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School-to-School Mobility Patterns and Retention Rates of Payroll Teachers in Sierra Leone

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Abbreviations and acronyms

ASC	Annual School Census
BUA	Built-up area
EMIS	Educational management information system
EWI	Education Workforce Initiative
GRID3	Geo-Referenced Infrastructure and Demographic Data for Development
HAM	Hamlet
HTC	Higher Teachers' Certificate
JSS	Junior secondary school
SSS	Senior secondary school
FQSE	Free Quality School Education
MBSSE	Ministry of Basic and Senior Secondary Education
PTR	Pupil-to-teacher Ratio
PQTR	Pupil-to-qualified-teacher Ratio
SSA	Small settlement area
TC	Teachers' Certificate
TSC	Teaching Service Commission

Background to the research project

This report is one of several (see Table 1 below) on the research project on the *Impact of GIS-Supported Teacher Allocation in Sierra Leone*.

The education workforce is the most important school-level determinant of student learning (↑Education Commission, 2019). In Sierra Leone, this challenge is particularly acute. Here, the pupil-to-qualified-teacher ratio rises from 44:1 for schools in urban centres to 76:1 for schools in rural areas (↑Mackintosh et al., 2020). Meanwhile, an average of a quarter of the workforce are absent from school on any given day. Even though the TSC has created new protocols for teacher deployment, these reforms have not achieved the intended results.

In this context, the TSC is exploring new options — including an innovative teacher preference matching model — to harness geospatial data to strengthen workforce allocation. EdTech Hub and research partners Fab Inc and the Education Commission are undertaking a Hub-Led research (HLR) study to support the TSC to build evidence on the most feasible approach to GIS-supported teacher allocation in Sierra Leone. Using a mixed-methods approach, we are assessing the impact of this approach on teacher attendance and retention.

The study seeks to understand whether improving teacher allocation using GIS data can increase job uptake, decrease teacher absenteeism, and improve teacher retention. Based on our literature review, we hypothesise that distance from a teacher's home to their school and their ability to choose which school they would like to work in impact teacher motivation, school attendance, and time on task. Efficient teacher allocation could improve each of these outcome estimates.

In February 2022, we explored teachers' school choice preferences and what matters most for teacher deployment in Sierra Leone through qualitative research (the report can be found here, and the blog post here).[1] Between October and December 2022, we also looked at teacher movements and retention rates through a quantitative study. The findings from this quantitative study are presented in this report. Based on these two studies, we want to look at the 'hot spots' and 'cold spots' for teacher retention to investigate what motivates teachers to stay at or leave a

[1] https://edtechhub.org/2022/05/06/using-technology-to-improve-the-equity-of-teacher-allocation-in-sierra-leone-the-challenge-and-a-way-forward/ Retrieved 21 March 2023

school. We will do this through intensive qualitative fieldwork and analysis in at least two districts in Sierra Leone in March 2023.

Table 1 below summarises our study's research activities and outputs.

Table 1. *Timeline of HL3 research activities and outputs*

Date	Phase	Activities
2021	Proposal	EdTech Hub, Fab Inc and Education Commission worked on a technical proposal to present to the Teaching Service Commission (TSC) on supporting teacher allocation using GIS and a preference matching model. 🔖 **Key output:** *Literature review* (↑Vijil et al., forthcoming)
2022	Kick-off	Worked with the TSC to further scope the research and understand what the TSC needed to know to improve teacher allocation. 🔖 **Key output:** *The impact of GIS-supported teacher allocation in Sierra Leone (Inception Report, unpublished) 2022*
February 2022	Qualitative fieldwork	Undertook semi-structured interviews and focus group discussions with teachers and school leaders in two districts to explore teacher preferences. 🔖 **Key outputs:** *Using technology to improve the equity of teacher allocation in Sierra Leone: the challenge and a way forward (Blog post on qualitative work) May 2022* *What Matters Most for Teacher Deployment? A Case Study on Teacher School Choice Preferences in Sierra Leone* (↑McBurnie et al., 2022: Report on qualitative fieldwork)
Oct–Dec 2022	Quantitative analysis	Quantitative analysis was carried out nationally to analyse movement and retention of payroll teachers from 2015 to 2021. 🔖 **Key output:** *School-to-school mobility patterns and retention rates of payroll teachers*

		in Sierra Leone (Report from quantitative analysis — this paper)
March 2023	Qualitative fieldwork	Semi-structured interviews and focus group discussions with teachers and school leaders to explore reasons for high and low retention in areas identified by quantitative analysis.

Our research partners on this study, the Education Commission and Fab Inc, have done extensive work on education data consolidation and the development of options for teaching workforce reforms in Sierra Leone through the Education Workforce Initiative (EWI).

To align with this research project, EdTech Hub has worked with Fab Inc and the TSC, through its country engagement work, to create an open-source, flexible algorithm for the teacher deployment exercise to make the process easier and quicker. Using this integrated approach of research and technical assistance, we continue to engage with the TSC to support their efforts in improving the teacher deployment exercise. As part of this work, we engaged with stakeholders in both the TSC and the Ministry of Basic and Senior Secondary Education (MBSSE). We wanted to understand what has and has not worked well with regard to teacher deployment, and going forward, how stakeholders believe teacher deployment can be improved. You can find this paper here.

1. Introduction

In 2018, Sierra Leone launched the Free Quality School Education Programme (FQSE), with the government committing to providing all children with access to free, quality, basic and secondary education. As a result, enrolment rates have increased significantly at all levels of education (↑Republic of Sierra Leone, 2020). To cope with the ever-increasing number of pupils and to deliver high-quality education, many more teachers need to be brought onto the government payroll and new ones hired.

The commitment to FQSE has been matched by increased resources, with the share spent on education increasing noticeably. As education is a national priority, the government has committed a minimum of 20% of the recurrent state budget to education (↑Government of Sierra Leone, 2019) — yet the reality is that it can only afford to hire and pay salaries for a fraction of the teachers needed.

An additional challenge in Sierra Leone is that, given the severe financial constraints, a large proportion of the teaching workforce (58% in 2021) is not on the payroll (↑MBSSE, 2022). While the government is making piecemeal progress in improving the situation by hiring more teachers each year, the fiscal constraints mean it will take a few years to rectify the shortage. Hence, making the best use of limited resources is fundamental for progress.

