Fuel, Transport and Food Poverty Mapping in Fermanagh and Omagh District Council

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Submitted 24th March 2023

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Acronyms
ARFPI = At Risk of Food Poverty Index
AWP = Affordable Warmth Programme
DfC = Department for Communities
FODC = Fermanagh and Omagh District Council
GIS = Geographical Information System
HFB = Healthy Food Basket
IDW = Inverse Distance Weighting
LPS = Land and Property Services
NI= Northern Ireland
NIMDM = Northern Ireland Multiple Deprivation Measures
NINIS = Northern Ireland Neighbourhood Information Service
NISRA = Northern Ireland Statistics and Research Agency
PHA = Public Health Agency
PV = Photo voltaic
PWC = Population weighted centroid
SA = Small Area
SVP = St Vincent De Paul
UU = Ulster University

Executive Summary

Globally, regionally and locally citizens are emerging from a Covid-19 pandemic, the United Kingdom's withdrawal from the European Union, a cost-of-living crisis and geopolitical instability. All of these have impacted on householders' ability to afford the basic essentials for living particularly in Northern Ireland where 17% of households live in relative poverty. Compounding this is the rural premium whereby there can be affordability and accessibility departments as a result of living rurally and Fermanagh and Omagh District (FODC) is predominantly rural with 70% of the population living outside the two main towns of Enniskillen and Omagh.

This research investigated the spatial patterns of fuel poverty (a household's inability to keep adequately warm at a reasonable cost), transport poverty (affordability of transport) and food poverty (insufficient economic access to an adequate quantity and quality of food to maintain a nutritionally satisfactory and socially acceptable diet) to identify if rurality increases the risk of fuel, transport and/or food poverty in FODC. The study aimed to provide food, fuel and transport poverty maps in order to inform poverty alleviation policies and programmes and targeted interventions at District Electoral Area level to maximise impact and ensure those most in need are supported. This is because tackling poverty is a priority which has been identified in the Fermanagh and Omagh Community Plan 2030. This research will help assess the impact the COVID-19 pandemic, cost-of-living crisis, as well as the rural premium has on residents in Fermanagh and Omagh. Assessing the symptoms and the data and evidence will allow for Community Planning to work in partnership to collectively address the root causes.

Fuel poverty: Ulster University created an area-based risk index for fuel poverty for each Census Small Area (SA) across NI (N=4,537) in 2017. Across the 11 council areas, FODC had the highest average eligibility score (49.48) compared with North Down and Ards which had an average eligibility score of 35.07. Within FODC, the highest eligibility was in rural areas (open countryside followed by villages) while urban areas (notably Omagh) have lower eligibility scores on average. Cluster analysis identified neighbouring areas that may benefit from targeted interventions. The clusters of highest eligibility (20% of Council area) are in "Open countryside" and are generally located along the border with Leitrim, Cavan and Monaghan. There is an understanding that cross-border shopping is possible, however without firm evidence to support this theory, the border effect is outside the remit of this study. This would require a further independent research study. It was concluded that the majority of SAs within the Council area will benefit from support schemes such as oil buying networks and energy support in the short term, but (fuel) poverty is a chronic problem requiring more sustainable, longer-term support that addresses the root causes including insulation upgrade programmes and possible exploration of renewable/green energy schemes.

Transport poverty: Transport poverty can be caused by a range of factors such as low population density, car dependency, and affordability and accessibility of public transport, compounded by personal health/mobility issues. For example, people who have regular bus services convenient to their home may be transport poor due to their individual inability to use public transport. Areas of higher population density are typically at lower risk of transport poverty and FODC has a low population density compared to other areas of the UK. Additionally, more than one in three (34.8%) of

domestic properties in FODC are more than a 10-minute walk from an existing bus stop. This, coupled with infrequent buses and areas of deprivation and poverty, indicates increased risk of transport poverty for a number of SAs in the Council area. There are SAs with 25% or more households with no vehicle ownership: Lisnaskea (Intermediate settlement), Irvinestown, Maguiresbridge, Fintona and Dromore (Villages) in addition to Belleek, Newtownbutler, Rosslea, Tempo and Drumquin (Open Countryside). Lowest vehicle ownership tended to occur in Omagh and Enniskillen which have a greater range of key services nearby and may also benefit from greater public transport provision. A combined transport poverty risk score concluded that Intermediate settlements and Villages have the highest average combined risk score followed by Open countryside, Medium Towns and Large Towns. Of the 84 Small Areas at high risk of fuel poverty, 22 of these Small Areas also have a high risk of transport poverty.

Several socio-economic groups (young renters, pensioners with disabilities or long-term ill-health and people on low incomes) are at particular risk of increases in motor fuel expenditure which makes them susceptible to transport poverty. The majority of young renters occurred in Omagh and Enniskillen though Irvinestown also had 25% of young people renting. Within FODC, there are 10 SAs with almost 20% of young renters, five of which have 20% of homes with an income below 60% of the NI median. Three of these SAs are in Omagh (Lisanelly ward, Drumragh ward and Killyclogher ward), one is in Enniskillen (Erne ward) and the other is in Irvinestown (Village). Drumragh ward in Omagh, Killyclogher ward and Irvinestown ward have a large proportion of homes with no vehicle access. Elderly people with long term health problems are also at increased risk of fuel and transport poverty. Elderly people with long-term health problems were mainly located in Omagh and Enniskillen though there was a relatively high proportion in Irvinestown (Village).

Food prices and availability in FODC: Healthy Food Basket price and availability audits for typical family shopping lists were conducted in 46 stores across FODC settlement types between August and October 2022. Of the retail outlets surveyed, 29 (63%) were in a rural settlement and 17 (37%) in an urban settlement. There were cost variations between stores for the shopping baskets with rural prices on average more expensive than urban prices. This may be explained, at least in part, by the characteristics of the stores in the retail audit sample. Small shops are more likely to have higher prices and smaller shops are more likely in rural areas. Furthermore, the presence of discount stores and other multi-nationals impacts the average prices audited in the area. This pattern also held true for food availability resulting in geographical disparities within FODC boundaries and therefore not all households have the same equal access to food. It is important to note that these findings assume that household food purchases are completed in one local shop, when in reality shopping can occur across a range of stores.

Food poverty: The *At Risk of Food Poverty Index* (ARFPI) is a pragmatic measurable index that identifies SAs at greatest potential risk of food poverty. It is a multi-variable, area-based food poverty risk index, mapped at regional scale. It is used to understand the role that location plays in determining food poverty and is used to identify area-based vulnerabilities and solutions to food poverty. In 2017, Ulster University developed the ARFPI and created an area-based risk index for each Census Small Area. Food poverty risk was calculated for each SA across NI with values ranging from

0.46 (Stranmillis ward, Belfast) to 68.31 (Glenderg ward, Derry & Strabane). Glenderg has the highest AWP eligibility score (fuel poverty) and food poverty risk score in NI. Across the 11 Council areas, Fermanagh and Omagh District Council had the third highest average risk score (39.06), with Mid Ulster and Newry, Mourne and Down having highest averages across NI. The ARFPI (2021) showed that FODC had the highest variance of all Council areas, suggesting substantial variation in food poverty risk within the Council area. It is important to note that the ARFPI encompasses multiple structural indicators of food poverty beyond food costs and availability as it integrates a range of variables such as income, deprivation, ownership, retailer density, education and health to develop an aggregated overall risk score at CSA. Within FODC, the algorithm showed that values ranged from 8.78 (Castlecoole ward, Enniskillen) to 62.72 (Belcoo and Garrison ward). Furthermore, FODC had the second highest minimum risk score of all Councils in NI, suggesting a high level of food poverty risk in the Council area.

Costs for retailers ranged from a minimum of £86.72 (Intermediate settlement) to £119.94 (Open countryside) with an average of £109.15. Of the 46 sampled stores, 29 (63%) had prices above the average. The majority of these retailers were in Villages (9) and Open countryside (8) though Omagh (Large town) had 7 retailers with prices greater than the sampled retailer average.

Availability for retailers ranged from a minimum of 26.4% (Open countryside) to 96.2% (Medium town) with an average of 76.41%. Of the 46 sampled stores, 19 (41%) had availability below the average. Most of these retailers were in Open countryside (11), followed by Villages (4). Again, Omagh (Large town) had 4 retailers with availability less than the sampled retailer average.

Application of Ulster's At Risk of Food Poverty Index (ARFPI) found high risk across all settlement types though, in general, rural areas tended to have higher scores, with the majority of these occurring in Open countryside (73 SAs). The clusters of highest eligibility ("High-High" – 15% of Council area) are in the North East of FODC and are mainly in Open countryside areas though 15 SAs in Omagh (Large town) and 4 SAs in Fintona (Village) are also classified as high risk clusters for food poverty.

There are six full time Emergency Food Providers within FODC – 2 in Omagh (Large town), 2 in Enniskillen (Medium Town), 1 in Lisnaskea (Intermediate Settlement) and 1 in Kesh (Village). In addition to these full time services, one of the food providers operates an outreach service in Irvinestown (Village)) Belleek (Open Countryside), and Newtownbutler (Open Countryside) on approximately a one hour per site per week basis. Further sites for outreach activity may be added.

The mean risk score for FODC is 37.50 and two of the SAs with emergency food providers have risk scores below the average i.e. lower eligibility (Kesh, Lisnaskea). Of the four SAs with emergency food providers and risk scores above the mean (i.e., higher eligibility), the highest risk score is 49.60 (Irvinestown, Village).

Multiple poverties: The clusters used to identify SAs experiencing high risk of fuel, transport and food poverty were amalgamated to identify areas experiencing more than one type of poverty. There were 157 Small Areas in FODC that were classified as high risk clusters for either fuel, transport or food poverty. Of these, 52 SAs (33%)

experience at least two types of poverty. There were 4 Small Areas that had high risk clusters for fuel, transport and food poverty (all three poverties) containing over 900 domestic properties. These areas were in Fintona ward, Derrygonnelly ward, Florencecourt and Kinawley ward (Open countryside) and Devenish ward (Medium town). Overall, there are multiple poverties occurring in Open countryside areas and Villages which are considered "rural" areas. However, "urban" areas also experience clusters of high fuel, transport and food poverty.

Recommendation: It is important to note that verification (ground truthing) is needed in order to increase confidence in the models. The Affordable Warmth Programme (AWP) was verified during initial creation in 2013-14 and obtained very high levels of accuracy (Walker *et al.*, 2014). However, the original verification process for fuel poverty occurred almost a decade ago. No verification has been done for the transport or food poverty indices. Ideally data from FODC on referrals could be integrated with the models in order to ground truth the models. Verification is required to ensure that all at-risk households are offered the help required and no vulnerable households are omitted. Greater integration of data and expertise between Councils and University departments can lead to improved data models and improved targeting.

Background and context

Globally, regionally and locally citizens are emerging from recessionary times. Northern Ireland consumers fare worse than their Great Britain counterparts in respect of lower disposable incomes, higher food prices, greater reliance on oil (an unregulated fuel), and a rural sparsity and spatial peripherality that is second only to Scotland (Neighbourhood Statistics, 2016). Rural areas are generally defined with respect to low population density and distance from centres of population (Cummins, 2004). Northern Ireland has a geographical area of 14,160 km^2 and while 62% of the population live in the Greater Belfast area (East of Northern Ireland), the rest of the eligible area is therefore more sparsely populated (38%) (UMSL, 2016).

This can in turn give rise to a number of secondary characteristics, including low levels of service provision, inadequate public transport and other important infrastructure, few employment opportunities, and social isolation (Connolly *et al*, 2012). This is because, as services tend to follow populations, many depopulated rural areas are left without important public and social services (O'Shea, 2009) potentially impacting negatively on rural dwellers' socialisation opportunities associated with accessing local shops, post offices and other social meeting places. Heenan (2010) identified difficulties in accessing fundamental services as a key driver in social exclusion among rural residents; while Scharf and Bartlam (2006) have previously discussed the negative impact on quality of life associated with poor service provision.

The issues of rural poverty and social exclusion are significant in Northern Ireland where 17% of households live in poverty, with children, older people and working age adults particularly at risk of poverty (DfC, 2021). Northern Ireland has yet to fully implement Welfare Reform, which will impact further on poverty rates and experiences here. More than one in three (37%) Northern Ireland citizens live in rural populations; this is a significant minority, and it is entirely appropriate that their experiences of poverty and social exclusion are ameliorated. The concept of rural poverty is an important one since relative income poverty rates are slightly higher in rural areas of Northern Ireland. Over time, absolute poverty rates in rural areas in NI were slightly higher than urban areas, particularly so for pensioners living in rural areas (Ulster Farmers' Union, 2017). While poverty rates have appeared relatively stable over time, relative poverty rates have generally been slightly higher in rural areas of Northern Ireland (DfC, 2017a). Therefore, Northern Ireland must not typify a two-tier system whereby householders and consumers are disadvantaged by consequences of their rurality.

Fuel poverty (or energy poverty) is defined as a household's inability to keep adequately warm at a reasonable cost. It arises from the complex interplay between low incomes, high domestic fuel costs and energy inefficient homes (Boardman, 1991 cited in Walker *et al.*, 2012, p.639). The University of York identified that Northern Ireland is set to be the region hardest hit by rising fuel and energy costs, with an expected 72% of households forecast to be living in fuel poverty by January 2023, compared to lower figures for London and the South East of England where an estimated 48% of households are expected to be living in fuel poverty (Chartered Institute of Housing, 2022). The implementation of the Energy Strategy may further increase the proportion of households in fuel poverty in Northern Ireland.

Transport poverty in the UK context builds on an "implicit analogy between (recognised) fuel poverty and (neglected) transport affordability issues" (Mattioli *et al*, 2017, p.94). Consideration of transport poverty has previously focused generally on social exclusion aspects and on low mobility individuals and carless households with less discussion about how transport affordability should be defined, measured and tackled.

The prominence of food poverty – insufficient economic access to an adequate quantity and quality of food to maintain a nutritionally satisfactory and socially acceptable diet (O'Connor *et al.,* 2016) – is becoming recognised as a public health emergency (Taylor-Robinson *et al.*, 2013). According to the Office for National Statistics (2022), groceries that have increased in price in the last year include: vegetable oil by 65%; pasta by 60%; tea by 46%; chips by 39%; bread by 38%; and biscuits by 34%. ONS monitoring has reported the following foods to have increased in the past five months: vegetable oil by 46%; chips by 24%; and bread by 22%.

The Food Standards Agency's report (March 2023) found that one in five (22%) in Northern Ireland is experiencing food insecurity at some level (i.e. low or very low food security). The FSA's May 2022 report concluded a widespread sense that the food system is not working as well as it should for the UK public - particularly for those less financially secure with price often the principal driver of food choices, leading many to make uncomfortable compromises regarding health, environment, wider ethical values, and for some even around 'basic' considerations like safety or even sufficiency. A greater number of Northern Ireland consumers (22% compared to the UK average of 20%) spontaneously mentioned food prices as an area of future concern - well ahead of any other spontaneous mentions (FSA, May 2022). The corresponding figure for prompted concern was 80% in Northern Ireland (compared to the UK average of 76%) with a majority of people (74% in Northern Ireland vs. 65% UK average) having modified their food behaviours as a result of financial concerns. The most recent data (September 2022) from this twice-yearly research concluded that 40% of participants reported feeling worried about being able to afford food in the next month; 30% of participants reported that they had skipped a meal or cut down the size of their meals because they did not have enough money to buy food in the last month. Therefore, food poverty has become a concerning issue within the UK.

Against this background, Ulster University was commissioned by Fermanagh and Omagh District Council in April 2022 to undertake a poverty mapping project for the District Council area. This research project was co-funded by the Department for Communities (DfC), the Public Health Agency (PHA) and Fermanagh and Omagh District Council (FODC).

This interdisciplinary research aimed to identify if rurality has an impact on consumers' access to fuel, transport and food.

The associated objectives for this research were:

- To identify and map food prices and availability in approximately fifty stores across Fermanagh and Omagh and overlay with deprivation and other indices
- To map fuel poverty risk scores and overlay with deprivation and other indices

- To use indicators/variables associated with access to and affordability of food, fuel and transport to map areas at risk of food, fuel and transport poverty in Fermanagh and Omagh
- To devise evidence-informed recommendations to support rural policymaking, reduce associated health inequalities through targeted interventions, and enhance consumer access to basic services provision.

Methodology

The research adopted an interdisciplinary approach (Business and Management (Consumer Management and Food Innovation) and Geography and Environmental Sciences (Geography) to address an outcome-based approach in the priority strategic themes of *an equal society; enjoying long healthy active lives; caring for people in need; and connecting people through infrastructure,* as identified in Northern Ireland's framed vision through the Programme for Government.

The proposed research adopted a mixed-methods (quantitative and qualitative data) approach to data collection. A range of variables relating to accessibility to food, mobility, deprivation and socio-economic status were integrated into a Geographical Information System (GIS) to visually and impactfully illustrate rural food, fuel and transport poverty and illuminate where targeted interventions might best be served.

Research design and rationale

This research is an empirical ethnographic investigation into the impact of rurality on consumers' access to basic services. The study aimed to provide three food, fuel and transport poverty maps in order to inform poverty alleviation policies and programmes. Primary data collection used a mixed-methods approach using both quantitative and qualitative design techniques. The first stage of the research (GIS mapping) systematically investigated and plotted variables to identify and map areas of high deprivation in rural Northern Ireland.

GIS mapping

GIS was used to create risk indices of food, fuel and transport poverty at the Small Area scale. Small Areas are a consistent scale of mapping from the UK Census (2011) with an average of 400 people and 155 households in each Small Area (NISRA, 2016). A range of "passport benefits" (Boardman, 2010) can be used from the UK Census to identify populations that may be at risk of poverty. A range of UK Census variables relevant to food, fuel and transport poverty were weighted and combined into final risk scores for each Small Area across Northern Ireland.

This research used Geographic Information Systems (GIS) to target areas at greatest risk of food, fuel and transport poverty. A GIS is a computer-based programme that enables a wide range of geographic data to be integrated into a common spatial framework. This stage used GIS to integrate pertinent socio-economic variables with retailer data at the scale of Census Small Areas (SA). Small Areas represent the highest scale of mapping available from the UK Census to map a range of variables that have a significant impact on food, fuel and transport poverty across Fermanagh and Omagh District Council. For example, factors relating to accessibility, mobility, deprivation and socio-economic status can all be mapped at Small Area scale. These variables were combined into risk indices to identify areas across Fermanagh and Omagh that are at risk of food, fuel and transport poverty. Data at Small Area level are

anonymised from the UK Census so there was no risk of identifying individuals from the data.

By combining a range of risk factors in a GIS framework, it was possible to identify Small Areas at greatest risk of these different poverties across Fermanagh and Omagh. Furthermore, by adopting a spatial approach, interventions can be mapped and investigated in relation to overall risk.

To map and explore options for targeted food access interventions
Additionally, GIS was used to map a range of retailers across Northern Ireland. GIS analysis was used to calculate a range of accessibility measures from each retailer in Fermanagh and Omagh. This analysis determined the access that consumers have to the existing network of retailers across Fermanagh and Omagh. Accessibility was calculated based on both walking time and driving time. Affordability was assessed by auditing the cost of different consensually agreed shopping baskets to arrive at price indices for a nutritionally adequate diet.

GIS can also be used to map a range of additional services, such as food banks and advice services to identify the current provision in target areas identified by the "food poverty risk index" as highly deprived.

Data analysis
Spatial data were inputted into the software package (ESRI ArcGIS Pro 2.7). Data consisted of two primary variables (1) the poverty measure; and (2) an income measure from the Multiple Deprivation Measure. Additional pertinent socio-economic variables contributing to food poverty were weighted and combined into the final score for each geographic Small Area across Fermanagh and Omagh. These scores were aggregated to make a total percentage of rural areas that are at risk of food, fuel and/or transport poverty. Cluster Analysis was generated to identify areas that have statistically significant clusters of risk. This cluster analysis has proved a powerful tool in directing interventions to communities in greatest need (Walker *et al.*, 2012).

Shopping basket price data were inputted into the software package SPSS version 27 for Windows (Inc., IBM). Prior to any statistical analyses, an exploratory analysis was carried out to screen the data for detection of outliers/mistakes and to check that the variables did not violate any parametric assumptions. Missing values were replaced with -999 using the system missing function in SPSS. Analyses indicating a probability of $P<0.05$ were considered significant. A price index was calculated for each food item across the stores. The mean cost of buying each item in a particular quantity from all shops within an area was calculated. In a separate calculation, the mean cost of each food product was expressed in relation to the mean price of that item in all shops using z-scores. A z-score represents 'the number of standard deviations a product price is from the mean product price' to generate a price index, in relative terms, for each product. Statistical analysis used z-scores to test relative variability within and between the different areas under study.

Spatial datasets were available from the Northern Ireland Neighbourhood Information Service (NINIS) and were integrated to provide a range of socio-economic variables for census Small Areas in Northern Ireland. The distance to retailers was calculated using a time travelled proximity analysis consisting of road network data to determine

both walking and drive time travelled from each census Small Area and the nearest retailer. To determine spatial patterns a cluster analysis was generated to identify areas that have statistically significant clusters of risk of food, fuel or transport poverty. By combining accessibility measures with socio-economic variables in a GIS it was possible to create a high-resolution database that identifies the risk of food, fuel and transport poverty across Fermanagh and Omagh.

Ethical considerations
Ethical approval was sought and secured from Ulster University's Research Ethics Filter Committee (Ulster University Business School) in June 2022. All signed documents and data collected were retained and stored securely by the Project Team. All retail participants were made aware that contributions to the research were voluntary and their right to withdraw at any stage was respected. Anonymity and confidentiality were assured. Formal request practices were used to secure retailers' informed consent.

The research was undertaken within Ulster University's research governance framework and in accordance with data protection. The collection of data, and their storage and security meet acceptable ethical standards.

Fuel poverty

NOTE: 'All information was correct at the time the research was undertaken. However, it is recognised that things have changed in regard to the support available.

For example, the NIHE have superseded 'oil buying clubs' with a 'Regional Oil Buying Network' that is not area specific and is believed to achieve a larger impact on oil price discounts.

In addition, SVP have begun phasing out oil stamps.

However, none of these impacts on the data used, analysis undertaken and identification of areas likely to be at risk of fuel poverty.

The Department for Communities (DfC) commissioned Ulster University (UU) in 2017 to identify addresses across Northern Ireland that would be eligible for the Affordable Warmth Programme (AWP). The following analyses rely on the 2017 dataset. The Research Team notes that the income criteria for the scheme changed in 2021 with the scheme now accepting referrals where the annual household income is less than £23k pa. and also excludes some benefits that were previously included. This resulted in more households being eligible.

It should be noted that other schemes are in operation including the Boiler Replacement Scheme and Energy Efficiency Grants from NI Sustainable Energy Programme. This programme is the main delivery mechanism to tackle fuel poverty across NI and consists of various energy efficiency measures such as replacement boilers, insulation, new windows and other measures. As part of this process UU created an area-based risk index for each Census Small Area (SA) across NI (N=4,537) in 2017. This was based on earlier work by Walker *et al.* (2012) which assigned a fuel poverty risk score to each Census Small Area in Northern Ireland. Figure 1 shows the map of AWP eligibility for each SA across NI in 2017 with values ranging from 13.72 (Windsor ward, Belfast) to 66.33 (Glenderg ward, Derry & Strabane).
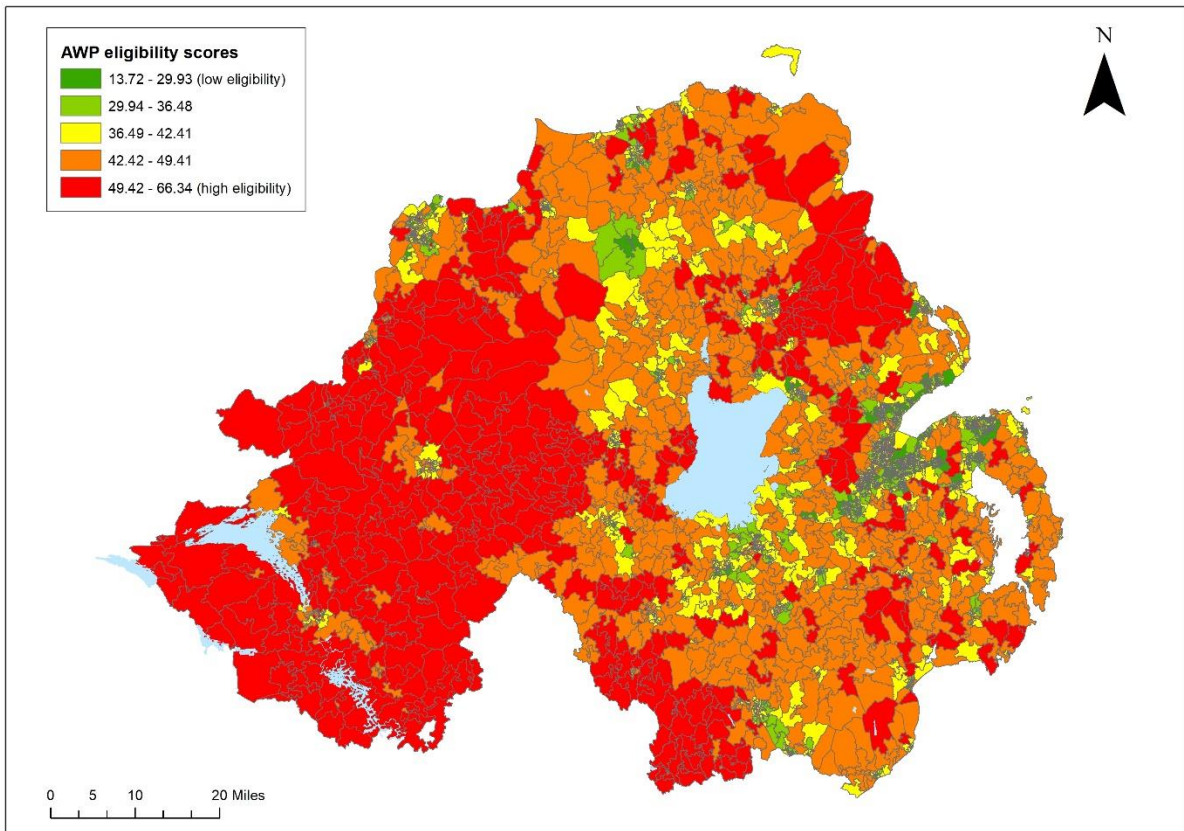
Figure 1: Affordable Warmth Programme (AWP) eligibility scores for each Small Area in Northern Ireland.

Across the 11 council areas, Fermanagh and Omagh District Council had the highest average eligibility score (49.48) compared with North Down and Ards which had an average eligibility score of 35.07 (Table 1). FODC had a relatively low variance, suggesting eligibility did not vary significantly within the Council area. FODC had the highest minimum eligibility score of all councils in NI. This means that the lowest AWP eligibility score in FODC is higher than AWP eligibility scores in other Council areas, suggesting a high level of AWP eligibility in the Council area.

Table 1: AWP descriptive statistics for each Council area in NI.

