GeoHealth

The Importance of Place in Understanding Health

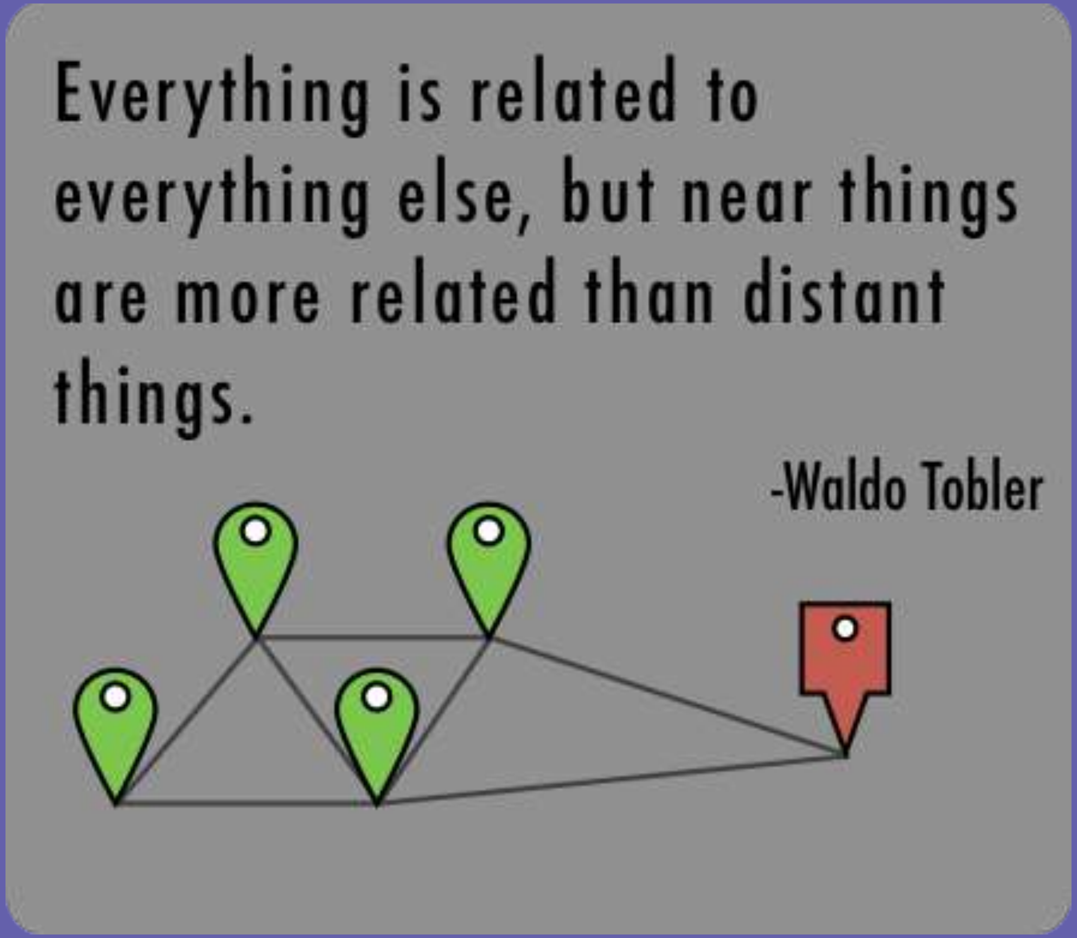
Associate Professor Neil Coffee
Health Research Institute
University of Canberra

The Art, Science and Business of Geospatial

GeoHealth

Spatial Epidemiology and Evaluation Research Group

Tobler's Law



Tobler W., 1970, A computer movie simulating urban growth in the Detroit region, Economic Geography, 46(2): 234-240.

"All Pervasive Enabler"

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- All: DATA
- Pervasive: ALL disciplines
- Enabler: <u>GIS</u>

Early GeoHealth Work

Not John Snow!

Charles Booth

Charles Booth's London poverty maps

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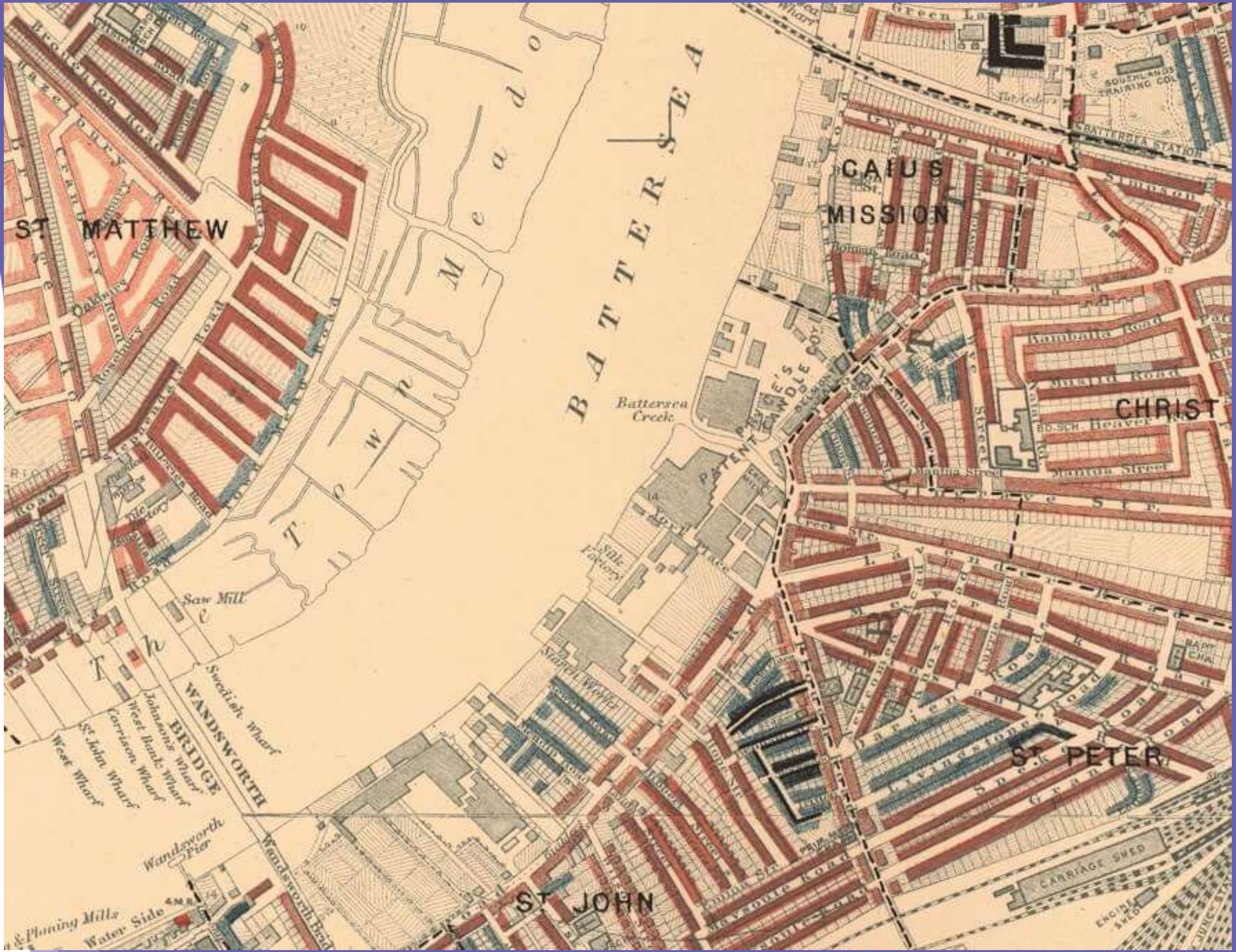
https://booth.lse.ac.uk/map/14/-0.1174/51.5064/100/0

https://booth.lse.ac.uk/learn-more/download-maps/sheet12

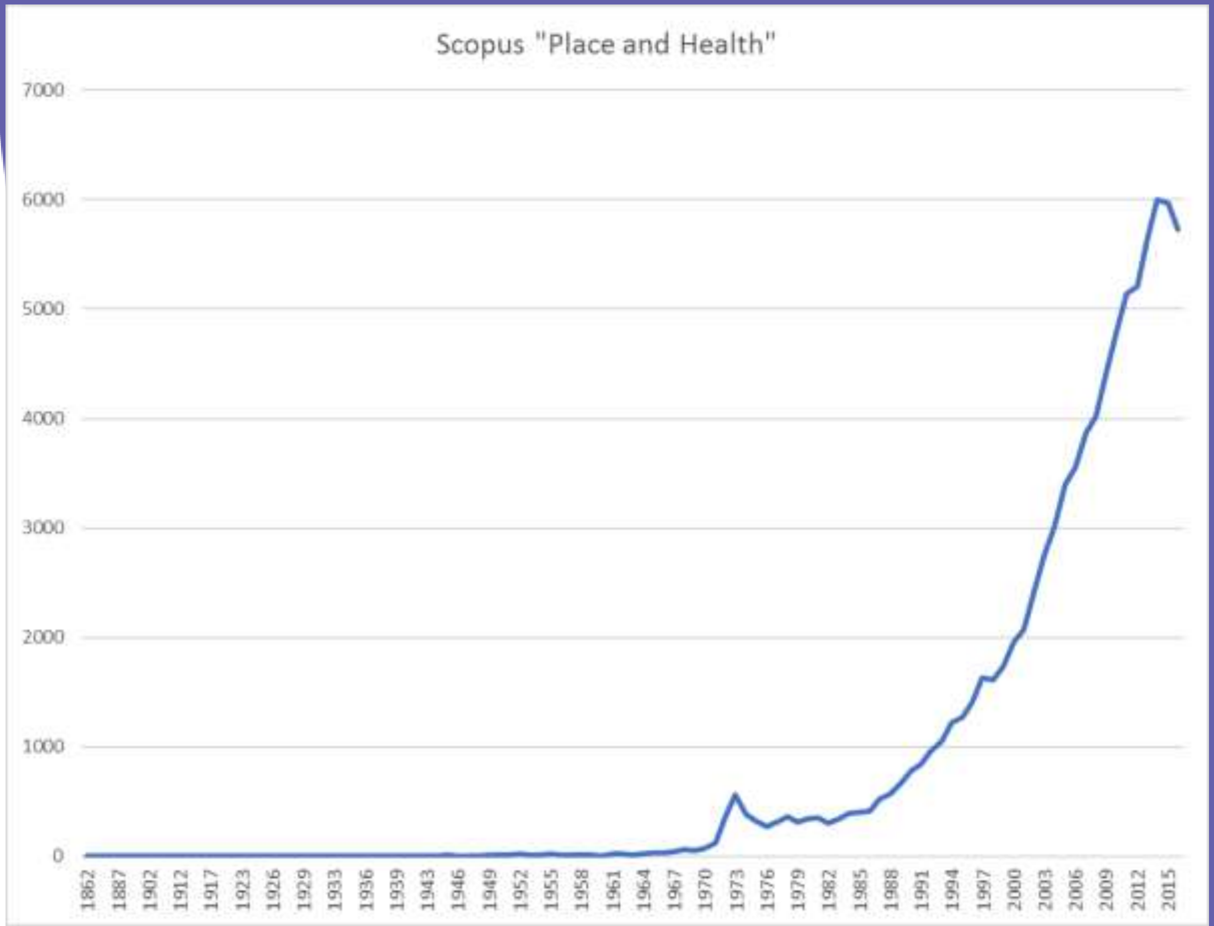


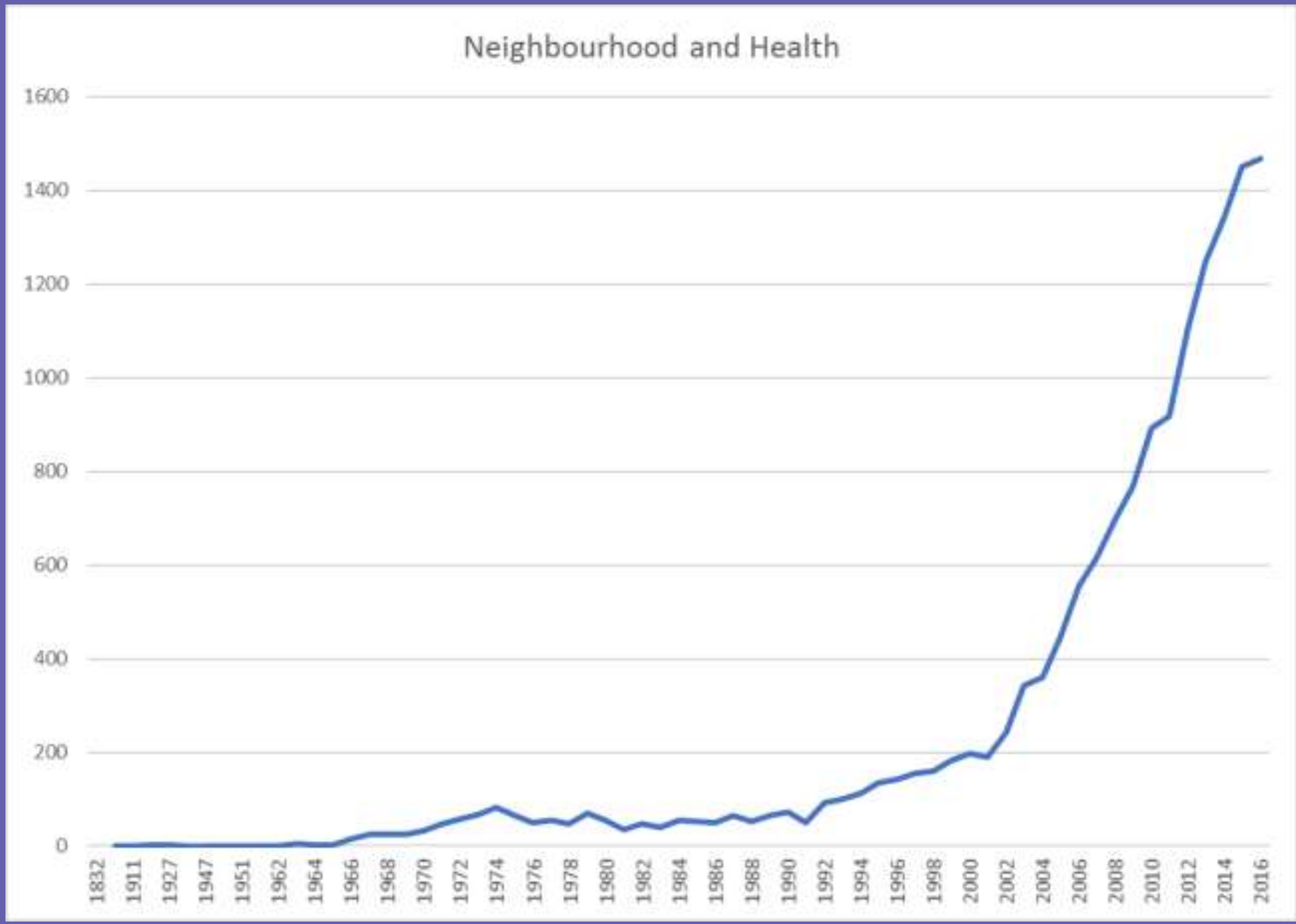
The Streets are coloured according to the general condition of the inhabitants, as under:--

- Lowest class. Vicious, semi-criminal.
- Very poor, casual. Chronic want.
- Poor. 18s. to 21s. a week for a moderate family.
- Mixed. Some comfortable, others poor.
- Fairly comfortable. Good ordinary earnings.
- Middle-class. Well-to-do.
- Upper-middle and Upper classes. Wealthy.