Remote areas in Sierra Leone are hard to staff, especially with qualified teachers. The pupil-to-qualified-teacher ratios (PQTRs) are 83:1 in non-private schools located more than 15 km from an urban centre, and 44:1 for schools within 5 km of an urban centre (↑Mackintosh et al., 2020). PTQRs for payroll teachers in remote areas are also high. In primary schools, the pupil-to-payroll-teacher ratio was 66:1 in 2020, rising to over 100:1 for schools further than 10 km away from an urban centre.

More teachers need to be brought onto the government payroll; more teachers in general need to be hired, and there are significant differences in pupil-teacher ratios across the country.

To tackle these problems, the government is bringing more teachers onto the payroll each year. It is selecting schools using a deployment strategy to ensure teachers in the most underserved parts of the country can go on the payroll. As government funds are limited, this strategy includes the creation of district and education level quotas and prioritising teachers in

terms of their qualifications, subject specialism, experience, and gender to be put on the government payroll (↑McBurnie et al., 2022; ↑The World Bank, 2021).

In Sierra Leone, a payroll position is attached to the teacher rather than to schools. To limit gaming of the system (where teachers take a job in a remote area just to get on the payroll and then move), the Teaching Service Commission (TSC) mandates that a teacher can only apply to transfer to another school after they have served in their allocated educational institution / location for more than three years.[2] However, as the teaching service institutional set-up is still relatively young, ensuring the transfer rule is fully implemented is difficult.

Recent studies have shown that being put on the government payroll can incentivise teachers to relocate to remote areas of the country (↑Espinoza-Revollo et al., 2022; ↑McBurnie et al., 2022). There is a concern, however, that being put on the payroll does not necessarily ensure the *retention* of teachers in these areas and that teachers will soon move to locations they consider more favourable. However, there is no data on teacher mobility patterns or school teacher retention rates, meaning that policies tend to be based on anecdotal evidence.

This paper aims to fill this evidence gap by exploring teachers' school-to-school mobility trends using the Annual School Census (ASC) data from 2015 to 2021.[3] We have tracked teachers' movements over time using their identifier numbers. This has allowed us to look at teacher movement patterns and trends from school to school. As the school census also contains information on the characteristics of teachers, we can also see if the patterns show any gender biases and how qualifications affect teachers' movements. By using the geospatial location data of each school, we can also gauge if the teacher workforce is urbanising — that is, if the urban and rural discrepancies in ratios are being driven by teachers moving to urban areas once they are on the payroll.

While studies have looked at teacher retention, this study is the first in a low-income country to use school census data to create a panel dataset to

[2] Transfers for those serving fewer years are considered under three special circumstances: medical grounds, severe family problems, and urgent needs in the teaching service (↑Teaching Service Commission, 2020)

[3] We excluded the 2016 data collection round, as payroll numbers were not collected for teachers that year.

study teachers' movements and school retention rates over time. Understanding which teachers are moving and where they are moving can help tailor policies on teacher deployment to context and needs.

2. Data and methods

In this section, we discuss the data used to carry out the research and the methods used for tracing the teachers on the government payroll. Following this, we look at the three main methods used for the analysis: movement analysis, spatial analysis, and benchmarking findings.

2.1. The data

The study uses six waves of the Annual School Census (ASC) in Sierra Leone from 2015 to 2021.[4] The ASC is completed by School Leaders, covers all schools in the country, and is collected once a year.

The ASC questionnaire has been relatively consistent since 2015 and has repeatedly collected information on various issues including:

1. School infrastructure
2. Location (including GPS coordinates)
3. School ownership
4. How accessible schools are
5. School approval status
6. Enrolment of students
7. Background details of teachers (age, sex, payroll numbers, position, qualifications, subject speciality, and payment source, among others).

This data was collated in one database as part of wider data improvement efforts by the Government of Sierra Leone (↑Fab Inc., 2021).

2.1.1. Tracing payroll teachers

For this study, we traced the movements of teachers on the government payroll over time to create a panel dataset from 2015 to 2021, excluding 2016 due to data quality issues. The process involved three steps:

[4] While this is seven waves of data, the 2016 dataset does not include teacher level data and hence was dropped.

1. For each year and for all teachers whose payment source is the government, we created teacher identifiers based on three characteristics: teacher's name,[5] payroll number, and sex. We used these identifiers to do the first round of tracking teachers over time.[6]

2. To deal with potential inconsistencies created by the phonetic algorithm (i.e., assignment of two different codes to the same teacher), we manually checked instances where a single payroll number had two different teacher codes. Once identified, we merged such instances and added the code to the dataset as a unique code for a teacher.

3. Payroll numbers may have been misreported or incorrectly entered in the ASC. Thus, the third step consisted of identifying cases where teachers were dropped from our database due to inconsistencies in their payroll numbers. To do this, we looked at all cases of teachers who seem to have 'exited' our database before 2021. Because some of these teachers could be seen as exiting the system due to an incorrect payroll number that cannot be tracked, we dealt with this to some extent by searching for them by name in the school they were last observed for all the remaining years until 2021. While allowing us to discover more teachers, this step also introduced a bias to the dataset, as we could not deal in the same way with teachers who have moved to a different school. Therefore, the magnitude of school-to-school movements — which is conflated with attrition figures — may be underestimated in our sample.

Table 2 shows the total number of teachers whose payment source is the government according to the ASC, the number of teachers in our sample, and the percentage it represents of government-paid teachers, year by year.

Overall, we could trace and match a high number of teachers in all years, with the lowest figures being for 2015 and 2021 (due to a lack of additional reference points prior to 2015 and after 2021).

[5] As spellings vary across years and names get shortened or abbreviated, we use the "average name", which is a code assigned to the teacher's name after being recoded using a phonetic algorithm — Soundex — that deals with differences in spelling and punctuation over time.

[6] Annex 1 explains the process of creating recoding names and creating teacher identifiers from 2015 to 2021 in detail.