Council Name	Number of Small Areas	AWP Scores			
		Minimum	Maximum	Average	Variance
Fermanagh & Omagh	263	32.44	60.94	49.48	34.73
Mid Ulster	294	27.08	62.93	43.87	40.25
Newry, Mourne & Down	385	28.33	65.05	43.06	40.42
Derry & Strabane	328	25.39	66.34	42.59	57.37
Causeway Coast & Glens	342	21.58	61.75	41.92	34.73
Armagh, Banbridge & Craigavon	467	27.94	58.91	41.65	31.44
Mid & East Antrim	369	21.14	60.31	39.13	48.51
Antrim & Newtownabbey	352	17.96	56.14	37.45	45.34
Belfast	951	13.72	64.04	36.20	39.10
Lisburn & Castlereagh	345	18.58	61.04	36.05	45.44
North Down & Ards	441	18.84	55.58	35.08	44.19

Each SA within Fermanagh and Omagh District Council (FODC) was extracted (Figure 2), leading to a list of 263 SAs. Within FODC, values ranged from 32.44 (Drumragh ward, Omagh) to 60.94 (Trillick ward).
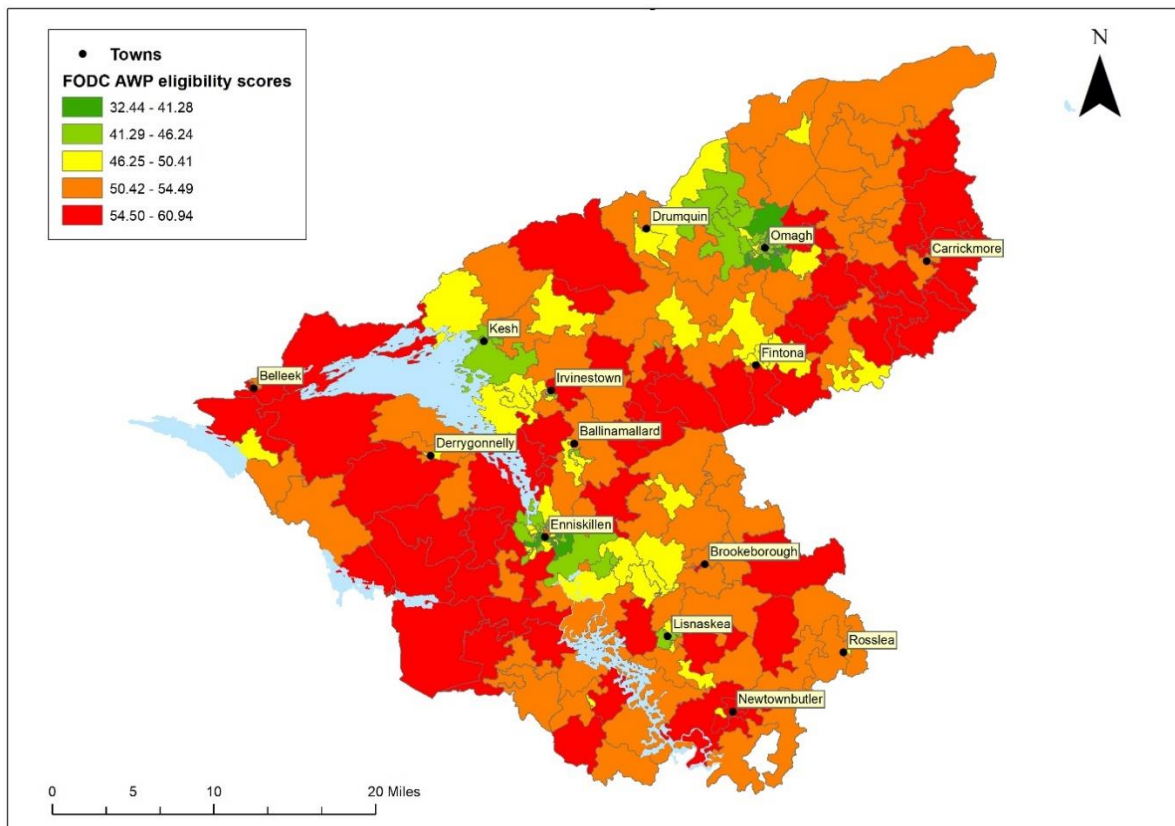
Figure 2: Affordable Warmth Programme (AWP) eligibility scores for each Small Area in Fermanagh and Omagh District Council (N=263).

Figure 2 shows the highest eligibility in rural areas while urban areas have lower eligibility scores on average. Table 2 shows descriptive statistics for eligibility scores in each settlement type across FODC in 2017.

Table 2: Descriptive statistics for eligibility scores and settlement types.

Settlement Type	Number of Small Areas	AWP Scores			
		Minimum	Maximum	Average	Variance
Open Countryside & small villages (1,000 people or less)	146	44.66	60.94	53.48	10.17
Village population (1,000-2,499 people)	25	41.97	58.31	48.58	16.51
Intermediate Settlements (2,500-4,999 people)	8	42.88	51.08	46.16	11.60
Medium Town (10,000-18,000 people)	41	38.11	53.36	44.76	14.01
Large Town (18,000 people or more)	43	32.44	49.40	41.60	13.91

Open countryside had the highest average eligibility score followed by Villages. The average eligibility score decreased along the rural-urban continuum with the most urban areas (e.g. Omagh) experiencing the lowest average eligibility scores. Open

countryside had the lowest variance which suggests these areas were relatively similar in terms of eligibility while Villages had the largest variance. The main Villages in the study area are Kesh, Irvinestown, Dromore, Tamlaght, Fintona, Ballinamallard, Lisbellaw and Maguiresbridge.

Within GIS a cluster analysis was run on the AWP eligibility scores. Cluster analysis is based on the Anselin model which distinguishes between a statistically significant cluster of high values (High-High), clusters of low values (Low-Low), outliers in which a high value is surrounded by lower values (High-Low), and outliers in which a low value is surrounded by higher values (Low-High). The method has proven very valuable in identifying neighbouring areas that may benefit from targeted interventions as economies of scale can occur when visiting numerous homes in a small geographic area (Walker *et al.*, 2012). Table 3 and Figure 3 illustrates the clusters based on FODC AWP eligibility scores.

Table 3: Clusters of AWP eligibility within FODC.

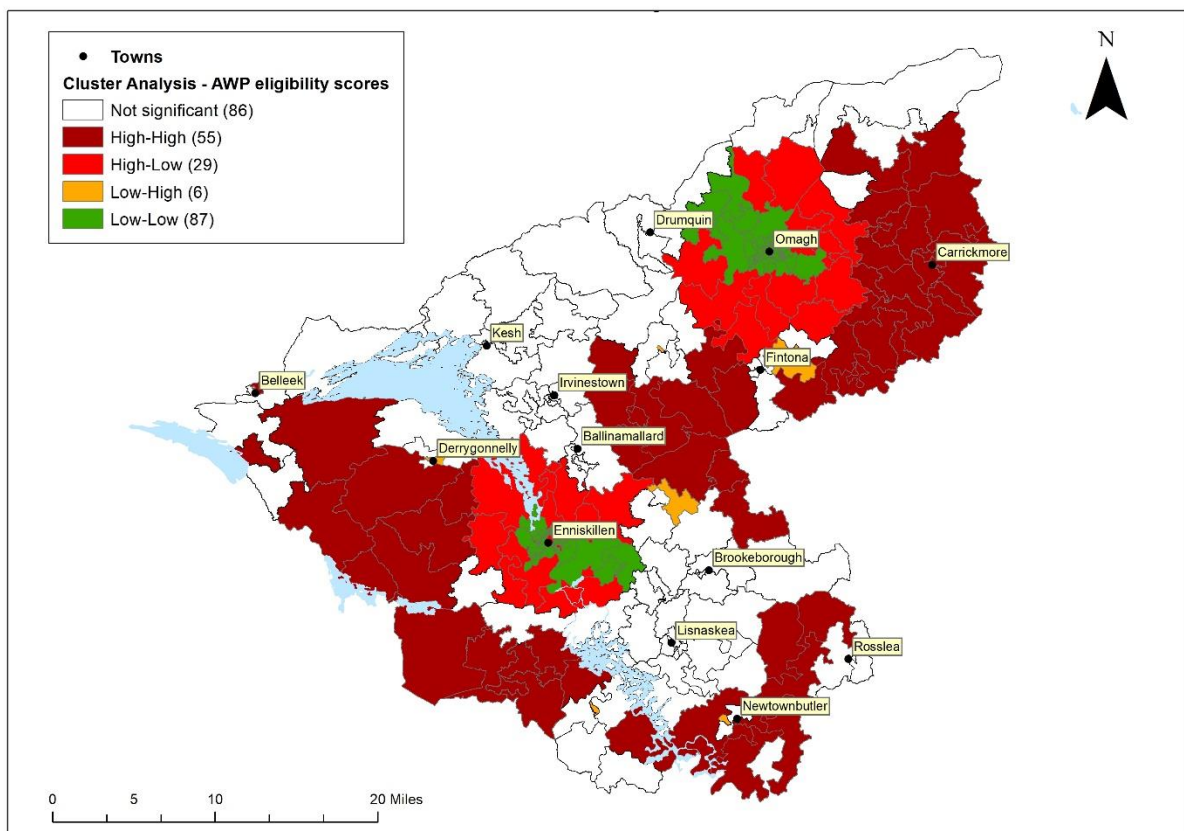| Cluster Classification	Number of Small Areas	% of FODC Small Areas
Not significant	86	32.70
High-High	55	20.91
High-Low	29	11.03
Low-High	6	2.28
Low-Low	87	33.08

Figure 3: Cluster analysis of FODC AWP eligibility scores.

Within the Council area there are areas that are not significantly clustered. Cluster analysis establishes relationships between groups of SAs that have a statistically similar or dissimilar risk score to their neighbouring SAs and therefore it is not expected that every SA will be categorised into a cluster. While these present as non-significant in terms of statistical clustering, this does not mean that fuel poverty does not exist in these areas. Establishing spatial clusters is important as it identifies SAs that could benefit from collective action, such as public policy targeted interventions. A third of SAs in FODC are classified as "Low-Low" clusters, identifying these SAs as blocks of significantly low values surrounded by similarly low values. These areas tend to be in Enniskillen (Medium town) and Omagh (Large town) which are the main urban areas. There are "Low-Low" clusters in "Open countryside" (6) and "Villages", namely Lisbellaw (2).

The clusters of highest eligibility ("High-High" – 20% of Council area) are in "Open countryside" and are generally located along the border with Leitrim, Cavan and Monaghan.

The SAs with both "High-Low" and "Low-High" are termed outliers and represent SAs with significantly different values than neighbouring SAs. The "High-Low" clusters are areas with higher eligibility scores surrounded by areas of lower scores. The "High-Low" outliers are predominantly in "Open countryside" areas surrounding Omagh and Enniskillen though there are some clusters within Enniskillen (Medium town) and the area between Bellanaleck, Tamlaght and Lisbellaw (Village). While there are very few "Low-High" clusters, 5 of these are in "Open countryside" while 1 is in a "Village" (Dromore). It is important to note that there may be valuable initiatives in 'low' risk areas that could be communicated to surrounding 'high' risk areas. It would also be important to ensure that 'high' risk areas don't spread into low risk areas.

Fuel Basket Retail Audit
In addition to the Healthy Food Basket, a selection of fuel items (oil stamps, oil drums, bags of logs and bags of coal) were included in the retail audit and recorded in terms of availability and price.

Oil stamps[1], purchased in quantities of £5 units, were available in only 4 of the surveyed retailers, resulting in an overall availability score of 8.7%. All stores were in rural areas, meaning that 13.3% or rural retailers provided these. Due to low availability, statistical analysis tests cannot be performed to determine if there is a statistically significant difference between rural and urban retailers.

Oil drums, available in quantities of 20 litres, had an overall availability score of 10.9%. For rural retailers, availability was 3.3% and 25% for urban retailers. This was the only fuel item that had better availability from urban retailers. The mean cost of the oil drum was £27.19. The lowest cost was £20 (urban retailer) and the highest cost was £38 (urban retailer), making a mean cost of £27.19. Due to low availability, statistical analysis tests cannot be performed to determine if there is a statistically significant difference between rural and urban retailers.

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[1] The Oil Stamps refer to the oil stamp programme offered and administered by St Vincent De Paul (SVP). It is recognised that this scheme was being phased out during the time the research was being conducted (Aug-Sept 22). This might partially explain the low level of availability and the variation across the district.

Bags of logs[2] were available in 67.4% of all surveyed retailers. For rural retailers, availability was 70% and urban retailers 62.5%. The lowest cost for logs was £1.65, and the highest cost was £5.59, resulting in a mean overall cost of £4.04. Both stores were in an open countryside area, and although there is a cost variation of £3.94, it should be noted that there was no indication on any of the bags of logs as to their weight. Resultingly, statistical analysis cannot be performed to determine if there is a statistically significant difference between rural and urban retailers.

Coal[3], measured in bags of 20kg were available in 78.3% of all surveyed retailers. For rural retailers, availability was 86% outperforming urban retailers at 62.5%. The lowest cost was £8 (rural retailer) and the highest cost was £18.10 (rural retailer). The mean cost for both rural and urban retailers was similar at £14.24 and £14.59 respectively. Results showed that there was no statistical difference between the cost of coal between rural (M = 14.24, SD = 2.6) and urban retailers (M = 14.59, SD = 2.4 = t (44) = -.45, p = .06, two tailed).

In summary, rural retailers have greater availability of fuel basket items in comparison with their urban counterparts (Figure 4).
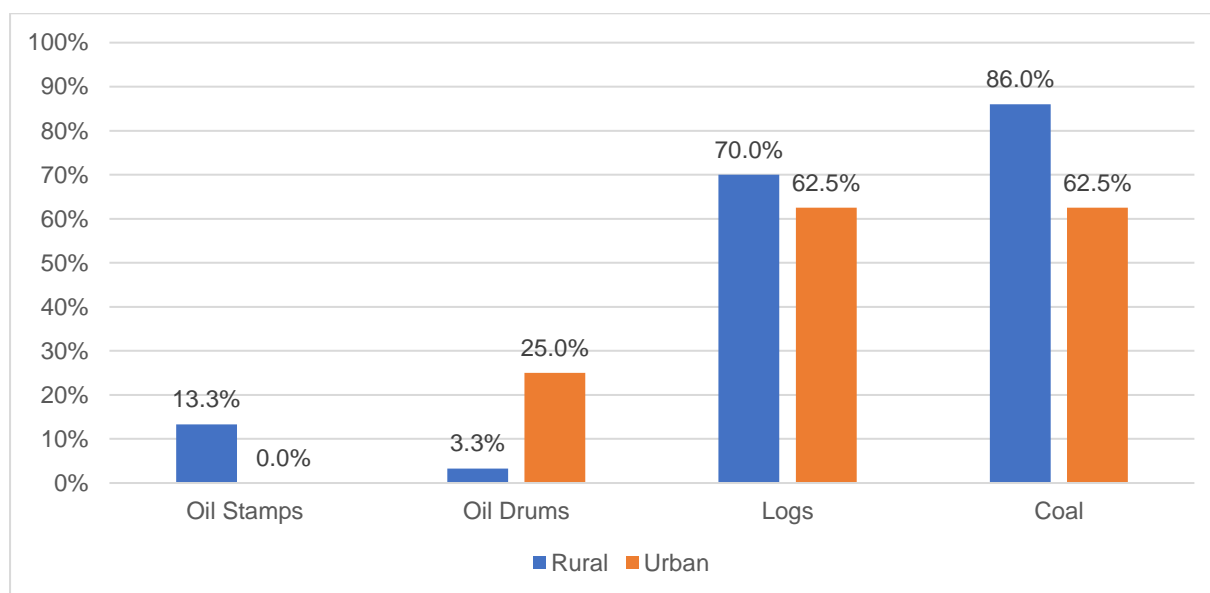

Figure 4: Availability of fuel items between rural and urban retailers

A layer of "Poverty Support Locations"[4] was shared with UU by FODC. This layer contained details of a range of support types including oil buying networks and energy support. Figure 5 illustrates the location of these support locations across FODC in relation to AWP eligibility scores.

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[2] The research audited the availability of bags of logs. There was no indication of the weight of the bag which may contribute to the variation in prices.
[3] The research audited the availability of coal, measured in 20kg bags. There was no allowance for coal of different grades / types of coal, which may contribute to the variation in prices.
[4] As noted at the outset of this section – this information was correct at the time this research was conducted. However, since then, a regional wide 'oil buying network' has been introduced which is not location specific.
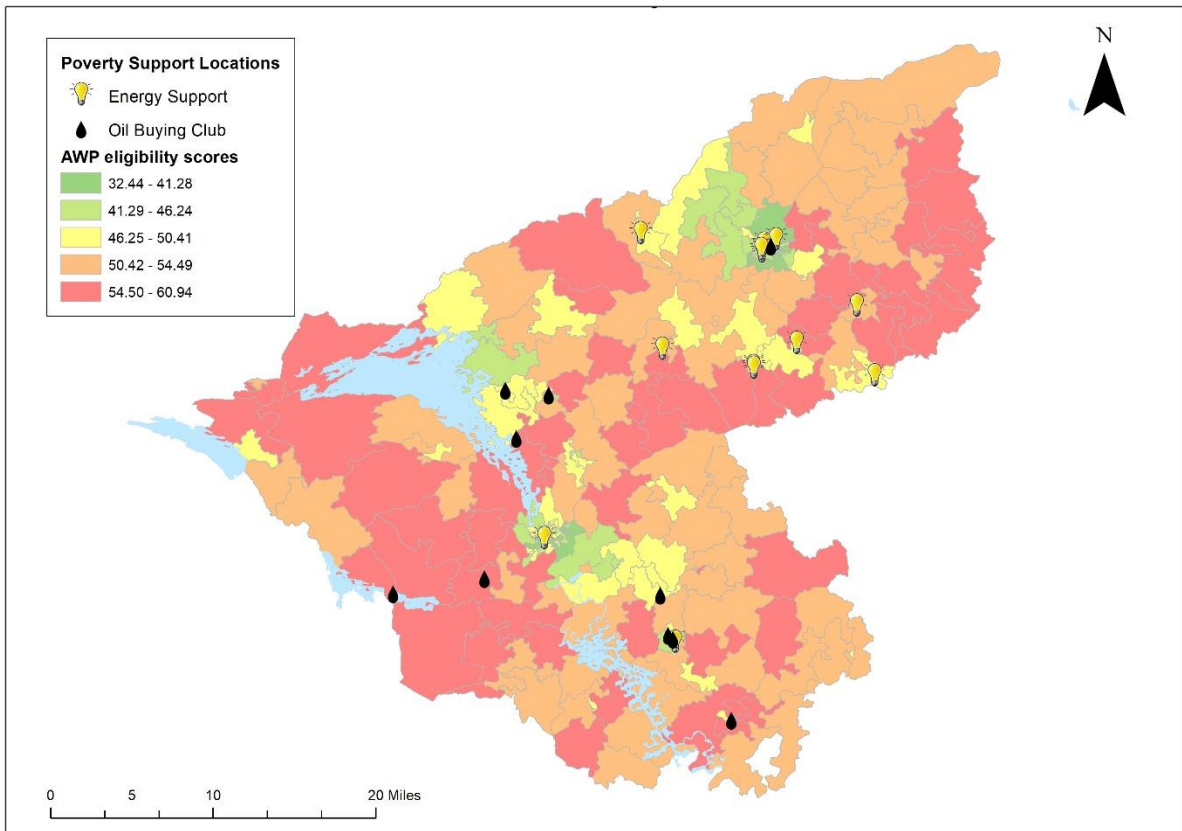
Figure 5: Fuel support locations across FODC (Autumn 2022).

Table 1 above outlines that FODC has a higher average eligibility score than other Council areas. As such, the majority of SAs within the Council area has benefitted and will continue to do so from support schemes.

There are 13 Fuel Stamp Outlets (Energy centres) within FODC which are situated in 12 SAs. They appear across most settlement types with 4 in Omagh (Large town), 1 in Enniskillen (Medium town), 1 in Lisnaskea (Intermediate settlement), 2 in Villages (Dromore and Fintona) and 4 in Open countryside. The mean eligibility score for FODC is 49.48 (Table 1) - 6 of the SAs with fuel stamp outlets have eligibility scores *below* the average i.e. lower eligibility (Omagh and Enniskillen) while 6 SAs with fuel stamp outlets and eligibility scores *above* the average (i.e., higher eligibility). The SA with the highest eligibility score (58.84) and a fuel stamp outlet is Newtownsaville ward (Open countryside).

There are ten oil buying networks across FODC which are situated across 10 SAs. They appear in Omagh (Large town, 1), Lisnaskea (Intermediate, 2), Irvinestown and Maguiresbridge (Village, 2) and 5 in Open countryside (Killadeas, Newtownbutler, Belcoo and Letterbreen). Four of the Open countryside SAs with oil buying networks have eligibility scores above the average (49.48).

Considering NI has scores ranging from 13.72 to 66.33, values greater than 54.31 tend to be in the top decile of eligibility. Considering SAs in FODC, 64 SAs are accordingly in the top decile – the majority of these occur in Open countryside though 2 are in Villages (Irvinestown and Dromore). Of the 64 SAs with high eligibility scores, 58 have no fuel poverty centre (neither fuel stamp outlet nor oil buying networks). Of

the 58 SAs, there are contiguous areas near Derrygonnelly, Carrickmore and Trillick (Figure 6).
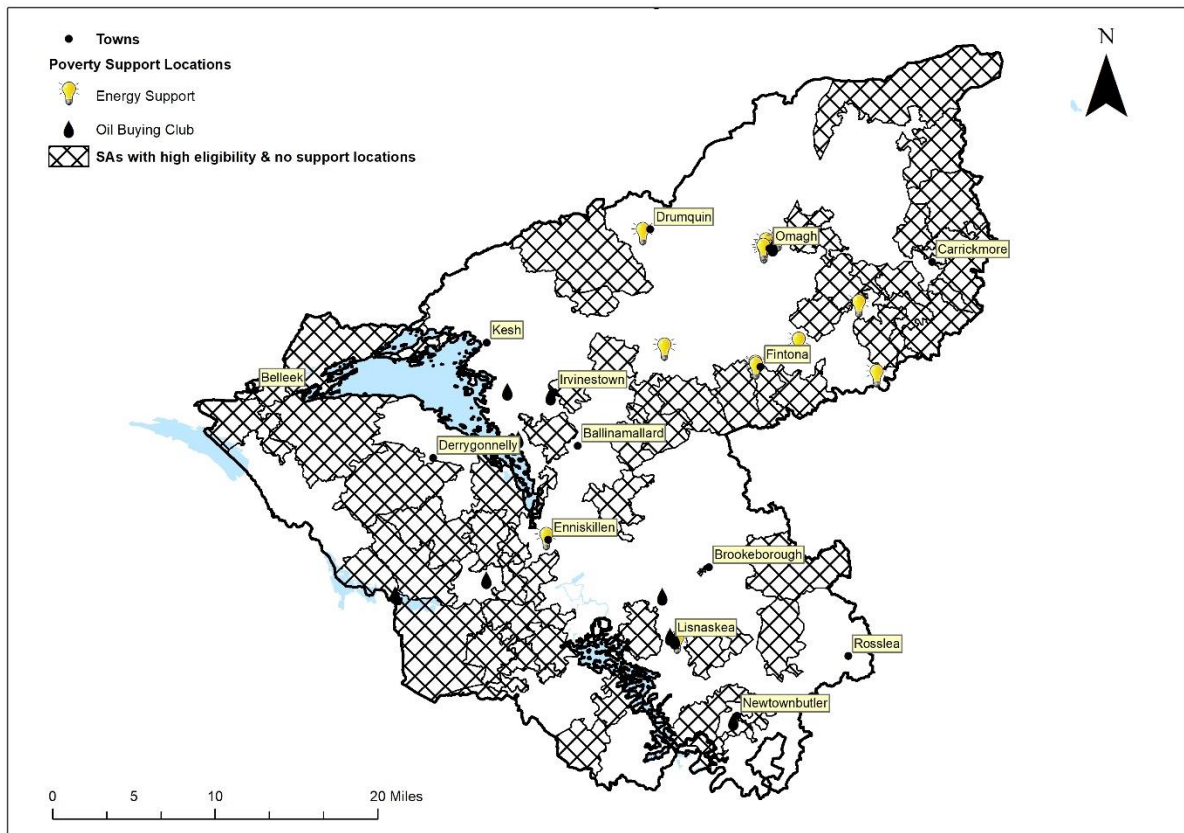

Figure 6: Small Areas with high eligibility and no fuel stamp outlets or oil buying networks (Autumn 2022).

Retailers offering fuel products

As part of the work carried out by Cognisense, retailers offering products such as oil stamps, oil drums, logs and coal were identified. The following details relate to the 46 retailers who were sampled by Cognisense. As such, other retailers in the area may offer a range of fuel products though these may not be included in the sample. Based on the sampled retailers, 34 Small Areas (13% of FODC) have at least one type of fuel being sold. The average AWP score for the 34 Small Areas offering fuel products is 49.3, ranging from 38.6 (Rossorry Ward, Enniskillen) to 58.3 (Dromore ward, Omagh). The average AWP eligibility score for FODC was 49.48.

Oil Stamps (Figure 7) are sold in Brookeborough, Ederney and Tempo (Open countryside) and Dromore (village).
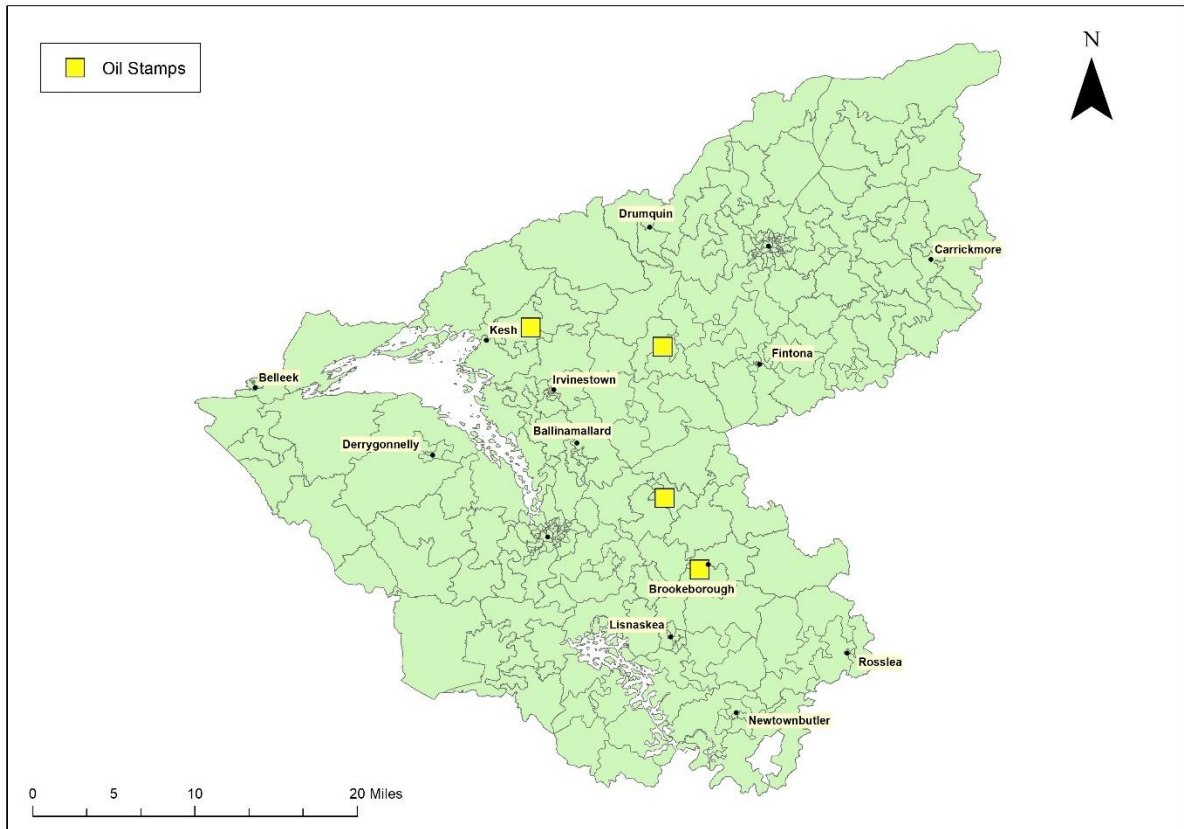
Figure 7: Retailers offering oil stamps throughout FODC

Brookeborough and Dromore are classified as high eligibility for fuel poverty while Kesh is also high risk. Tempo has several high-risk areas nearby. Most high-risk areas for fuel poverty have no oil stamp retailer nearby. There are 60 Small Areas with a high-risk score for fuel poverty and only 16 of these Small Areas are within 5 five miles of a retailer offering oil stamps (Figure 8).
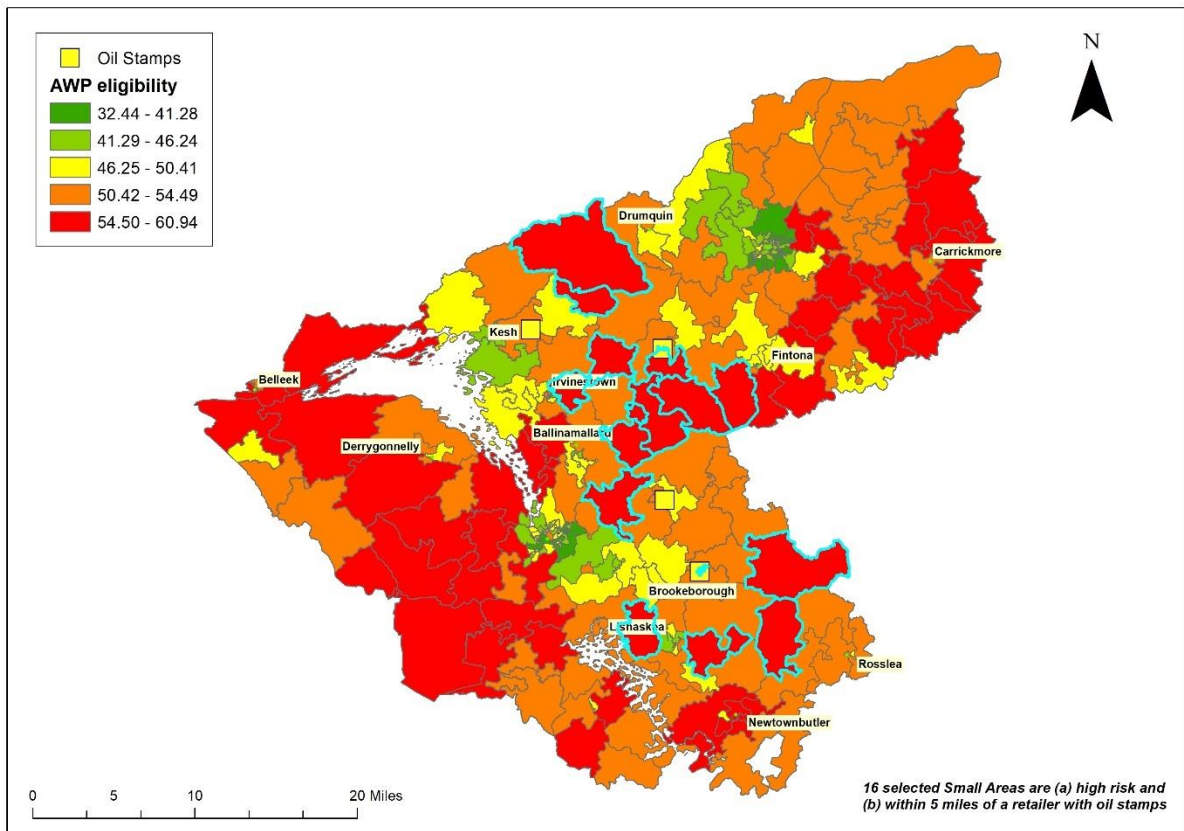
Figure 8: Retailers offering oil stamps throughout FODC and AWP eligibility.

