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Scientific Report

Determining accessibility of physical bank branches for residents residing in Isle of Wight using geospatial approaches.

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Abstract

The physical bank branches closure has led to substantial accessibility related challenges to residents who rely on physical banking services in Isle of Wight. With this decline, the importance of assessing the remaining branches is crucial in aiding our understanding of spatial disparities for service provision. This study is aimed to investigate accessibility potential of residents to banks primarily using Euclidean Buffer and Network Analysis approaches. The results reveal significant reduction in households' reachability to bank branches with only 63.1% in 2019 and 84% in 2014. Buffer method overestimated accessibility, while also demonstrating its technical limitations. The decline in bank branches provision affected highly dense household areas. In addition, the study evaluated role of internet banking as viable solution for households, incapable of accessing physical bank branches and analysing existing broadband strength in unserved regions. Despite, the positive change in improvement of broadband penetration across the island, significant households still lack adequate broadband speeds to access internet banking. The investigation concludes that even though broadband connectivity and expansion may address some of the accessibility issues due to bank closures, the disparities of accessibility remain strongly particularly in rural regions of the island.

Introduction

The accessibility of physical banking remains to be vital concern for households and communities, particularly living in rural or isolated areas such as the Isle of Wight (Toussaint et al., 2019). The physical high street bank branches hold great importance in ensuring financial inclusion at present times considering the extent of resident's reliance towards the banking (Toussaint et al., 2019b). The physical bank branches offer wide range of banking services, particularly for residents based in geographically isolated region of the county where broadband connection is not viable due to frequent natural calamities such as storms (Duqi, 2023). The physical bank branches facilitate households that are deprived and lack means to access the banking services (Duqi, 2023). However, a significant number of banks in the UK have ceased operations in recent years, resulting in concerns about decreased physical accessibility and impact towards vulnerable populations. In 2023, the ONS (Office for National Statistics) reported 6% of households lacked broadband access which is akin to one in every 16 households and an approx. 1.6 million households. This distribution was notably higher in rural and isolated region such as the Isle of Wight (ONS, 2024). Likewise, 20% of the adult populations aged 65+ and over were observed to experience digital exclusion due to limited digital literacy and cost (FCA, 2023). The demographic report by (ONS, 2021) indicate that about 26.7% residing in the IOW are aged 65 and over further making it a pertinent concern. As per the UK Finance (2023), about 5162 bank branches have closed their doors in the UK between 2015 and 2023. In addition, the report by Financial Conduct Authority (FCA) indicate that about 47% individuals in the UK rely on cash for most of their transactions indicating the significance of physical banking infrastructure. One study conducted to understand influence of land use on walking

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observed that circular buffers tend to use linear distances to compute coverage resulting in overestimation of accessibility in areas with complex road networks whereas network analysis take real world barriers, connectivity and road networks into account proving more applicable (Oliver et al., 2007). A study by (James et al., 2014) indicate how the varying size of buffer prove to influence the outcomes of accessibility analyses as smaller buffers were capable of capturing nearby environmental influences whereas larger ones diluted the impacts often due to overlaps, thereby highlighting the importance of setting optimal buffer parameters while evaluating accessibility. Similarly, a study conducted about accessibility to public parks at Tando City, Pakistan also demonstrates network analysis to yield accurate and realistic assessment of residents as service area captured by network analysis was one-third of that calculated utilising the buffer method (Tahiri et al., 2023).

This report aims to assess the accessibility potential of physical bank branches for residents living in the Isle of Wight through 3 objectives. The study will first compare the determine the outcomes of Euclidean buffer and network analysis approaches in evaluating the accessibility of physical banks opened in 2019. Secondly, it will analyse the temporal trend in accessibility of residents to banks opened between 2014 and 2019 and deduce meaningful insights. Lastly, identify the households with and without sufficient broadband speed to evaluate whether internet banking could serve as a viable option for residents who are incapable of accessing physical bank branches.

Materials and Methods

2.1 Study site description

For the study, Isle of Wight the largest island and second most populous county situated off the southern coast of England was chosen as the subject area (Downes, 2021). This region consists of populations approx. to 141,000 residents with an average age ranging from 47.5 years, suggesting an old aged demographic as opposed to the national average (Downes, 2021) and (ONS, 2023). The island spans across 380sq.km and harbour to 371 residents per sq.km (Downes, 2021). The island is situated 5 miles away from the mainland county of Hampshire and consists of coastline stretching 92 km in length. The island's economy is mainly driven by tourism, agriculture and maritime industries.

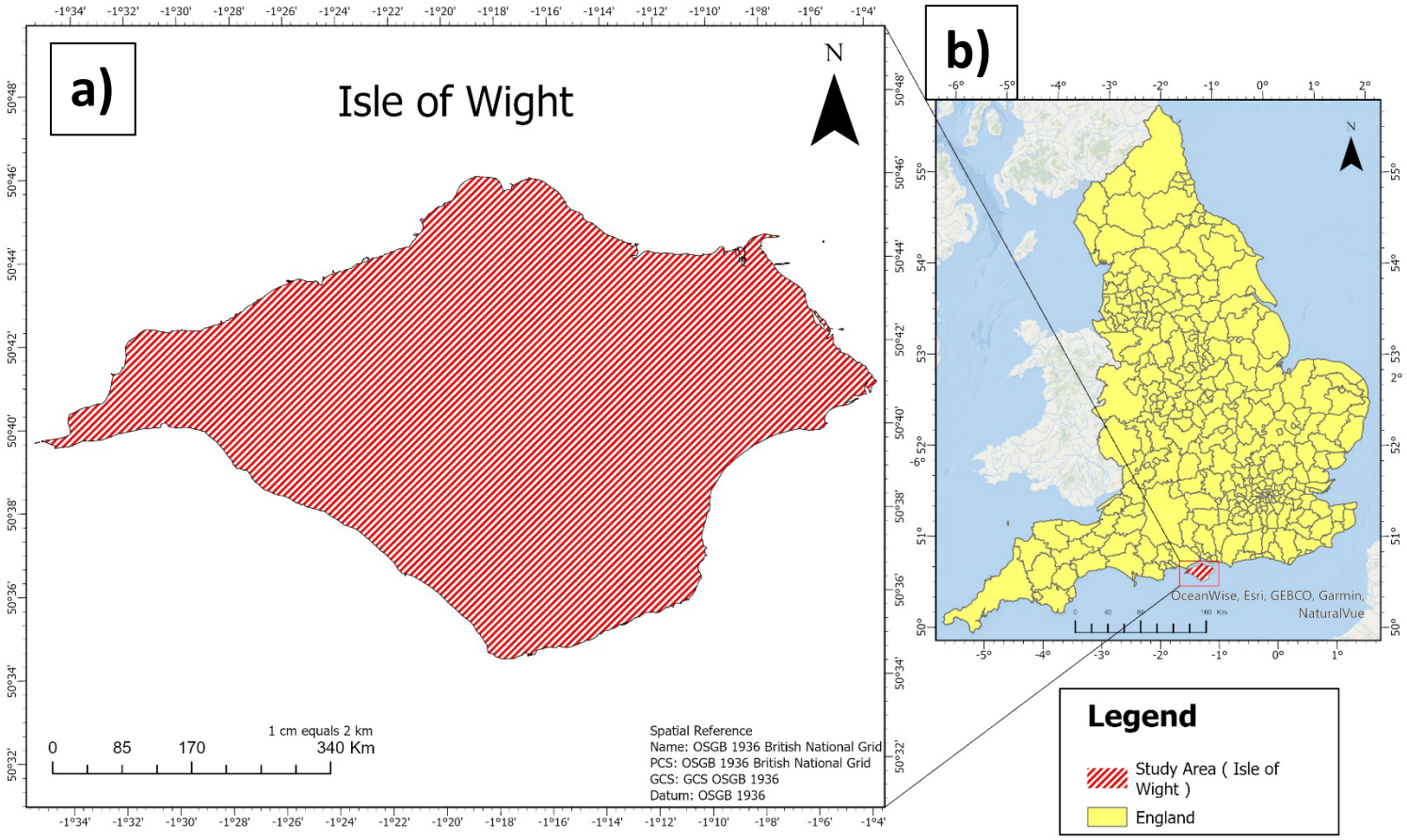

Figure 1: Isle of Wight shown as study area(a) and an inset map of England(b) showing its placement within England.

2.2 Euclidean Buffer Analysis

To determine the accessibility of physical branches for residents, a buffer zone of about 5km radius was created around banks that were opened in 2019. There were total of 4 buffer catchments, out of which 2 buffer catchments were dissolved in order to avoid redundancies as overlapping buffer prevent accurate reflection of combined accessibility coverage presented by the bank branches. Thus, the use of dissolve operation was adopted to merge overlapping areas into one single continuous buffer. This also ensured enumeration of households living within and outside the catchment area to be counted once and not double to avoid the redundancy. The choice of selecting 5000m buffer was due to the size of the study area itself as island is comparatively smaller than mainland and a 5km distance strikes a feasible and practical balance in ensuring effective capture of households living in reasonable proximity to the banks.

