Spatial epidemiology of sports and recreational injuries

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Introduction

My research study focuses on investigating:

- What is the ***spatial pattern*** of sport and recreational injuries and ***spatial relationship*** with associated external factors ?

Overview of sport/rec injuries

- Sport/rec activities includes team sport, individual sport, exercise and non-organised physical activity (Eime et al, 2013)
- In Australia, ~ ***80%*** of the adult population participate in sport/rec activities (ERASS 2010)
- An estimated ***5%*** of participants sustain an injury in two week period (Finch et al, 2006)
- ***No significant decline*** in overall injury rate over five years in New South Wales (Finch et al, 2011)
- Cost of sport/rec injuries is estimated to be at around ***$1.8 billion*** per annum (State Government Victoria, 2013)

Overview of sport/rec injuries

- In Victoria, 30,000 emergency department presentations, 6,500 hospital admissions and 5 deaths every year (Victorian Injury Surveillance & Applied Research System)
- Estimated annual ***growth of 6%*** in emergency department presentations (State Government Victoria, 2013)
- Hospitalised major trauma (9.7%) from sports activity accounted more cases than workplace traumas (9.3%) in the period 2006-2007 (Andrew et al 2012)
- Strong evidence that sport/rec injuries are a significant burden to individual and to society

Sport/rec injury prevention

- Injuries can be prevented by identifying ***their causes*** and removing these, or reducing people's exposure to them

- ***Internal or immediate factors*** such as equipment, training-related behaviour

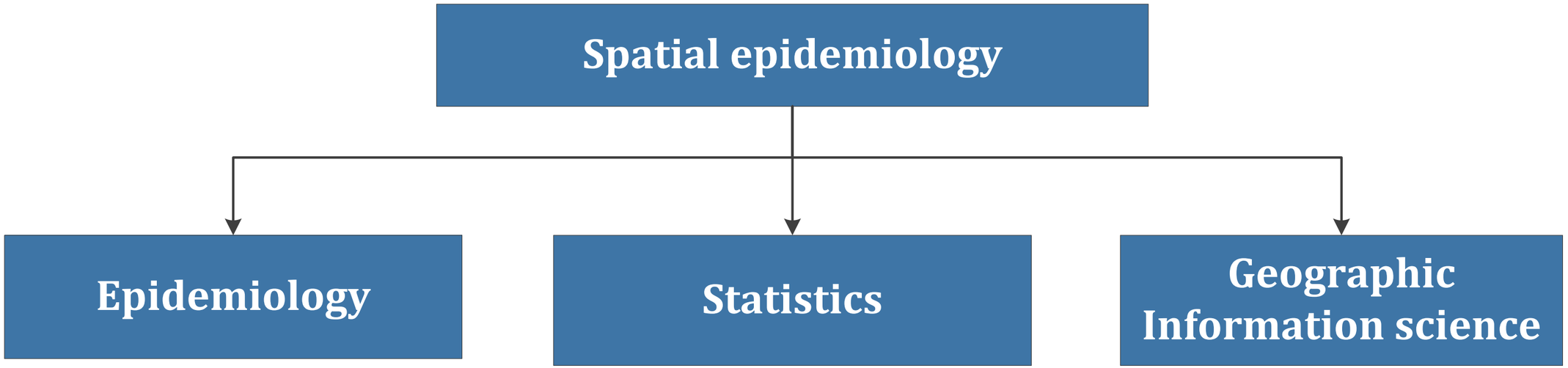
- ***External factors*** such as social, economic, environmental

Sport/rec injury and external factors

- Higher incidence of
    - Sport/rec injuries in ***social disadvantage and rural areas*** (Cassell et al 2003 ,Finch et al 2009)
    - Injuries in rugby during ***warm or dry conditions*** (Orchard 2002, Gabbett et al 2007).
    - ***Heat*** related hospitalizations in sports such as running, cricket and golf (Finch et al 2008)
- ***Spatial epidemiology*** is the approach to better understand this relationship

Spatial epidemiology

Study of the geographical distribution of incidence of disease or injury in relation to demographic, environmental, behavioural, socioeconomic, genetic and infectious risk factors.



Spatial epidemiology

A map by Dr John Snow to investigate the cause of the 1854 cholera outbreak in the London district of Soho

- Map showed some evidence of clustering of cholera deaths around Broad Street
- Overlaid the map of water pumps
- Discovered that the cases were concentrated around the pump on Broad Street

Why spatial epidemiology?

Tabular view of two datasets

Participant	Injury outcome
A	Yes
B	No
C	Yes
D	N/A
E	No
F	Yes
G	N/A
H	No
I	N/A

Participant	Injury outcome
A	Yes
B	No
C	Yes
D	N/A
E	No
F	Yes
G	N/A
H	No
I	N/A

Why spatial epidemiology?

Statistical view of two datasets

Injury outcome	Frequency
Yes	3
No	3
N/A	3

Injury outcome	Frequency
Yes	3
No	3
N/A	3

Why spatial epidemiology?

Spatial view

Yes	No	Yes
No	N/A	N/A
N/A	Yes	No

Yes	No	N/A
Yes	No	N/A
Yes	No	N/A

Geographic Information System

Combination of cartographic tools and spatial statistical methods for the management, analysis and presentation of spatial data.

- Georeferencing or geocoding
- Visualisation
- Exploratory data analysis
- Geographic/spatial analysis

ESRI ArcGIS, GRASS GIS, QGIS

Summary

Spatial epidemiology: A study of a spatial pattern in relation to range of factors

