Spatial information on bicycle crash risk for evidence-based interventions on the city-scale

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Is Cycling Dangerous?

Cyclists are overrepresented in Austrian crash statistics: 10.47% (fatalities) : 3% (modal split)
“Cyclists make up 8% of all who died on the road in the EU. The number of cyclist fatalities decreased by only 4% between 2010 and 2014, which is much lower than the total fatality decrease (18%).”

Source: CARE database, data available in May 2016
Promotion of sustainable modes of transport (cycling) → Increasing popularity of cycling → More cyclists using limited infrastructure

More crashes occur (in absolute numbers) → Decision makers seek to adapt to knew demand

Where to put the money in?

Data shortage on local scale

Financial limitations
GIS for Evidence-based Decisions

- Required: evidence-base on the local scale = where measures are implemented
- Geographical Information Systems (GIS) facilitate …
  - Spatial and spatio-temporal analysis
  - Spatial models
- Where and when do bicycle crashes occur?
  - Patterns and dynamics
- What is the risk (probability) to get involved in a crash?
  - Incidences / exposure
GIS in Crash Analysis

Bicycle crashes are spatial (and temporal) by their very nature.
Examples from Salzburg (Austria)

- 3,048 geo-located crash reports 2002/01 – 2011/12
  - Police reports only (« underreporting!)
- City of Salzburg (148,000 inhabitants): modal split ≈ 20%

Crash analysis
(Loidl et al. 2016a)

Bicycle flow model
(Wallentin & Loidl 2015)

Risk estimation on local scale
(Loidl et al. 2016b)

Pictures © Stadtgemeinde Salzburg
Dynamics
3,048 crashes at 1,865 locations (1,379 single crash locations)

16 locations with > 10 crashes (6.5% of all crashes)
Spatio-temporal Seasonality

January
• Globally high correlation \textit{bicycle volume} – crash occurrences

\begin{figure}
\centering
\includegraphics[width=\textwidth]{chart.png}
\caption{Bicycle traffic: annual counts at one central station. Number of accidents: 10 year aggregate per day.}
\end{figure}

• Spatial distribution and variation beyond scale level of whole city?
Problem of **exposure variable** → flow model for bicycles

- Agent-based model for simulation of bicycle flows:
Risk Estimation – Spatial Implications

- Bicycle crash risk = number of incidents / distance travelled
- Spatial implications:
  - Spatial heterogeneity: variability within reference unit
  - Modifiable areal unit problem: different patterns due to scaling and zoning effects
  - Statistical robustness: confidence interval for calculated rates

Reliability: Confidence interval for calculated rates
Detail: Account for spatial heterogeneity
Risk on Local Scale

Crashes / 100,000 km

95% CI Size in Crashes / 100,000 km

0 10 1,307

0.16 12 4,238.5

No Data

City of Salzburg

ZGIS
Risk on Local Scale

Crashes / 100,000 km

95% CI Size in Crashes / 100,000 km

- 365
- 1.514
- 1.3
- 1.15
- 0
- 0.16

No Data

City of Salzburg
Examples: MAUP

Analysis of bicycle crashes on the local scale unveil patterns and dynamics that are hidden in epidemiological studies.

- High risk at intersections (mainly due to poor infrastructure design)
- High spatio-temporal variability (e.g. seasonal effects)
- Number of incidents ≠ risk

Definition of spatial reference units » emerging patterns (MAUP, spatial heterogeneity)

Data availability and quality

- Increasingly important with higher level of detail (e.g. flow model, crash and near-miss data)
- Investment pays off » evidence base for informed decisions

Evidence base for decision making: prioritization, targeted measures, monitoring etc.