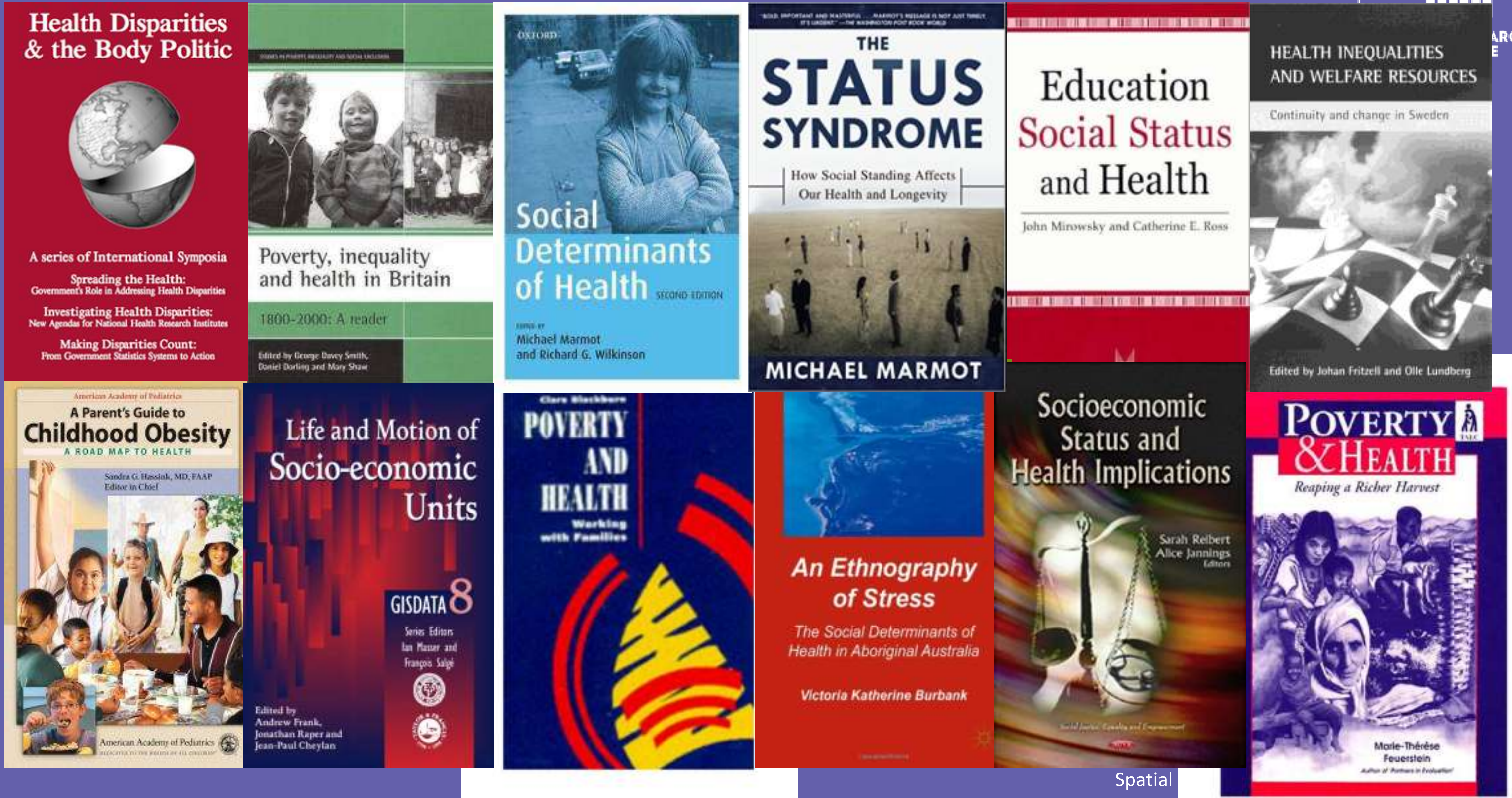
A combination of colours-- as dark blue and black, or pink and red-- indicates that the street contains a fair proportion of each of the classes represented by the respective colours.

Evolving Interest





Well established link between social disadvantage and poorer health outcomes



Spatial

Socio-economic Status

- SES strong relationship with health outcomes.
- Includes:
  - Obesity
  - Diabetes
  - Cardio vascular Disease
  - Cancer
  - Mental Illness
  - Hypertension
  - High Cholesterol
  - Metabolic Syndrome………

Importance of “Place” to health

- Associations
  - Obesity
  - Diabetes
  - Cardio vascular Disease
  - Cancer
  - Mental Illness
  - Hypertension
  - High Cholesterol
  - Metabolic Syndrome………

GIS and Health

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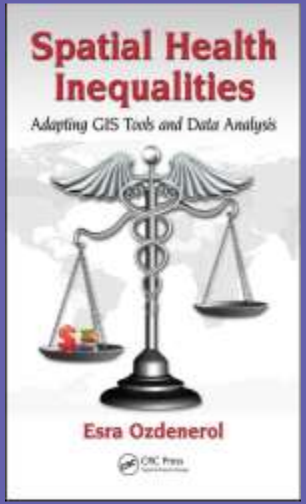
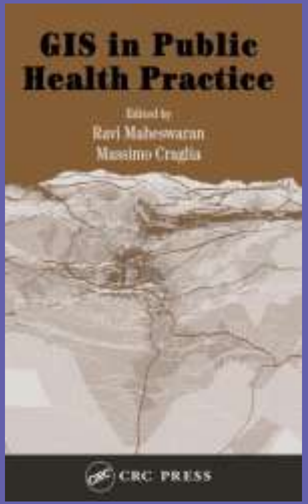
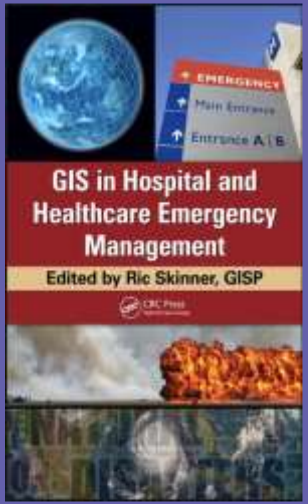
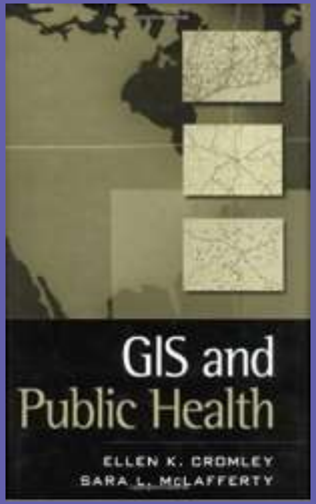
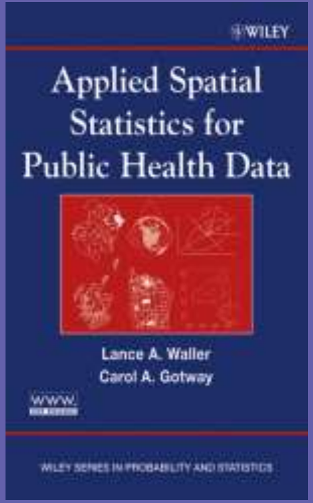
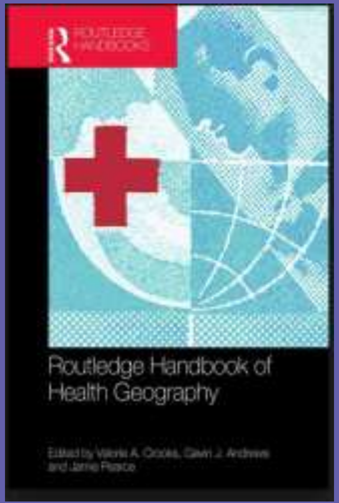


