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Using spatial data to identify suitable locations for Local Work Hubs

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Using spatial data to identify suitable locations for Local Work Hubs

Produced by Dan van der Horst & Kira Myers (University of Edinburgh) for the Construction Scotland Innovation Centre

March 2022.

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- Non-technical project summary (slides 3-7)

- Technical report;
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  - Methods (GIS & Modelling; slides 12-15)
  - Example applications (GIS maps; slides 16-44)

- Notes on further/future use + references (slides 45-46)

Non-technical project summary

- Dependent on location*, new local work hubs could provide a number of social, environmental and economic benefits.
- We identified and collected available spatial data to represent these benefits (performance criteria).
- We developed GIS** methods to assess the potential of different locations, dependent on the spatial distribution of these criteria.
- We illustrate several potential applications:
  - (a) Identifying potential local demand for villages/towns/neighbourhoods (dependent on population size, user group characteristics, road networks..)
  - (b) Assessing the relative suitability of a given location / set of locations (scoring and ranking existing buildings or available building site).
  - (c) Identifying catchment areas of selected locations (e.g. to assess the number of potential users living within an x minutes walk/bike ride/ car journey)

* Plus design and management
** Geographical Information Systems; software to analyse spatial data

Background: what are work hubs?

- Desk-based work used to take place in the offices of the employer. The revolution in information & communication technologies (ICT) has enabled people to work more remotely & flexibly.

- In the 1990s this led to the emergence of internet cafes (catering especially for leisure and private computer users who did not have a computer and internet at home, or who were travelling) and the first (more spacious and better kitted out) co-working spaces for and by IT professionals; often self-employed but keen to collaborate. The novelty of the concept was perhaps more on co-working as an activity, but it also shaped (and was constrained by) the space where it took place.

- Cheaper hardware (laptops, smart phones) and mobile high-speed internet have killed the cubicle-style internet cafes. People can now open their laptop and access internet in most 'normal' cafes. Co-working spaces or work hubs have evolved and grown in diversity and functionality. Some cater specifically for start-ups, and many offer meeting rooms. Public libraries have diversified to offer co-working facilities. Dedicated 'work cafes' cater more explicitly for individual laptop users in a 'normal' but quiet café environment. They may offer some IT services (e.g. better connectivity), and may charge for space use by the hour with free hot drinks provided.

- For the purpose of this study, we use the term 'work hub' broadly, to indicate a 'working place with benefits' for people whose options are otherwise limited to work from home and/or make long and costly commutes to the offices of their employer. We have added the word 'local' to clarify that our focus is more on enabling people to work locally and commute less (in contrast with more car-centric ideas, like work hubs by a motorway junction).

Why are local work hubs important?

- Pandemic has speeded up the trend to work more from home
- No going back: In Scotland, 31.3% of businesses intend to use increased homeworking as a permanent business model going forward (Office for National Statistics, 2021)
- Whilst businesses can save money on office space, employees who normally commute, can save time and money
- But some employees may face barriers to working more from home (e.g. lack of space and facilities – affecting especially disadvantaged socio-economic groups).
- Various dis-benefits associated with extensively working from home (e.g. social isolation, lack of exercise, impact on work-life balance, impact on energy bills).
- Local work hubs could be designed to help to overcome some of these barriers and mitigate these dis-benefits.
- Local work hubs may be able to provide new/additional benefits (e.g. child care, IT support, training, skills exchange, building local social capital).
- Local work hubs could be co-located with existing services (schools, libraries..), or could be developed in currently vacant commercial premises (e.g. former high street shops that didn't survive the pandemic and/or the competition with on-line shopping)

Links to recent Scottish policies and projects

- Policy fit: The idea of local work hubs aligns with a number of existing policies. For example, key themes in Scotland's National Planning Framework (NPF4; draft for consultation) include local living, 20 minute neighbourhoods, town centre regeneration, sustainable living, place making, local jobs, digital connectivity, reducing car-dependency and the need to travel.

- Our analysis is informed by Construction Scotland Innovation Centre's NearHome project, which was funded by Transport Scotland under the Work Local Challenge Programme. NearHomes was established to support the creation of local work hubs to respond to changes in work and travel patterns. It demonstrates the potential for local work hubs by repurposing existing buildings in a sustainable manner, utilising Scottish materials, digital design and offsite manufacturing

Project outcomes

- Reviewed existing analytical approaches; we didn't find relevant existing studies about the siting of work hubs (i.e. it is still novel), but there are various analogies (i.e. siting other types of services), using (GIS) 'location-allocation' models (similar to what we use in this report).

- Identified relevant variables & publicly available datasets for a Scotland oriented approach (in this report)

- Developed a generic GIS mapping approach for Scotland and create (example) maps to communicate the methods, variables and possible applications (in this report)

- Sharing the work, eliciting feedback, participating in discussions going forward (ongoing beyond this report / open invitation)

Technical Report

This report consists of three main sections;

1. Input Data (selected variables/ key siting criteria)

2. GIS Method

3. Example applications (GIS maps, case studies in Scottish Borders, Edinburgh):
    a. Visualising individual variables/criteria (thematic maps for 'eyeball' analysis)
    b. Visualising catchment areas (selection of travel modes and travel times)
    c. Basic models (demand only) versus combined models (economic + environmental + social criteria)
    d. Whole area assessment versus the ranking of pre-selected sites (example: libraries)

Please note that:

- *For this report we chose to illustrate our approach with maps from SE Scotland and the city of Edinburgh. We could easily replicate this for other parts of Scotland.*

- *This report is in powerpoint format to facilitate visualisation of our analysis. The output maps are all aligned for visual comparison; the reader can use the arrow keys to go forwards and backwards; the map outline remains static but the thematic contents change*

- *The 'notes' section underneath the slide may provide additional technical explanation*

For a work hub, what would success look like?

Effective work hubs will be multi-functional, designed and managed to address local needs and opportunities. Performance criteria will vary dependent on stakeholders & user groups:

Economic	Environment & health	Social
Cost recovery for the building	Reduce car use	Reduce travel time
Occupancy rate	Reduce heating demand (@ home)	Direct cost saving (travel,…)
Increased labour participation	Increase active travel	Social capital & networking
Improved labour productivity	Offer or facilitate physical exercise (group or individual)	Scope for collective action; car-share, child care, bulk-buying…
Multiplier effects (co-located) e.g. printing, IT, laundry services, nursery, café…	More ergonomic furniture, ambient temperature, better indoor air quality..	Mental health e.g. relief for crowded households, lone single residents…

This table is illustrative rather than definitive; we welcome feedback.

Data Sources: Demographics

| Use	Data	Unit	Date	Scale	Notes	Source
Predicted Future Work from Home per Industry (Predicted Future WFH Demand)	Future homeworking intentions per industry	Surveyed percent of businesses	April-May 2021	Scotland	These datasets were combined by multiplying the number of people employed per industry by the future homeworking intention percentage for the corresponding industry. Where there was no corresponding industry in the ONS dataset, the all industries percentage was used except for agriculture, mining, and electricity/gas supply industries which were assumed to not be suitable for any homeworking.	(Office for National Statistics, 2021)
	Industry	Number of employed people aged 16 to 74/ industry/ datazone	2011	Datazone		(Scotland's Census, 2011)
Vulnerability Indicator	Person per room	Number of households with >1 person per room/datazone	2011	Datazone	Sum the over 1.0 and up to 1.5 persons per room and over 1.5 persons per room categories * >1 is defined as overcrowded (Cable and Sacker, 2019)	(Scotland's Census, 2011)
	Dependent children in households	Number of dependent children/datazone	2011	Datazone		(Scotland's Census, 2011)
	Lone parent households with dependent children	Number of lone parents/datazone	2011	Datazone		(Scotland's Census, 2011)
Emissions Indicators	Method of travel to work	Number of people who travelled by car, van, or taxi to work/datazone	2011	Datazone	Sum the driving a car or van and taxi or minicab categories	(Scotland's Census, 2011)
	Distance of travel to work	Number of people who travelled more than 10km/ datazone	2011	Datazone		(Scotland's Census, 2011)

Data Sources: Spatial

Scale	File or Geopackage Name	File Type	Content Date	Geographic Coordinate System	Original Extent	Source
Libraries	pub_lib	Points	February 2022	GCS_OSGB_1936	Scotland	(Improvement Service, 2022)
Buildings	main_local_buildings in OpenZoomstack	Polygons	December 2021	GCS_OSGB_1936	Great Britain	(Ordnance Survey, 2021a)
Datazone Boundaries	Boundary-Line	Polygons	October 2021	GCS_OSGB_1936	Great Britain	(Ordnance Survey, 2021b)
Local Authority Boundaries	Boundary-Line	Polygons	October 2021	GCS_OSGB_1936	Great Britain	(Ordnance Survey, 2021b)
Road Network	OS Open Road	Lines	October 2021	GCS_OSGB_1936	Great Britain	(Ordnance Survey, 2021c)

Models and Input Variables

I - Basic Model - Demand Only (i.e. number of potential users within catchment area)

- Predicted Future WFH Demand ⟶ Input 1 Score*

* Examine demographic differences after location allocation

II – Combined Model - Demand (as above)+ Travel Emissions (environmental) + Vulnerability (social)
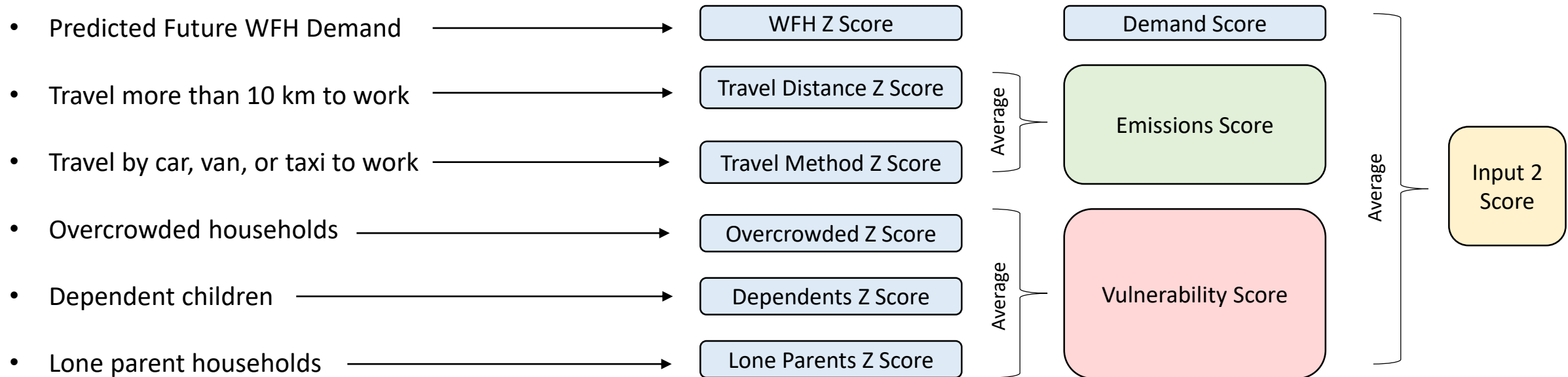
GIS Method (I): data zones, polygons to points