Geospatial methods: Methods used in spatial epidemiological studies

Geographic Information System: Tool used for geospatial analysis

Overview of PhD

Stage 1: Summary of geospatial methods

Stage 2: Identify potential sport/rec injury data sources

Stage 3: Mapping of sport/rec injuries

Stage 4: Sport/rec injuries in relation to external factors

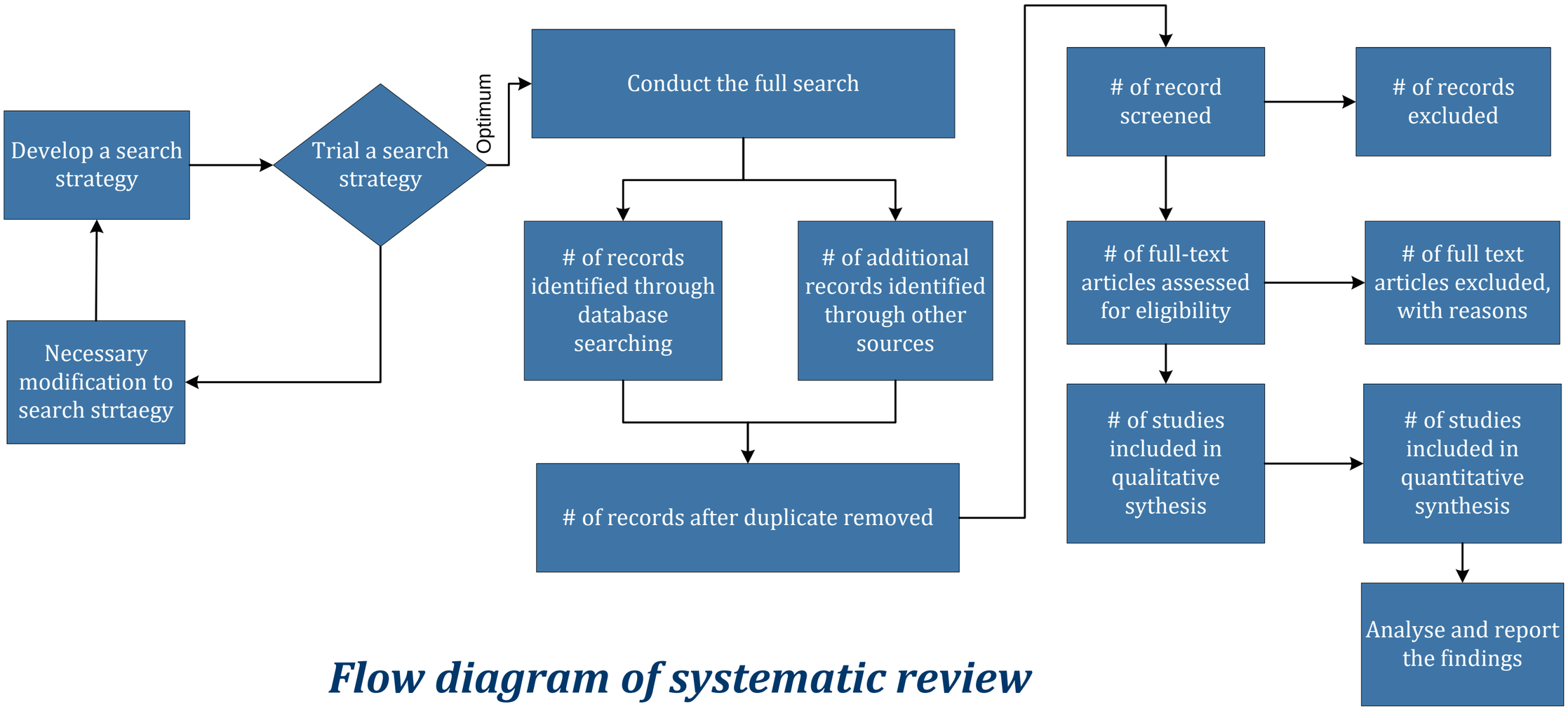
Stage 5: Sport injuries in relation to sports delivery factors

Stage 6: Atlas of Sports and Recreational Injuries (ASRI)

Stage 1: Summary of geospatial methods

- What ***categories of injuries*** have been analysed using geospatial methods?
- What ***methods*** have been used in those analyses and what was the ***justification*** for using them?
- What ***social/environmental factors*** have been analysed in relation to the spatial distribution of injures?

Stage 1: Summary of geospatial methods



Flow diagram of systematic review

Stage 1: Summary of geospatial methods

PRISMA (Preferred Reporting Items for System Reviews and Meta-Analyses) guidelines (Liberati, 2009).

Inclusion Criteria

- ***Reported map or at least one geospatial method is used for analysis***
- Acute injuries and trauma
- Population level studies
- Unintentional injuries
- Full original research paper
- English language and human injuries

Exclusion Criteria

- Suicides and social harm
- Injuries from natural disasters or war

Databases

- PubMed
- Science Direct
- Web of Science

Stage 1: Summary of geospatial methods

Category of injury	*Number of studies*
Road traffic	XX
Burn	X

Type of study	*Number of studies*
Mapping	X
Cluster detection	X
Modelling	X

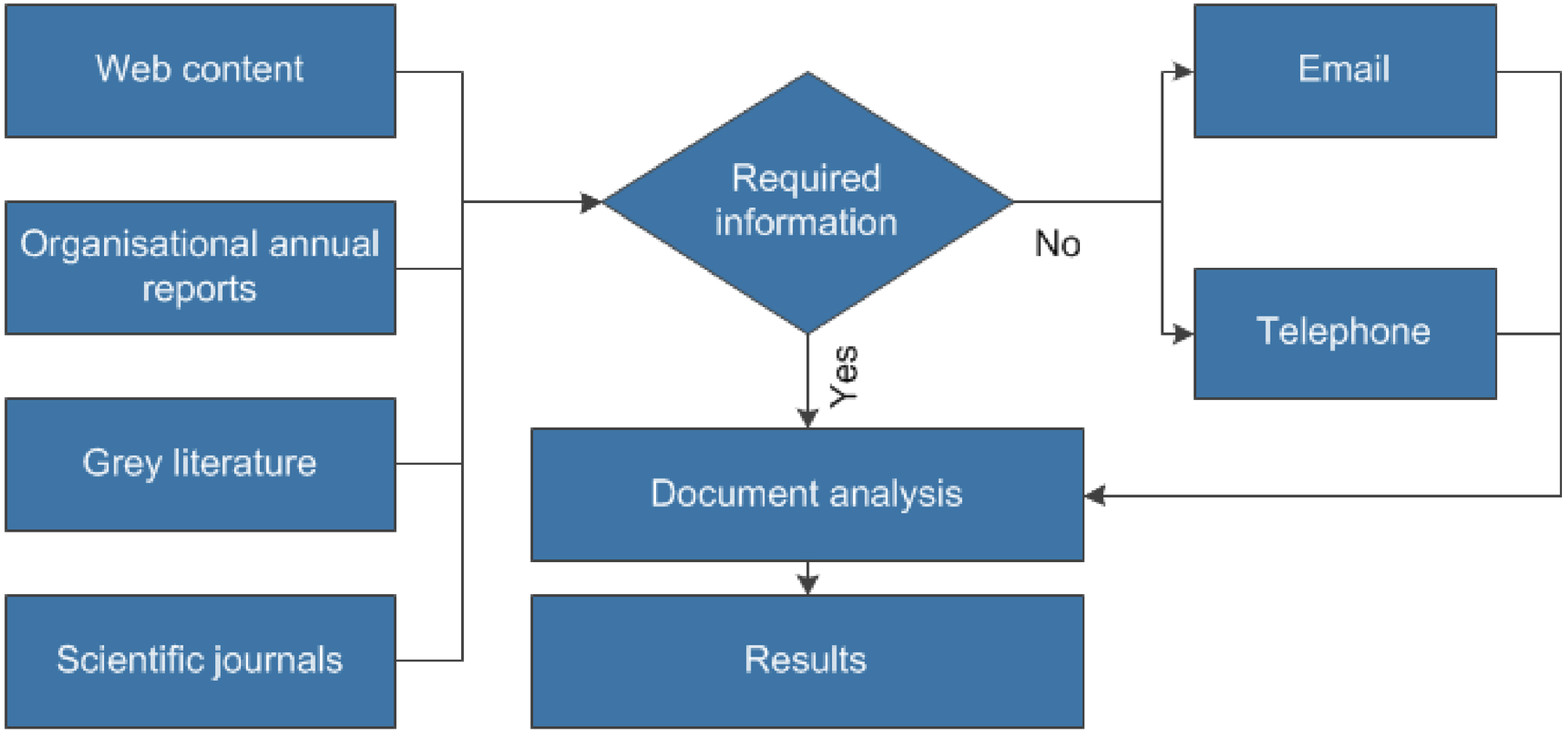
Authors (date)	*Injury type*	*Methods*	*Spatial resolution*	*Variables*	*Software*	*Justification for selection*	*Limitations reported*