Evidence suggests that people living in fuel poverty often rely on emergency oil drums which may be significantly more expensive than larger quantities (Age NI, 2011; CCNI, 2012). Liddell and Gray (2014) carried out an audit of 2,063 homes as part of the Affordable Warmth Pilot survey. Most homes were in severe fuel poverty and had to spend at least 15% of their income on heating. The report identified that 60% of owner occupiers used 20 litre emergency drums while only 40% of private renters resorted to this option. There is therefore a risk that oil drums are sold mainly in areas of highest risk (Figure 9).

Most retailers supplying oil drums (Figure 9), logs (Figure 10) and coal (Figure 11) are in Enniskillen and Omagh though no oil drums are sold in open countryside (Figure 9).

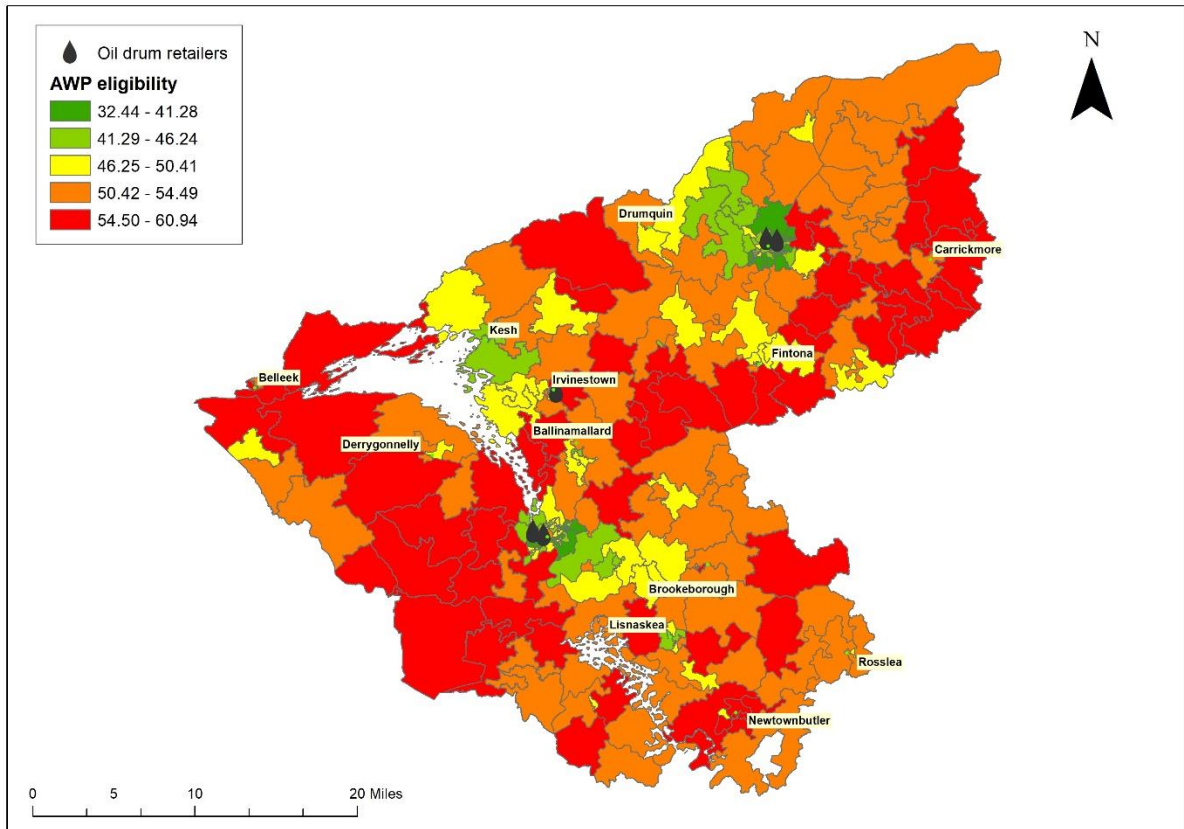**Figure 9: Retailers offering 20 litre oil drums throughout FODC and AWP eligibility.**

There are 5 Small Areas that have a retailer selling oil drums. While there are several higher risk Small Areas within the vicinity (Irvinestown), most oil drum retailers are in Small Areas with lower risk scores.

The data on oil drums and oil stamps show areas of need that could benefit from the regional oil buying networks, renewable technologies and district heating[5]. Specific areas include:

- Belcoo and Garrison ward
- Boho Cleenish and Letterbreen ward
- Derrygonnelly ward
- Florencecourt and Kinawley ward
- Fintona ward
- Sixmilecross ward
- Termon ward
- Beragh ward

With a regional oil buying network now available to these areas, consideration should be given to promotion of the oil buying network in these areas (short term) and options

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[5] 'District heating' is a system for distributing heat generated in a centralised location through a system of insulated pipes for residential and commercial purposes. For example, large factories may produce a lot of heat during production that would be wasted. This can be pumped to nearby homes. An example is: https://www.leeds-pipes.co.uk/

to introduce modern and renewable technologies and appropriate insulation in the longer term.
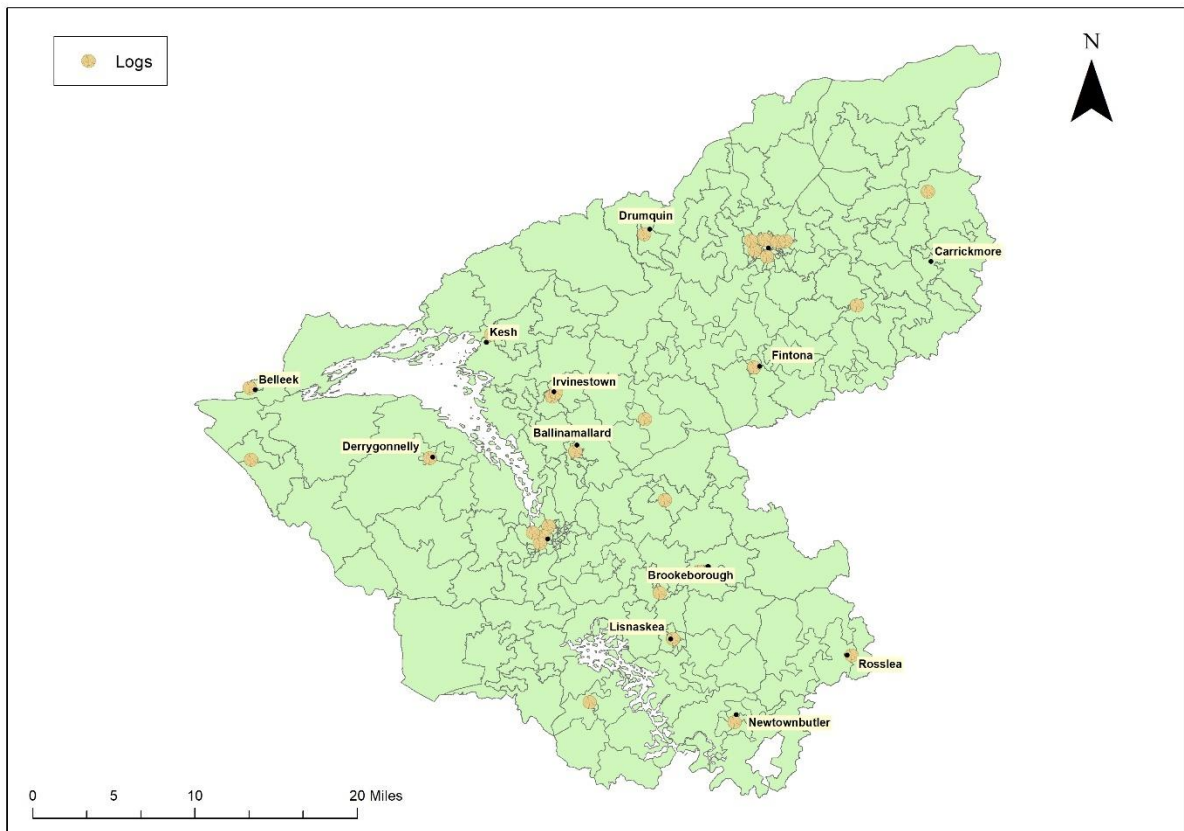
Figure 10: Retailers offering logs throughout FODC

Coal is sold in 20 kg bags throughout FODC (Figure 11) and costs range from £8.00 (Open countryside) to £18.10 (Open countryside) with an average price of £14.33. There is considerable variation in the cost, especially within Enniskillen and Omagh. Within Omagh the price of a 20 kg bag of coal varies by almost £8.00 between two retailers who are 200 metres apart. Within Enniskillen, prices vary by approximately £5.00 per bag within a 1.2 mile area. For this reason, it is important to note that slightly different products are being compared, but the emphasis is on availability as much as cost.

Figure 11: Retailers offering bags of coal (20 kg) throughout FODC.

Open countryside retailers (N = 14) had the lowest average price for a bag of coal at £13.48 though prices ranged from a minimum cost of £8.00 to a maximum cost of £18.10. The average price per bag of coal was similar in Villages (N = 9; Mean = £14.91), Enniskillen (N = 5; Me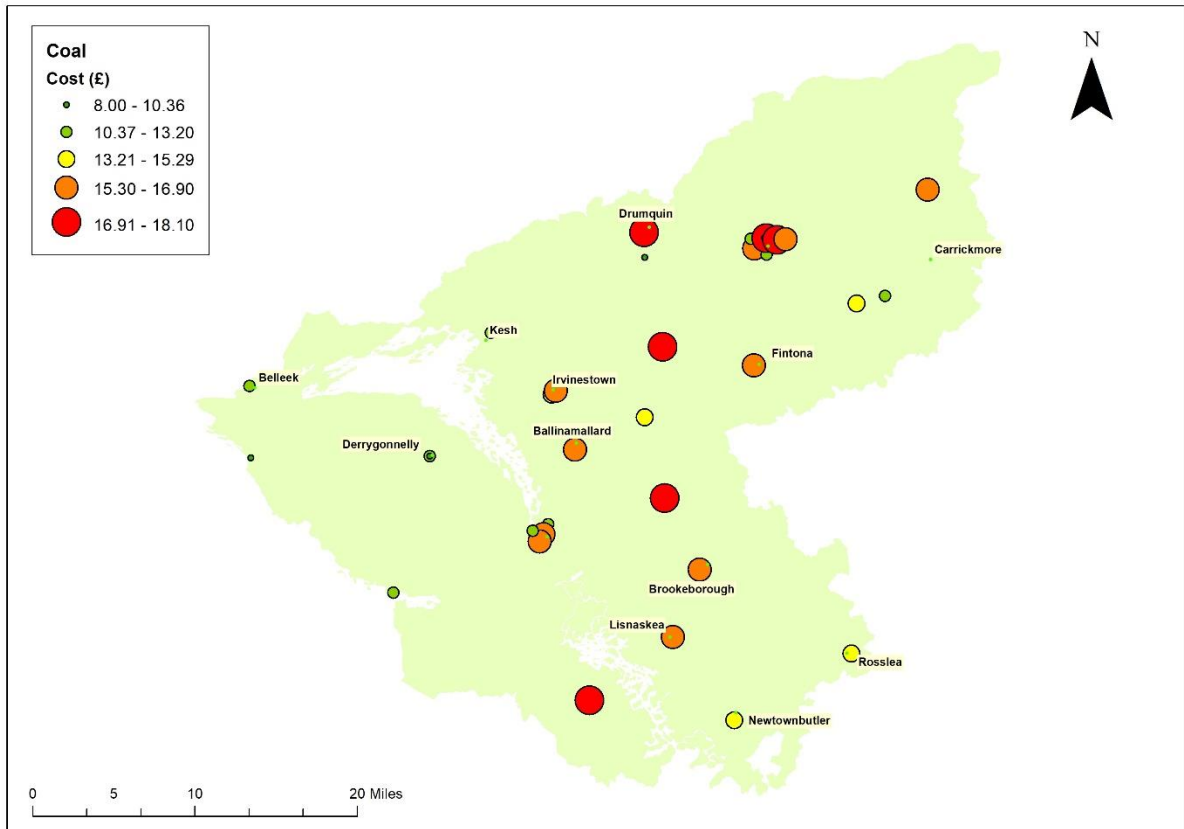an = £15.05) and Omagh (N = 7; Mean = £14.54) with a range between £7.00 and £8.00. Lisnaskea as an intermediate settlement had the highest average at £15.95 though this only represented one retailer.

Walker et al. (2015) identified that Home Heating Oil (HHO) prices varied significantly in relation to poverty (β = -0.44, p = 0.01) and the provision of gas (β = 0.47, p = 0.01) in a Super Output Area. When categorized into an urban-rural split, the influence of poverty on oil prices increased significantly (β = -0.61, p = 0.01). The results suggested that oil prices *increased* in areas with lower poverty (i.e. more affluence), particularly in rural areas.

Based on the work by Walker et al. (2015) there is some indication that coal price varies in relation to the deprivation and poverty in an area. A Spearman's rank order correlation was carried out between coal price and the Income Deprivation Rank (NISRA, 2017) which identified a non-significant correlation of 0.272 (N = 36; p = 0.108). A Pearson correlation was also carried out between coal price and the poverty variable from NISRA (proportion of the population living in households whose equivalised income is below 60% of the NI median). The Pearson correlation was -0.262 though the correlation was not statistically significant (p = 0.123). While the correlations were not statistically significant, there appears to be a weak relationship between poverty and price with lower prices occurring in areas with increasing poverty rates (Figure 12). For instance, in Omagh higher prices for coal occur mainly in Small

Areas with lower poverty rates. In areas with higher poverty rates (e.g., Belleek, Kesh or Irvinestown), the price of a bag of coal tends to be lower. This pattern does not hold in every case with low prices occurring in affluent areas across a range of settlement types.
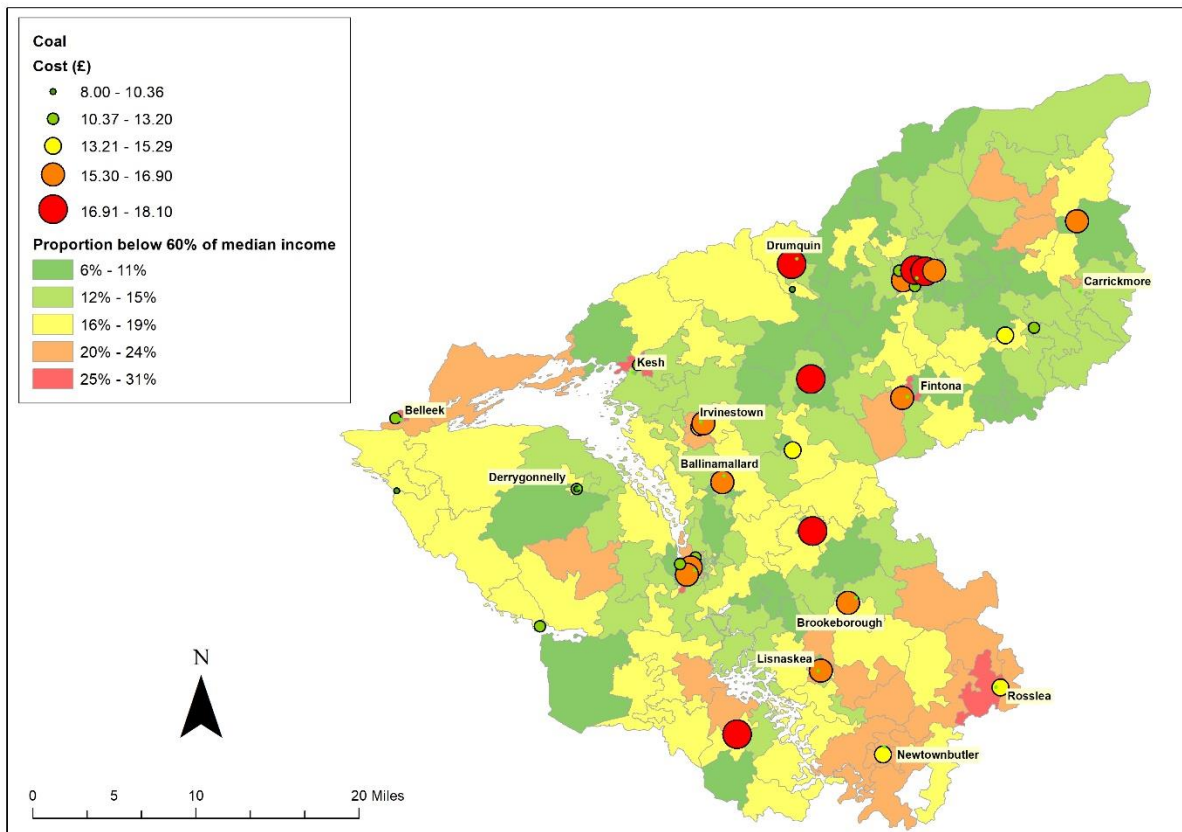

Figure 12: Retailers offering bags of coal (20 kg) throughout FODC and poverty rates.

Transport poverty

Transport poverty can be caused by a range of factors such as low population density (Mattioli and Colleoni, 2016), car dependency (Mattioli, 2021) and affordability and accessibility of public transport (Lucas *et al.*, 2016). Dellaccio *et al.* (2022) identified that several socio-economic groups are at particular risk of increases in motor fuel expenditure which makes them susceptible to transport poverty. These groups include young renters, pensioners with disabilities or long-term ill-health and people on low incomes. Many of these categories can co-exist (e.g. young social renters with low incomes) yet it is useful to identify areas that have high concentrations of specific groups. When combined with low accessibility to public transport and living in dispersed settlements, a spatial model can lend itself to identification of areas that may experience higher risk of transport poverty.

Figure 13 identifies all settlement types within the Fermanagh and Omagh District Council area.
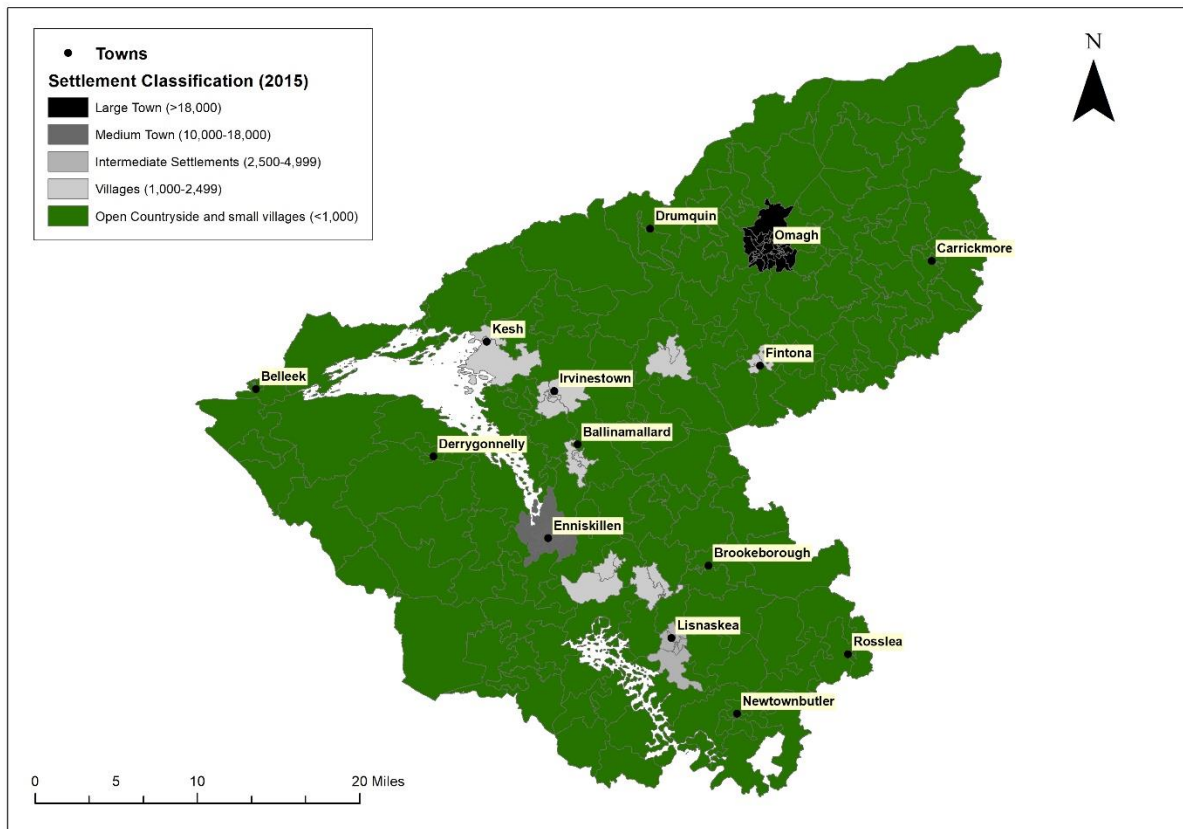
Figure 13: Settlement types in FODC.

Mattioli *et al.* (2017) identified that areas of higher population density are typically at lower risk of transport poverty. While FODC has a low population density compared to other areas of the UK, this variable will be used as an indicator of increased risk of transport poverty for each SA. The majority of FODC is Open Countryside with 55% of the 263 Small Areas in this category. Figure 14 shows the population density across FODC based on population counts in 2020.

Figure 14: Population density within FODC based on population counts in 2020 (Source: NINIS).

FODC operates on the principle that 70% of the population live outside Enniskillen and Omagh, thus are rural Based on 2020 population figures the percentage of the population living in the different settlement types are as follows:

- Open Countryside = 69,475 people (59% of the FODC population)
- Large town (Omagh) = 20,418 people (17%)
- Medium town (Enniskillen) = 13,776 people (12%)
- Village = 10,634 people (9%)
- Intermediate = 3,038 people (3%)

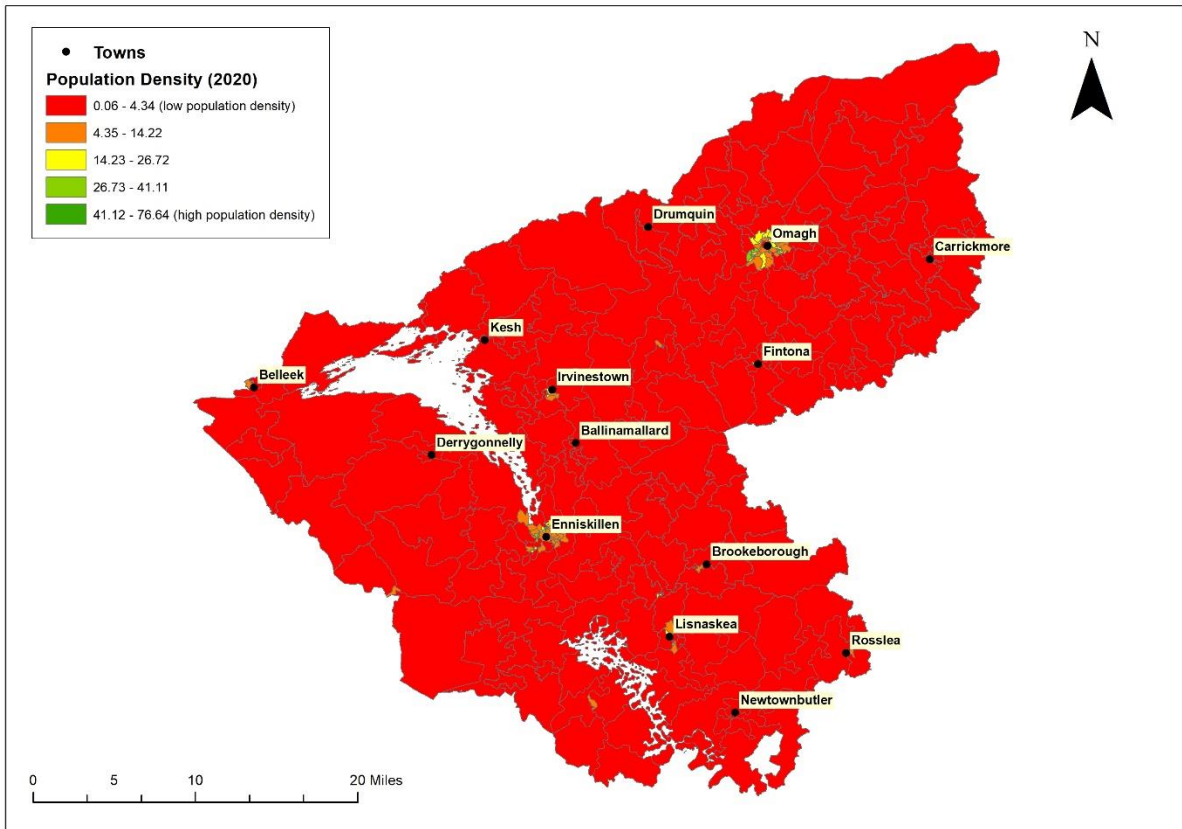When considering public transport, Figures 15-18 shows the main bus routes and bus stops within FODC alongside bands showing areas that are within a 10-minute walk from each bus stop.