Table 2. *Number of teachers on the government payroll and sample sizes per year*

	2015	2017	2018	2019	2020	2021
Teachers paid by government	30,964	28,945	30,561	29,773	34,800	34,307
Sample	27,953	28,457	29,652	28,539	31,860	28,355
% of government-paid teachers	90.3	98.3	97.0	95.9	91.6	82.7

2.1.2. School education management information system (EMIS) codes

To map teachers' movements across schools, we assigned each teacher in each year the EMIS code for the school they are working in.

In the dataset, we saw cases of teachers reported as working in a school in some years but not others — for example, one teacher worked in a school in 2017 and 2019 but not in 2018. For such cases, we interpolated the data by comparing consecutive prior and post-school codes (e.g., data for 2017 and 2019) to the year with a missing value (e.g., 2018). We did so under the assumption that while teachers can be temporarily suspended from the payroll, they are not removed from the school teaching roll unless they move or retire. We used the following three rules to do this:

Teacher ID	2017	2018	2019	2020	2021
ABC		1234	1234		1234
DEF	5678		9012	9012	9012
GHI		8356			8356

Teacher ID	2017	2018	2019	2020	2021
ABC		1234	1234	1234	1234
DEF	5678	5678	9012	9012	9012
GHI		8356	8356	8356	8356

1. A missing value (in 2020) between two *identical* consecutive prior and post-school codes (1234). We assume the school is the same and fill in with the same school code.

2. A missing value (in 2018) between two *different* consecutive prior and post-school codes (5678 and 9012), we assume the school was the same as the previous year and fill in with this code (5678).

3. For more than one consecutive missing value between *identical* school codes (8356), we assume the school is the same and fill in with the same school code.

These rules did not work with 342 cases with two or more consecutive missing values and different codes for the start year and 2021. These cases were dropped from our analysis.

2.1.3. Caveats and limitations

There are some caveats to bear in mind when interpreting the results:

- Our dataset is limited to teachers on the government payroll, who accounted for about 40% of the total working force in 2021. Therefore, mobility and retention trends described in this paper cannot be generalised to the whole teaching force in Sierra Leone.
- Our sample may underestimate school-to-school mobility, as we cannot trace the movements of teachers with invalid payroll numbers who have moved to a different school. As these teachers are shown as leaving the payroll, attrition and mobility may be conflated. This means we cannot draw firm conclusions on the exact magnitude of mobility or attrition, so we focused on patterns instead.
- The 2016 ASC did not collect information on key variables for this study, including teachers' payroll numbers, making it impossible to use data for this year in our analysis. This means that 2015 and 2017 are treated as consecutive years.
- While we know where teachers teach, we do not know where they live. Moreover, we do not know where they lived before taking up a teaching post. This means that it is not possible to see if teachers who went off the government payroll had or have moved to take up their teaching post.[7]

2.2. Methodology

2.2.1. Movement analysis

The resulting dataset has a panel structure where each row represents a teacher, and the columns the years. Each element in this matrix is a unique school code where the corresponding teacher was known to be employed for the corresponding year.

[7] However, it is common that existing teaching staff are moved onto payroll positions when a school is identified as needing more payroll teachers.

For a given teacher, *a change in school code between two consecutive years* = 'a school-to-school movement'.[8] As teachers go on the payroll in different years, the number of times they have the option to move differs — the maximum number of times a teacher can move is the number of years since they went on payroll until they leave the system.

We focus on teachers' individual characteristics to see who is moving, the average distance they move, and the characteristics of the places they move from and to.

2.2.2. Spatial analysis

Since 2018, the ASC has collected the precise locations of schools via GPS coordinates, which we used to map schools in each year (going back to 2015). We have a source, destination school, and their coordinates for any teacher movement. This allows us to:

1. Estimate the distance between the schools
2. Observe the direction of teacher movement — where direction is defined as movements between types of settlements.

To do this, we use the Geo-Referenced Infrastructure and Demographic Data for Development (GRID3) classification of settlement areas, based on building density, as a proxy for remoteness / rurality. Specifically, we look at movements between hamlets, small settlements, and built-up areas, defined as follows:

- **Built-up areas (BUAs)** are generally areas of urbanisation with moderately to densely spaced buildings and a visible grid of streets and blocks. BUAs are characterised as polygons that maintain a 100m^2 building density of 13 or more across an area greater than or equal to 0.4 km^2.
- **Small settlements (SSAs)** are areas of permanently inhabited structures and compounds of roughly a few hundred to a few thousand inhabitants. The housing pattern in SSAs is an assemblage of family compounds adjoining other similar habitations. Small settlement areas are characterised as polygons containing 50 or more buildings and not a BUA.

[8] In cases where teachers worked in more than one school in the same year, a movement is defined as cases where none of the school codes match the one(s) in the consecutive year.

- **Hamlets** are a collection of several compounds or sleeping houses in isolation from small settlements or urban areas. Hamlets are characterised as polygons containing between 1 and 49 buildings (↑GRID3, 2021).

In addition, we also measured remoteness using a 'nearest neighbour calculation' — where the distance from each school to the nearest school of its type is calculated (e.g., junior secondary school(JSS) to JSS; primary to primary).

2.2.3. Benchmarking findings

One challenge is that while we can describe the patterns in the data, it is difficult to draw conclusions about what is 'normal' — i.e., what is a common pattern of movement — as most of the literature merely reports overall retention rates (we discuss this in Section 3.1.2).

As such, we do not have a set benchmark to measure against — so we use permutation testing to see if our observed patterns are the same as random chance (by simulating the random movement of teachers across schools) or if any patterns are observed more often. We do this by creating distributions of possible rearrangements of the data through multiple permutations of the original data.[9, 10]

By using random distribution, we test the following null hypothesis:

> *When a teacher chooses to move from their current school, they have no preference for which school to move to other than the fact that the school is willing to let them teach there.*

We assume that the collection of all observed schools that teachers have moved from or to includes a set of all possible choices of schools to move from or to and a set of all possible available positions.

The movements that we observe correspond to one possible one-to-one mapping between these two sets. If our null hypothesis is true, then this mapping is no more likely than any other possible one-to-one mapping.

