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DCLG/DEFRA
Research into Drivers of Service Costs in Rural Areas

Fire and Rescue Statistics Analysis

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Contents

1. Summary

- As part of the DCLG/DEFRA commissioned research into Drivers of Service Costs in Rural Areas, national unit cost analysis was carried out to assess whether there were statistically significant relationships between service provision costs and various measures of sparsity, rurality and remoteness.

- Controlling for deprivation, the report found a positive relationship between sparsity and unit costs for Fire & Rescue Operations; however, this relationship was not statistically significant (despite being close to the significance threshold, with p=0.07). The report also found a negative and statistically significant (p<0.05) relationship for Community Fire Safety. The former category accounted for 88% local authorities' spending in 2012/13.

- This paper supplements the previous analysis, focusing on nationally available fire statistics.

- Regression analysis was again carried out, this time using total fire and rescue expenditure from 2013/14. The results confirmed the positive and statistically significant relationship between sparsity and unit costs, controlling for deprivation.

- Analysis was carried out to identify possible explanations for the difference in unit costs between sparse and non-sparse authorities. Four key differences were examined: (i) differences in the number of stations, appliances and staff, (ii) differences in staffing structures which could affect employee costs, (iii) differences in the number and type of incidents responded to, and (iv) differences in the level of services provided, measured by casualty rates and response times.

- **Differences in Stations, Appliances and Staff –** Fire and Rescue Authorities (FRAs) in sparse areas were found to have a higher number of stations, operational appliances and staff relative to the number of incidents responded to. This supports the argument that sparse authorities face diseconomies of scale in comparison to urban authorities, as they incur the same fixed costs necessary to provide emergency coverage to all areas, regardless of the number of residents living in those areas.

- **Differences in Staffing Structures –** Sparse FRAs were found to have a significantly higher proportion of retained vs. wholetime fire fighters. This appears to translate to lower wage and salary costs, with sparse authorities having significantly lower employment costs per FTE member of staff.

- **Differences in Incidents Attended –** The number of incidents per resident was only weakly related to sparsity. In 2013/14, rural FRAs attended fewer incidents per resident. This was mostly due to a lower rate of fire incidents, offset by a higher rate of non-fire incidents, mostly traffic-related. Of the fire incidents that did occur, the proportion of primary fires was higher in rural authorities (47%) than urban ones (36%), suggesting higher unit costs.

- **Differences in Service Levels** – Service levels were assessed based on (i) casualty rates and (ii) emergency response times. There did not appear to be significant differences in casualty rates between rural and urban areas, although response times were systematically higher in sparse authorities.

2. Background

2.1 As part of the DCLG/DEFRA commissioned research into Drivers of Service Costs in Rural Areas, separate national unit costs analysis has been carried out to assess whether there were statistically significant relationships between service provision costs and various measures of sparsity, rurality and remoteness.

2.2 In addition, quantitative service surveys were circulated to a sample of 27 local authorities covering 10 service areas, agreed in advance with DCLG/DEFRA. Discussions with DCLG's Fire Research team suggested that national analysis of fire statistics would be likely to generate more robust analysis than a survey approach, and this paper reports on the results of this national analysis, which supplements the previous wider national unit costs analysis.

2.3 The paper focuses on the costs of providing Fire and Rescue services in England. It aims to identify any factors that may explain cost differences between Fire and Rescue Authorities (FRAs) in rural or sparsely populated areas, relative to those which are more urban or densely populated.

2.4 The main data sources used in this report included:

- CIPFA's *Fire and Rescue Service Statistics 2014*, for data on actual expenditure, the number of stations and operational appliances, and staffing structures. We would like to extend our thanks to CIPFA, in particular, for providing us with access to this data and acknowledge the usefulness of this data for our research;
- DCLG's *Fire Statistics Monitor: England April 2013 to March 2014*, for data on incidents and casualty rates; and
- DCLG's Appendices to *Fire Incidents Response Times, England, 2013-14*, for data on average response times.

2.5 As part of the separate national unit cost analysis, unit costs were calculated using actual expenditure for 2012/13, which was divided by the resident population and deflated by the appropriate Area Cost Adjustment. Unit costs were calculated for (i) Fire Fighting and Rescue Operations and (ii) Community Fire Safety.

2.6 Simple statistical models were developed to quantify the relationship (if any) between unit costs and various measures of sparsity. Deprivation variables were also included if they improved the explanatory power of the model. The results were as follows:

- For Fire Fighting and Rescue Operations, there was found to be a **positive** relationship between sparsity and unit costs in all the models, controlling for deprivation. However, the relationship was not found to be statistically significant, despite approaching the significance threshold (with p=0.07).[1]

[1] In informal terms, the P-value is the probability that the relationship between sparsity and unit does not exist. The lower the P-value, the more likely there is to be a relationship. For example, if the P-value is 0.01, then we would conclude that there is only a 1% chance that there is no relationship between sparsity and unit costs, given what we actually observed. We follow the common convention of defining a relationship as 'statistically significant' if $p<0.05$, i.e. where there is less than a 5% chance of the relationship being zero.

- For Community Fire Safety, there was a **negative** relationship between sparsity and unit costs, again controlling for deprivation. The model explained 21% of the variation in unit costs, and sparsity was statistically significant ($p<0.05$).

2.7 This suggests that sparsely populated authorities may, on average, face higher costs per resident in the provision of fire and rescue services, controlling for deprivation. Nationally, Fire Fighting and Rescue Operations account for a much larger share of total expenditure (88.0%) than Community and Fire Safety (11.4%).[2] In this report, we carry out similar analysis using total fire expenditure in 2013/14.

2.8 This report aims to identify the underlying factors that may explain differences in unit costs. It is structured in four parts, corresponding to key differences between sparse and non-sparse FRAs that potentially explain variations in unit costs. These are:

- Differences in the number of stations, appliances and staff maintained for a given number of incidents;
- Differences in staffing structures and average wage/salary costs;
- Differences in both the number and type of incidents attended; and
- Differences in level of services provided, measured by casualty rates and fire damage.

[2] Based on actual expenditure in 2012/13, reported on the Revenue Outturn forms. The remaining expenditure category was Emergency Planning and Civil Defence (0.6% of total expenditure), which was excluded, because of its small size.

2. Sparsity Measurements

3.1 In this report, sparsity is measured using DEFRA's 2011 Rural-Urban Classification for small areas. This classification assigns each small area (Output Areas) to one of four urban or six rural categories. At the local authority level, DEFRA also publishes the percentage of residents living in each category. Using this information, LG Futures has constructed a sparsity value for each local authority, based on the percentage of the population living in (i) villages, (ii) villages in sparse settings, (iii) hamlets and isolated dwellings and (iv) hamlets and isolated dwellings in sparse settings. These correspond to the most remote and sparsely populated areas in DEFRA's classification system, as shown in Table 1 below.