The problem which stimulates the spatial analysis approach of this study is that the smallest geographic unit available for the demographic data (from the Census) is the data zone level. Data zones are areas, represented as polygons in programs for spatial analysis such as ArcGIS, which cannot be used for location allocation network analysis as there needs to be individual points to serve as demand points for the calculation. The following slide outlines the method used to represent the data zone level demographic information as points suitable for the network analysis.
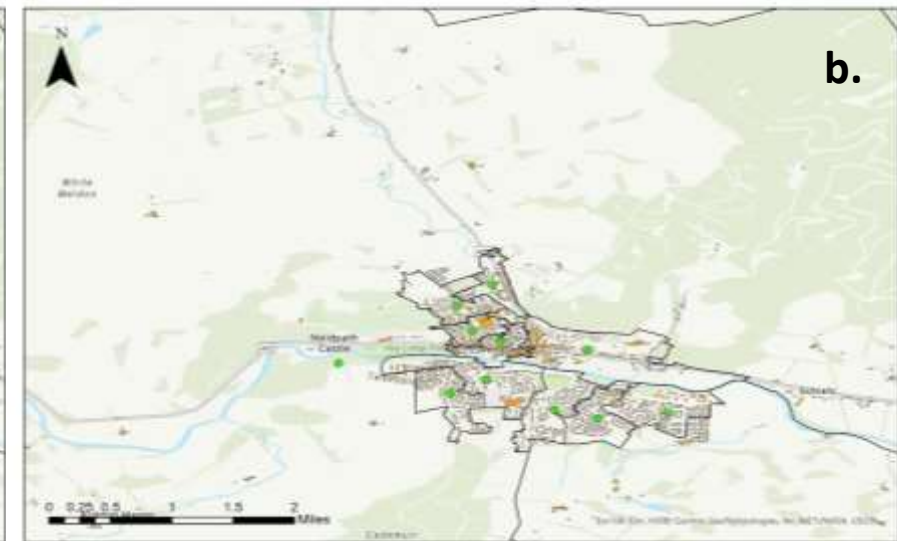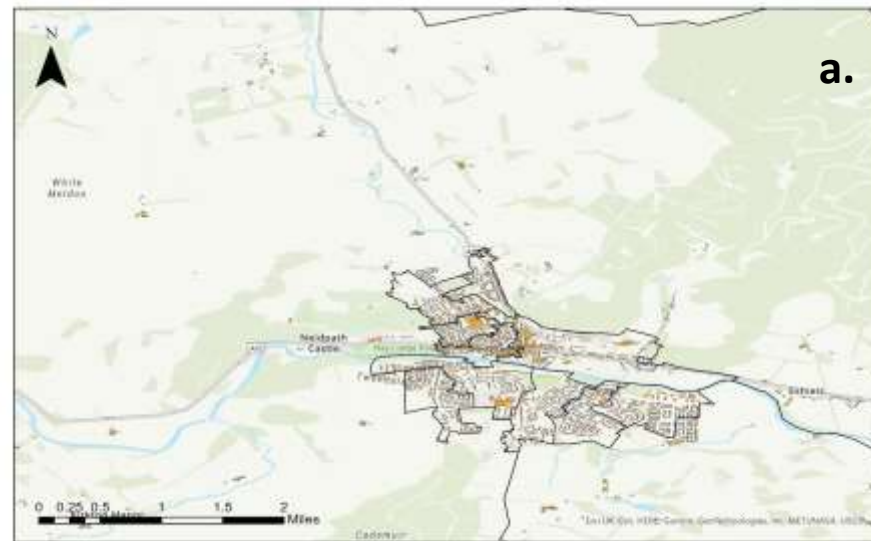
(Continued)

a. A building shapefile forms the basis for calculating centroids.

b. One centroid per data zone is created based on the distribution of the buildings. All data zone level demographic information is then joined to the corresponding centroid.*

c. Using the ESRI built-in road network, drive times around each centroids are calculated, and the data values from all centroids which fall within the polygon are summed.

d. The location allocation process selects the centroid with the greatest summed value from the centroids which fall within its drive time polygon.


Legend

|			
🟧 Buildings	🟢 Centroids	🟥 5min Drive Time	— Serviced Centroids
▢ Data Zones	— Road Network	⭐ Selected Hub	

14
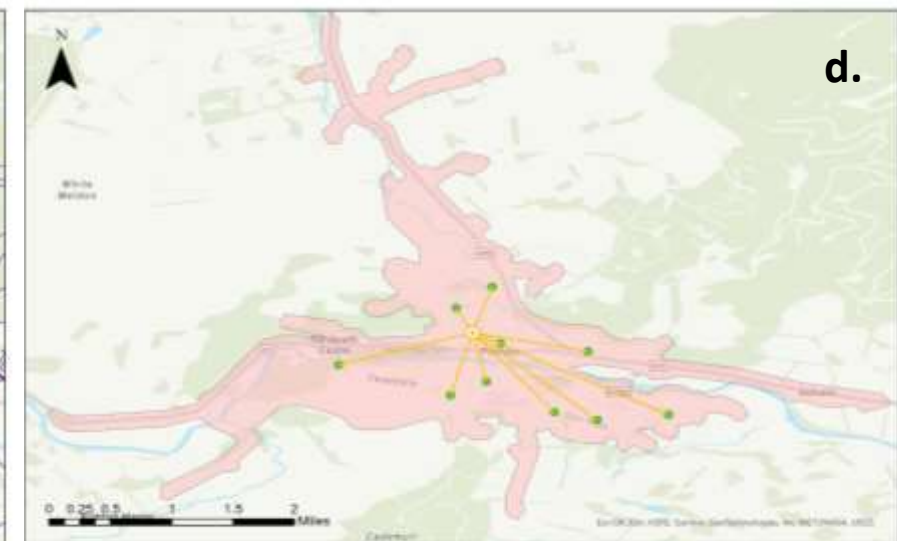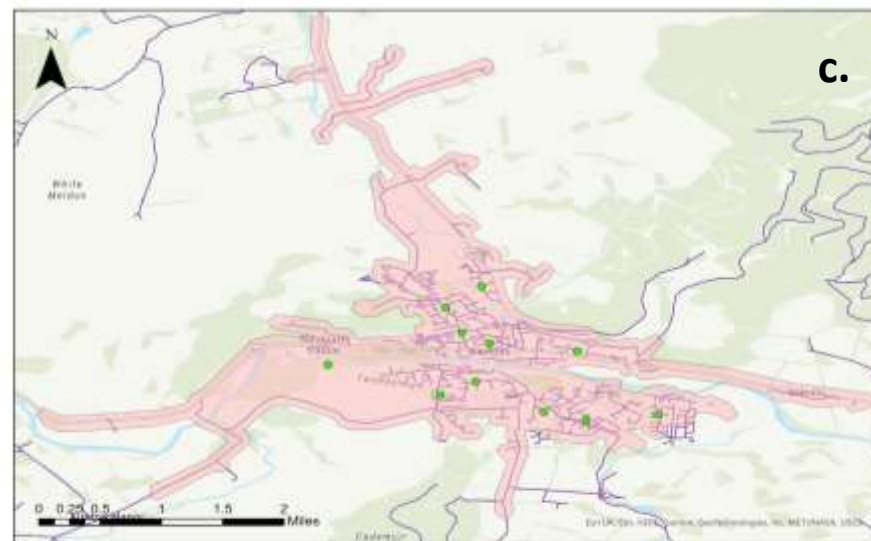
GIS Method (II): generic steps

1) Spatially Join the building shapefile to the datazone outlines to know which datazone each building is in.

2) Use the Mean Center function to calculate a centroid based on the distribution of buildings within each datazone.

3) Join the Input data csv file to the centroid based on the corresponding datazone. You then have one centroid per datazone with the Census datazone level data attached to that centroid.

4) Conduct a location allocation network analysis setting the facilities and demand points as the building centroid. Choose to weight the demand points based on the score from either Input method 1 (purely potential to work from home) or 2 (potential to work from home and vulnerability and emissions factors). Change the direct to "towards the facility," the cutoff to either 5 or 10 minutes, the facilities to 5, and the type to "maximize attendance."*

5) Export the 5 selected facilities and use these to conduct a Service Area Network Analysis to generate drive time polygons around the facilities. Change the direction to "towards the facility" and the cutoff to either 5 or 10 minutes.