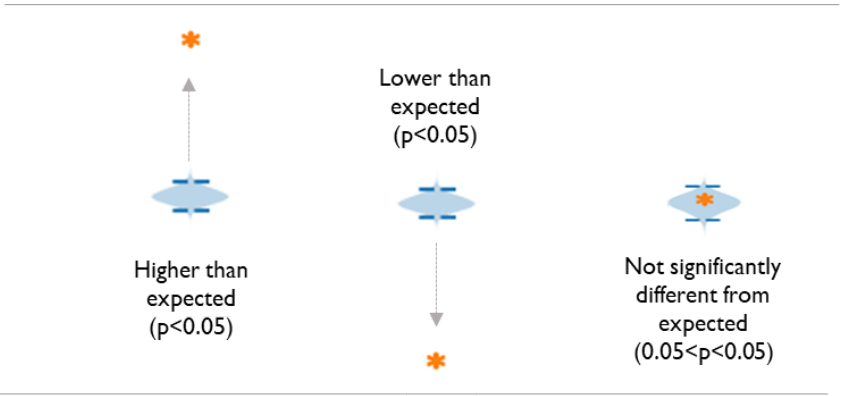
[9] The benefit of permutation testing over other forms of inferential statistics is that we make no assumptions about the form of the null distribution; rather, we estimate it directly through resampling.

[10] For more information on permutation testing see ↑Collingridge, 2013; ↑Fisher, 1935.; ↑Good, 2005; ↑Pitman, 1937.

By permutating the possible mappings and deriving our statistic each time, we produce a distribution of that statistic under the null hypothesis (that there is no preference). By comparing our observed statistic to the distribution under the null hypothesis, we can say how surprising it would be to see a value higher or lower than that if the null hypothesis were true.

Figure 1 provides a visual guide to how the results should be interpreted. The blue curves are the distributions of a statistic derived from permutations. The blue dotted lines correspond to values of the statistic, above or below, which we would expect to observe less than 5% of the time if the null hypothesis were true. The orange star is our observed statistic. When the observed statistic is above the top dotted line, we can conclude that it is significantly higher than expected if the null hypothesis were true ($p<0.05$). When the observed statistic is below the dotted bottom line, we can conclude that it is significantly lower than expected if the null hypothesis were true ($p<0.05$). When the observed data lies between the two dotted lines, we fail to reject the null hypothesis and can conclude that the observed statistic is not significantly different from what we would expect if the null hypothesis were true.

Figure 1. *Permutation testing interpretation*



2.3. Retention analysis

Alongside understanding which teachers moved, we also wanted to understand what was happening at the school level and how many payroll teachers moved each year. To do this, we calculated a school-level retention rate for payroll teachers.

We looked at yearly retention between 2015–2017, 2017–2018, 2018–2019, 2019–2020, 2020–2021 and the overall average. We also looked at six-year

retention rates, which we calculated for schools in the sample from 2015 to 2021 (about 60% of all schools).

We looked at the characteristics of the schools with the highest and lowest retention rates, and using the GPS coordinates, we mapped and identified hotspots (i.e., spatial clusters of schools with high teacher retention rates) using Getis-Ord-Gi* analysis.[11]

[11] For more information, see https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/hot-spot-analysis.htm Retrieved 19 January 2022

3. Results

Section three presents the results of the analysis. Here, we look at the school-to school mobility of teachers on the government payroll and school retention rates, including retention rates by location.

3.1. Teachers' school-to-school mobility

The panel data allows us to see the teachers' payroll and movement history; we can see when teachers went on the government payroll for the first time and if and when they moved to work in a different school. In our study, teachers are deemed as being in one of five categories:

1. Not on the government payroll
2. On the government payroll (the first time a teacher joined the government payroll — except for those who were on the payroll in 2015 as they could have gone on the payroll in previous years)
3. Stayed at the same school
4. Changed school
5. Left the government payroll

Within these parameters, we are interested in teachers' mobility — teachers who changed schools.

3.1.1. School-to-school mobility

We are interested in two aspects of teacher mobility — first, if and when teachers move schools and second, specifically, if they move schools the year after going on the government payroll. Our interest in the second aspect is motivated by the TSC's desire to use payroll status as an incentive to teach in rural schools. In Sierra Leone, the teacher payroll system is 'attached' to the teacher and not the school, so currently, there is little incentive to work in a rural or remote area. We looked at how mobility rates differ by gender and by teachers' qualifications.[12] We separated secondary

[12] The different levels of qualification in order of minimum requirements are: (i) Teacher's Certificate (TC); (ii) Higher Teacher's Certificate in Primary (HTC-Primary); (iii) Higher Teacher's Certificate in Secondary (HTC-Secondary); (iv) Bachelor of Education degree; and (v) post-graduate degree in education (post-graduate diploma, Master Degree or PhD).

schools (which require specialist teachers) from primary and pre-primary and present the differences in Table 3.

Table 3. *Teacher characteristics by movement*

	All			Pre-primary and primary			Junior and Senior Secondary		
	Mean (%)	Diff	N	Mean (%)	Diff	N	Mean (%)	Diff	N
A. Movement at some point									
Teachers' sex									
Male (ref)	22.6		31,269	22.0		18,409	23.4		12,860
Female	25.5	2.9 ***	12,059	26.5	4.5 ***	9,447	22.0	-1.5	2,612
Teachers' qualifications									
No formal qualification (ref)	16.1		3,799	15.9		2,485	16.4		1,314
TC	21.6	5.5 ***	18,122	21.5	5.7 ***	17,297	23.0	6.6 ***	825
HTC-Primary	29.7	13.7 ***	7,323	30.3	14.5 ***	6,581	24.4	7.9 ***	742
HTC-Secondary	24.0	7.9 ***	7,647	28.7	12.9 ***	1,053	23.2	6.8 ***	6,594
Bachelor	24.9	8.8 ***	5,499	28.9	13.0 ***	348	24.6	8.1 ***	5,151
Postgraduate	24.8	8.7 ***	944	29.0	13.2 ***	94	24.3	7.9 ***	850
B. Movement the year after going on payroll									
Teachers' sex									
Male (ref)	7.6		10,752	7.0		5,562	8.3		5,190
Female	9.1	1.5 ***	4,629	9.6	2.6 ***	3,538	7.4	0.9	1,091
Teachers' qualifications									
No formal qualification (ref)	4.8		1,043	5.2		503	4.4		540
TC	7.4	2.6 ***	6,559	7.3	2.2 *	6,241	9.1	4.7 **	318
HTC-Primary	10.4	5.6 ***	2,142	10.5	5.3 ***	1,867	9.5	5.0 **	275
HTC-Secondary	9.0	4.2 ***	3,441	9.2	4.1 **	347	9.0	4.5 ***	3,094
Bachelor	7.6	2.8 ***	1,919	13.6	8.4 ***	103	7.3	2.8 **	1,816
Postgraduate	9.7	5.0 ***	277	7.7	2.5	39	10.1	5.6 ***	238

Note. Reference groups are highlighted.
Payroll teachers in 2015 are excluded from B. Movements the year after being put on payroll
*** p<0.01, ** p<0.05, * p<0.1

Looking at teachers who moved at some time, we found that, overall, nearly a quarter of our sample moved at some point — and this is likely an underestimate due to potential sampling bias.