Using Pointer data from LPS, there were approximately 51,713 domestic properties in FODC (2017). Of these, 33,736 properties were within the 10-minute walking bands from existing bus stops in the area (65.2%). The remaining 17,977 properties are more than a 10-minute (i.e. 500m – 800m) walk from an existing bus stop in FODC. However, for those properties near to a bus stop, the frequency of public transport is a further consideration.

Figure 15 shows the frequency of public transport via buses within FODC between 7am and 9am between Monday and Friday.

Figure 15: Weekday (AM) bus frequency in FODC.

Figure 16 shows the frequency of public transport via buses within FODC between 4pm and 6pm between Monday and Friday.

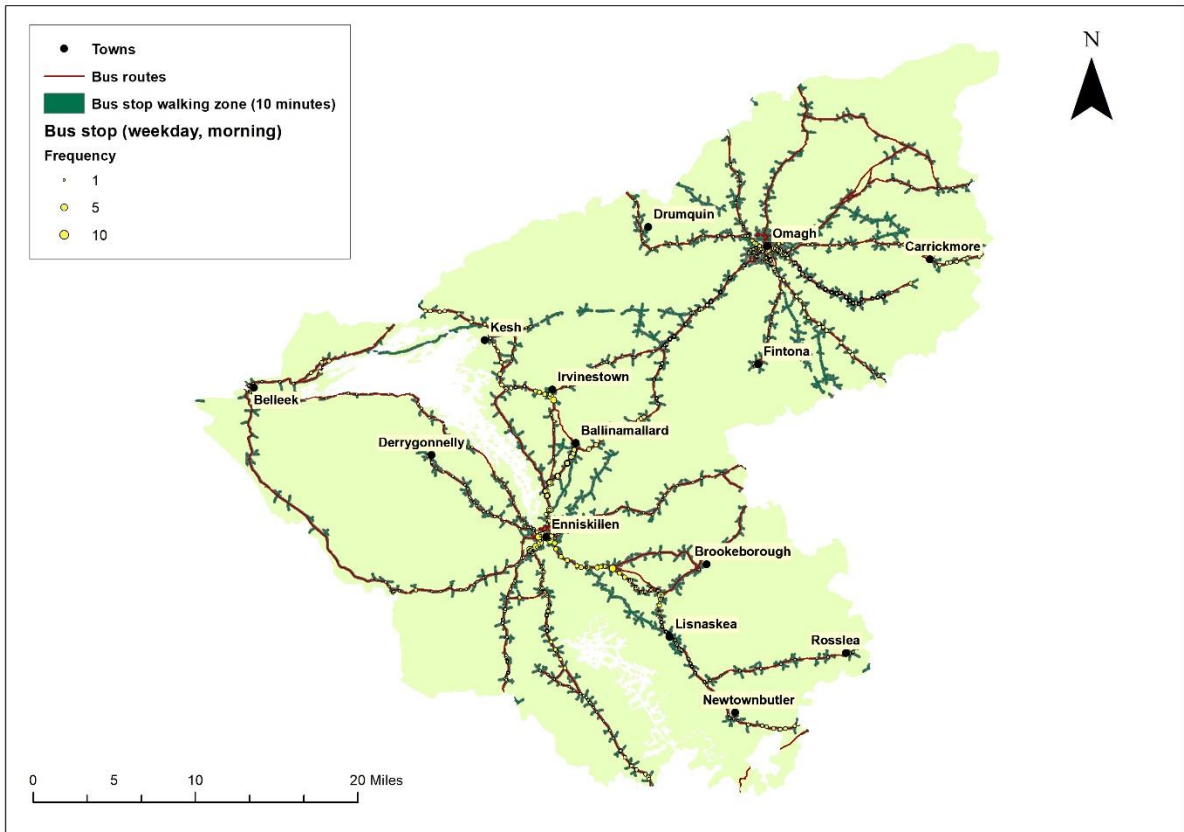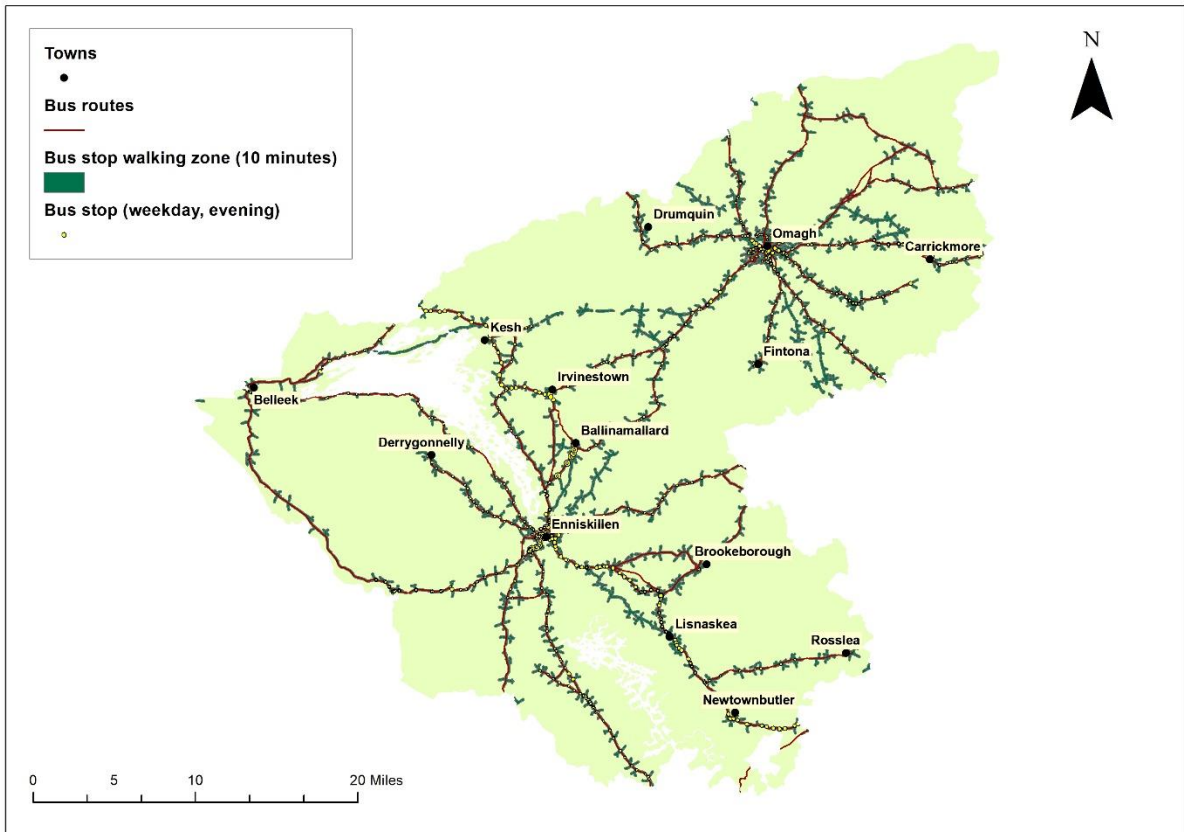**Figure 16: Weekday (PM) bus frequency in FODC.**

Figure 17 shows the frequency of public transport via buses within FODC between 7am and 9am over Saturday and Sunday.
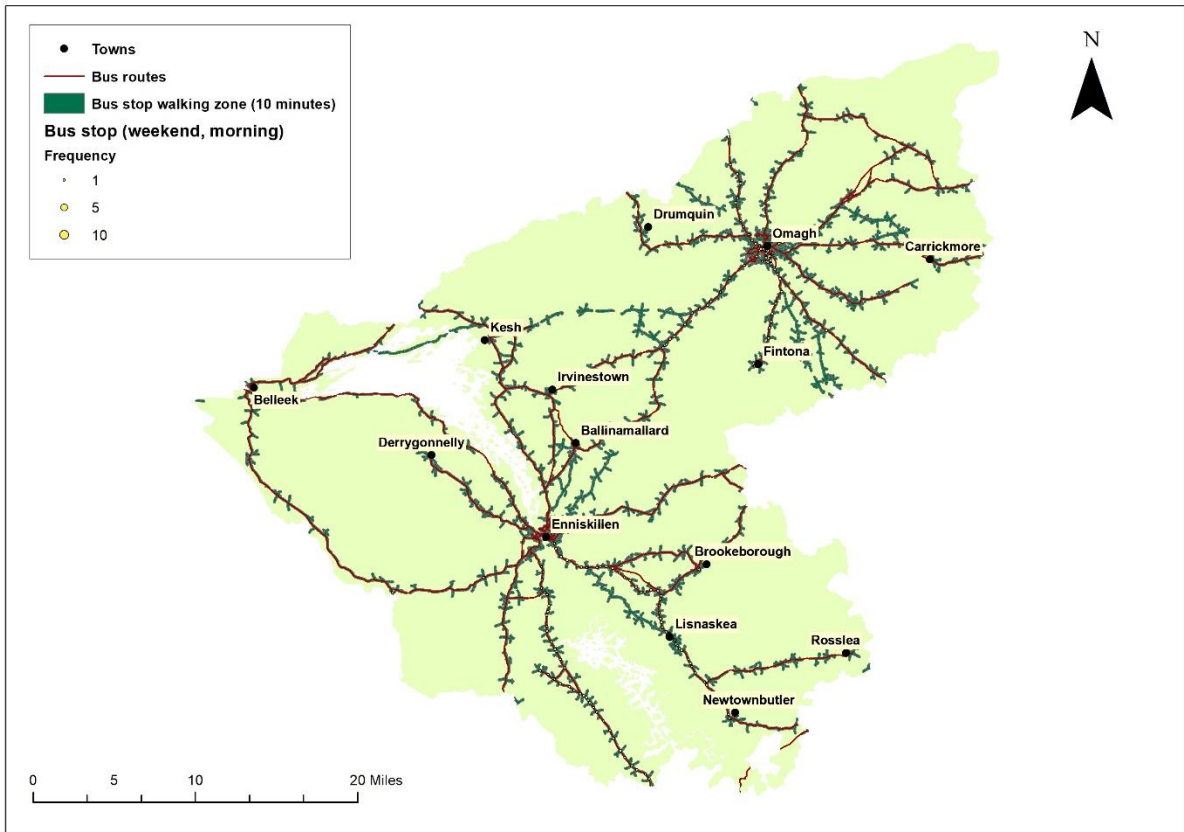
Figure 17: Weekend (AM) bus frequency in FODC along with bus routes

Figure 18 shows the frequency of public transport via buses within FODC between 4pm and 6pm over Saturday and Sunday.
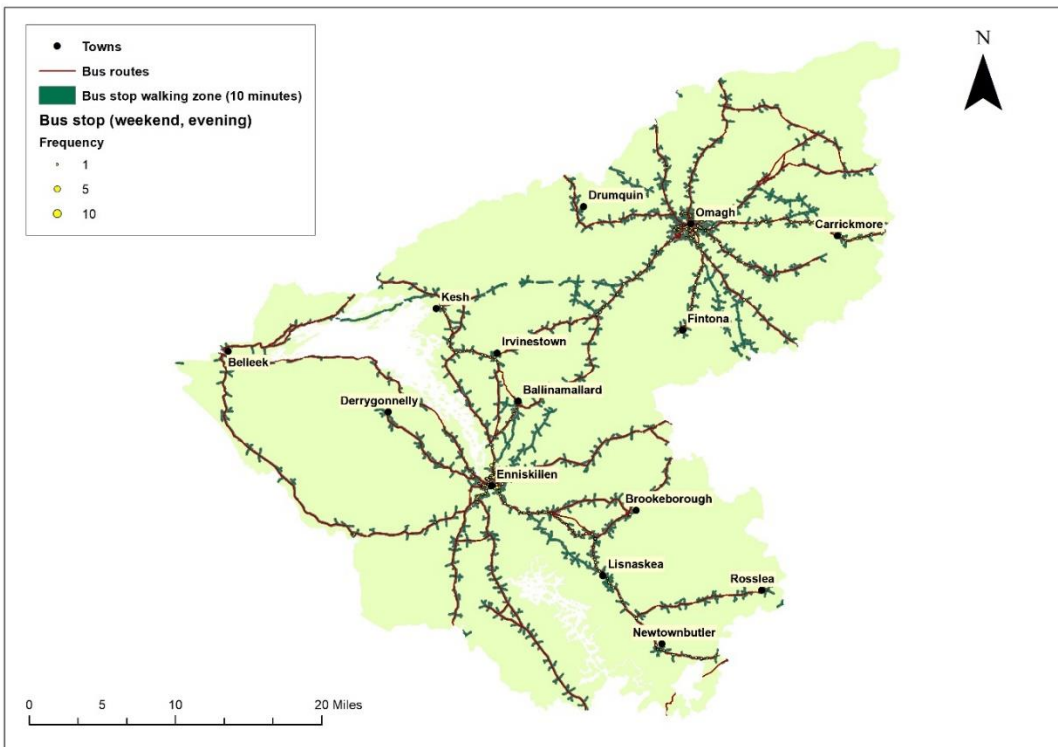
Figure 18: Weekend (PM) bus frequency in FODC.

Table 4 shows the frequency of bus stops throughout each week.

Table 4: Frequency of bus stops throughout each week in FODC

Day	Time period	Frequency of stops
Weekday	7am to 8am	4
Weekday	8am to 9am	5
Weekday	11am to noon	5
Weekday	noon to 1pm	4
Weekday	4pm to 5pm	4
Weekday	5pm to 6pm	4
Weekend	7am to 8am	1
Weekend	8am to 9am	2
Weekend	4pm to 5pm	3
Weekend	5pm to 6pm	2

In addition to accesss to public transport, income is a significant element of all types of poverty and must be captured in any area-based models. Figures 19 and 20 show two datasets representing different elements of deprivation and/or low income. Figure 19 shows the Mulitple Deprivation Measure (MDM) for each SA in FODC based on data from 2017. The values are ranks with each SA placed on a scale between 1 (most deprived) and 4,537 (least deprived). The MDM captures deprivation for 38 indicators across seven domains:

Income; Employment; Health & Disability; Education Skills & Training; Access to Services; Living Environment; and Crime & Disorder.

NINIS, 2018

The domains are then weighted to create the overall MDM.
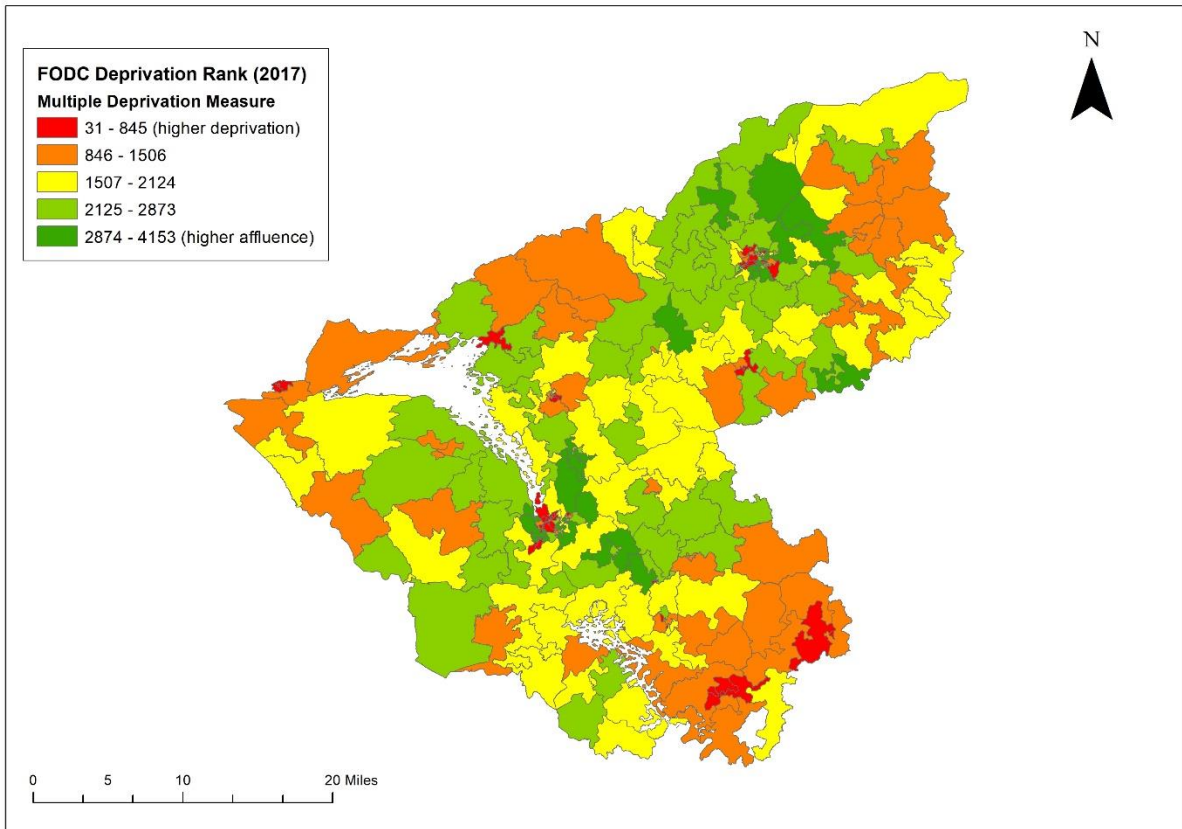
Figure 19: The Multiple Deprivation Measure (Rank) for each SA in FODC, 2017.

There are clear areas of higher deprivation though these are mainly based in urban areas such as Omagh (Large Town), Enniskillen (Medium Town) and Lisnaskea (Intermediate Settlement). However, Villages such as Fintona, Irvinestown and Kesh had pockets of high deprivation as did several areas classified as Open countryside (e.g. Rosslea, Belleek and Newtownbutler).

The Northern Ireland MDM was updated in 2017 to include an Income Rank which was based on:

Proportion of the population living in households whose equivalised income is below 60% of the NI median

DfC, 2015/16

Figure 20 below shows the "proportion of the population living in households whose equivalised income is below 60 per cent of the NI median" (NINIS, 2017). Across NI, this variable ranges from a maximum of 44 (Armagh, Banbridge and Craigavon) to a minimum of 0 (Glencairn, Belfast). Within FODC, values range from a maximum of 31 (Devenish ward) to a minimum of 6 (Rossorry ward). The average value for all NI is 13 – 60% of Small Areas in FODC are above the NI average.
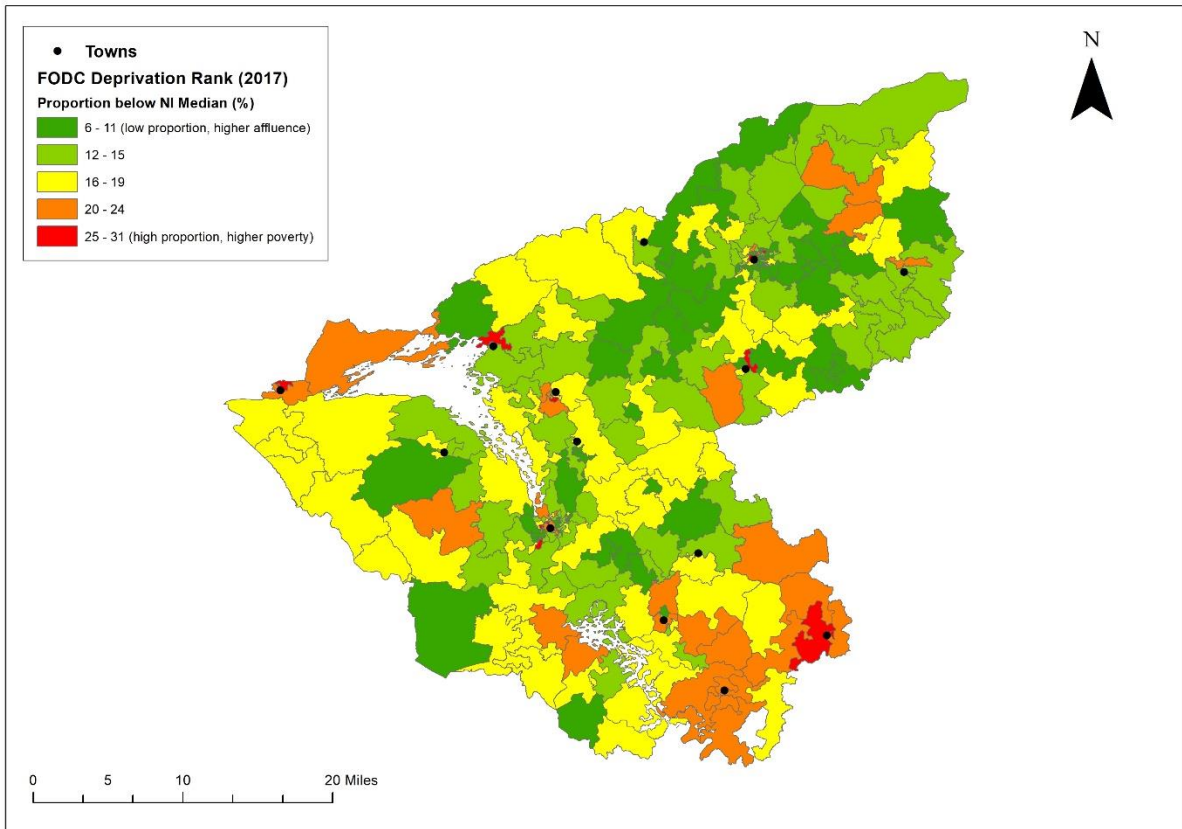
Figure 20: Proportion of the population living in households whose equivalised income is below 60 per cent of the NI median (NINIS, 2017).

Areas in the highest band (25% +) occur in Omagh, Enniskillen (Large and Medium towns) along with Irvinestown, Fintona and Kesh (Villages) and Rosslea (Open countryside).

There are clear Small Areas across FODC that have high deprivation and lower incomes that place these areas at greater risk of all types of poverty.

Transport poverty is susceptible to both low socioeconomic status and high car dependence (Mattioli *et al.*, 2019). Dodson and Sipe (2007) investigated oil vulnerability in Australian cities and identified that suburban and peri-urban areas were at greater risk than more urban areas. They also identified that "low socioeconomic status and high car dependence are strongly co-located" (p. 57) with peripheral areas experiencing low population density and poor public transport provision. In other words, people with low incomes find themselves dependent upon having a car due to infrequent public transport, increased distance to key services, more precarious employment opportunities. Lucas *et al.* (2016) also refer to transport affordability in terms of transport poverty in addition to limited transport choices and poor accessibility to key services.

Figure 21 shows SAs in FODC that had no car or van availability in 2011.
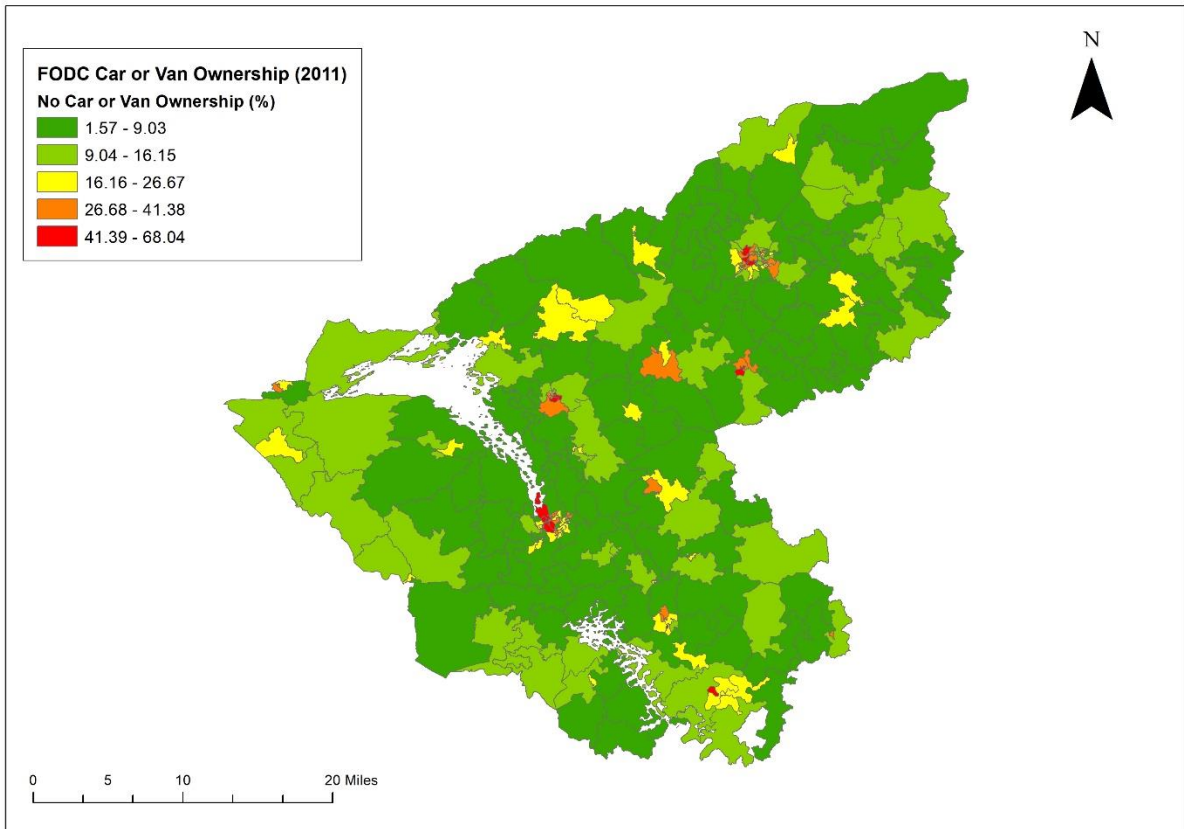
Figure 21: Percentage of households with no car or van ownership (UK Census, 2011).

Lowest vehicle ownership tended to occur in Omagh and Enniskillen which have a greater range of key services nearby and may also benefit from greater public transport provision. However, there are SAs with 25% or more households with no car or van ownership. These areas include Lisnaskea (Intermediate settlement), Irvinestown, Maguiresbridge, Fintona and Dromore (Villages) in addition to Belleek, Newtownbutler, Rosslea, Tempo and Drumquin (Open Countryside).