Stage 2: Identify potential sport/rec injury data sources

1. What are the ***potential sources*** of sports injury data in Victoria?

2. What ***coverage, opportunities*** and ***limitations*** do the data offer for injury prevention research?

Stage 2: Identify potential sport/rec injury data sources



Document analysis, organized way of reviewing and evaluating printed and electronic documents (Bowen, 2009)

Stage 2: Identify potential sport/rec injury data sources

Data collection	*Administrative agency*	*Injury type*	*Injury Classification System*	*Description*	*Time frame*	*Sport/recreational injuries identification criteria*
Victorian Admitted Episodes Datasets (VAED)	Victorian injury Surveillance Unit (VISU)	Non-fatal	ICD-10-AM	hospital admission from external cause	Public hospitals from 1987/88-2010/11 Private hospitals from 1994/95-2010/11	ICD-10-AM Activity (U50-U72)

Data items	*ABS-Death unit record*	*Victorian Admitted Episodes Datasets (VAED)*	*Victorian Emergency Minimum Datasets (VEMD)*	*Data source 3*	*Data source 4*
Age or Age group	Yes	Yes	Yes	No	Unidentified

Stage 3: Mapping of sport/rec injuries

1. How are sport/rec injuries ***geographically distributed*** by specific sport, age groups, and gender across Victoria?

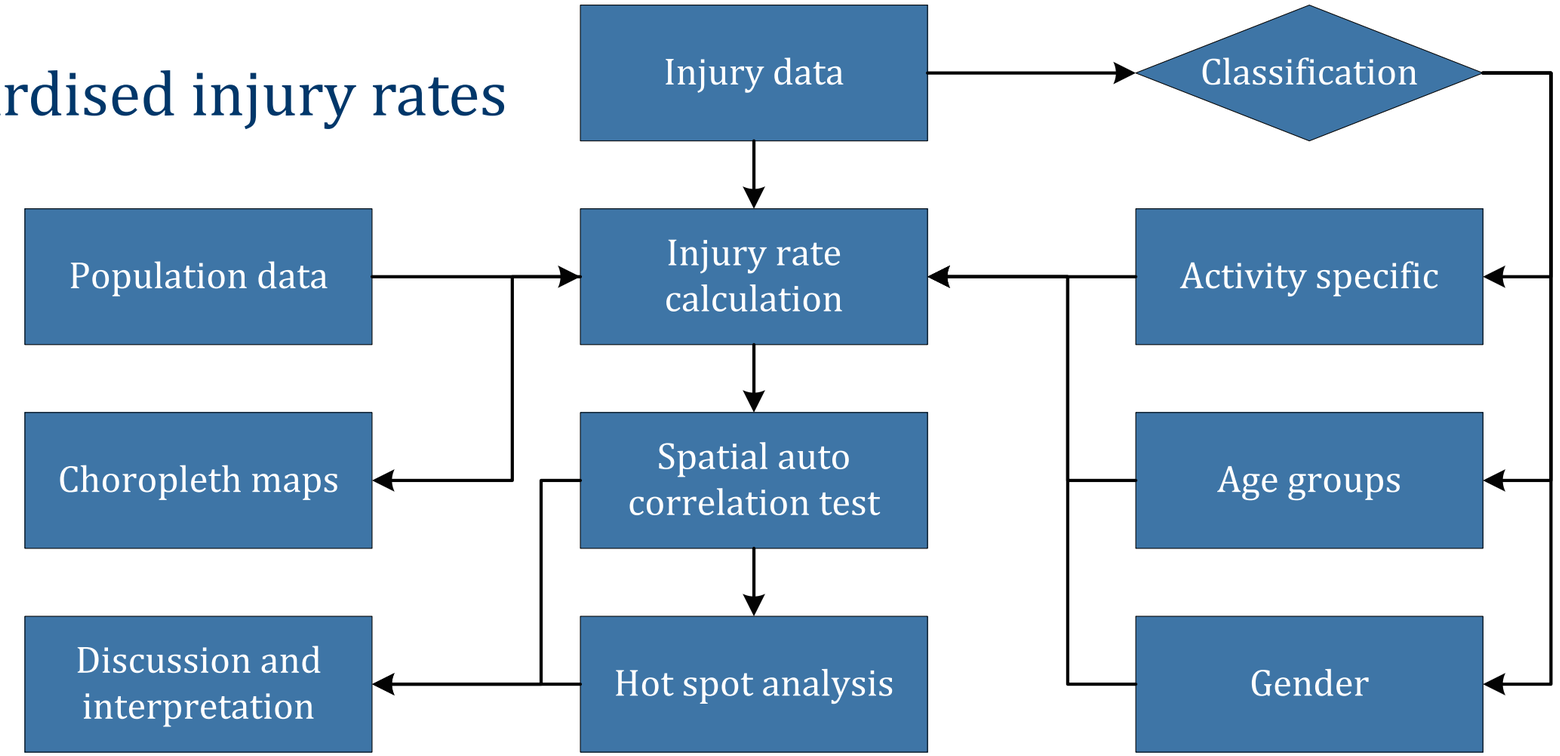
2. What are the ***hotspot areas*** for the targeting of potential injury prevention programs?