Table 3 shows that female teachers moved more than male teachers by 2.9 percentage points (p.p.). However, this is driven by larger differences in movement rates in primary schools (4.5 p.p.) compared to secondary schools, where there are no statistically significant differences.

Teachers without qualifications are the least likely to move schools, with all other qualification types having significantly increased movement rates, with differences from 5.5 p.p to 13.7 p.p. This holds in both primary and

secondary schools, with lower magnitudes at the secondary level. With the exception of TC-qualified teachers in primary, movement rates for all other qualified teachers are within a narrow range, suggesting that unqualified teachers did not move as much, perhaps due to difficulties securing jobs without formal qualifications.

As expected, the movement rate the year after going on the payroll is much lower, but 8.1% of teachers still moved schools. Women are more likely than men to move (by 1.5 p.p) — 9.6% of women put on the payroll in primary schools moved school the following year.

While teachers with no formal qualifications are the least likely to move school, teachers with a bachelor's degree are the most likely to move school at pre-primary and primary levels. Teachers with a postgraduate degree are the most likely to move school at the secondary level.

3.1.2. How far do teachers move?

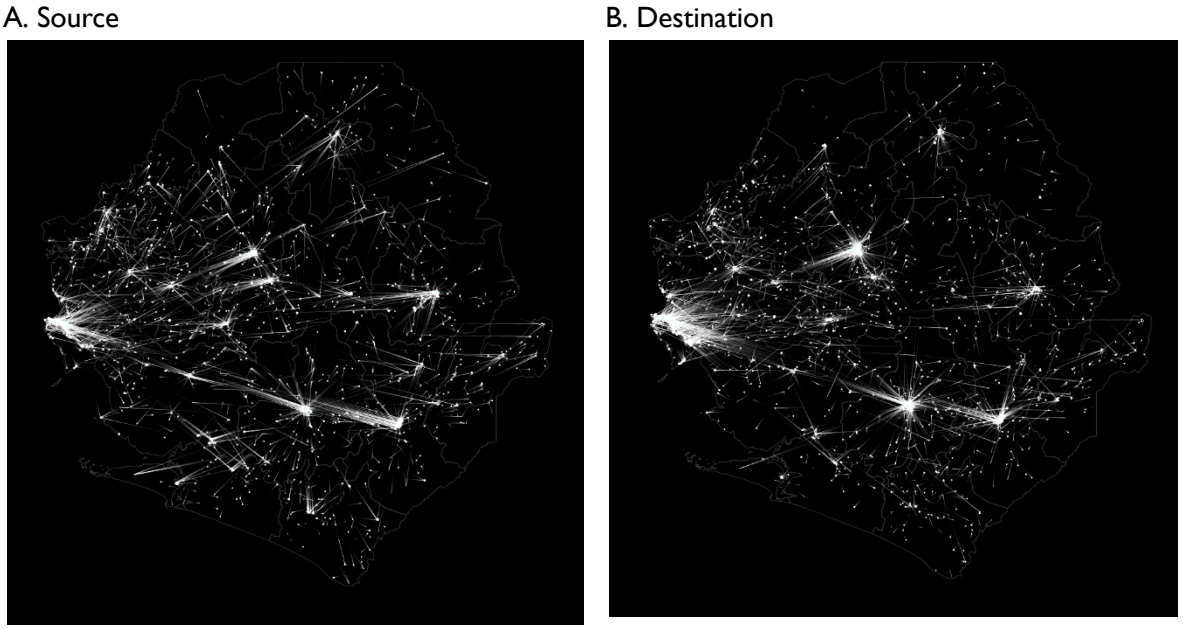
We used school GPS coordinates to analyse the spatial patterns of teacher movement between schools. The objective was to understand how far and where teachers moved to and from. Out of a total of 12,880 moves in our sample, we were able to match GPS coordinates for source and destination schools for 9,841 teachers (76%).[13]

Looking visually at the data (Figure 2: Map 1), we separated the source and destination schools for the maps to allow us to see which areas have high tendencies to be sources (Panel A, i.e., where teachers are moving from) and which are destinations (Panel B, where teachers are moving too).

Each line in Map 1 below connects the latitude / longitude coordinate points of the source and destination schools, with the brighter points showing a high volume in that area. It is clear that cities (especially Freetown, Makeni, Bo, Kenema, and Koidu) are important source and destination locations for teachers.

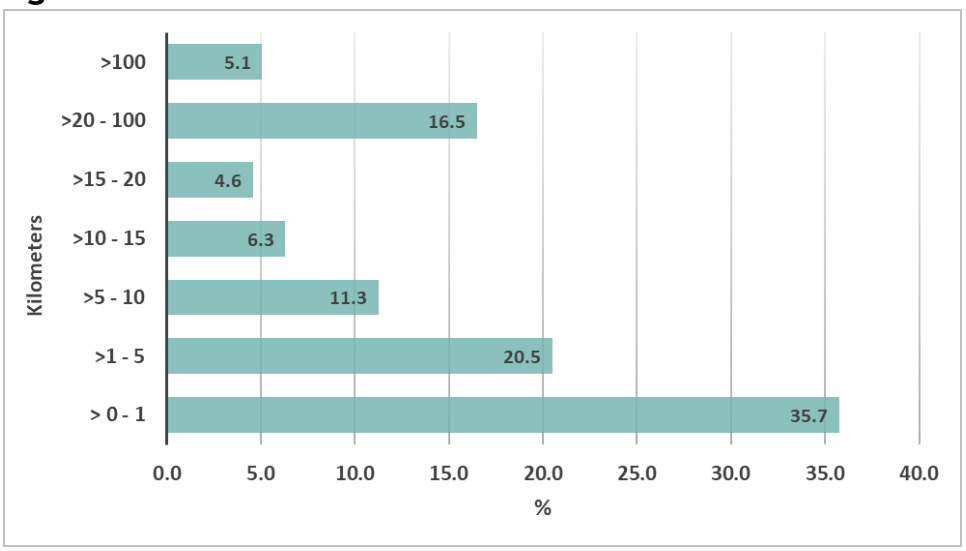
[13] Data collection issues and the fact that GPS coordinates have only been collected since 2018 means that there is a small set of schools with no GPS coordinates data.

