The Effect of Road Network "Bendiness" on Traffic Crash Occurrence

Megan Fowler Glen Koorey and Andre Dantas

Outline

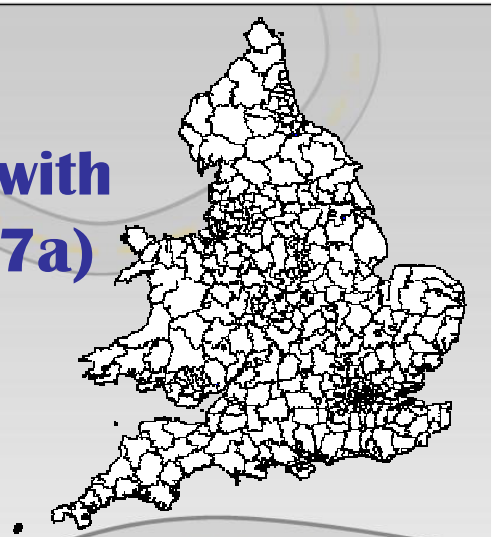
- Background Information
- Case Study Overview
- Results
- Conclusions
- Questions and Comments

Horizontal Curves

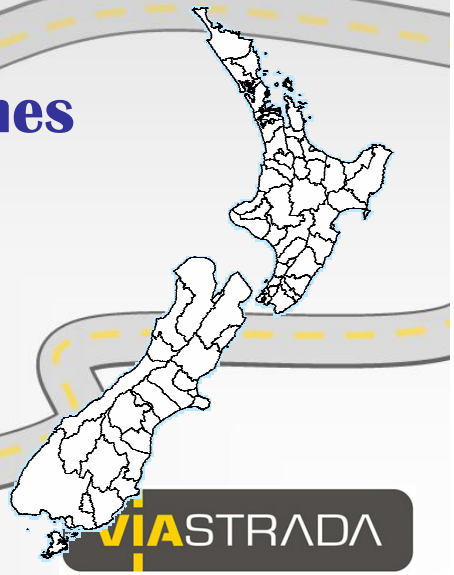
- ↓Radius = ↑Crashes
- What about straight roads?
- Context of curve with respect to other road elements
- Design consistency
- Demand on drivers
- "Bendiness"

Motivating Studies

- **District Variations in Road Curvature in England and Wales and their Association with Road Traffic Crashes – Haynes *et al* (2007a)**
  - 403 Local Authority Districts

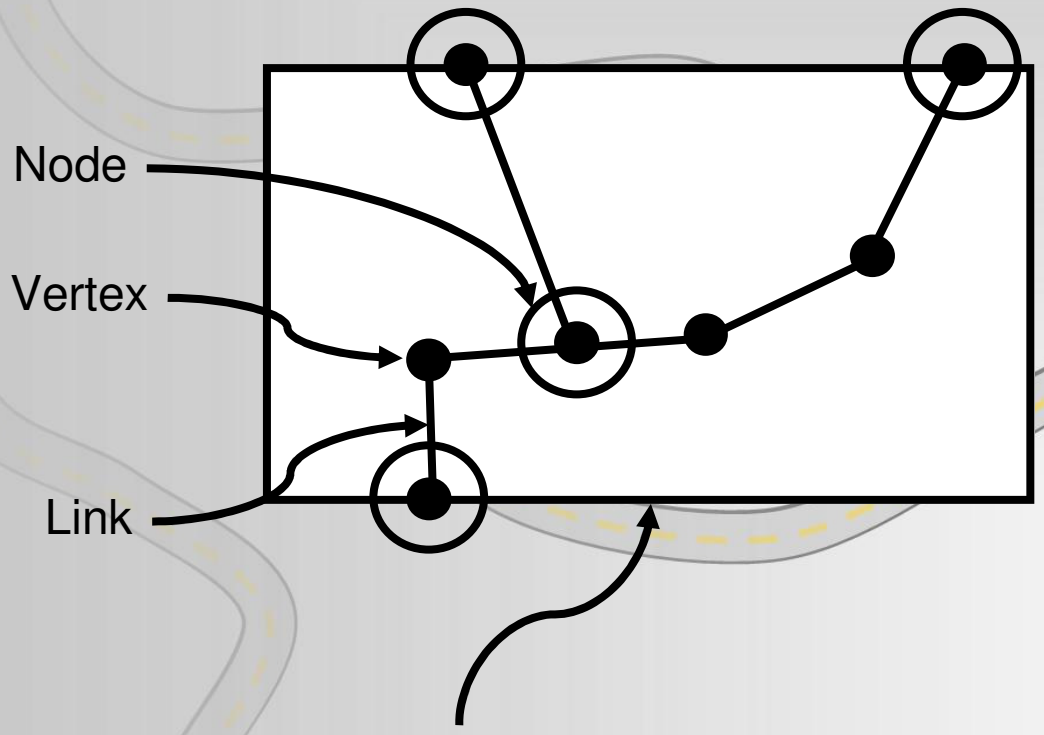


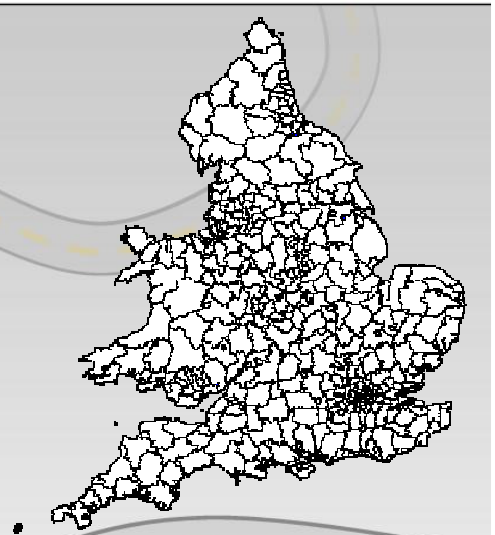
- **Influence of Road Curvature on Fatal Crashes in New Zealand – Haynes *et al* (2007b)**
  - 74 Territorial Local Authority Regions