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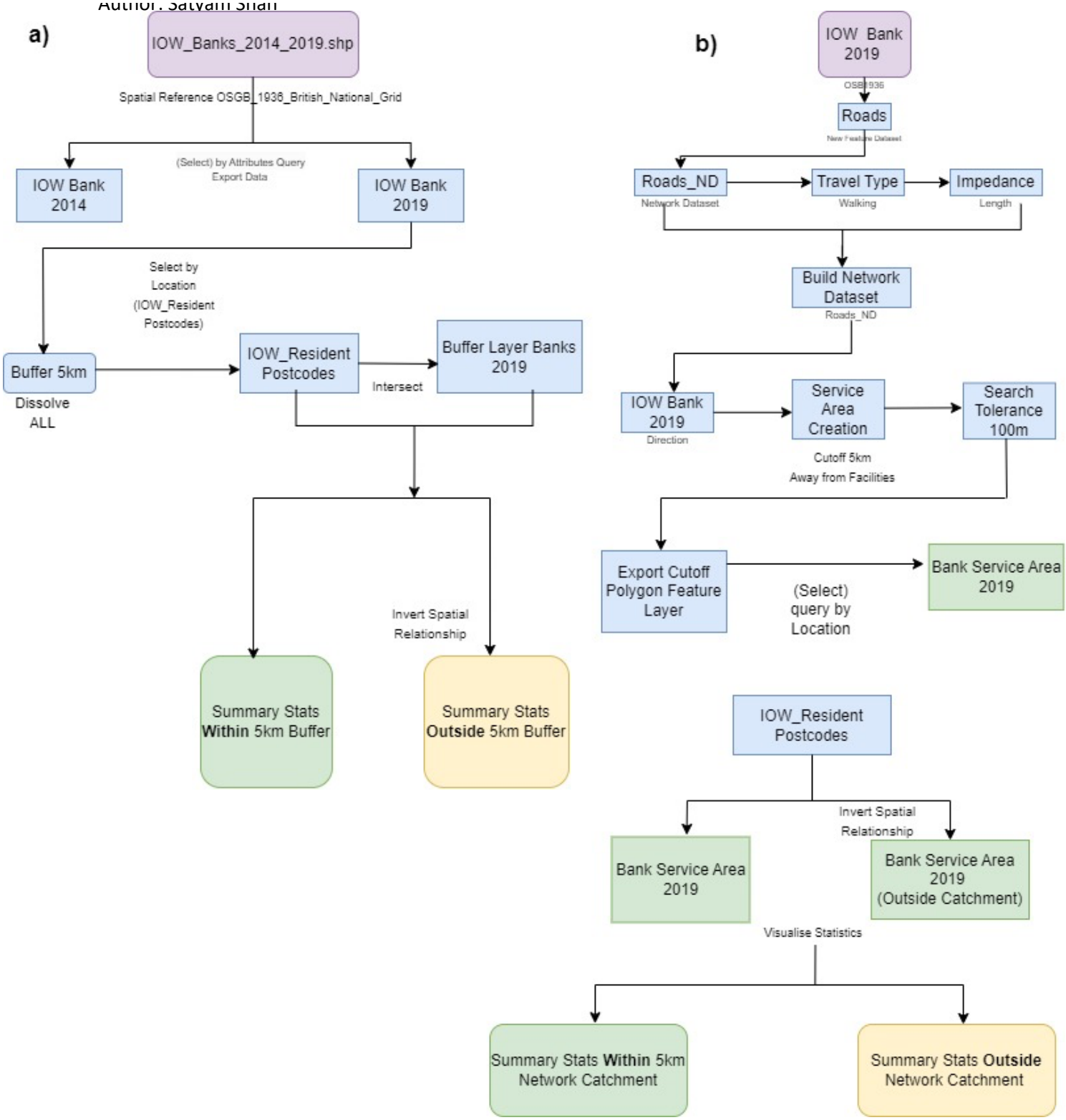

Figure 2: The flowchart shows the geoprocessing steps taken to obtain catchment range insights for the banks opened in 2019 using a) buffer and b) network analysis approaches.

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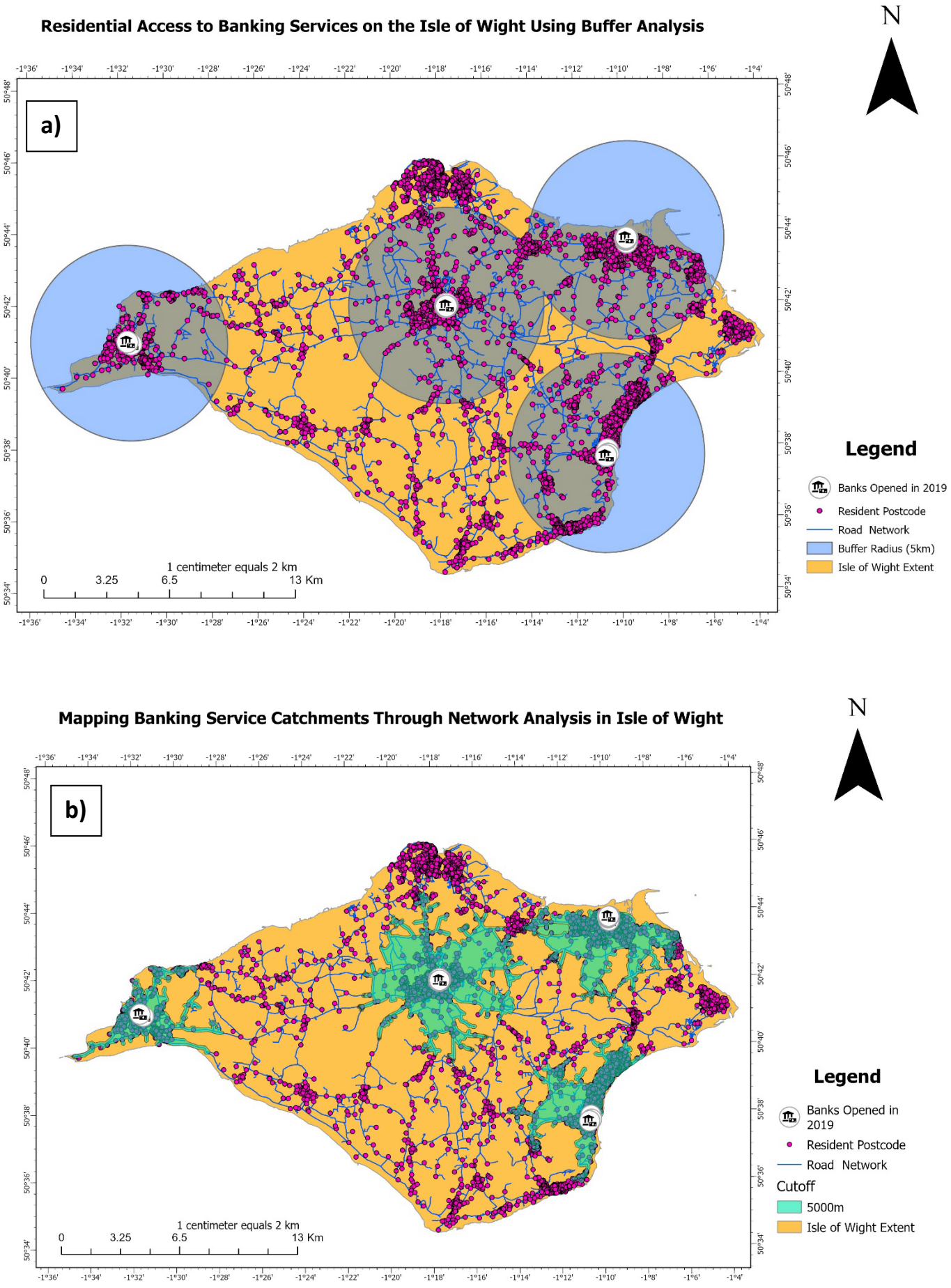

Figure 3: Map of Bank service catchment areas opened in 2019 using a) Buffer Analysis (b) Network analysis approaches

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2.3 Network Analysis

The network analysis was performed on banks that were opened in two distinct periods between 2014 and 2019 as part of fulfilling the study objectives. This analysis was opted in order to take road network and walking distance into account to represent the real-world movements. The os_roads.shp layer was pre-processed in order to ensure connectivity and eliminate any gaps. Likewise, a search tolerance of 100m was applied to account for any minor positional deviation between geocoded postcode points as the county consists of challenging rural and suburban areas leading to some networks being away from the postcode points. The occupied household data was incorporated to catchment area to assess the distribution of number of households that fall within and outside the regions. The service area was created from the network dataset and total households within or outside the catchment area were calculated to spot any accessibility related discrepancies.