Stage 3: Mapping of sport/rec injuries

*Injury rate per 100,000 = (Average frequency/population)*100,000*

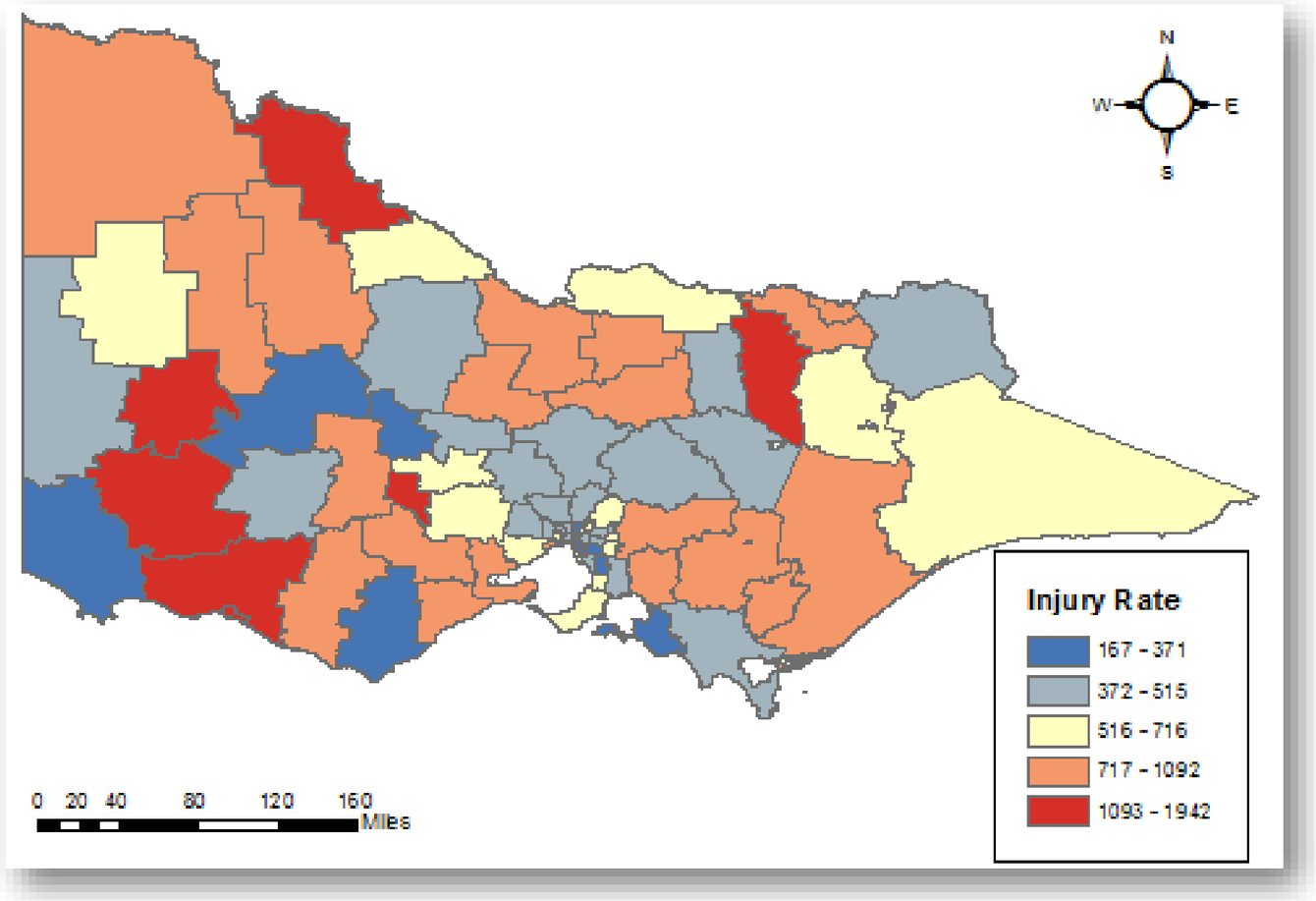
Choropleth maps of standardised injury rates

