Daily Rhythms 1: Population Denominators and Spatio-Temporal Crime Hotspots

Manchester Metropolitan University Crime & Well-Being Big Data Centre

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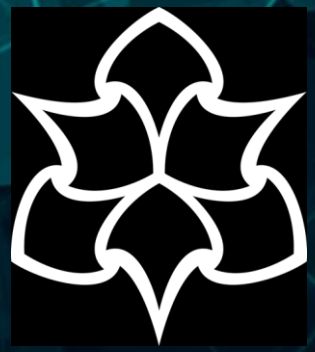


Contents

Population measures

1. Residential Population
2. Workplace Population (Malleson & Andresen, 2016)
3. Ambient Population (Mburu & Helbich, 2016; Andresen, 2011; Bogomolov et al., 2014)

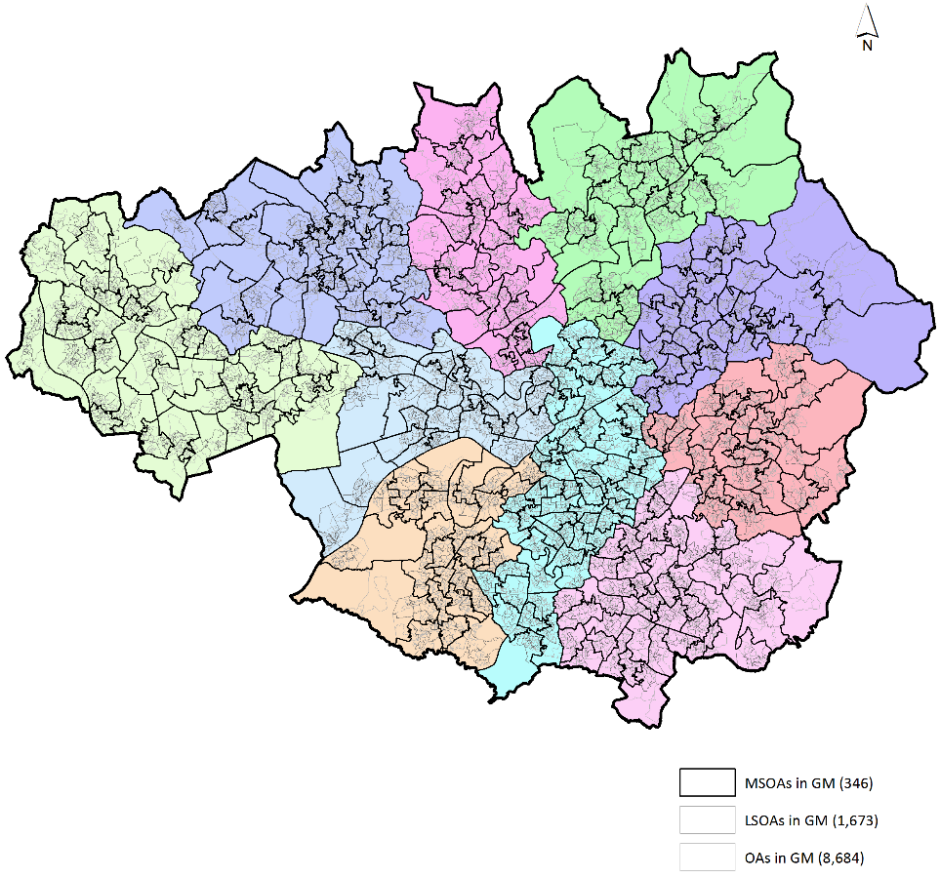
<u>Research Questions</u>

Q1. Do these population estimates capture the daily rhythms of the city?