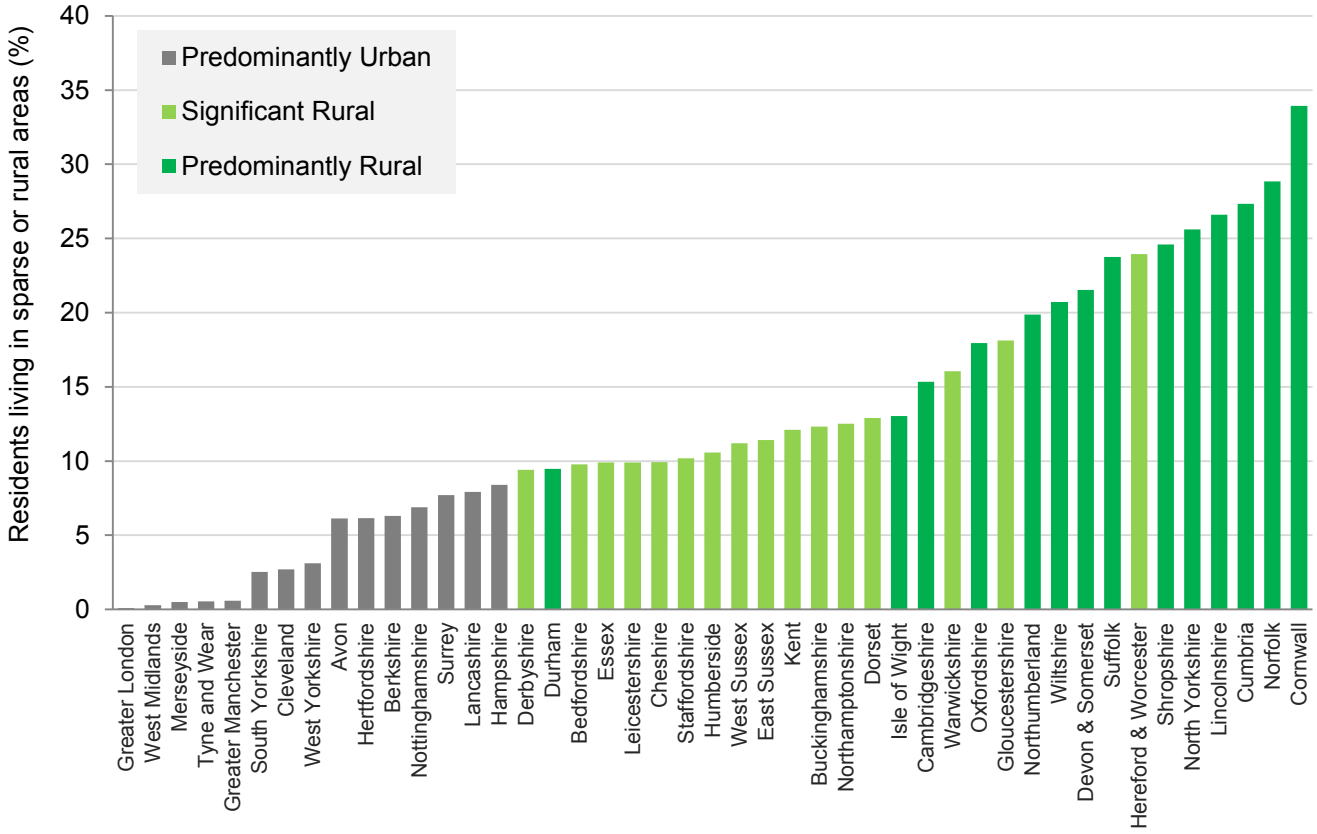
Table 3.1 – Sparsity Indicators

DEFRA's 2011 Rural-Urban Classification		Sparsity Indicator in this report
Urban	Major Conurbation	
	Minor Conurbation	
	City & Town	
	City & Town in Sparse Setting	
Rural	Town & Fringe	
	Town & Fringe in Sparse Setting	
	Village	✓
	Village in a sparse setting	✓
	Hamlets and Isolated Dwellings	✓
	Hamlets and Isolated Dwellings in a sparse setting	✓

3.2 The benefit of this sparsity indicator is that it provides a continuous variable for measuring small differences in relative sparsity. However, it can also be useful to summarise results based on broad sparsity groupings. For this, we used DEFRA's Local Authority Rural-Urban Classification. This assigns authorities to one of three categories: (i) Predominantly Rural, (ii) Significant Rural and (iii) Predominantly Urban. This classification is currently based on the 2001 Census, and, unlike the small area classification, has not been updated for the 2011 Census.

3.3 For each FRA, the percentage of residents living in sparse or rural areas (i.e. villages, hamlets or isolated dwellings) and its DEFRA classification is summarised in the chart below. It should be noted that there is some overlap between the Significant Rural and Predominantly Rural categories, in terms of the percentage of the population living in sparse or rural areas. This reflects the fact that DEFRA uses different definitions to assign authorities to these categories (based on the percentage in 'Urban' and 'Rural' areas) and the fact the data relates to different years.

Chart 3.2 – Measurements of Sparsity



4 Differences in Total Costs

4.1 Separate national unit costs analysis showed that sparsity was positively related to unit costs for Fire & Rescue Operations, but negative related to costs for Community Fire Safety. This was based on 2012/13 actual expenditure.

4.2 For this report, we carried out similar analysis using total Fire and Rescue expenditure. Unit costs were calculated using actual expenditure in 2013/14, as published by CIPFA, divided by the resident population and deflated by the Area Cost Adjustment for Fire and Rescue Services.

4.3 Expenditure data was not available for Isle of Wight or Hampshire, and these authorities were excluded from the analysis.

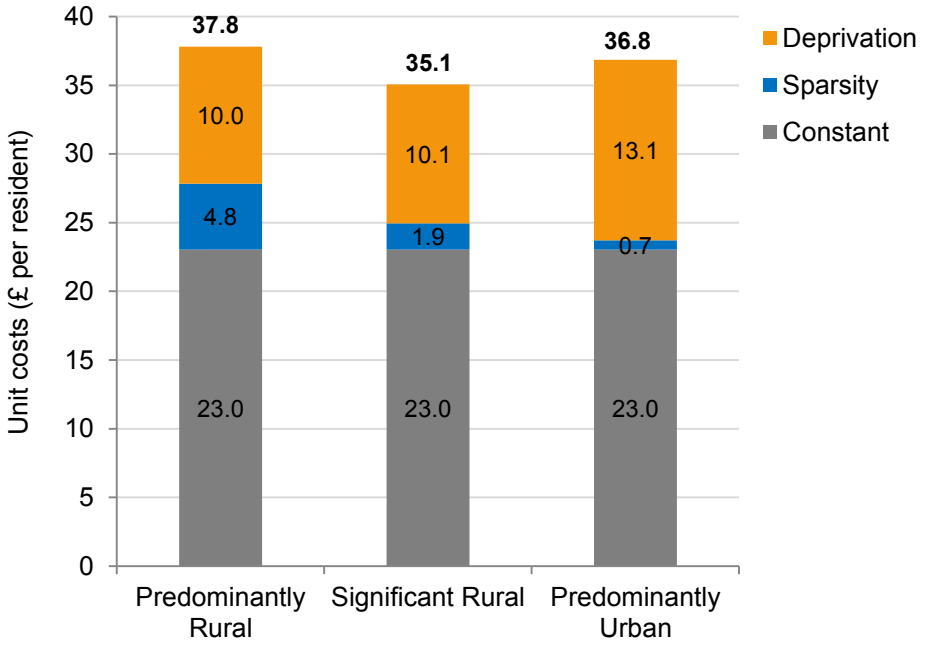
4.4 The results confirm a statistically significant correlation between sparsity and total unit costs, after controlling for deprivation (without controlling for deprivation, a significant relationship was not found). Using the same sparsity and deprivation variables as in the original regression analysis[3], this simple model explained 31% of the variation in fire and rescue unit costs. This was a better goodness-of-fit than the original regression models, and both sparsity and deprivation were found to be highly statistically significant ($p<0.01$).

4.5 The chart below illustrates the average unit costs for each DEFRA category, as predicted by the model. The average cost-per-resident associated with sparsity is £4.80 in Predominantly Rural authorities, £1.90 in Significant Rural authorities and £0.70 in Predominantly Urban authorities. For Predominantly Urban authorities, this is offset by higher costs associated with deprivation. It should be emphasised that these values are all predicted values, based on the simple model described above, rather than actual or observed values.

4.6 The following sections seek to identify the factors that could potentially explain the higher costs associated with sparsity in rural areas.

