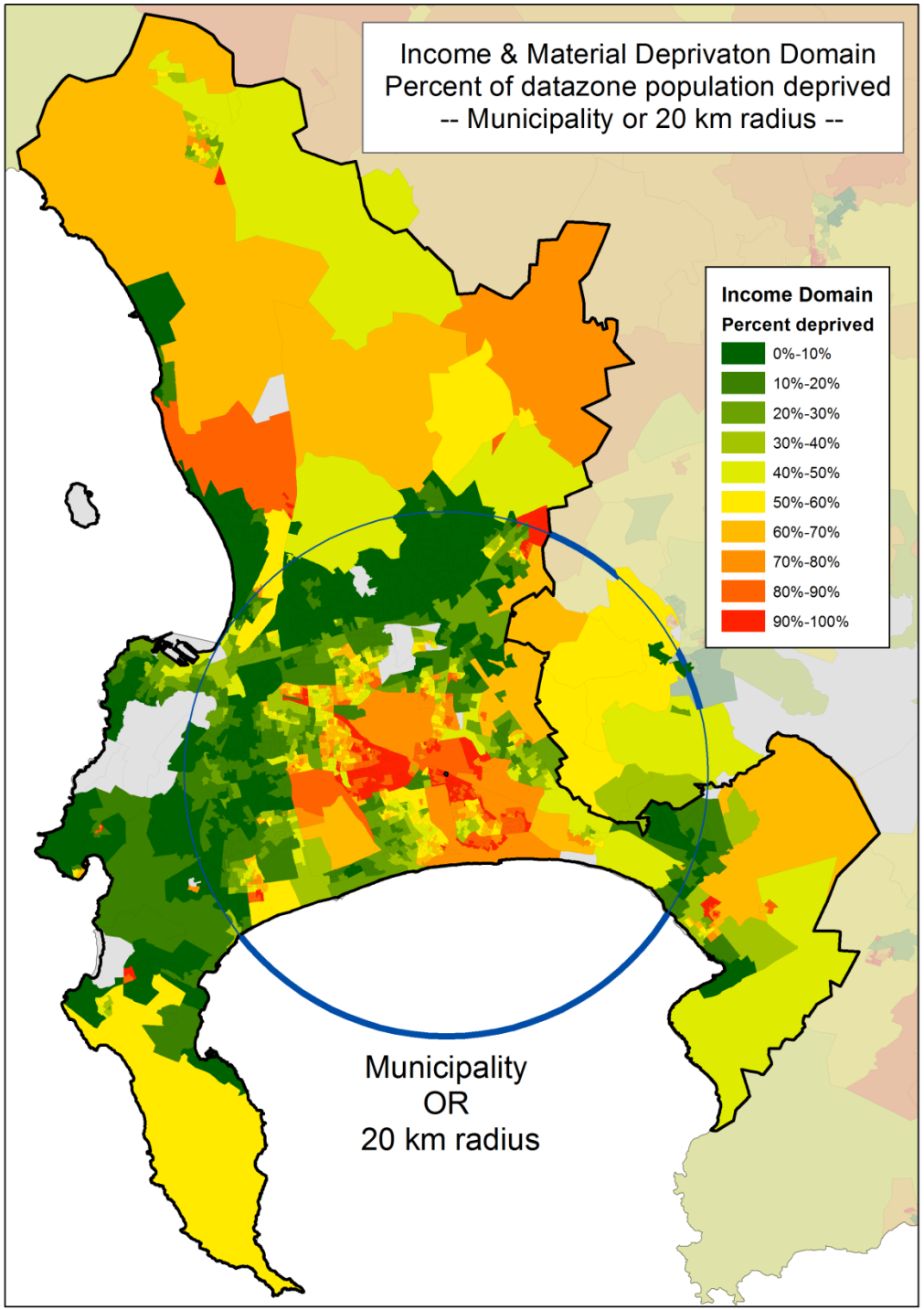
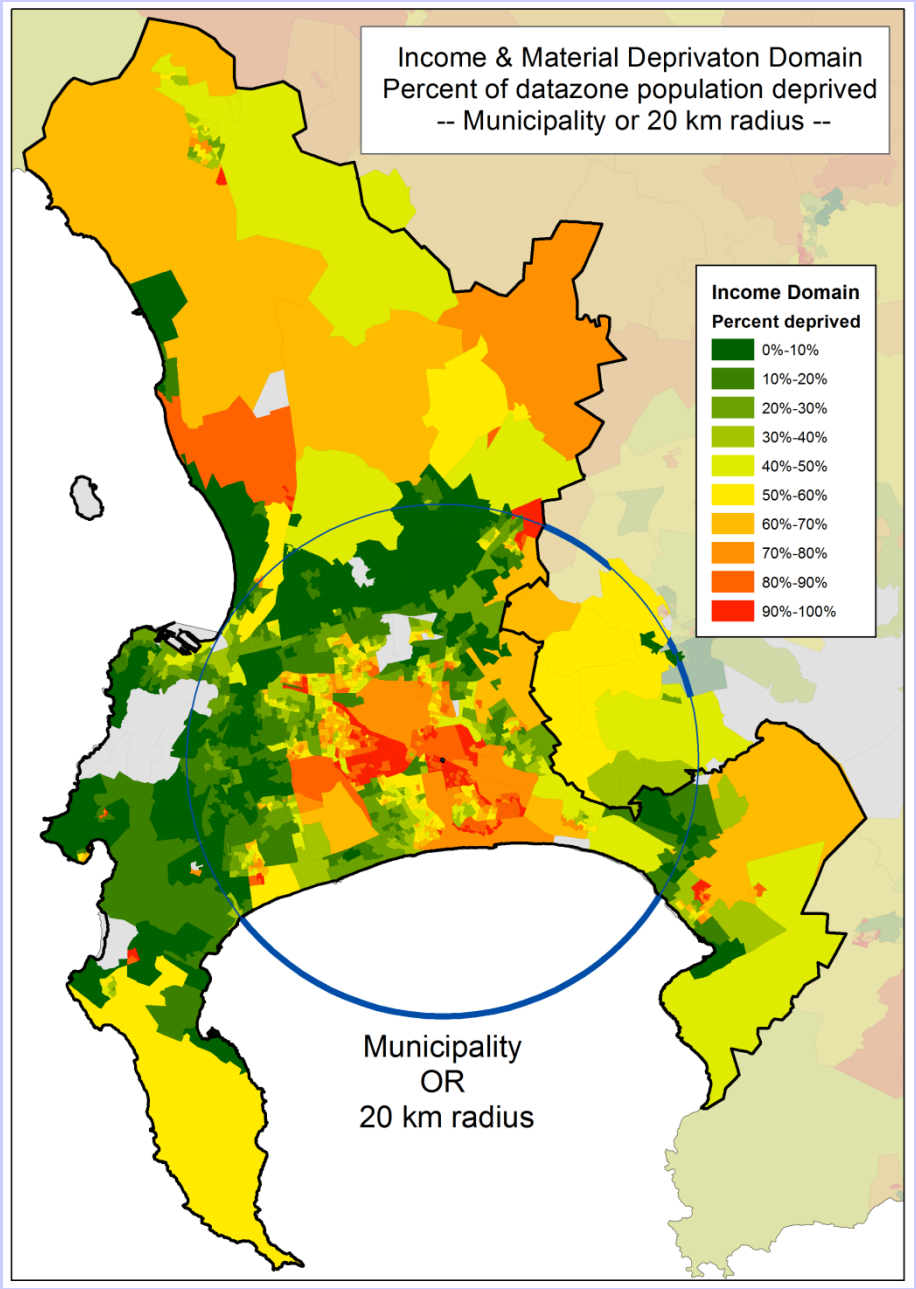
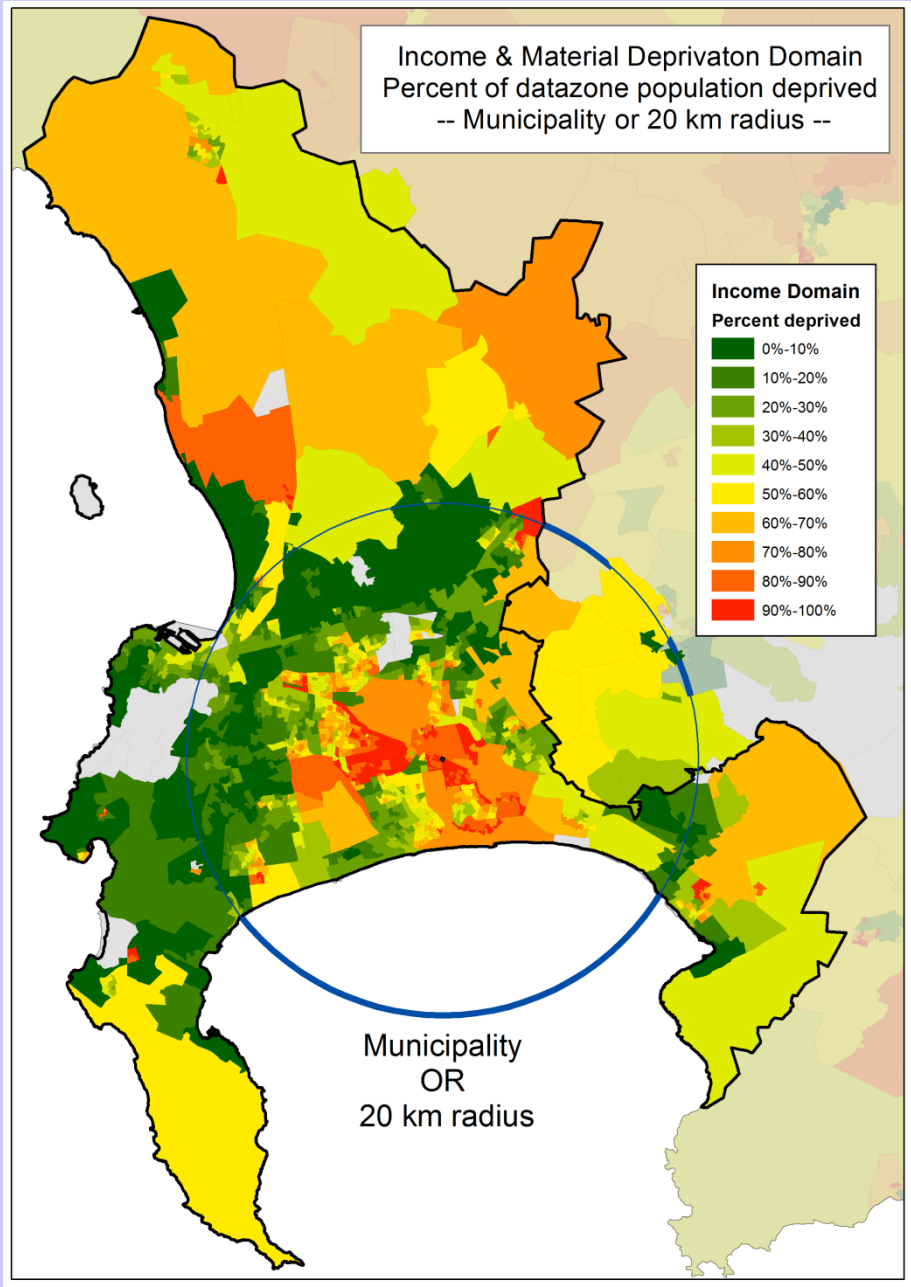