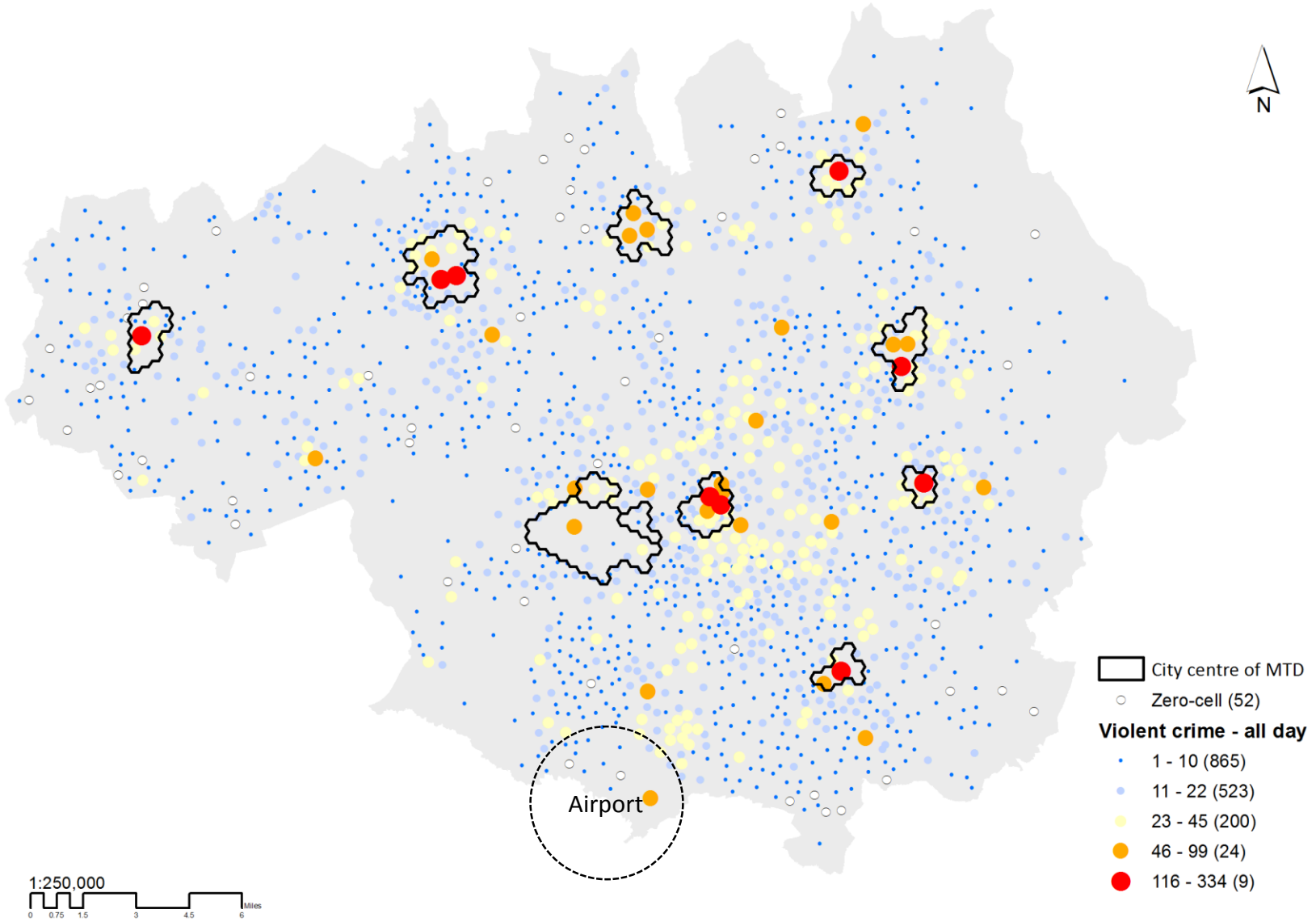
Q2. Do they represent the population-at-risk?

Our Greater Manchester data

- **Mobile Phone Origin Destination (MPOD)** matrices from Transportation of Greater Manchester (TfGM)
  - Average number of persons travelling per trip from Origin A to Destination B in different time bins (T_0, T_1,…,T_N)!
  - Each trip assigned with a flag to represent final Destination (1- YES, 0-No)
- **Crime Data** from Greater Manchester Police (GMP)
  - Attributes: Crime records with spatial coordinates and time-stamps / (non domestic) violent crime



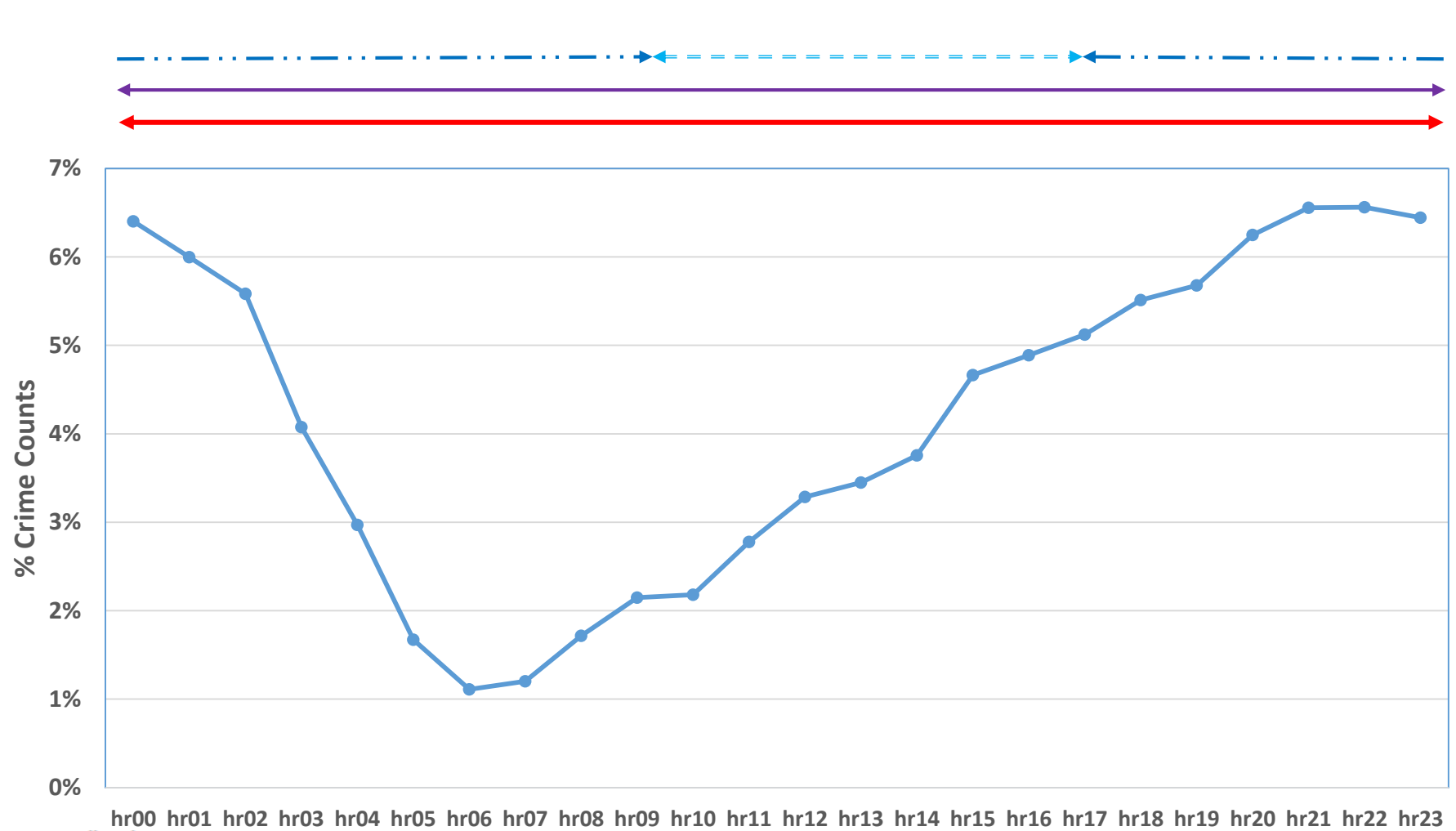
The spatial patterning of violent crime counts