[3] The sparsity variable used in these models is different to the DEFRA measurement used in this report. Sparsity was measured by the average number of hectares per resident, calculated at the Lower Layer Super Output Area (LSOA) level. The LSOAs were averaged together (weighted by population) to get the local authority total. This variable was referred to as '*SparsityLSOA*' in the main report.

Chart 4.1 – Predicted Costs per Resident by DEFRA Classification



5 Differences in Stations, Appliances and Staff

5.1 This section assesses whether differences in the number of stations, appliances and staff could potentially explain cost differences for FRAs in rural or sparsely populated areas.

5.2 It is often argued that sparse authorities experience diseconomies of scale in comparison urban authorities, as they incur the same fixed costs necessary to provide adequate emergency coverage to all areas, regardless of the number of number of residents living in those areas. This could translate to higher average costs per resident.

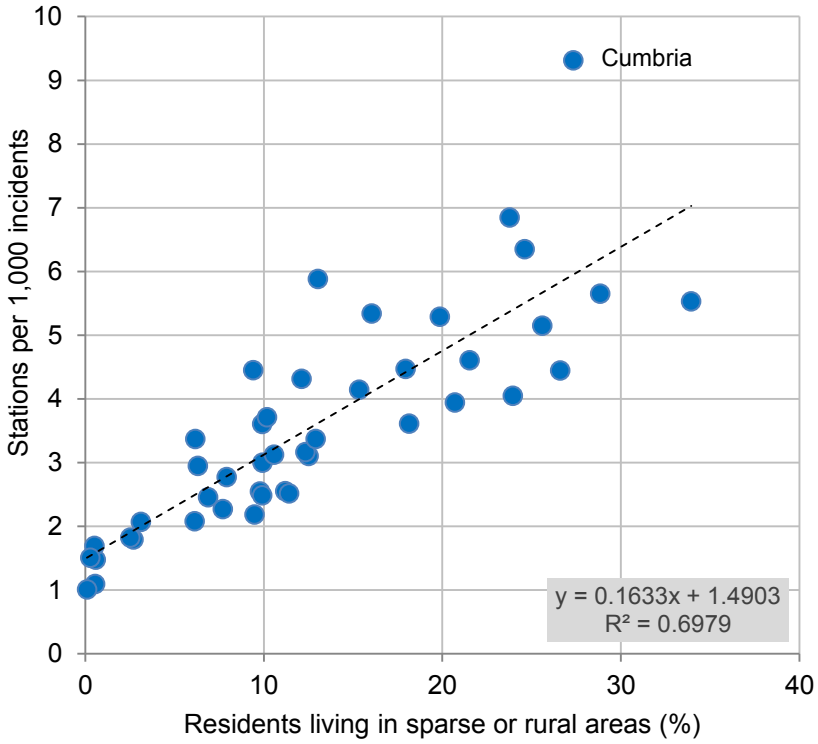
5.3 To assess this, we calculated the total numbers of stations, appliances and staff per 1,000 incidents. [4] This included both fire and non-fire incidents.[5] Overall, sparsely populated FRAs were found to have a significantly higher number of stations, appliances and staff relative to the number of incidents they attended. These results are described in the following sections.

Number of Stations

5.4 Figure 4.1 illustrates the relationship between sparsity and the number of fire stations per 1,000 incidents. As can be seen, there is a strong, positive correlation between the two variables, with higher sparsity being associated with a larger number of fire stations. On average, a 10% increase in the proportion of residents living in sparse areas corresponds to 1.6 additional stations per 1,000 incidents. Cumbria is an outlier, with the largest number of stations per thousand incidents, and higher than would be expected based on its sparsity alone.

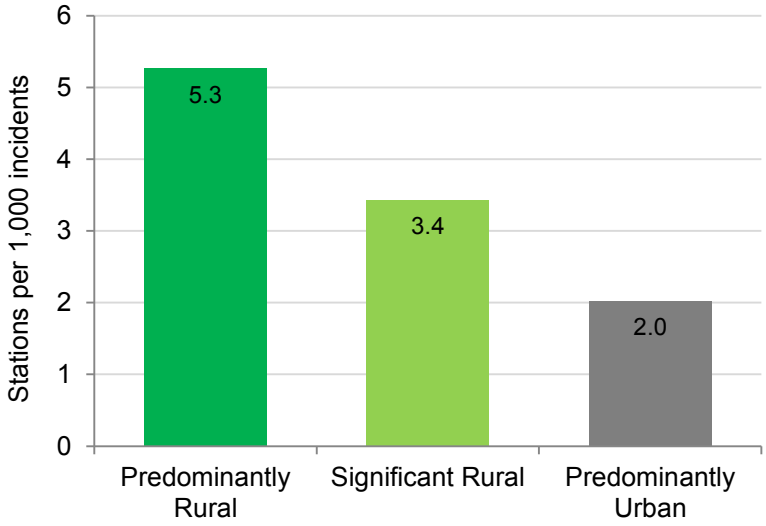
[4] Data on stations, appliances and staff was taken from the CIPFA publication *Fire and Rescue Service Statistics 2014*. Data on the number of incidents was taken from the tables accompanying CLG's *Fire Statistics Monitor: England April 2013 to March 2014*.
[5] This approach assumes a constant number of incidents per resident.

Chart 5.1 – Stations (per 1,000 Incidents) vs. Sparsity



5.5 Chart 5.2 presents the same information summarised by the local authorities' DEFRA classification. Predominantly rural authorities maintain more than double the number of stations than predominantly urban ones, with 5.3 stations versus 2.0 stations per 1,000 incidents and significant rural authorities having 3.4 stations per 1,000 incidents.

Chart 5.2 – Stations (per 1,000 Incidents) by DEFRA Classification

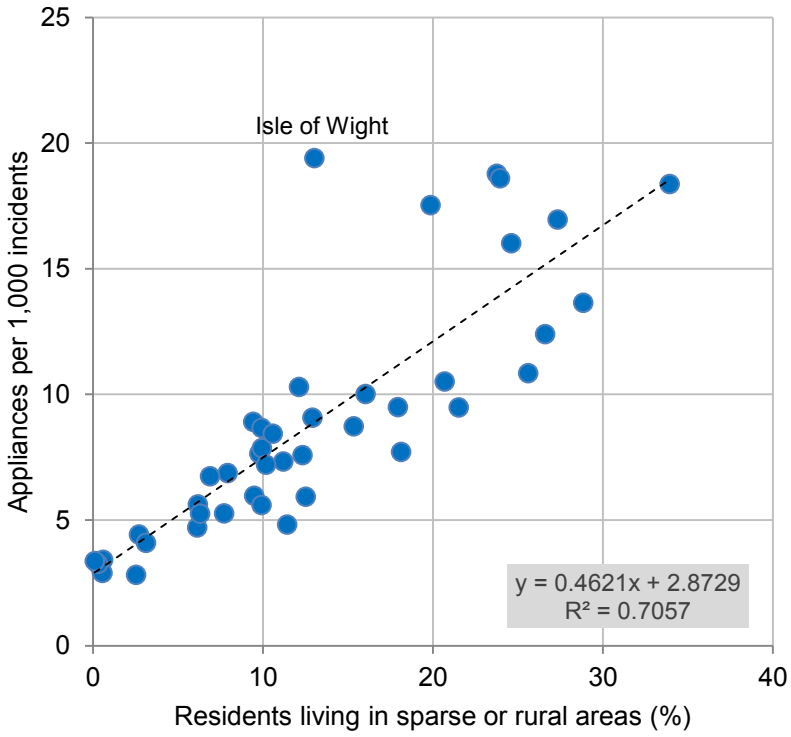


Number of Appliances

5.6 Similar results apply to the number of operational appliances per 1,000 incidents. This includes both operational and resilience appliances (such as pumping appliances, fire boats, urban search and rescue, decontamination units and so on), but excludes non-operational vehicles.