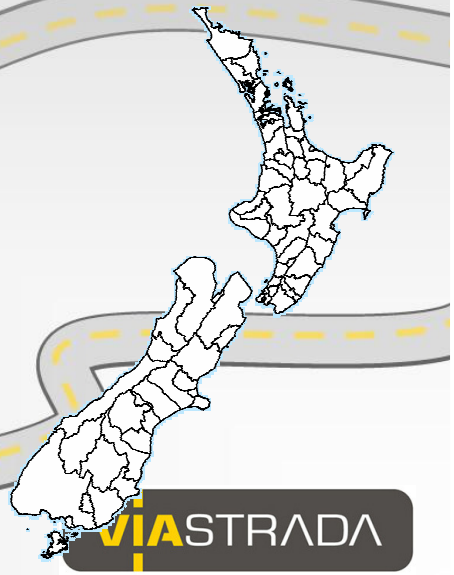


Motivating Studies

Road Network Data:

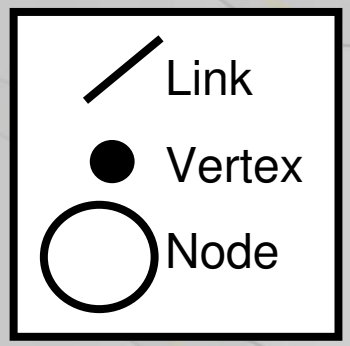


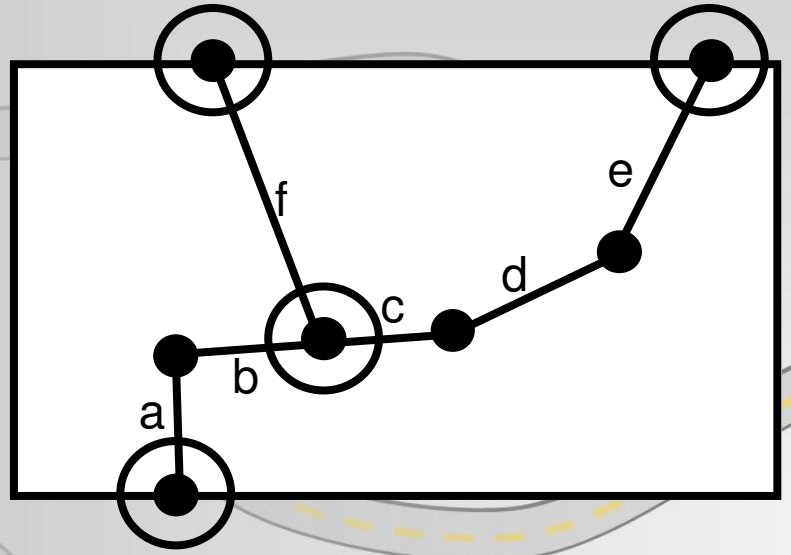




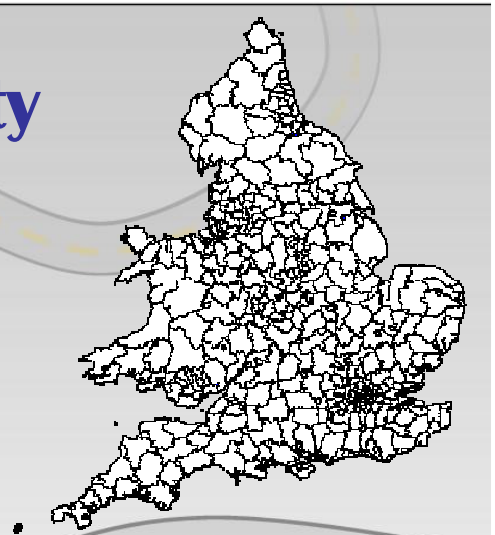
Motivating Studies

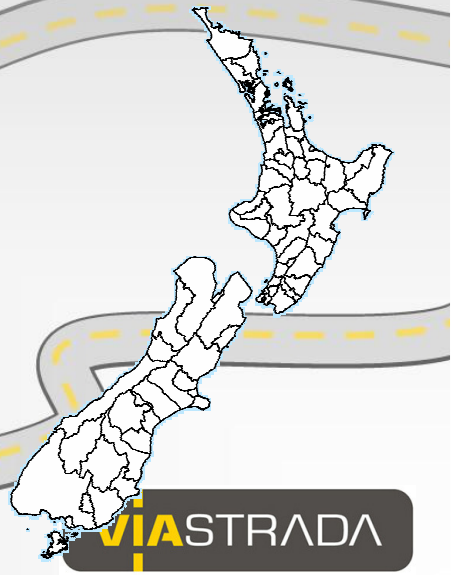
Bendiness Measures – Bend Density





$$BD = \frac{N_{vertices} - N_{nodes}}{a + b + c + d + e + f}$$

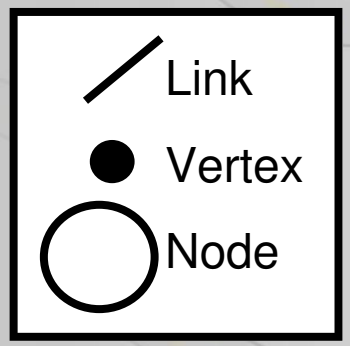


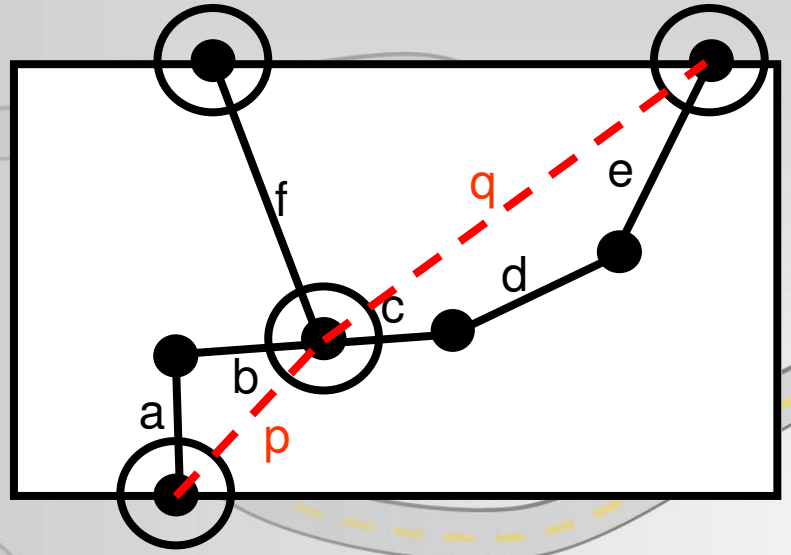


Effect of Bendiness on Crashes