- Overall injury rate
- Gender
- Age groups
- Activity specific



Stage 3: Mapping of sport/rec injuries

Choropleth map

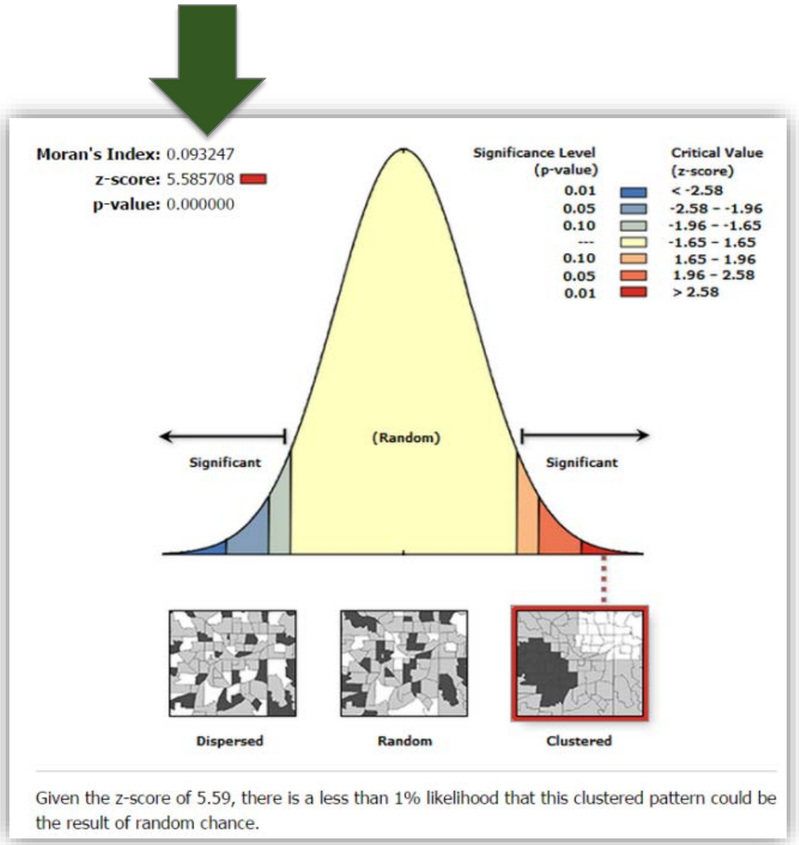


Stage 3: Mapping of sport/rec injuries

Moran's I, test for spatial autocorrelation

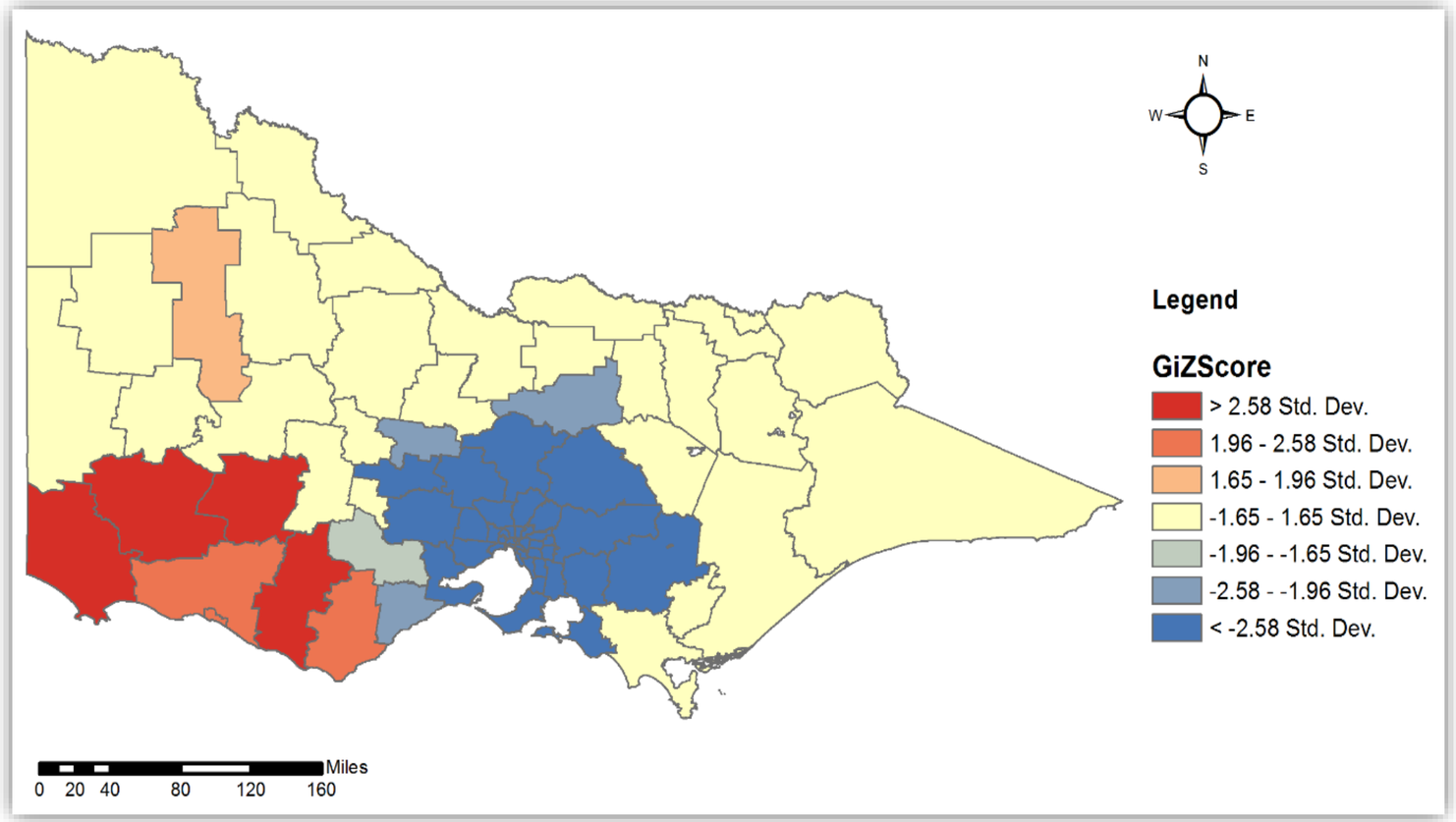
Value range from -1 to 1

- I < 0, negative spatial autocorrelation, dispersed pattern
- I = 0, no spatial autocorrelation, random pattern
- I > 0, positive spatial autocorrelation, clustered pattern



Stage 3: Mapping of sport/rec injuries

*Getis Ord Gi** hotspot analysis tool



Stage 4: Sport/rec injuries in relation to external factors

1. What is the ***nature of the association*** between sport/rec injuries and ***socio-economic factors*** e.g. Socio-Economic Index For Areas (SEIFA)?

2. What is the ***spatial and/or temporal relationship*** between the injury occurrence and ***environmental factors*** e.g. temperature, rainfall and humidity?

Stage 4: Sport/rec injuries in relation to external factors

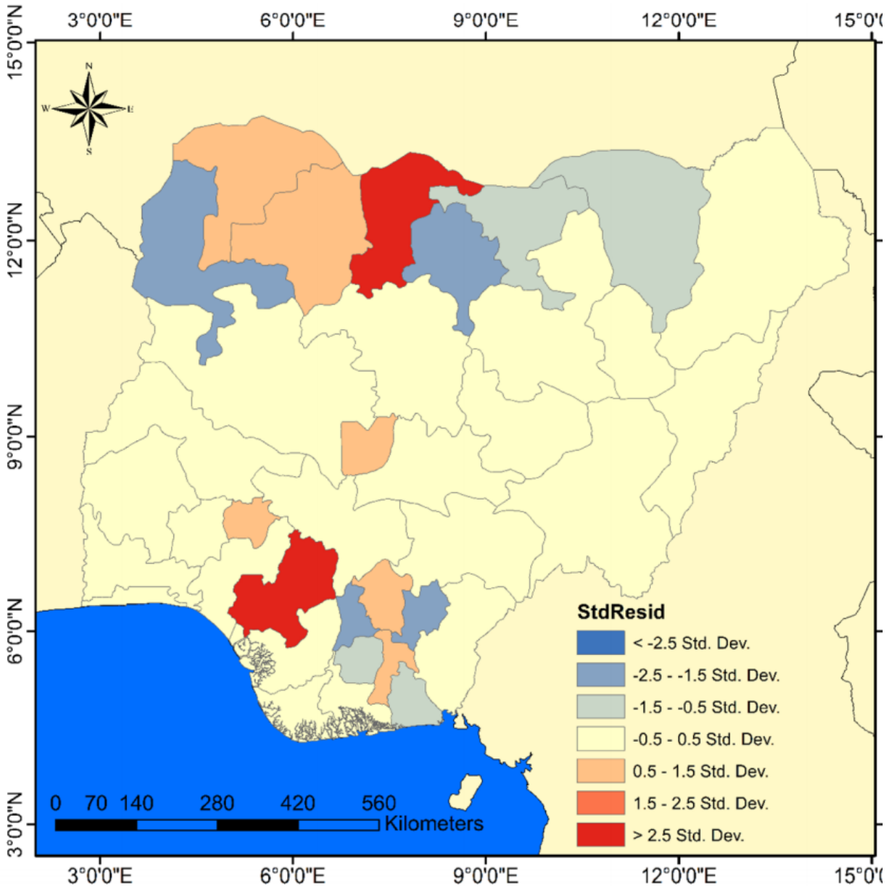
Ordinary Least Square (OLS) is global statistical model, will be used in our analysis as a diagnostic tool and for selecting the appropriate variable:

$$\gamma_i = \beta_0 + \sum_{j=1}^{p} X_{ij}\beta_j + \varepsilon_i$$

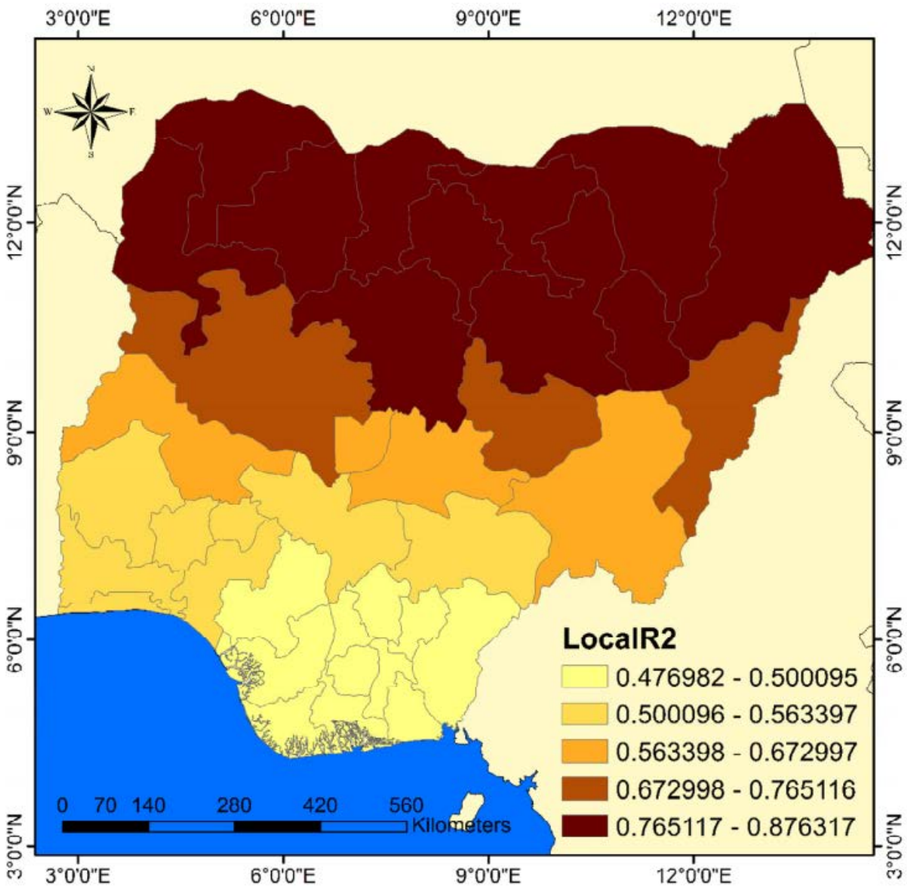
Geographically Weighted Regression (GWR) is a local spatial technique, which allows the relationship to vary over geographic space:

$$\gamma_i = \beta_0(u_i v_i) + \sum_{j=1}^{p} X_{ij}\beta_j\,(u_i v_i) + \varepsilon_i$$

Stage 4: Visualisation of GWR results



Residuals of GWR



Strength of relationship between outcome and explanatory variables

GWR results of water sources and cholera outbreak Nkeki et al (2013)

Stage 4: Visualisation of GWR results

Strength of relationship between outcome and each explanatory variable

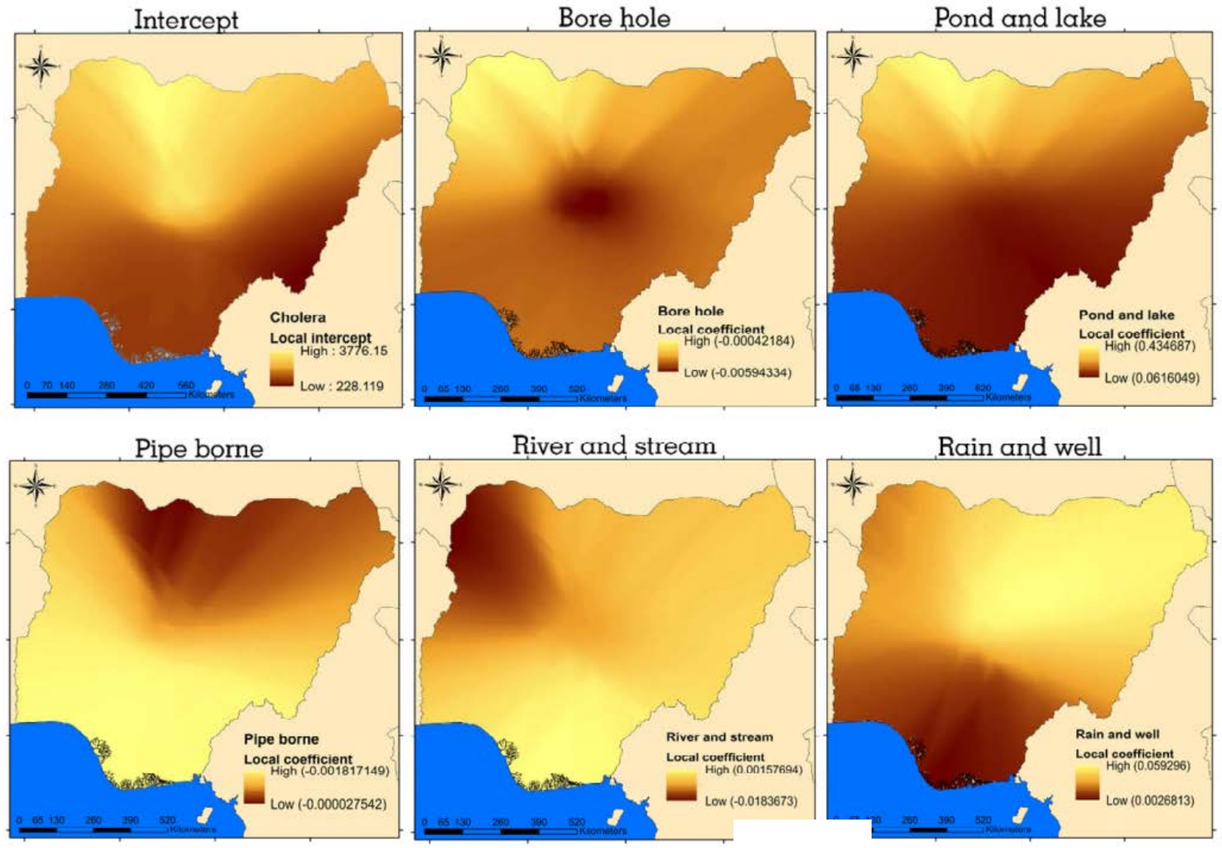


Figure 9. Local parameter estimates of GWR.

GWR results of water sources and cholera outbreak Nkeki et al (2013)

Stage 5: Sport injuries in relation to sports delivery factors

1. What is the relationship between the ***injury rate*** and ***sports delivery factors*** such as facilities rate, participation rate and coach rate for ***five major sports*** of Australia?