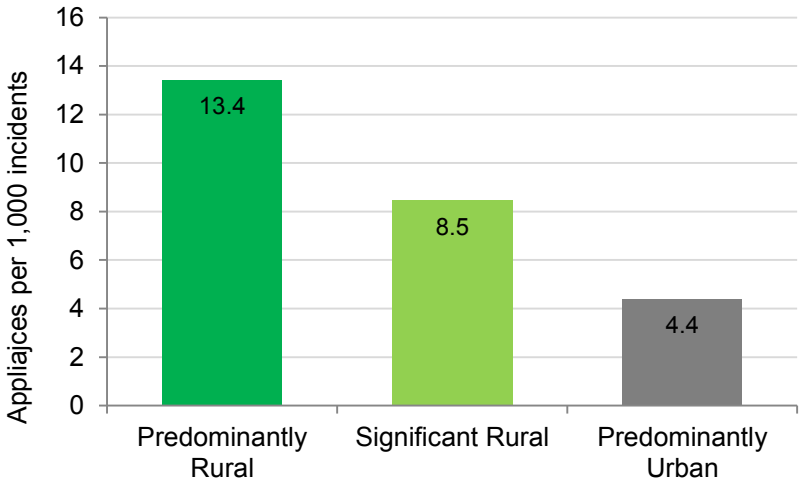
5.7 As shown previously, there is a strong positive correlation between the FRAs' sparsity and the number of appliances maintained per 1,000 incidents. The main outlier is the Isle of Wight, which has the largest number of appliances relative to the number of incidents, and more than would be expected given its level of sparsity, although its island location could be a contributing factor here, rather than rurality.

Chart 5.3 – Appliances (per 1,000 Incidents) vs. Sparsity



5.8 Relative to Predominantly Urban authorities, the number of appliances per 1,000 incidents is three times as high in Predominantly Rural authorities, and around twice as high in Significant Rural authorities. This is illustrated in the chart below.

Chart 5.4 – Appliances (per 1,000 Incidents) by DEFRA Classification

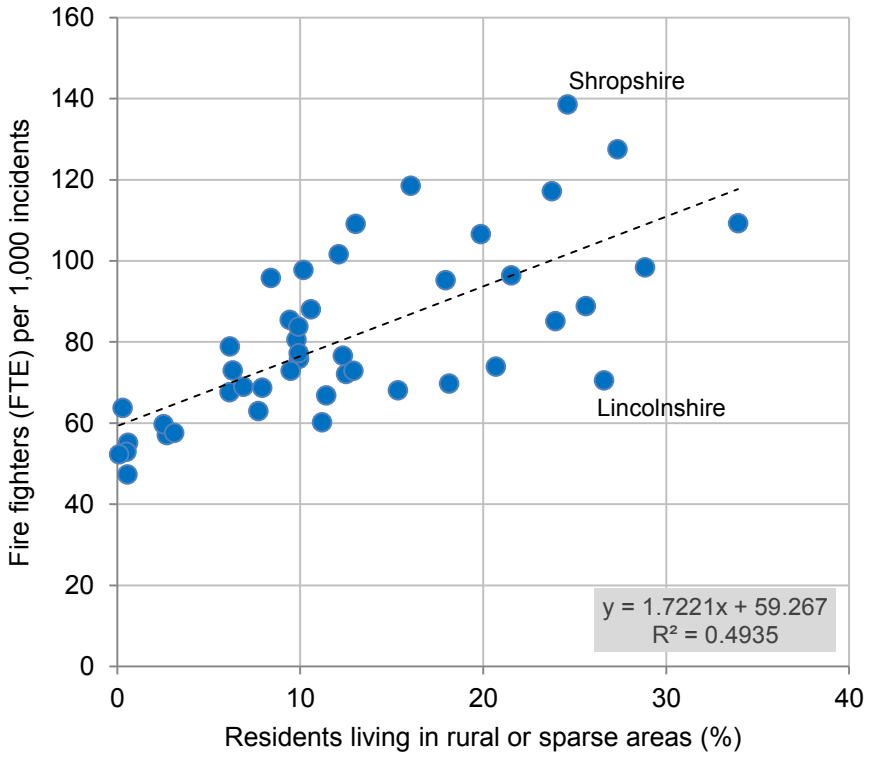


5.9 The results above are relatively unchanged when we restrict the analysis to pumping appliances per 1,000 incidents. The main difference is that the Isle of Wight ceases to be an outlier, i.e. the number of pumping appliances per 1,000 incidents is consistent with its level of sparsity.

Staffing Levels

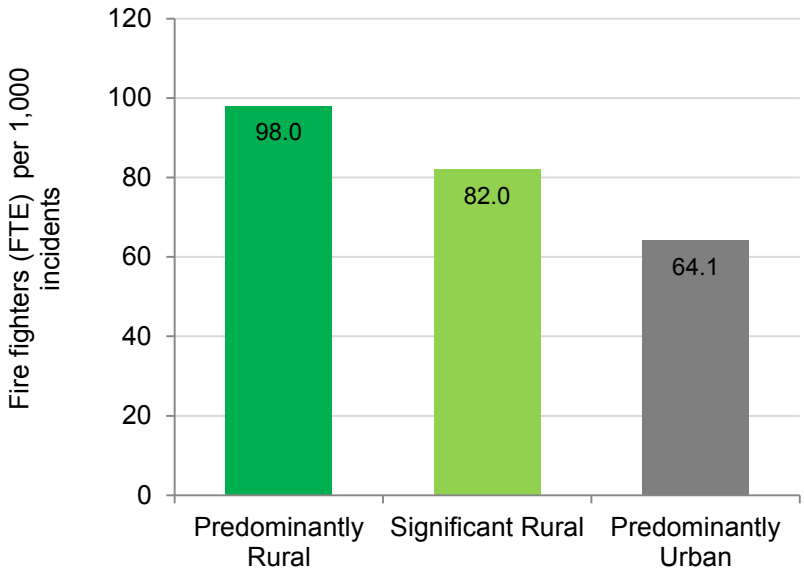
5.10 The final chart illustrates the relationship between sparsity and the number of firefighters (FTE) per 1,000 incidents. This includes both wholetime fire fighters and Retained Duty System (RDS) fire fighters. The RDS comprises 'on call' fire fighters who live in the local community and are typically engaged in other primary employment. Again, higher levels of sparsity are associated with a larger number of fire fighters per thousand incidents. While there is a clear positive relationship, it is weaker than was the case with fire stations and appliances.

Chart 5.5 – Fire Fighters (per 1,000 Incidents) vs. Sparsity



5.11 Overall, the number of fire fighters retained by Predominantly Rural authorities was 53% higher than Predominantly Urban ones, adjusting for the number of incidents attended. This is illustrated below.

Chart 5.6 – Fire Fighters (per 1,000 Incidents) by DEFRA Classification



5.12 The relationship between sparsity and staffing levels does not appear to apply to other personnel, including control room and non-uniformed support staff. The relationship between staffing and sparsity appears random, and is not statistically significant. This

suggests that these functions are potentially more consistently provided, even for authorities with dispersed and remote settlements.