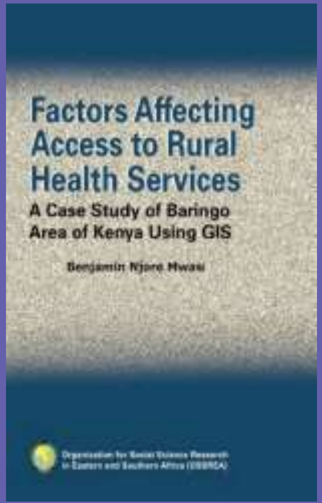


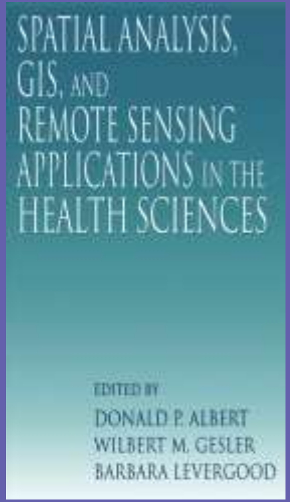


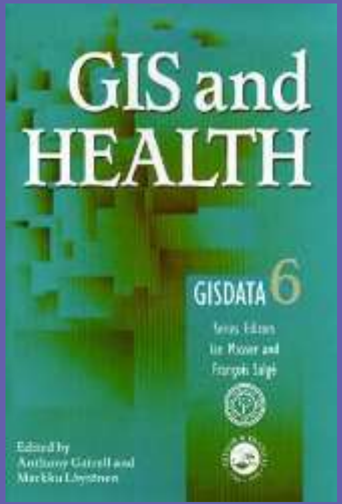




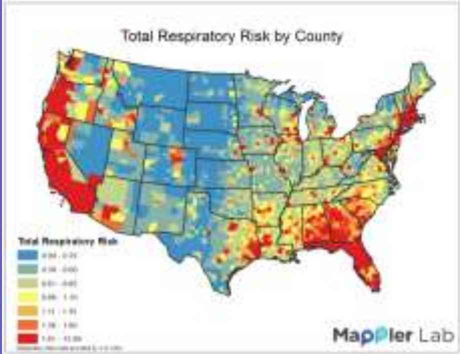




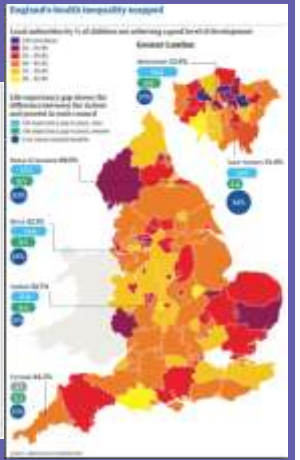


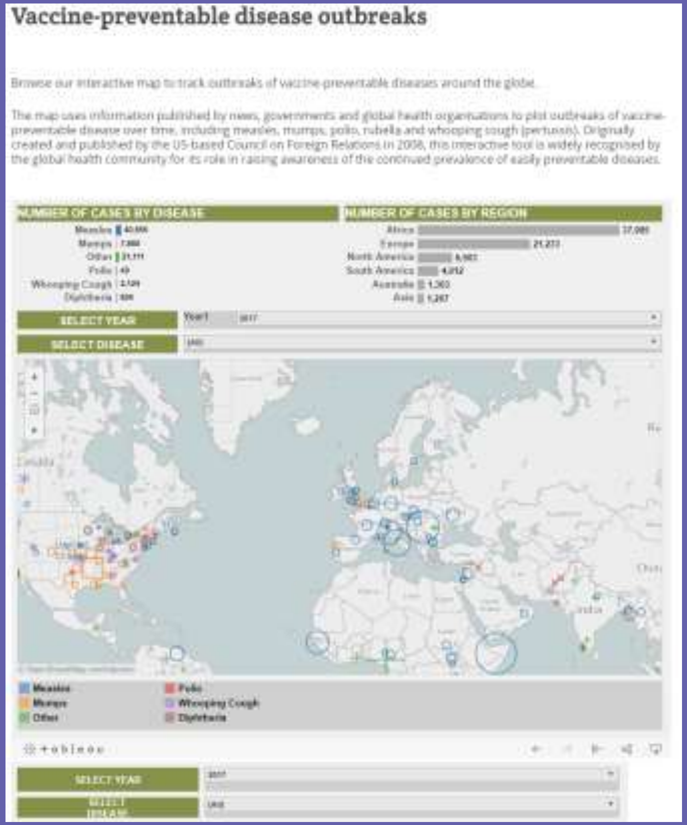


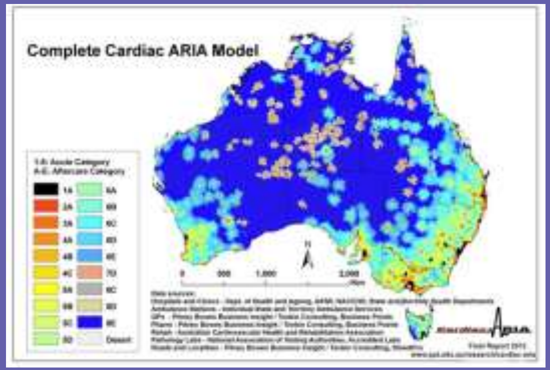
World Examples



https://healthmap.wordpress.com/2016/06/09/cdc-respiratory-risk-data/







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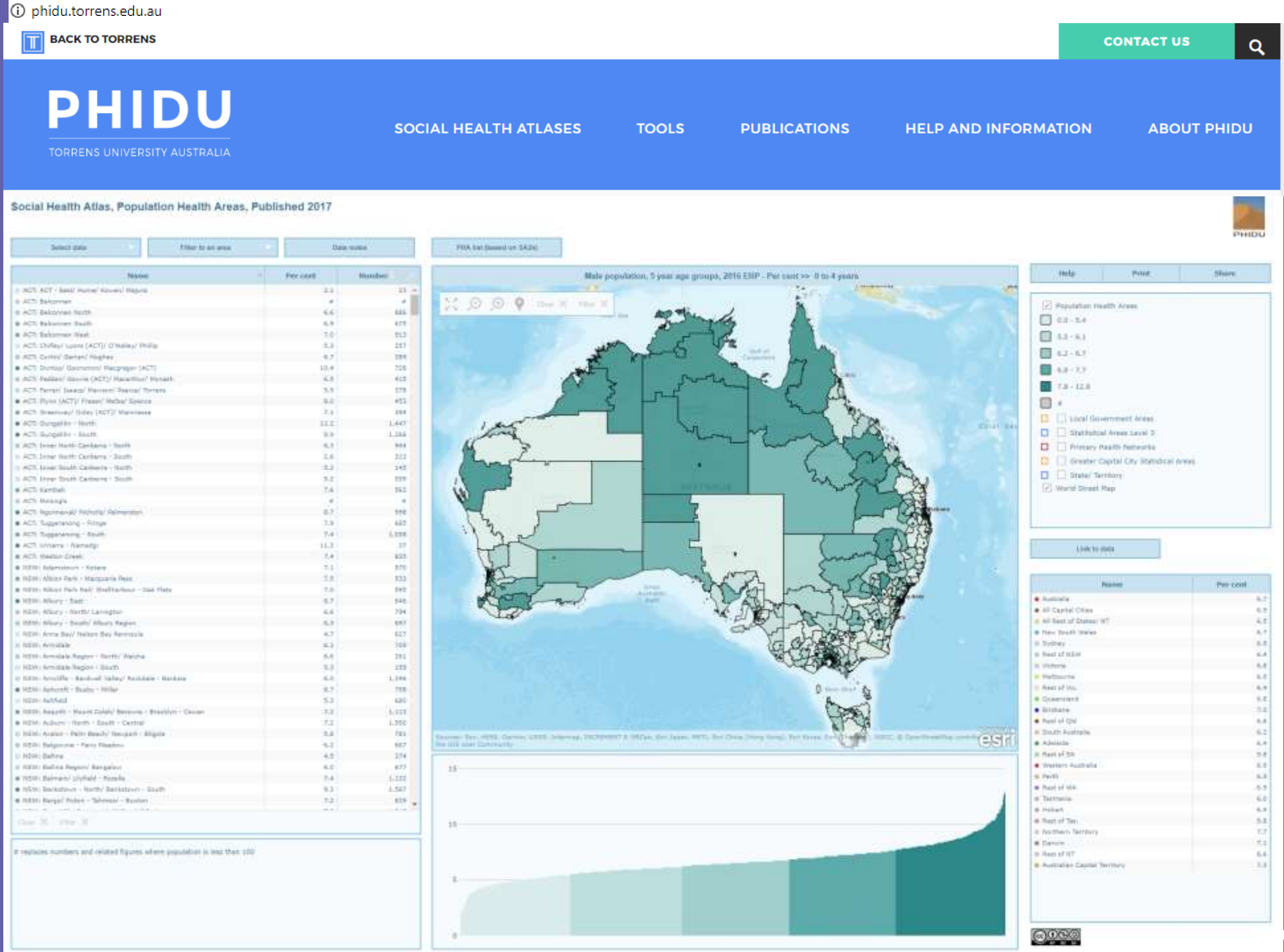

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uation Research Group

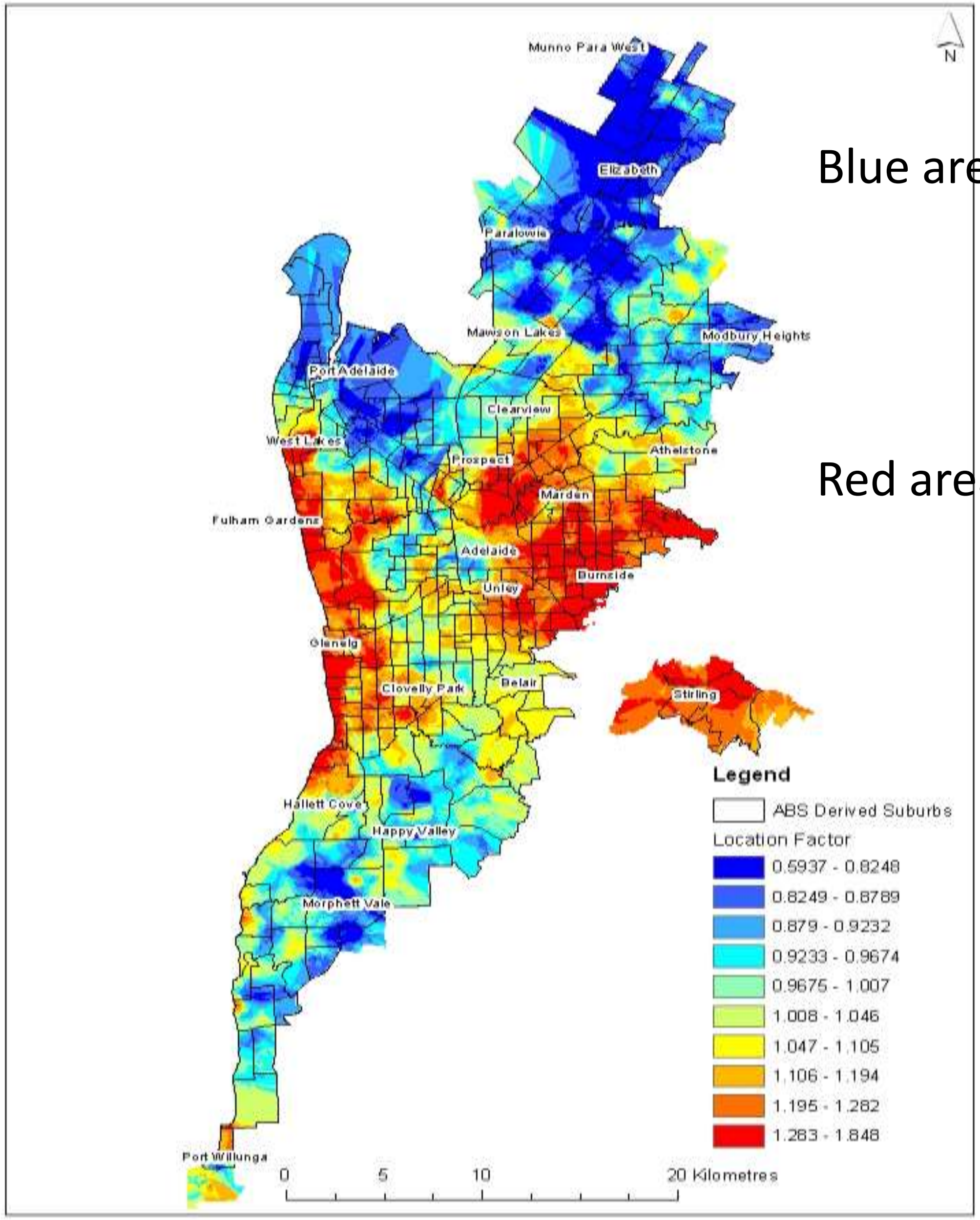
SES and Place

- Associations are common
- Spatial SES
- Create a measure at the property level that could provide a disaggregated SES indicator
- Application in Adelaide used GIS, Sales and Property Cadastre data“Relative Location Factor (RLF)”
- For more detail regarding the Methodology see:
  - Coffee N, Lockwood T, 2012, The Property Wealth Metric and Socio Economic Indicators. *Proceeding of Pacific Rim Real Estate Society, 18th Annual Conference*, 15-18 January 2012.
  - NT Coffee, T Lockwood, G Hugo, C Paquet, NJ Howard, M Daniel, 2013, Relative residential property value as a socio-economic status indicator for health research, International journal of health geographics 12 (1), 22.
  - T Lockwood, NT Coffee, P Rossini, T Niyonsenga, S McGreal, 2018, Does where you live influence your socio-economic status?, Land Use Policy 72, 152-160.

Methodology

- Georeferenced sales data for May to October to avoid changes to sales market
- The RLF was calculated using the hedomic global Ordinary Least Squares (OLS) regression model comprising independent variables that were deliberately ‘blind’ to location
- The residual was then considered to represent these omitted location variables at each sale point
- These are then interpolated across the study area to give a continuous RLF surface from which values can be extracted for each property

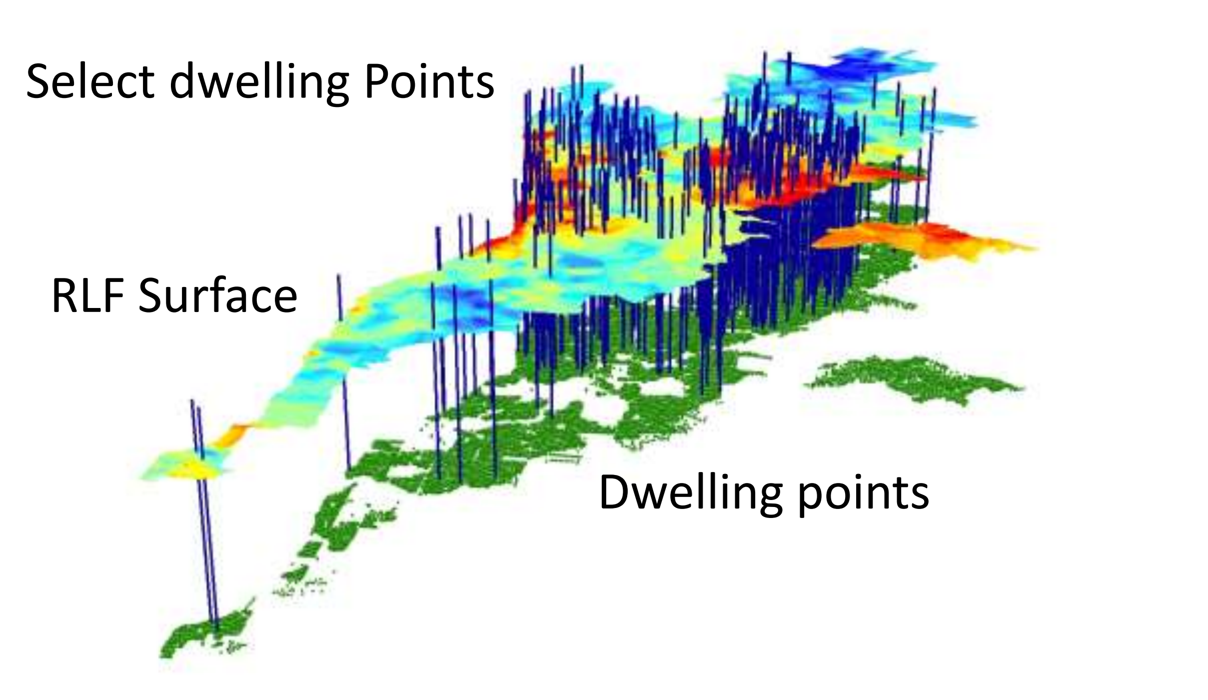
Continuous RLF



Blue areas are below the mean

Red areas are above the mean

- RLF Values are extracted to dwelling point data

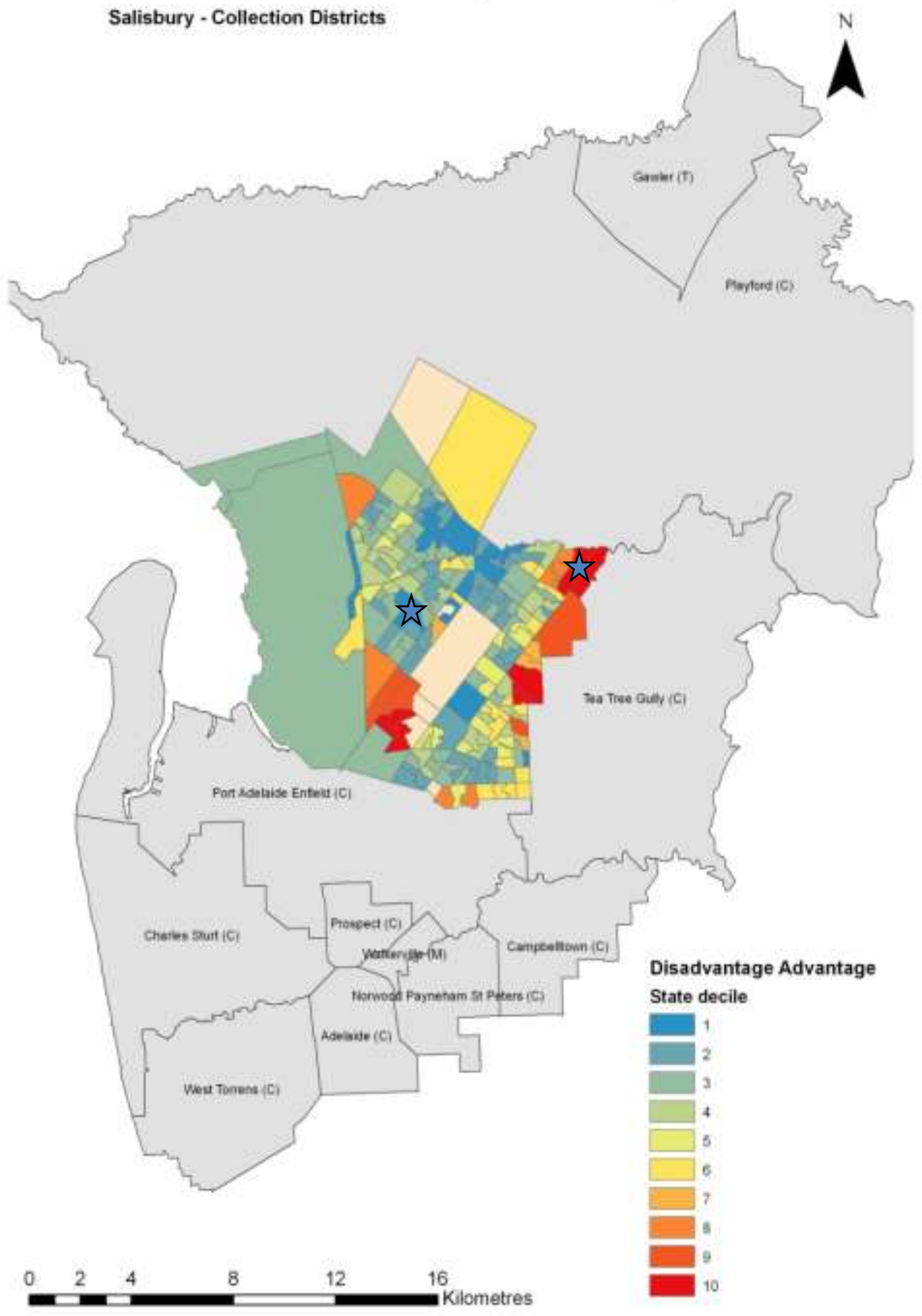


MAUP & ABS SEIFA Index

- ABS* calculate several Indices
- ABS confidentiality prohibits unit record census data being made available
- ABS provide SEIFA for spatial units
  - Collection District (pre 2011) or SA1 smallest unit
  - Also (pre 2011)Suburb, Postal Area, SLA,LGA and 2011 the SA1-SA4
- Remember MAUP & Ecological Fallacy
- Lets look at some of these spatial units in Adelaide