Stage 5: Sport injuries in relation to sports delivery factors

- Five sports ***Australian football, basketball, cricket, hockey*** and ***netball***
- ***High participation rates/popular*** sports in Australia
- The number of ***registered*** participants, facilities and coach in each of the five sports will be included in the analysis

The methods for this stage will be same as stage 4

Stage 6: Atlas of Sports and Recreational Injuries

1. What are the ***requirements*** (technical, data and ethical) during the development of atlas of sports and recreational injuries?

2. What are the ***challenges*** during the development of atlas of sports and recreational injuries?

Stage 6: Sport and recreation spatial

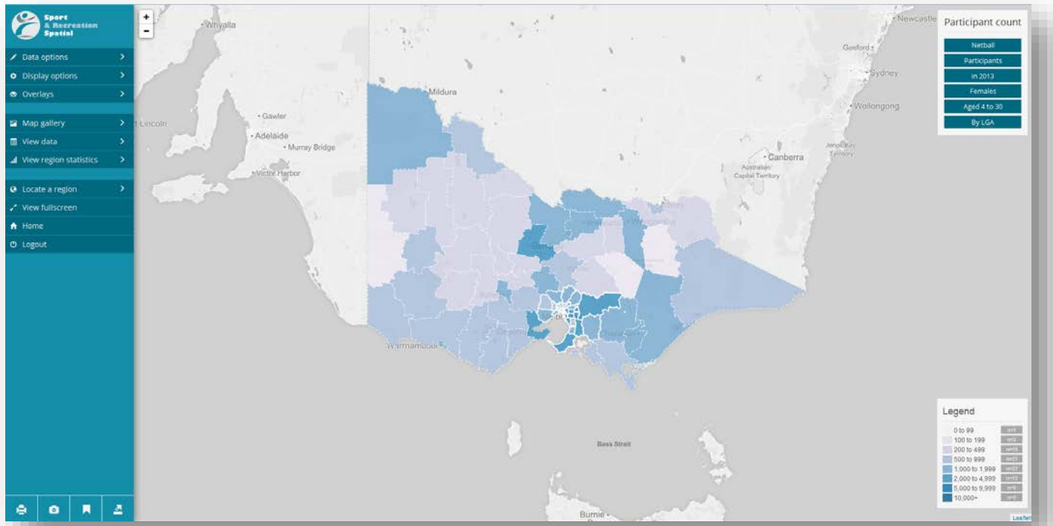
Be a part of **sport and recreation spatial** project

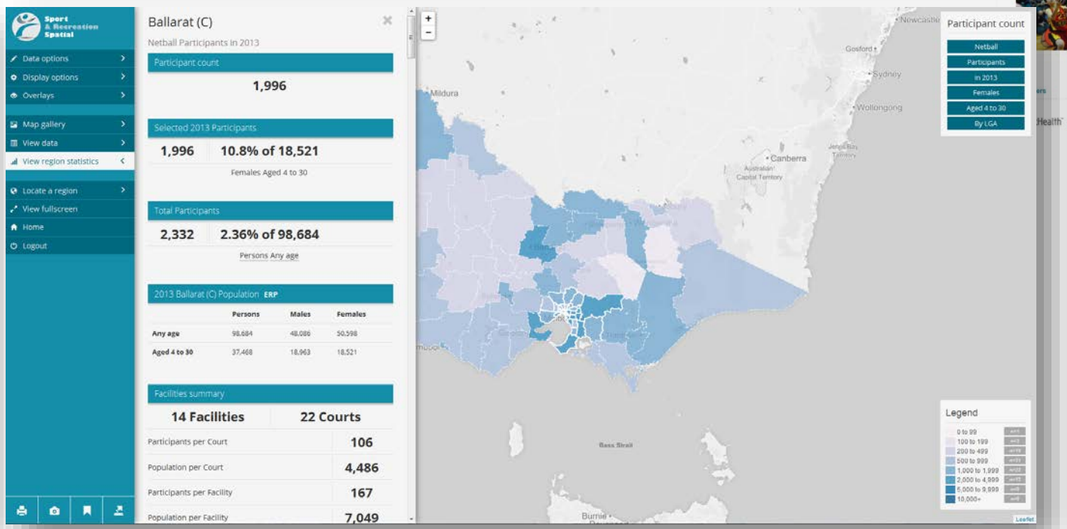
Geographical information system that contains:

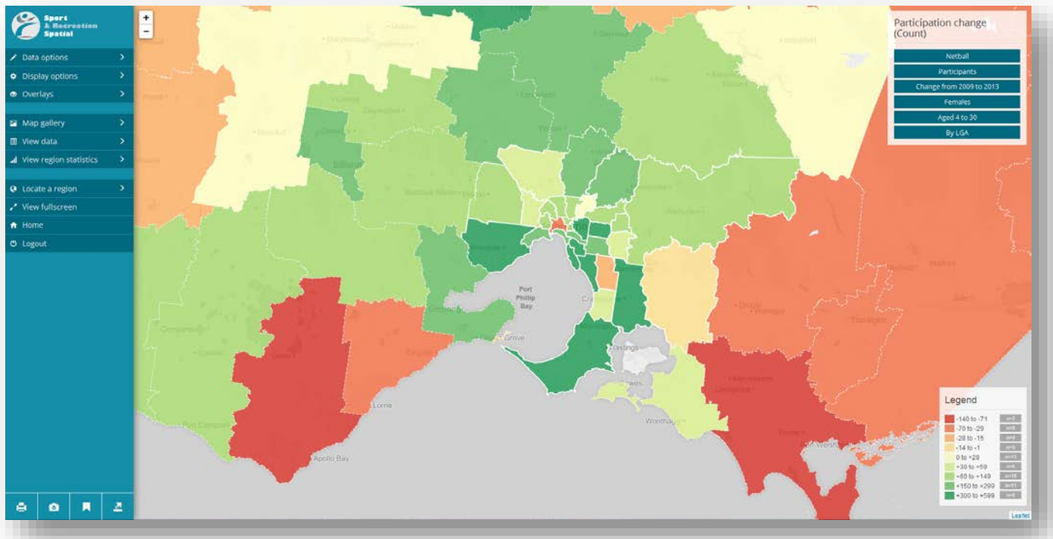
- ~200,000 Exercise, Recreation and Sport Survey (ERASS) records over 10 years
- ~ 2.5 million participant membership records
- ~185,000 coach and umpire membership records
- ~5,000 Victorian sporting facility locations