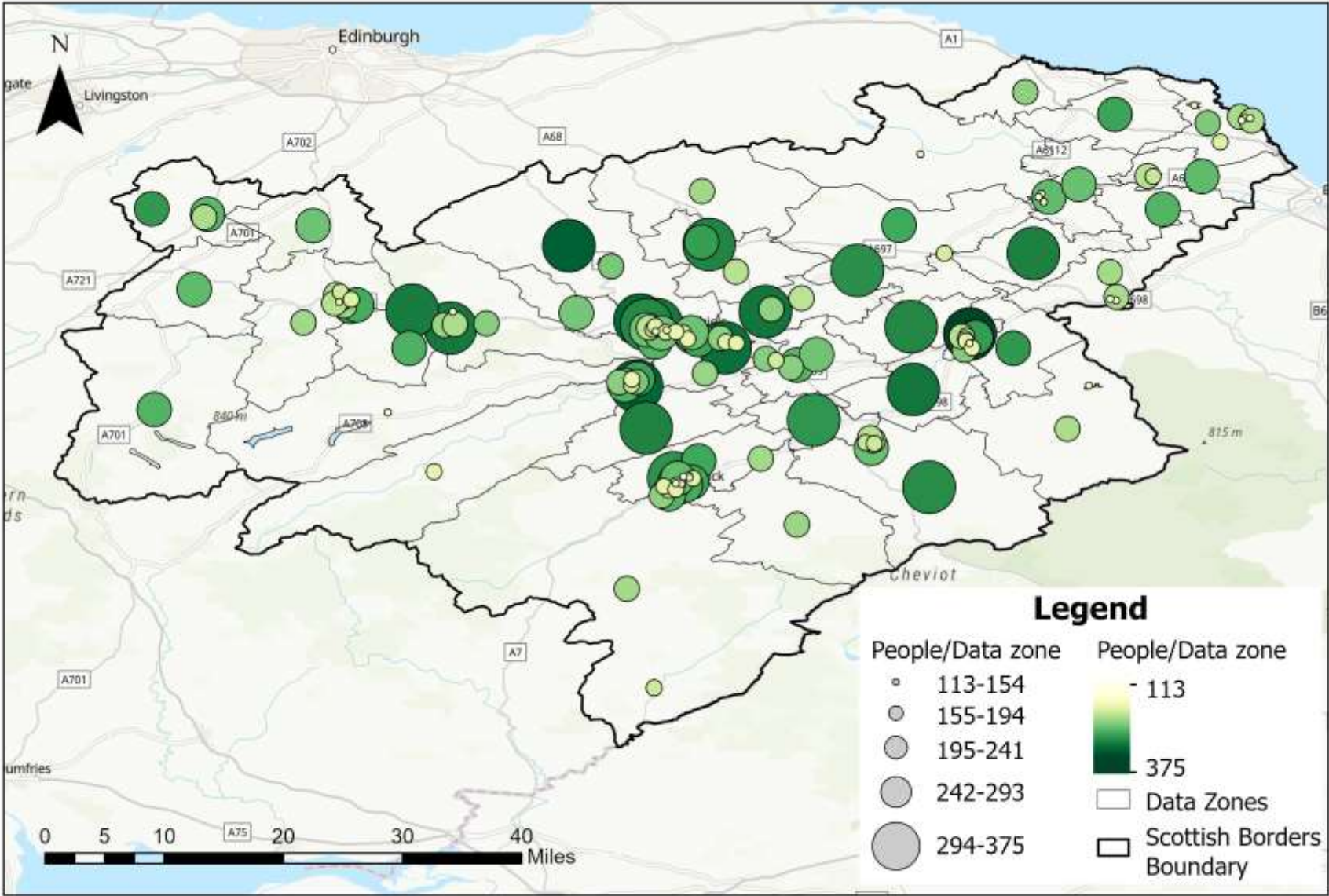# Example maps of individual variables (siting criteria)
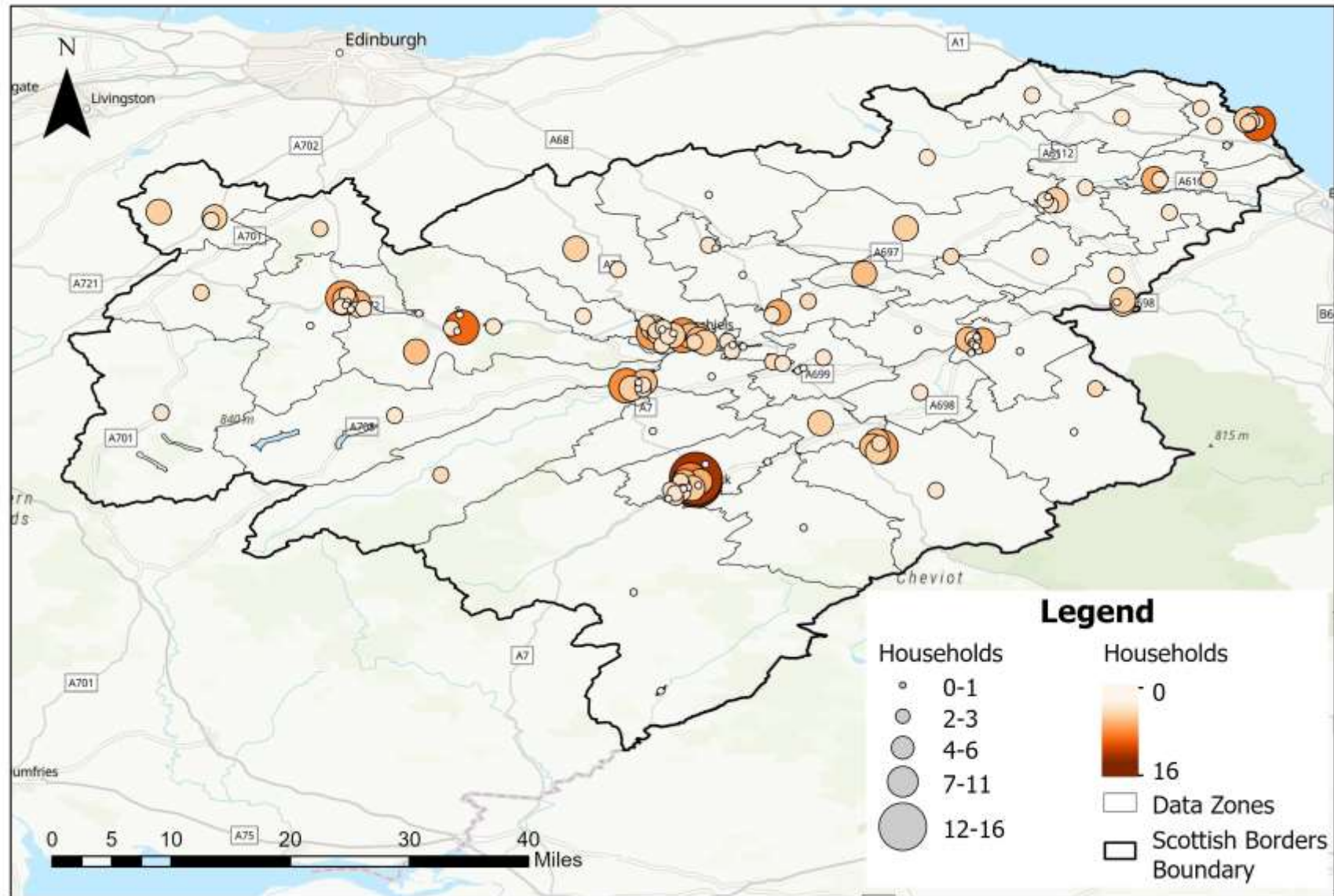
Predicted Work From Home Demand
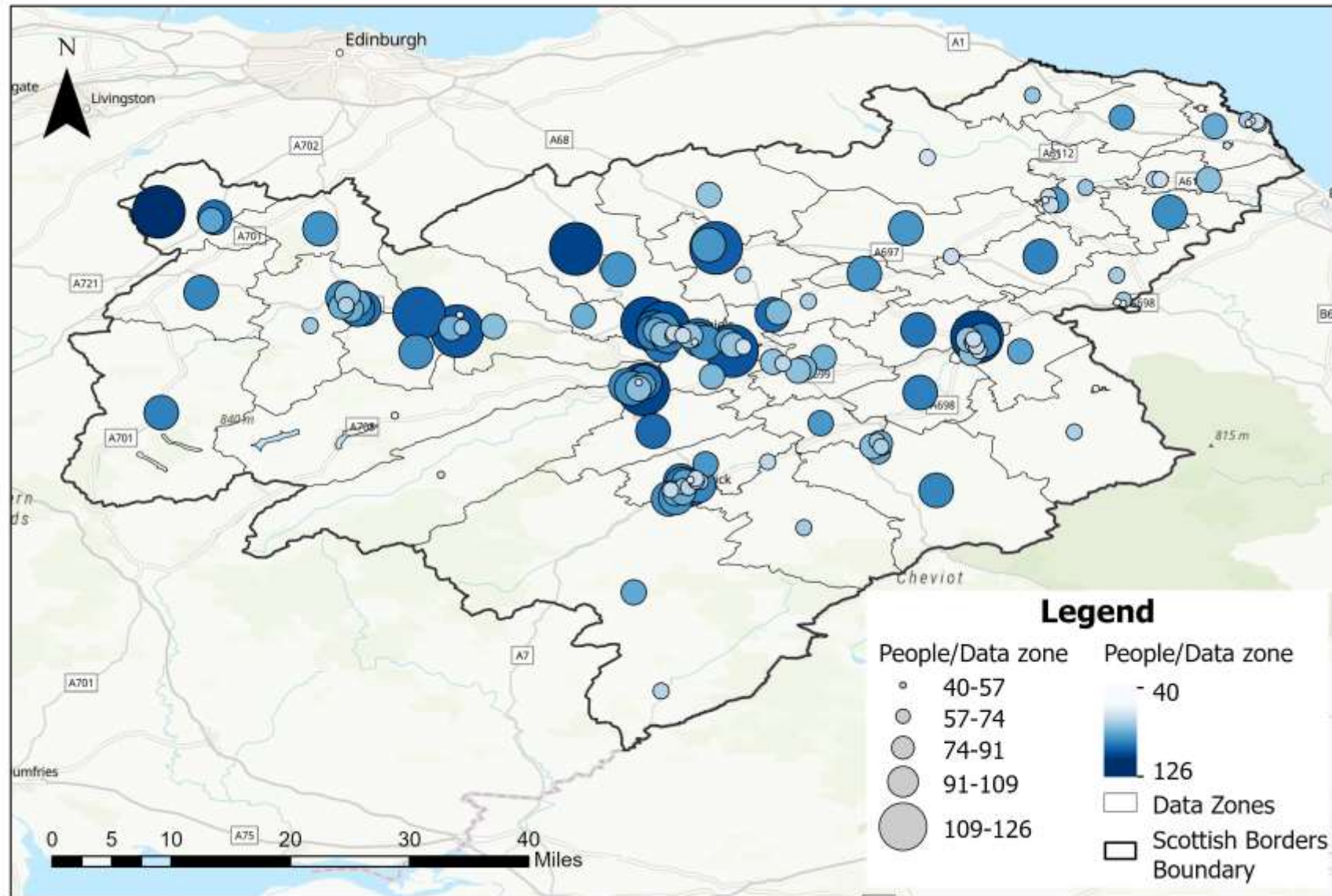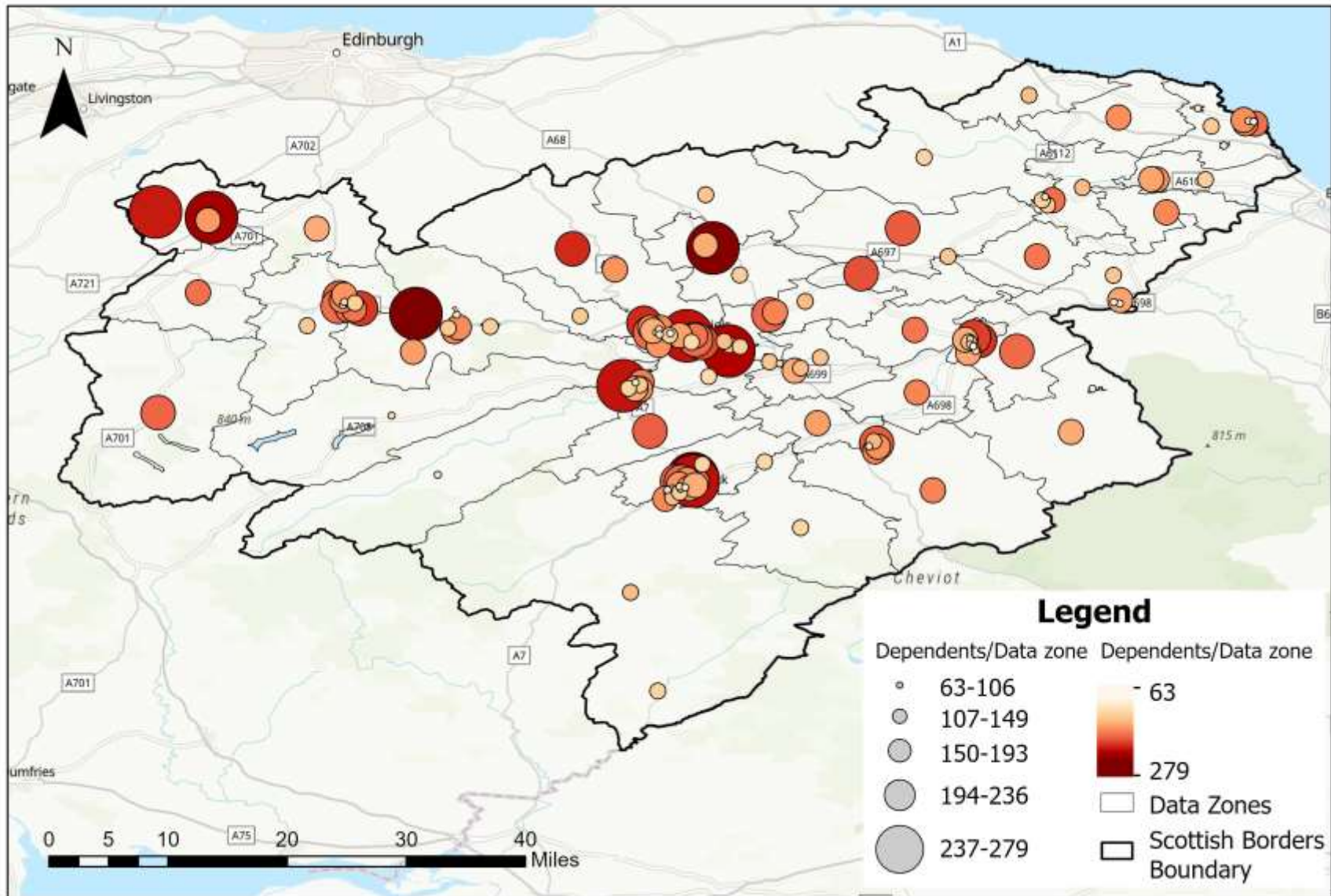
Emissions: Travel >10km to work
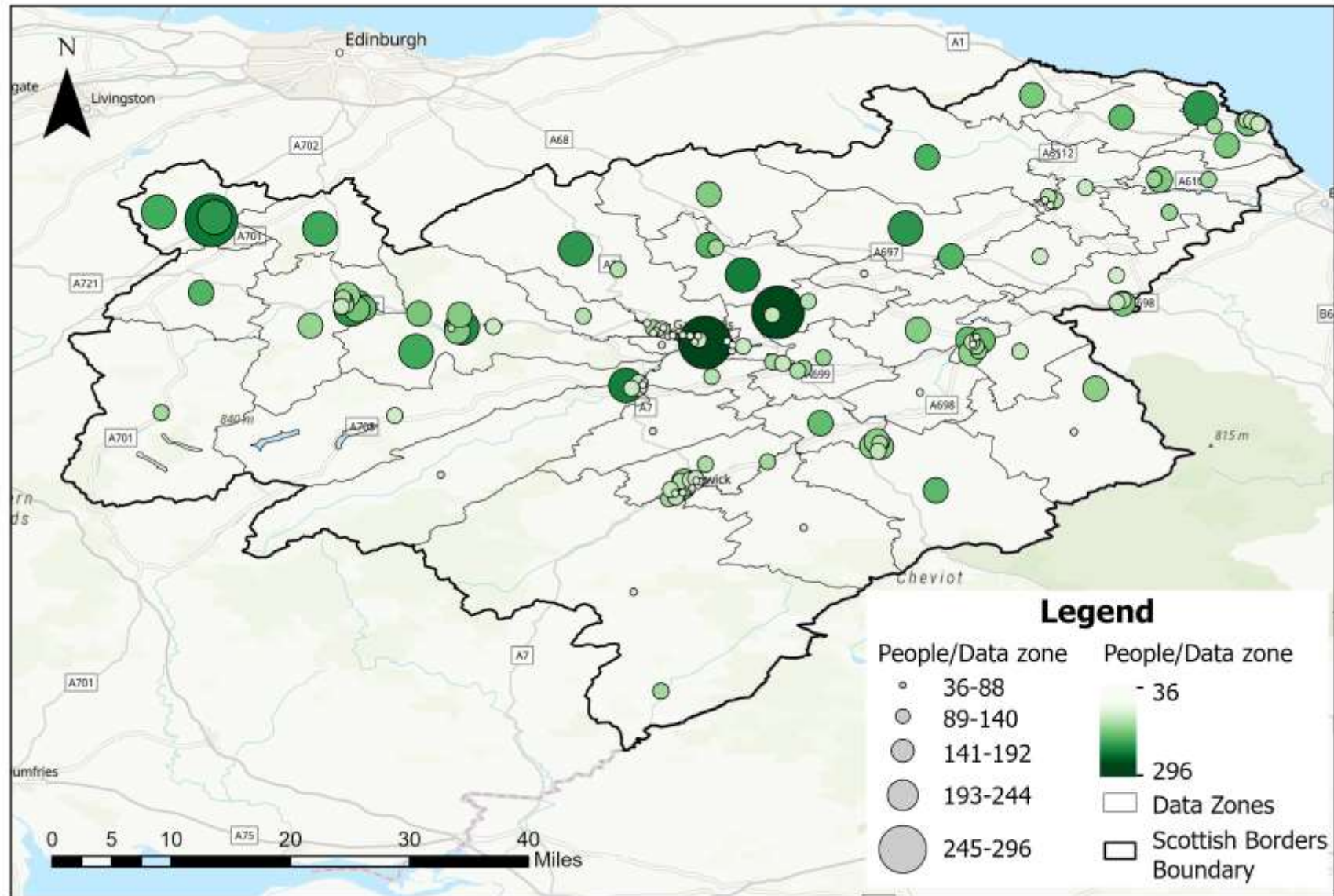
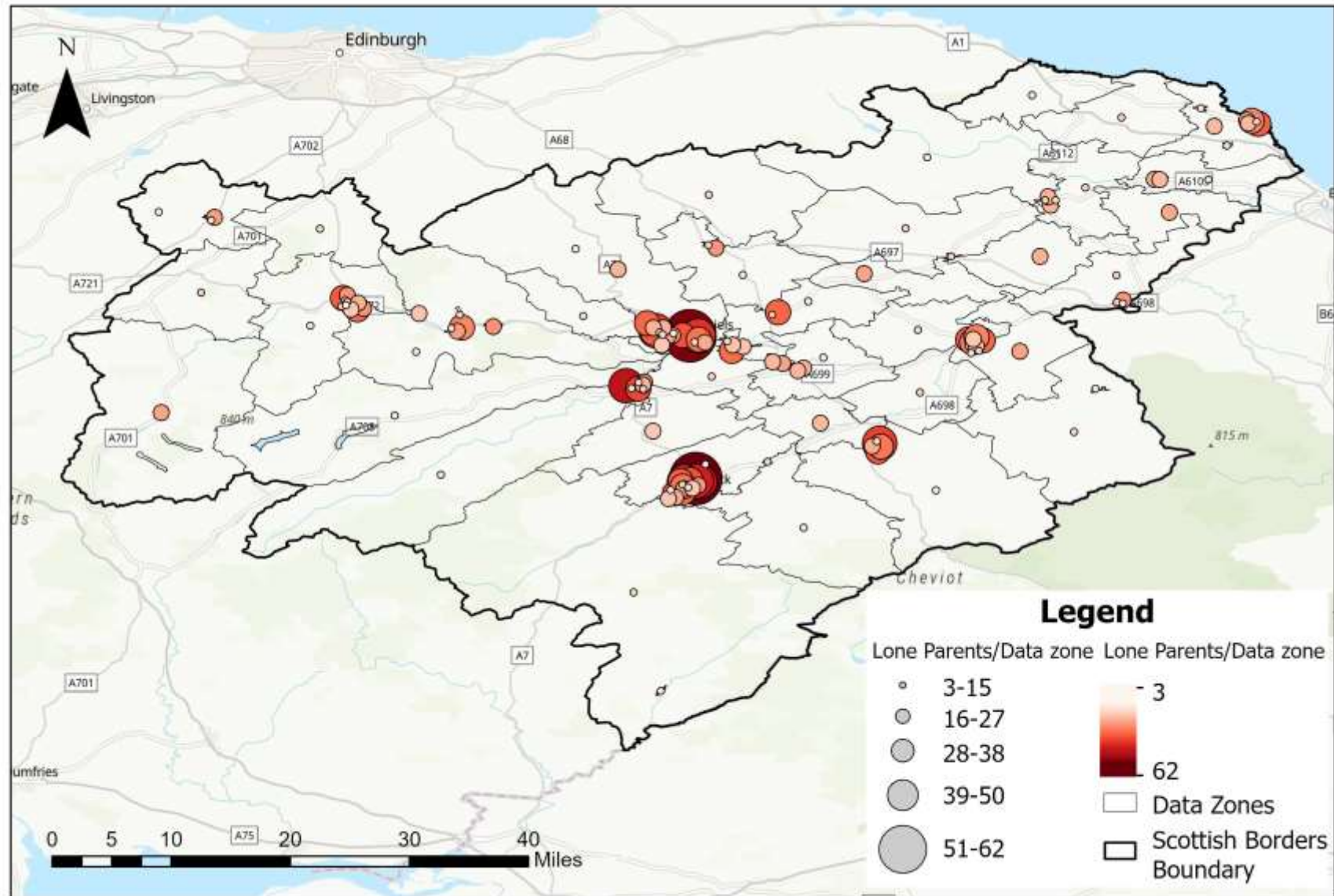# Emissions: Travel by car, van or taxi to work