* Australian Bureau of Statistics

2006 ABS SEIFA Disadvantage-Advantage State Decile



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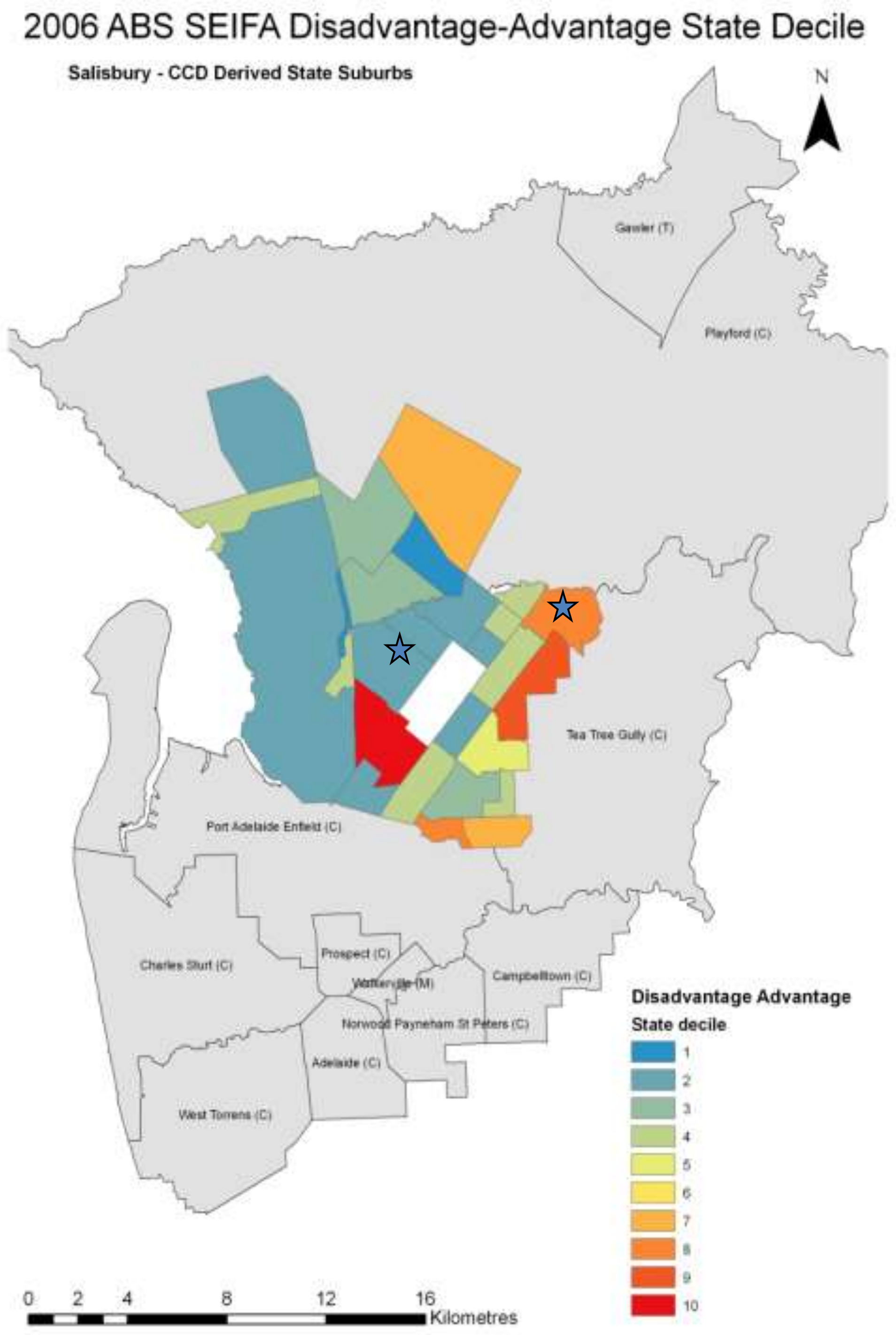

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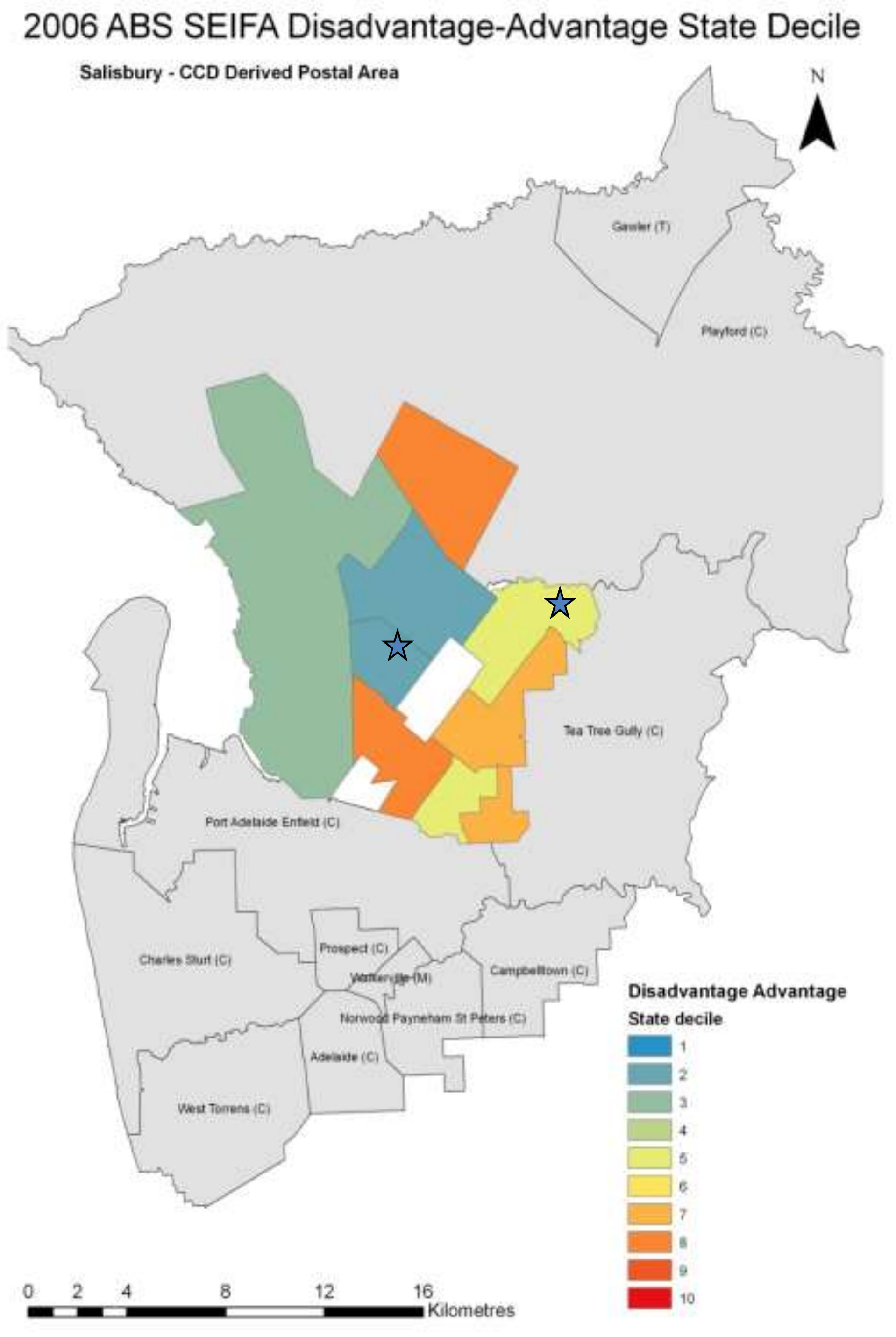

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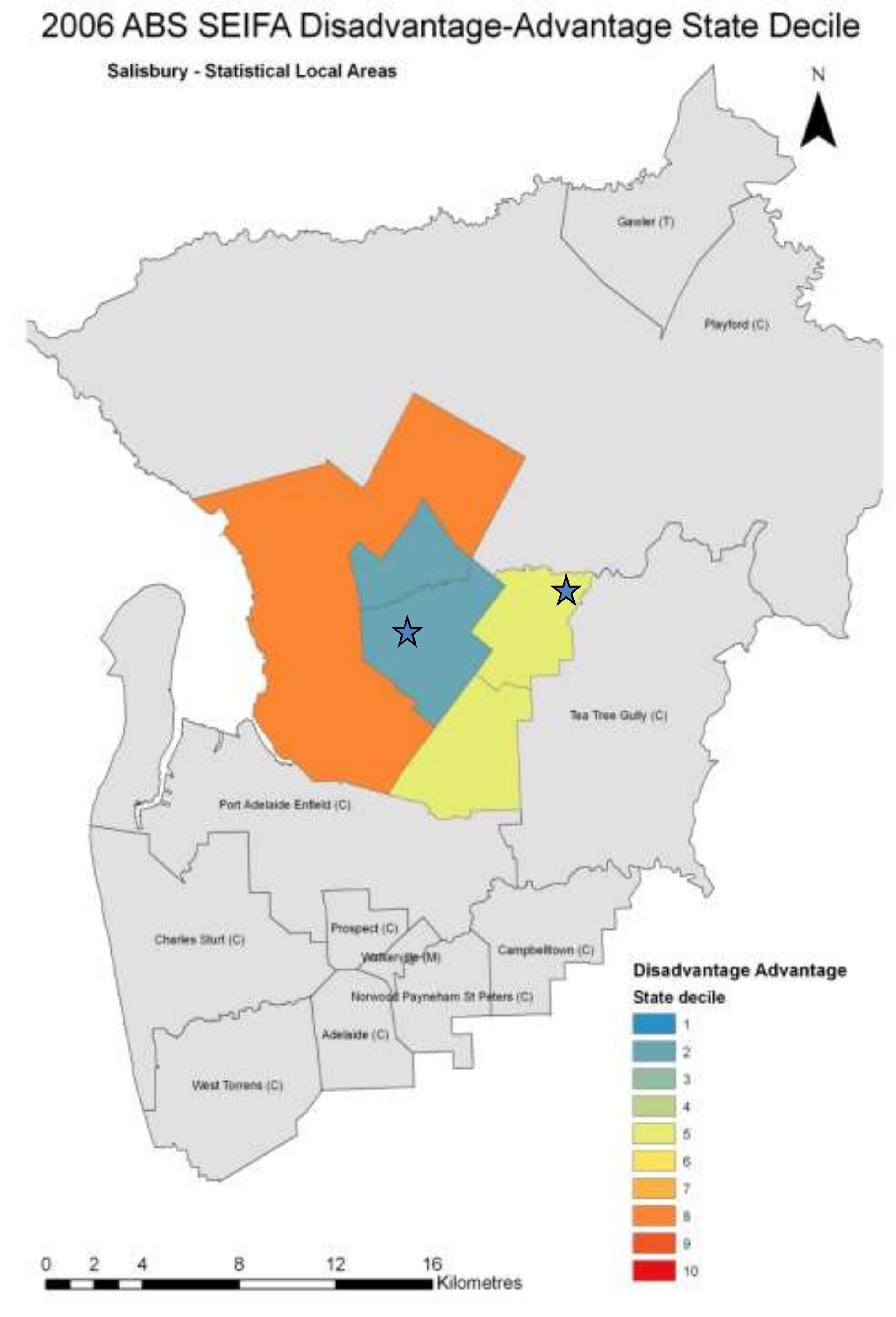