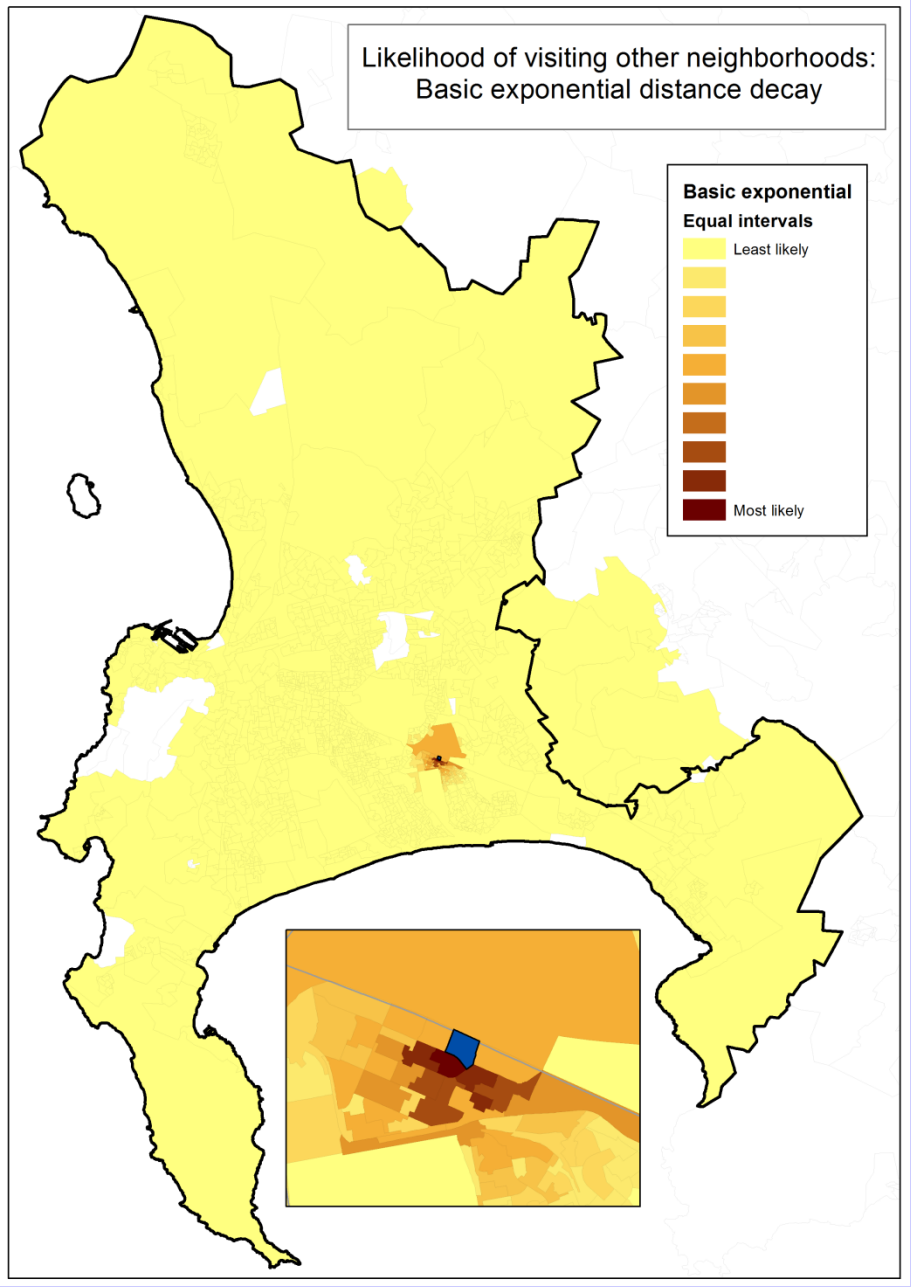
Our chosen parameters

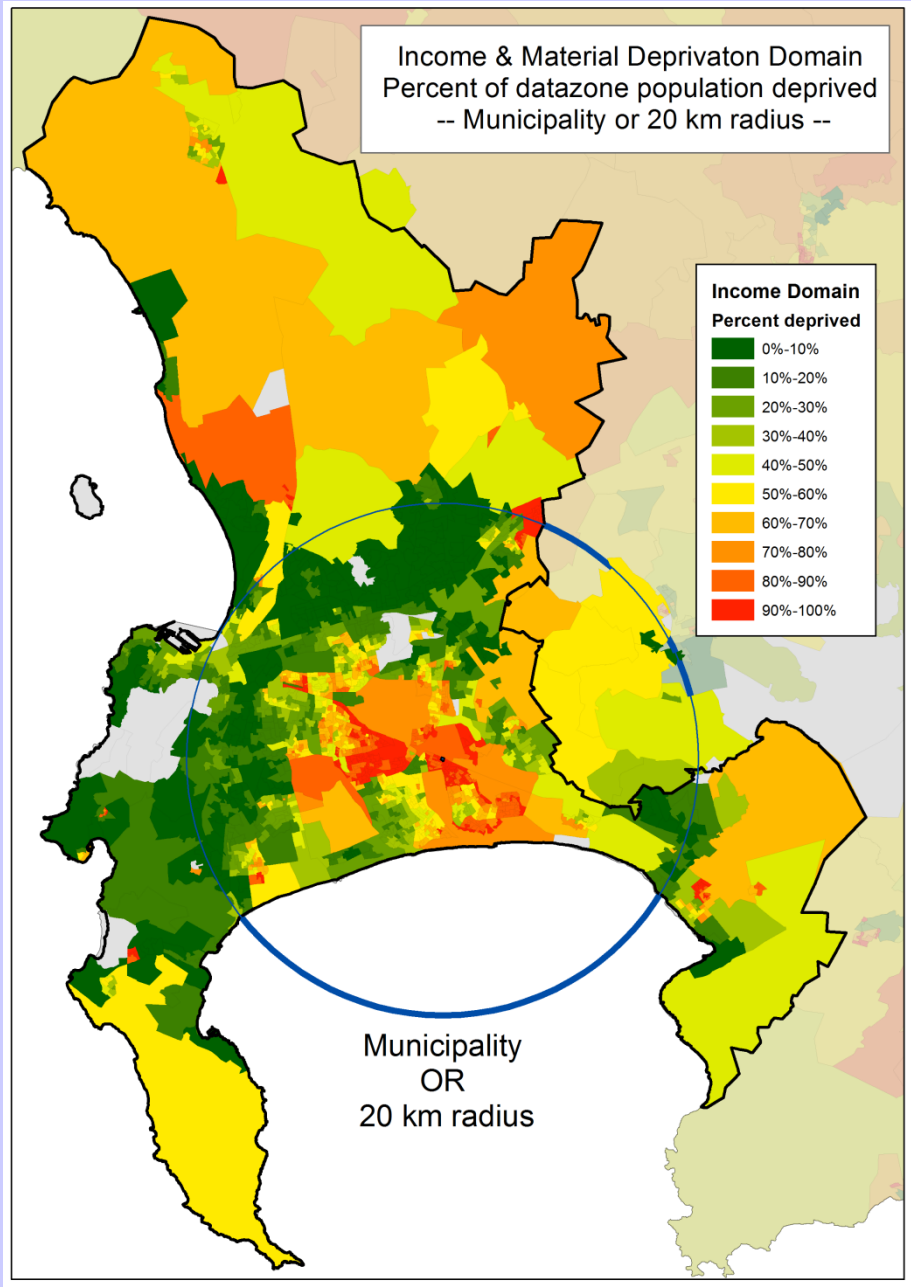


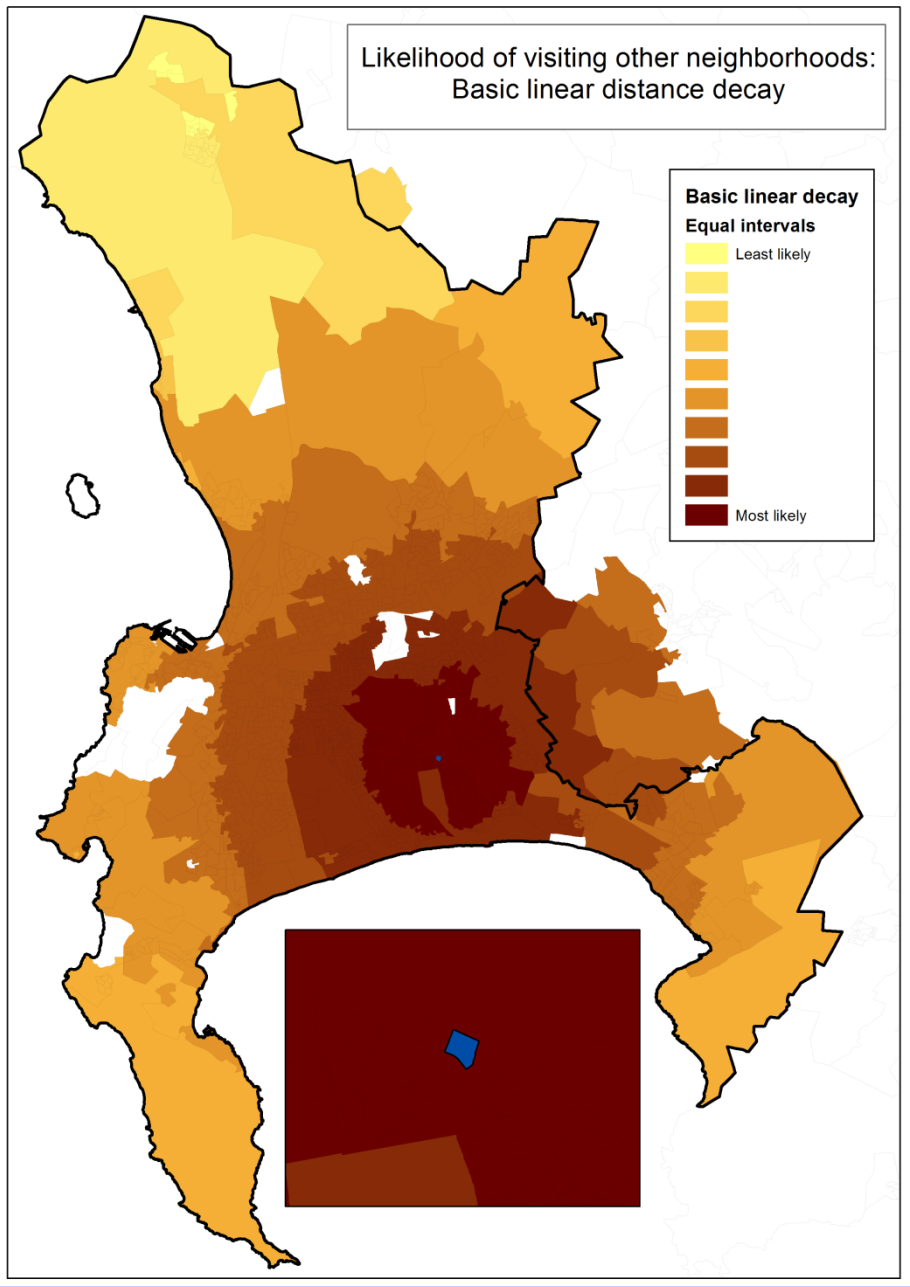
Various different ways to build assumptions as to likelihood of a person actually visiting each constituent neighbourhood within the defined spatial bounds, including:

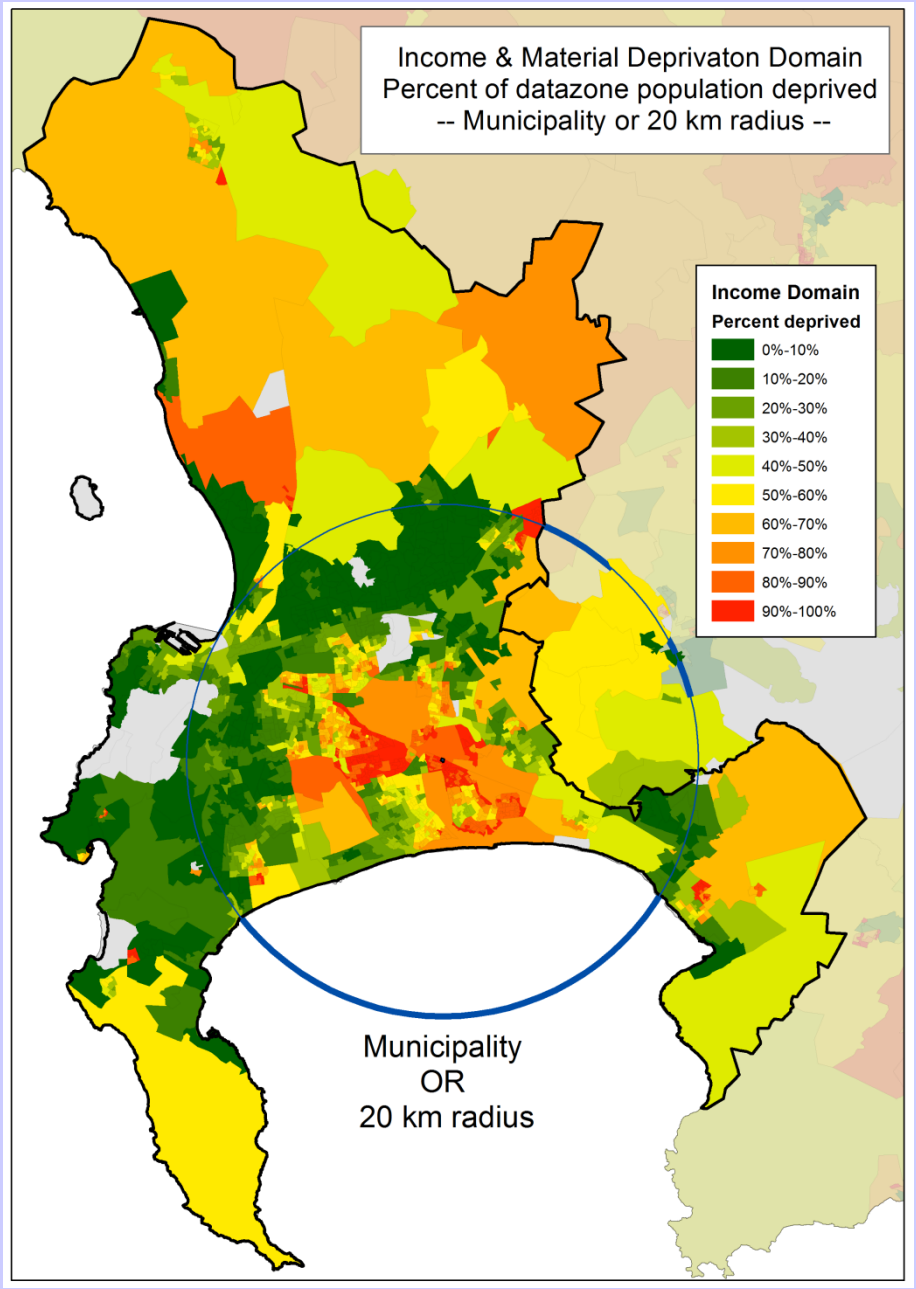
- Exponential distance decay
- Linear distance decay
- Modified distance decay