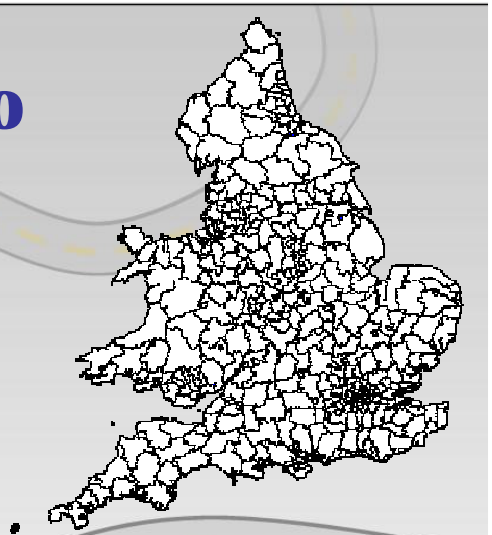
Motivating Studies

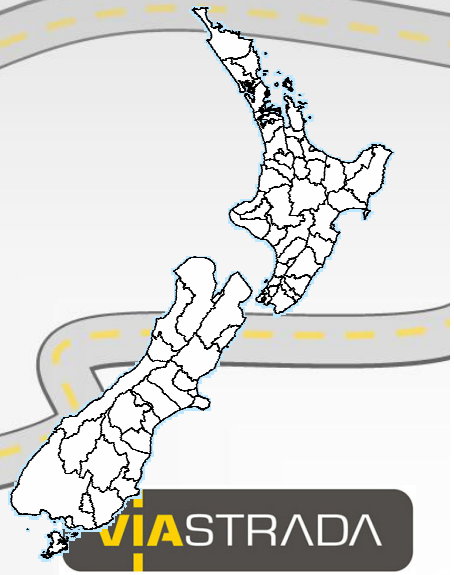
Bendiness Measures – Detour Ratio





$$DR = \frac{a+b+c+d+e+f}{p+q+f}$$

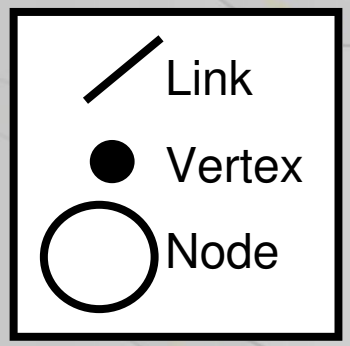


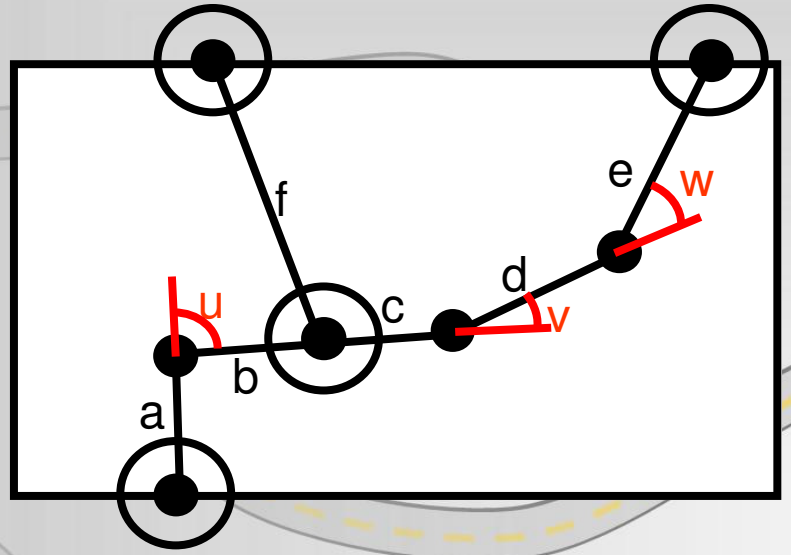


Effect of Bendiness on Crashes

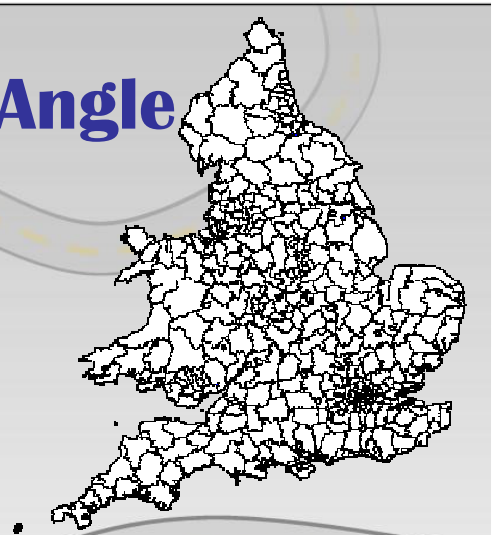
Motivating Studies

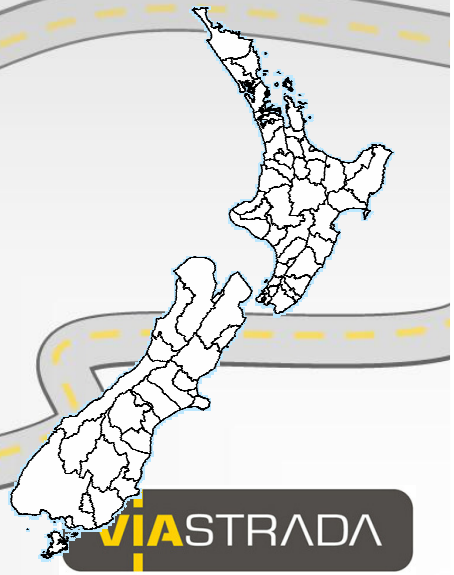
Bendiness Measures – Cumulative Angle





$$CA = \frac{u + v + w}{a + b + c + d + e + f}$$