In addition to population density, income and car ownership, accessibility to public transport is important to consider transport poverty. Figure 22 was created by identifying any SA population weighted centroid (PWC) that intersected a 10 minute walking band from an existing bus stop. For instance, the PWC for SA N00004432 is in the middle of Omagh. There are 28 bus stops within a 10-minute walk from this PWC suggesting higher provision of public transport in this SA.
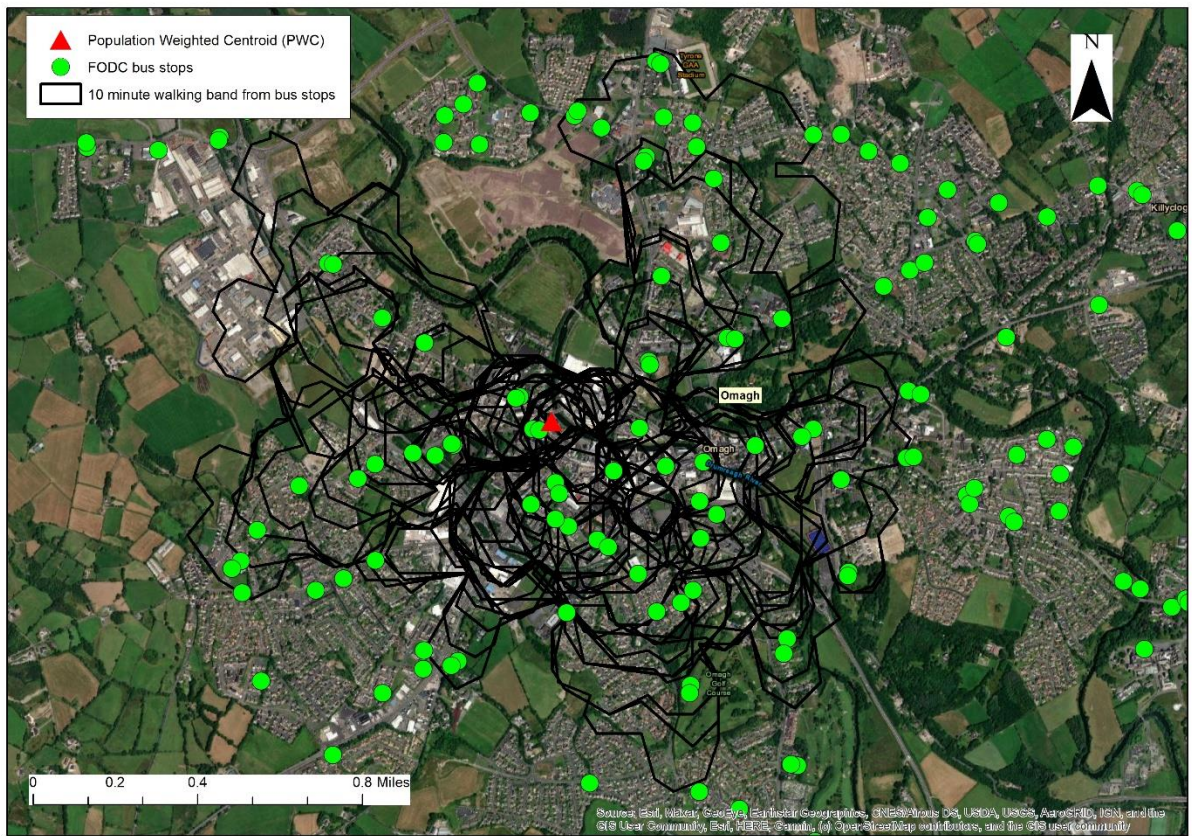
Figure 22: Bus stop accessibility to a selected SA in Omagh.

The number of bus stops within a 10-minute walk of all SA PWCs in FODC was calculated to produce a count of accessible bus stops (Figure 23).
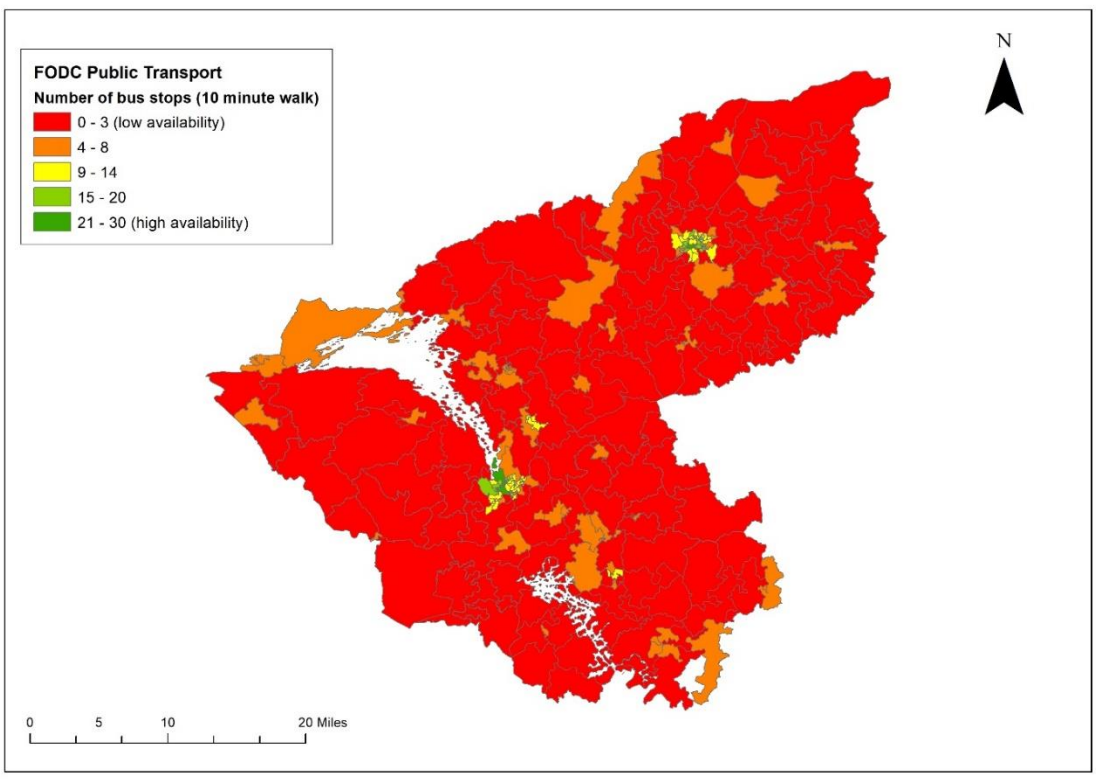
Figure 23: Bus stop accessibility for each SA in FODC.

A further dataset was provided by NINIS which calculates the travel time from each Small Area to a range of 20 key services (Table 5).

Table 5: Key services considered in terms of travel time for each Small Area

Key Services	
GP premises	Council Leisure Centre
Accident and Emergency hospital	Financial services
Dentist	Day nursery
Pharmacist	Primary school
Optician	Post-primary school
Job Centre	Restaurant
Post Office	Fast-food outlet
Food store	Pub
Large service centre	Filling station
Library	Health & beauty establishment

The file contains private and public transport travel times to key services from each of the 4,537 Small Areas (SA). This information was used in the Access to Services Domain in the Northern Ireland Multiple Deprivation Measures (NIMDM) 2017. The values are ranked from 1 (longest travel time) to 4,537 (shortest travel time). The Small Area with the longest travel time in NI for both public and private transport occurs in FODC (N00002918, Belcoo and Garrison). Figures 24 and 25 show the private and public transport ranks across FODC.
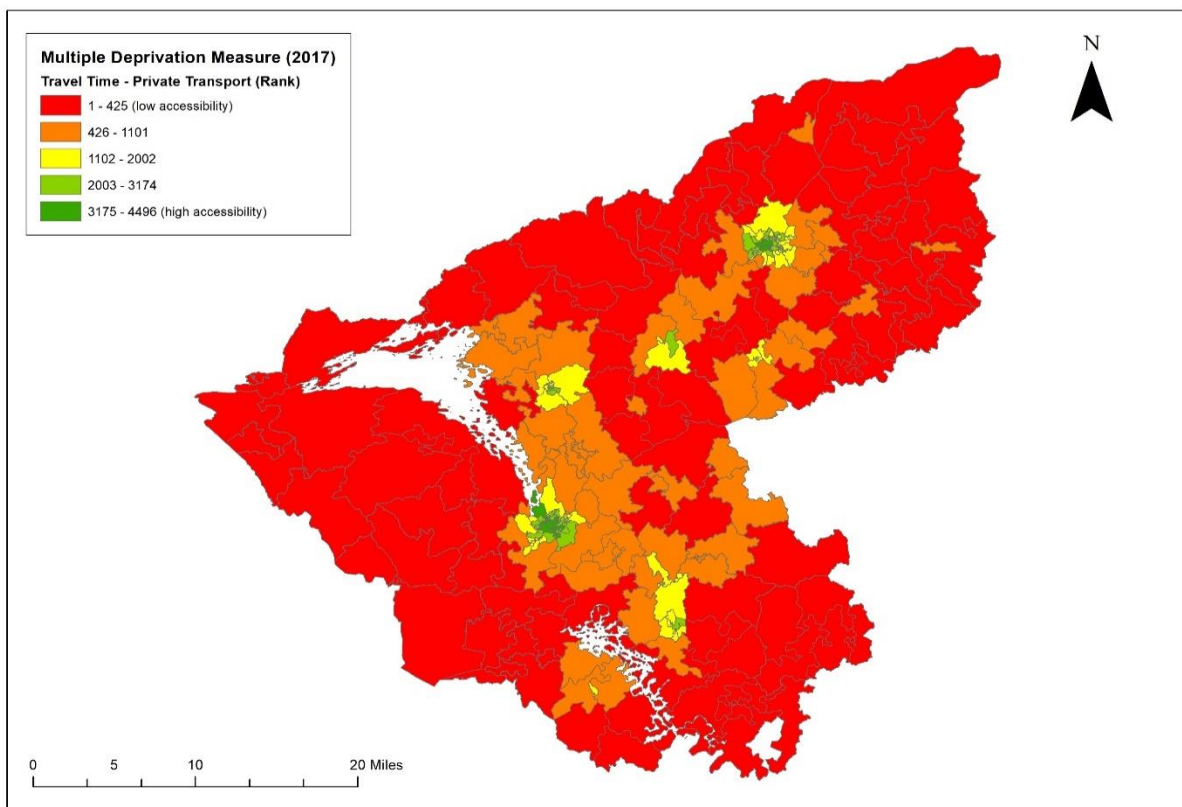
Figure 24: Ranked private travel time to a range of key services (NISRA, 2017).
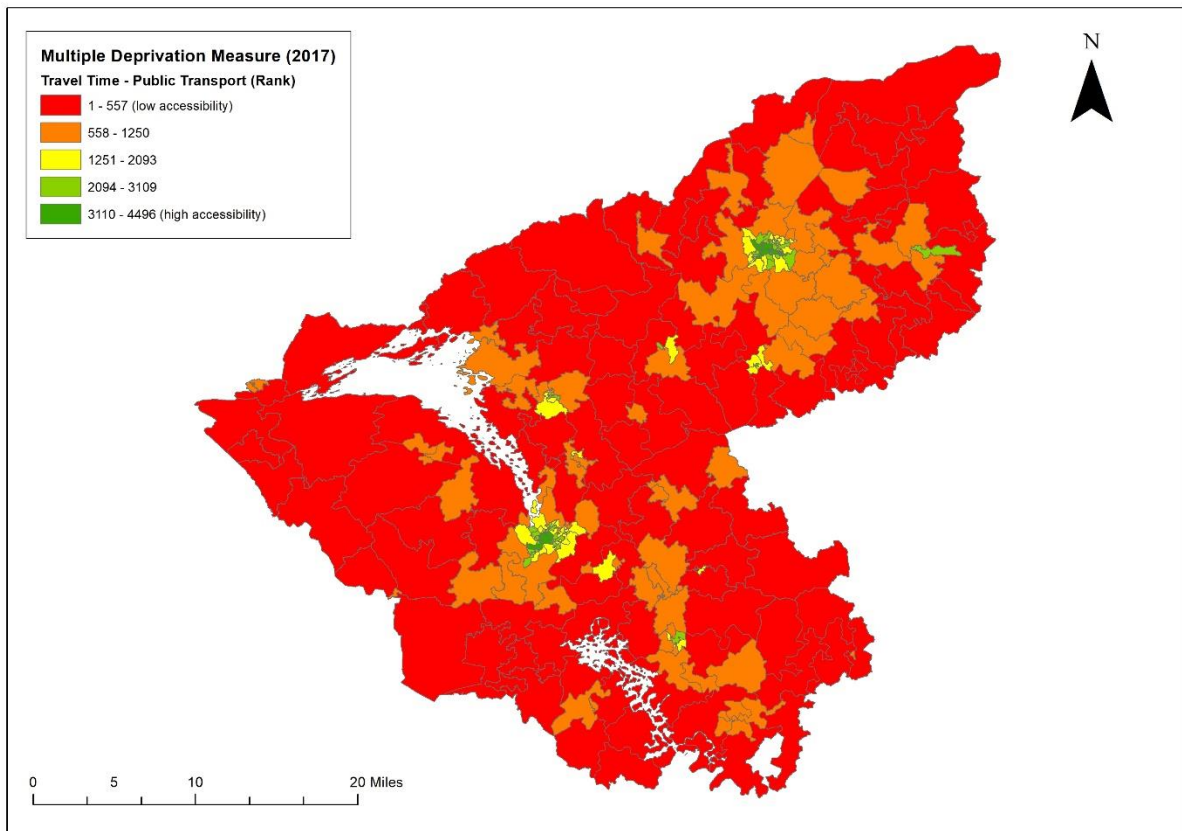
Figure 25: Ranked public travel time to a range of key services (NISRA, 2017).

Four indicators were considered, namely population density, the percentage of no vehicle ownership, income and provision of public transport. Each of these variables was given a score between 1 and 5, with 1 representing lower risk and 5 representing higher risk. For example, a SA with high population density and high income would receive a score of 1 (low risk) for both indicators. Therefore, each SA was ranked from a theoretical minimum of 4 (low risk for all four indicators) to a theoretical maximum of 20 (high risk for all four indicators). The indicators were not weighted due to time constraints. Figure 26 shows the spatial variation in transport poverty using this approach.
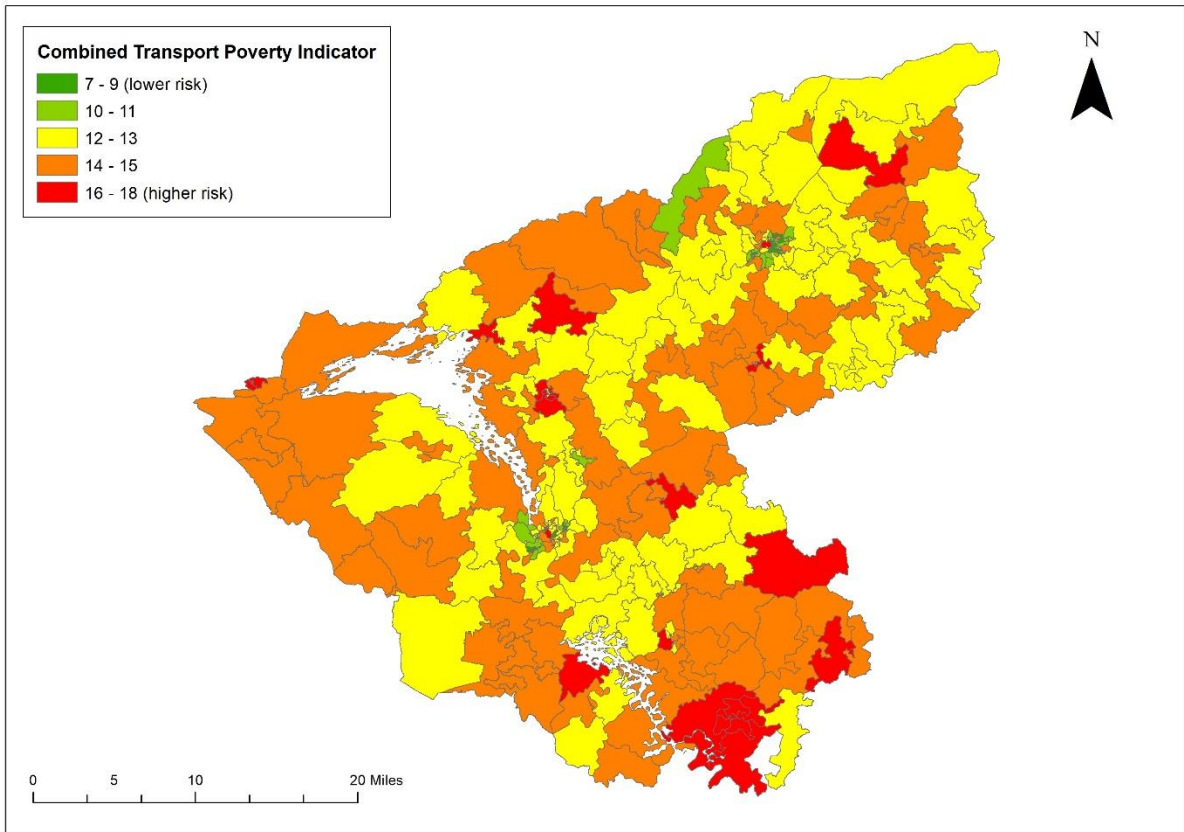
Figure 26: Combined Transport Poverty indicator.

The actual values ranged from a minimum of 7 (Castlecoole ward) to a maximum of 18 (Irvinestown ward). Of the five settlement types in FODC, Intermediate settlements and Villages had the highest average combined risk score (14.2) followed by Open countryside (13.8), Medium Towns (11.6) and Large Towns (11.3). Large and Medium Towns had the highest range, suggesting spatial variations within urban areas however, there was also variation in the range of rural values though it was smaller.

Cluster Analysis was performed on the transport poverty metric (Figure 27 and Table 6).
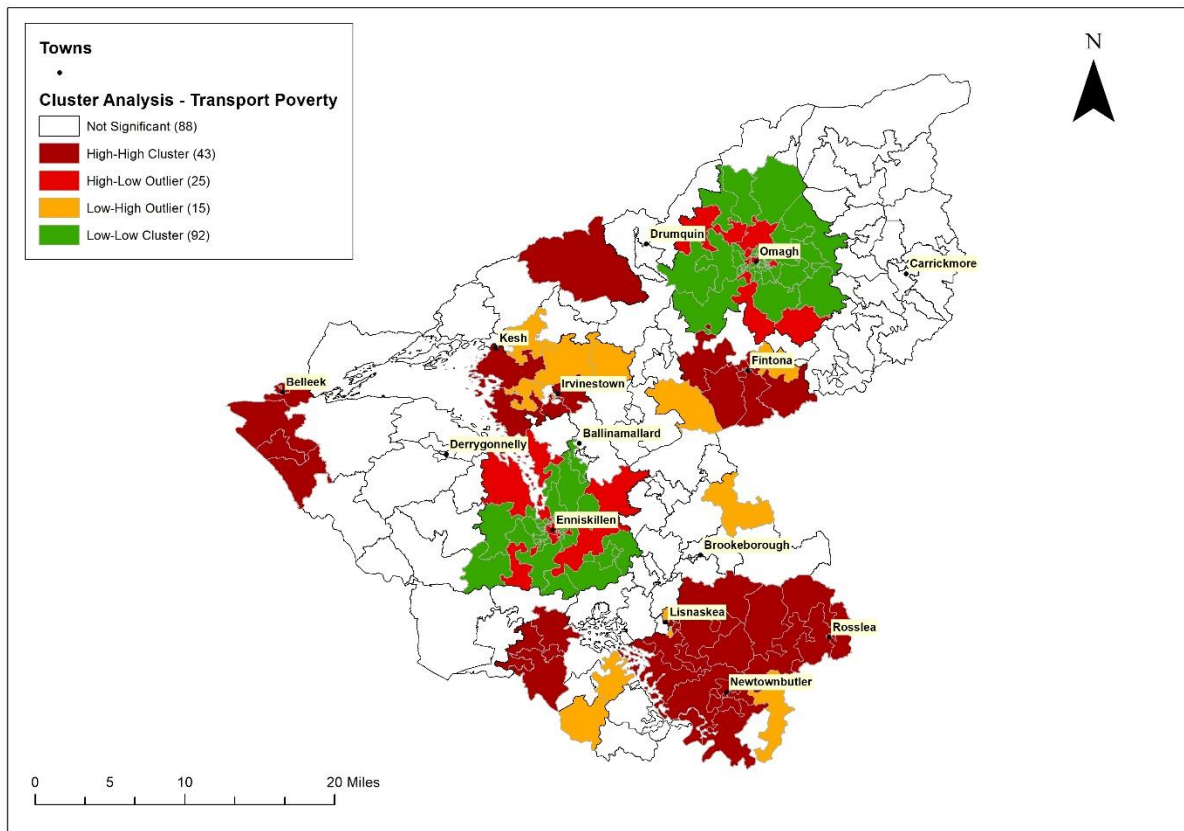
Figure 27: Cluster Analysis of Combined Transport Poverty metric.

Within the Council area there are areas that are not significantly clustered. While these are non-significant in terms of clustering, this does not indicate that these areas do not contain homes experiencing transport poverty.

Table 6: Clusters of Transport poverty within FODC.

Cluster Classification	Number of Small Areas	% of FODC Small Areas
Not significant	88	33.46
High-High	43	16.34
High-Low	25	9.50
Low-High	15	5.70
Low-Low	92	34.98

There were 43 "High-High" clusters with 32 of these (74%) occuring in Open Countryside. The remaining 11 "High-High" clusters were in Intermediate settlements or Villages. The highest risk clusters are generally located along the border with Monaghan, Cavan and Donegal.

As with fuel poverty, approximately a third of SAs in the Council area are classified as "Low-Low", suggesting these are at a low risk of being in transport poverty using the combined indicator. For transport, these areas tend to be in Omagh (Large town, 35

clusters) and Enniskillen (Medium town, 32 clusters). A small number of "Low-Low" transport clusters occur in Open countryside (21 clusters) and Villages (4 clusters), namely Ballinamallard and Lisbellaw.

The "High-Low" outliers (higher risk surrounded by lower risk) were in Omagh (8 clusters) and Enniskillen (9 clusters) but also in Open countryside (8 clusters). These outliers could be termed peri-urban or suburban (Dodson and Sipe, 2007) as they are all located within a 7-mile radius of Omagh and Enniskillen.

While there are very few "Low-High" clusters, the majority of these (10 of the 15 clusters) were in Open countryside while 3 were in Lisnaskea (Intermediate settlements) and 2 were in Irvinestown (Village).

Figure 28 indicates clusters of high fuel poverty risk ("High-High" or "High-Low") along with clusters of high transport poverty risk ("High-High" or "High-Low"). Of the 84 Small Areas at high risk of fuel poverty, 22 of these Small Areas also have a high risk of transport poverty. On Figure 21 these areas are symbolised as red diagonal lines on an orange background and a strong black border.
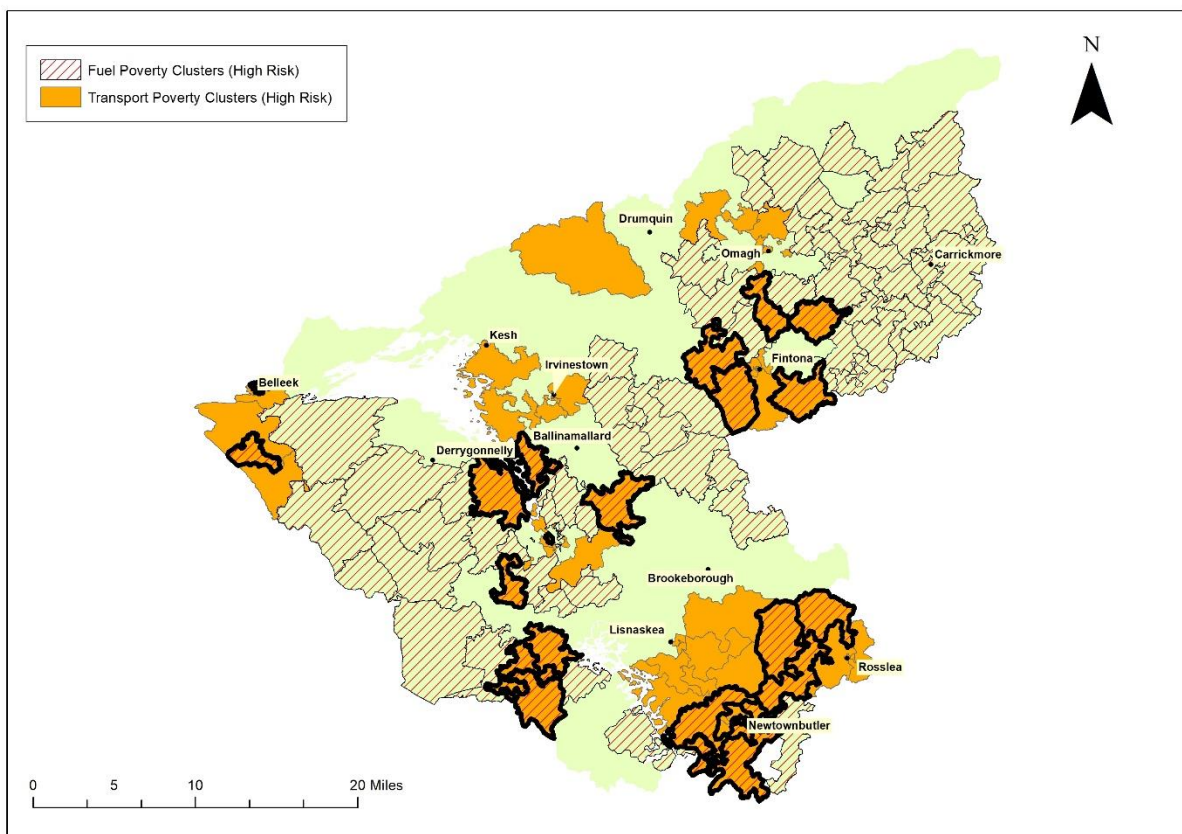
Figure 28: Small Areas classified as high risk clusters for both fuel and transport poverty.

Dellaccio *et al.* (2022) identify that young renters are at particular risk of both energy and transport poverty. Using data from the UK Census (2011) it was possible to calculate the proportion of renters in each SA. Figure 22 shows the proportion of young people (aged 34 or under) that were renting in FODC in 2011.
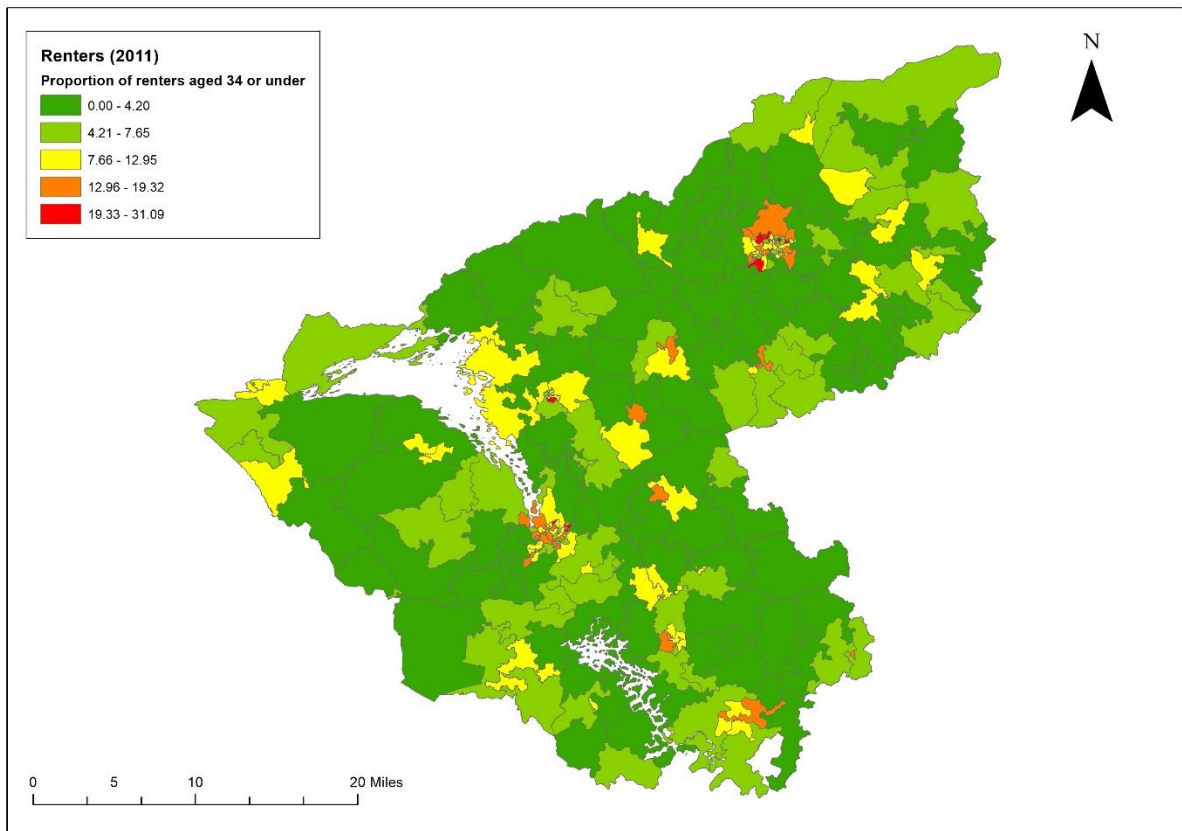
Figure 29: Renters aged 34 years or under in FODC (UK Census 2011).