Figure 2. *Map 1: Source and destination of school-to-school movements occurring between 2015 and 2021*



On average, we find that teachers moved to a school 18.6 km away — although this is skewed by some teachers moving large distances. Looking at the distribution of moves, we see that over half the teachers (56.2%) moved less than 5 km, suggesting a localised labour market. One in five teachers (21.6%) moved further than 20 km, while one in twenty (5.1%) moved further than 100 km.

Figure 3. *Distance of school-to-school movements*



Looking in more detail at the distance of movement by teachers' characteristics and school level — presented in Table 4 — we do not observe significant differences between male and female teachers for the distance moved when pooling all schools. However, for pre-primary and primary schools, female teachers moved slightly closer than male teachers (by less than half a kilometre), while for secondary-level schools, female teachers moved significantly farther than male teachers, with an average difference of 8.5 km.

In terms of teachers' qualifications, across all schools, teachers with a bachelor's degree moved the furthest — on average, 6.1 km further than teachers with no formal qualification as educators.

The teachers who moved significantly shorter distances are those with a TC qualification; they moved about 3 km less than unqualified teachers. Pre-primary and primary school teachers moved significantly shorter distances than secondary school teachers — 16.6 km and 22.2 km on average, respectively.

Secondary school teachers who moved the longest distances are those with a bachelor's degree (27 km) and teachers with no formal qualifications (26 km). Indeed, the difference between these groups is not statistically significant. Teachers who moved shorter distances are those with an HTC-Primary, TC, or HTC-Secondary; on average, these teachers respectively moved about 12 km, 8 km, and 6 km less than teachers with no formal qualifications as educators.

Table 4. *Distance of movements by teachers' characteristics*

	All			Pre-primary and primary			Junior and Senior Secondary		
	Mean	**Diff**		**Mean**	**Diff**		**Mean**	**Diff**	
Teachers' sex									
Male (ref)	18.6			16.8			21.0		
Female	18.6	0.0		16.3	-0.4	***	29.5	8.5	***
Teachers' qualifications									
No qualification (ref)	19.8			16.2			26.0		
TC	16.6	-3.1	*	16.6	0.4		18.0	-8.0	*
HTC-Primary	17.1	-2.7		17.4	1.2		14.0	-11.9	**
HTC-Secondary	19.0	-0.8		13.8	-2.4		19.9	-6.0	*
Bachelor	25.9	6.1	***	13.0	-3.1		27.0	1.1	
Postgraduate	19.0	-0.8		13.0	-3.2		19.8	-6.1	

Note. *** p<0.01, ** p<0.05, * p<0.1. Reference groups are highlighted

It is possible that the reason that pre-primary and primary teachers moved shorter distances than their counterparts in secondary schools could be because primary schools are more closely clustered than secondary schools. We explored this by looking at the average distance to the nearest neighbouring school of the same educational level. We confirmed that the average distance between primary schools in our sample is significantly smaller than those between JSS and senior secondary school (SSS), though the distance is relatively small.[14]

Also, using the nearest neighbouring school (as an additional proxy for remoteness), we are able to analyse whether teachers from more remote schools are more or less likely to move. As schools are clustered and movements are localised, we use two 'distance bins' (different sets of distances) 'within 5 km' and 'more than 5 km'. The results, presented in Table 5, suggest that teachers are less likely to move from remote schools (i.e., schools whose nearest neighbour is located more than 5 km away). Pre-primary and primary schools drive this trend — teachers from these schools are 17p.p. less likely to move at any point than those from schools with a nearest neighbour located within 5 km.

Table 5. *Likelihood of teacher movement by school distance to the nearest neighbouring school*

Distance to nearest neighbour	All schools			Pre-primary and primary			Junior and senior secondary		
	Mean	Diff	N	Mean	Diff	N	Mean	Diff	N
> 0 - 5 Km	29.8%		12,616	29.4%		10,055	31.3%		2,561
>5 Km	24.6%	-5.2 % **	509	11.7%	-17.7% ***	197	32.7%	1.4 %	312
Total	29.6%		13,125	29.0%		10,252	31.4%		2,873

Note. *** p<0.01, ** p<0.05, * p<0.1.

The analysis suggests that the teacher labour market is localised for primary schools, while secondary school teachers demonstrate a more varied pattern of movement. This supports the findings from the qualitative work on teacher preferences in Sierra Leone (↑McBurnie et al., 2022), which suggests that teachers prefer schools near their homes.