Conventional correlation analysis (daily population measure)

Total crime	Residential pop	Workplace pop
Pearson Correlation	.202**	.626**
Sig. (2-tailed)	.000	.000
N	1673	1673
**. Correlation significant at 0.01 level (2-tailed).		

The temporal patterning of violent crime



Time coverage

- Workplace (Business hours; 9to5)
- Resident (Night time; 5to9)
- Exposed (hourly; 24 hours)
- Ambient (hourly; 24 hours)

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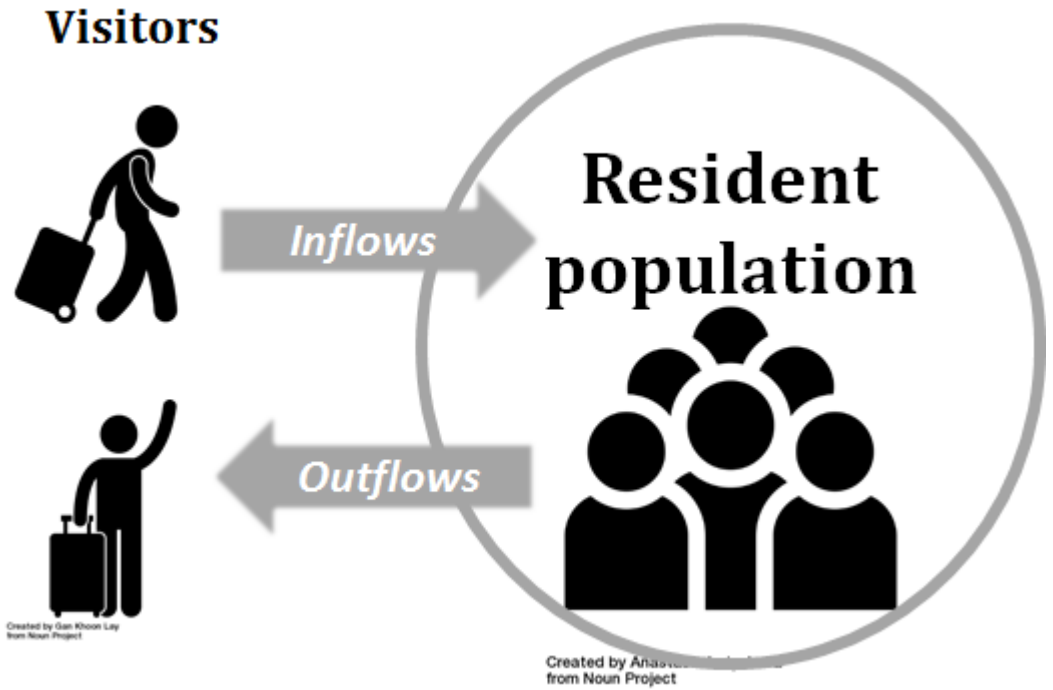
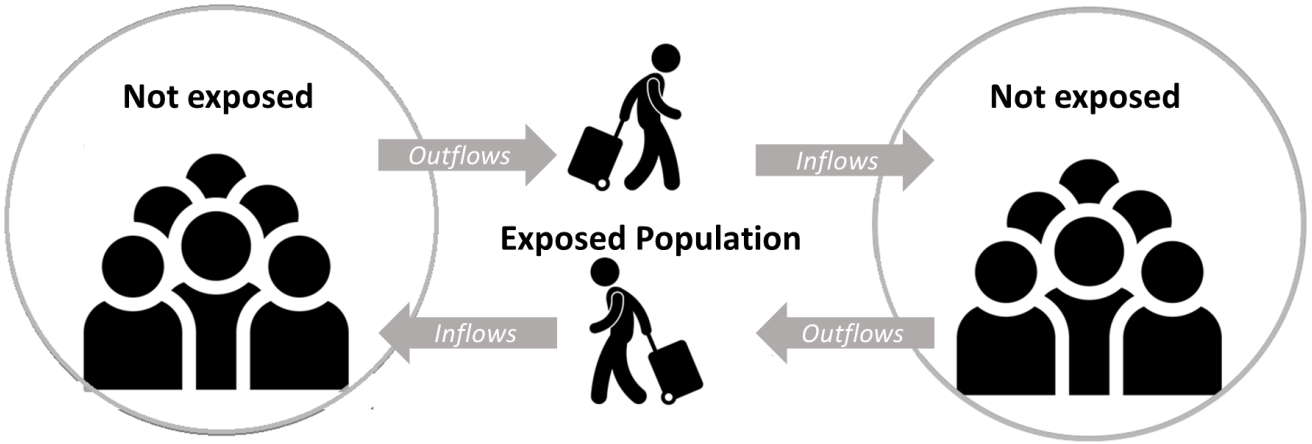
Ambient (total) population

