An exploration of fuel poverty in the private rental housing market in City of Glasgow

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Personal Introduction

- Using urban analytical approaches to solve social, economic, and environmental problems in our cities with new forms of urban big data.

- Approaches include but not limit to:
  - GIScience (GIS, remote sensing, spatial analysis)
  - Machine learning/statistics
  - Operations research
  - Sensor network
  - Urban climate modeling and instrumentation

- Teaching: Big Data & Urban Analytics, Programming Tools for Urban Analytics, and Urban Analytics Group Project

- Check out my staff and personal website to learn more: https://www.gla.ac.uk/schools/socialpolitical/staff/qunshanzhao/ or http://qunshanzhao.weebly.com/
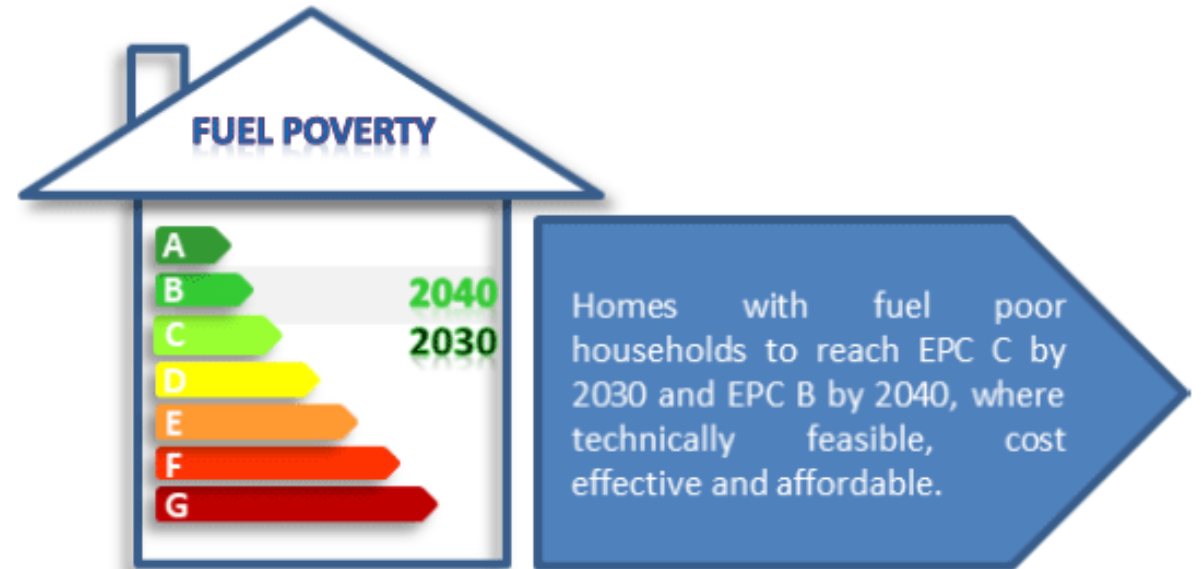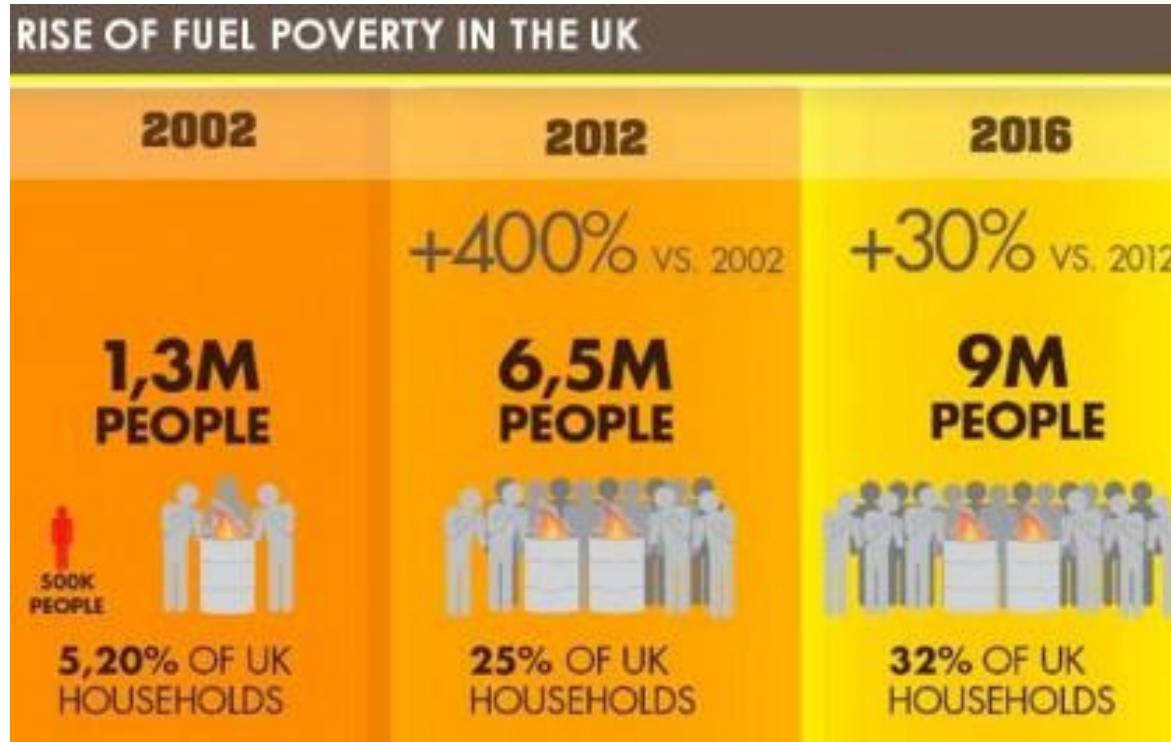
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- UBDC is a research centre that is jointly funded by the ESRC and the University of Glasgow.

