HIGH-RESOLUTION THERMAL SATELLITE IMAGERY FOR ENERGY EFFICIENCY

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INTRODUCTION

- Satellite Vu: Earth observation company delivering 3.5m resolution thermal imagery
  - Satellites launching 2022
  - Applications include agriculture, water quality and built environment…
- Direct emissions from buildings 17% of total UK greenhouse gas emissions [1]
- Efficiency assessed using Energy Performance Certificate (EPC)
  - Required when property is built, sold or rented
  - EPC Band (*A: very energy efficient* to *G: not energy efficient*) assigned based on features including those in Fig. 1
    - Improving these features should reduce heat losses detectable from Satellite Vu data, so…

are EPC ratings related to temperature?

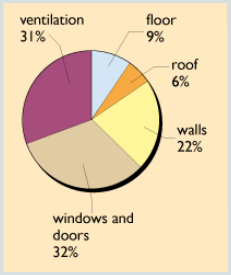

Figure 1: Contributions to overall heat loss by building elements for a reasonably modern end-of-terrace house. [2]

METHODOLOGY

Ahead of satellite launch, Satellite Vu have flown their engineering model camera over regions of interest. Three small areas were selected from the data collected during these flights. Target areas included lots of large houses with EPCs which could be distinguished in the 1m resolution imagery (satellite data will be 3.5m resolution). The areas analysed were parts of:

1. Liverpool L20
2. Manchester M34/Stockport SK16
3. Wirral CH43

Area 1 consisted of mostly semi-detached houses and the available imagery was captured at 19:48 on 22/4/21. After analysis of this area, area 2 was selected for its later timestamp (22:18 on the same day) and greater concentration of detached houses. Area 3 imagery, also focused on detached houses, was from 18:41 on 5/3/21.

ANALYSIS

Thermal and EPC data for each area were analysed as follows using QGIS and Python in Jupyter Notebooks:

1. Inspect and clean EPC data
2. Match addresses in EPC data to Ordnance Survey feature ID for each property
3. Use feature IDs of OS polygons (see Fig. 2) to find:
   a. Mean brightness temperature for area of house alone
   b. Standard deviation of brightness temperature values within area of house + 2-pixel (i.e. 2m) buffer
   c. Mean brightness temperature of 2-pixel buffer alone since most heat loss is through windows, doors and walls (see Fig. 1)
4. Analyse relationships between EPC features and thermal signatures of houses

Figure 2: Snapshot of QGIS map with OS polygons (black lines) showing buildings and roads on top of Satellite Vu brightness temperature data. Each polygon has a unique feature ID. [3]

- No clear relationships between EPC rating or other features and brightness temperature for this data from aerial campaigns (similar results for all statistics and all areas)
- Various issues which can be addressed using data from future flights and satellites before ruling out relationships…

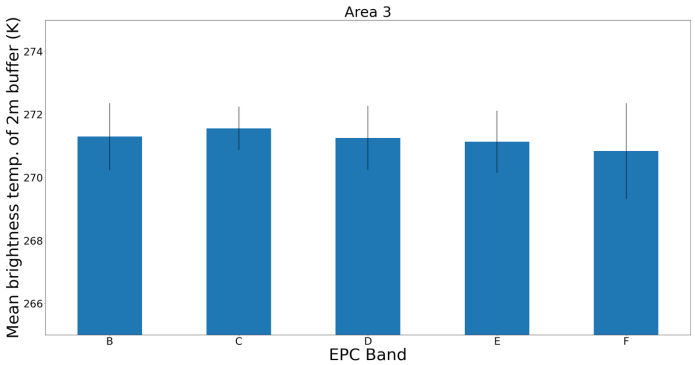

Figure 3: Mean brightness temperature of a 2m buffer around houses with an EPC in Area 3.

CHALLENGES

Brightness temperature variability due to solar effects	→	Solar filter on satellite cameras
Images taken close to peak of daily heating demand curve	→	Satellite Vu constellation will allow 10 revisits per day
Small sample size (~300 houses)	→	Satellites will provide global coverage, automatic address matching trialled here will speed up process

CONCLUSION

In the present study, no conclusive relationship between a house's brightness temperature signature and its EPC was found. However, it is expected that this will change as new Satellite Vu data is collected for different times of day and year with corrections for solar effects.

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REFERENCES

1. The Climate Change Committee (2020). *The Sixth Carbon Budget: Buildings*
2. The Open University. Online course notes, *Energy in Buildings: 2.4.1*. Last accessed 23/08/21
3. Ordnance Survey MasterMap Topographic Layer [GML geospatial data]