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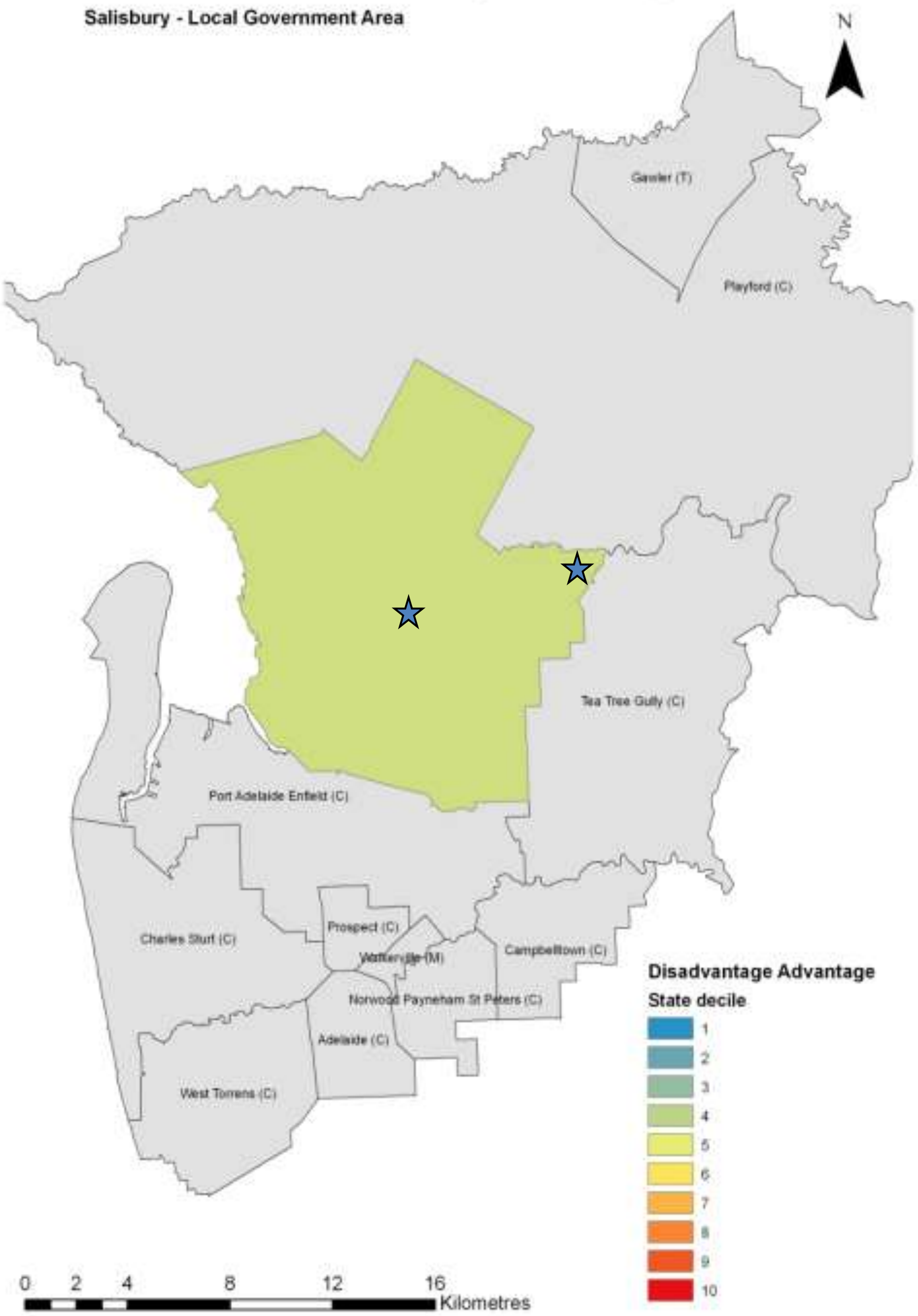
2006 ABS SEIFA Disadvantage-Advantage State Decile



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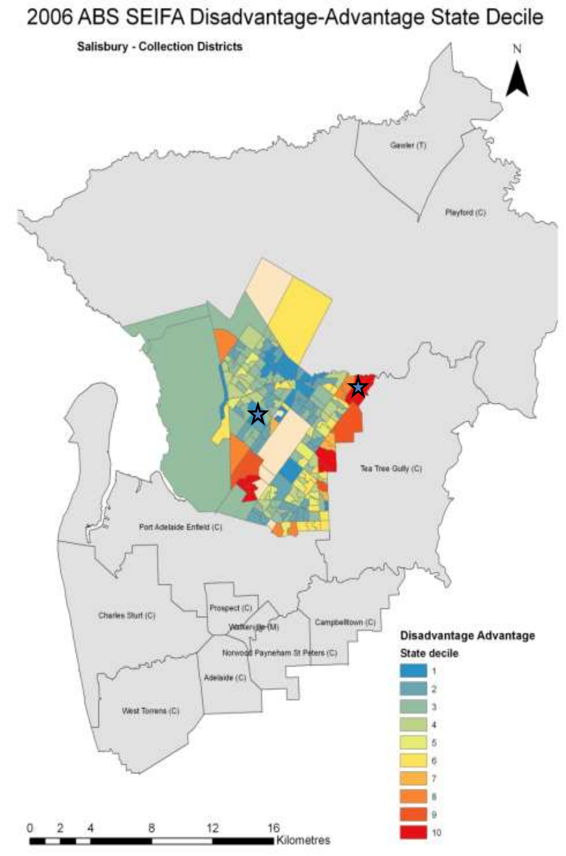
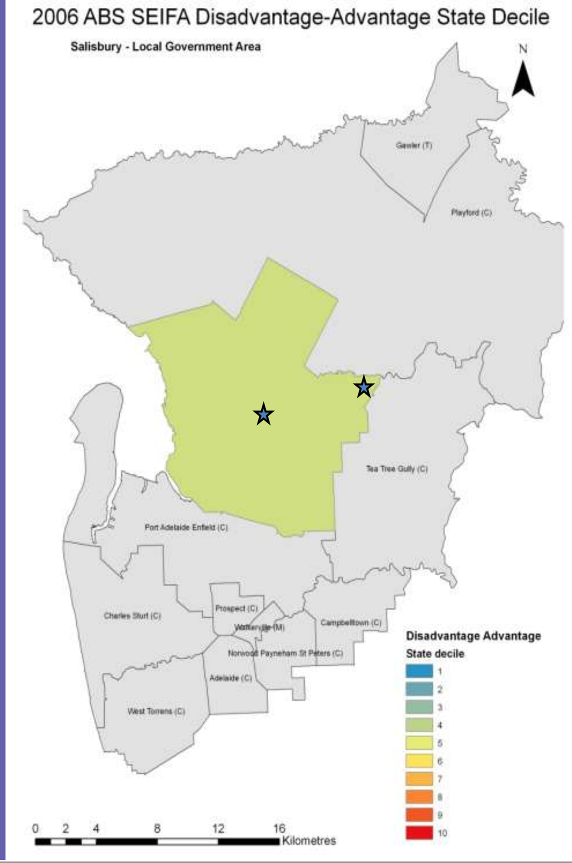


Score

Spatial Unit	Low SEIFA House	HIGH SEIFA House
CCD	826.42	1059.35
SSC	891.45	1025.43
POA	891.45	939.69
SLA	889.32	938.27
LGA	922.53	922.53
Change	96.11	-136.82

Decile

Spatial Unit	Low SEIFA House	HIGH SEIFA House
CCD	1	10
SSC	2	8
POA	2	5
SLA	2	5
LGA	5	5
Change	4	-5



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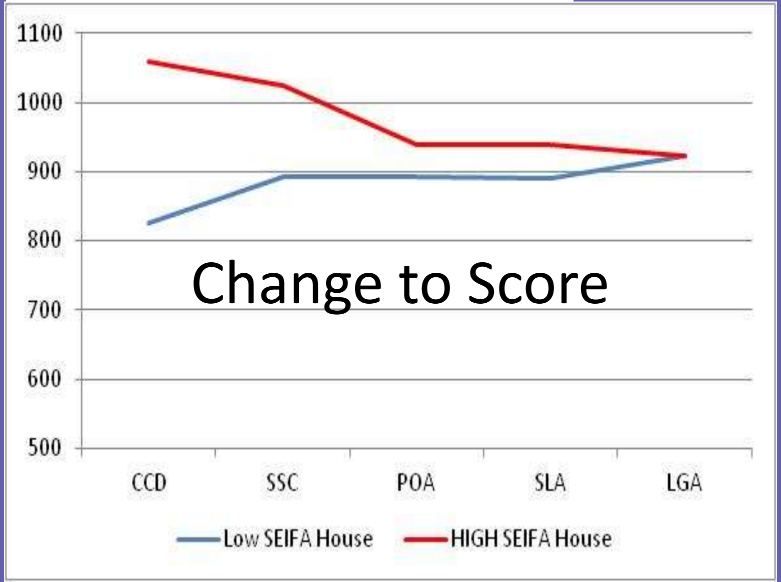
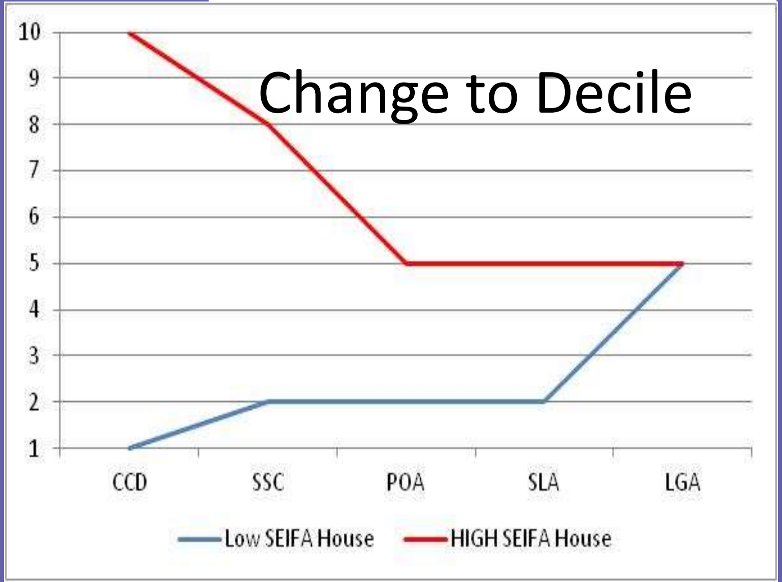
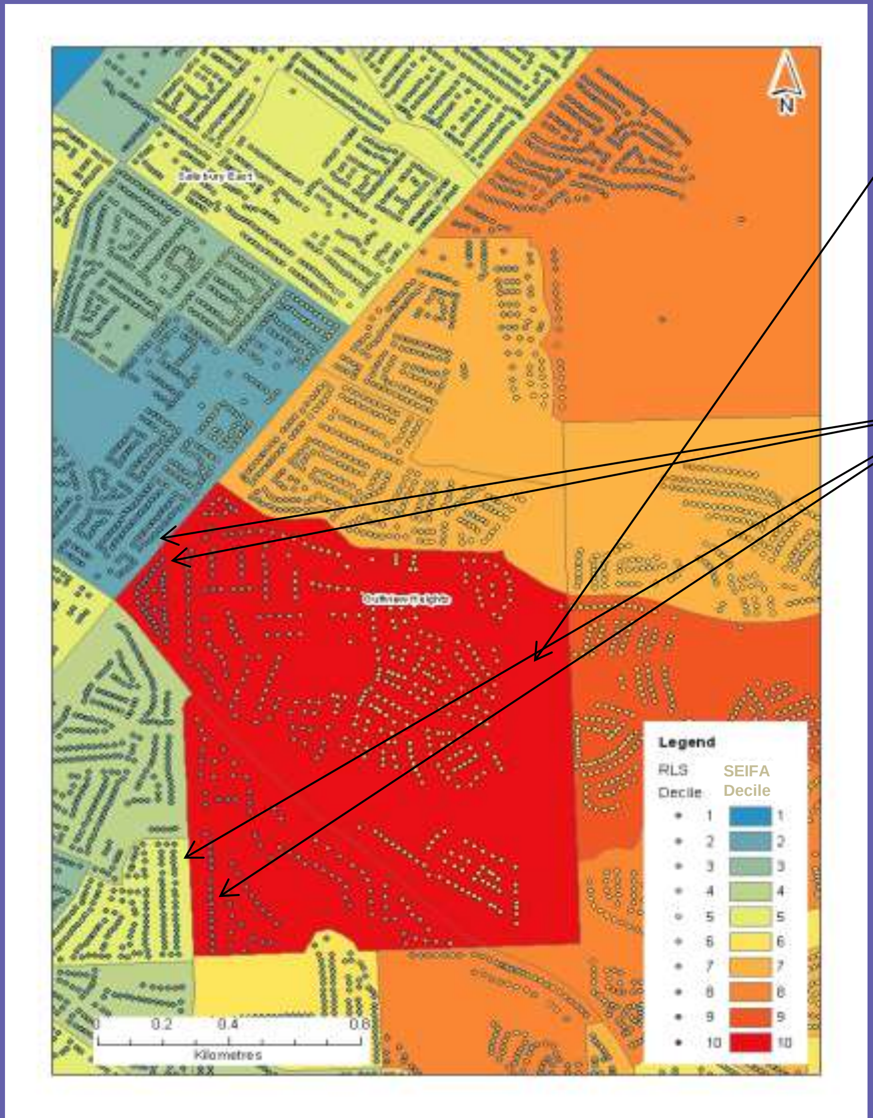




RLF: Within CD variation



- Spatial variation within the RED CD noted through the change in decile of the individual property scores
- More aligned with neighbouring CDs which may suggest CD boundaries are inappropriate SES boundaries

Utility of General Practice Data Capture and Spatial Analysis for Understanding COPD and Asthma