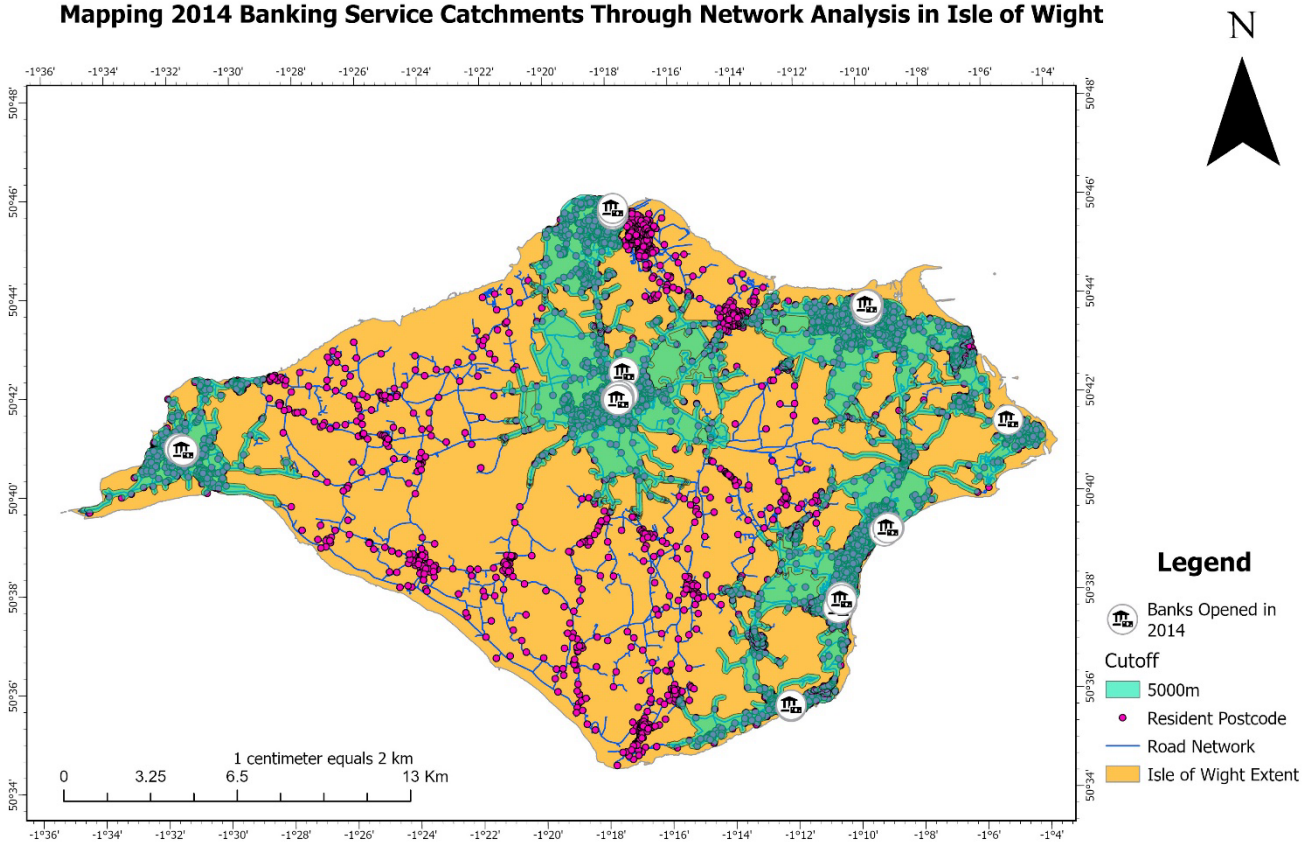


Figure 4: Map of Bank service catchment areas opened in 2014 using network analysis approach.

2.4 Threshold Analysis

The threshold analysis was performed using summary statistical values retrieved from both buffer and network analyses outputs to trace out any pattern or trends within the data. This approach involved categorising and defining continuous data to particular ranges. First, the range of household count within the output was determined from the statistics and thresholds were chosen and estimated midpoints were assumed for each range for dealing with binned data. The (0-10) was allocated as Low Household Count, (11-30) as Moderate Household Count, (31-60) as High Household Count (31-60) and (61+) as Very High Household Count respectively.

2.5 Annual Rates of Change (Slope) Analysis

The slope analysis was carried out in order to investigate the rate of change in broadband access over time progression for areas within and outside the catchment radius of 5km as specified by the buffer range. In this study, slope was defined as the extent of measure of dependent variable (% of households without <10 mbps broadband) changes as the year changes where year is considered as the independent variable. The formula of Slope = Change in y/ Change in x = y_2-y_1/x_2-x_1.

Results

3.1 Comparative accuracy of two geospatial approaches for Bank branches accessibility assessment

3.1.1. Euclidean Buffer Analysis vs Network Analysis

The findings from buffer analysis and network-based approach reveal distinct result in terms of the effectiveness and bank branch accessibility potential of residents living in the Isle of Wight. As per the result from buffer analysis (Table 1), the banks opened in 2019 reveal that about 73% of households fall within the catchment bank service area which is equivalent to 44,608 households out of 61,081 whereas 27% of households fall outside the catchment area which is equivalent to 16,473 households. In contrast, 63% of households fall within the bank service catchment area which is equivalent to 38,539 households meaning nearly 2 out of every 3 households fall within the catchment zone whereas 37% which is 22,542 households fall outside the catchment zone.

The second objective required using one approach to assess the accessibility of banks that was attained by network analysis approach for the banks opened in 2014. The results (Table 1) reveal 81% of households fall within service catchment zone comprising of about 51,289 households whereas 19% equivalent to 9,792 households fall outside the bank service catchment range in order to access physical bank branches.

Category	Metric	Buffer Analysis (2019)	Network Analysis (2019)	Network Analysis (2014)	Change (Net 2019 vs Net 2014)	Difference (Buffer 2019 vs Net 2019)
Within Catchment Area	Total Households	44,608	38,539	51,289	-12,750	+6,069
	Postcode Points (within buffer)	3219	2721	3691	-970	+498
	% Of Total Households (Within Catchment)	73.03%	63.10%	84.00%	-20.90%	+9.93%
	Mean Household Count	13.86	14.16	13.90	+0.26	-0.30
Outside Catchment Area	Total Households	16,473	22,542	9,792	+12,750	-6,069
	Postcode Points (within buffer)	1339	1837	867	+970	-498
	% Of Total Households (Outside Catchment)	26.97%	36.90%	16.00%	+20.90%	-9.93%
	Mean Household Count	12.30	12.27	11.29	+0.98	+0.03

Table 1: Table shows the analysed findings of both gis approaches utilised in assessing accessibility to bank branches across Isle of Wight between the year (2014- 2019).

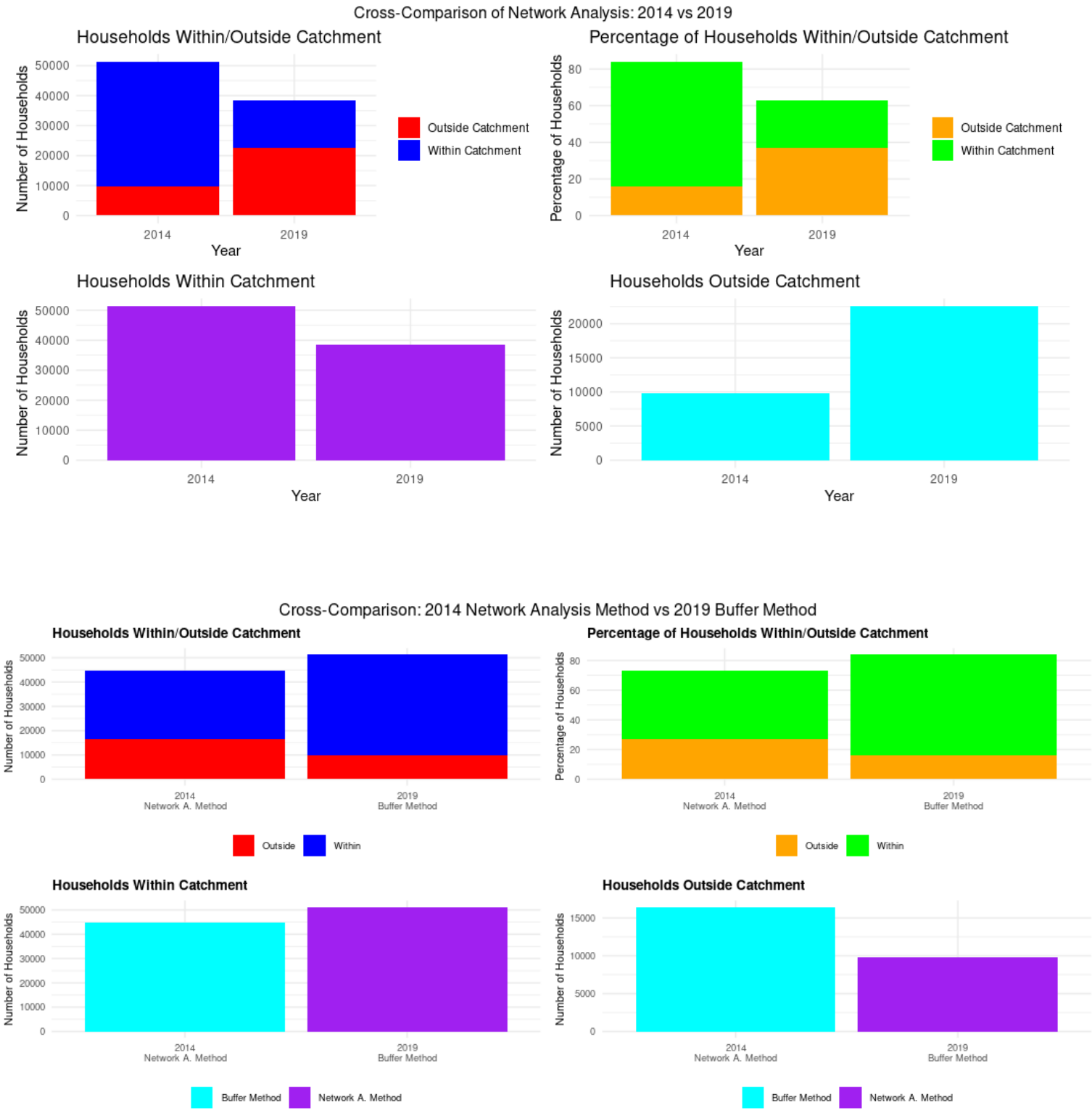


Figure 5: Bar plots showing cross-comparison of catchment and household insights acquired using buffer and network analysis on two different time scales (2014 and 2019).