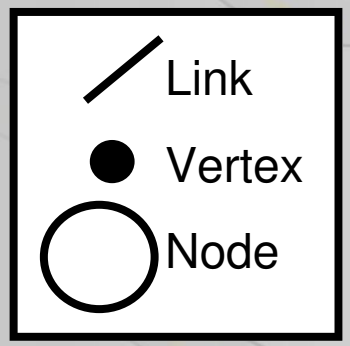


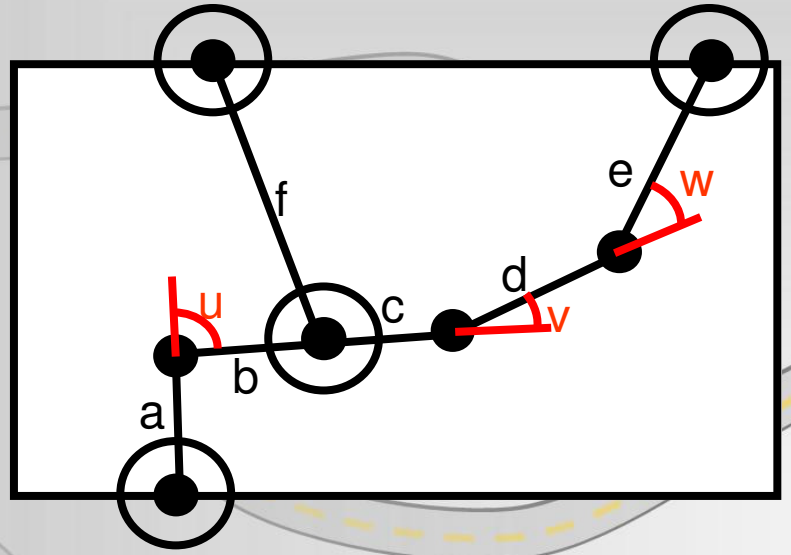


VIASTRADA

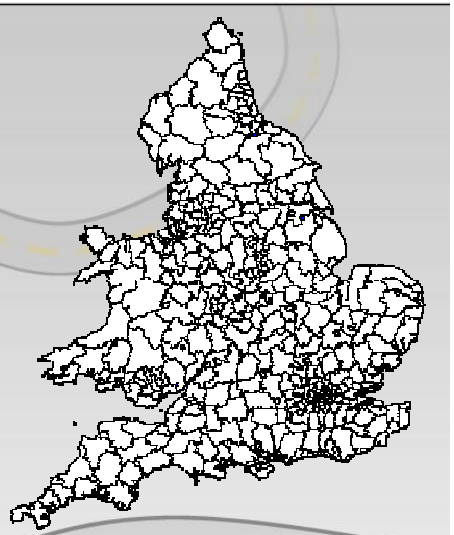
Motivating Studies

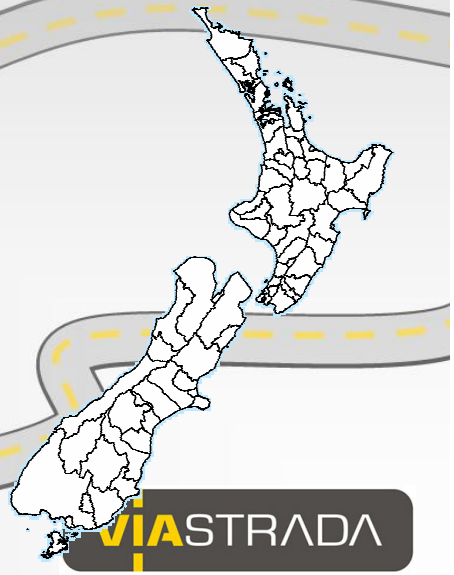
Bendiness Measures – Mean Angle





$$MA = \frac{u + v + w}{N_{angles}}$$

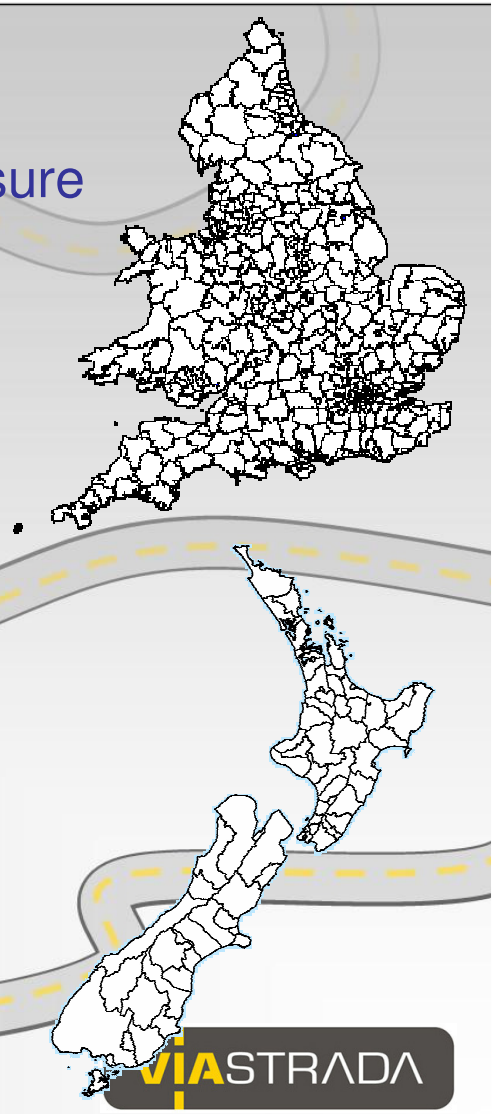




Motivating Studies

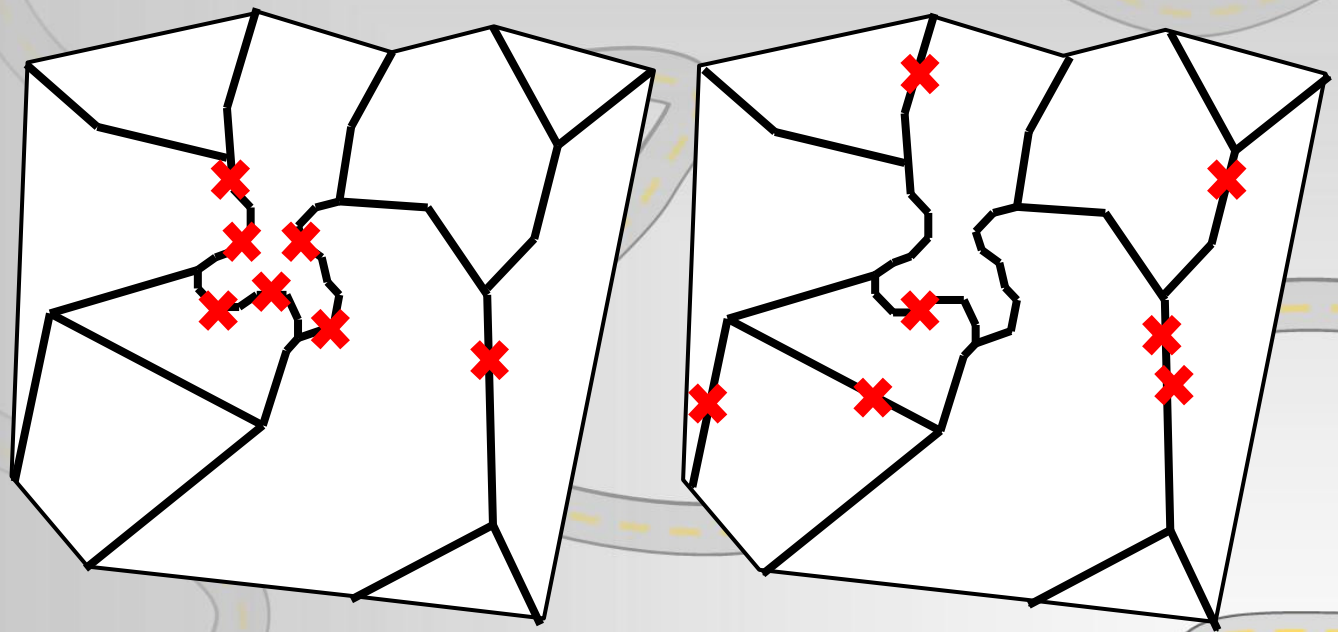
- **Britain – Haynes *et al* (2007a):**
  - Cumulative angle most useful bendiness measure
  - 0.6% decrease in fatal crashes for a 1deg/km increase
  - Bendiness helps prevent crashes

- **New Zealand – Haynes *et al* (2007b):**
  - No significant trend for rural roads
  - Slight trend for urban roads



Assumptions

- **Level of aggregation is important**



Assumptions

- **Other bendiness measures may be developed**
  - Measures involving the standard deviation of angles should be tested.
- **Perhaps these measures could be combined in the analysis**