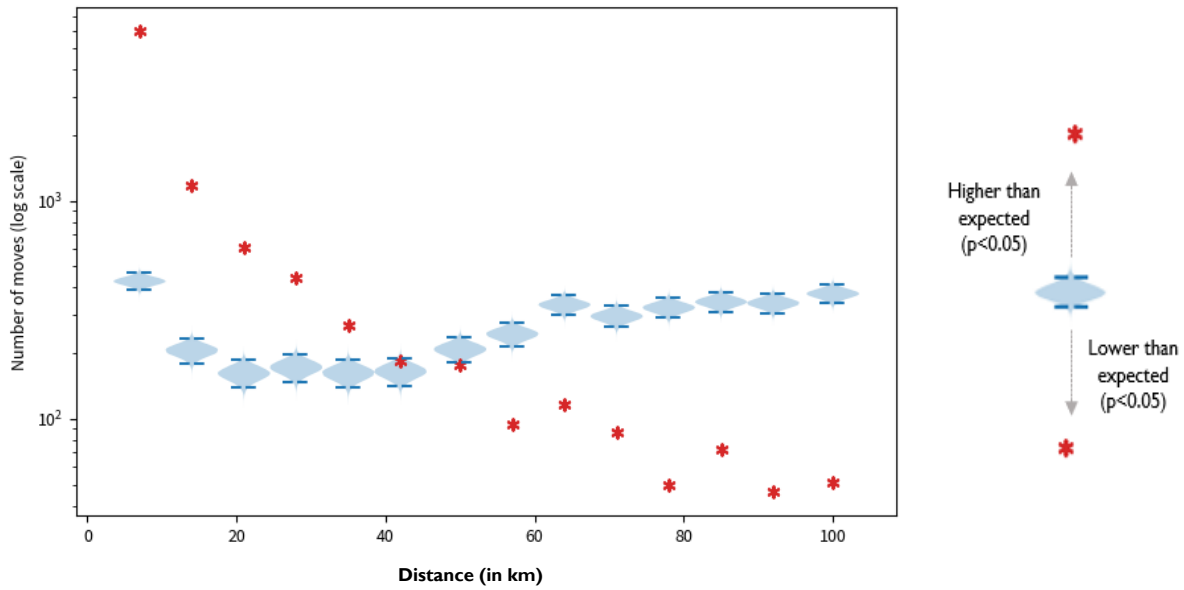
As we don't have data on teachers' homes, we cannot test this hypothesis directly — so we use permutation testing to simulate and test the null hypothesis that *when a teacher chooses to move from their current*

[14] The average distance between the nearest neighbouring pre-primary schools is 0.7 km, between primary schools it is 1.2 km, between JSSs it is 1.7 km, and between SSSs it is 1.9 km. All the differences are significant at the 0.01 level.

school, they have no preference for which school to move to other than the fact that the school is willing to let them teach there.

We tested the null hypothesis for different sets of distances (distance bins), as shown in Figure 4. The blue curves are the null hypothesis distributions of 'no preference'— or, in other words, the number of movements we would expect if teachers had no preference about where they move to. The red stars are the observed number of movements in our sample. Each pair of expected and observed movements is compared for different distance bins.

Figure 4. *Comparison of observed and expected school-to-school teacher movements under the null hypothesis of 'no preference'.*



Note. Red stars are the observed number of movements in the sample. Blue curves are the expected number of movements for the null hypothesis of 'no preference'. The number of movements is shown on a log scale to aid reading of the plot.

The figure shows that for all distance ranges under 42 km, teachers moved more often within that range than expected if the null hypothesis of no preference were true. In fact, for distance ranges greater than 50 km, teachers moved less often than expected. For ranges between 42 km and 50 km, there is no significant difference from the null hypothesis.

These results indicate that teachers have a clear preference for moving shorter distances — supporting our finding that movements, and hence the labour market, are localised.[15]

While distance is one consideration, teachers also prefer the services and amenities within a specific location (see ↑McBurnie et al., 2022). Again, we cannot test this directly for our sample. We further explored patterns of school-to-school movements between settlement types, as defined by the GRID3 programme (↑GRID3 2021) (see Section 3.3.2). This also allows us to see if payroll teachers are becoming more urbanised — i.e., moving to schools in built-up areas.

The GRID3 programme defines three types of settlement areas: built-up areas (BUAs), small settlements (SSA), and hamlets (HAM). School-to-school movements could therefore have nine trajectories. Because we saw that more than half of the movements are within 5 km of each other, we expected that at least 50% of teachers must have moved within the same type of settlement. Table 6 below shows trajectory trends, highlighting the ones that occur from and to the same type of settlement (the diagonal pattern is highlighted by grey shading).

Table 6. *Direction of school-to-school movements, by type of settlement*

		Destination		
		BUA	SSA	HAM
Source	BUA	49.3%	4.3%	1.7%
	SSA	6.9%	20.1%	5.4%
	HAM	2.7%	5.5%	4.1%

Nearly half of the movements occurred from and to schools in built-up areas, and a fifth of them from and to schools in small settlements. The most unlikely direction of movement was teachers moving from a built-up area to a hamlet.[16]

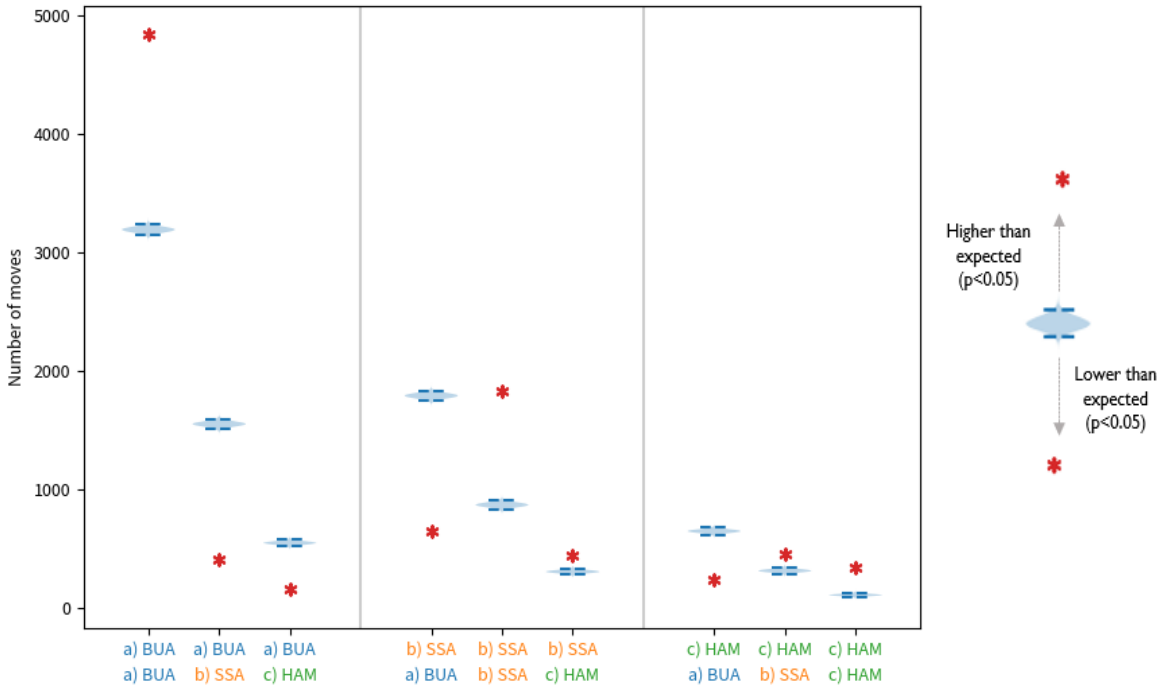
As these figures do not account for the fact that there are more teachers in built-up areas (as there are more schools), we simulated random chances