3.2 Threshold Analysis

In addition, the findings of threshold analysis (Table 2) ;(Table 3) reveal further insights that can aid our understanding to distinguish the effectiveness of both approaches to evaluate spatial distribution of households and accessibility challenges. The threshold results were acquired initially using Number of Areas in threshold = Total Postcode Points* % of areas in threshold and to acquire the total households in threshold Number of areas in threshold * average household count.

a) Within the 5km Catchment Buffer 2019

Threshold (Households)	Number of Areas (Buffer Selection)	Percentage of Total Areas	Total Households	Percentage of Total Households
0–10	1,865	57.9%	11,190	25.1%
11–30	1,002	31.1%	18,036	40.4%
31–60	292	9.1%	12,165	27.3%
61+	60	1.9%	3,217	7.2%
Total	3,219	100%	44,608	100%

b) Outside the 5km Catchment Buffer 2019

Threshold (Households)	Number of Areas (Buffer Selection)	Percentage of Total Areas	Total Households	Percentage of Total Households
0–10	805	60.1%	4,001	24.3%
11–30	394	29.4%	7,015	42.6%
31–60	118	8.8%	4,724	28.7%
61+	22	1.6%	733	4.4%
Total	1,339	100%	16,473	100%

Table 2: Table shows threshold analysis of Isle of Wight (a)within and (b)outside the catchment region using Buffer approach in 2019.

a) Within the 5km Catchment Network Analysis 2019

Threshold (Households)	Number of Postcodes (5Km Range Catchment)	% of Total Areas	Total Households	Percentage of Total Households
0–10	1551	57.0%	9,288	24.1%
11–30	852	31.3%	15,339	39.8%
31–60	261	9.6%	10,868	28.2%
61+	57	2.1%	3,045	7.9%
Total	2721	100%	38,540	100%

b) Outside the 5km Catchment Network Analysis 2019

Threshold (Households)	Number of Postcodes (5Km Range Catchment)	% of Total Areas	Total Households	Percentage of Total Households
0–10	1119	60.9%	5590	24.8%
11–30	544	29.6%	9783	43.4%
31–60	158	8.6%	6289	27.9%
61+	17	0.9%	902	4.0%
Total	1838	100%	22564	100%

Table 3: Table shows threshold analysis of Isle of Wight (a)within and (b)outside the catchment region using Network Analysis approach in 2019

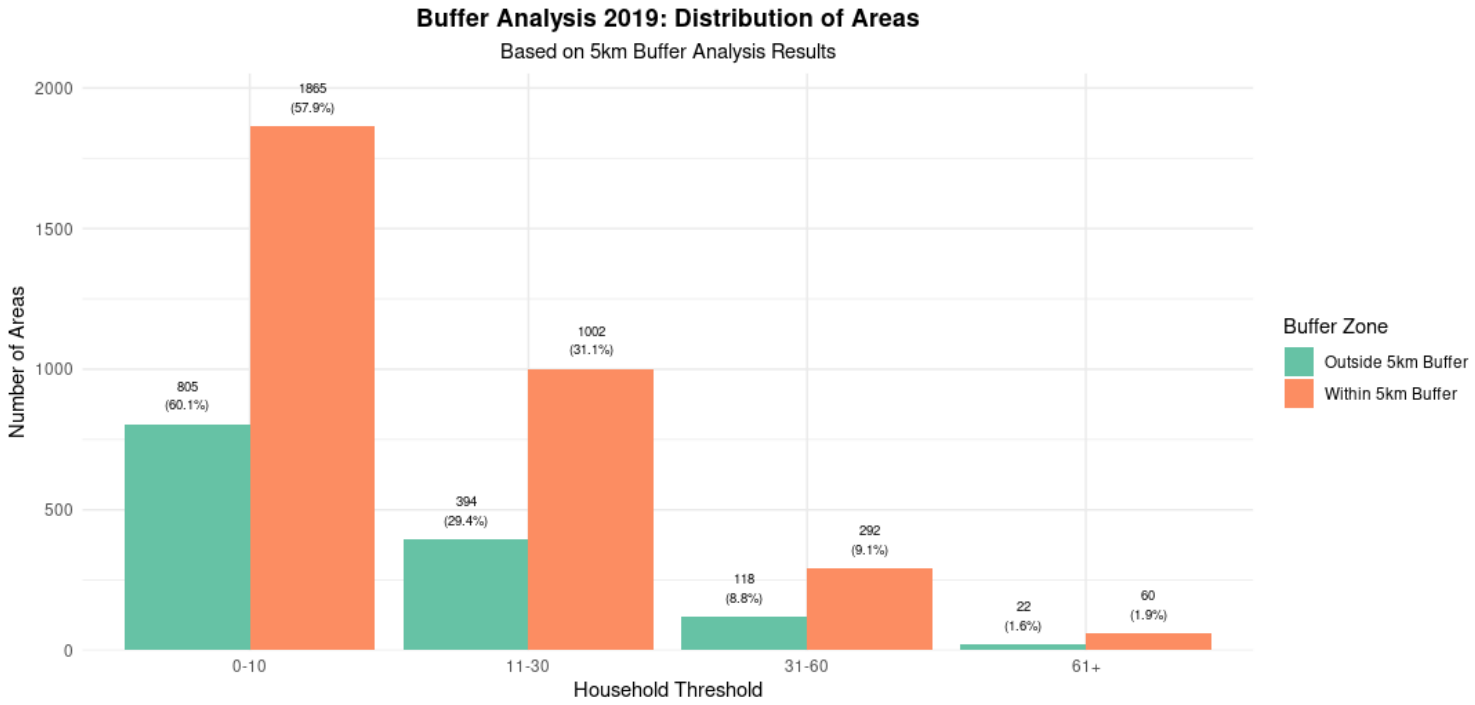
a) Within the 5km Catchment Network Analysis 2014

Threshold (Households)	Number of Postcodes (5Km Range Catchment)	% of Postcodes	Total Households	% of Total Households
0–10	1,846	50.0%	9,230	18.0%
11–30	1,107	30.0%	22,140	43.2%
31–60	554	15.0%	24,930	48.6%
61+	184	5.0%	13,800	26.9%
Total	3,691	100%	51,289	100%

b) Outside the 5km Catchment Network Analysis 2014

Threshold (Households)	Number of Postcodes (5Km Range Catchment)	% of Postcodes	Total Households	% of Total Households
0–10	434	50.0%	2,170	22.2%
11–30	260	30.0%	5,200	53.1%
31–60	130	15.0%	5,850	59.7%
61+	43	5.0%	3225	32.9%
Total	867	100%	9792	100%

Table 4: Table shows threshold analysis of Isle of Wight (a)within and (b)outside the catchment region using Buffer approach in 2014.