The majority of young renters occurred in Omagh and Enniskillen though Irvinestown (N00002993) also had 25% of young people renting. Within FODC, there are 10 SAs with almost 20% of young renters. Of these 10 SAs, 5 SAs have 20% of homes with an income below 60% of the NI median. Three of these SAs are in Omagh (Lisanelly ward, Drumragh ward and Killyclogher ward), one is in Enniskillen (Erne ward) and the other is in Irvinestown (Village - N00002993). Drumragh ward in Omagh also has a high proportion of homes with no vehicle access (57.98%) while Killyclogher ward and Irvinestown ward also have a large proportion of homes with no vehicle access (40.2% and 43.2% respectively). The majority of the 10 SAs with high numbers of young social renters have access to public transport though Irvinestown ward has lower access to public transport as does Coolnagard ward in Omagh.

Elderly people with long term health problems are also at increased risk of fuel and transport poverty. Using data from the UK Census (2011) it was possible to calculate the proportion of people in each SA that had limitations to daily activities. Figure 30 shows the proportion of people aged 64 or above that had limitations to daily activities ("a little" and "a lot").
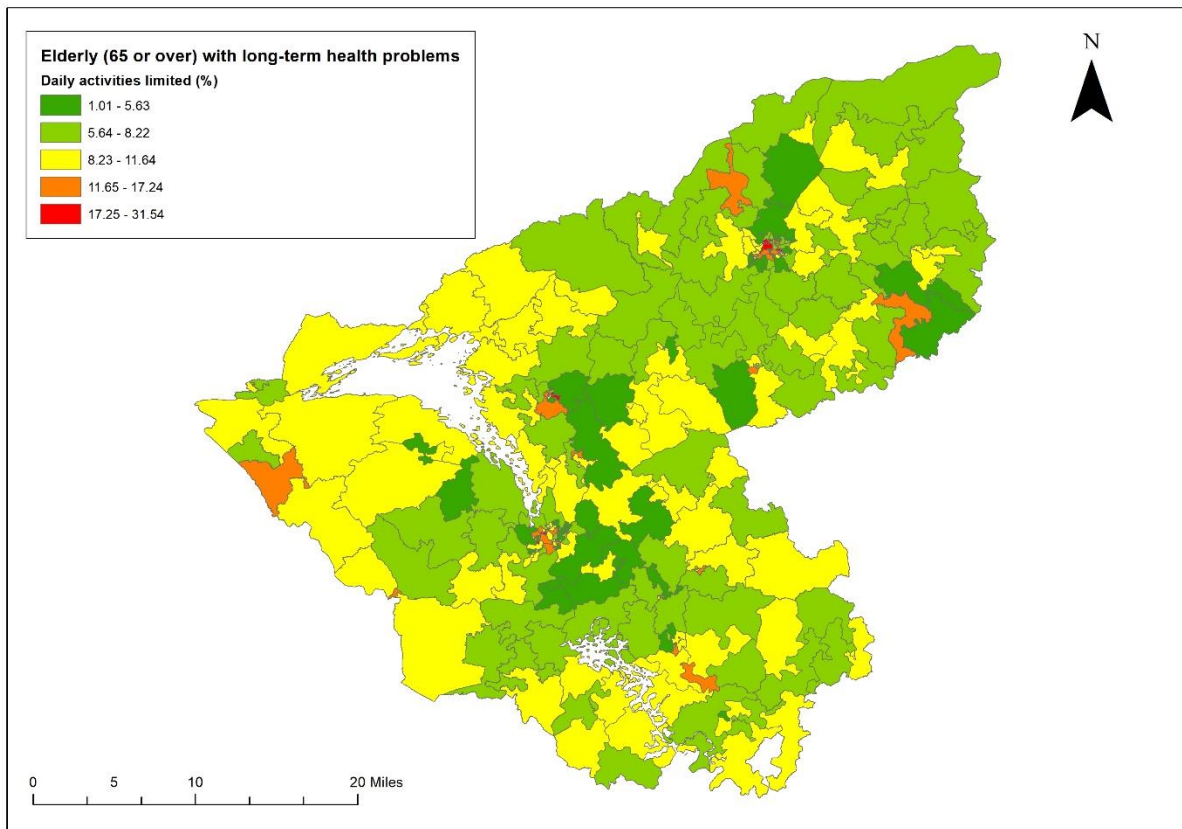
Figure 30: Elderly people with limited daily activities.

Elderly people with long-term health problems were mainly located in Omagh and Enniskillen though there was a relatively high proportion (22.5%) in Irvinestown (Village).

The Small Area in Irvinestown with a high proportion of elderly residents with limited daily activities is N00002996. The SA had a medium AWP eligibility of 46.2 which was below the average for FODC (49.48). The homes in the SA were a mix of old (built in 1910) and new (built in 2007) with the majority of homes being terraced (71) followed by apartments (29). SAP Energy ratings (from the DfC *Land Mark database*) in the area were generally low, ranging from 50.6 (Band E) to 66.6 (Band D).

The SA was at higher risk of transport poverty with a score of 16 in the Combined Transport Poverty indicator. This was mainly due to a low population density, 56% of homes with no car or van, 16% of homes with an income below 60% of the NI median and low access to public transport.

Healthy Food Basket Audits

Healthy food basket (HFB) surveys are cross-sectional studies used to examine affordability and availability of food shopping baskets in both rural and urban locations (Ginn *et al.*, 2016). For this research pre-existing HFBs from '*The cost of a healthy food basket in Northern Ireland'* (MacMahon and Weld, 2015) and '*What is the cost of a healthy food basket in Northern Ireland'* (MacMahon and Mooney, 2016) were used as the data template.

The purpose of the HFBs was to provide data on the affordability and availability of a minimum essential but nutritionally adequate diet, for four household types (Table 7), in FODC.

Table 7: Household composition

Household Reference Number	Number of members per household	Household composition
1	4	Two parents and two children (pre-school & primary school)
2	4	Two parents and two children (primary school & secondary school)
3	3	Single parent and two children (pre-school & primary school)
4	1	Pensioner living alone (aged 65 years or more)

Retailer Audit

The retailer survey was carried out across Fermanagh and Omagh District Council between August and October 2022. Each of the retailers were visited by a member of the data collection team to conduct in-person store audits. In-store audits were conducted due to the variation of pricing strategies by the various retailers. Permission for store access was obtained by UU and FODC prior to the commencement of data collection. Data were collected on the price, and availability of all food items in the HFBs. To ensure data consistency and analysis validity, a product selection criterion was applied:

- If the item size was not available, then the smaller item was selected, and the cost was calculated to match the specific size recommendations;
- If the smaller size was not available, the next largest size was selected, and the cost was calculated to meet the specific size recommendations;
- If the specific brand was not available, the cheapest, alternative, generic brand was selected;
- For loose items sold as per kilogram, such as meat or fruit, the cost per kilogram was recorded and the cost calculated to meet the specific size recommendations; and
- Special offer prices were excluded.

Overall, 46 stores were visited ranging from large multinational supermarkets to independent stores. A full breakdown of the store types is shown in Table 8.

Table 8: Breakdown of retailer type

Retailer type	Number of store audits
Large multi-national supermarket	5
Large/Medium independent supermarket	4
Local convenience store	3
Symbol group store	28
Small independent store	6
Total	46

For comparative analysis the rural/urban typology as defined by the 'Review of the statistical classification and delineation of settlements' (NISRA, 2015) was used. NI has a total of nine settlement classifications, identifying rural boundaries as populations with less than 5,000 inhabitants, as described in Table 9.

Table 9: Urban and rural settlement classification (NISRA, 2015)

Settlement Classification	Settlement Band	Settlement Type	Population
Urban	Band A	Belfast	280,211
	Band B	Londonderry	83,125
	Band C	Large town	18,000 +
	Band D	Medium town	10,000 – 17,999
	Band E	Small town	5,000 – 9,999
Rural	Band F	Intermediate settlement	2,500 – 4,999
	Band G	Village	1,000 – 2,499
	Band H	Open countryside	<1,000

Retailers within the bands of A-E were categorised as urban retailers and those within F-H were considered as rural retailers. Of the retailers surveyed (n=46), 29 (63%) were in a rural settlement and 17 (37%) in an urban settlement. Higher rural representation reflects the geographical typology of FODC. To test for statistical relationships between rural and urban settlements, independent t-tests were carried out, using IBM SPSS Statistics to compare the mean scores of the overall weekly nutritional cost and product availability (including substitutions) of the Healthy Food Basket, for each household type. The results for each of the referenced household types are presented in the subsequent sections.

Household 1
Household one consists of a family of two adults and two children. One child is of pre-school age (2-4 years old) and the other child is of primary school age (6-11 years old. For rural retailers, the minimum weekly nutritional cost of the HFB was £102.00, and the highest cost was £137.03, making a mean weekly cost of £127.62. For urban retailers the minimum weekly cost was £105.91, and the maximum was £134.29, making a mean weekly cost of £124.77. Based on the mean average prices, there was a difference of £2.85 per mean weekly costs, whereby rural dwellers paid more. An independent t-test was carried out to compare the statistical costs of the HFB between rural and urban retailers. Results showed that there was no statistical difference between the nutritional cost of the HFB between rural (M = 127.62, SD =

6.2) and urban retailers (M = 125.80, SD = 8.5 = t (44) = 1.31, p = .09, two tailed). Whilst there is no statistical difference between costs for rural and urban retailers, there were existing cost variations between stores (Figure 31). The results are not unexpected given the presence of multi-nationals and discounters within the settlement types. By taking the difference of the minimum and maximum costs, the HFB was £35.03 more expensive depending on from which store the items were purchased; therefore, resulting in geographical pricing disparities.
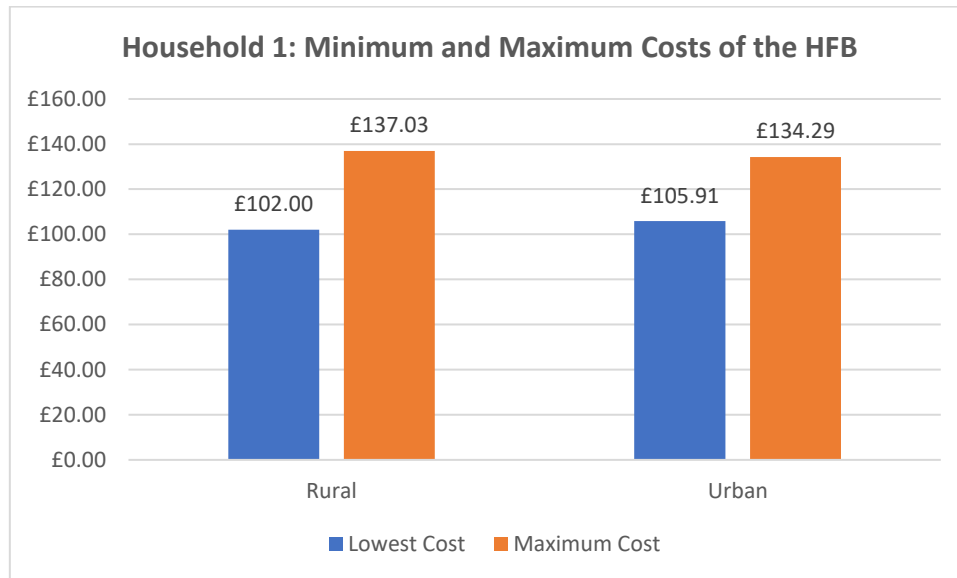

Figure 31: Household one, minimum and maximum cost variations

With regards to availability, none of the stores surveyed stocked all the items within the HFB even when items were substituted to different sizes and or brands. The mean availability of the HFB for rural retailers was 74.9% and 80.6% for urban retailers. The poorest availability was 29.1%, which was found in a store located in an 'open countryside' settlement. To determine if there was a statistically significant difference in availability between rural and urban settlements, an independent t-test was conducted. Results found that there is not a statistically significant difference in the availability of the HFB between rural (M = 74.9, SD = 15.04) and urban retailers (M = 80.6, SD =10.1 = t (44) = 1.37, p = .17, two tailed).

Household 2
Household two consists of a family of two adults and two children. One child is of primary school age (6-11 years old) and the other child is of secondary school age (11-16 years old). The difference between household one and two is the age of the children, whereby in household two they are older.

For rural retailers, the minimum weekly nutritional cost of the HFB was £115.91, and the maximum cost was £161.82, making a mean weekly cost of £147.90. For urban retailers the minimum weekly cost was £119.60, and the maximum was £155.47, making a mean weekly cost of £144. Based on the average prices, there was a difference of £3.90 per mean weekly costs, whereby rural dwellers paid more. An independent t-test was carried out to compare the statistical costs of the HFB between rural and urban retailers. Results showed that there was no statistical difference between the nutritional cost of the HFB between rural (M = 147.90, SD = 7.49) and

urban retailers (M = 125.80, SD = 8.68 = t (44) = 1.60, p = .11, two tailed). Like household one, there was no statistically significant difference between rural and urban costs, however there is a sizable difference between the minimum and maximum costs (Figure 32). The largest cost difference between the minimum and maximum retailers was £45.91 and was greatest for rural retailers. Of all the household this was the largest cost difference.
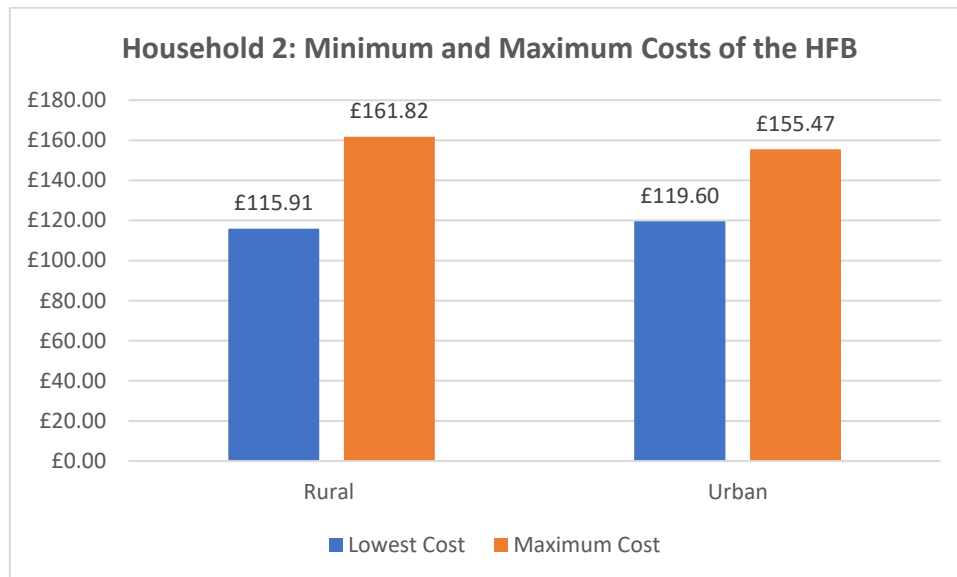

Figure 32: Household two, minimum and maximum cost variations

With regards to availability, none of the stores surveyed stocked all the items within the HFB even when items were substituted to different sizes and or brands. The mean availability of the HFB for rural retailers was 76.9% and 83.1% for urban retailers. The poorest availability was 29.2%, found in an 'open countryside' retailer. To determine if there was a statistically significant difference in availability between rural and urban settlements, an independent t-test was conducted. Results found that there is not a statistically significant difference in the availability of the HFB between rural (M = 76.9, SD = 14.02) and urban retailers (M = 83.1, SD = 8.5 = t (44) = -1.64, p = .11, two tailed).

Household 3
Household three is a single parent family, consisting of one parent and two children. One child is of pre-school age (2-4 years old) and the other child is of primary school age (6-11 years old).

For rural retailers, the minimum weekly nutritional cost of the HFB was £80.74, and the maximum cost was £114.48, making a mean weekly cost of £104.28. For urban retailers the minimum weekly cost was £82.74, and the maximum was £113.16, making a mean weekly cost of £101.10. Based on the average prices, there was a difference of £3.18 per mean weekly costs, whereby rural dwellers paid more. An independent t-test was carried out to compare the statistical costs of the HFB between rural and urban retailers. Results showed that there was no statistical difference between the nutritional cost of the HFB between rural (M = 104.28, SD = 5.54) and urban retailers (M = 101.10, SD = 7.62 = t (44) = 1.63, p = .11, two tailed). As with household one and two there are substantial differences between the minimum and

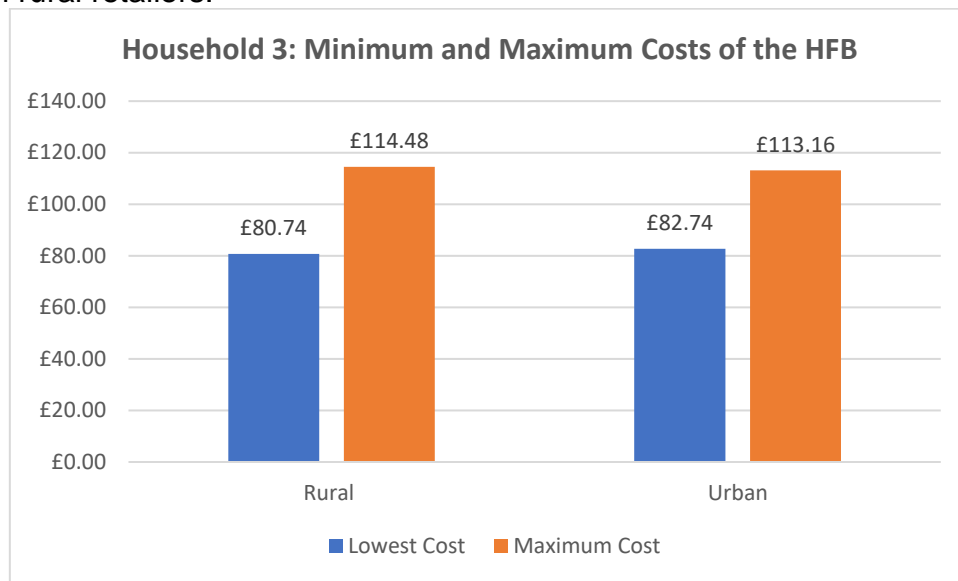maximum costs (Figure 33). The largest cost difference was £33.74 and was found between rural retailers.

Household 3: Minimum and Maximum Costs of the HFB

Rural: Lowest Cost £80.74, Maximum Cost £114.48
Urban: Lowest Cost £82.74, Maximum Cost £113.16

Figure 33: Household three, minimum and maximum cost variations

With regards to availability, none of the stores surveyed stocked all the items within the HFB even when items were substituted to different sizes and or brands. The mean availability of the HFB for rural retailers was 74.9% and 80.3% for urban retailers. The poorest availability was 26.4%, found in an 'open countryside' retailer. To determine if there was a statistically significant difference in availability between rural and urban settlements, an independent t-test was conducted. Results found that there was no statistically significant difference in the availability of the HFB between rural (M = 74.9, SD = 15.41) and urban retailers (M = 80.3, SD = 10.11 = t (44) = -1.29, p = .20, two tailed).

Household 4
Household four is a pensioner, age 65 years and over, who lives alone.

For rural retailers, the minimum weekly nutritional cost of the HFB was £48.21, and the maximum cost was £67.18, making an –mean weekly cost of £60.93. For urban retailers the minimum weekly cost was £47.37, and the maximum was £67.48, making an mean weekly cost of £59.68. Based on the average prices, there was a difference of £1.25 per weekly costs, whereby rural dwellers paid more (Figure 34). An independent t-test was carried out to compare the statistical costs of the HFB between rural and urban retailers. Results showed that there was no statistical difference between the nutritional cost of the HFB between rural (M = 60.93, SD = 3.41) and urban retailers (M = 59.68, SD = 4.90 = t (44) = 1.01, p = .31, two tailed). As with the previous households, there were considerable cost variations between retailers. The largest amount was £20.11 and unlike the other households whereby the greatest cost differences was found between rural retailers, this difference was found in urban retailers. Of all the households, this was the smallest cost difference.
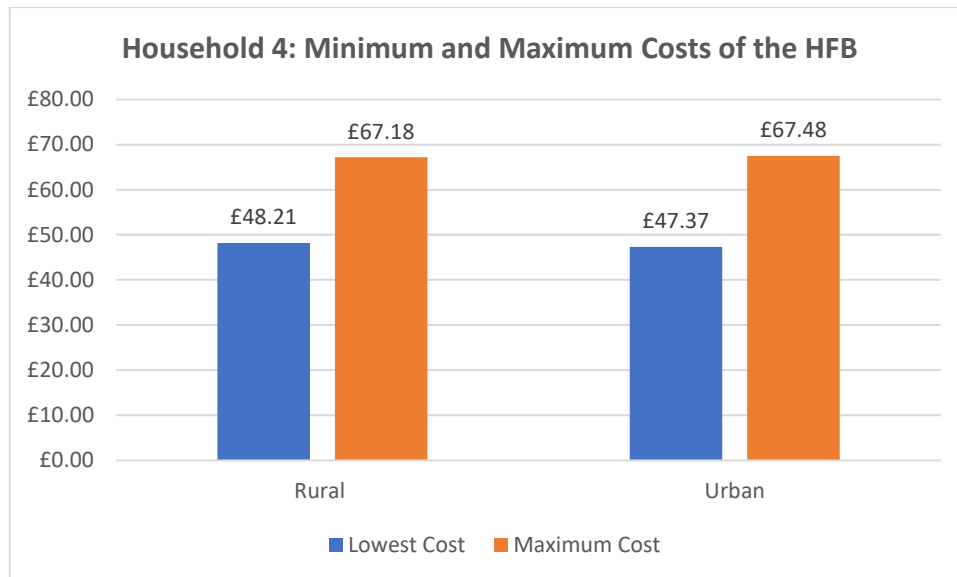
Figure 34: Household four, minimum and maximum cost variations

With regards to availability, none of the stores surveyed stocked all the items within the HFB even when items were substituted to different sizes and or brands. The mean availability of the HFB for rural retailers was 69.8% and 77% for urban retailers. The poorest availability was 29.9%, found in an 'open countryside' retailer and was the same retailer with the lowest availability in the audit for household one, two and three. To determine if there was a statistically significant difference in availability between rural and urban settlements, an independent t-test was conducted. Results found that there is not a statistically significant difference in the availability of the HFB between rural (M = 69.8, SD = 14.25) and urban retailers (M = 77, SD = 11.44 = t (44) = -1.76, p = .08, two tailed).

Retailer Audit Summary

To summarise, for all four households the HFB from rural retailers was marginally more expensive and had less availability than urban retailers. However, these findings were not statistically significant when conducting comparison of means tests. It should be noted that within the rural sample, three retailers belonged to large multi-national groups, which had some impact on the overall nutritional costs and availability for rural retailers, however it cannot be said if this would affect the statistical significance. Large multi-national supermarkets tend to have lower prices and higher availability meaning that this may lower the overall price and increase availability. Statistical analysis was carried out on the complete data set to reflect the surveyed sample and hence the true experience of consumers in FODC. Despite this, considerable cost and availability variances were found throughout the sample, resulting in geographical disparities within FODC boundaries and therefore not all households have the same equal access to food (Figures 39 and 41 refer).

It is important to note that these findings assume that household food purchases are completed in one local shop, and it is recognised that shopping across a range of stores is common practice (Bowyer *et al.*, 2009). Nevertheless, households such as the disabled, the elderly, single parents (Wills and Dickenson, 2017) and those without cars (Koh *et al.*, 2019) have a greater reliance on retailers with a closer proximity.

Furthermore, since the Covid-19 pandemic, there has been an upward trend towards greater localised shopping driven by the continued use of home and or hybrid working (Caroll, 2020).

Food poverty

The At Risk of Food Poverty Index (ARFPI) is a pragmatic measurable index that identifies SAs at greatest potential risk of food poverty. It is a multi-variable, area-based food poverty risk index, mapped at regional scale. It is used to understand the role that location plays in determining food poverty and is used to identify are-based vulnerabilities and solutions to food poverty.

UU created an area-based risk index for each Census Small Area (SA) across NI (N=4,537) in 2017. Figure 35 shows food poverty risk for each SA across NI with values ranging from 0.46 (Stranmillis ward, Belfast) to 68.31 (Glenderg ward, Derry & Strabane). Glenderg has the highest AWP eligibility score (fuel poverty) and food poverty risk score in NI.

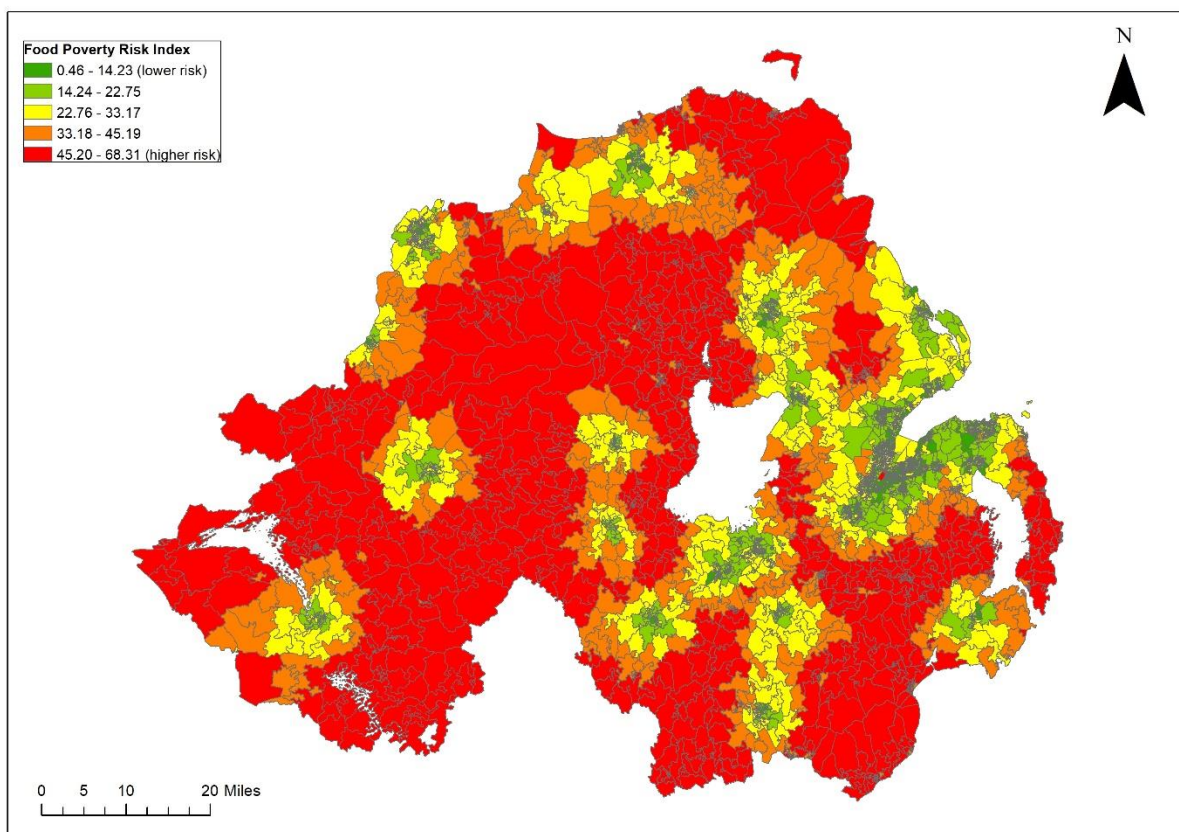**Figure 35: Food Poverty Risk Index (ARFPI) for each Small Area in Northern Ireland.**

Across the 11 Council areas, Fermanagh and Omagh District Council had the third highest average risk score (39.06), with Mid Ulster and Newry, Mourne and Down having highest averages across NI (Table 10). FODC had the highest variance of all Council areas, suggesting substantial variation in food poverty risk within the Council area.