- We promote the use of big data and innovative research methods to improve social, economic & environmental well-being in cities.

- We do this through:
  - World-leading Urban Research
  - Data Collection and Data Services
  - Teaching and Capacity Building

- *Education & Skills*
- *Urban Governance*

- *Housing, Neighbourhoods & Environment*
- *Transport & Infrastructure*

- *Urban Sensing & Analytics*

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Why study fuel poverty?

RISE OF FUEL POVERTY IN THE UK

2002	2012	2016
1,3M PEOPLE	+400% VS. 2002 6,5M PEOPLE	+30% VS. 2012 9M PEOPLE
500K PEOPLE		
5,20% OF UK HOUSEHOLDS	25% OF UK HOUSEHOLDS	32% OF UK HOUSEHOLDS

FUEL POVERTY

A
B   2040
C   2030
D
E
F
G

Homes with fuel poor households to reach EPC C by 2030 and EPC B by 2040, where technically feasible, cost effective and affordable.

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Traditional methods to understand fuel poverty

- Household and building survey (Rudge & Gilchrist, 2005)

- Official statistics and energy cost from electricity companies (Teller-Elsberg et al., 2016) and (Bosch et al., 2019)

- Qualitative and conceptual discussion (Baker et al., 2018)

- What's next??

Rudge, J., & Gilchrist, R. (2005). Excess winter morbidity among older people at risk of cold homes: A population-based study in a London borough. *Journal of Public Health*, *27*(4), 353–358. https://doi.org/10.1093/pubmed/fdi051

Teller-Elsberg, J., Sovacool, B., Smith, T., & Laine, E. (2016). Fuel poverty, excess winter deaths, and energy costs in Vermont: Burdensome for whom? *Energy Policy*, *90*, 81–91. https://doi.org/10.1016/j.enpol.2015.12.009#

Bosch, J., Palència, L., Malmusi, D., Marí-Dell'Olmo, M., & Borrell, C. (2019). The impact of fuel poverty upon self-reported health status among the low-income population in Europe. *Housing Studies*, *34*(9), 1377–1403. https://doi.org/10.1080/02673037.2019.1577954

Baker, K. J., Mould, R., & Restrick, S. (2018). Rethink fuel poverty as a complex problem. *Nature Energy*, *3*(8), 610–612. https://doi.org/10.1038/s41560-018-0204-2

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New forms of urban big data to understand fuel poverty