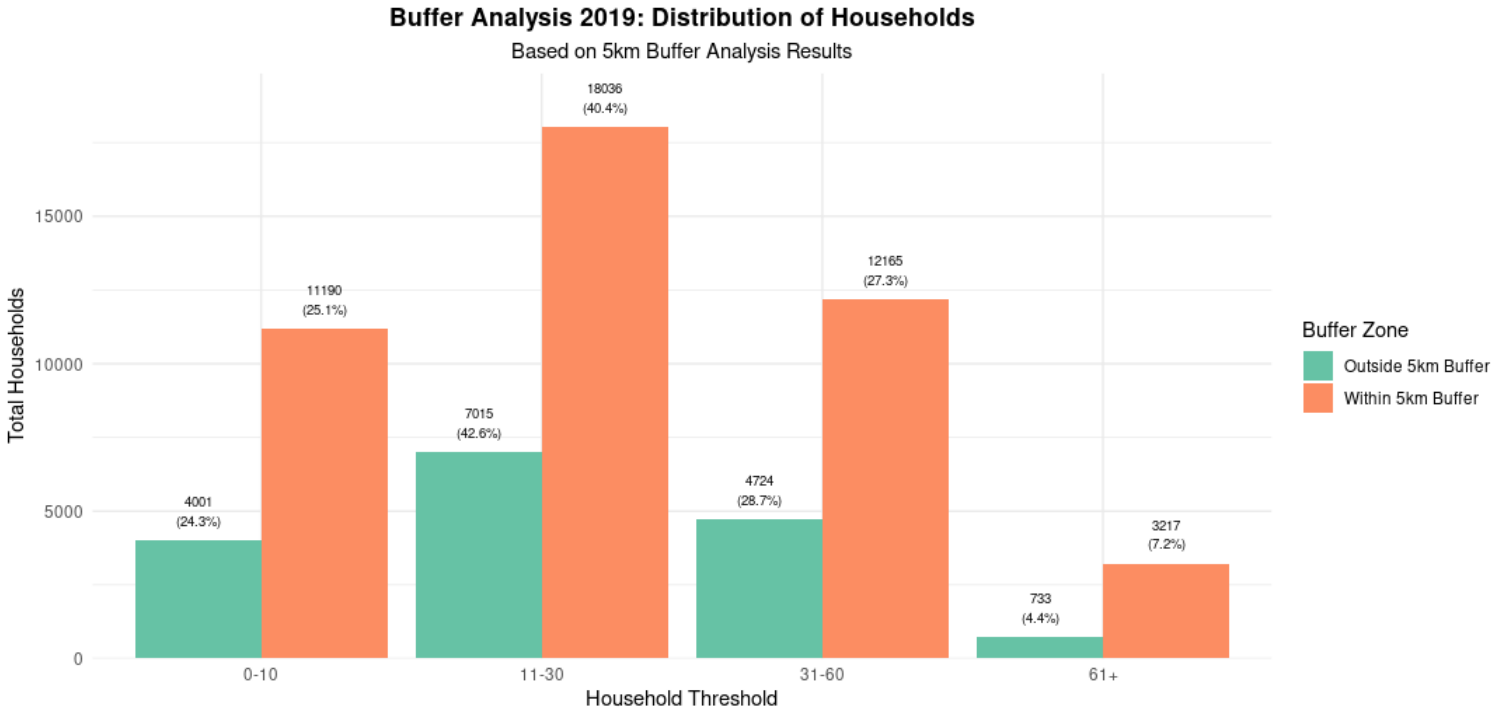
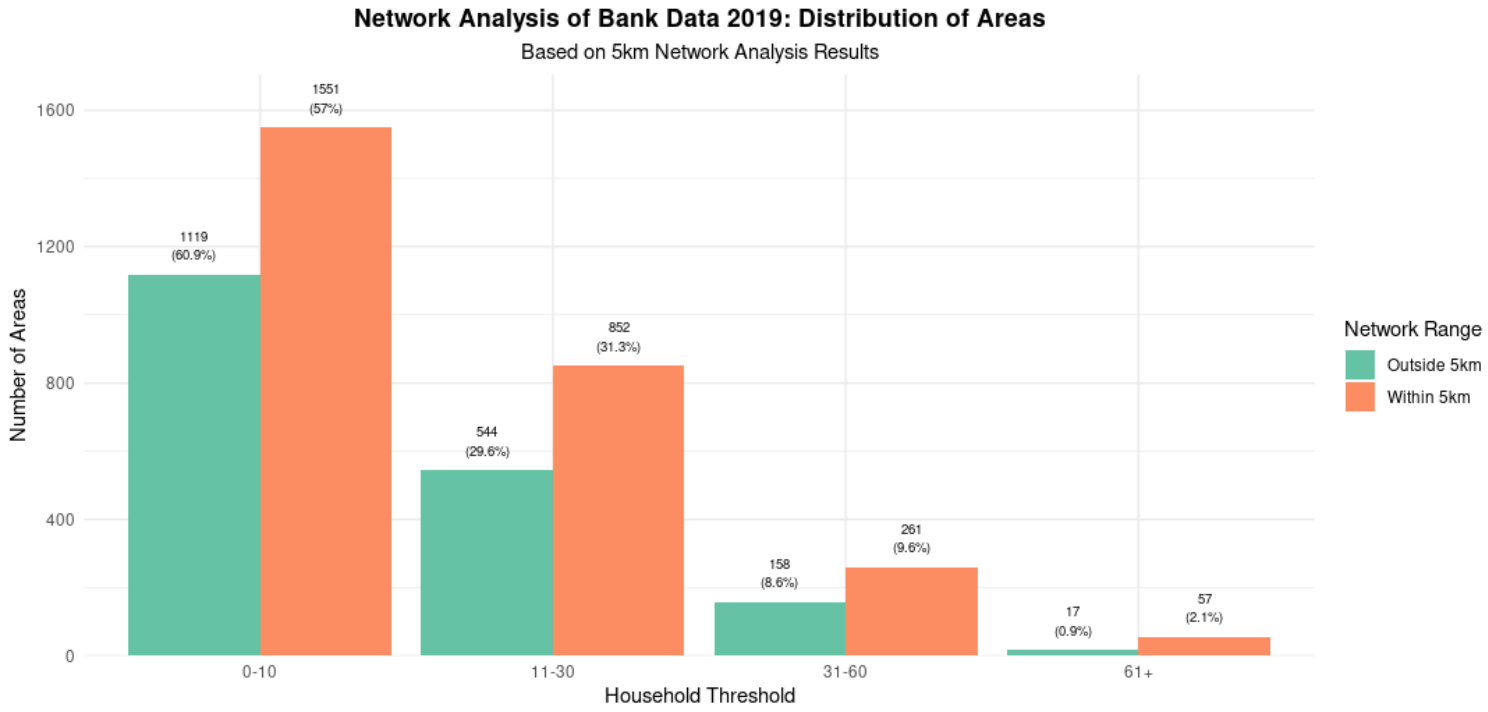


Figure 6: Bar plots depicting insights from buffer analysis of banks opened in 2019 a) number of postcode areas across defined thresholds b) total households' distribution within and outside the catchments.



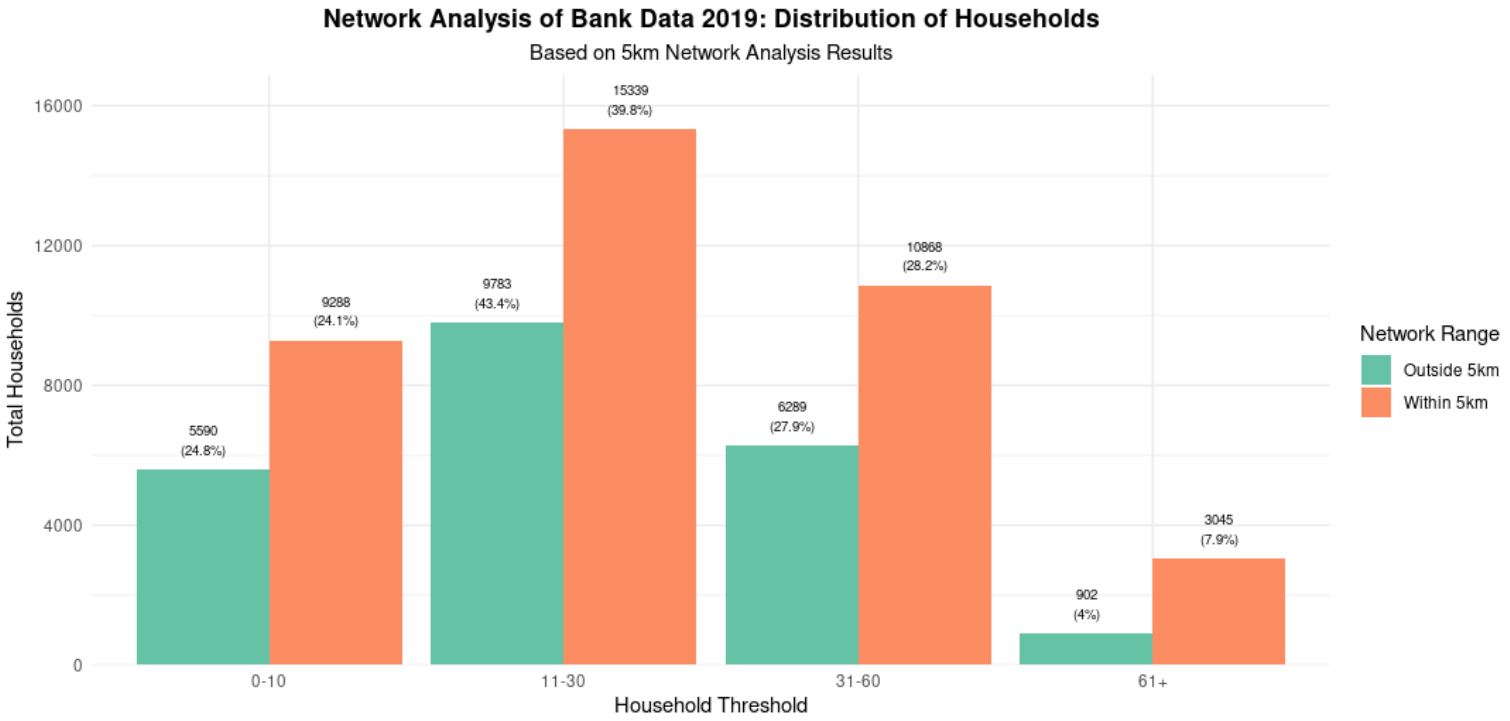
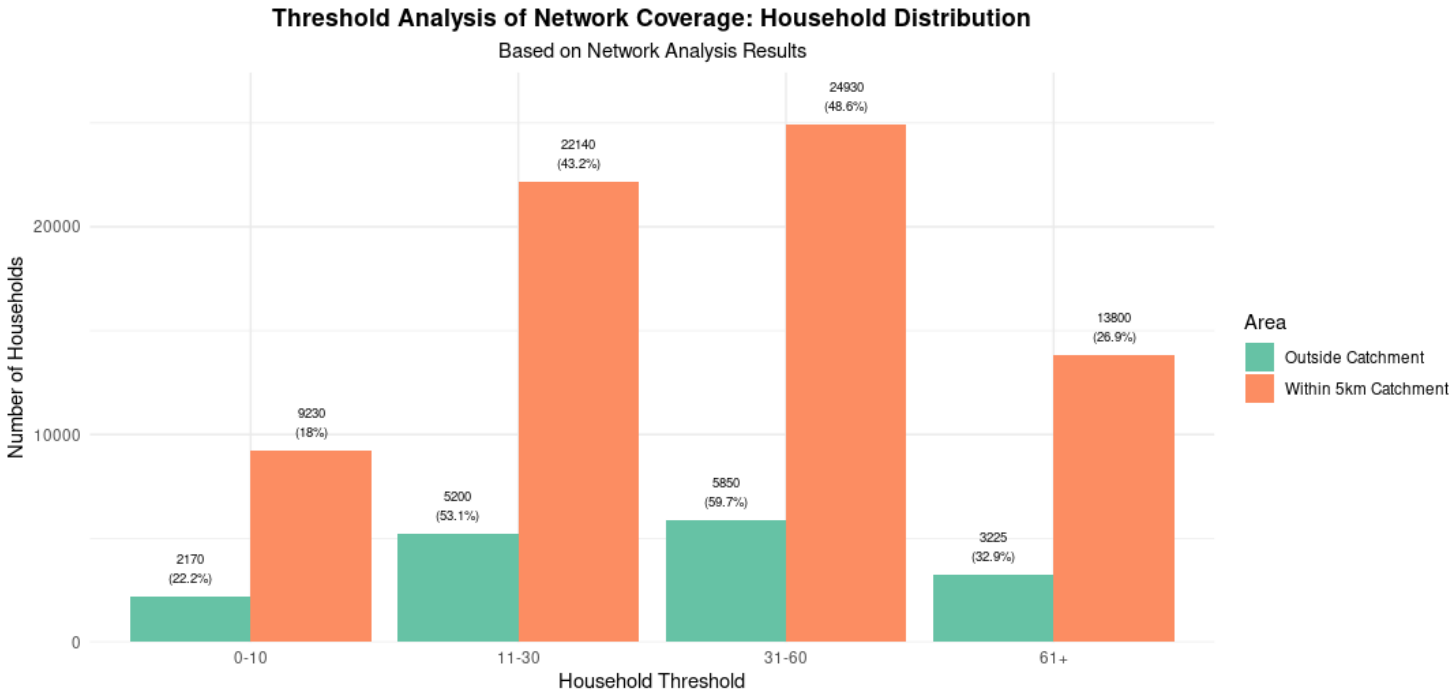