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
30%-40%
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%
Municipality
OR
20 km radius


Likelihood of visiting other neighborhoods:
Basic exponential distance decay
Basic exponential
Equal intervals
Least likely
Most likely


Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
30%-40%
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%
Municipality
OR
20 km radius


Likelihood of visiting other neighborhoods:
Basic linear distance decay
Basic linear decay
Equal intervals
Least likely
Most likely



Modified linear distance decay

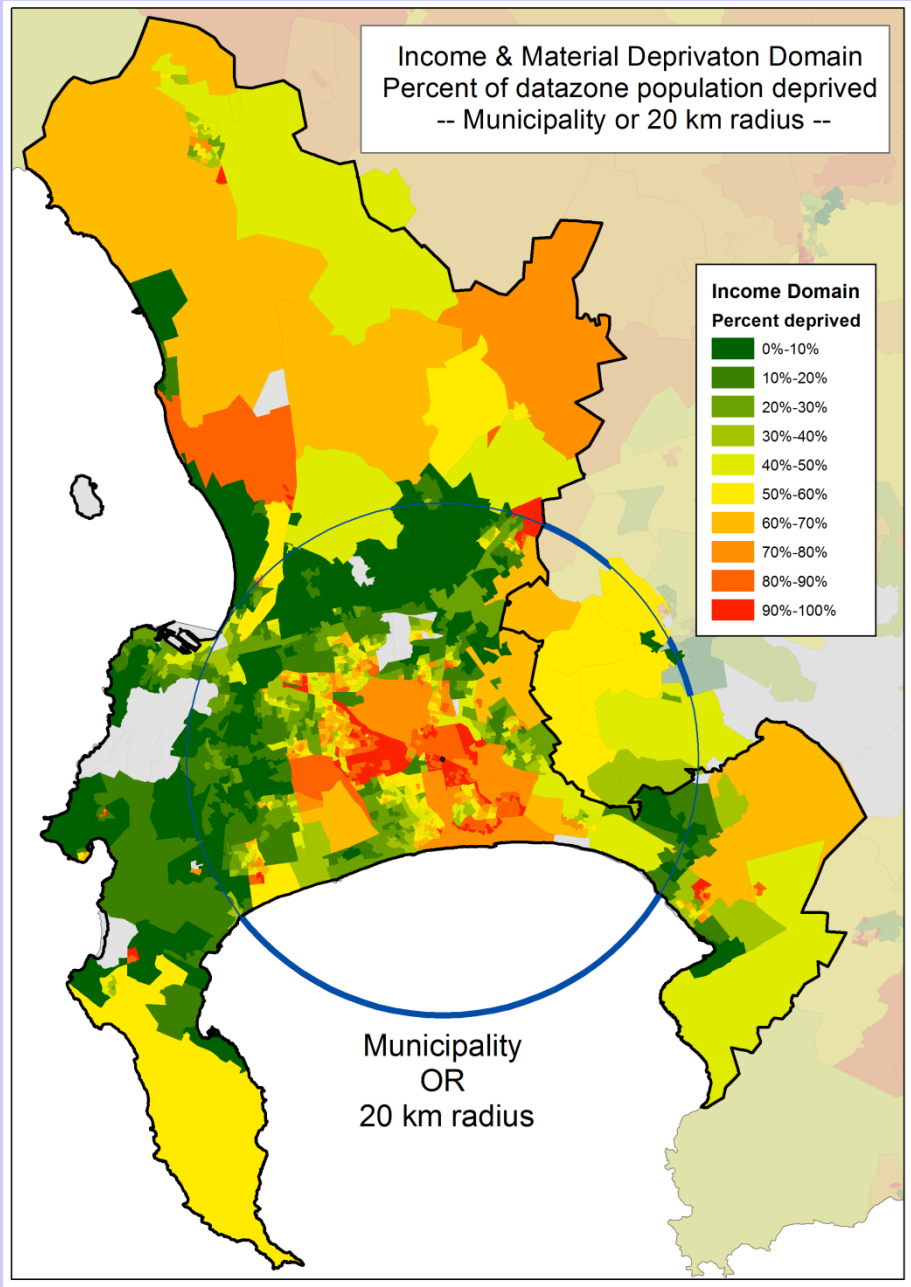
Our starting position is that people's travel patterns are contoured by:

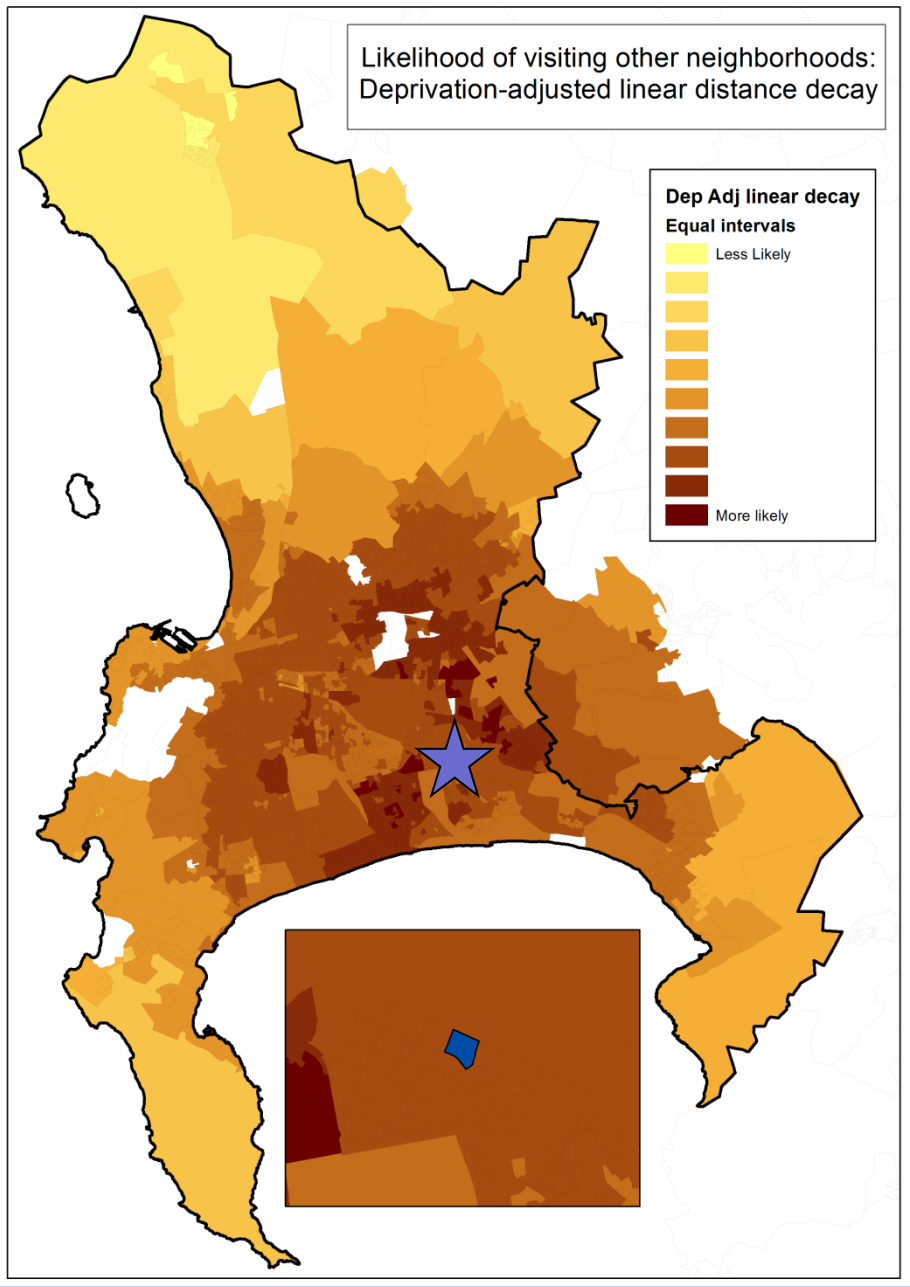
- Needs (e.g. work; study; visiting local administrative functions);
- Opportunities (e.g. seeking work); and
- Barriers (e.g. physical, cultural, perceptions of safety).