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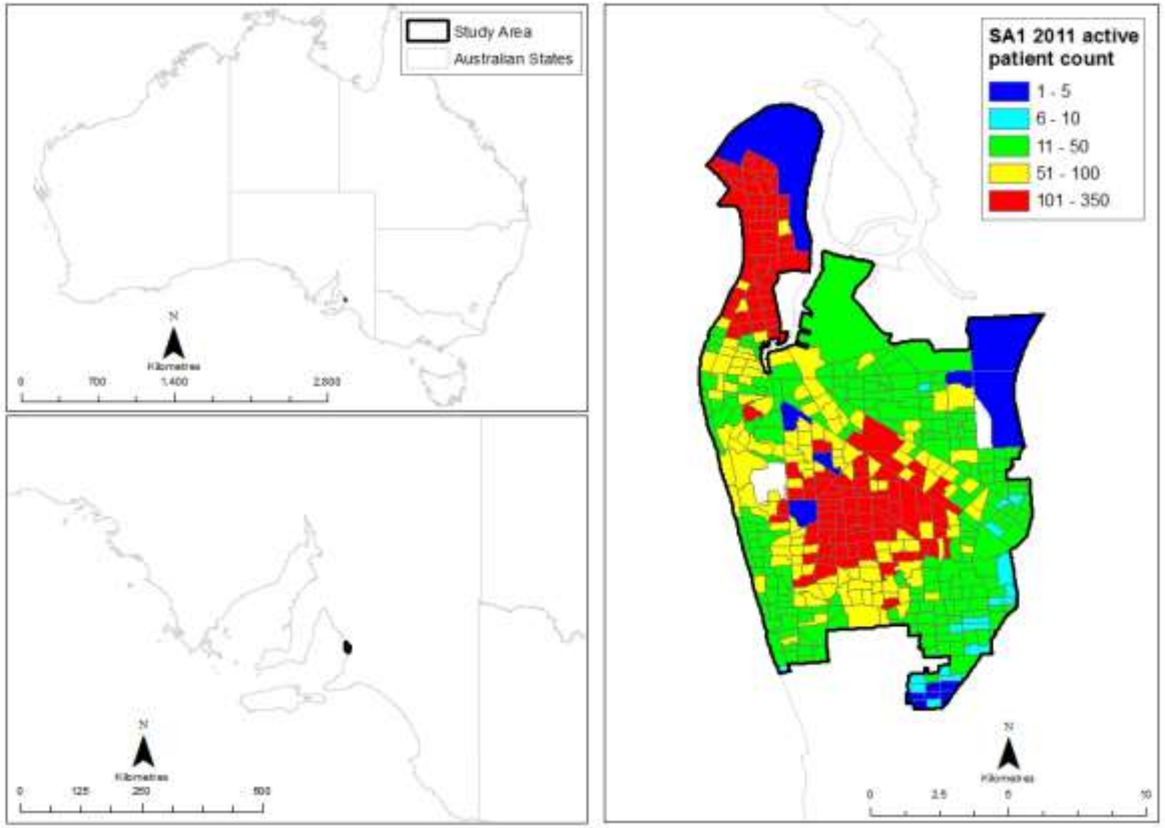
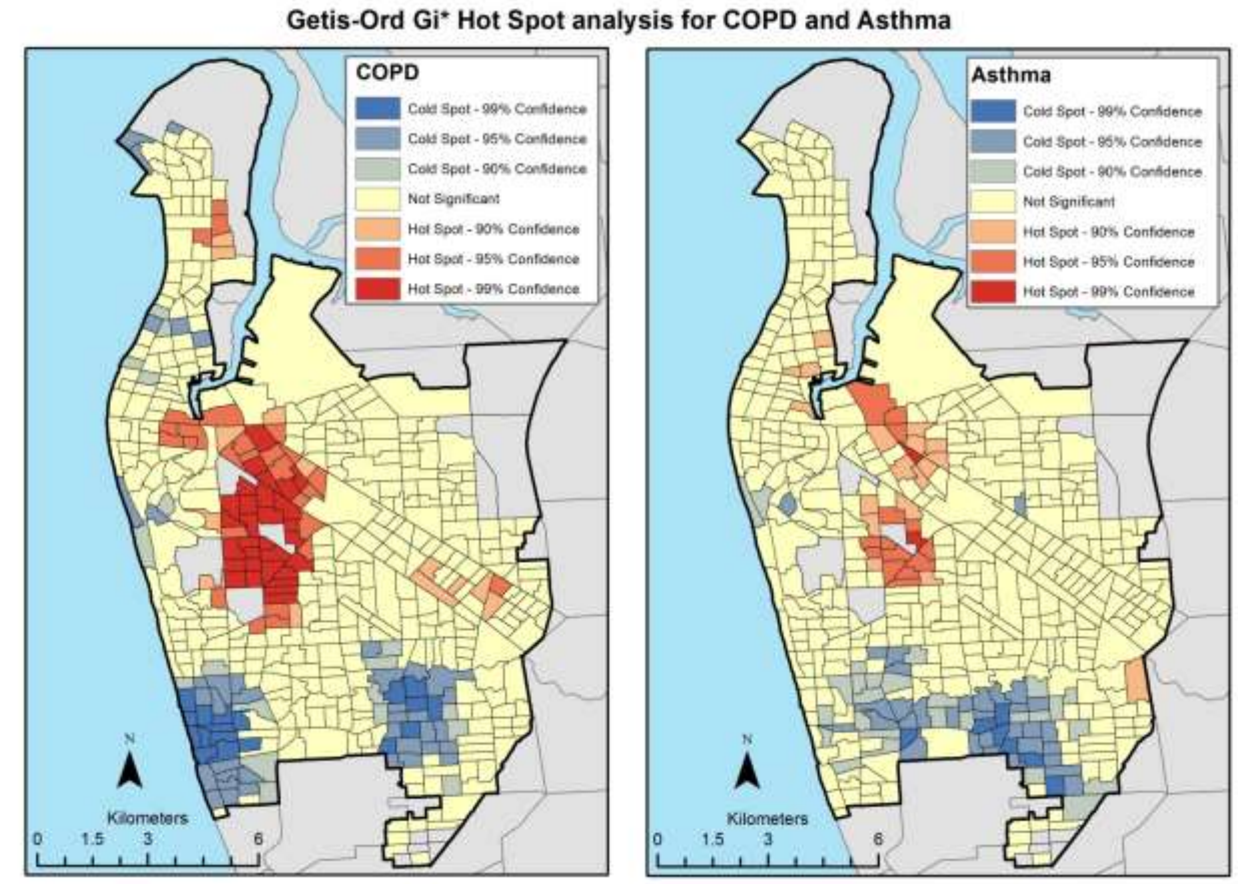
Prevalence and standardised incidence ratios of COPD by medical practice

	Active patients	Observed cases	Expected cases	Prevalence (=O/A*100%)	SIR (=O/E)
Practice 1	12,032	374	409	3.1	0.91
Practice 2	8,004	345	290	4.3	1.19
Practice 3	7,085	243	269	3.4	0.90
Practice 4	4,140	103	154	2.5	0.67
Practice 5	2,464	65	77	2.6	0.84
Total	33,725	1,130	1,228	3.4	0.92

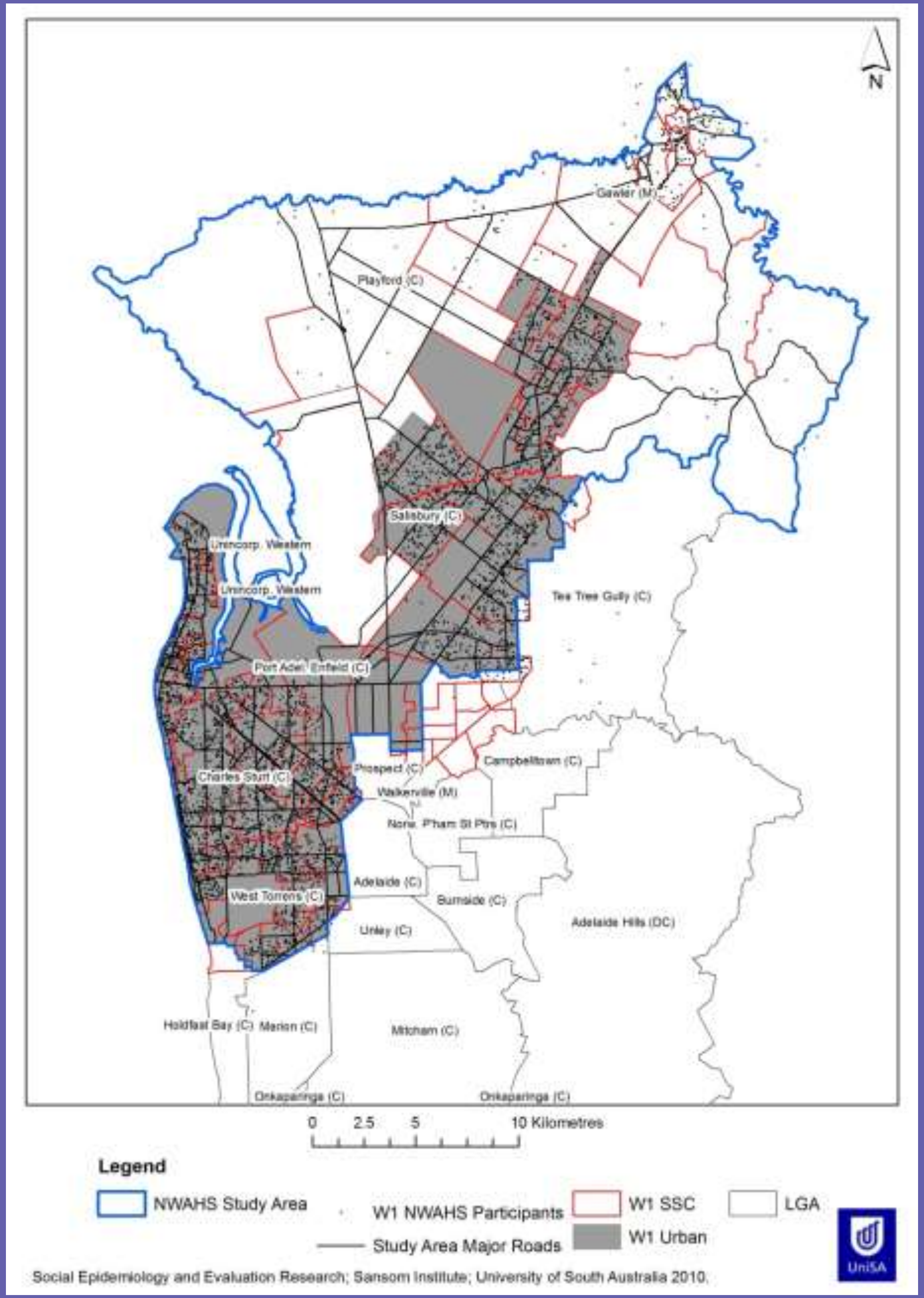
Multilevel logistic regression of active COPD

	Model 1					Model 2				
Covariates	Est.	SE	p		CI]	Est.	SE	p	[95%	CI]
Within-cluster										
Age	---	---	---	---	---	2.348	0.239	<0.0001	[1.880	2.816]
Age^2	---	---	---	---	---	-0.697	1.121	<0.0001	[-0.933	-0.461]
Male	---	---	---	---	---	0.522	0.077	<0.0001	[0.372	0.672]
Female	---	---	---	---	---	0.0	---	---	---	---
Smoker	---	---	---	---	---	2.477	0.116	<0.0001	[2.251	2.704]
Ex-smoker	---	---	---	---	---	1.522	0.093	<0.0001	[1.340	1.704]
Never smoked	---	---	---	---	---	0.0	---	---	---	---
Indigenous Australian	---	---	---	---	---	0.871	0.341	0.011	[0.203	1.540]
Non- Indigenous Australian	---	---	---	---	---	0.0	---	---	---	---
Unmarried	---	---	---	---	---	0.365	0.126	0.004	[0.118	0.613]
Married	---	---	---	---	---	0.0	---	---	---	---
N-Comorbidities	---	---	---	---	---	1.060	0.029	<0.0001	[1.004	1.117]
Between-cluster				---	---					
IRSD (Q4)	-1.280	0.171	<0.0001	[-1.614	-0.945]	-0.513	0.182	0.005	[-0.870	-0.155]
IRSD (Q3)	-0.712	0.114	<0.0001	[-0.936	-0.489]	-0.299	0.117	0.010	[-0.528	-0.071]
IRSD (Q2)	-0.358	0.083	<0.0001	[-0.520	-0.196]	-0.156	0.091	0.088	[-0.335	0.023]
IRSD (Q1)	0.0	---	---	---	---	0.0	---	---	---	---


Study Area
Australian States
SA1 2011 active patient count
1 - 5
6 - 10
11 - 50
51 - 100
101 - 350


Getis-Ord Gi* Hot Spot analysis for COPD and Asthma
COPD
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
Asthma
Cold Spot - 99% Confidence
Cold Spot - 95% Confidence
Cold Spot - 90% Confidence
Not Significant
Hot Spot - 90% Confidence
Hot Spot - 95% Confidence
Hot Spot - 99% Confidence
N
Kilometers
0 1.5 3 6

The North West Adelaide Health Study (NWAHS)



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- longitudinal population-based biomedical cohort
- three waves of data collected between 2000 and 2010.
- self-report socio-demographic and health data.
- clinic biomedical data and prescription medication.
- residential address used to geocode.
- ethics approval form the Human Research Ethics Committees of:
  - the University of South Australia;
  - the North West Adelaide Health Service: and
  - the South Australian Department of Health.