Figure 7: Bar plots depicting insights from network analysis of banks opened in 2019 a) number of postcode areas across defined thresholds b) total households' distribution within and outside the catchments.



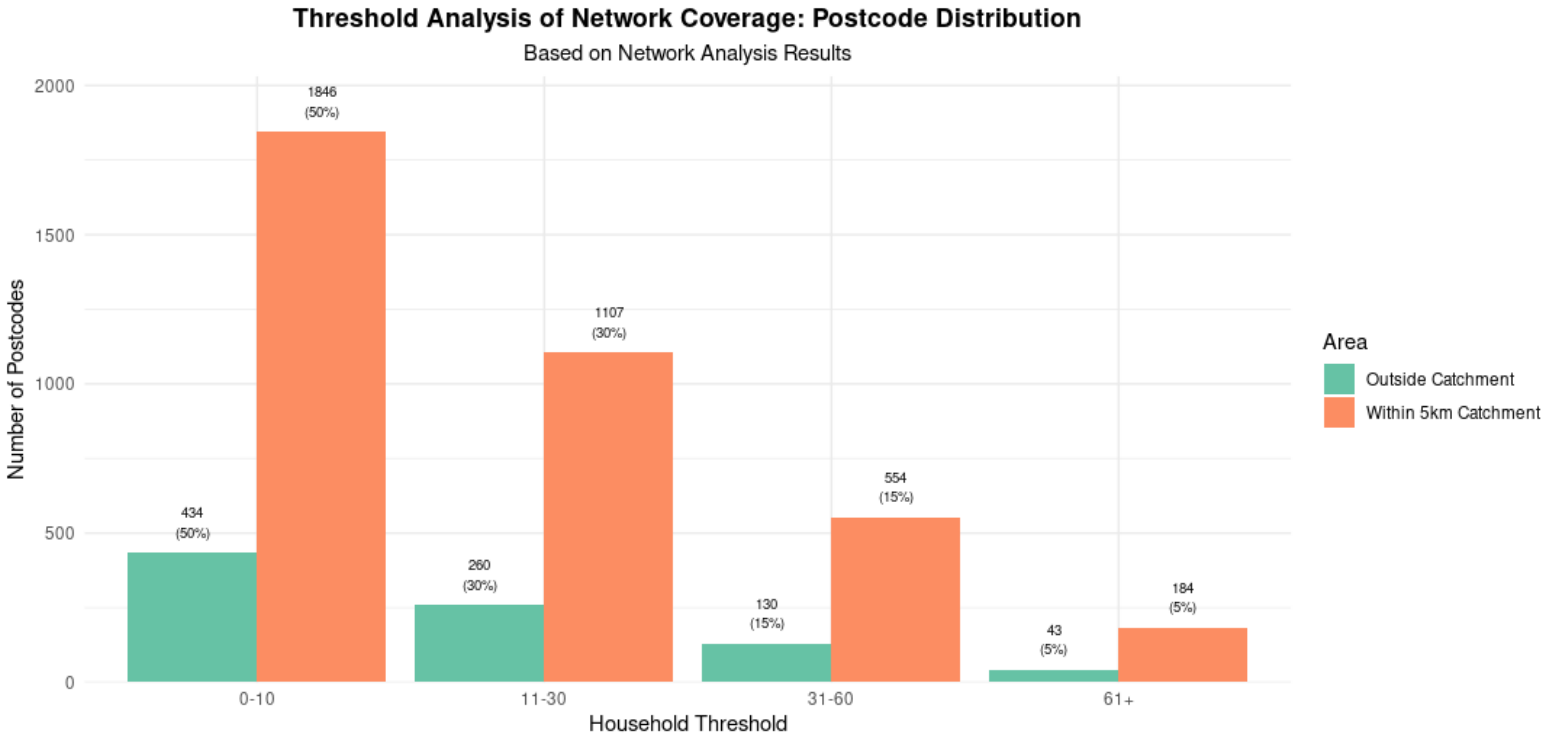


Figure 8: Bar plots depicting insights from Network analysis of banks opened in 2014 a) number of postcode areas across defined thresholds b) total households' distribution within and outside the catchments.

3.3 Percentage of households with and without sufficient broadband access

The findings reveal a notable disparity in broadband access across the households that fall within and outside the allocated 5km catchment range for both banks that were opened in the year of 2014 and 2019. The areas outside the catchment range consists of -32.33% change in percentage of households without broadband access as 91.86% a significantly greater percentage of households lacked sufficient broadband access as opposed to those within the catchment area which was 42.05% in 2014.