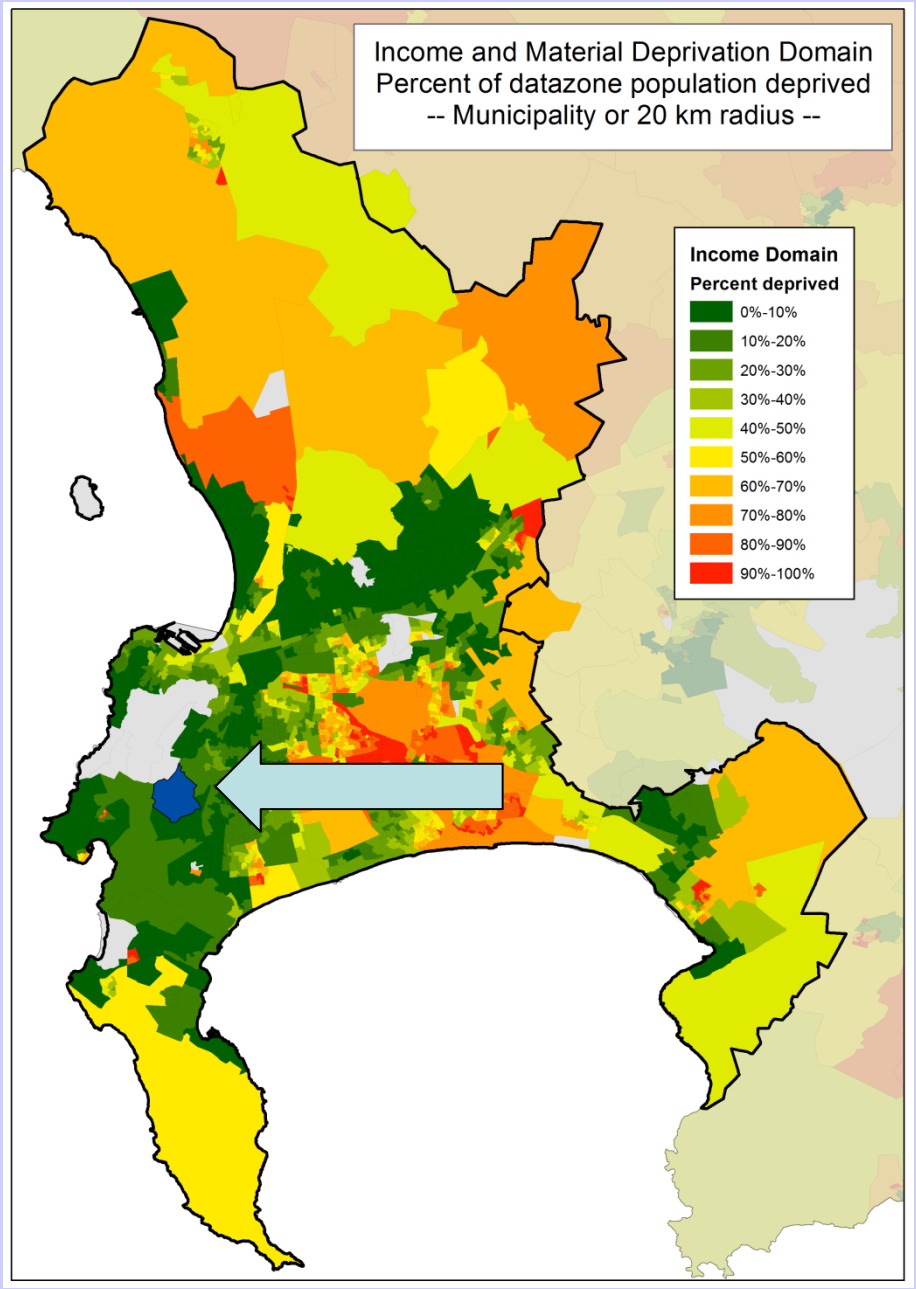
In the context of **resources** and therefore **choices**.

Assumption:

- More affluent areas exert stronger 'pull' factors

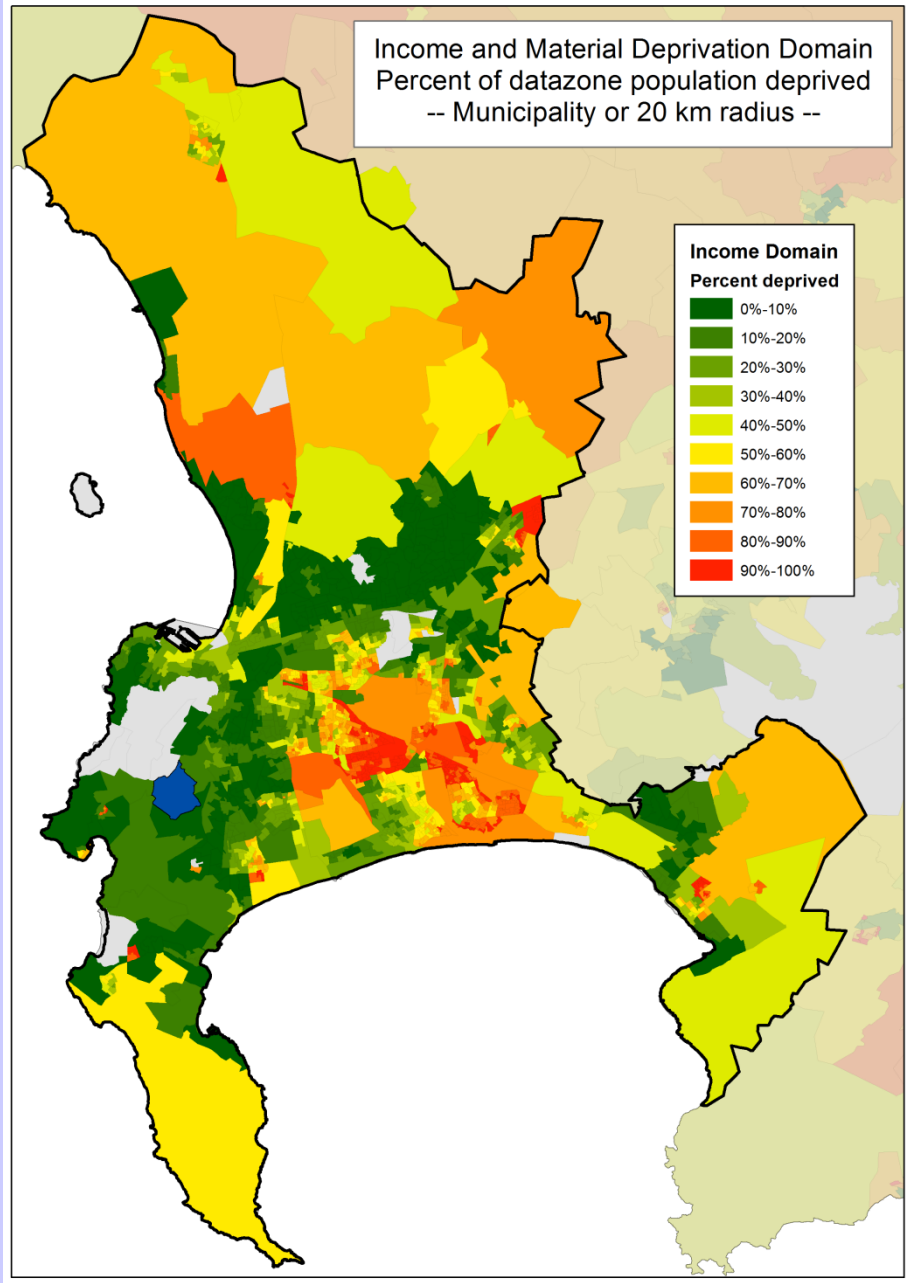

Income & Material Deprivaton Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
30%-40%
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%
Municipality
OR
20 km radius