- Zoopla private rental listing data

- Energy performance certificate
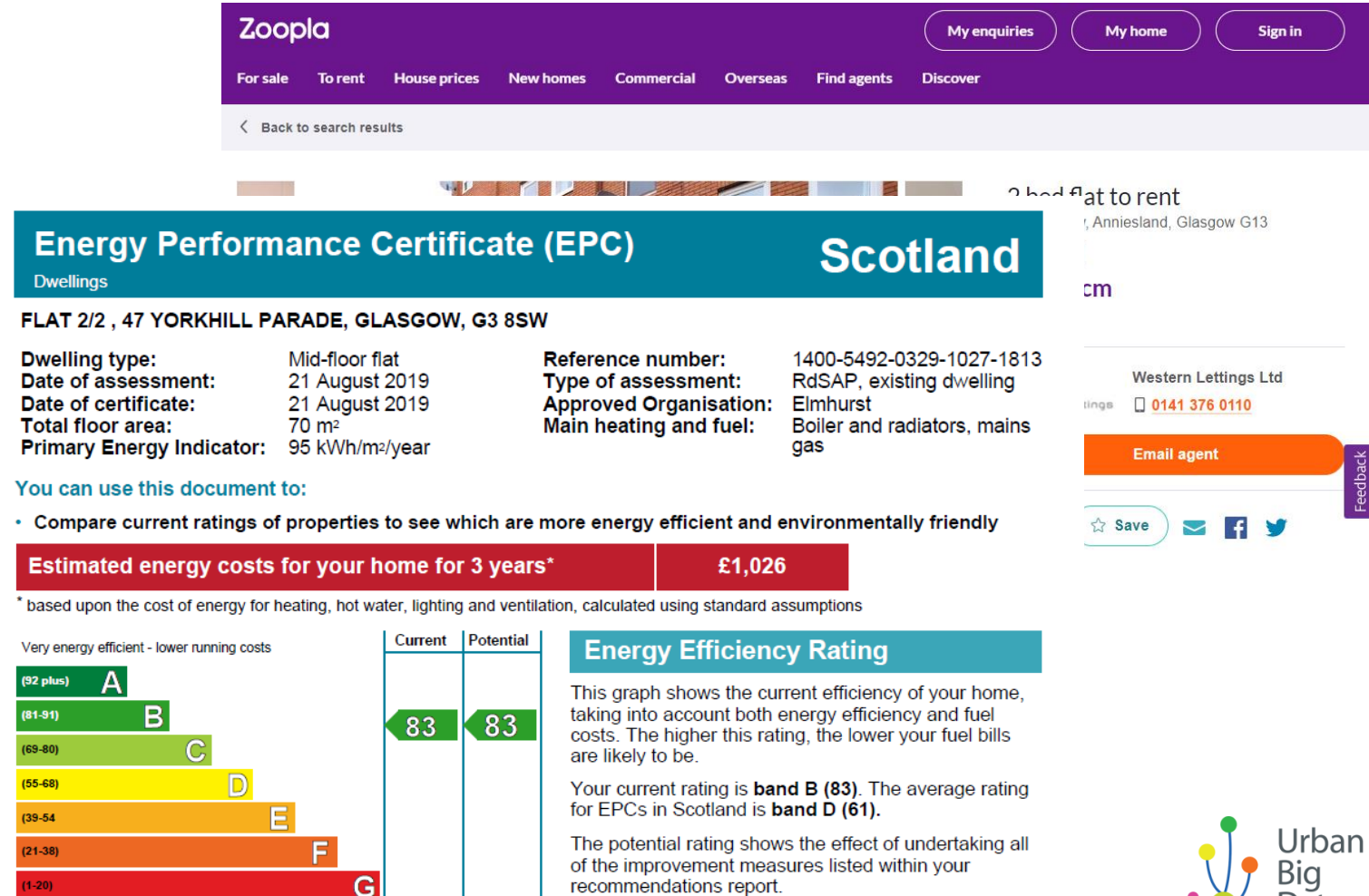
Zoopla Data

- Zoopla data can be obtained through UBDC data services for non-commercial research: https://www.ubdc.ac.uk/data-services/data-catalogue/housing-data/zoopla-property-data/. Feel free to check out!

- Zoopla data time range: 01/01/2010 - 31/03/2019

- Zoopla files: 188 csv, 44.3 GB

- Coverage: Great Britain (England, Wales, Scotland)

- Geographical unit: full postcode

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Scottish EPC Data

- Scottish EPC data can be obtained through Scottish Government:

  https://statistics.gov.scot/data/domestic-energy-performance-certificates

- EPC data time range: Oct 2012 - Mar 2020.

- EPC data: 2.5GB, 30 csv.