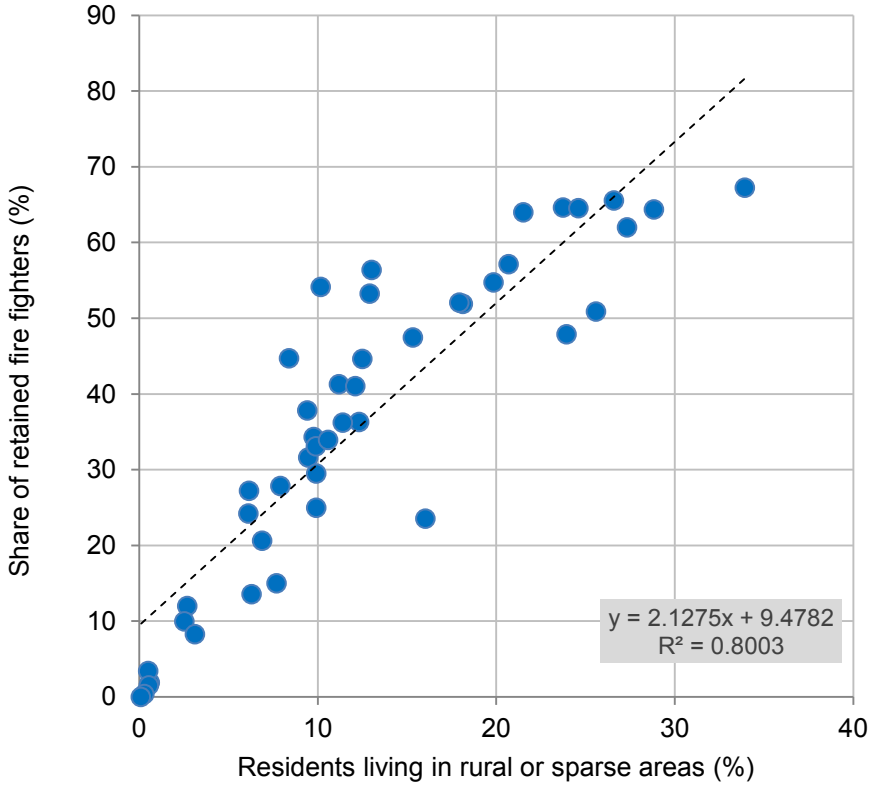
5.13 Overall, there appears to be a clear relationship between sparsity and the number of fire stations, appliances and staffing levels maintained by FRAs (relative to the number of incidents attended). This supports the view that sparse authorities do not have the same economies of scale experienced by densely populated ones, who can maintain adequate response times to a given number of incidents with fewer fixed costs.

6 Differences in Staffing Structures

6.1 This section assesses whether the staffing structure varies between FRAs, in terms of the proportion of wholetime vs. retained fire fighters. Analysis is based on the share of total number firefighter employees (expressed in FTE) that is comprised of Retained Duty System employees.

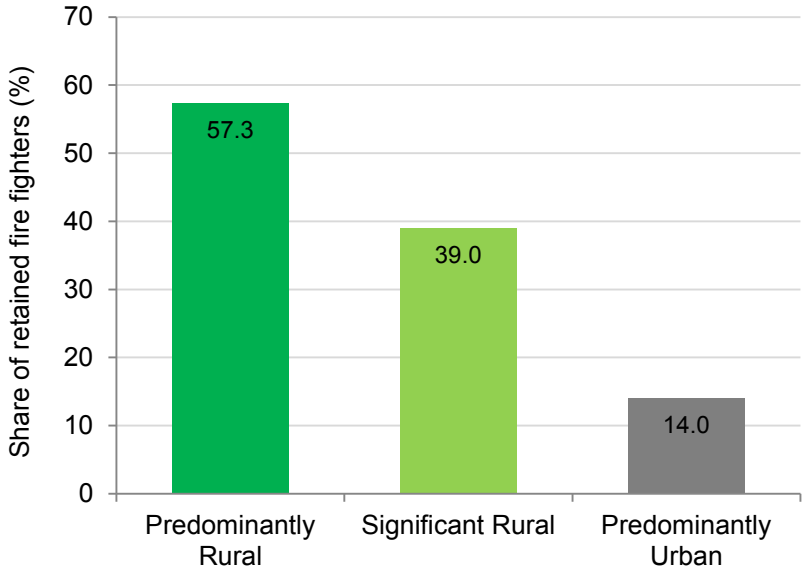
6.2 Chart 6.1 below shows the strong correlation between sparsity and the share of retained fire fighters. On average, the proportion of retained fire fighters increases by 2.1% for every 1.0% increase in the share of residents living in rural or sparse areas.

Chart 6.1 – Share of Retained Fire Fighters vs. Sparsity



6.3 Overall, retained fire fighters accounted for 14% of all fire fighting staff (on an FTE basis) among Predominantly Urban authorities, increasing to 39% for Significant Rural authorities and 57% for Predominantly Rural authorities. This is illustrated below.

Chart 6.2 – Share of Retained Fire Fighters by DEFRA Classification



6.4 To assess the cost implications of these different staffing structures, average employee costs were calculated for each FRA. Total employee costs for 2013/14[6] were divided by the number of employees, including fire fighters, control room and support staff. This gave an average employee cost per FTE employee. This was then deflated by the Area Cost Adjustment (ACA) for fire and rescue services, reflecting the fact that FRAs in higher wage areas (most notably London and the South East) receive additional funding to reflect local labour market conditions.

6.5 The results, presented in Charts 6.3 and 6.4 below, show a negative correlation between sparsity and unit costs. Authorities in sparse or rural areas have lower wage and salary costs for full-time equivalent employee. The average employee cost in Predominantly Urban authorities is £38,900 per year, falling to £33,800 in Significant Rural authorities and £28,500 in Predominantly Rural authorities, after adjusting for regional labour costs.

6.6 Lower wages could potentially explain the negative relationship between sparsity and unit costs for Community Fire Safety, as found in the earlier regression analysis. Assuming this service is more labour intensive than Fire and Rescue Operations – i.e. relying more heavily on employees and less on machinery and equipment – then sparsely populated authorities may experience lower costs than urban authorities.

[6] Total employee expenses were taken from the subjective analysis of actual expenditure, published by CIPFA in 'Fire and Rescue Statistics 2014'. Data was not available for Isle of Wight or Hampshire.