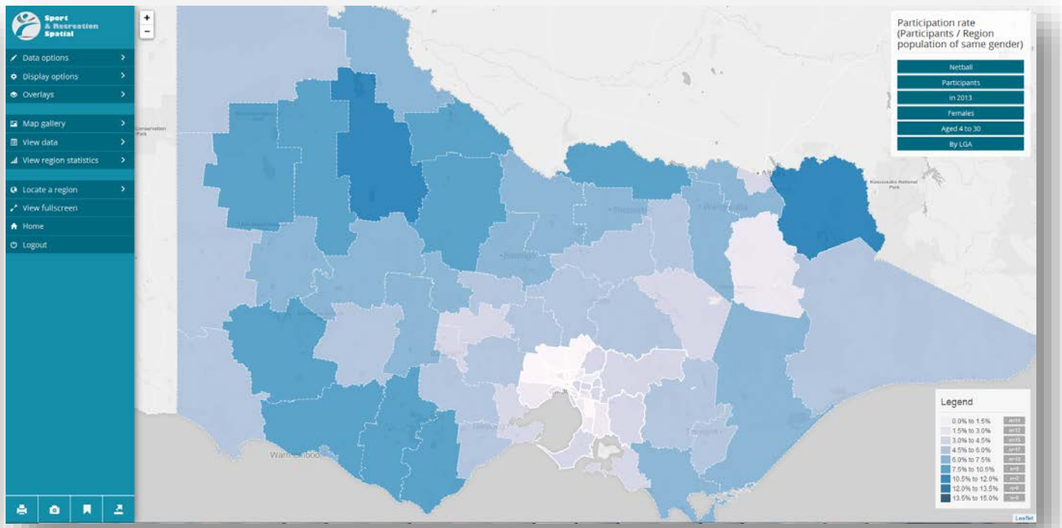
The aim of this project is to explore the relationship between sport participation and health

Stage 6: Sample maps





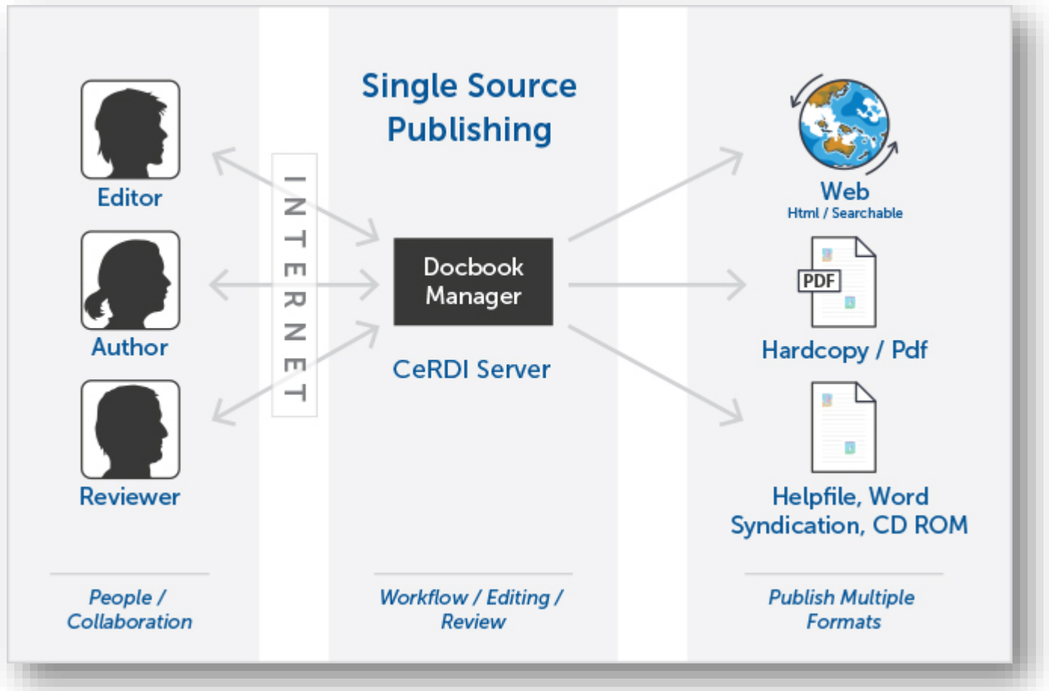




Stage 6: Atlas of Sports and Recreational Injuries (ASRI)

Features:

- Visualisation of sport/rec injury rates
- Hotspots by specific age, gender and sport
- Geographically weighted regression results



Potential tools to develop this application will be Quantum GIS (QGIS), GeoServer and Post GIS

Contribution to literature

1st paper : ***Potential sources of sport/rec injury data in Victoria: coverage, opportunities and limitations***

2nd paper: ***Applications of geospatial methods to analyse injury and trauma data: A systematic review***

3rd paper: ***Geographical variation of sport/rec injuries in Victoria***

4th paper: ***Sport/rec injuries in relation to external factors***

5th paper: ***A spatial analysis of sports injuries and sports delivery factors***

Atlas of sports and Recreational Injuries

Progress to date

Stage 1: Summary of geospatial methods

- Keywords have already been selected for this stage
- An optimal search strategy has been developed after a number of trials
- The full search has been conducted on in three databases
- Records identified from this search have been screened (n = 89)

Progress to date

Stage 2: Potential sport/rec injury data sources

- Relevant information about the potential organisations has been gathered
- Document analysis has started on the gathered information

Progress to date

Stage 3: Mapping of sport/rec injuries

- Injury data from hospitalisations and population data have already been obtained from VISU and ABS respectively.
- An ethics application for this stage has been prepared.

Timeframe

Aim	Specific Tasks	2014										2015												2016												2017		
		M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M
CoC document	Background study																																					
CoC document	Research objectives																																					
CoC document	CoC document																																					
	Collection of relevant data																																					
	Ethical applications																																					
Stage 1	Gathering the relevant information																																					
Stage 1	Analyse and documentation																																					
Stage 1	Write paper and submit																																					
Stage 2	Search strategy and collection of papers																																					
Stage 2	Analyse and summarize findings																																					
Stage 2	Write paper and submit																																					
Stage 3	Refine study objectives																																					
Stage 3	Data analysis and summarize findings																																					
Stage 3	Write paper and submit																																					
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Stage 5	Data analysis and summarize findings																																					
Stage 5	Write paper and submit																																					
Stage 6	Feasibility study and conceptual design																																					
Stage 6	Detailed design & coding																																					
Stage6	Testing, documentaion & implementation																																					
Final thesis	Thesis preparation																																					
Final thesis	Revise and submit																																					

Acknowledgements

- Federation University Australia
  - School of Health Sciences and Psychology
  - Australian Centre for Research into Injury in Sport and its Prevention (ACRISP)
  - Centre for eResearch and Digital Innovation (CeRDI)
- Victorian Injury Surveillance Unit (VISU)
- Environmental Systems Research Institute (ESRI)