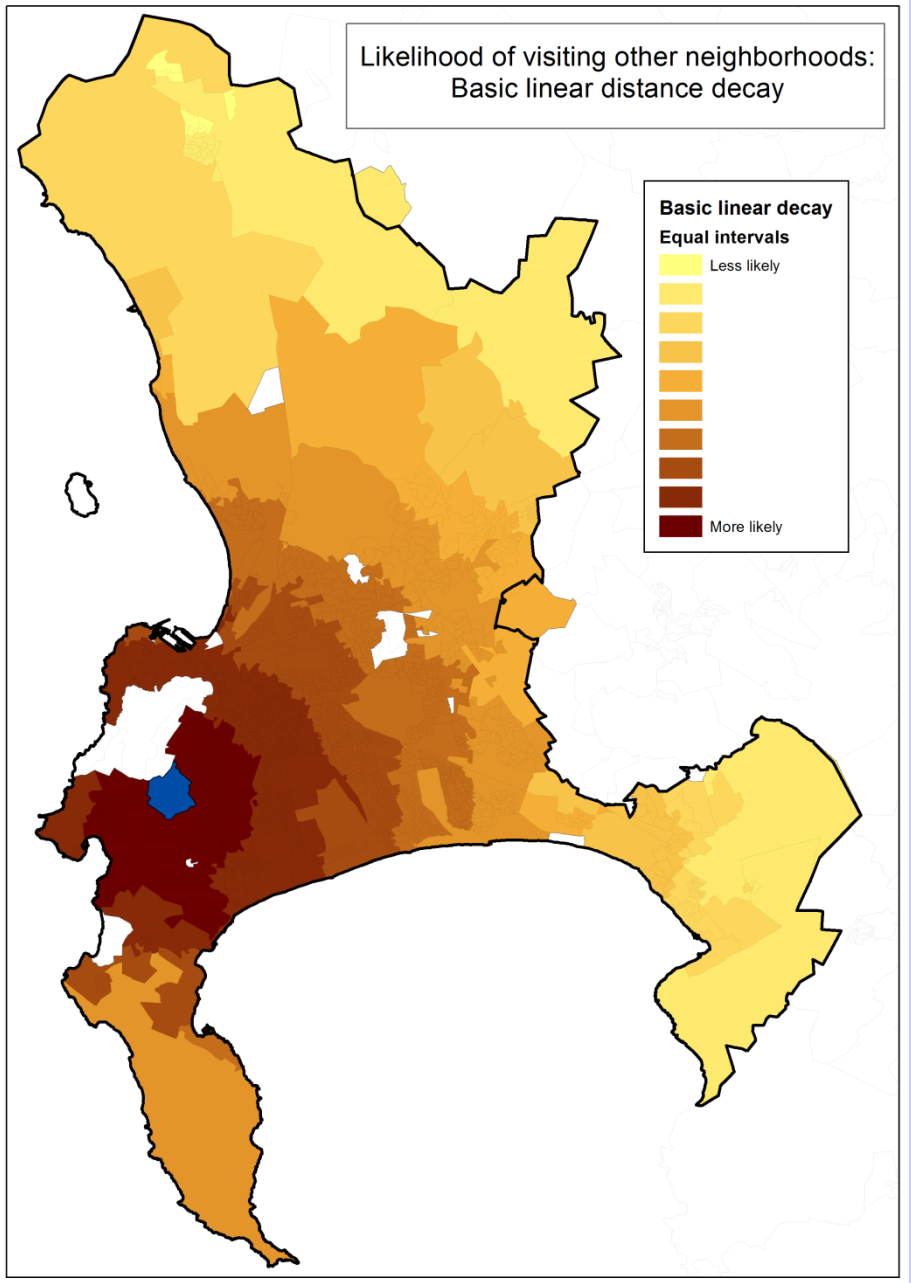

Likelihood of visiting other neighborhoods:
Deprivation-adjusted linear distance decay
Dep Adj linear decay
Equal intervals
Less Likely
More likely