- Based on the incremental flows of the residential population in different time bins (T_0, T_1,…,T_N)!
- Assuming the ambient population to be equivalent to residential population at T_0 (midnight)
  - **Amb_pop_T_0 = Resid_pop + Inflows_T_0 - Outflows_T_0]**
  - **Amb_pop_T_1 = Amb_pop_T_0 + Inflows_T_1 - Outflows_T_1]**



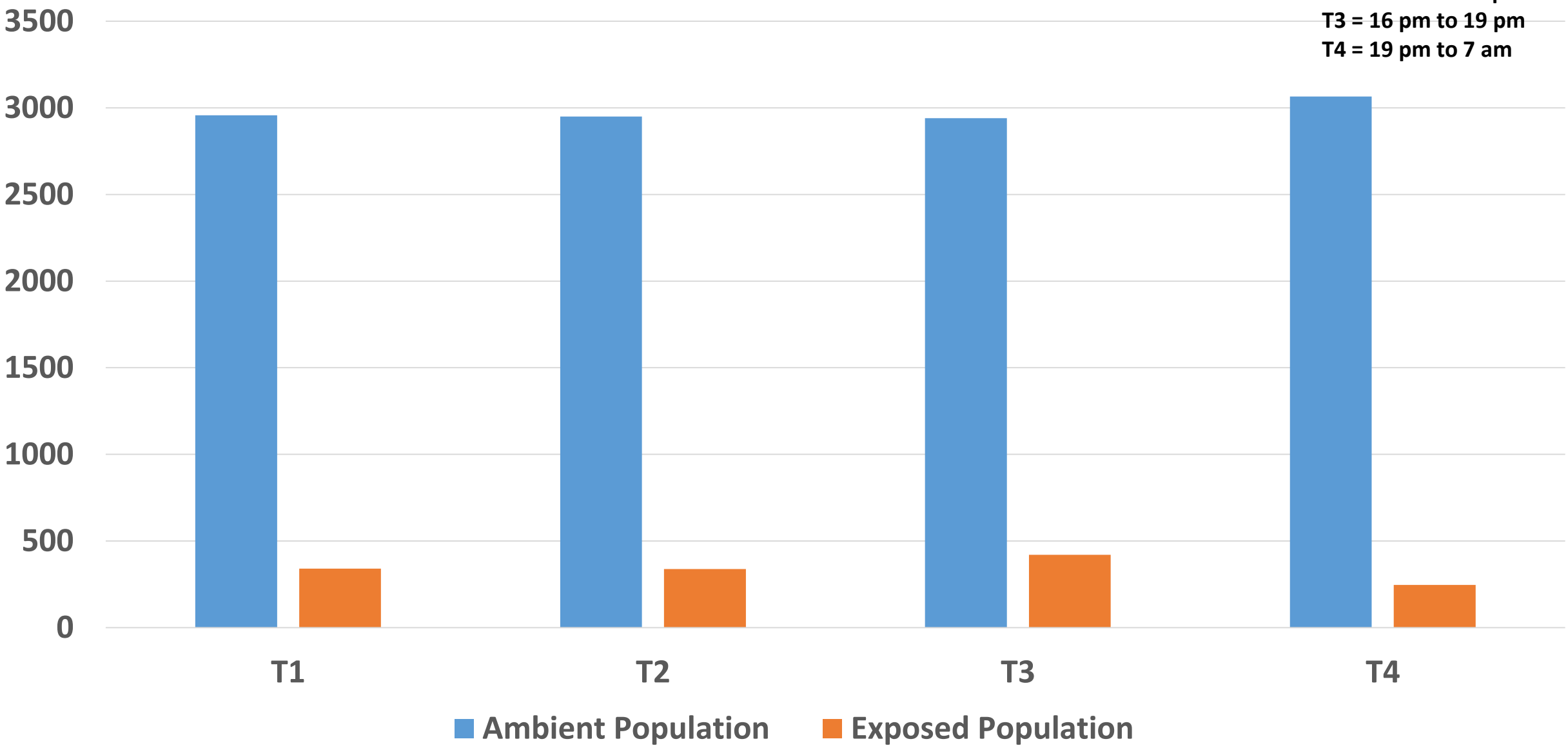
Exposed (mobile) population

- Based on determining the street based population at different time bins (T_0, T_1,…,T_N)!
- This excludes the population who have reached their **final destination** or have left the area (**initial origin**) at particular time
- **$Exp\_pop\_T_0$ = $Inflows\_T_0$ + $Outflows\_T_0$ – $Inflows\_T_0\_FD$ – $Outflows\_T_0\_FO$**