Vulnerability: Overcrowdedness

Vulnerability: Dependent Children
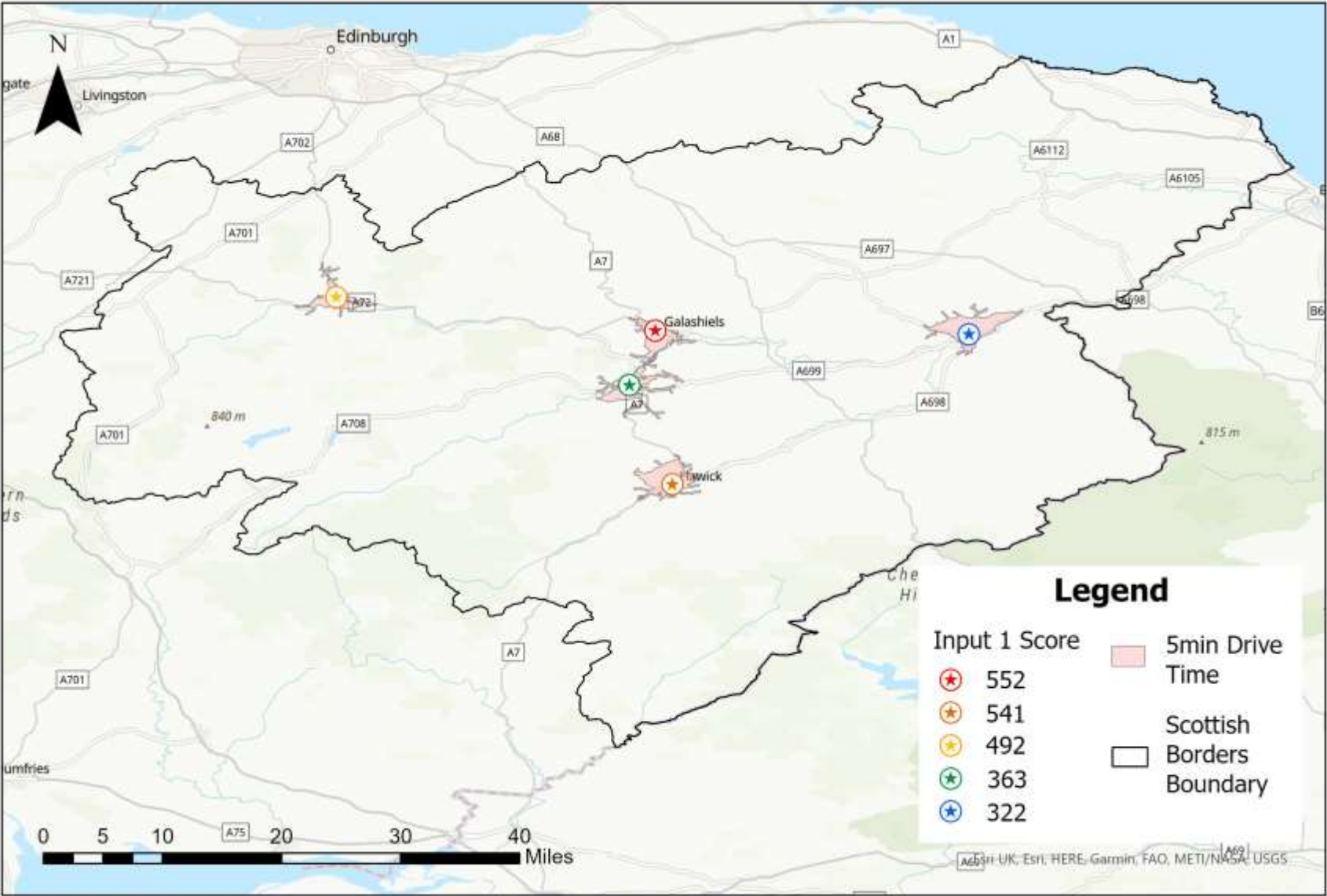
Vulnerability: Lone Parents

I - Basic Model (Demand Only)

Evaluating potential hub locations without a selection of preexisting sites

Example: Scottish Borders (whole area + key towns in more detail)

Demand Only: 5min Drive Time

Rank	Location
#1	Galashiels
#2	Hawick
#3	Peebles
#4	Selkirk
#5	Kelso

Demand Only: 10min Drive Time
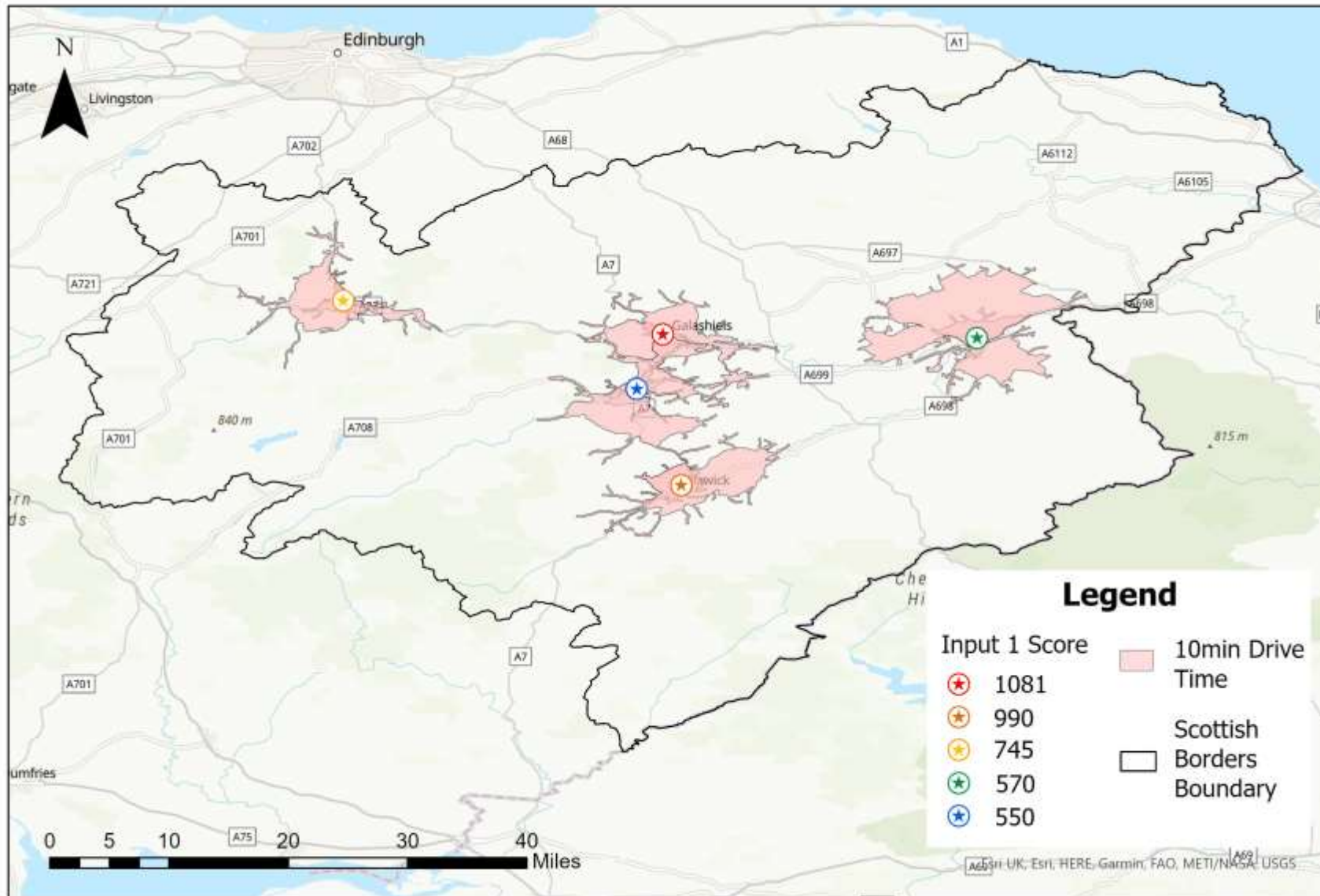
Rank	Location
#1	Galashiels
#2	Hawick
#3	Peebles
#4	Kelso
#5	Selkirk