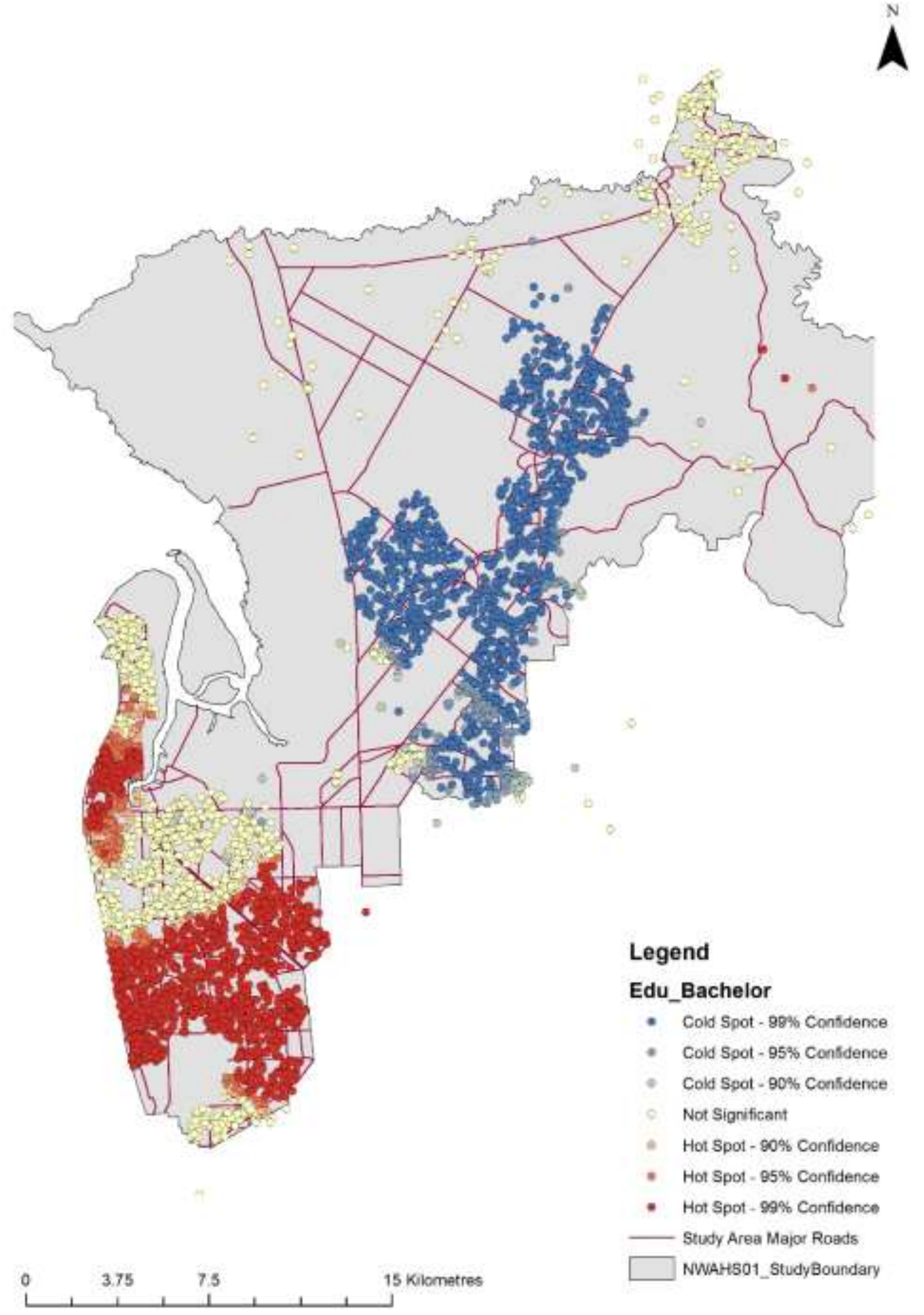
NWAHS Analysis

Natural breaks		RR	95% CI		P
Central Obesity* **	RLF: 3 v 1	0.89	0.83	0.95	0.0004
	RLF: 2 v 1	0.93	0.89	0.98	0.0033
Hypertriglyceridemia* **	RLF: 3 v 1	0.79	0.70	0.90	0.0005
	RLF: 2 v 1	0.90	0.82	0.98	0.0173
Reduced HDL#	RLF: 3 v 1	0.79	0.67	0.92	0.0025
	RLF: 2 v 1	0.87	0.78	0.97	0.0159
Hypertension* **	RLF: 3 v 1	0.94	0.88	1.01	0.0824
	RLF: 2 v 1	0.90	0.85	0.95	<.0001
Diabetic\diabetes Risk* **	RLF: 3 v 1	0.52	0.43	0.64	<.0001
	RLF: 2 v 1	0.79	0.70	0.89	<.0001
High LDL^	RLF: 3 v 1	0.95	0.77	1.17	0.6277
	RLF: 2 v 1	1.05	0.90	1.23	0.5399
CMR Score* **	RLF: 3 v 1	0.81	0.76	0.86	<.0001
	RLF: 2 v 1	0.91	0.86	0.95	<.0001

Gender, Age and Bachelor Education were included in all models.
*** Gender, Age and Bachelor Education Significant.
# Gender Significant.
^ Age Significant.

- Wave 1 NWAHS, 2001, n=3585
- Factors - Log binomial generalized linear models
- CMR score - Poisson regression
- Parameter estimates exponentiated - relative risk (RR)
- Accounted for age, gender and education (no university degree)
- Statistical significance was set at alpha = 0.05
- Statistically significant relationship between RLF & CMR score all but one of the risk factors.
- Participants in the advantaged and intermediate group had a lower risk for CMD.
- CMR score RR for the most advantaged was 19% lower (RR = 0.81; CI 0.76-0.86; p <0.0001) and the middle group was 9% lower (RR = 0.91; CI 0.86-0.95; p <0.0001) than the least advantaged group.

Coffee et al. International Journal of Health Geographics 2013, http://www.ij-healthgeographics.com/content/12/1/22



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Health & Place

journal homepage: www.elsevier.com/locate/healthplace

Is walkability associated with a lower cardiometabolic risk?

Neil T. Coffee [a,b,*], Natasha Howard [a], Catherine Paquet [a,c], Graeme Hugo [b], Mark Daniel [a,d]

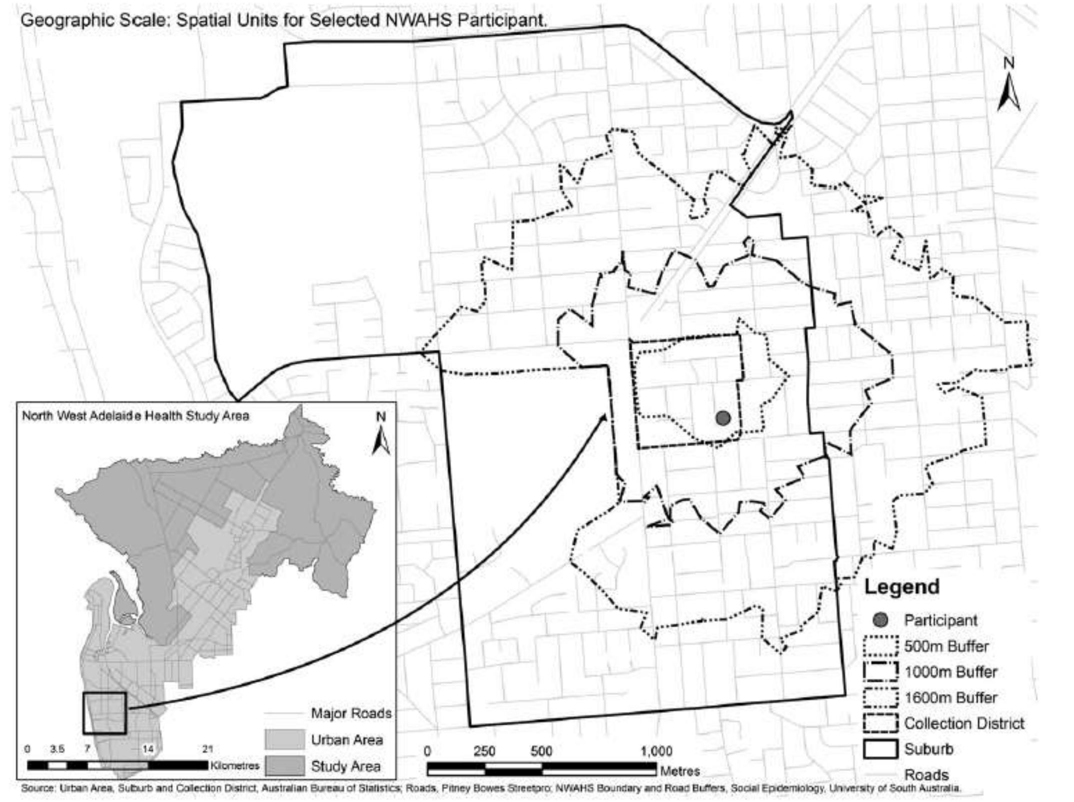

Fig. 2. Geographic scale variation, selected NWAHS participant.

Table 3
Parameter estimates for associations between cardiometabolic risk score and spatial unit walkability score ($n=3593$)[a].

Walkability score	RR	95% CI		P
500 m road buffer	0.97	0.94	1.00	0.04
1000 m road buffer	0.94	0.91	0.98	0.002
1600 m road buffer	0.94	0.90	0.97	< 0.001
Collection district	0.98	0.94	1.03	0.47
derived suburb	0.97	0.91	1.04	0.37

[a] Adjusted for individual gender, age (< 55 or ≥ 55), education (no university or university degree), weekly income (0–19,999; 20,000–59,999, > 60,000) and suburb weekly median household income.

Lower CMR score was associated with higher WI for the three road buffer representations of the built environment with a three per cent reduction in relative risk for the 500 m road buffer, and six per cent for the 1000 m and 1600 m road buffers. No statistical relationship was found for either of the two predetermined administrative spatial unit. These results indicate that the choice of spatial unit used and its scale influence the nature of relationships estimated between the built environment and clinical risk factors.

Location Data

- Dwelling density
- Destination choice
- Road system
  - connectivity/accessibility/barriers
  - Main road exposure/traffic/noise
- Open space/Greenspace/Parks/Sport and recreation
- Crime and Safety
- Food environment
  - Unhealthy
  - Healthy
- Topography
- Service and facility locations

Health Data

- Hard health outcomes difficult to access at a spatial scale that is meaningful
- Confidentiality problems
- We have the technology but generally lack the access to data
- Data available for administrative units that are not meaningful!
- MAUP issues

Measures

- Counts
- Distance
- Density
- Access
- Index
- Ratio

Data Issues

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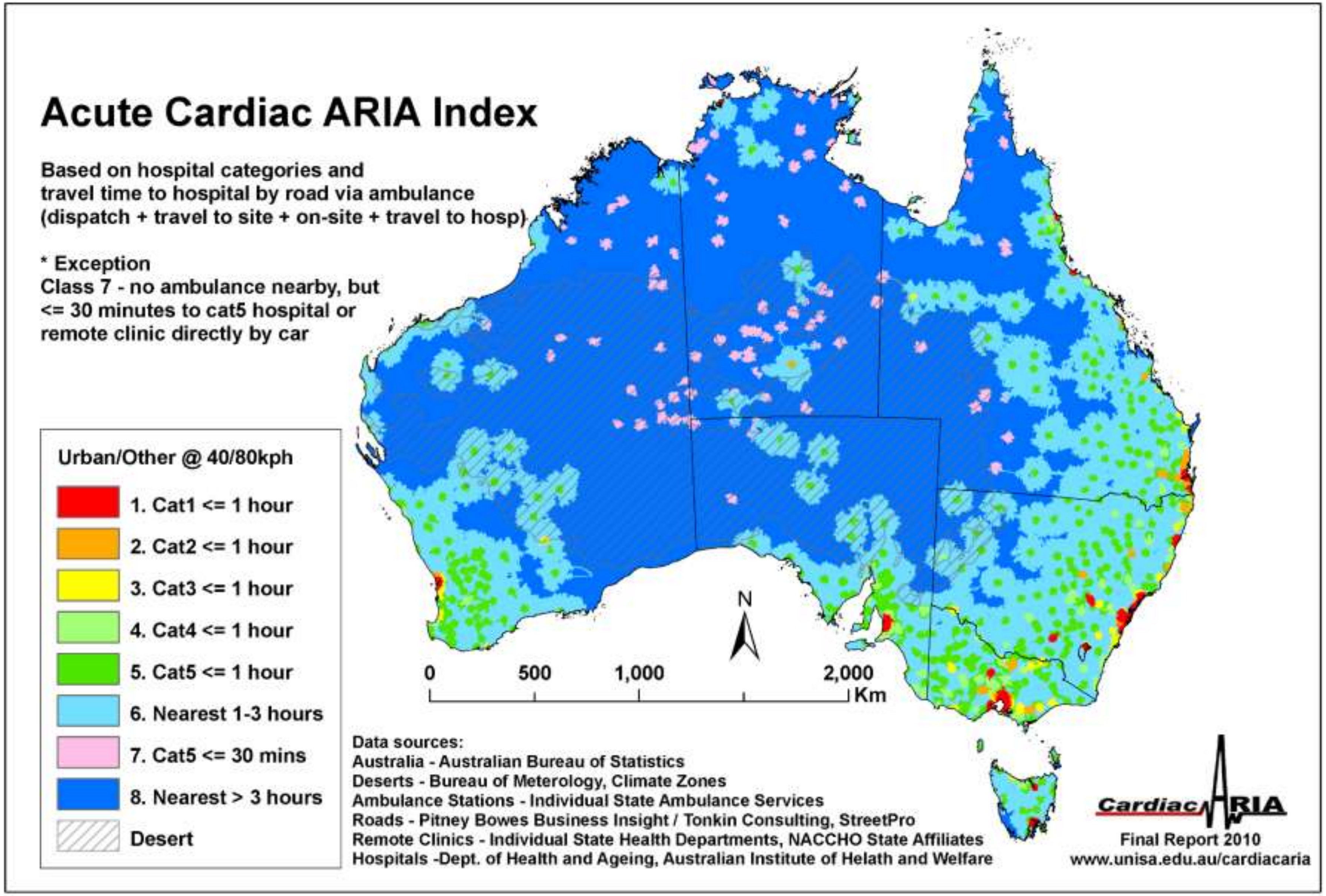
- Confidentiality
- Data linkage costs
- Large spatial units that mask spatial variation
- Poor quality data especially address data
- Enormous cost and time to geocode health data
- Apart from these issues – it is very difficult to get data for research



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Example: Geocoding

N=572,496

Category	Number	Remark
Actual XY	453674 (79.2%)	Exact match found (or almost exact where unit/flat/appt number wasn't found)
SA2	7009 (1.2%)	
Review	8963 (1.6%)	Manual clerical review needed to classify as XY, SA1, SA2 or reject
Unclassified	102009 (17.8%)	Not enough information to be geocoded at XY/SA1 level; SA2 codes could be generated where locality and postcode were known; some could still be worth cleaning for future geocoding
Reject	841 (0.1%)	No match possible

New Projects

- Signing a $2.7m collaboration with the Dasman Diabetes Institute to build Geohealth infrastructure, capability and conduct research
- Developing a MOU with ESRI to build a GeoHealth Hub at University of Canberra
- Starting a Graduate Certificate in GeoSpatial Health Semester 2 at UC
- Delivery of Graduate Certificate in GeoSpatial Health in Kuwait starting October 2018