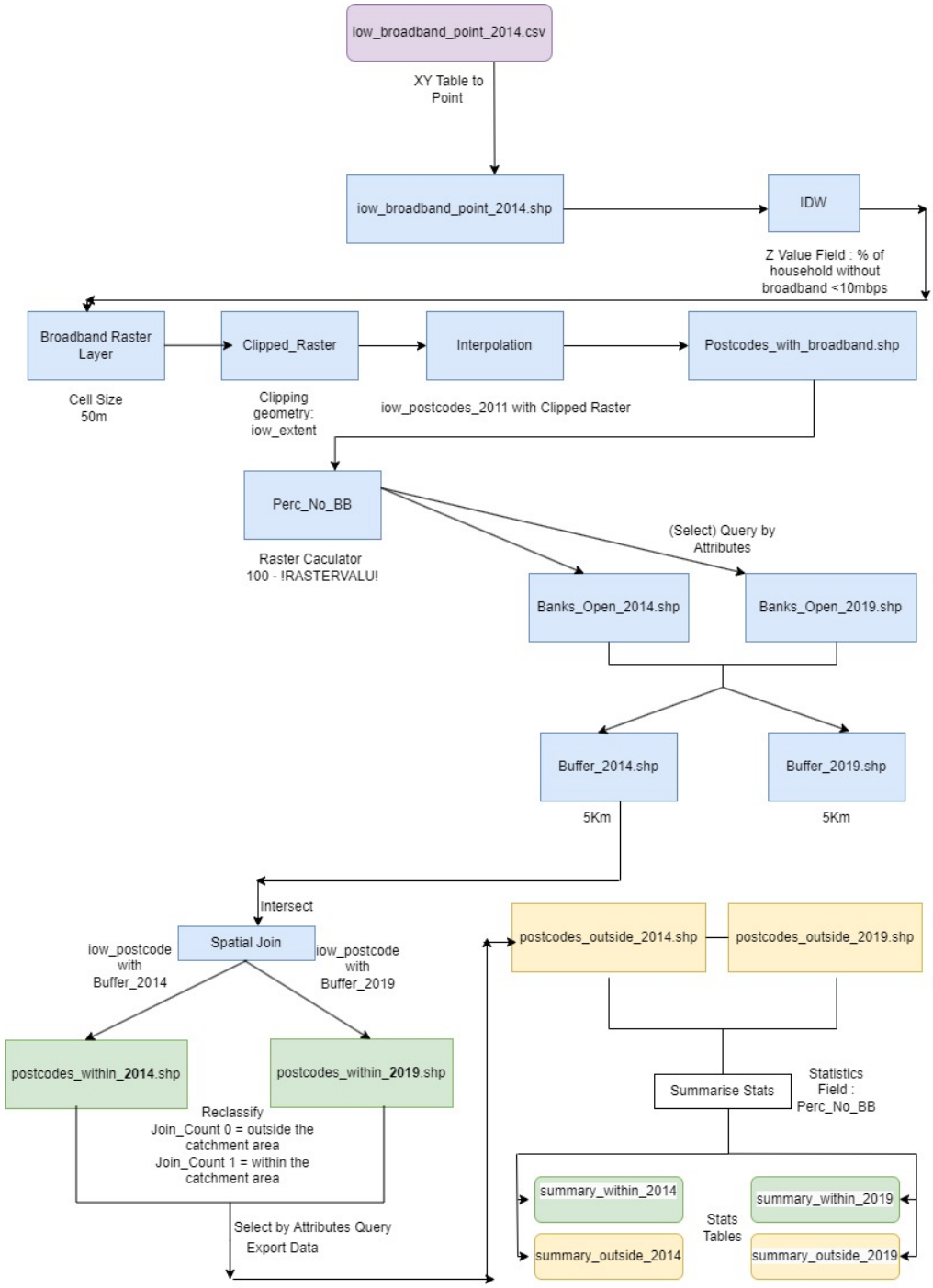


Figure 9: The flowchart depicts the geoprocessing steps carried out in order to assess calculate the viability of broadband across Isle of Wight and analyse percentage of households with and without adequate broadband connectivity.

Category	Year	Total Households	% Without Broadband less than 10Mbps(mean)	Estimated Households Without Broadband less than 10mpbs (Calculated)	Postcode Points (Count)	% Change (2014 – 2019)	% With Broadband Suitable for Internet Banking
Within 5km Catchment Range	2014	173,317	42.05%	72786.74	4122		57.95%
	2019	133,660	41.52%	55479.62	3219	-0.53% *	58.48%
Outside 5km Catchment Range	2014	40,049	91.86%	36,788.48	436		8.14%
	2019	79,706	59.53%	47,460.76	1339	-32.33% *	40.47%

Table 5: Cross comparison of broadband strength in Isle of Wight within and outside the catchment zone between 2014 and 2019.

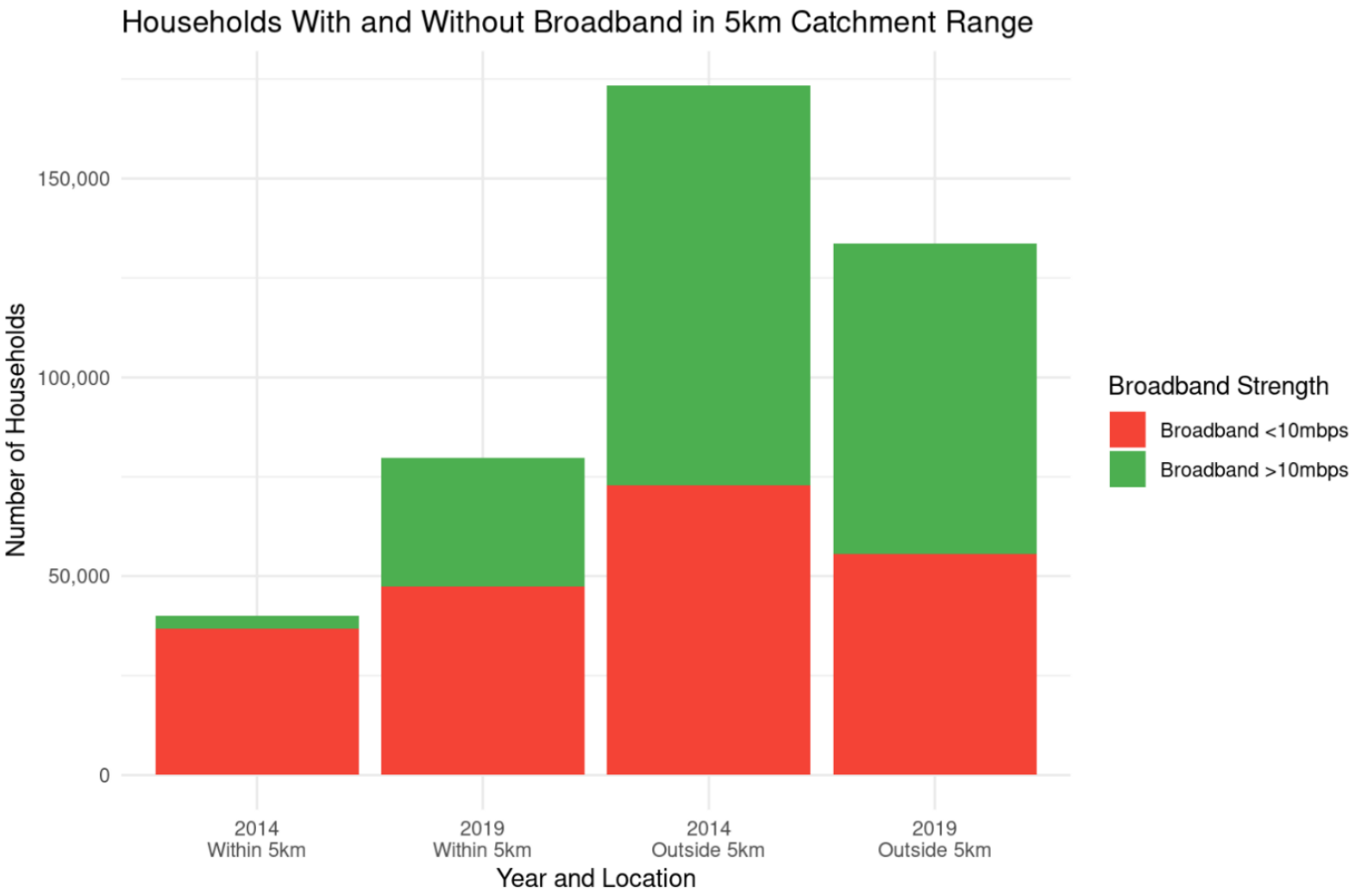


Figure 10: The bar plot depicts the number of households with and without adequate broadband strength across 5km catchment range between 2014 and 2019.

Distribution of Households Without Sufficient Broadband Access for Internet Banking Across the Isle of Wight