Problem of Overlapping Hubs
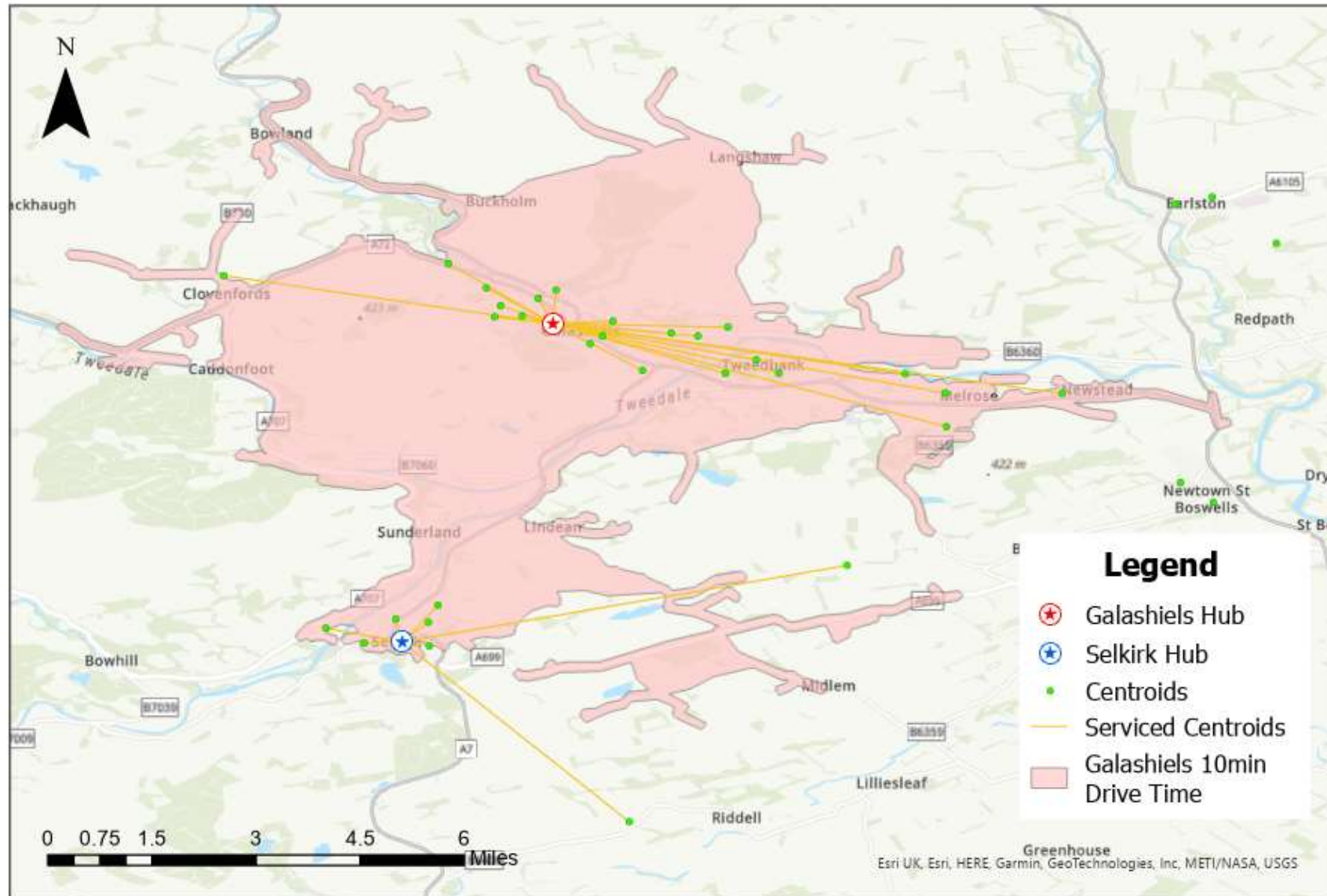
Galashiels Hub Demographics

Variables	Driving		Cycling	Public Transport
	5 mins	10 mins	10 mins	30 mins (8-9am)
Employed people	5397	10960	5770	10670
People who potentially work from home	1170	2439	1244	2379
Households defined as overcrowded	42	89	47	83
Dependent children	1874	4375	2116	4085
Lone parents	292	681	351	614
People who travel to work by car	2897	6317	3081	6186
People who travel more than 10km to work	978	2484	1018	2329

Hawick Hub Demographics

Variables	Driving		Cycling	Public Transport
	5 mins	10 mins	10 mins	30 mins (8-9am)
Employed people	5647	7244	6509	8005
People who potentially work from home	1171	1512	1357	1702
Households defined as overcrowded	72	75	75	82
Dependent children	2367	2907	2682	3210
Lone parents	455	511	491	561
People who travel to work by car	2896	3882	3389	4345
People who travel more than 10km to work	1575	2075	1818	2202

Peebles Hub Demographics

Variables	Driving		Cycling	Public Transport
	5 mins	10 mins	10 mins	30 mins (8-9am)
Employed people	4310	4748	4310	4748
People who potentially work from home	955	1066	955	1066
Households defined as overcrowded	29	30	29	30
Dependent children	1785	2064	1785	2064
Lone parents	198	214	198	214
People who travel to work by car	2358	2677	2358	2677
People who travel more than 10km to work	1695	1856	1695	1856

Kelso Hub Demographics

Variables	Driving		Cycling	Public Transport
	5 mins	10 mins	10 mins	30 mins (8-9am)
Employed people	2883	4222	2883	4309
People who potentially work from home	608	873	608	919
Households defined as overcrowded	17	18	17	20
Dependent children	1090	1626	1090	1679
Lone parents	185	227	185	236
People who travel to work by car	1658	2493	1658	2634
People who travel more than 10km to work	948	1349	948	1488

Legend

⊛ Kelso Hub   • Centroids

Kelso 5min Drive Time   Kelso 10min Drive Time

Selkirk Hub Demographics
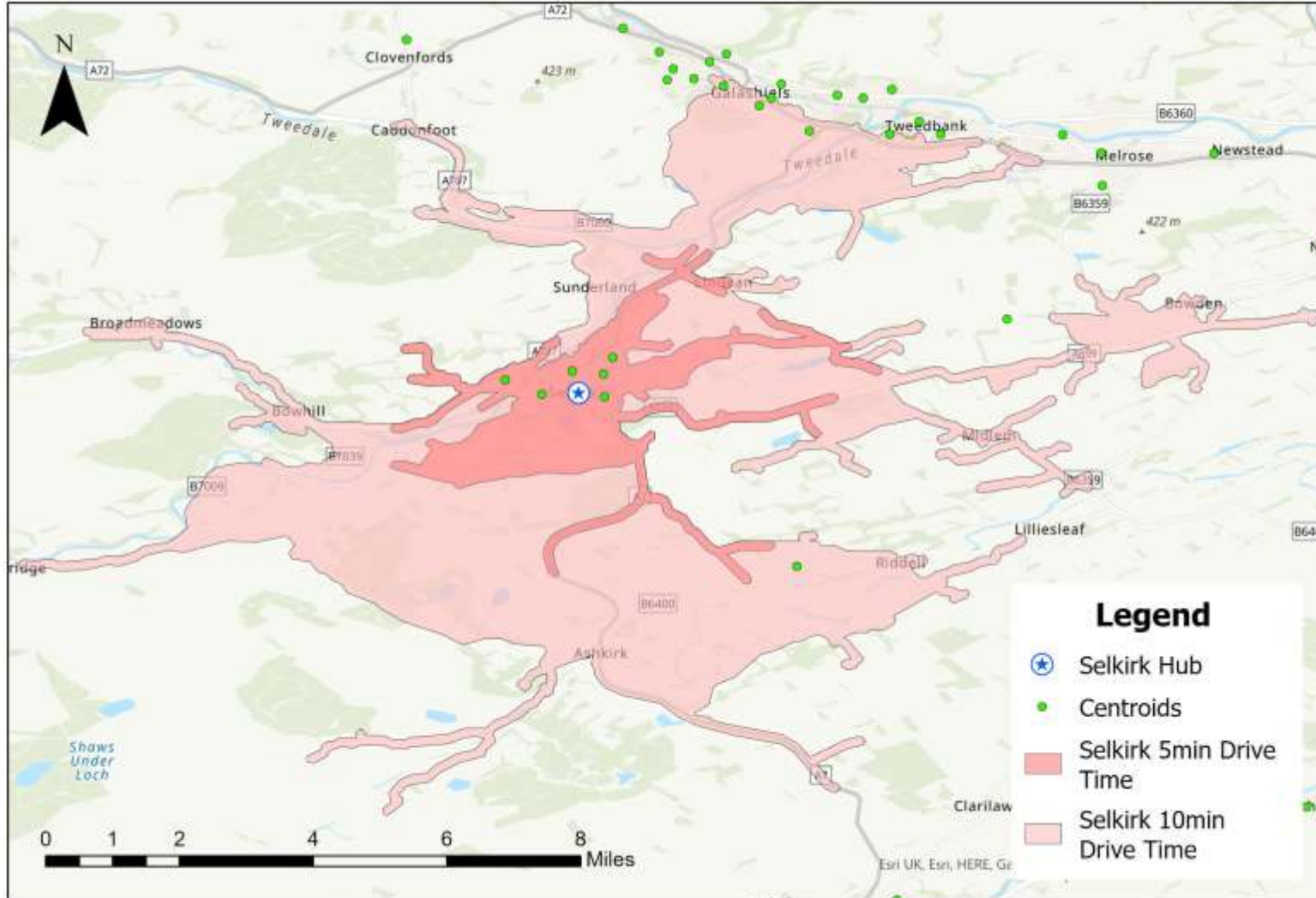
Variables	Driving		Cycling	Public Transport
	5 mins	10 mins	10 mins	30 mins (8-9am)
Employed people	2771	4718	2339	8849
People who potentially work from home	632	1070	537	1920
Households defined as overcrowded	22	33	14	96
Dependent children	1078	1828	837	3441
Lone parents	164	234	114	564
People who travel to work by car	1709	2844	1477	4754
People who travel more than 10km to work	755	1115	512	2293