Assumptions

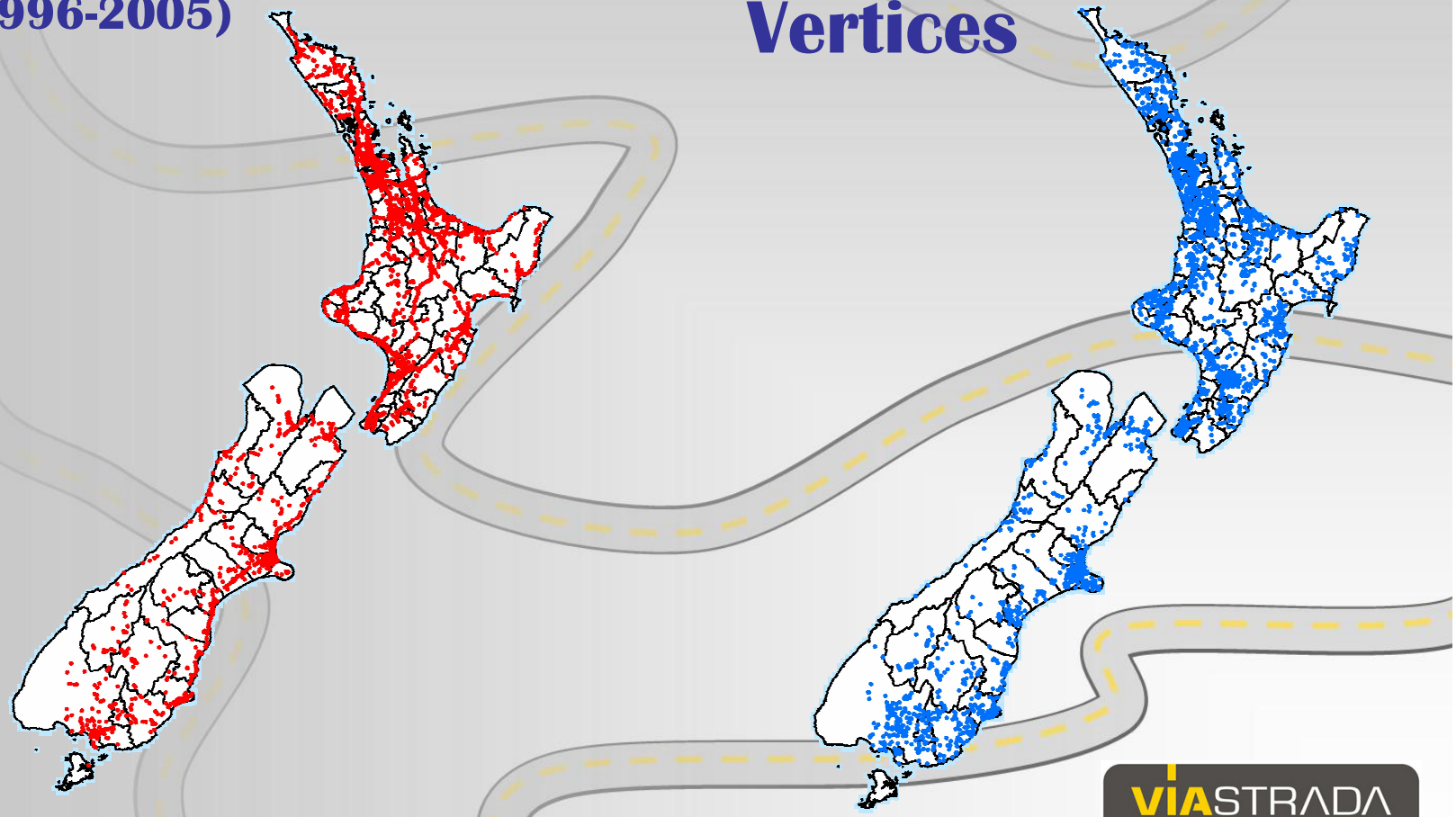
- **Other factors may be more important than bendiness in urban locations**
  - Greater junction densities
  - More route options
  - Slower travel speeds
  - Higher traffic flows (and conflicts)

Assumptions

- **If we know that regions with certain bendiness properties have lower crash risks, how does this help us?**
  - As engineers we generally design road sections rather than whole regions.