Chart 6.3 – Employee Unit Costs vs. Sparsity

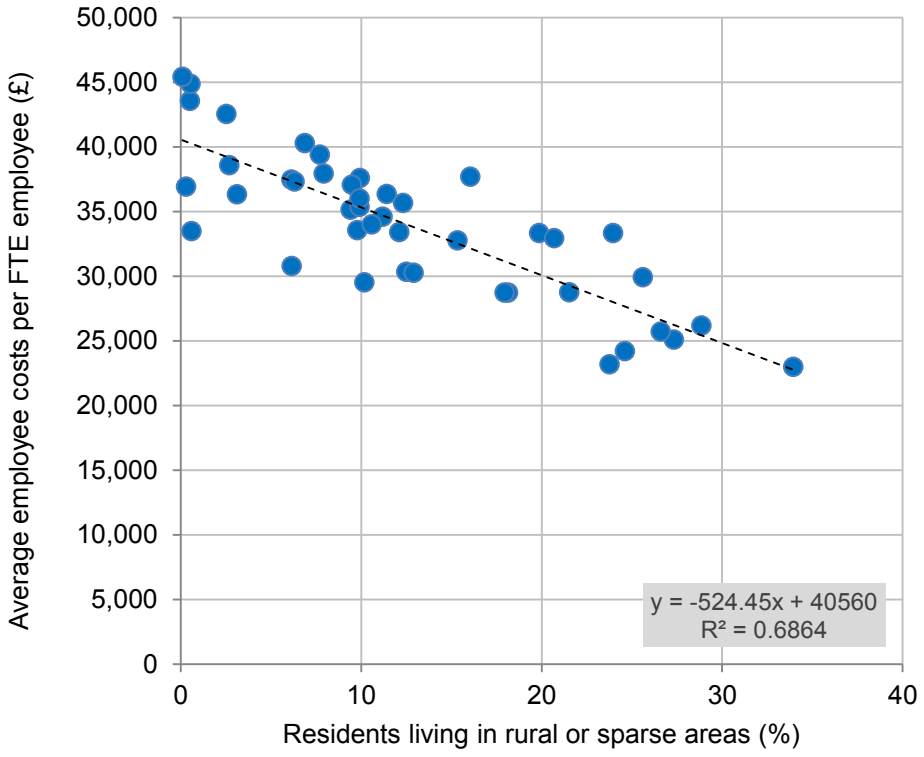
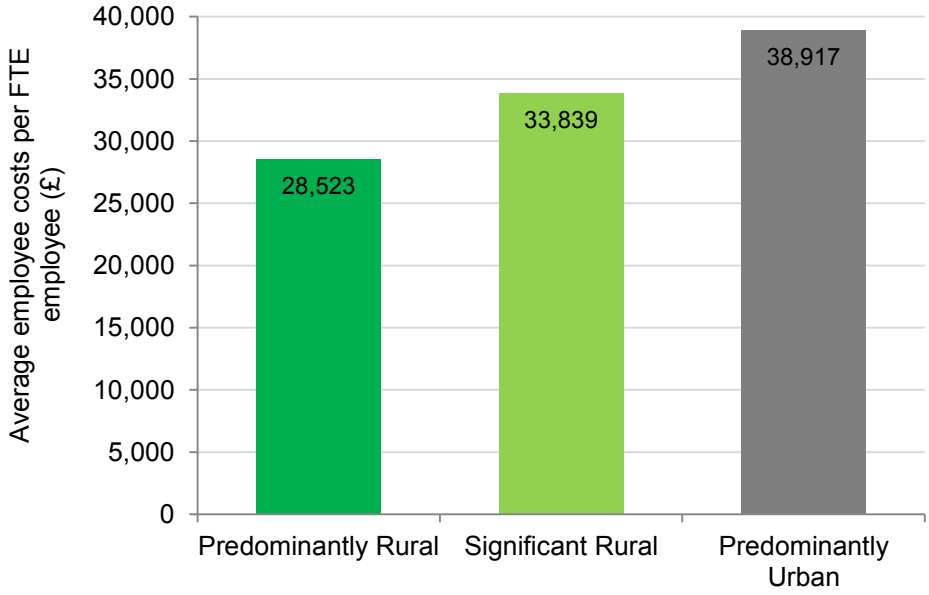


Chart 6.4 – Employee Unit Costs by DEFRA Classification

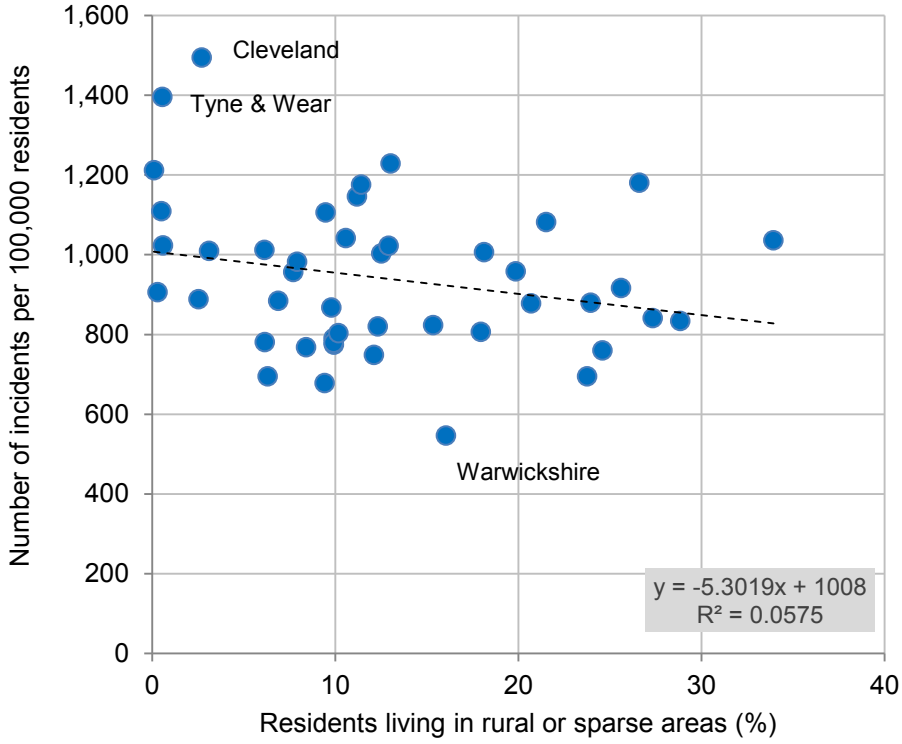


7 Differences in Incidents (Rates and Types)

7.1 Whereas previous sections have considered factors affecting costs per incident, this section examines whether the number of incidents per resident varies between sparse and non-sparse authorities. The main variable of interest is the total number of fire and non-fire incidents in 2013/14 per 100,000 residents.

7.2 Overall, there appeared to be a very weak and negative correlation between sparsity and incidents per head. This is illustrated in the chart below. Differences in sparsity only explained 5.8% of the difference in incidents per head. However, this relationship was not found to be statistically significant (despite approaching the threshold, with $p<0.1$).

Chart 7.1 – Rate of Incidents vs. Sparsity

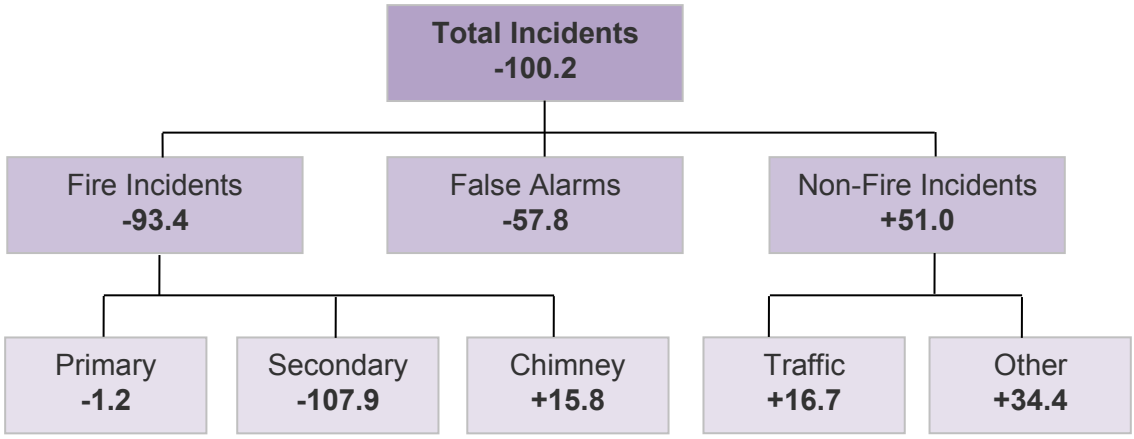


7.3 Looking at the DEFRA classifications, none of the differences in incident rates (i.e. between Predominantly Urban, Significant Rural or Predominantly Rural authorities) were found to be statistically significant.[7] This reflects the large variation in incident rates among authorities, regardless of their level of sparsity. These differences are likely to be explained by other factors, such as deprivation levels, property and building types, and the age profile of the resident population.[8]

[7] This result is based on one-way ANOVA test.
[8] These are all factors associated with fire risk, as reflected in DCLG's Relative Needs Formula in (respectively) the Fire & Rescue Deprivation Top-Up, the Property & Societal Risk Top-Up and the Community Fire Safety Top-Up.