Table 10: Food poverty descriptive statistics for each Council area in NI.

Council Name	Number of Small Areas	AWP Scores			
		Minimum	Maximum	Average	Variance
Mid Ulster	294	12.71	63.21	42.03	183.24
Newry, Mourne & Down	385	6.74	63.40	41.28	181.37
Fermanagh & Omagh	263	8.78	62.72	39.06	226.37
Causeway Coast & Glens	342	8.66	60.18	37.14	163.38
Derry & Strabane	328	7.93	68.31	29.41	158.63
Armagh, Banbridge & Craigavon	467	7.61	61.49	28.19	155.79
Antrim & Newtownabbey	352	4.97	60.45	23.98	151.65
North Down & Ards	441	3.58	56.76	23.78	180.02
Mid & East Antrim	369	6.14	58.22	23.57	113.86
Lisburn & Castlereagh	345	3.40	51.28	23.05	133.55
Belfast	951	0.46	48.95	17.26	58.24

Within Fermanagh and Omagh District Council (FODC) values ranged from 8.78 (Castlecoole ward, Enniskillen) to 62.72 (Belcoo and Garrison ward). FODC had the second highest minimum risk score of all Councils in NI, suggesting a high level of food poverty risk in the Council area.

As part of this project, Cognisense was tasked with capturing the price and availability of household shopping baskets for a sample of retailers across FODC. A sample of 46 stores was sampled according to the breakdown in Table 11:

Table 11: Retailers sampled across FODC

Settlement	Number of retailers sampled
Large Town (Omagh)	10
Medium town (Enniskillen)	8
Intermediate settlements	3
Villages	9
Open countryside	16
TOTAL	**46**

The location of the 46 retailers is shown on Figure 36 along with settlement types across FODC.
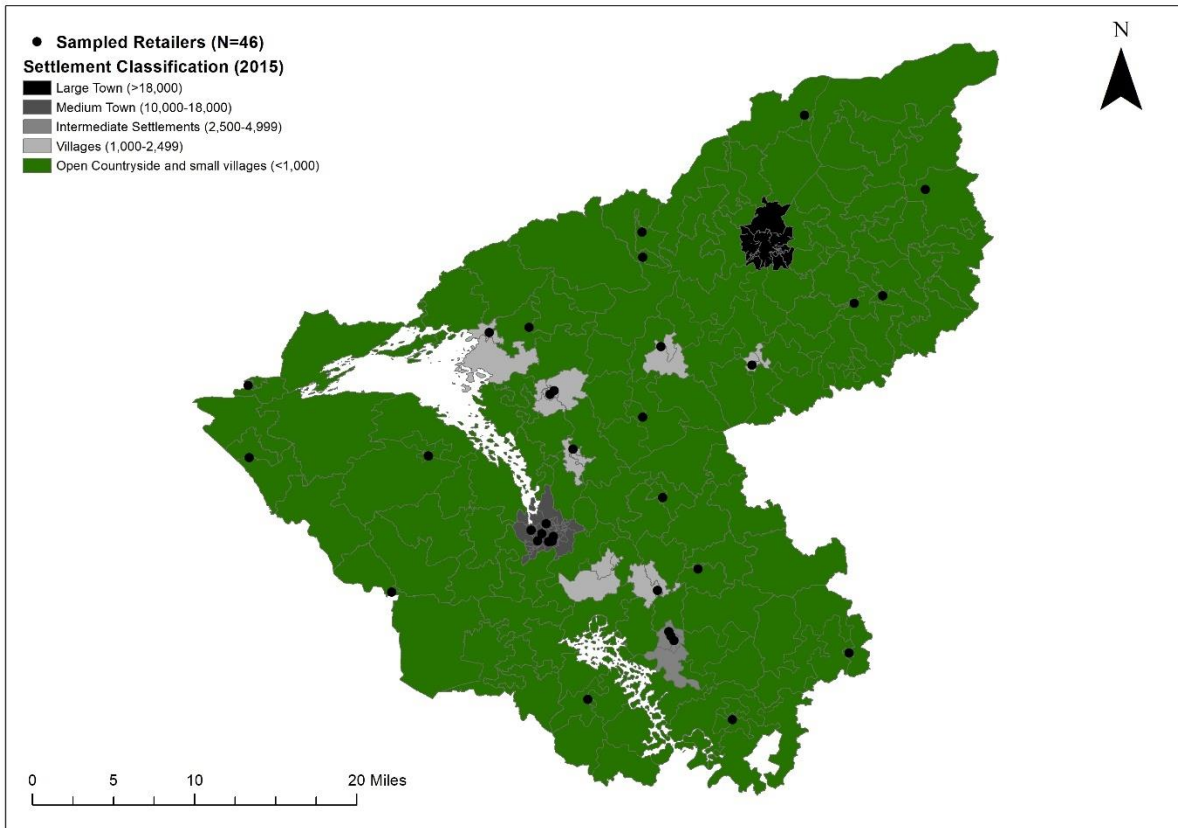

Figure 36: Sampled retailers across FODC

The mean price and availability were provided for each sampled retailer. Within GIS, these values could be interpolated to create both a price surface and an availability surface. This process was completed using Inverse Distance Weighting (IDW) which is an exact interpolator, meaning the minimum and maximum values are maintained from the original sample. Interpolation is an estimation technique, used to estimate values for *unknown* locations based on values for *known* locations. In this scenario, the figures for price and availability for the sampled retailers act as the known values for the estimation model. IDW considers all known values and creates a surface for all areas in the study area. As this is a mathematical estimation process, it does not guarantee that the *modelled* values (price and availability) are accurate for all unsampled retailers. For instance, if the model suggested a specific price and availability for an unsampled retailer, this is a modelled estimate and certainty would only be gained from actual in-store sampling. Interpolation is a well-known and respected technique that reduces time by not requiring all point locations (i.e. retailers) to be individually sampled. However, the drawbacks of using an estimated value over a sampled value need to be stated clearly.

In the interest of anonymity, no retailer will be named, and only locations are shown.

Costs for retailers ranged from a minimum of £86.72 (Intermediate settlement) to £119.94 (Open countryside) with an average of £109.15. Of the 46 sampled stores, 29 (63%) had prices above the average. The majority of these retailers were in Villages

54

(9) and Open countryside (8) though Omagh (Large town) had 7 retailers with prices greater than the sampled retailer average (Figure 37).
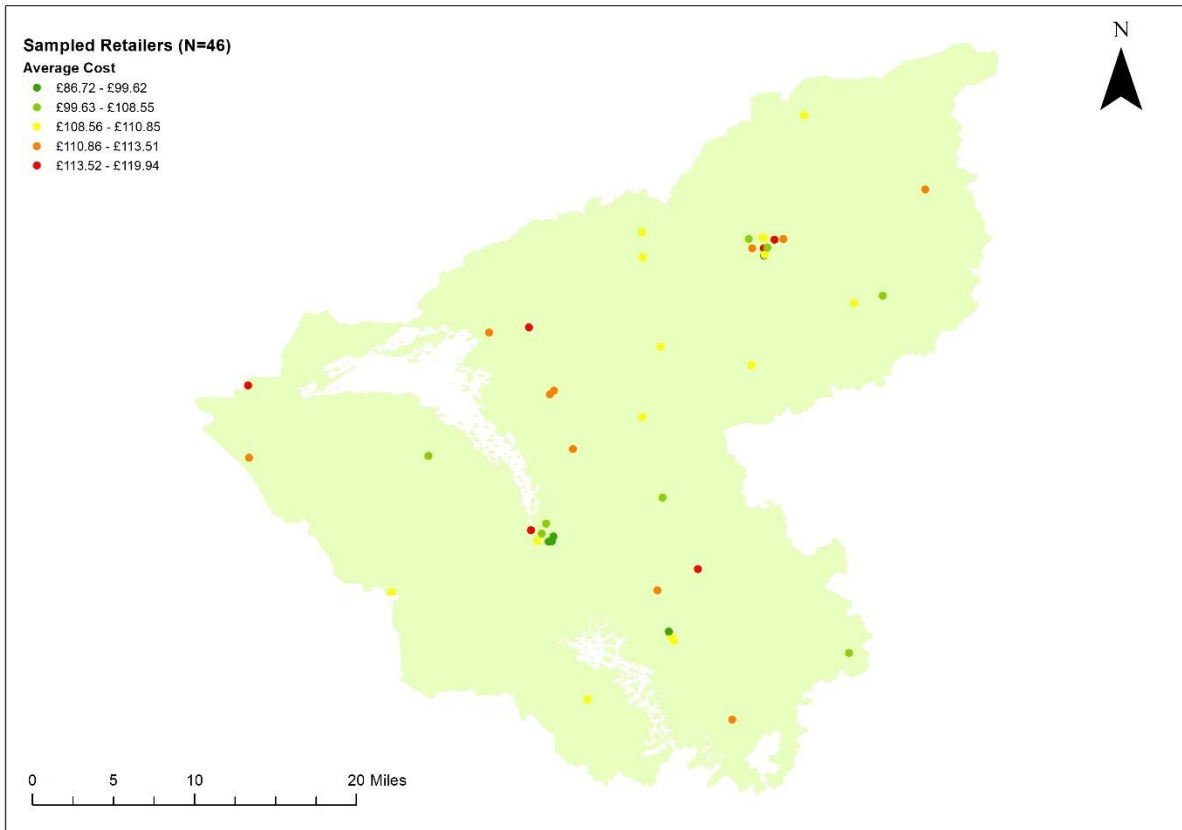

Figure 37: Sampled retailers and average price

Figure 38 shows the interpolated cost surface for FODC.
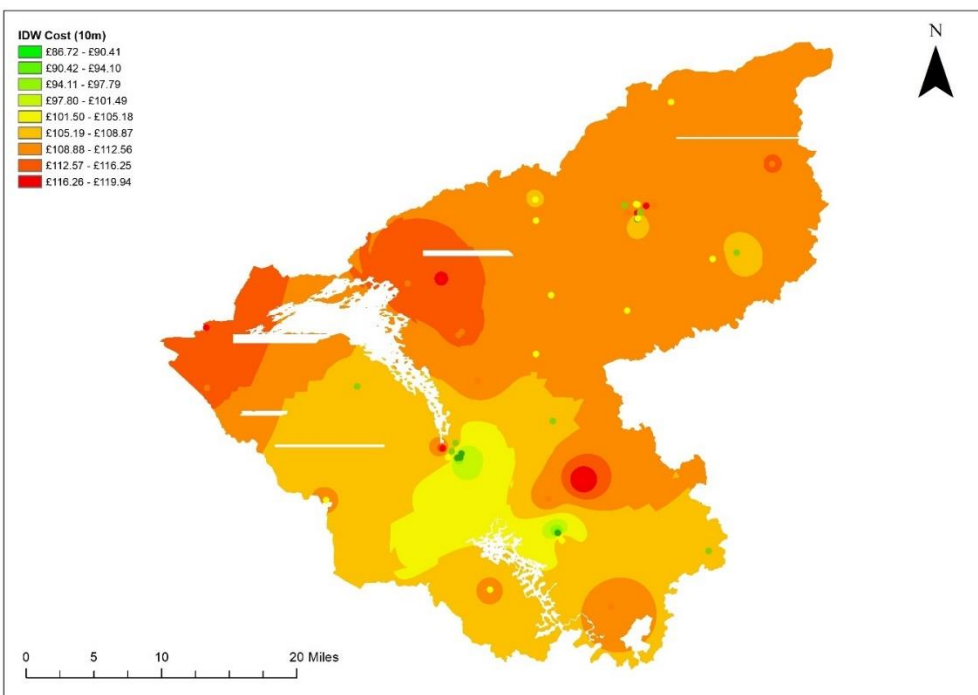

Figure 38: Interpolated retailer prices for FODC based on IDW.

Using GIS, the estimated prices were averaged for each Census Small Area. The process uses the boundary of each SA to sample each price and create an average price for that SA. This means that each SA can be assigned a risk based on its price. Figure 39 shows the average cost of the shopping basket for each SA in FODC.
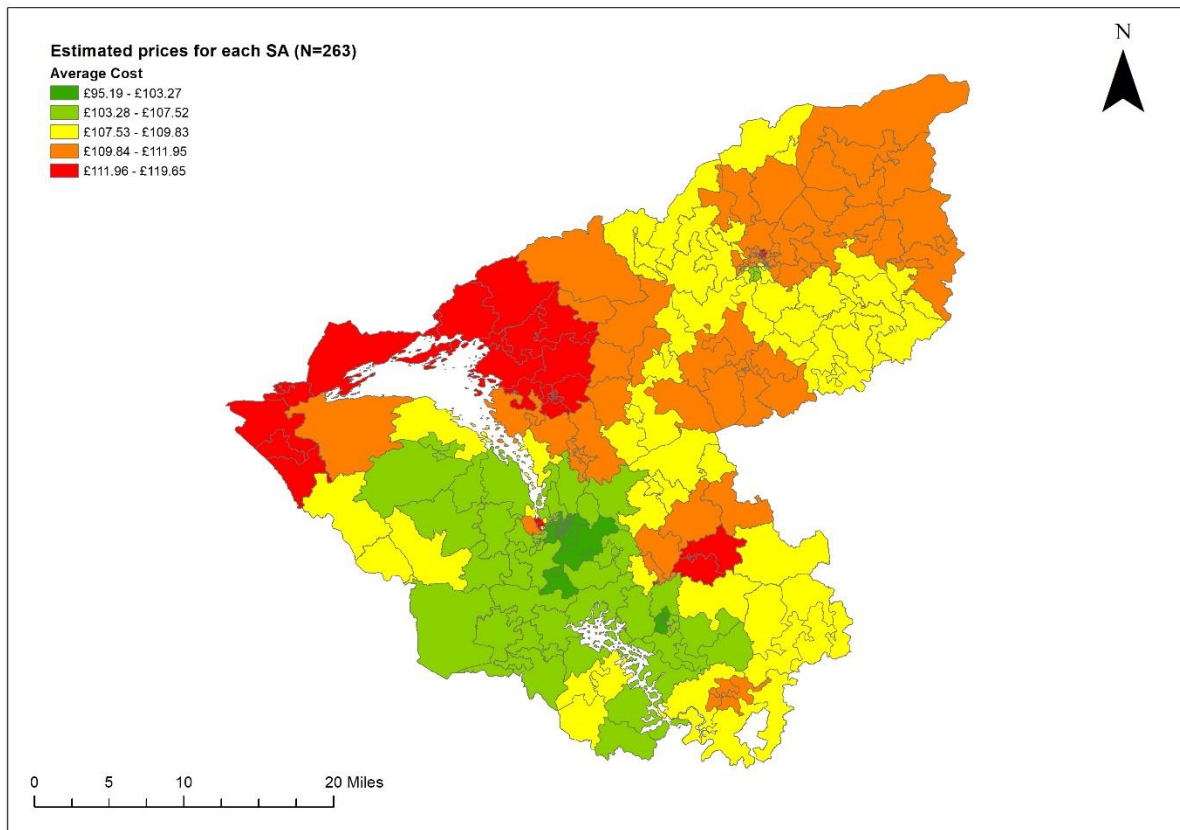

Figure 39 Estimated prices for each SA in FODC

As can be seen from Figure 32, the low costs within Enniskillen and Lisnaskea are retained along with Florencecourt and Kinawley to the South West. There are SAs with lower prices in Omagh, but the main cluster of lower average prices is in the South West of FODC, mainly within a 10-mile buffer of Enniskillen.

The process can also be repeated for availability of items. Figure 40 shows the interpolated availability surface for FODC. Lower values represent lower availability while higher values represent higher availability.

Availability for retailers ranged from a minimum of 26.4 (Open countryside) to 96.2% (Medium town) with an average of 76.41. Of the 46 sampled stores, 19 (41%) had availability below the average. Most of these retailers were in Open countryside (11), followed by Villages (4). Again, Omagh (Large town) had 4 retailers with availability less than the sampled retailer average.
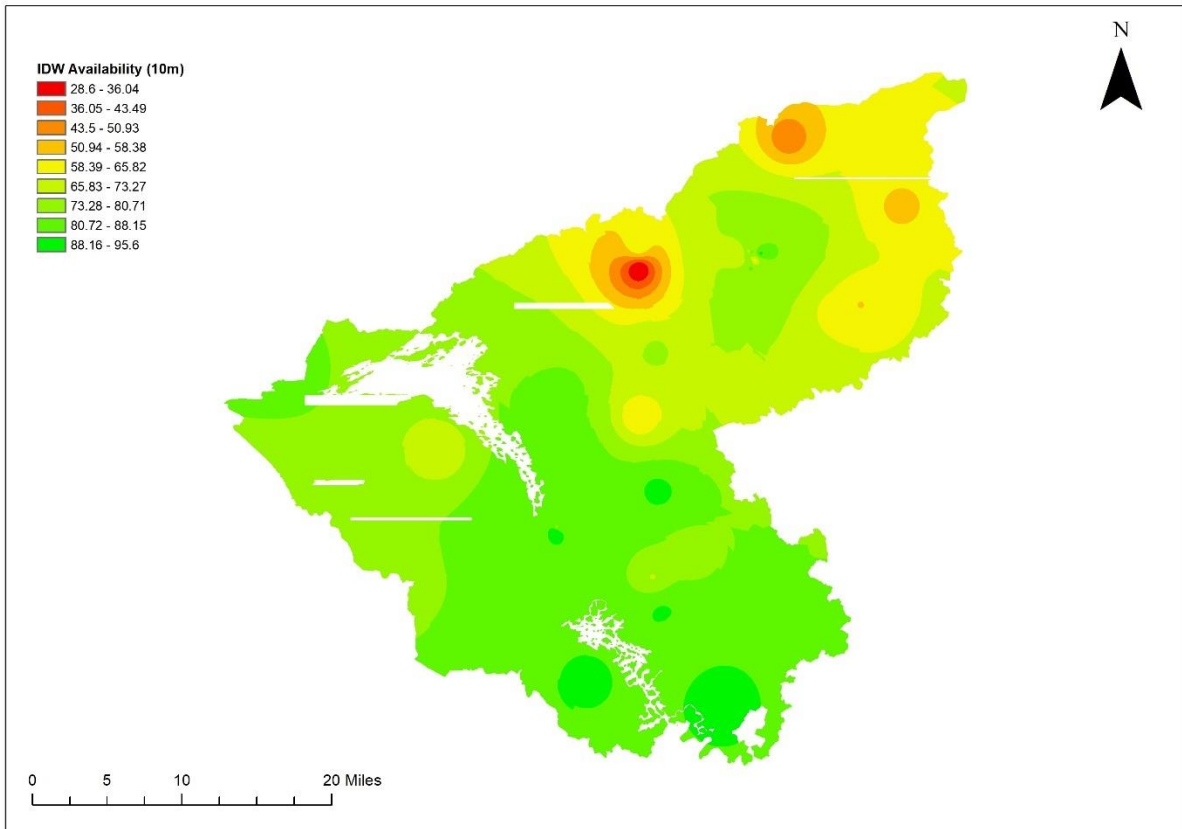
Figure 40: Interpolated retailer availability for FODC based on IDW.

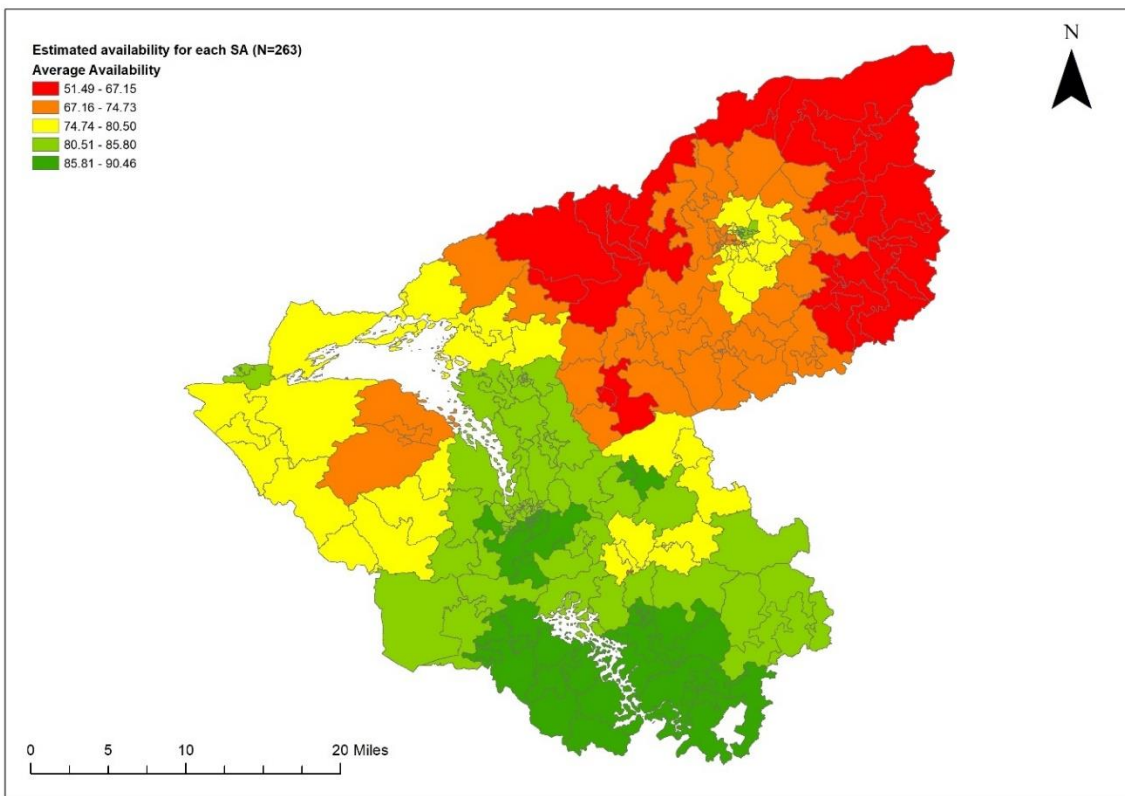Figure 41 shows the average availability for each SA in FODC.

Figure 41: Estimated availability for each SA in FODC.

The average price and average availability for each Small Area were incorporated into the original "At Risk of Food Poverty Index" (McClelland *et al.*, 2021). The ARFPI was based on five core indicators: Affordability, Accessibility, Availability, Health, and Awareness. Stakeholders were used to develop the weighted algorithm of the index (Table 12). Weighting of the indicators is important, otherwise indicators with greater variables would overload the ARFPI and skew the data. Each of the indicators had a number of measurable variables attached to them, which were also consensually agreed by stakeholders. Data for these variables were categorised into the five indicators (affordability, accessibility, availability, health, and awareness) and standardised so all variables were scaled between zero and one. This means that the final vulnerability risk index was scaled from zero to one.

Table 12: ARFPI weighting of the indicators

Indicator	Weighted Score (Percentage)
Affordability	33
Accessibility	22
Availability	19
Health	14
Awareness	12

Affordability was weighted by the stakeholders as the highest risk indicator at 33% of the overall model. It was based on the primary data from the HFB in FODC, and incorporated a range of secondary economic data measures, such as the NI Multiple Deprivation Measure and data relating to benefits (e.g., Employment Support Allowance, Working Tax Credits, Free School Meals).

Accessibility was considered as the second highest indicator by the stakeholders. It was based on car ownership along with accessibility to retailers in FODC. To quantify this, a 500-metre walking distance service area and a 25-minute drive time service area was applied from each retailer to identify the extent to which households in a particular SA could access retailers. The 500-metre walking distance is recognised as an appropriate distance for an individual to walk to their nearest food retailer (McEntee and Agyeman, 2010; Lucius *et al.*, 2011). Proximity to the food retailers were calculated using the ArcGIS Network Analyst extension tool. This models the shortest transport distance between two points on the network for both walking and driving. A driving parameter of 40 miles per hour was applied. Car ownership was mapped using data from NINIS (2016).

The availability indicator weighted at 19% used the mean availability from the HFB data in FODC mapped to each SA. Spatial interpolation was used to estimate the value of unknown points by using the Inverse Distance Weighted (IDW) interpolation method. In doing so, availability for each SA in FODC was obtained.

The awareness indicator weighted at 12% and health weighted at 14% were mapped using data from the NINIS datasets. For awareness, education was mapped based on educational attainment by measuring the number of school leavers achieving at least 5 GCSE's Grades A* - C in FODC. This measure is the minimum requisite of education in Northern Ireland. Health measured those individuals who considered themselves in the Census (2011) to be in 'poor health', for each of the SAs in FODC.

The majority of data values used data populated from the NI Census (2011) and the NINIS (2019) website. It should be noted that some variables such as Income Support, Housing Benefit, Disability Living Allowance, Job Seekers' Allowance, Working Tax Credit and Child Tax Credit had more up-to-data measures (dated 2016) and therefore these were used. The price and availability data were updated based on the work completed in 2022.
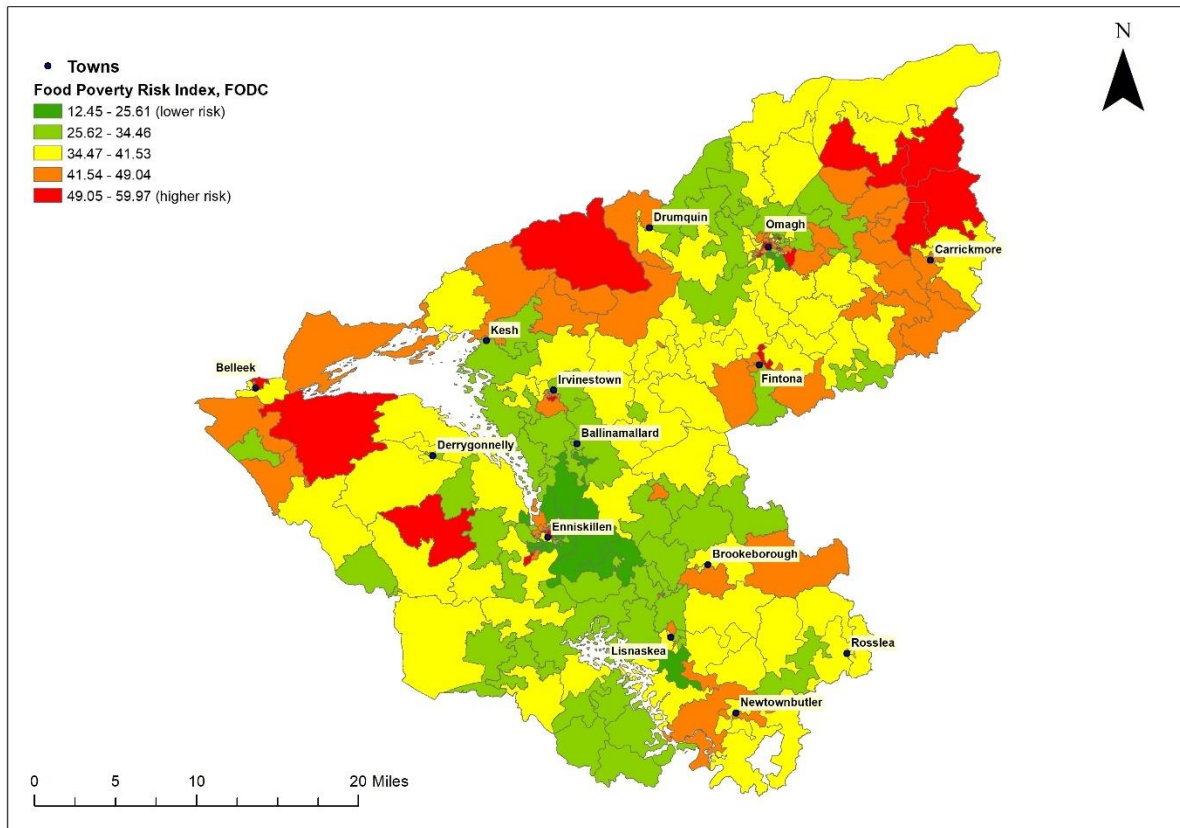

Figure 42: At Risk of Food Poverty Index for FODC.