Hub Demographic Comparison: 10min Drive
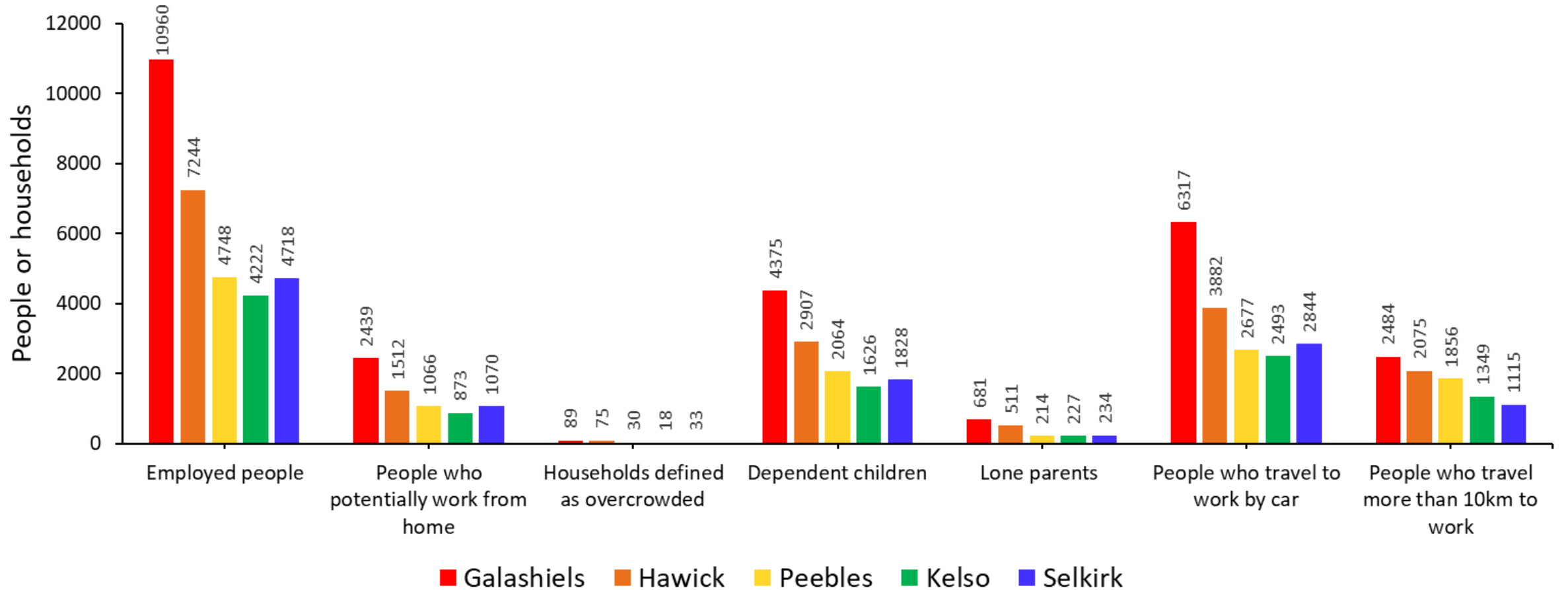
Hub Demographic Comparison: 5min Drive
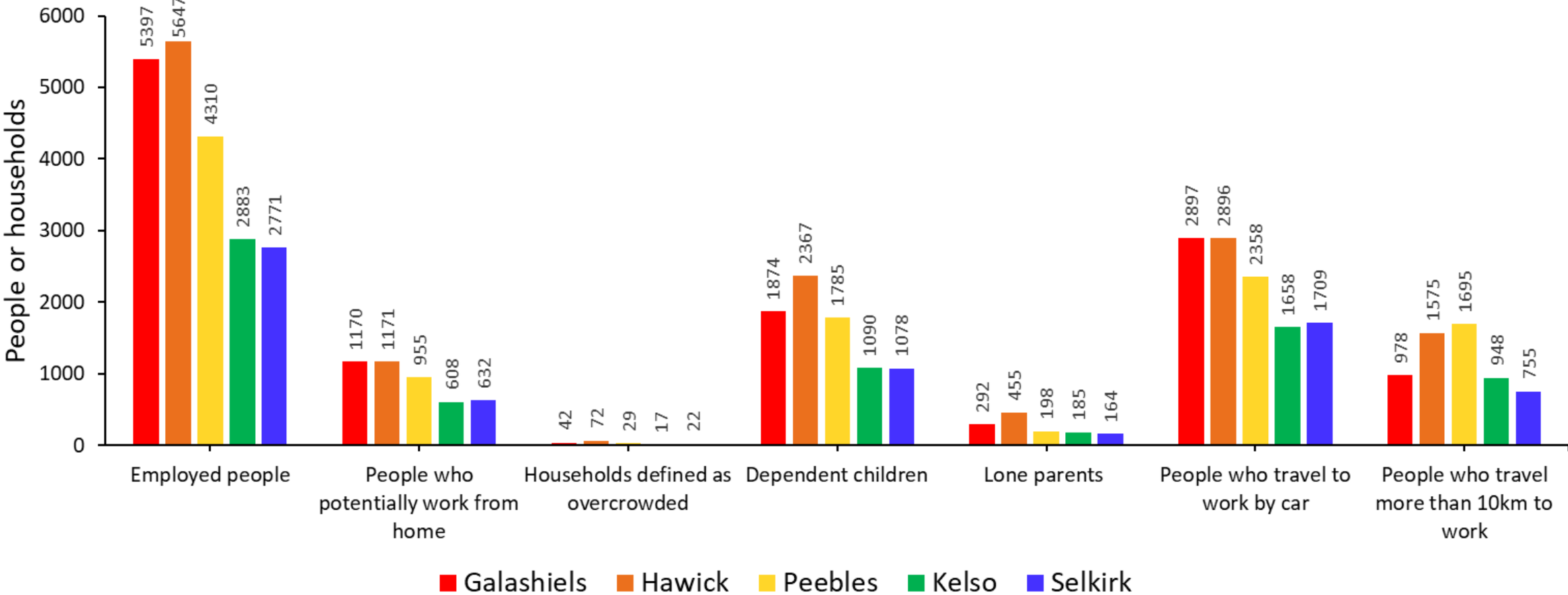
II - Combined Model
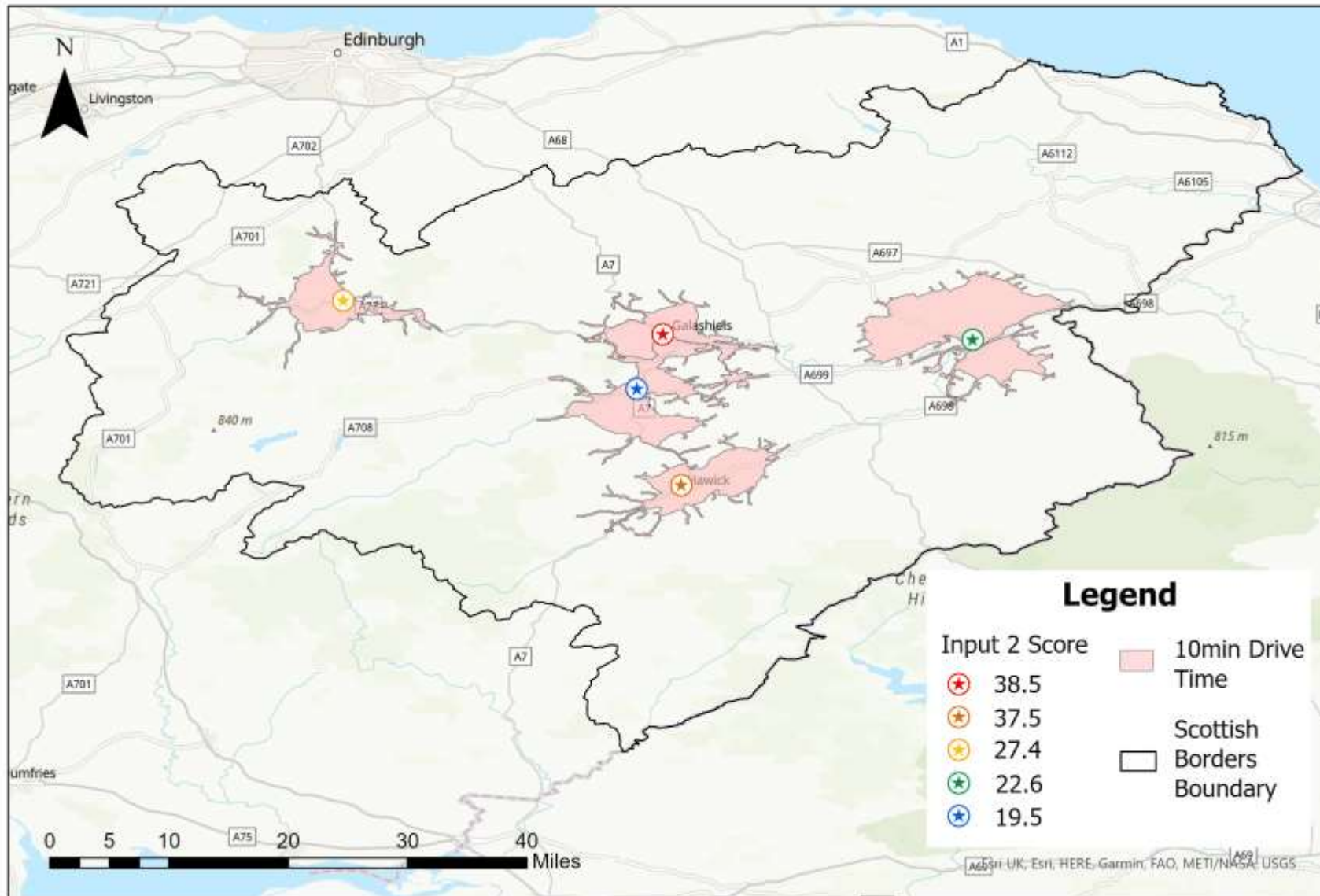## Demand (economic) + Emissions (environmental) + Vulnerability (social)

Evaluating potential hub locations without a selection of preexisting sites

Variable Combination: 5min Drive Time
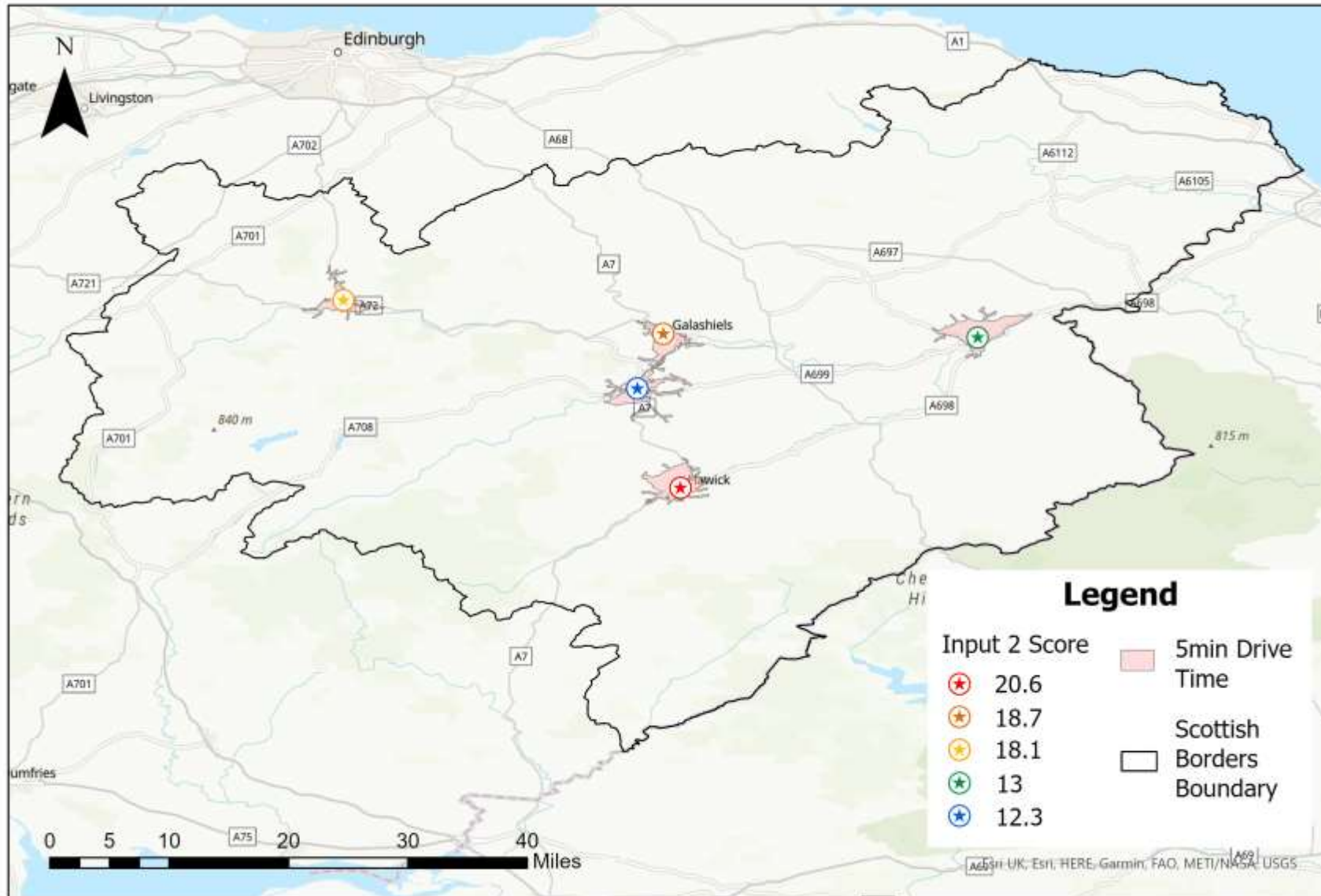
Rank	Location
#1	Hawick
#2	Galashiels
#3	Peebles
#4	Kelso
#5	Selkirk

Variable Combination: 10min Drive Time

Rank	Location
#1	Galashiels
#2	Hawick
#3	Peebles
#4	Kelso
#5	Selkirk

Legend

Input 2 Score
- ⭐ 38.5
- ⭐ 37.5
- ⭐ 27.4
- ⭐ 22.6
- ⭐ 19.5

🟥 10min Drive Time

⬜ Scottish Borders Boundary

How to prioritise pre-existing sites?