7.4 Nevertheless, a comparison between the incident types attended by rural and urban authorities may still be informative. To simplify the analysis, we grouped together both rural classifications (Significant Rural and Predominantly Rural) into a single category, and compared the average incident rate with those of Predominantly Urban authorities. Overall, the rural authorities experienced 9.9% fewer incidents per head, corresponding to 100.2 fewer incidents per 100,000 residents.[9] A breakdown of this difference is provided in Figure 7.2 below:

Figure 7.2 – Difference in Incidents per 100,000 Residents, Rural vs. Urban Authorities (2013/14)

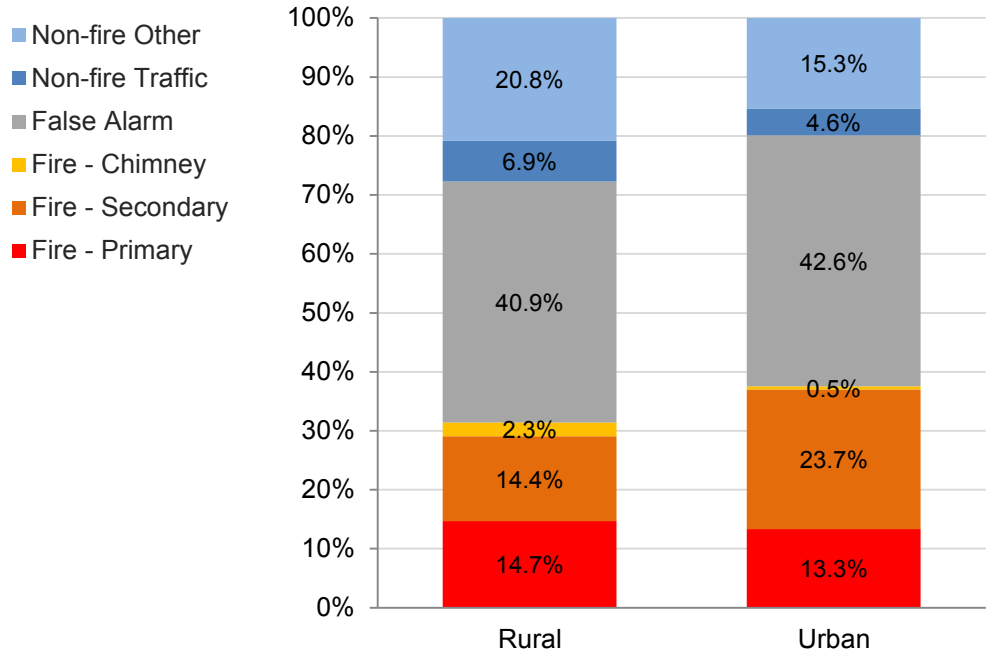


7.5 As can be seen, the lower incident rate among rural authorities is primarily due to a lower rate of fires and false alarms. This is offset by rural authorities' higher rate of chimney fires and non-fire incidents - road traffic collisions and other traffic incidents.

7.6 The charts below provide further information on the breakdown of incidents in rural and urban authorities. Chart 7.3 confirms that, in rural areas, non-fire incidents accounted for a larger share of total incidents in 2013/14. Possible reasons for the greater rate of non-fire incidents include the need for specialist rescues and an increased likelihood of traffic collisions due to the nature of rural roads.

[9] The average number of incidents per 100,000 residents was 1,007.8 for urban authorities and 907.6 for rural authorities.

Chart 7.3 – Type of Incidents, 2013/14



7.7 The rate of all fire incidents (with the exception of chimney fires) was found to be lower in rural areas. However, of the fire incidents that did occur, the proportion of primary fires was higher in rural authorities relative to urban ones. In 2013/14, these accounted for 47% of all fires in rural areas, compared to 36% of fires in urban areas. Primary fires are likely to be more costly in nature, as they include (i) fires in non-derelict buildings and vehicles, (ii) any fires involving casualties or rescues, or (iii) any fire attended by five or more appliances. Secondary fires do not have these characteristics, and the majority involve outdoor fires, including refuse and grassland fires.

7.8 In summary, there are two factors that can affect fire and rescue costs per resident: (i) the number of incidents per resident, and (ii) the average cost of responding to each incident. As described above, number of incidents per resident does not appear to be higher in rural areas than in urban ones, and may in fact be slightly lower (based on 2013/14 data). However, there is evidence that costs per incident may be higher in rural areas, evidenced by the higher number of stations, appliances and staff per intervention – though the latter is offset by lower average costs per FTE employee. The greater proportion of primary fires in rural areas may also translate to higher average costs per incident.

8 Differences in Service Levels

8.1 This final section seeks to assess whether FRAs in rural and urban areas deliver broadly equivalent levels of service. This is a key assumption underpinning regression analysis – it is assumed that patterns of current expenditure are a reasonable proxy for differences in underlying need. However, given the close relationship between funding and expenditure, it is possible that lower unit costs simply reflect lower levels of funding (rather than lower levels of need).

8.2 To assess whether FRAs are able to deliver equivalent levels of service, we consider two key measures: (i) minimising fire-related deaths and injuries and (ii) response times. It is assumed that if every FRA was funded according to its relative level of need, then these measures should be roughly equalised across England, and measures should not vary systematically based on authorities' levels of sparsity.[10]

8.3 The remainder of this section assesses whether there appears to be significant differences between rural and urban authorities in terms of the (i) number of fire-related casualties and (ii) response times.

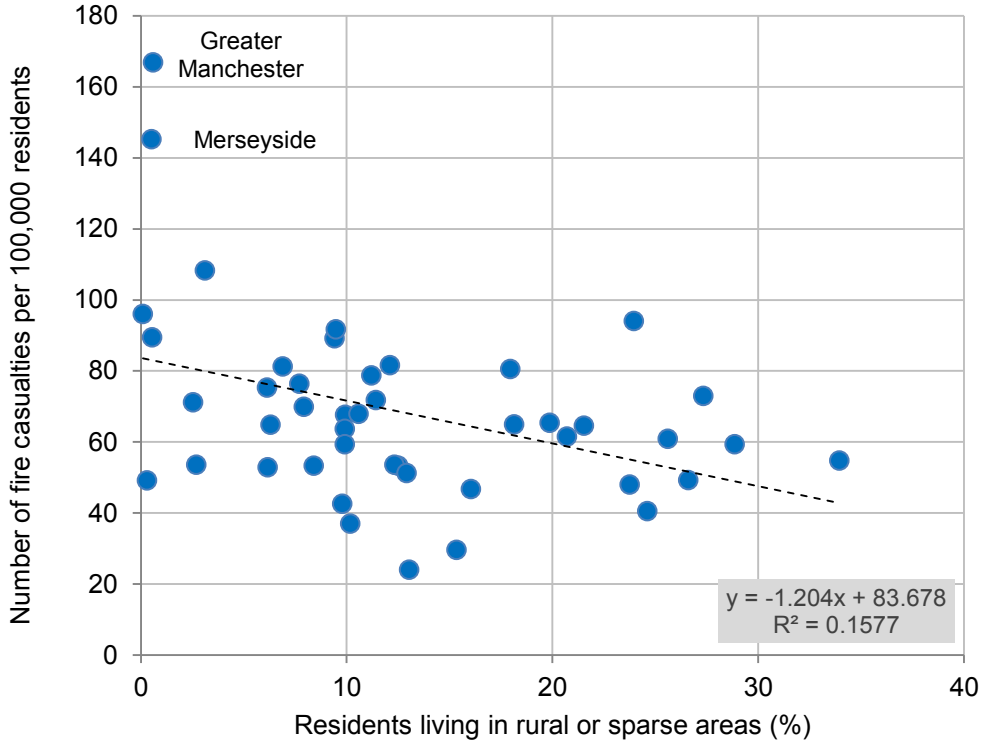
Casualty Rates

8.4 Analysis was carried out using average fire casualty rates between 2011/12 and 2013/14. Casualties include all fire fatalities (including deaths attributed to fires following road traffic collisions), and any non-fatal cases where the victim was admitted to hospital with 'severe' or 'slight' injuries. It excludes the least serious categories, where the victim was given first aid at the scene or where a precautionary check was recommended. The total number of casualties were divided by the resident population, and expressed as a casualty rate per 100,000 residents.