Figure 42 shows high risk across all settlement types though, in general, rural areas tend to have higher scores. Table 13 shows descriptive statistics for ARFPI scores in each settlement type across FODC.

Table 13: Descriptive statistics for ARFPI scores and settlement types.

Settlement Type	Number of Small Areas	AWP Scores			
		Minimum	Maximum	Average	Variance
Large Town (18,000 people or more)	43	19.75	59.97	39.88	86.43
Village population (1,000-2,499 people)	25	16.92	55.37	37.77	93.50
Open Countryside & small villages (1,000 people or less)	146	18.50	55.86	37.70	45.48
Intermediate Settlements (2,500-4,999 people)	8	23.43	48.74	36.67	60.03
Medium Town (10,000-18,000 people)	41	12.45	59.16	34.33	162.33

Omagh (Large town) had the highest average ARFPI score followed by Villages and Open countryside. While Enniskillen (Medium town) had the lowest average ARFPI score, it had the greatest variance suggesting spatial variations in food poverty risk across the settlement type. As with fuel poverty, Open countryside had the lowest variance, again suggesting that these areas are relatively similar in terms of food poverty. Villages had a large variance for both fuel and food poverty. The main Villages in the study area are Kesh, Irvinestown, Dromore, Tamlaght, Fintona, Ballinamallard, Lisbellaw and Maguiresbridge.

ARFPI ranged from a maximum value of 59.96 (Omagh) to 12.44 (Enniskillen) with an average value of 37.50. Of the 263 SAs in FODC, 135 (51%) had values greater than the mean with the majority of these occurring in Open countryside (73 SAs).

Figures 43 and 44 show the spatial variation of ARFPI within Enniskillen and Omagh.
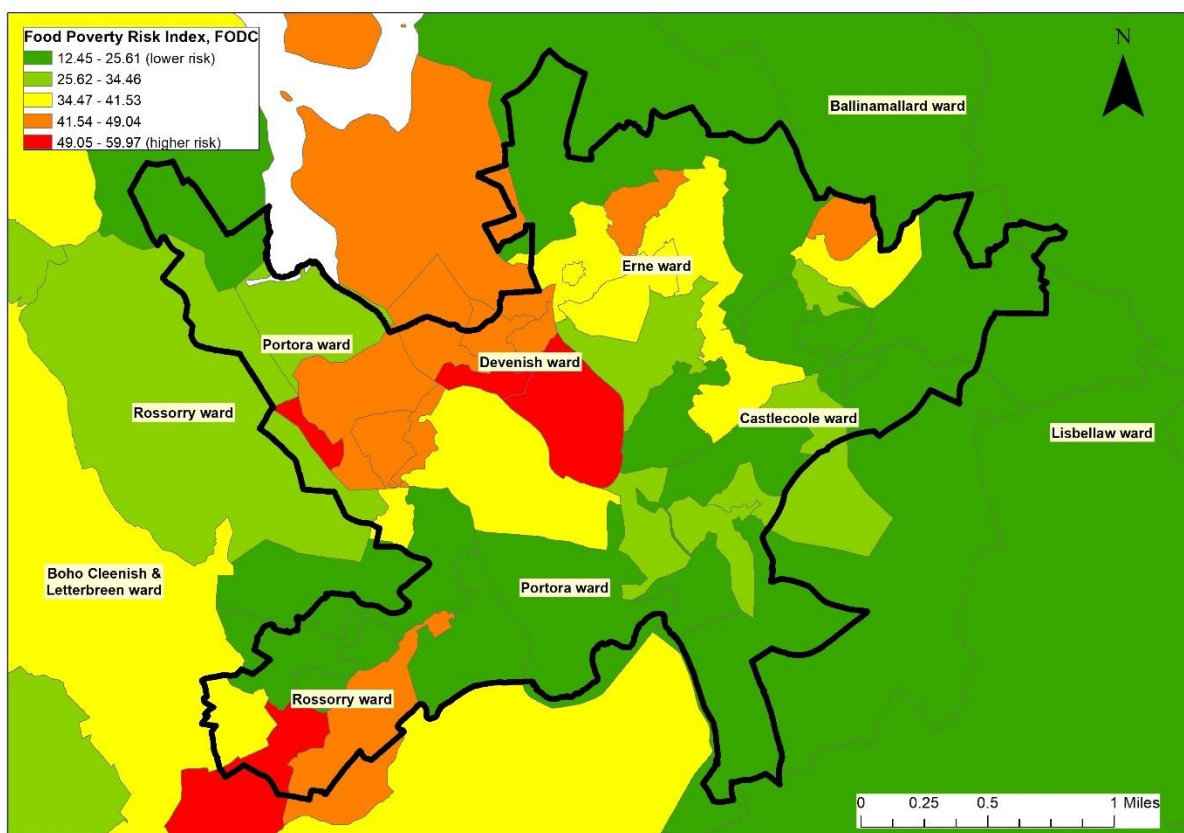
Figure 43: Spatial variation of ARFPI within Enniskillen.
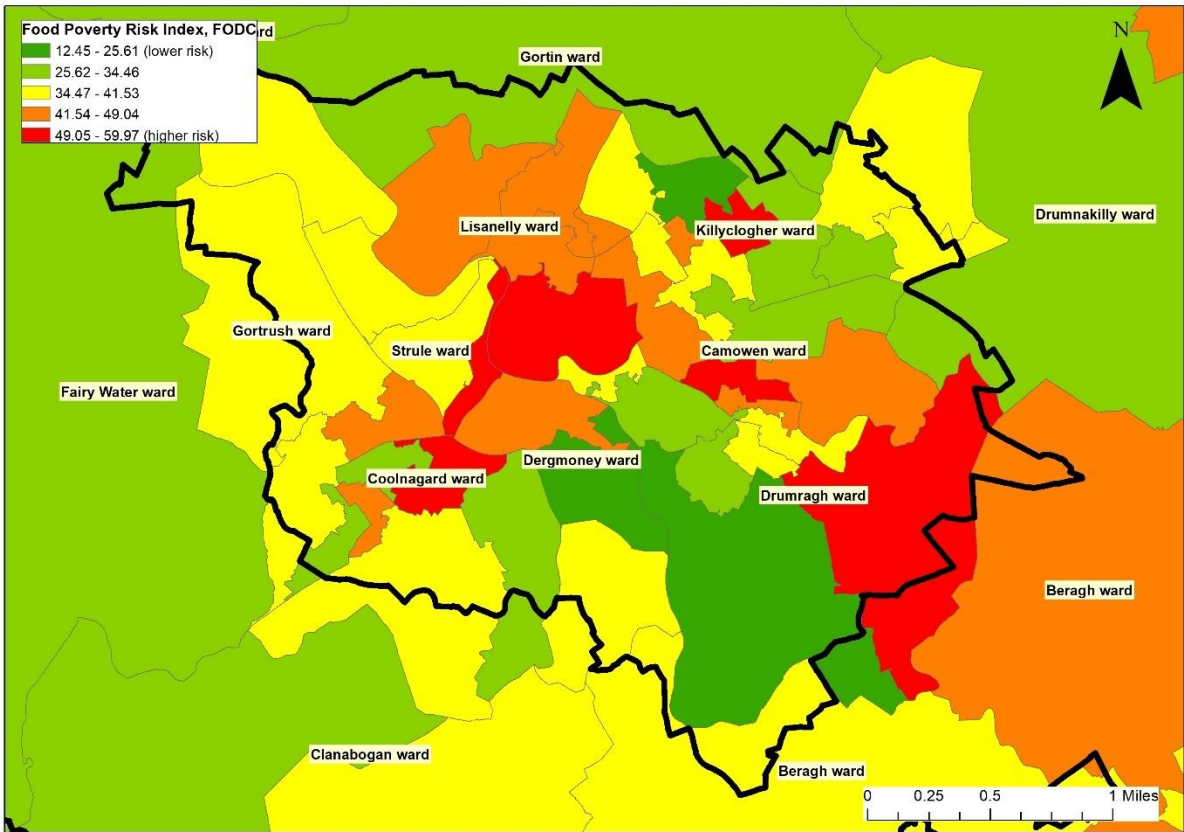
Figure 44: Spatial variation of ARFPI within Omagh.

Within GIS a cluster analysis was run on the ARFPI scores as was done for the fuel and transport poverty layers. Table 14 and Figure 45 illustrate the clusters based on FODC food poverty risk scores.

Table 14: Clusters of ARFPI scores within FODC.

Cluster Classification	Number of Small Areas	% of FODC Small Areas
Not significant	147	55.89
High-High	40	15.21
High-Low	15	5.70
Low-High	21	7.98
Low-Low	40	15.21

Figure 45: Cluster analysis of FODC ARFPI scores.

Within the Council area there are areas that are not significantly clustered for food poverty. While these are non-significant in terms of clustering, this does not indicate that these areas are at low risk of food poverty. There is a smaller group of "L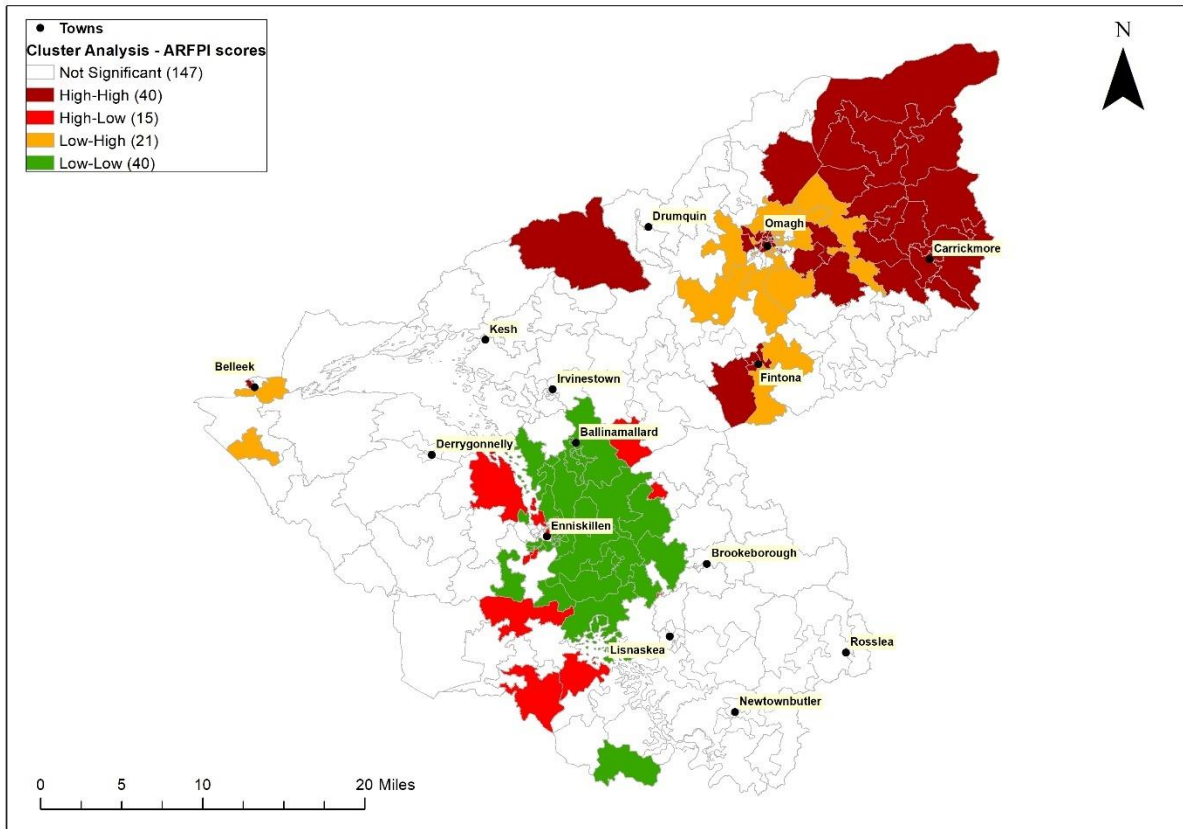ow-Low" clusters for food poverty (15% of Council area) which tend to be in the area around Enniskillen (similar to fuel and transport poverty). Ballinamallard also has several low risk clusters, along with Lisbellaw and Tamlaght.

The clusters of highest eligibility ("High-High" – 15% of Council area) are in the North East of FODC and are mainly in Open countryside areas though 15 SAs in Omagh (Large town) and 4 SAs in Fintona (Village) are also classified as high risk clusters for food poverty.

For food poverty, the "High-Low" outliers are predominantly in Enniskillen (8 "Low-Low" clusters) and Open countryside (6 "Low-Low clusters). Maguirebridge also has one SA which is classified as a "High-Low" outlier.

Of the 21 SAs classified as "Low-High" clusters, 10 were in Omagh and 11 were in Open countryside.

The "Poverty Support Locations" file also contained details of 7 emergency food providers. Figure 46 illustrates the location of these support locations across FODC in relation to ARFPI food poverty scores.
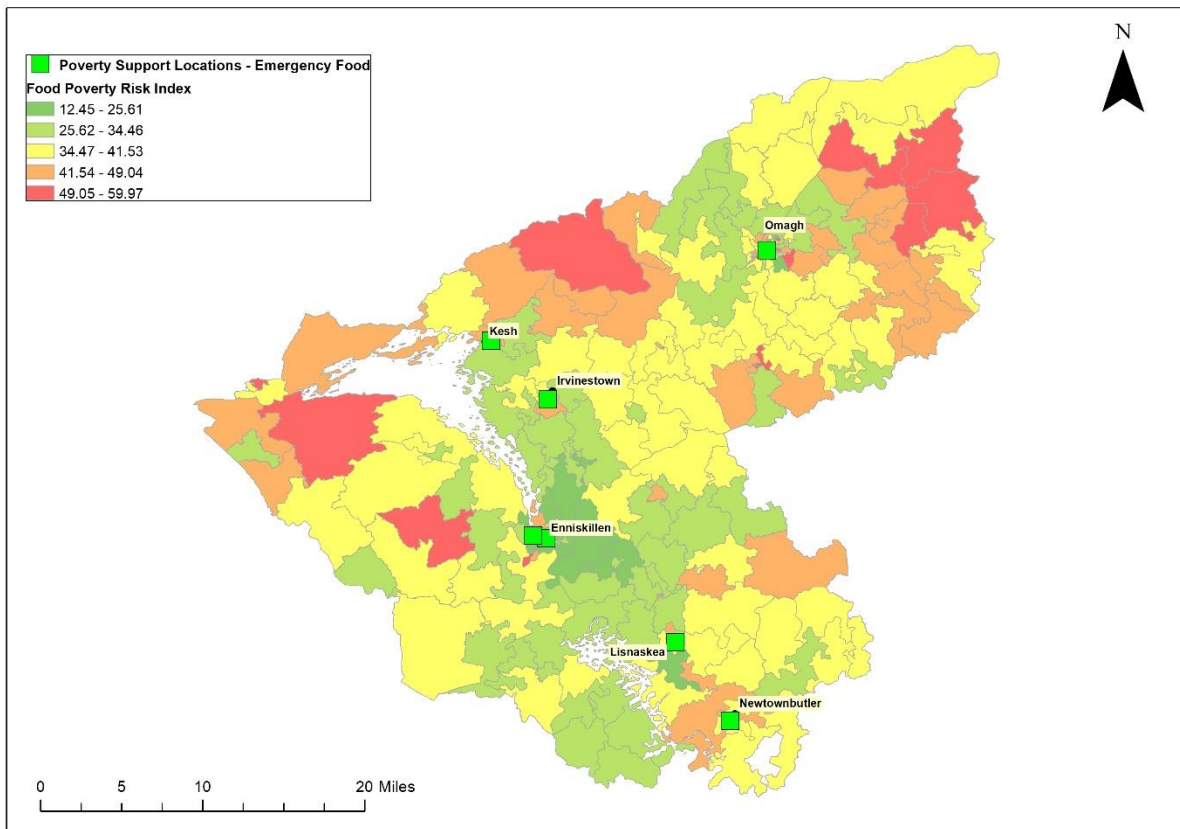
Figure 46: Food support locations across FODC.

There are 7 Emergency Food Providers within FODC which are situated in 7 SAs. They appear across most settlement types with 1 in Omagh (Large town), 2 in Enniskillen (Medium town), 1 in Lisnaskea (Intermediate), 2 in Villages (Irvinestown and Kesh) and 1 in Open countryside (Newtownbutler). The mean risk score for FODC is 37.50 and 3 of the SAs with emergency food providers have risk scores below the average i.e. lower eligibility (Kesh, Lisnaskea and Newtownbutler). Of the 4 SAs with emergency food providers and risk scores above the mean (i.e., higher eligibility), the highest risk score is 49.60 (Irvinestown, Village).

Multiple poverties

The clusters used to identify Small Areas experiencing high risk of fuel, transport and food poverty were amalgamated to identify areas experiencing more than one type of poverty. The term "Double Energy Vulnerability" was suggested by Robinson and Mattioli (2020) to describe areas experiencing both domestic energy poverty and transport energy poverty.

Considering high risk clusters for both fuel and transport poverty, there were 22 Small Areas in FODC (Figure 47).
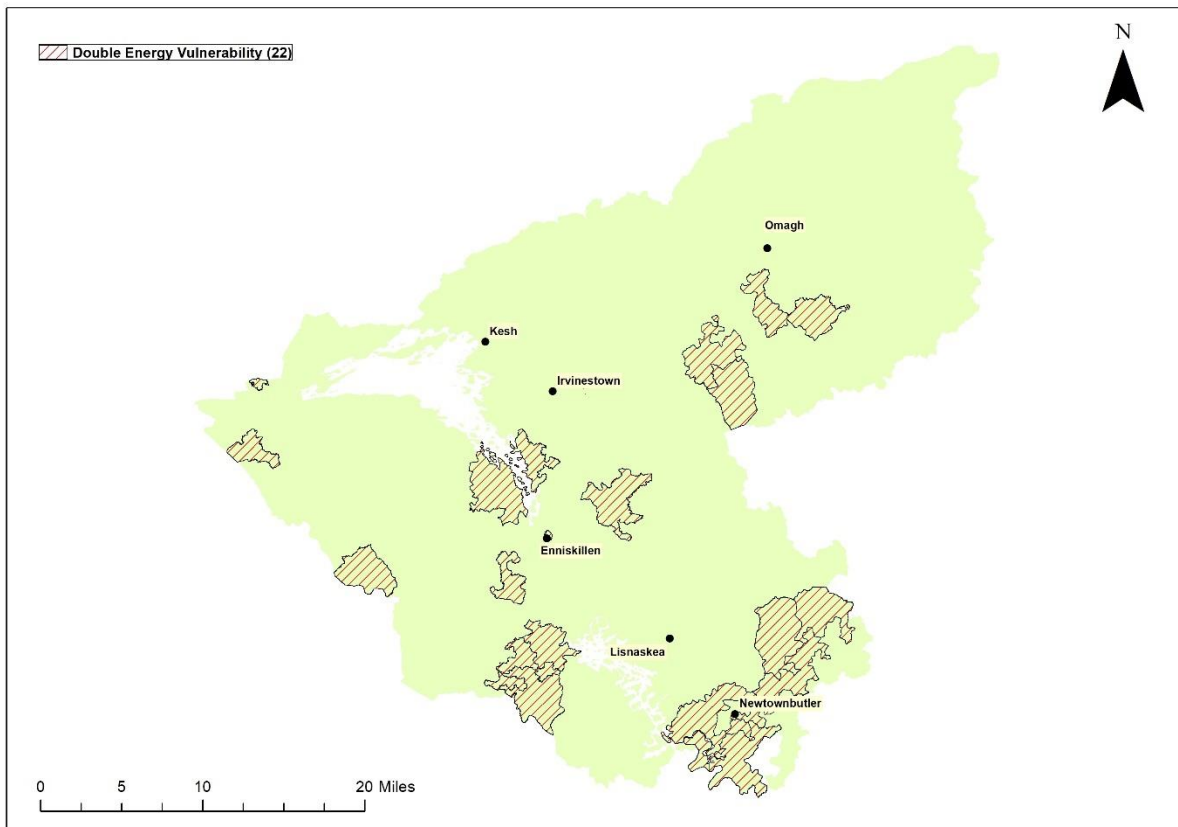

Figure 47: Small Areas at risk of both transport poverty and fuel poverty.

Of the 22 Small Areas with high risk clusters of both fuel and transport poverty, 21 were in Open countryside and 1 was in Enniskillen (Devenish ward).

There were 23 Small Areas identified as high-risk clusters for both fuel and food poverty. 21 occurred in Open countryside with 2 in Enniskillen (Erne ward and Devenish ward).

There 17 Small Areas classified as high risk clusters for both food and transport poverty. 4 of these areas were in Fintona (Village), 5 were in Open countryside, 4 were in Enniskillen and 4 were in Omagh.

There were 157 Small Areas in FODC that were classified as high risk clusters for either fuel, transport or food poverty. Of these, 52 SAs (33%) experience at least two types of poverty. There were 4 Small Areas that had high risk clusters for fuel, transport and food poverty (all three poverties). These areas were in Fintona ward,

Derrygonnelly ward, Florencecourt and Kinawley ward (Open countryside) and Devenish ward (Medium town). Using the Pointer layer for 2022, these areas contained over 900 domestic properties.

Overall, there are multiple poverties occurring in Open countryside areas and Villages which are considered "rural" areas. However, "urban" areas also experience clusters of high fuel, transport and food poverty. Some Villages are identified as "High-Low" outliers which means they are significantly higher than neighbouring areas. For instance, Bellanaleck, Tamlaght and Lisbellaw are three Villages classified as "High-Low" outliers for fuel poverty. Maguiresbridge was also classified as a "High-Low" outlier for food poverty.

Villages such as Lisbellaw were classified as significantly "Low" risk areas for fuel poverty, transport poverty and food poverty. Ballinamallard also was classified as significantly "Low" risk for both food and transport poverty, though for fuel poverty it was not a statistically significant cluster.

By certain areas experiencing lower risk of some forms of poverty, this may reduce pressure on household spending which reduces risk of other poverties. For instance, if a household is not at risk of either food or transport poverty, there may be sufficient disposable income to reduce fuel costs. Hernandez (2013) identified the "trifecta of insecurity" which is based on housing costs, food and energy. There are likely to be many pressures on household incomes that impact on the physical and mental health of residents. However, identifying areas at greatest risk of experiencing poverties allows interventions and strategies to be initiated that can reduce pressure and lead to greater long-term control. For instance, solar PV can be installed in rural areas and could form the basis of "energy communities" (Lazdins *et al.*, 2021). For instance, Figure 37 shows large solar PV sites that could generate significant electricity. Finn and McKenzie (2020) estimated that Fermanagh could potentially host over 50 solar PV sites within non-built land. Of the suitable area, if 10% of those sites were converted to solar PV, between 13.6 and 33.9 MW may be generated for use across the Council area.
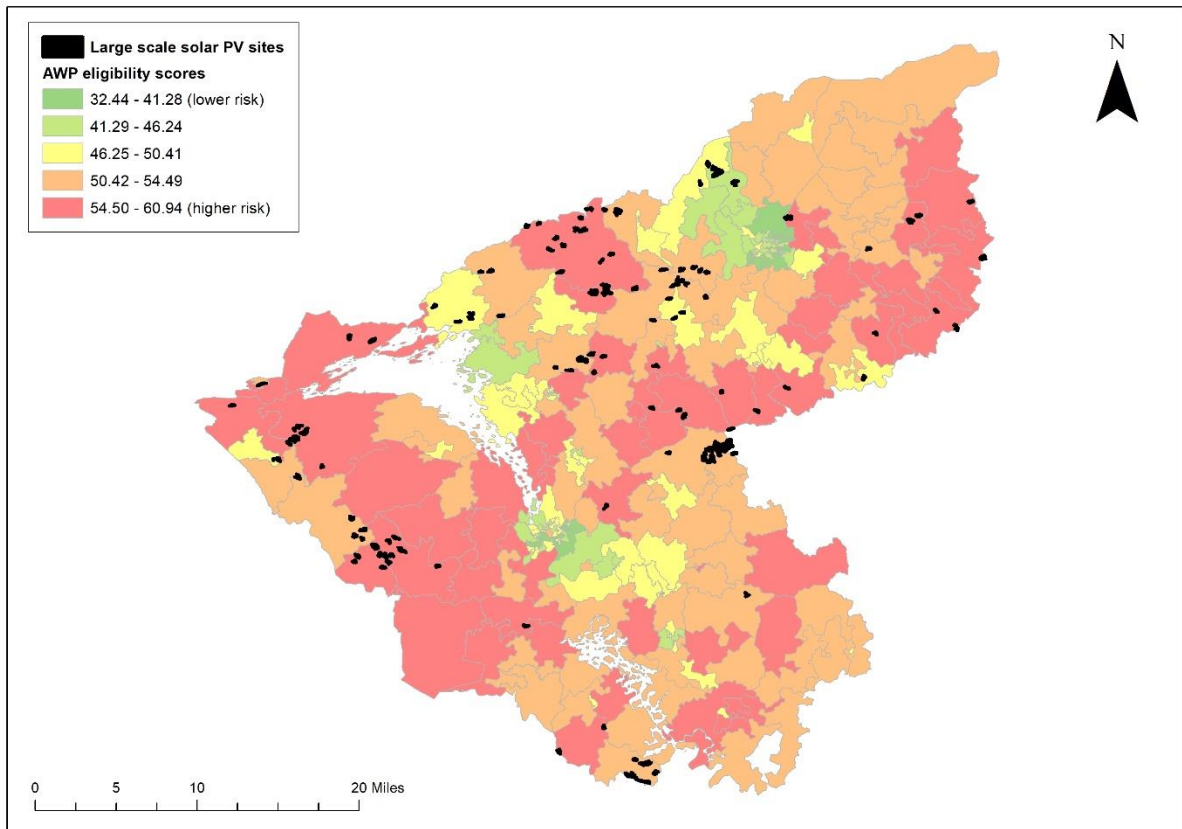
Figure 48: Potential solar PV sites across FODC in relation to AWP eligibility.

As can be seen from Figure 48, there is potential to generate energy through low carbon technologies in areas that are reliant on home heating oil and at greatest risk of fuel poverty. Through adoption of renewable technologies, electricity prices can be reduced, leaving greater proportions of household income for other living costs. Other work by Gawley and McKenzie (2022) suggest that solar PV can cover over 60% of residential electricity demand through carefully placed panels.

Recommendations

It is important to note that there was an overlap between the indices presented in this report. For instance, transport poverty was partly based on population density with rural areas scoring more highly than urban areas. Food poverty was also based on isolation from key services which means there is a degree of overlap between both indices. Furthermore, poverty and deprivation were included in the transport poverty metric, the food poverty metric and, to some extent, the fuel poverty metric. Ideally a metric would be created which would capture distinct elements of each issue.

It is also important to note that verification is needed in order to increase confidence in the models. The Affordable Warmth Programme (AWP) was verified during initial creation in 2013-14 and obtained very high levels of accuracy (Walker *et al.*, 2014). However, the original verification process for fuel poverty occurred almost a decade ago. No verification has been done for the transport or food poverty indices. Ideally data from FODC on referrals could be integrated with the models in order to ground truth the models. Verification is required to ensure that all at-risk households are offered the help required and no vulnerable households are omitted. Greater integration of data and expertise between Councils and University departments can lead to improved data models and improved targeting.

Finally, the models are based on an amalgam of datasets, some dating back to the last UK Census in 2011. Area-based statistics for the UK Census in 2021 are expected in summer 2023. This provides an excellent opportunity to capture updated data and liaise with Council staff and other stakeholders to not only ground truth models, but also inform weighting of variables to identify overall risk.

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Datasets

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Ulster University is a participant of the Northern Ireland Mapping Agreement (NIMA) which provides Ordnance Survey data for use in education and research (NIMA S&LA 577.319).

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https://www.nisra.gov.uk/support/geography/northern-ireland-small-areas

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