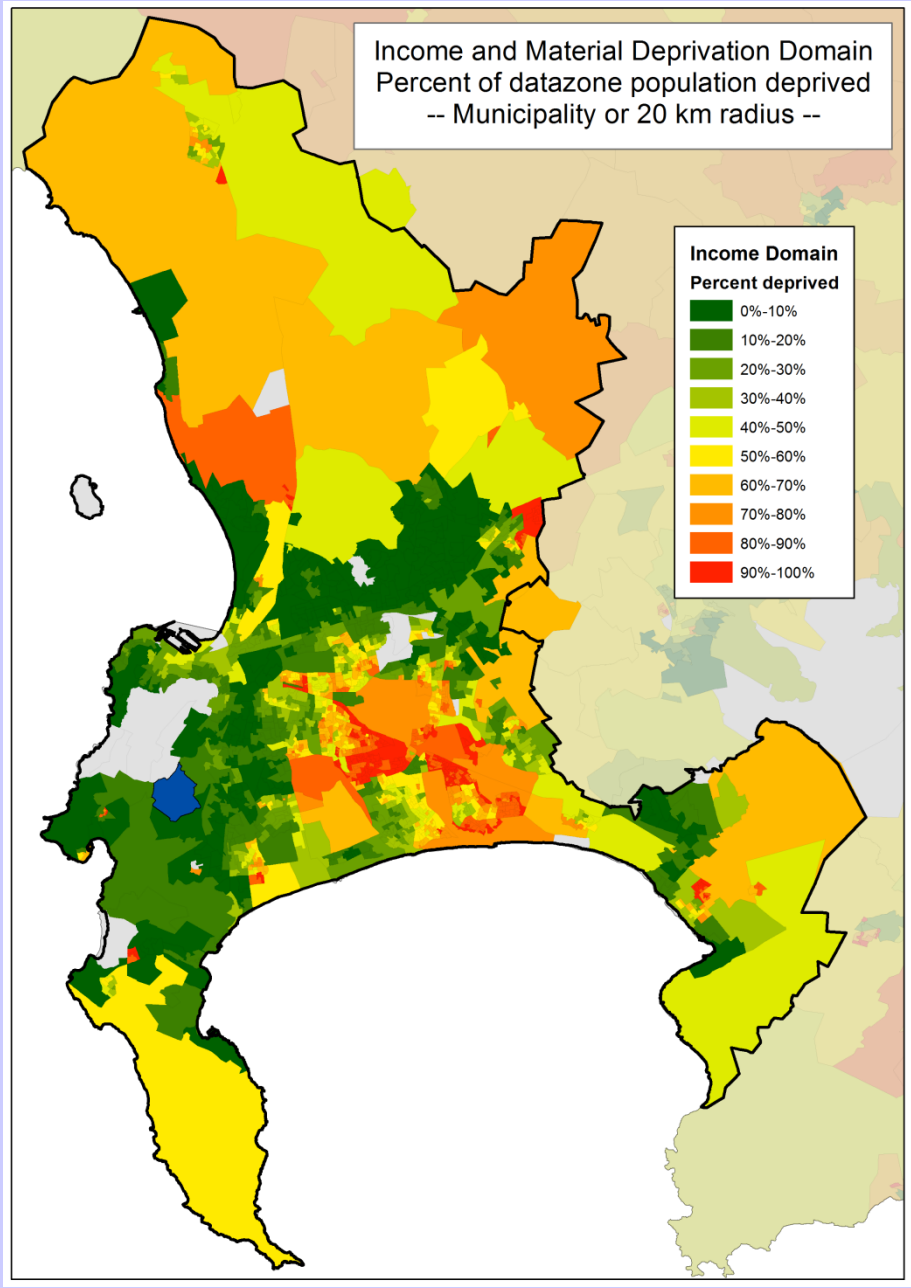


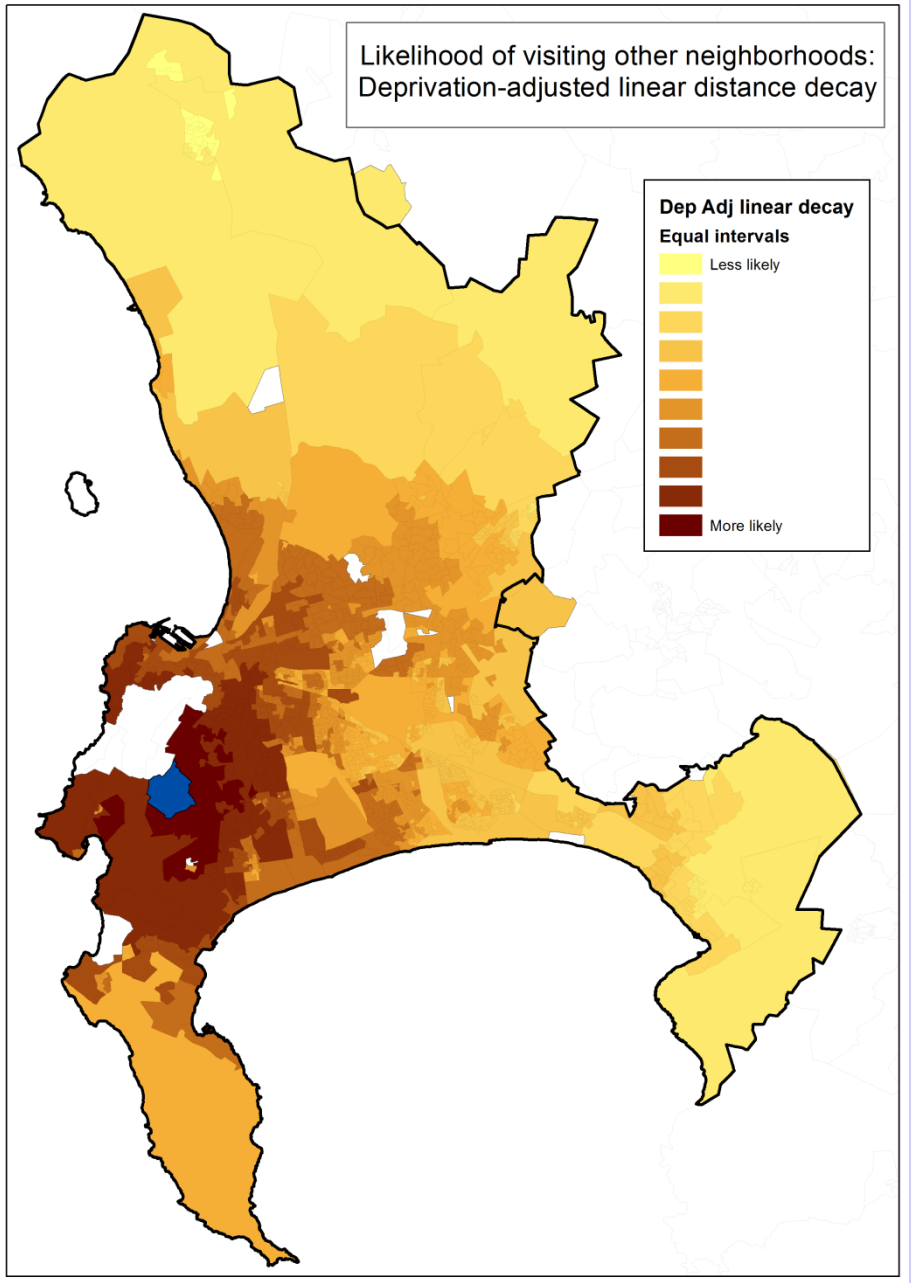
Example datazone in Constantia, where < 5% of population are deprived on the Income Domain

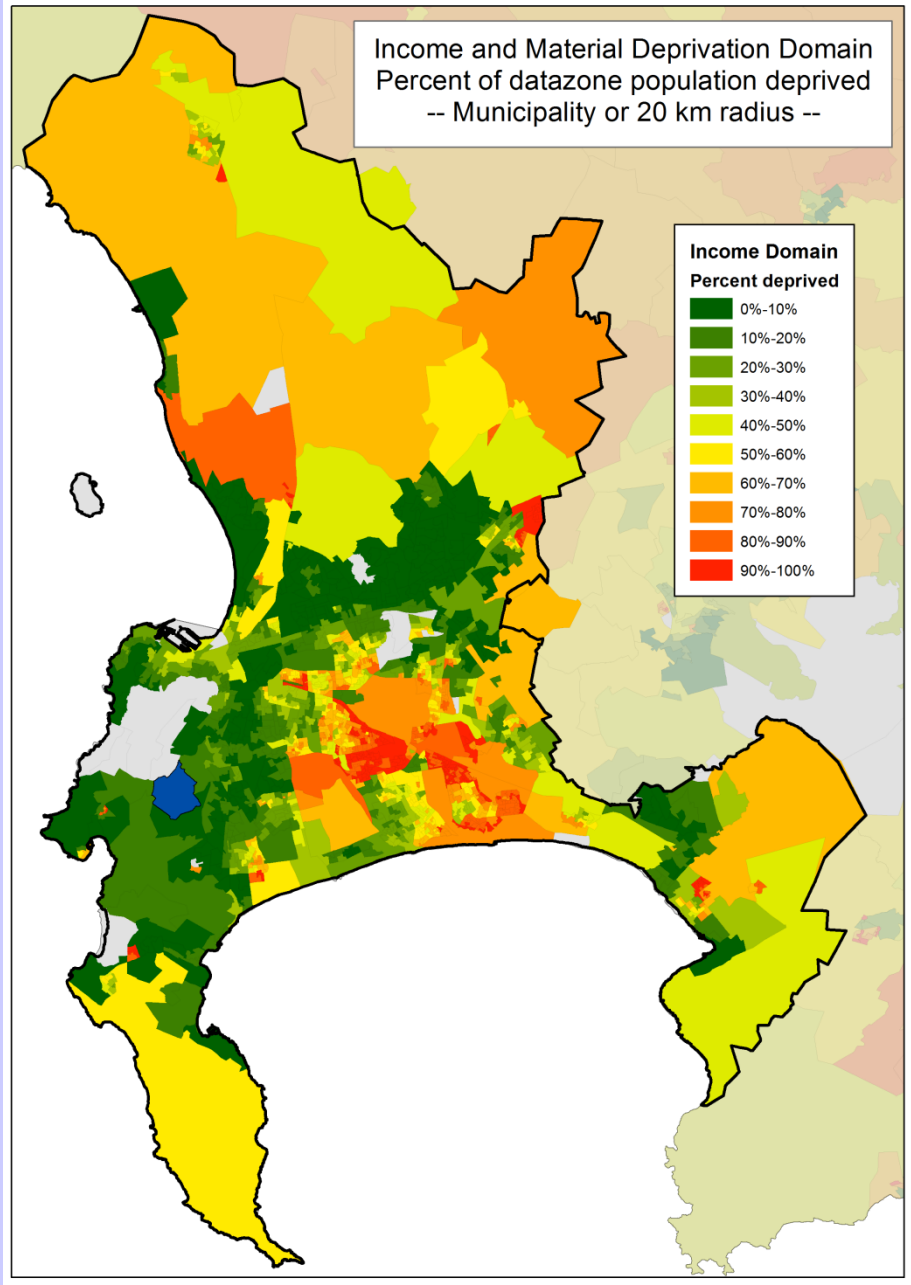
Same methodology, same assumptions regarding spatial bounds and use of ‘deprivation adjusted linear distance decay’……


Income and Material Deprivation Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
30%-40%
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%


Likelihood of visiting other neighborhoods:
Basic linear distance decay
Basic linear decay
Equal intervals
Less likely
More likely