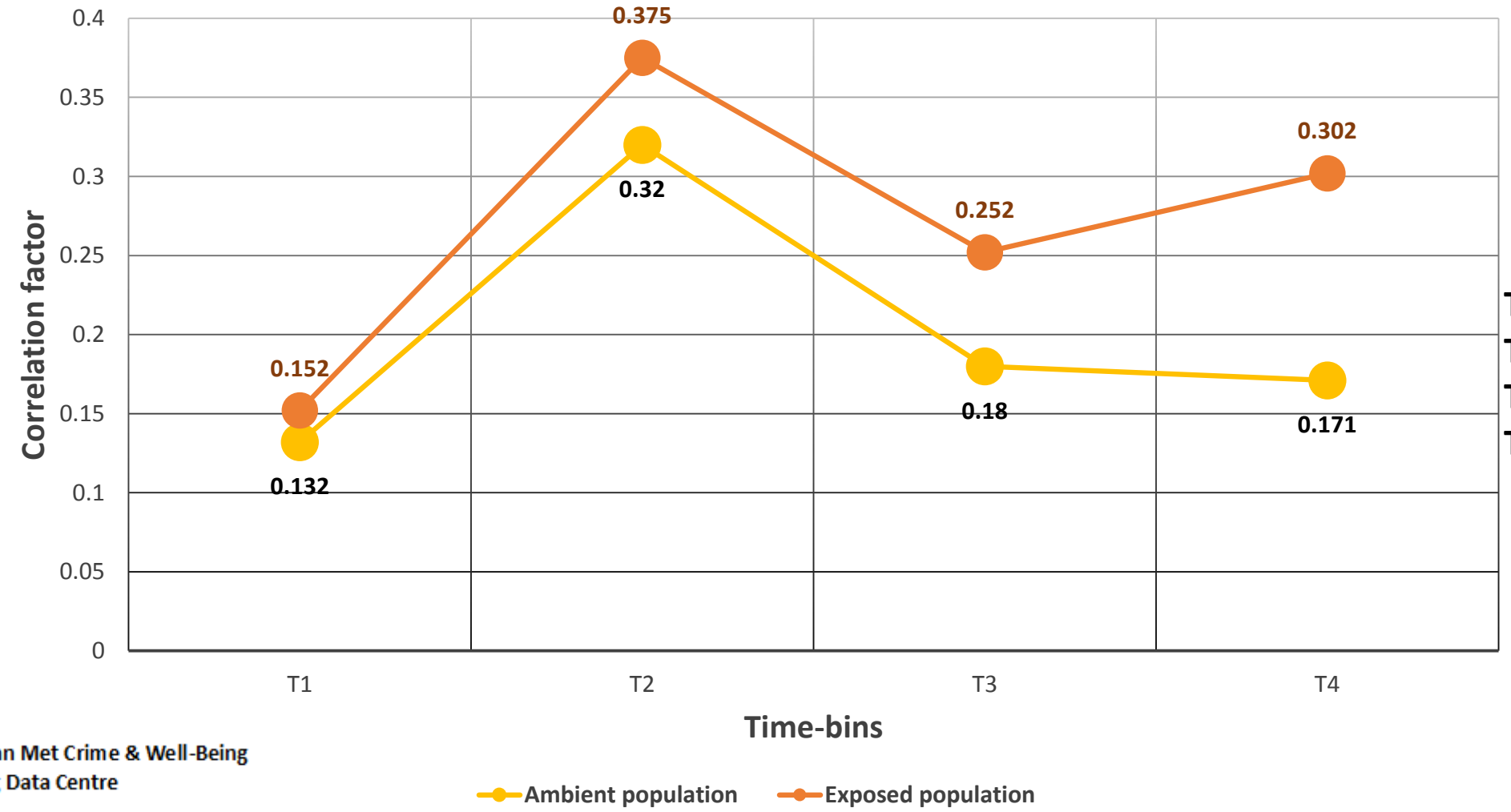


Time sensitive ambient and exposed populations

T1 = 7 am to 10 am
T2 = 10 am to 16 pm
T3 = 16 pm to 19 pm
T4 = 19 pm to 7 am



Time sensitive correlation analysis



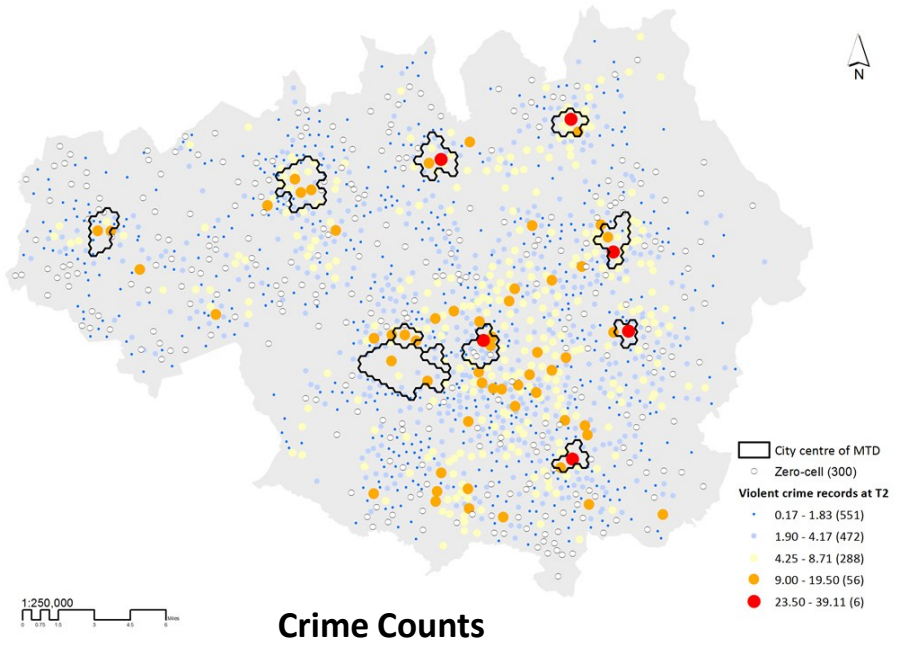
T1 = 7 am to 10 am
T2 = 10 am to 16 pm
T3 = 16 pm to 19 pm
T4 = 19 pm to 7 am

Hotspot analysis

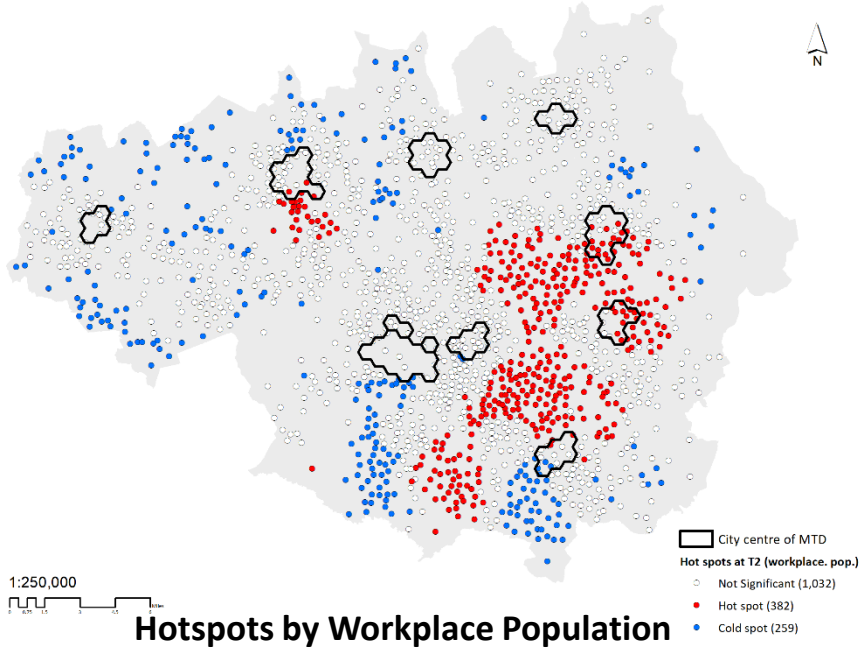
- Gi* statistics (Getis-Ord's Gi*)
- Z-score of Gi* (p-value <0.05) enables identification of high or low value clusters of spatial units.
- Question – to what extent does the method of spatio-temporal clustering impact on the detection of hotspots?

Violent Crime Count and Crime Rate Hotspot Analysis by Different Population Denominators in Different Time Bins