- Coverage: Scotland

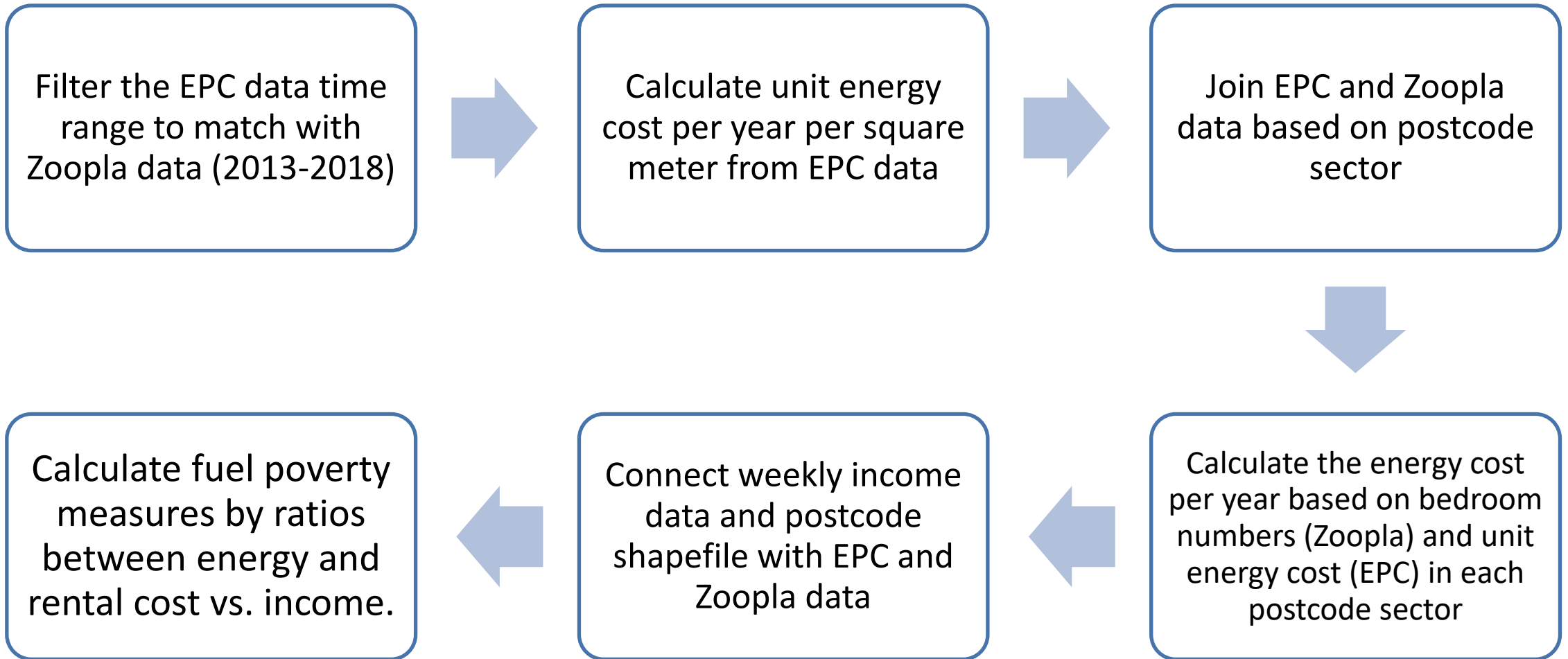- Geographical unit: postcode sector

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Other Data

- Weekly household average income estimate from Scottish Government:

  https://statistics.gov.scot/data/local-level-average-household-income-estimates-2014

- Scottish postcode directory files:

  https://www.nrscotland.gov.uk/statistics-and-data/geography/our-products/scottish-postcode-directory/2020-2