Income and Material Deprivation Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
0%-10%
10%-20%
20%-30%
30%-40%
40%-50%
50%-60%
60%-70%
70%-80%
80%-90%
90%-100%


Likelihood of visiting other neighborhoods:
Deprivation-adjusted linear distance decay
Dep Adj linear decay
Equal intervals
Less likely
More likely


Income and Material Deprivation Domain
Percent of datazone population deprived
-- Municipality or 20 km radius --
Income Domain
Percent deprived
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30%-40%
40%-50%
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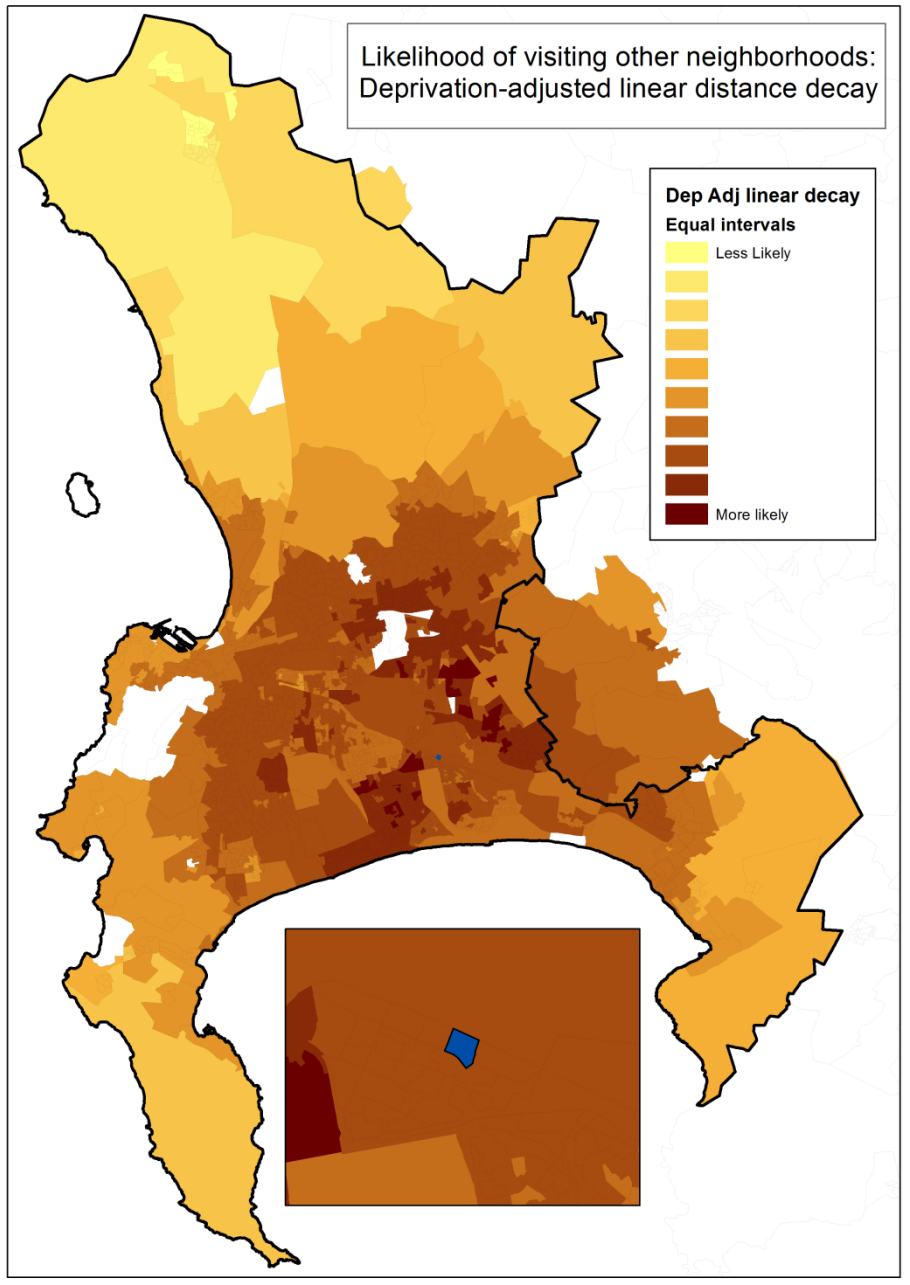
90%-100%