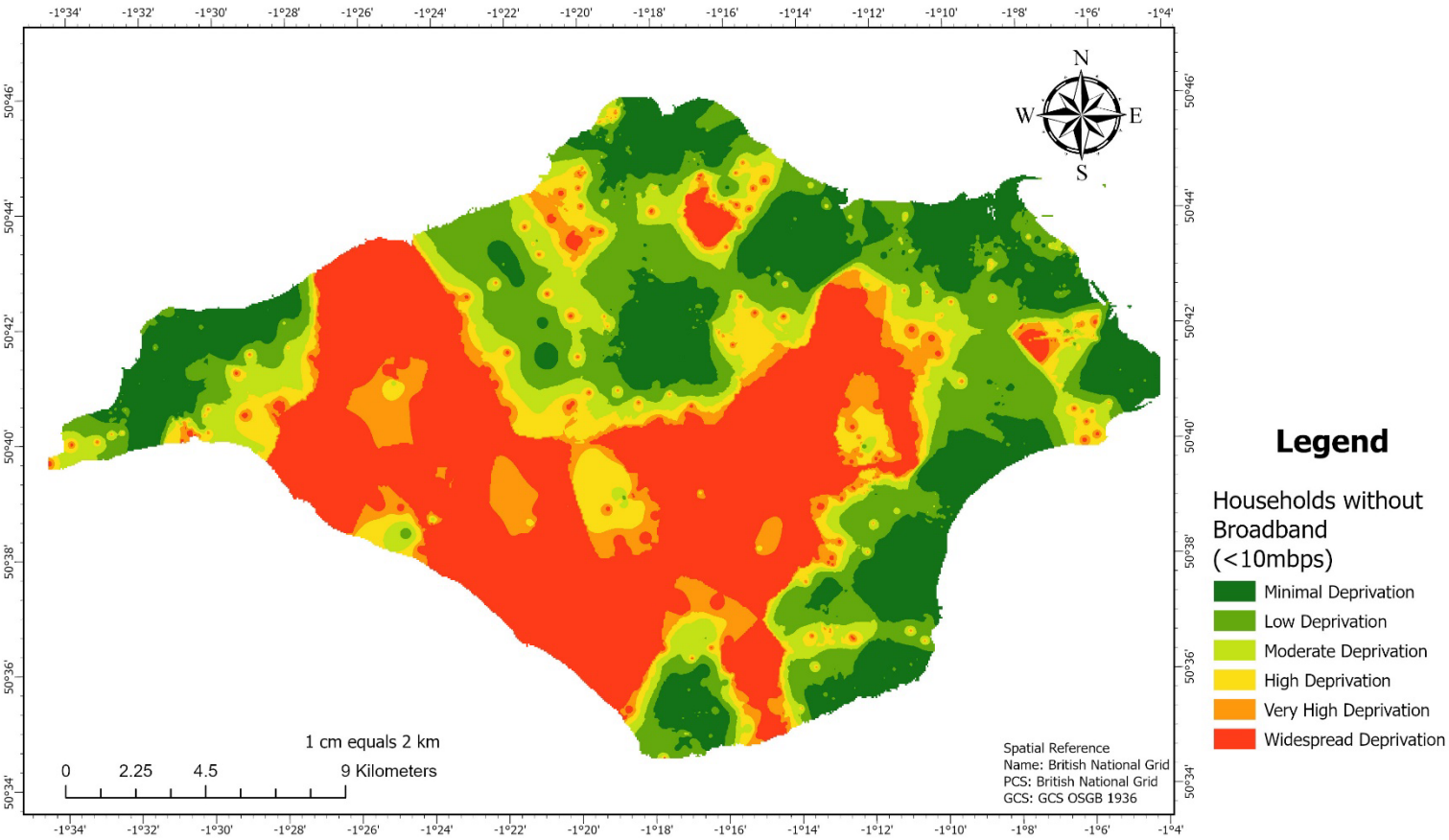


Figure 11: The raster map shows the percentage distribution of households without sufficient broadband access required for Internet banking across the Isle of Wight County, England.

3.3.1 Slope based yearly trends

The slope analysis findings reveal a slight yearly improvement in broadband access within the 5km catchment bank service range. As per the analysis, $(x_1, y_1) = (2014, 42.05)$ and $(x_2, y_2) = (2019, 41.52)$. When applying the Slope formula = (41.52 - 42.05) / (2019 - 2014) = -0.53 / 5 = -0.106. The negative slope is -0.11% per year, whereas when performing calculations for outside the catchment (x_1, y_1) = (2014, 91.86) and (x_2, y_2) = (2019, 59.53) Slope = (59.53 - 91.86) / (2019 - 2014) = -32.33 / 5 = -6.466. The negative slope is -6.47% per year for outside 5km bank service catchment region.

Discussion

4.1 Cross Comparison of Network Analysis (2014- 2019)

The findings suggest 51,289 households fell within the reach of bank service area in 2014 reducing down to 38,539 homes which is 25% reduction. In contrast, the number of households outside the catchment has doubled from 9,792 in 2014 to 22,542 in 2019. This trend hints towards service desertification in particular areas. The drastic increase in the number of households excluded from the catchment suggest the potential role of road networks in influencing accessibility to banks. The road networks previously could have linked underserved urban and rural areas, however rapid urbanization could have downgraded or closed resulting in exclusion of some households within and outside the service area zone. A study done in rural India shows how building efficient road networks increased the threshold of population opting for bank loan signifying the importance of infrastructure (Das et al., 2024). The decline in bank branches could have resulted in reduction of coverage as increasing number of banks are transitioning to digital channels affecting households based in rural regions. One study by (Higgs et al., 2022) also shows how bank branch closures led to less households fall within the direct reach of bank's network which they previously were connected to.

4.2 Cross Comparison of Euclidean Buffer and Network Analysis approaches

Buffer analysis tend to account for linear radial road distances when estimating the coverage resulting in overestimation of areas while network analysis considers realistic complex road networks and length in estimating the coverage which buffer tend to overlook resulting in skewed perception (Brown et al., 2014) and (Li et al., 2022). The buffer analysis retrieved 73% households within the range of bank branches with 13.86 as mean signifying a moderate level of accessibility meaning buffer is useful when prioritising broad coverage zones. The buffer method is efficient when only considering distance correlating with the service accessibility as it is applicable in areas with simple road networks and fewer access restrictions (Upchurch et al., 2004). However, it lacks to account for real world factors such as roads and route points (Upchurch et al., 2004). It assumes households to have uniform and equal access to banking branches when in reality it varies from distances. Unlike buffer, network analysis consists road network, routes, barriers and many more. It offers more nuanced breakdown of accessibility as it identifies postcodes that buffer overlook which is important considering the nature of county such as Isle of wight that consists of strategic network and topography (Curtin, 2013) and (Sevtsuk et al., 2012). The Network analysis is heavily dependent on accurate road network data as rural regions might lack extensive updated networks compared to urbanised regions which can potentially lead to limited accuracy given if roads are missing or imprecisely represented (Curtin, 2013).

4.3 Threshold Category Analysis

The low-density count (0-10) category across all analyses indicate 57-60% postcodes areas fall within this threshold whilst only accounting for 18-25% of total households, signifying a huge proportion of sparsely populated regions across the county. One study done in Atlanta, US also align with the pattern as the average density was 1500 per sq.km which was comparatively lower than other

compact cities like Boston housing households over 5000 per sq.km (Lee et al., 2009). Likewise, 56% of classified low-density land only housed 19% of urban households. Similarly, the 11-30 category make up 30% of postcode areas, despite only 30% it harbours 40-43% of households indicating substantial chunk of population reside in moderately dense region. One study by (Dempsey et al. 2012) suggest despite having 33% of classified moderate density areas, people housed nearly 48% of suburban city's population which more than what the area is expected to sustain.

4.4 Penetration of sufficient Broadband strength to access banking services

The broadband connectivity is vital in bridging gaps that exclude disadvantaged and disabled individuals in accessing necessary services. The findings suggest that a significant 57.95% in 2014 to 58.48% in 2019 of households within the catchment range of bank branches had optimal internet speed suitable for banking. This modest transition is also evident from the slight slope of -0.106% per year indicating a 0.53% improvement of broadband speed within the allotted buffer range. Studies suggest urban and peri-urban areas experience slow paced improvements in their infrastructure due to existing legacy established in the past (Riddlesden and Singleton 2014). This can be attributed to costs and investment required to upgrade the legacy networks at the cost which is 2-3 times higher than rolling out new internet fibre networks across underserved areas resulting in over 50% of broadband connections in developing cities rely on old copper cables (Blank et al., 2017). The relative uniform broadband strength of 58.48% within the catchment also aligns with the concept of digital maturity (Riddlesden and Singleton, 2014b) meaning prioritised area are ensured to hold sufficient strength required to sustain functioning of infrastructures such as internet banking. In contrast, the striking trend of improvement in broadband connection is observed outside the catchment range indicated by -6.47% per year reducing 32.33% households without sufficient broadband strength, indicative of bright infrastructural development. , the relative improvement from 8.14% to 32.33% in 2019 in underserved areas indicate targeted governmental effort in providing coverage that include and involve households based in rural regions to access internet banking as an alternative. Nonetheless, the stark contrast between the rates of improvement annually (-0.106% vs -6.47%) suggests a gradual increment in proportion of households utilising internet connection. The consistent gap in access levels of 40.47% vs 58.48% of households signify a need for continued attention as it aligns with the concept of double disadvantage effect (Blank et al., 2017) where postcodes with limited infrastructure result in limited digital inclusion. Studies done on peri-urban transition affirms the slow progress where cities such as Nairobi and Mumbai comprised of 70%-76% urban households possess broadband access to the internet while only 18%-25% in rural households (Wachira and Arlikatti, 2010).

Conclusion

The study highlights a significant reduction in physical bank branch accessibility located on the Isle of Wight as one fourth which is quarter of the total households within the service catchment range was observed to have declined between 2014-2019. The Network analysis demonstrated higher precision compared to Euclidean Buffer, but marginally depicted similar trends. Nonetheless, a notable change and improvement in broadband connectivity was observed as unserved households outside the catchment range without broadband strength dropped from 91.86% in 2014 to 59.53% in 2019, indicating ease with adopting this alternative to access internet banking. Therefore, studies

conducted on geographical accessibility modelling suggests the expansion of broadband connection can likely mitigate challenges rose by declining physical bank branches. In addition, the hybrid approach of implementing both methods can assist in detecting areas where developments in road network infrastructure or distribution of bank branches could optimise the accessibility potential to banking services particularly in an area such as Isle of Wight (Soltani et al., 2022); (Zhao et al., 2004); (Langford et al., 2022).

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