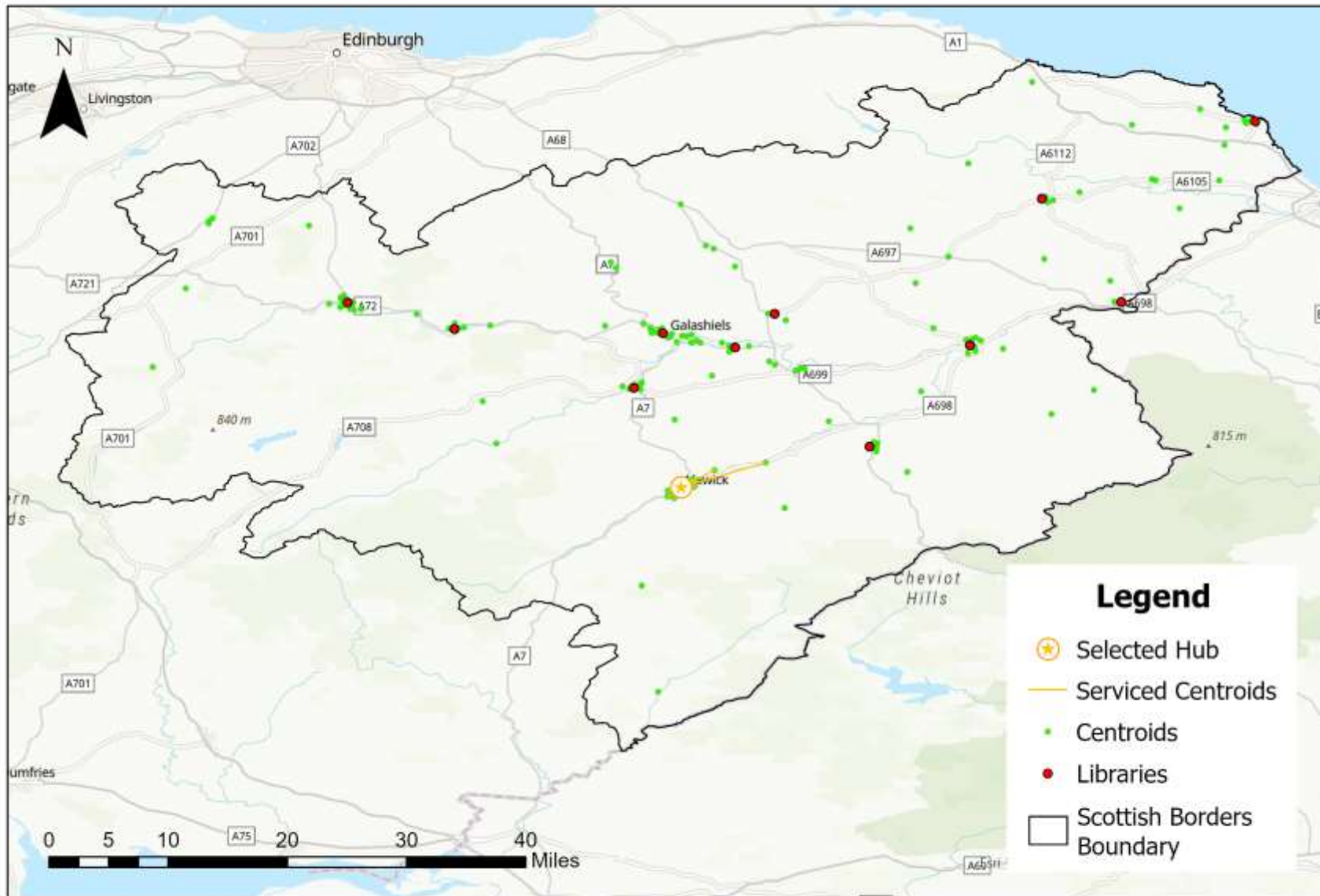## Rural Example: Scottish Borders Libraries

Selection of Existing Buildings (Libraries)
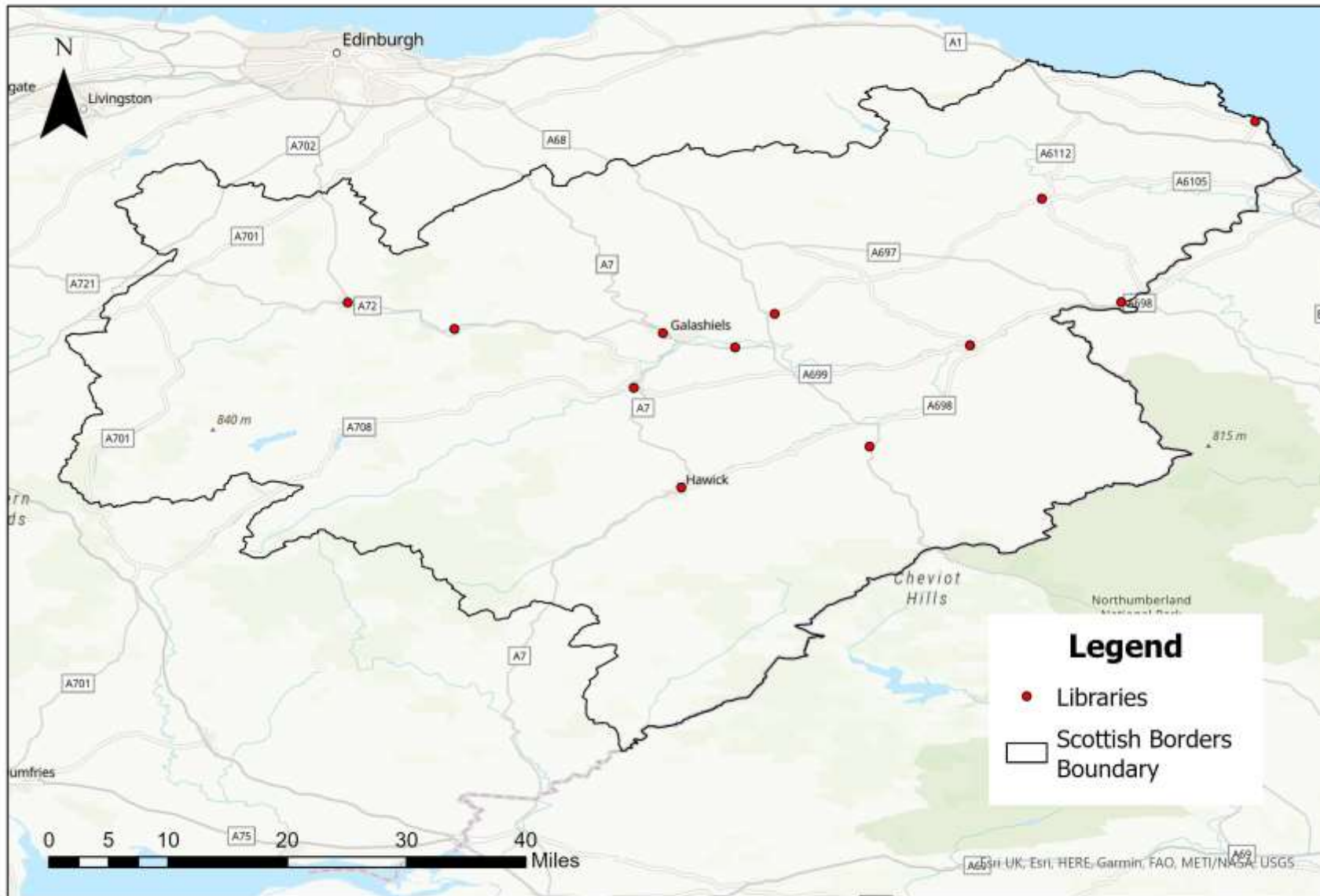
Selected Hub: Basic Model (Demand only)
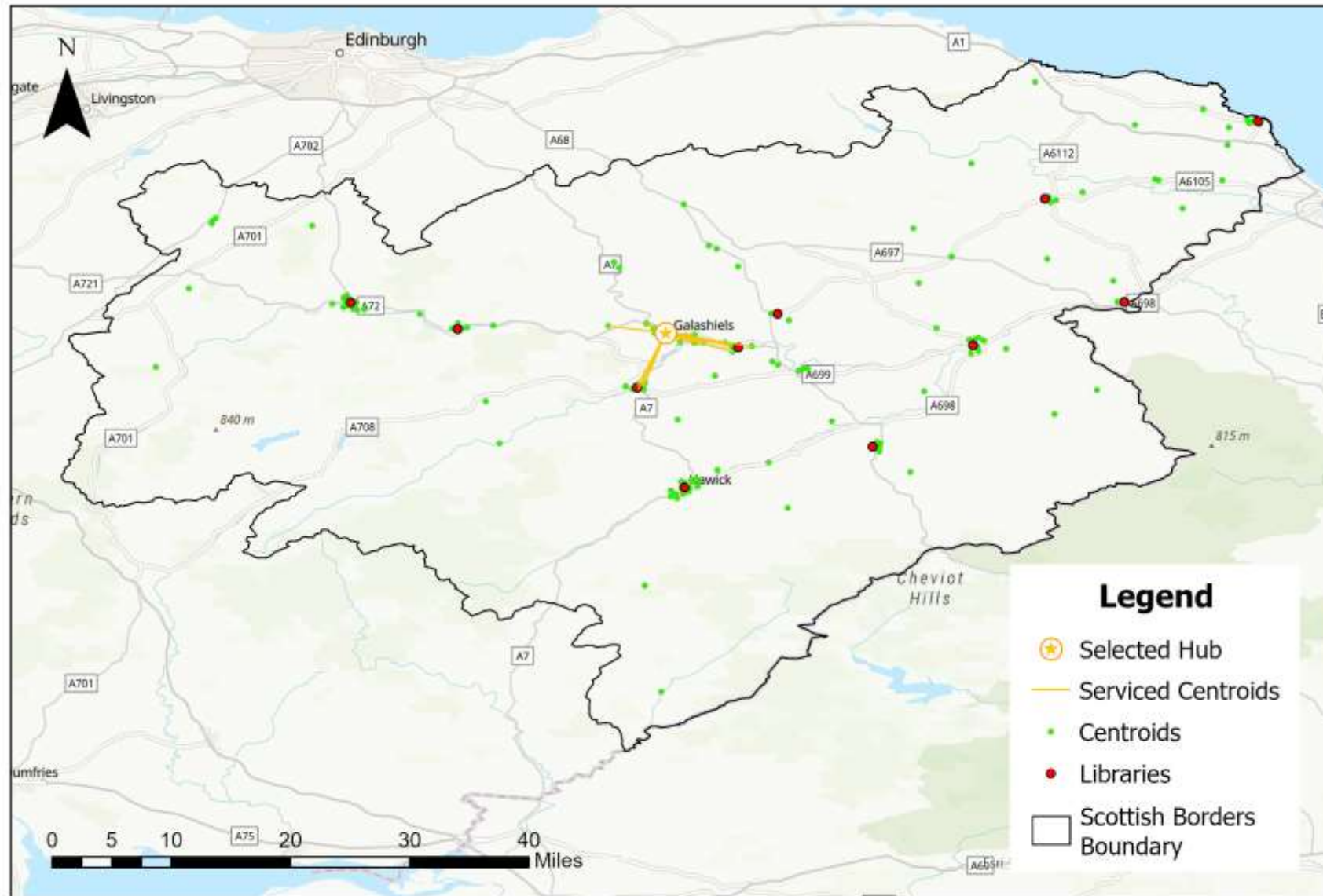
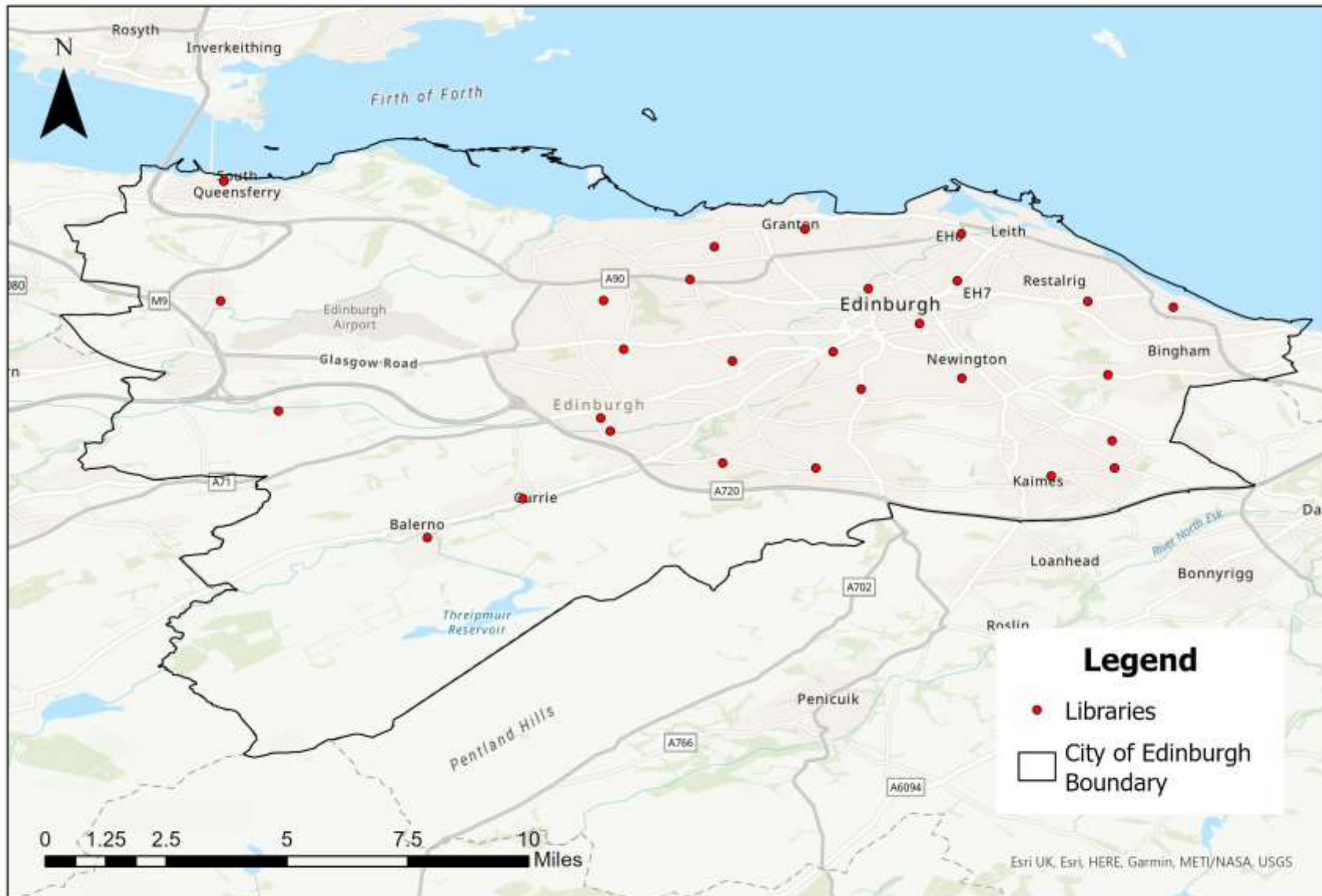# Selected Hub: Combined Model