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Zoopla Data Cleaning: Big data to 'small' data

```
┌─────────────────────┐      ┌─────────────────────┐      ┌─────────────────────┐
│  Original data: 1.3m │  ⇒  │   Glasgow region:   │  ⇒  │  Glasgow City: 71k  │
│        rows          │      │        124k         │      │                     │
└─────────────────────┘      └─────────────────────┘      └─────────────────────┘
                                                                      ⇓
┌─────────────────────┐      ┌─────────────────────┐      ┌─────────────────────┐
│   Calculate yearly   │  ⇐  │    Data cleaning    │  ⇐  │  Rental properties: │
│   rental cost at     │      │  (missing values,   │      │        18k          │
│   postcode sector    │      │   outliers, time    │      │                     │
│        level         │      │    range): 15k      │      │                     │
└─────────────────────┘      └─────────────────────┘      └─────────────────────┘
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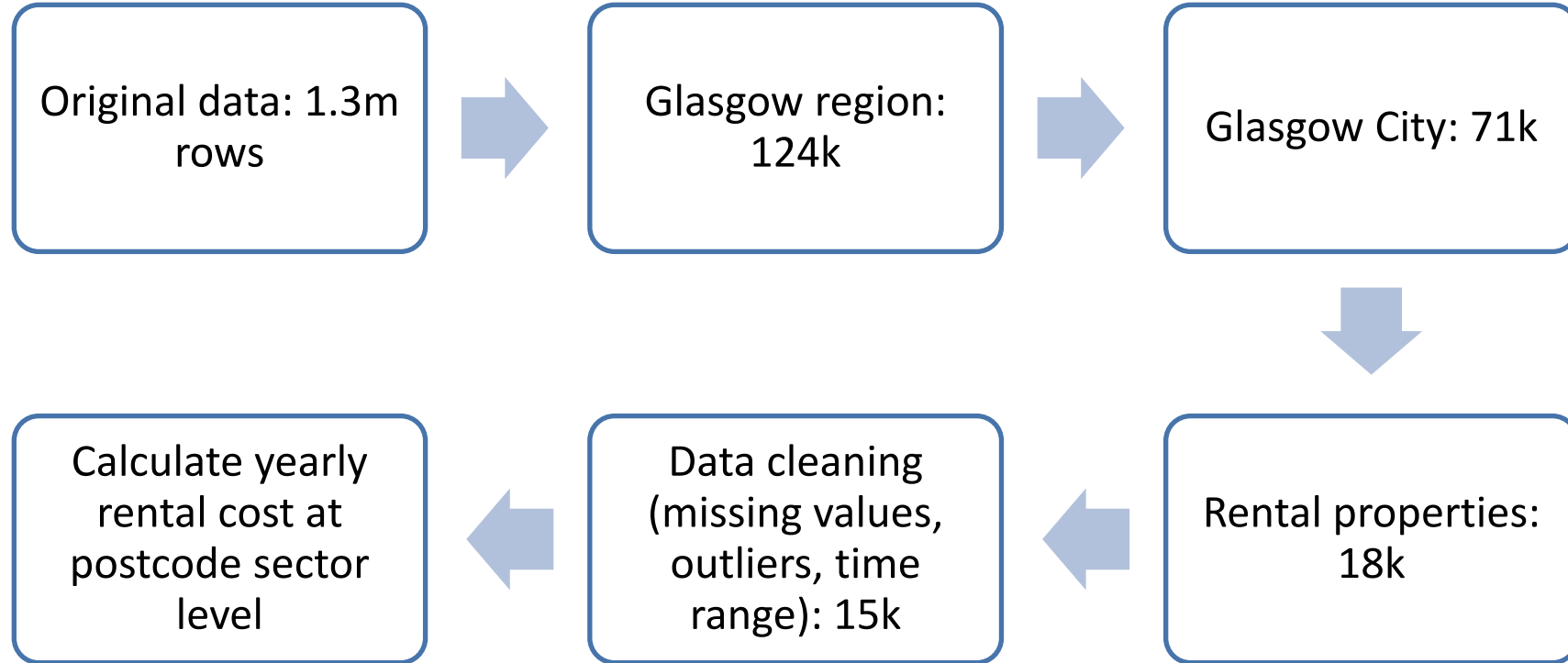
Further Data Cleaning and Analysis

Filter the EPC data time range to match with Zoopla data (2013-2018)

→

Calculate unit energy cost per year per square meter from EPC data

→

Join EPC and Zoopla data based on postcode sector

↓

Calculate fuel poverty measures by ratios between energy and rental cost vs. income.

←

Connect weekly income data and postcode shapefile with EPC and Zoopla data

←

Calculate the energy cost per year based on bedroom numbers (Zoopla) and unit energy cost (EPC) in each postcode sector

1 bedroom: 35 m2, 2 bedrooms: 70 m2, and 3 bedrooms: 105
Source: https://hqnetwork.co.uk/download.cfm?doc=docm93jijm4n2909.pdf&ver=5651

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Fuel Poverty Measures