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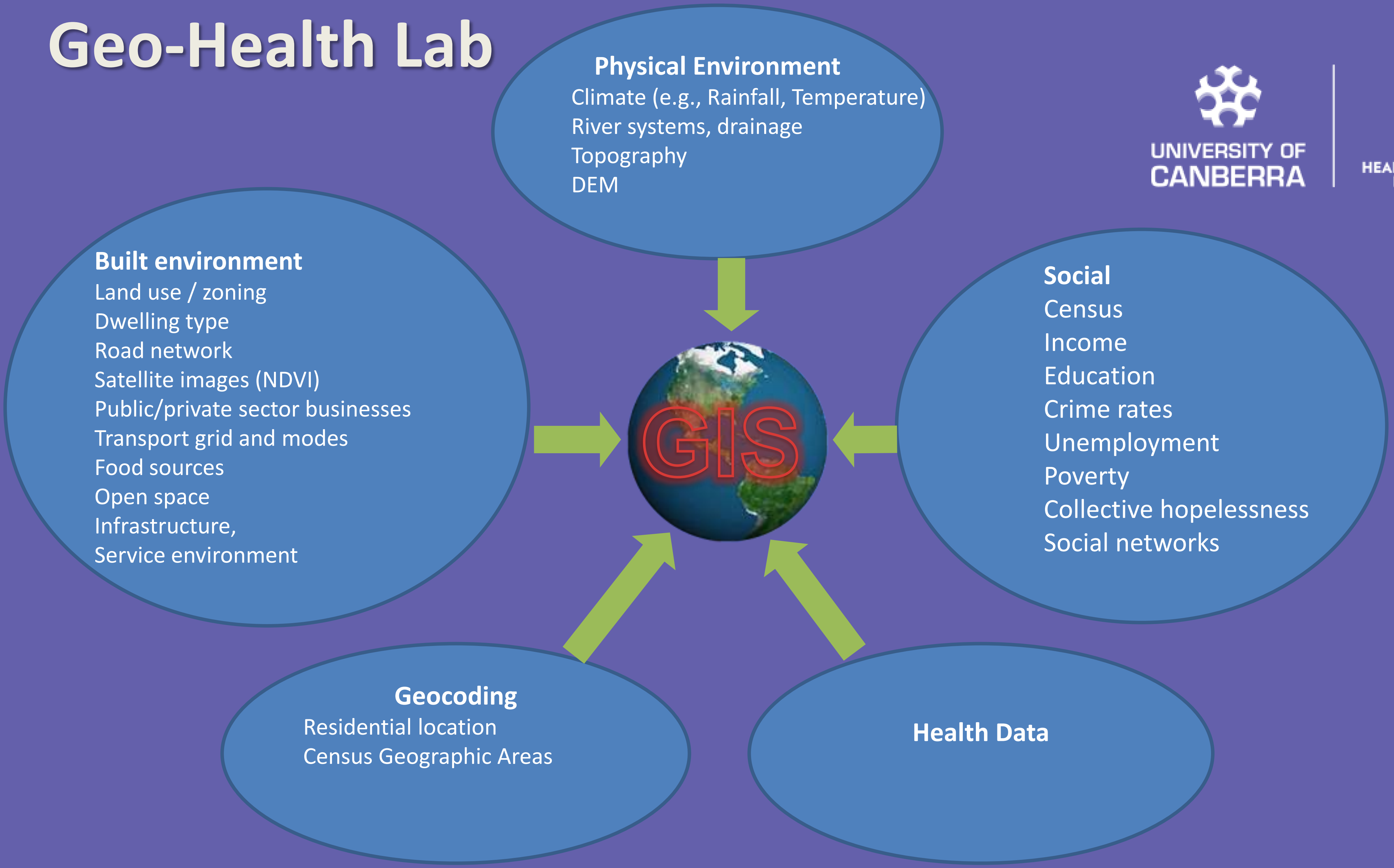

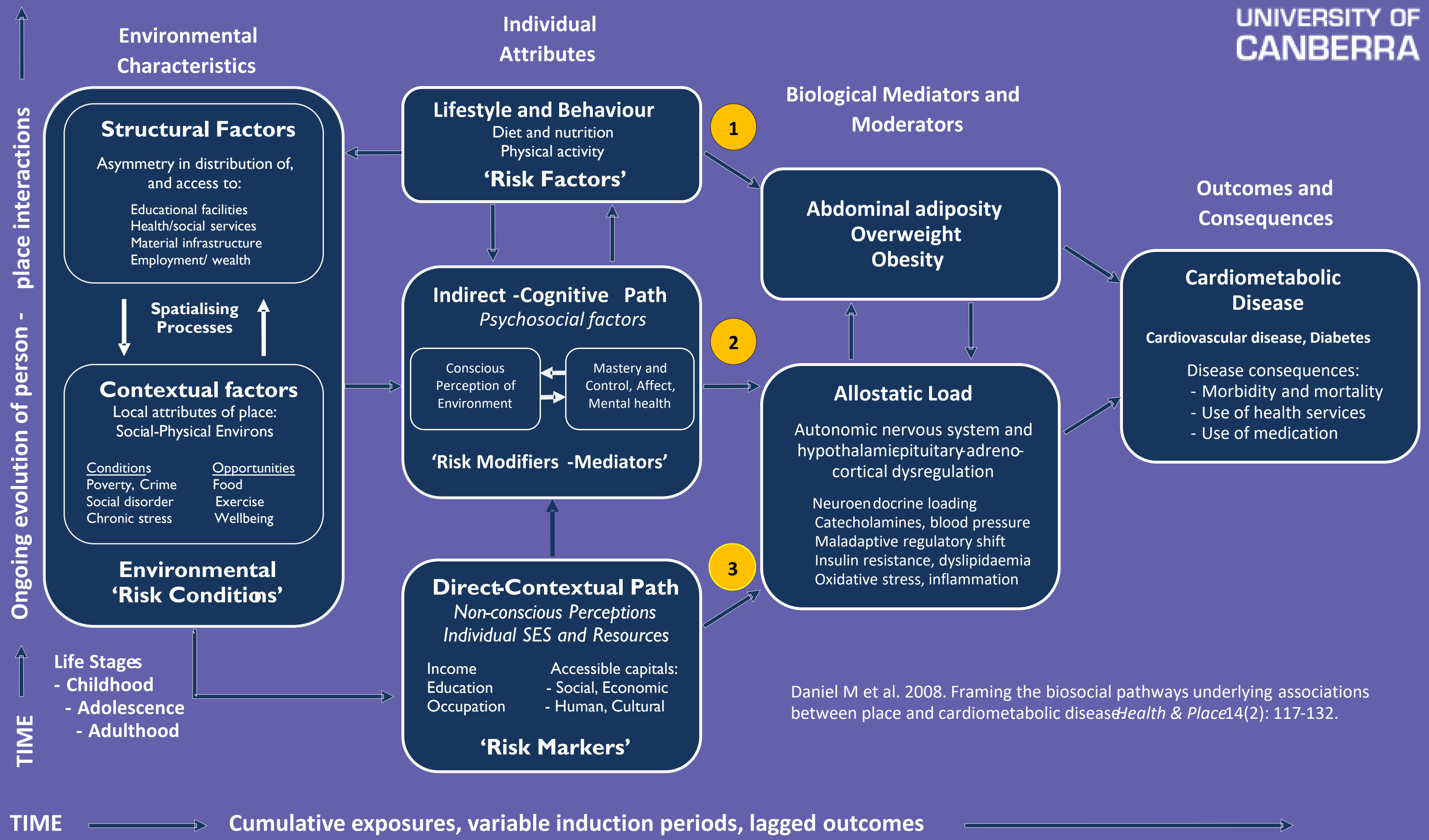

Daniel M et al. 2008. Framing the biosocial pathways underlying associations between place and cardiometabolic disease. *Health & Place* 14(2): 117-132.

Health & Place 28 (2014) 173–176
Contents lists available at ScienceDirect
Health & Place
journal homepage: www.elsevier.com/locate/healthplace

Short Report

Food environment, walkability, and public open spaces are associated with incident development of cardio-metabolic risk factors in a biomedical cohort

Catherine Paquet[a,b,*], Neil T. Coffee[a], Matthew T. Haren[a], Natasha J. Howard[a], Robert J. Adams[c], Anne W. Taylor[d], Mark Daniel[a,e,f,g]

Health & Place 21 (2013) 163–169
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Is walkability associated with a lower cardiometabolic risk?

Neil T. Coffee[a,b,*], Natasha Howard[a], Catherine Paquet[a,c], Graeme Hugo[b], Mark Daniel[a,d]

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ABSTRACT

Walkability of residential environments has been associated with more walking. Given the health benefits of walking, it is expected that people living in locations with higher measured walkability should have a lower risk of cardiometabolic diseases. This study tested the hypothesis that higher walkability was associated with a lower cardiometabolic risk (CMR) for two administrative spatial units and three road buffers. Data were from the North West Adelaide Health Study first wave of data

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Fast-food exposure around schools in urban Adelaide

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International Journal of Environmental Research and Public Health
MDPI

Article

Does Physical Activity Mediate the Associations between Local-Area Descriptive Norms, Built Environment Walkability, and Glycosylated Hemoglobin?

Suzanne J. Carroll[1,2,*], Theo Niyonsenga[1,2], Neil T. Coffee[1,2], Anne W. Taylor[3] and Mark Daniel[1,2,4]

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Routledge
Taylor & Francis Group

Validating and measuring public open space is not a walk in the park

Mark Daker[a,b], Johannes Pieters[a] and Neil T. Coffee[b]
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ABSTRACT
Despite the widespread application of public open space (POS) in urban planning and health research, defining POS and the subsequent measurement remains an issue. Coupled with the issue of definition is the choice of data set, as the data accuracy can influence the research results. The interpretation of an analysis depends on the intended outcome and the data definition and accuracy. This research used GIS and aerial imagery to develop a validated public open space (VPOS) data set for Metropolitan Adelaide and tested this against two publicly available POS data sets, the MapInfo® StreetPro Park data and Australian Bureau of Statistics (ABS) Meshblock. The 4 ha of open space per 1000 population standard was calculated for three administrative spatial units (local government areas, postcodes and suburbs). The number of spatial units that met or did not meet the standard was calculated and the VPOS data were taken as the data standard.
For local governments areas most met the standard. For the postcodes and suburbs, the ABS Meshblock under reported and the Parks data over reported. The results varied depending on the spatial unit and choice of data and this demonstrated the importance of the choice of data set and spatial unit.

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Public open space; GIS; strategic planning; built environment; modifiable areal unit problem

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BMC Public Health

RESEARCH ARTICLE Open Access

Local descriptive body weight and dietary norms, food availability, and 10-year change in glycosylated haemoglobin in an Australian population-based biomedical cohort

Suzanne J. Carroll[1*], Catherine Paquet[1,2], Natasha J. Howard[1], Neil T. Coffee[1], Robert J. Adams[3], Anne W. Taylor[3], Theo Niyonsenga[1] and Mark Daniel[1,4,5]

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Local descriptive norms for overweight/obesity and physical inactivity, features of the built environment, and 10-year change in glycosylated haemoglobin in an Australian population-based biomedical cohort

Suzanne J. Carroll [a,*], Catherine Paquet [a,b], Natasha J. Howard [a], Neil T. Coffee [a], Anne W. Taylor [c], Theo Niyonsenga [a], Mark Daniel [a,d,e]

International Journal of Environmental Research and Public Health
MDPI
Article

Neighbourhood Environmental Attributes Associated with Walking in South Australian Adults: Differences between Urban and Rural Areas

Narelle M. Berry [1,*], Neil T. Coffee [2], Rebecca Nolan [3], James Dollman [4] and Takemi Sugiyama [5]

Preventive Medicine 93 (2016) 39–45
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Preventive Medicine
journal homepage: www.elsevier.com/locate/ypmed

Residential proximity to urban centres, local-area walkability and change in waist circumference among Australian adults

Takemi Sugiyama [a,b,c,*], Theo Niyonsenga [b], Natasha J Howard [b], Neil T Coffee [b], Catherine Paquet [b,d], Anne W Taylor [e], Mark Daniel [b,f,g]

Landscape and Urban Planning
Volume 118, October 2013, Pages 70-78

Are accessibility and characteristics of public open spaces associated with a better cardiometabolic health?

Catherine Paquet [a,b,g], Thomas P. Orschulok [c,g], Neil T. Coffee [a,g], Natasha J. Howard [a,g], Graeme Hugo [d], Anne W. Taylor [e], Robert J. Adams [e], Mark Daniel [a,f,g]

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Obesity Research & Clinical Practice
Volume 8, Supplement 1, December 2014, Page 15

88

Contributions of local-area fast-food availability and area-based weight and dietary norms to 10-year change in cardiometabolic risk

Suzanne J. Carroll [1], Catherine Paquet [1,2], Natasha J. Howard [1], Neil T. Coffee [1], Robert Adams [3], Anne W. Taylor [3], Theo Niyonsenga [1], Mark Daniel [1,4,5]

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Special Issue Articles

Visualising 30 Years of Population Density Change in Australia's Major Capital Cities

Neil T. Coffee, Jarrod Lange & Emma Baker

Pages 511-525 | Published online: 16 Sep 2016
Download citation https://doi.org/10.1080/00049182.2016.1220901

Health & Place
Volume 13, Issue 1, March 2007, Pages 111-122

Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes

Eva Leslie [a], Neil Coffee [b], Lawrence Frank [c], Neville Owen [d], Adrian Bauman [e], Graeme Hugo [b]

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https://doi.org/10.1016/j.healthplace.2005.11.001 Get rights and content

Circulation
American Heart Association

Application of Geographic Modeling Techniques to Quantify Spatial Access to Health Services Before and After an Acute Cardiac Event: The Cardiac ARIA Project

Robyn A. Clark, Neil Coffee, Dorothy Turner, Kerena A. Eckert, Deborah van Gaans, David Wilkinson, Simon Stewart and Andrew M. Tonkin

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Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

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Conclusions

- We can do great things (with access to data!!!)
- Partner with health agencies to gain confidence
- We do not do this to embarrass anyone, but to improve population health
- Spatial industry has data providers, software and applied (users)
- I am not a young professional – but still believe in "not giving up" (especially around data access!!!)

Thank You

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Questions

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