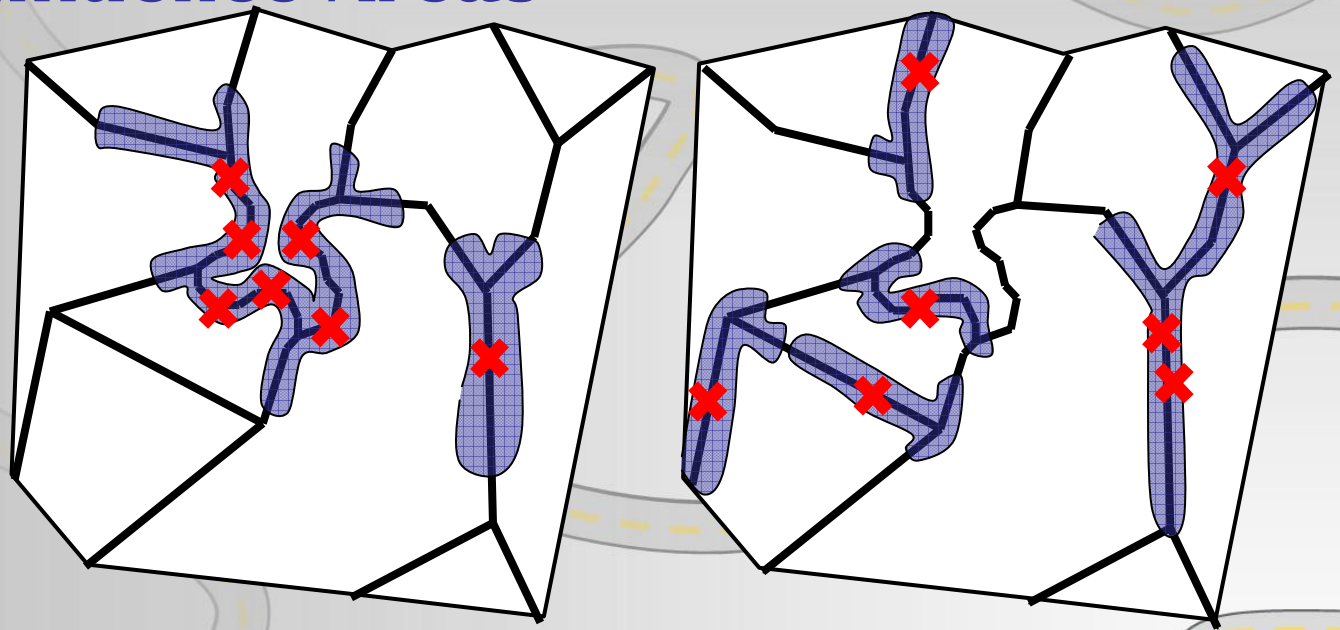
Case Study

- **4019 Fatal Crashes (1996-2005)**
- **4000 Comparison Vertices**



Case Study

- **Bendiness measures applied to "Influence Areas"**



Case Study

- **Bendiness measures applied to "Influence Areas"**
  - Actual routes taken by drivers involved in crashes unknown
  - Weightings applied to all possible routes between crash and extent of influence area

Case Study

- **Binary logistic regression models developed**
  - For rural State Highway, rural non-SH and urban cases
  - Including effects of other influencing variables

Results

- **Rural state highway model**
  - Detour Ratio
  - Cumulative Angle
  - Standard Deviation of Angles
  - AADT
  - Mean elevation above sea level