$$\alpha = Yearly\ energy\ cost$$

$$\beta = Yearly\ rental\ cost$$

$$\gamma = Yearly\ household\ income$$

$$Fuel\ Poverty = \frac{\alpha}{\gamma}$$

$$Rental\ Poverty = \frac{\beta}{\gamma}$$

$$Deprived\ Poverty = \frac{\alpha + \beta}{\gamma}$$
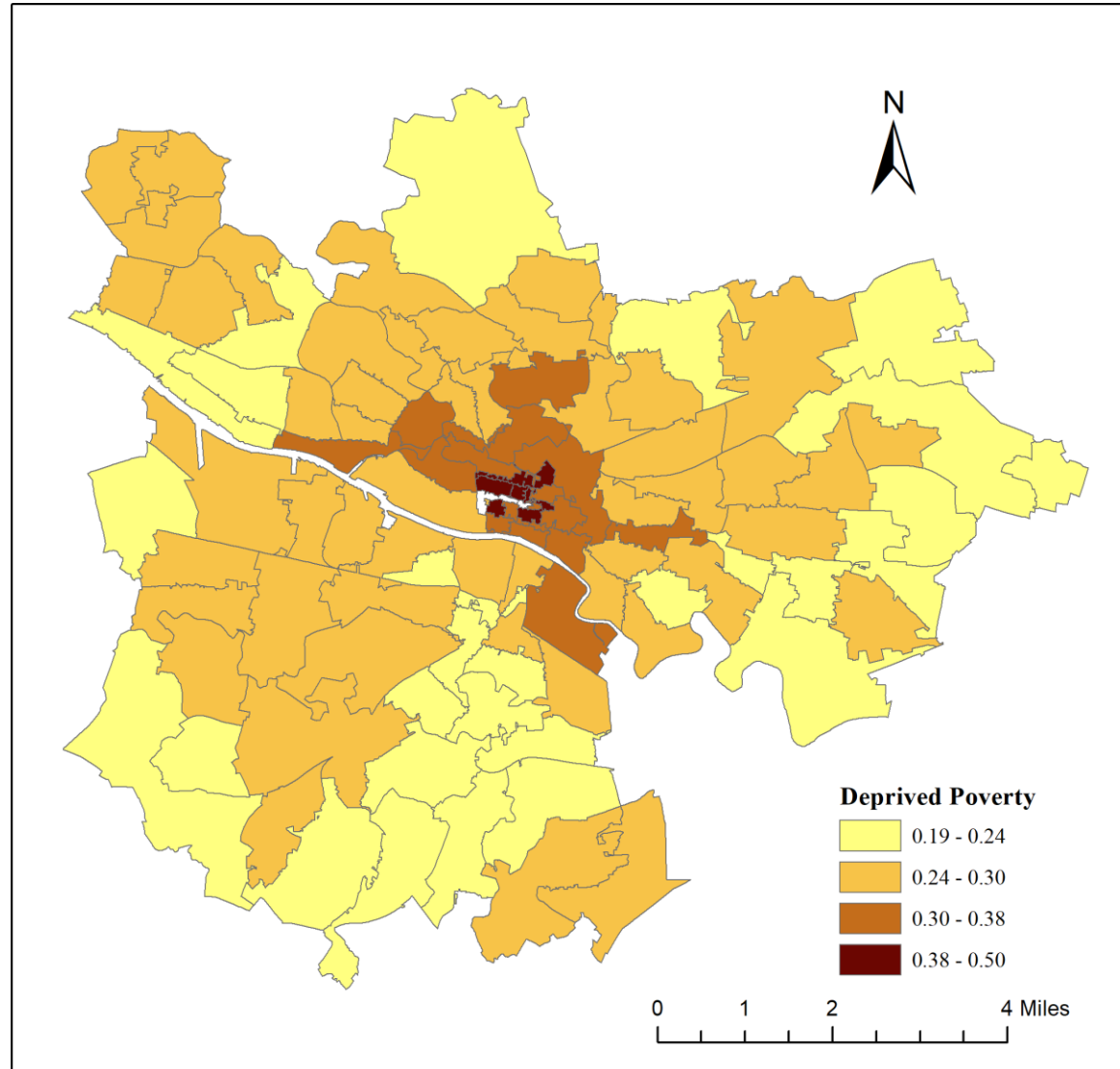
Fuel Poverty + Rental Poverty = Deprived Poverty!!

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Results – fuel poverty
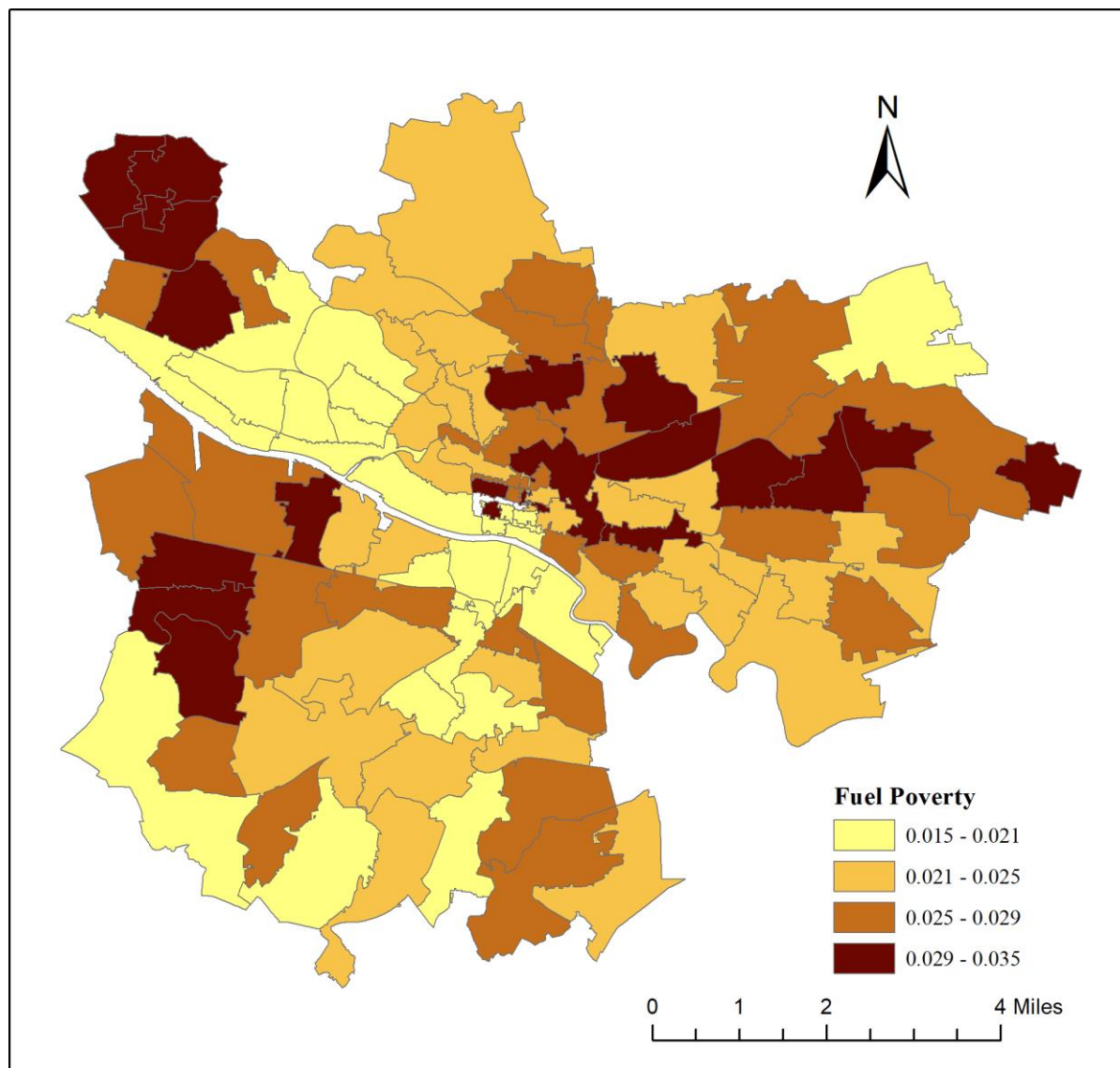
Results – rental poverty
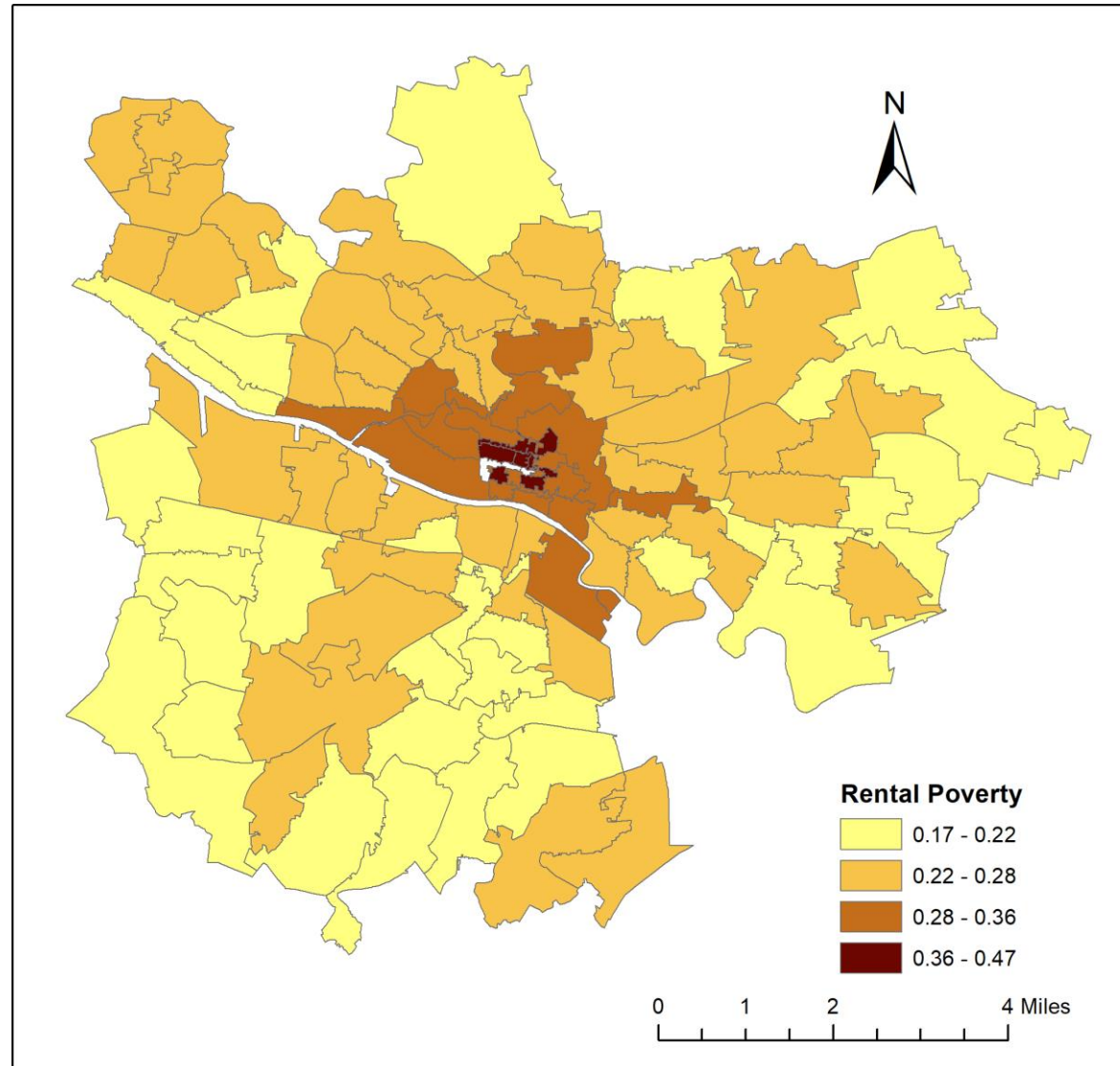
Results – deprived poverty

Deprived Poverty
- 0.19 - 0.24
- 0.24 - 0.30
- 0.30 - 0.38
- 0.38 - 0.50

0 1 2 4 Miles

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Summary

- Fuel poverty has been observed in the east end of Glasgow, as well as northwest and southwest of the city.

- High rental cost has been confirmed in the city centre, and gradually decrease from the city centre to the outskirt.

- The most deprived areas is in the north of the city centre

- Results illustrate the value of using new forms of urban big data to understand fuel poverty, and more generally, a new way to tackle traditional urban questions.

Future Work

- Extend the study area to the major cities of Scotland (and potentially England and Wales).

- Analyze the fuel poverty for homeowners.

- Further understanding of fuel poverty with other data such as Scottish census.

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Related publication

- Vonnak, R., & Zhao, Q. (2020). Fuel Poverty and Income Deprivation in Bristol, UK. GISRUK 2020. 25th Geographical Information Science Research UK Conference (GISRUK 2020). http://eprints.gla.ac.uk/215736/1/215736.pdf

Thank you!
Questions?

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UBDC website: https://www.ubdc.ac.uk/