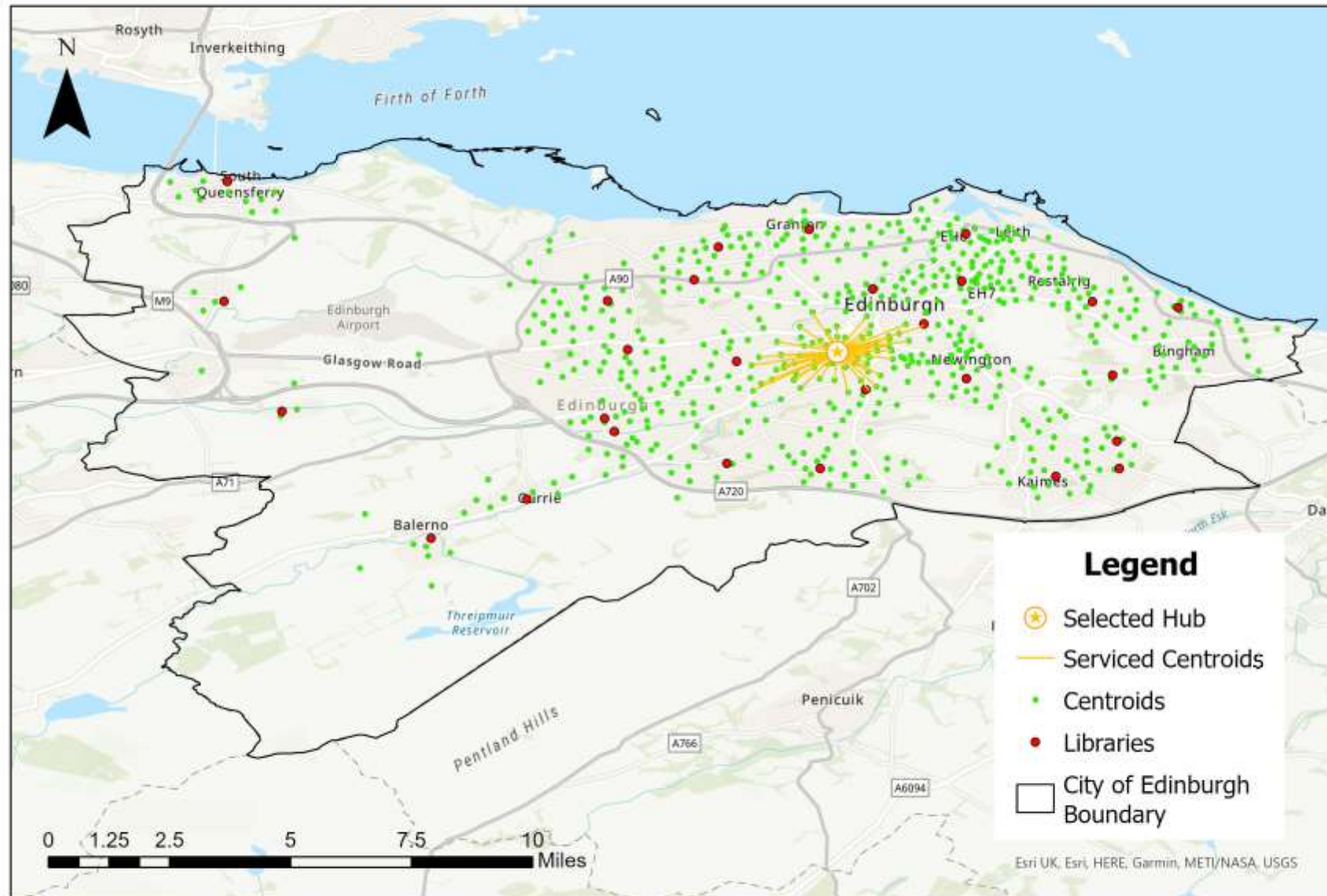# How to prioritise pre-existing sites (continued)

Urban Example: Edinburgh Libraries

Ps urban areas have smaller and overlapping catchment areas; environmental criteria tend to be less prominent, social criteria become more important (due to spatial inequalities)
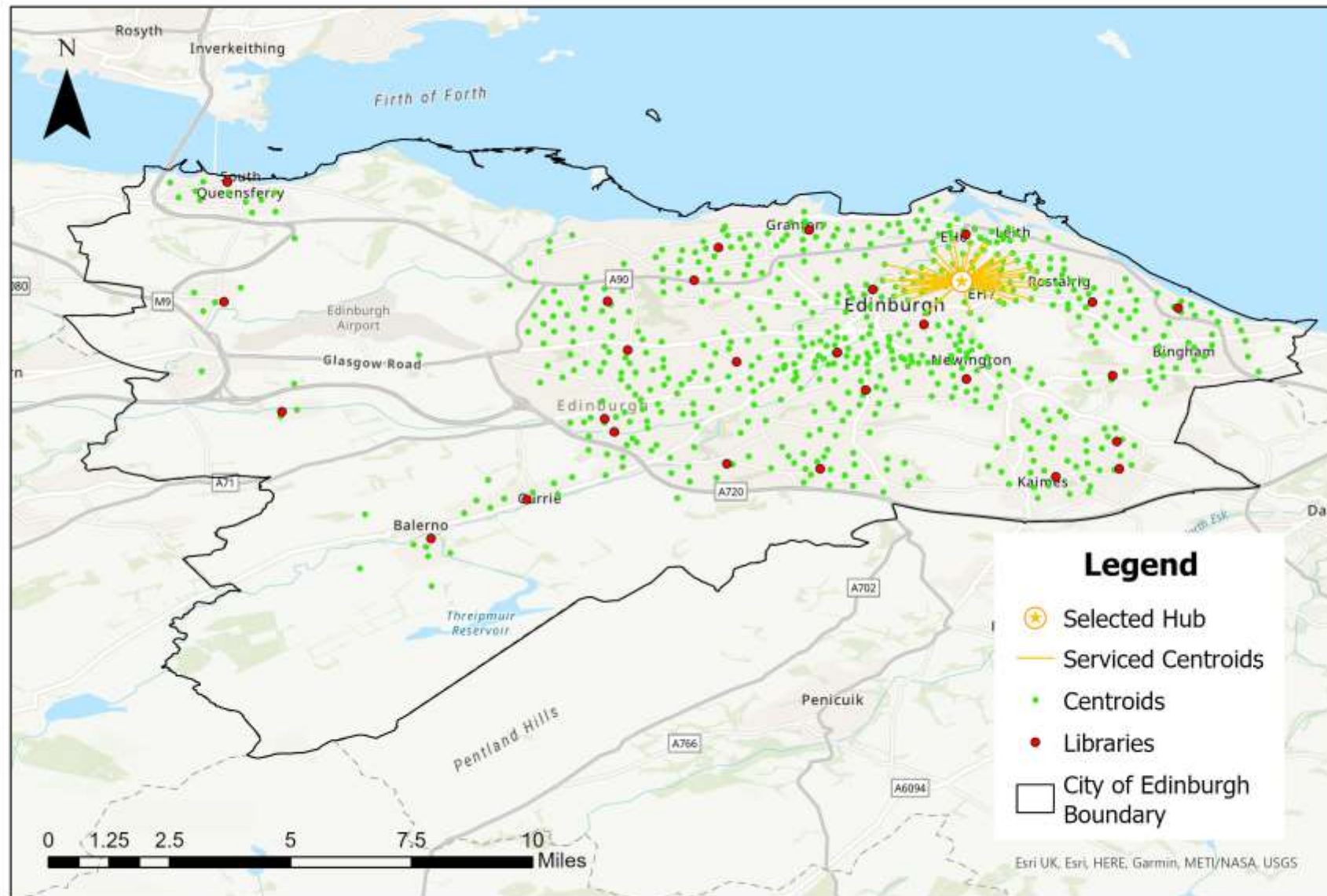
Selection of Existing Buildings (Libraries)

Selected Hub: Basic Model (Demand only)

Selected Hub: Combined Model

Final notes

Potential further discussion with / analysis by the authors of this report:

- The maps provided here are for illustrative purpose; the method we developed can be easily replicated/deployed anywhere else in Scotland.

- Our generic approach can be refined and tailored for more specific purposes. We welcome any enquiries or further discussions.

Further potential of using census data

- We were still using 2011 census data, but data from the new census will soon be released. This will also open the door to undertake temporal comparisons within and between places (e.g. trends in demographic change, commuting characteristics etc. over the last decade)

- It is possible to commission data from the census that targets specific interest groups (opportunity for drilling down and better targeting of the analysis).

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