8.5 Overall, there was a slight negative relationship between sparsity and the casualty rate. This is illustrated in Chart 8.1 below. The correlation was not particularly strong, with sparsity only explaining around 16% of the variation in casualty rates, but the relationship was statistically significant ($p<0.01$). Outliers include the Greater Manchester and Merseyside fire authorities, with casualty rates that were more than double the national average.

[10] Some authorities will have higher needs than others, based on their particular characteristics – for instance, the risk of dying in a fire is twice as high for people aged 65 and over. However, it is expected that the funding system would equalise resources on the basis of these additional needs or risks; for example, by allocating additional funding to authorities with a higher proportion of older residents.

Chart 8.1 – Casualty Rates per 100,000 Residents versus Sparsity



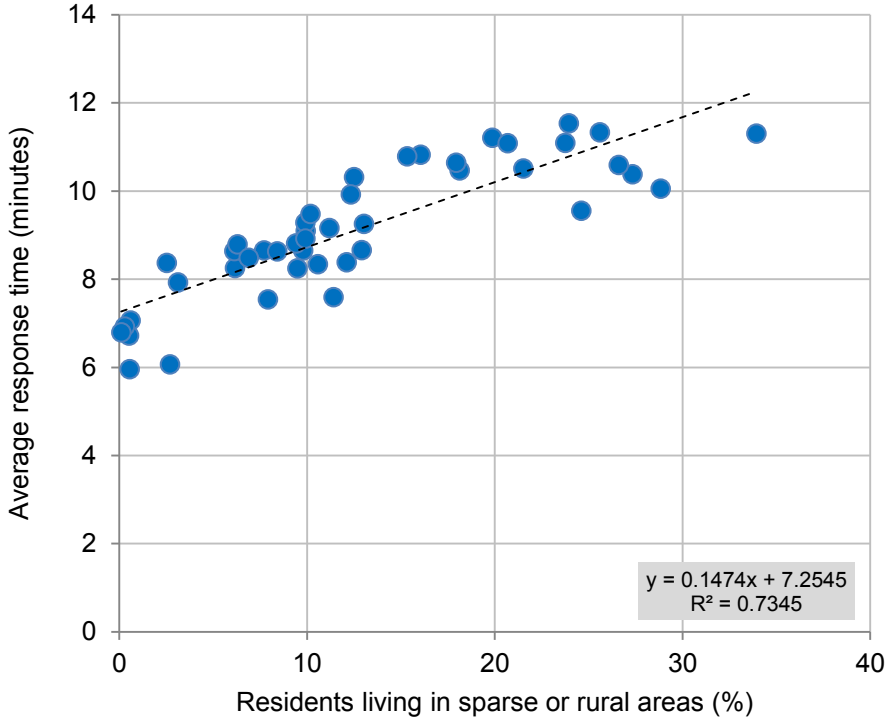
8.6 When non-fatal cases were excluded from the analysis, a statistically significant relationship between sparsity and the casualty rate was not found.

8.7 The foregoing analysis suggests that rural or sparse authorities do not have systematically worse outcomes, as measured by the simple correlation between sparsity and fire casualty rates.

Response Times

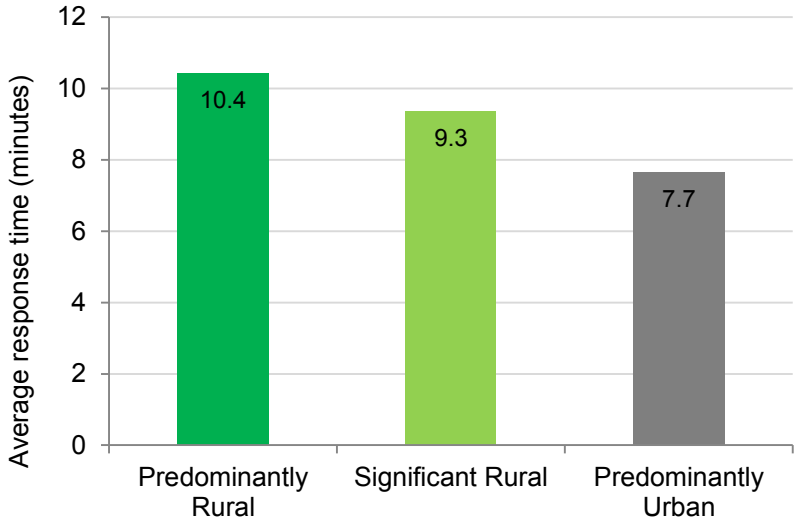
8.8 Response times to primary fires (in minutes) were analysed by type of authority and, as illustrated in Chart 8.2 below, there is a clear relationship between a local authority's level of sparsity and its average response time to primary fires.

Chart 8.2 – Response Times vs. Sparsity



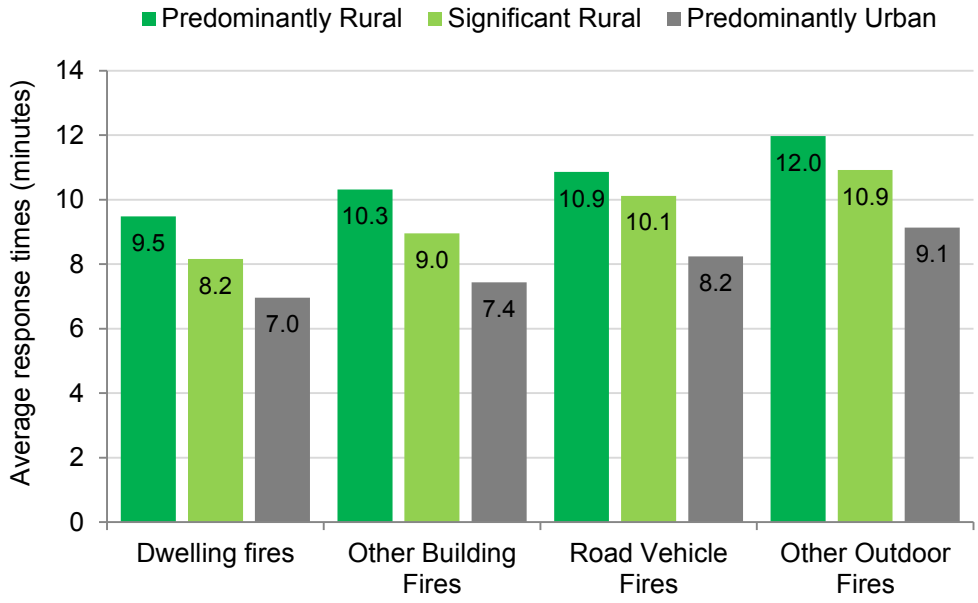
8.9 Compared to Predominantly Urban authorities, response times were 1.7 minutes (or 22%) longer for Significant Rural authorities and 2.8 minutes (36%) longer for Predominantly Rural authorities. This is shown below.

Chart 8.3 – Response Times by DEFRA Classification



8.10 The pattern of longer response times for rural authorities is consistent across all primary fire types, which includes dwelling fires, other building fires, road vehicle fires and other outdoor fires. This is illustrated below.

Chart 8.4 – Response Times by DEFRA Classification and by Primary Fire Type



8.11 Longer response times may indicate that rural authorities are not able to provide a similar level of service compared to their urban counterparts. However, there may also be a wider debate as to whether response times *should* be equalised across all FRAs. For example, it is possible that the resources needed to equalise response times in highly sparse authorities would be prohibitively costly and may potentially be better allocated to preventative measures.