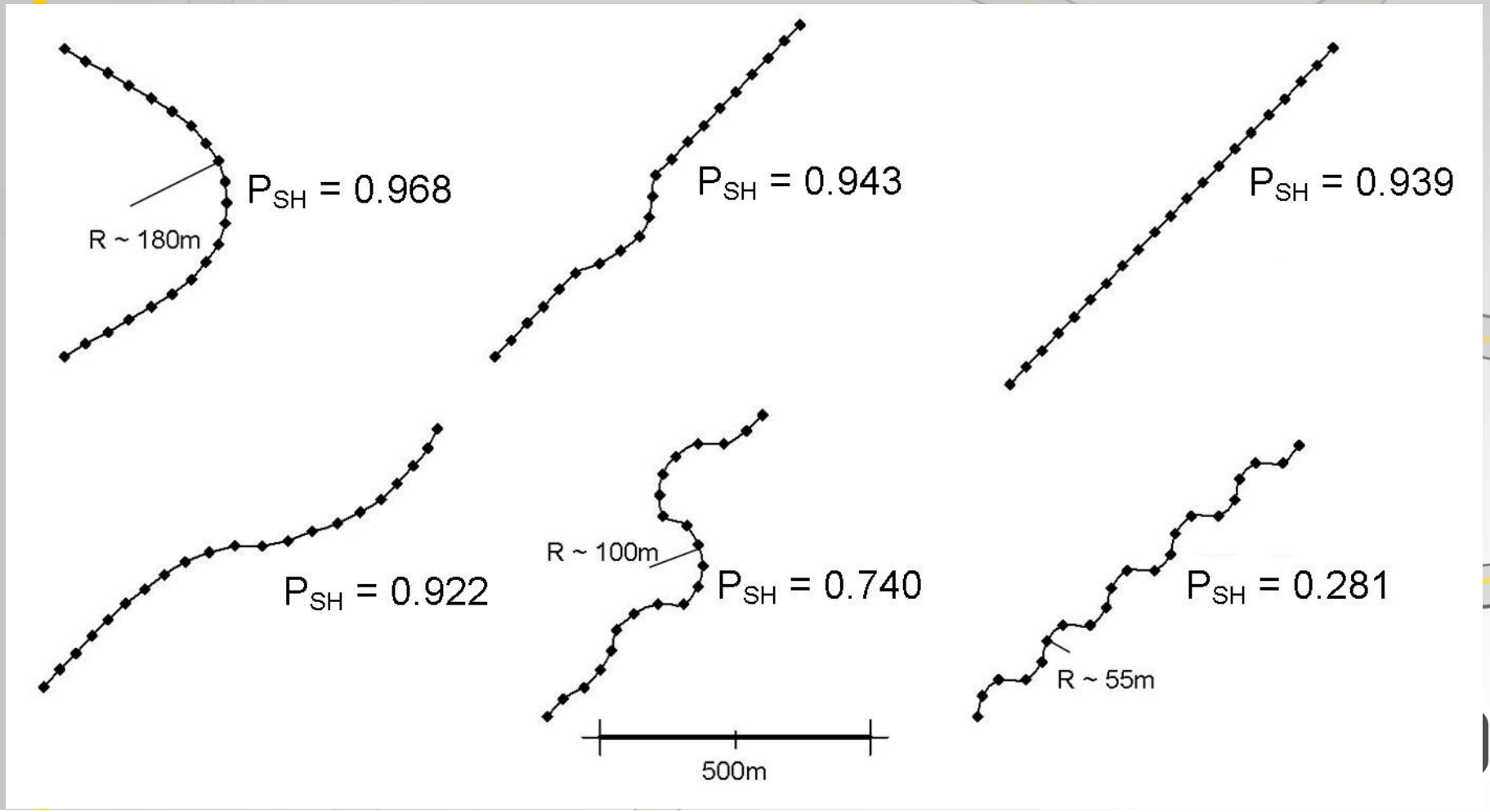
Bendiness Measures

Results

- **Rural non-state highway model**
  - Detour Ratio
  - Cumulative Angle
  - Standard Deviation of Angles
  - Mean Rainfall
  - Mean Elevation above sea level
  - Intersection within 30m?
  - Meshblock Area

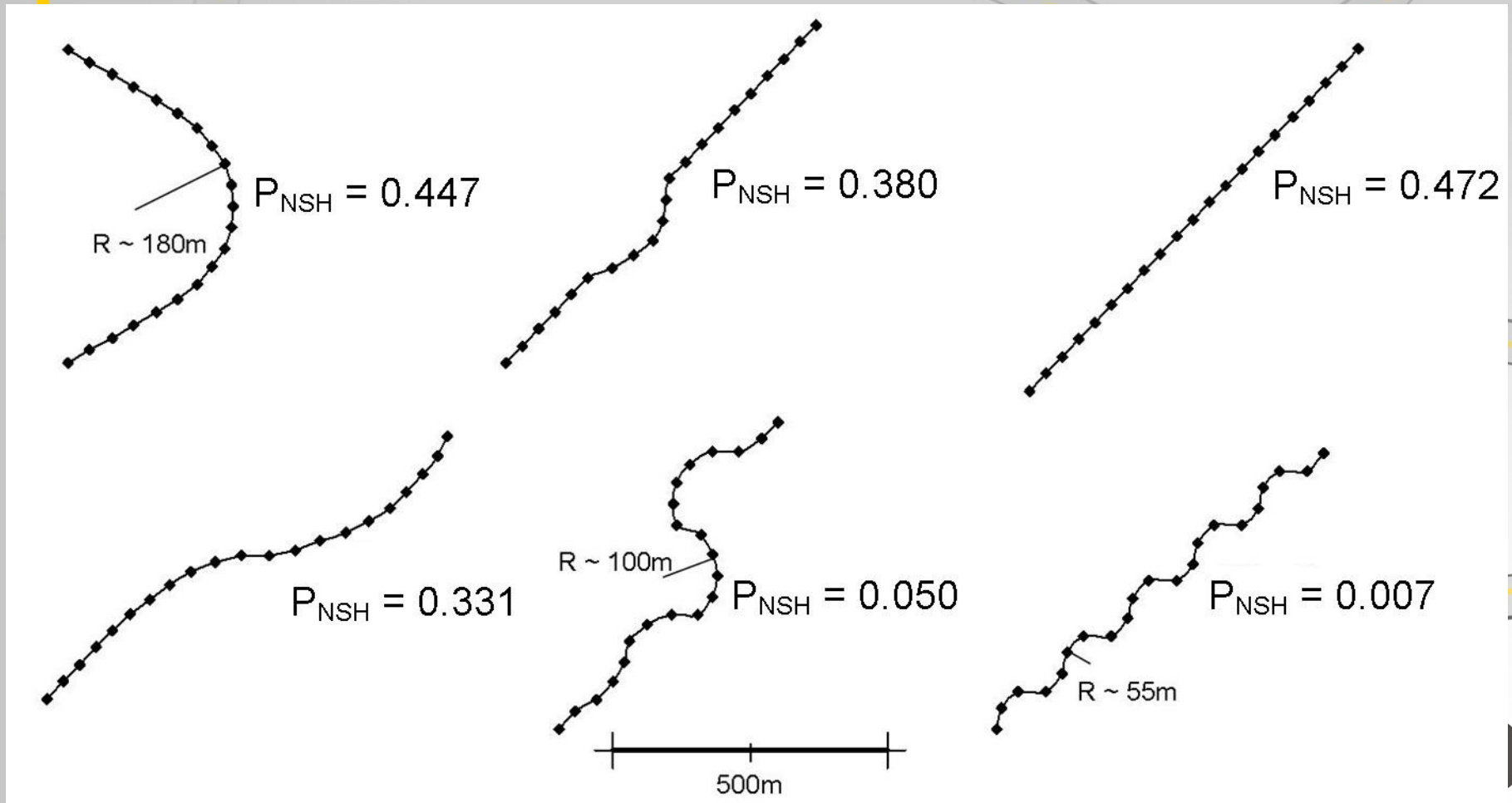
Results

- **Rural state highway model**



Results

- **Rural non-state highway model**



Results

- **Rural state highway model**
  - Bendiness protect against crashes
  - Design consistency is important

- **Rural non-state highway model**
  - Different parameters to SH model
  - Similar results

Results

- **Urban roads model**
  - Inconclusive
  - Not discussed further for this paper

Conclusions

- Influence area method is more appropriate than large scale aggregation
- Bendiness protective in rural areas, provided design consistency is maintained
- Difficult to make conclusion for urban areas – method may not be applicable here

Thank you

Questions?