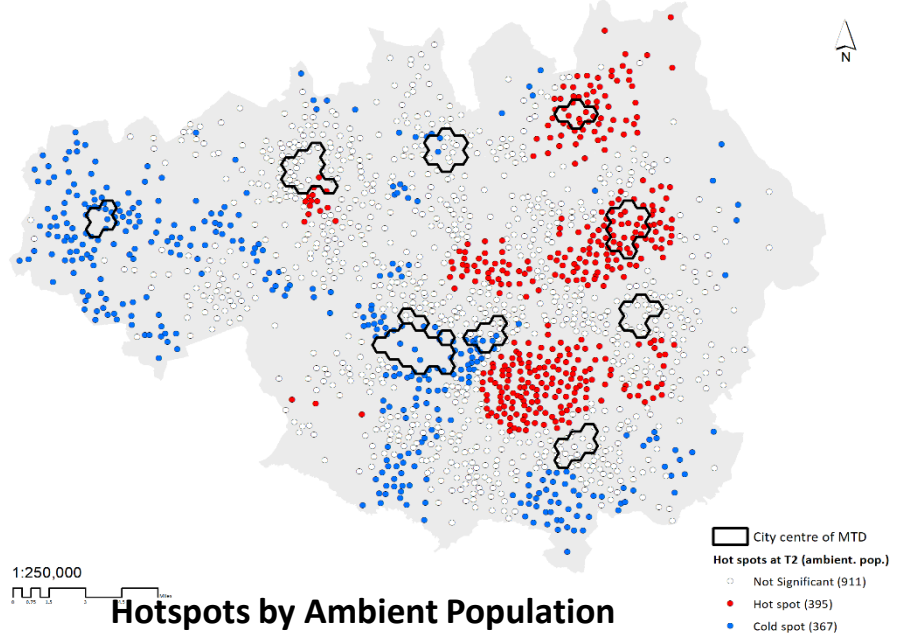
T2 = 10 am to 16 pm



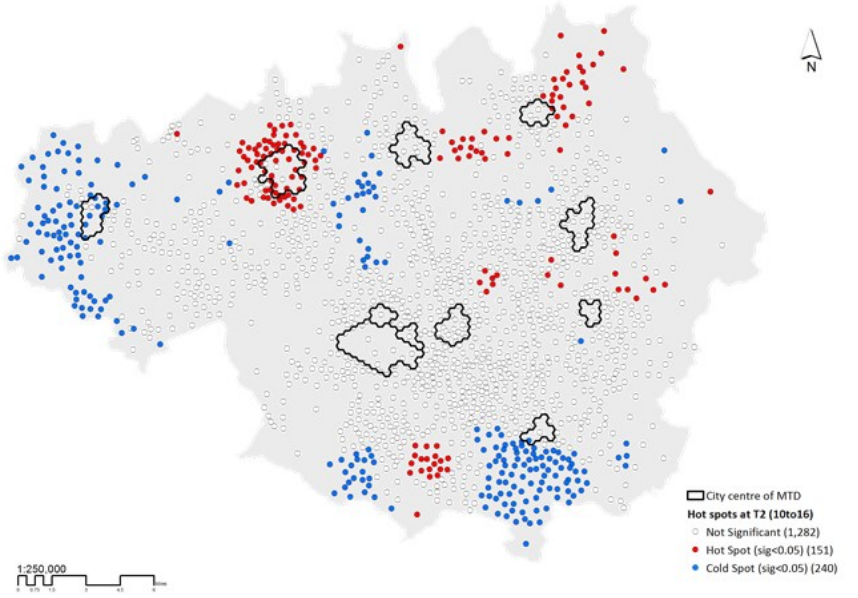
Crime Counts



Hotspots by Workplace Population



Hotspots by Ambient Population



Hotspots by Exposed Population

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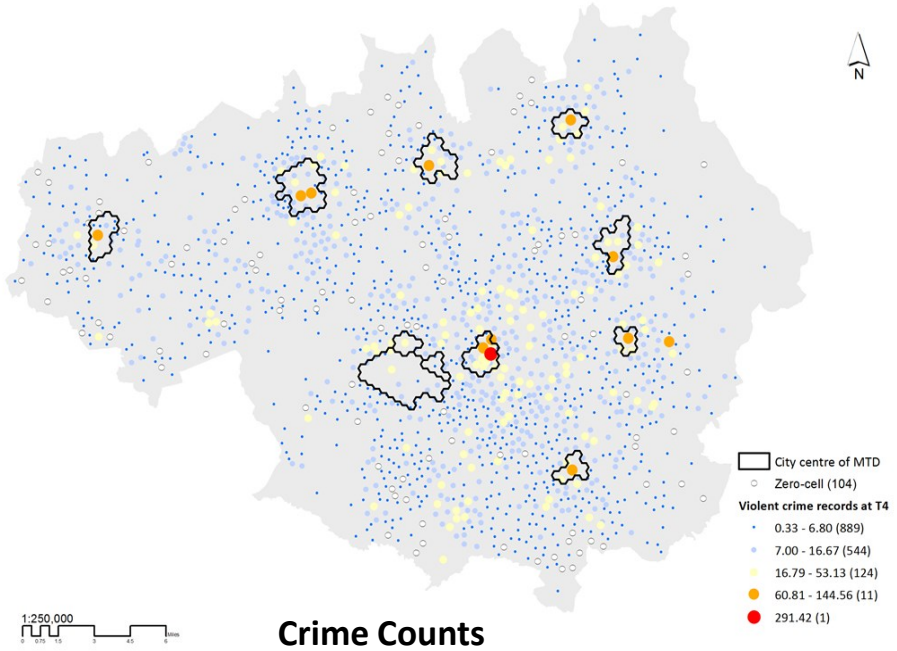
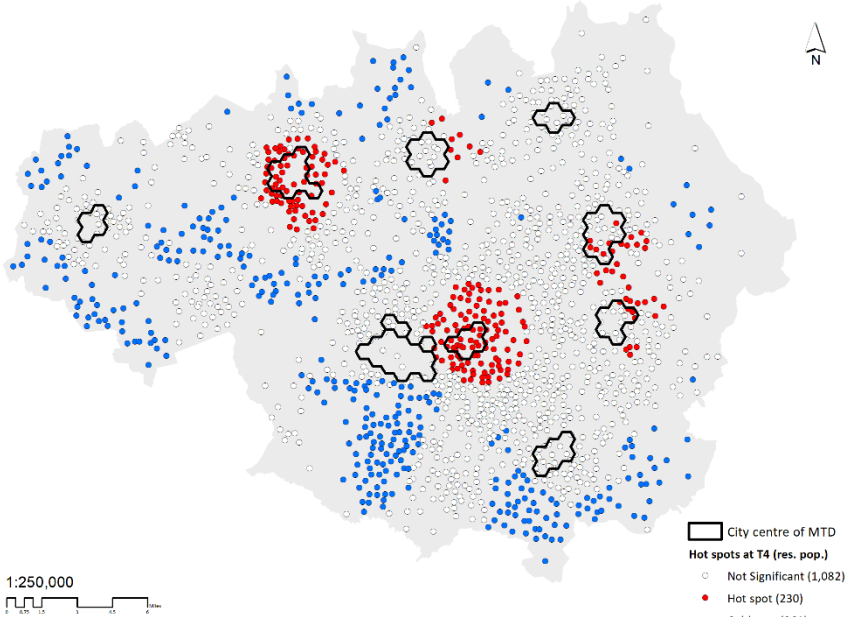
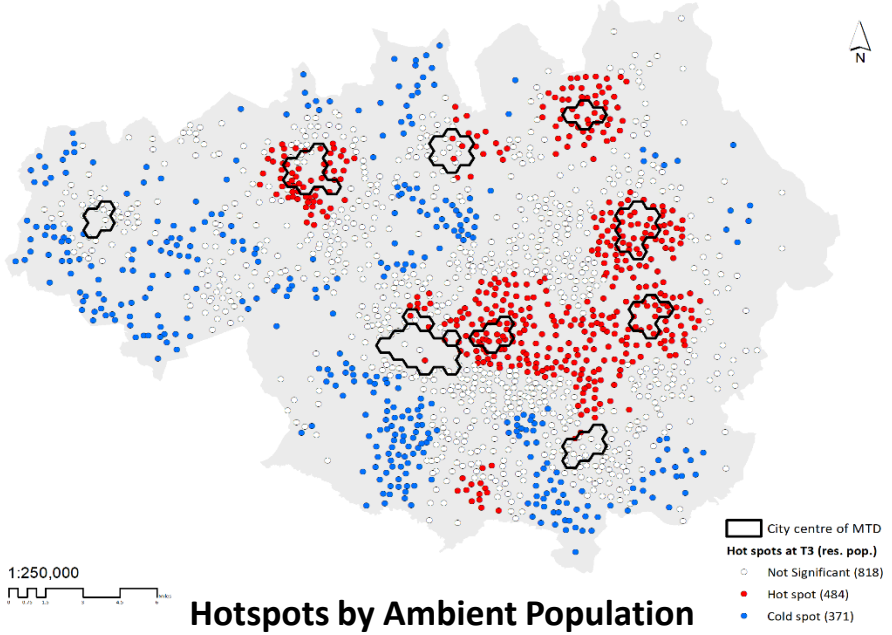
T4 = 19 pm to 7 am



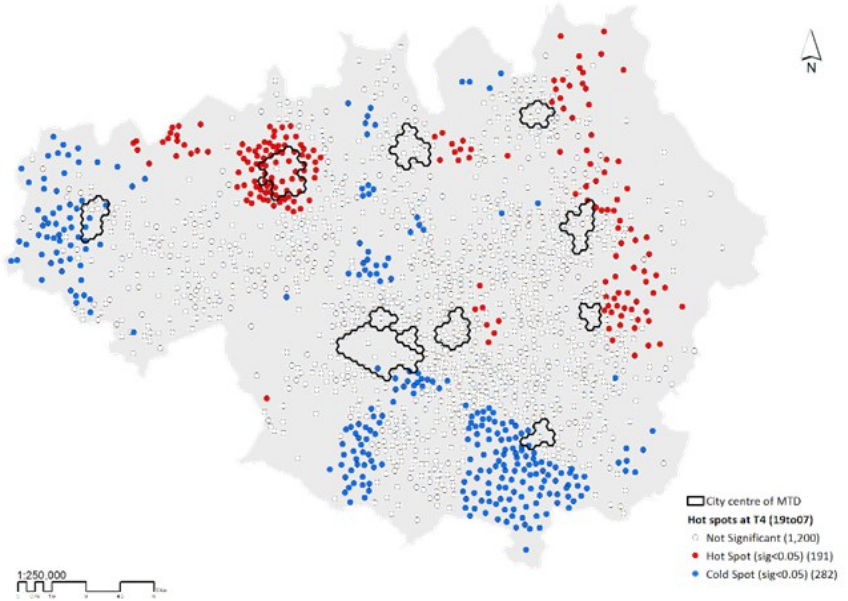
Crime Counts



Hotspots by Residential Population



Hotspots by Ambient Population



Hotspots by Exposed Population

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Conclusion

- The daily rhythms of the city – ambient and exposed populations.
- The exposed (theoretically correct?) population holds a higher correlation with the violent crime than the ambient population across multiple time bins.
- Different population denominators generate markedly different hotspots.
- Population denominators require to be sensitive to crime type.

Questions?

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