Likelihood of visiting other neighborhoods:
Deprivation-adjusted linear distance decay
Dep Adj linear decay
Equal intervals
Less Likely
More likely

Summary of exposure measure

Our exposure measure is dependent upon the two inter-related factors of:

1. The likelihood of a given person from a given neighbourhood visiting each separate other neighbourhood within the defined spatial bounds, and
2. The likely level of exposure to inequality the person would experience in each of those separate other neighbourhoods.

Constructing the deprivation-adjusted linear distance decay weight variable:

$$W_{ij} = \frac{(\max(d_{ij}) - d_{ij})}{\sum_{j=1}^{n} [\![\max(d_{ij}) - d_{ij})} + \left(\frac{\max(d_{ij}) - d_{ij}}{\sum_{j=1}^{n} [\![\max(d_{ij}) - d_{ij})} \times \left(\frac{y_j}{t_j} - \frac{y_i}{t_i} \right) \right)$$

$$Z_{ij} = W_{ij} \times \frac{1}{\sum_{j=1}^{n} W_{ij}}$$

where dij is the distance between area i and area j, max(dij) is the maximum distance from area i to any other area j within the specified spatial bounds (i.e. within the local municipality or within 20km of area i), y and t are the numbers of non-poor population and total population, respectively, in areas i and j, Wij is the pre-scaling deprivation-adjusted distance weight between areas i and j, and Zij is the final scaled deprivation-adjusted distance weight between areas i and j

Constructing the final exposure measures

- $$ExposInc_{xy} = \sum_{j=1}^{n} Z_{ij}\left(\frac{y_j}{t_j}\right)$$

$$ExposInc_{yx} = \sum_{j=1}^{n} Z_{ij}\left(\frac{x_j}{t_j}\right)$$

where Zij is specified as shown in equation (1), x, y and t are the numbers of poor population, non-poor population and total population, respectively, in areas i and j, and $ExposInc_{xy}$ and $ExposInc_{yx}$ are the final local deprivation-adjusted distance-weighted exposure indices for each area i.

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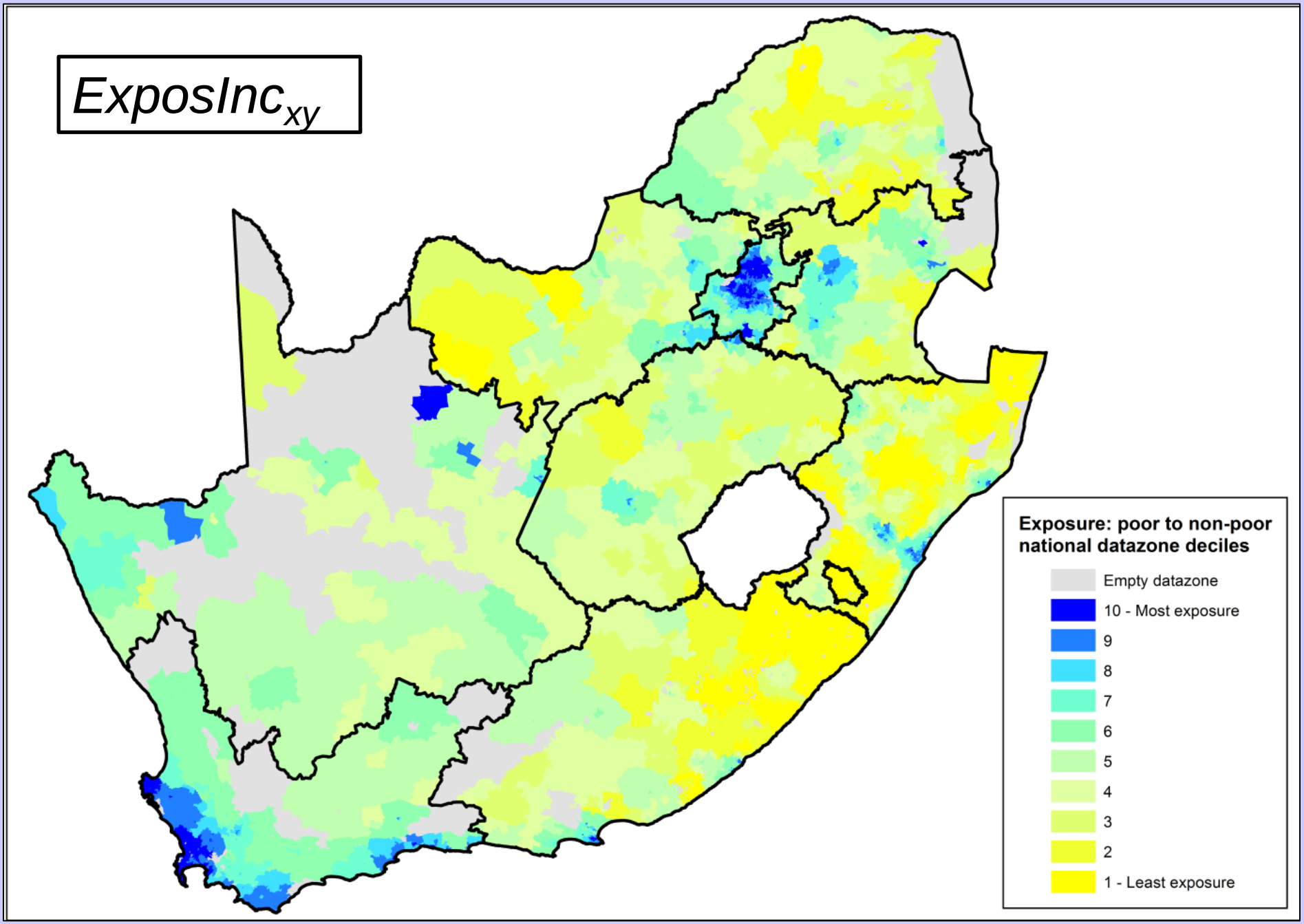
$ExposInc_{xy}$
Exposure: poor to non-poor national datazone deciles
Empty datazone
10 - Most exposure
9
8
7
6
5
4
3
2
1 - Least exposure

Summary

- Exposure indices measure the degree of likely interaction between different population sub-groups.
- We are interested in:
  - the degree to which the poor population is exposed to the non-poor (i.e. the lived experience of inequality from the perspective of the poor)
  - the degree to which the non-poor population is exposed to the poor (i.e. the lived experience of inequality from the perspective of the non-poor)
- ‘Local’ measures of exposure provide a geographically nuanced picture of variations at neighbourhood level.

Summary

Assumption: Exposure to socio-economic inequality is related to people's routine activities.

- Our chosen approach involves two components:
  - People's travel patterns are restricted to occurring within their own local municipality and/or within a 20km radius of their home neighbourhood.
  - The likelihood of an individual from one neighbourhood visiting a different neighbourhood is influenced by:
    a) the distance between the neighbourhoods, and
    b) the respective levels of poverty within the neighbourhoods.

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