[15] Similar patterns are observed for primary schools if we analyse results for primary and secondary schools separately. For secondary schools, however, teachers moved more often within smaller distance ranges (under 28 km). The results are presented in Annex 2.

[16] In Annex 3 we map the direction of the movements by type of settlement of source and destination schools.

of movement between the settlement types — where teachers have no preference about the type of area. The results are shown in Figure 5 below, where our observed statistic (indicated by red stars) is the total number of movements between the three settlement types.

Figure 5. *Comparison of observed and expected number of movements between settlement types*



Note. Red stars are the observed number of movements in the sample, and blue curves are the expected number of movements for the null hypothesis of 'no preference' for movements between settlement types. The settlement type at the top is the source, and the one at the bottom is the destination.

We find that teachers moved more within settlement types than predicted by random chance. All three cases of movement between the same type of settlement (BUA–BUA, SSA–SSA, HAM–HAM) are higher than the null, as are movements between hamlets and small settlements. All other pairs of movements between settlement types are lower than expected. This further suggests that teachers in our sample had a preference for moving to schools in the same settlement type.

There is no strong indication here of urbanisation, with our analysis finding that teachers do not have a particular preference for moving to built-up areas when they move from a small settlement or a hamlet.

Were teacher preferences driven by a desire not to move far away or a desire for more or less urbanisation? To answer this question, we looked at movements by school level (pre-primary / primary and secondary).

The results are shown in Annex 4. We find that primary school teachers clearly preferred school-to-school movements between the *same* settlement types (and between SSA–HAM and HAM–SSA).

Secondary school teachers had more mixed preferences. When moving locally (i.e., within 5 km), they preferred moving within the same settlement; but no such patterns hold for moving distances greater than 5 km.

Two points emerge from the above analysis, which are useful for policy. First, women seem more prone to moving than men, and secondary-level teachers appear to move greater distances than primary teachers. Second, the results do not suggest widespread urbanisation. Teachers appear to strongly prefer moving locally and moving more often between the same type of location.

Alongside looking at individual choices, we looked at the impact on schools. We tried to identify areas where mobility rates are leading to low retention of teachers, which may cause issues with the continuity of schooling and pastoral care of children.

3.2. School retention rates

Alongside looking at the patterns of individuals' movements, we also looked at school-level retention rates of payroll teachers to try and understand how the individual choices aggregate at the school level. We sought to identify any schools and / or areas with better or worse retention rates, and whether these trends can be explained by school location.

It is important to note that our data does not reflect the true retention rate of school teachers, as it excludes volunteer and community teachers. Volunteer and community teachers are likely to be more transient, since their salaries are dependent on the availability of funds.

We define 'one-year retention rates' as the proportion of teachers who remain at a given school for two consecutive years. To establish who these teachers were, we compared payroll numbers to make sure the same teachers were observed in the two consecutive years. We also looked at the impact this had on long-term staffing in schools — and calculated six-year retention rates for the sub-sample of schools for which we have data for all

six years. We calculated this as the proportion of teachers who remained at a given school for all the years between 2015 and 2021.

Figure 6 shows year-to-year school retention rates for our sample of payroll teachers. Each line represents one school, and changes in school retention rates are shown by changes in colour. Greens point to higher retention rates, and reds point to low retention rates. A retention rate of 0.5 (yellow) between 2015 and 2017 should be read as 'half (50%) of the payroll teachers in 2015 in a given school were still at that same school in 2017'.

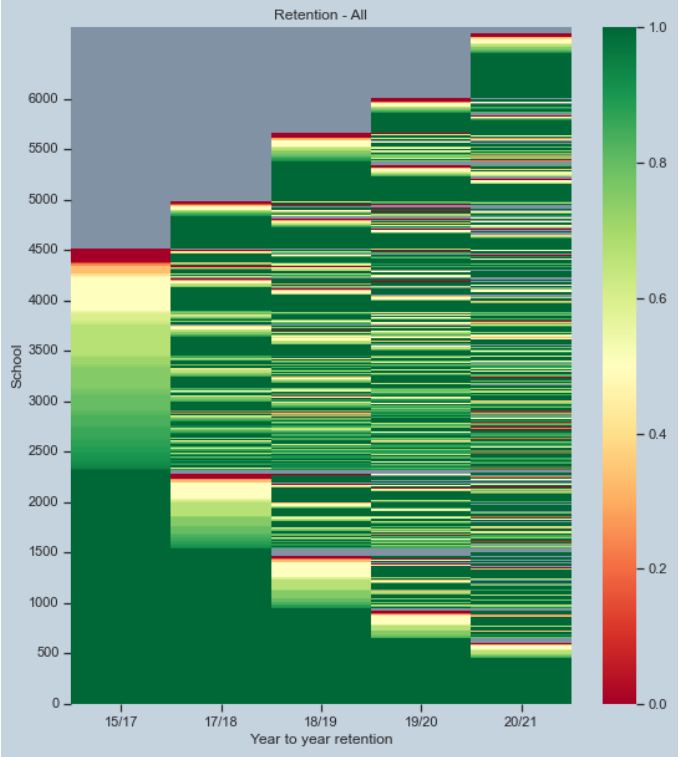
Figure 6 shows that, overall, the year-to-year retention rates of payroll teachers is 84%, which, if compounded over time, would suggest a fairly high rate of teacher turnover (see below). This means that if a school had 20 teachers on the payroll, three would leave each year.

The highest retention rate can be seen for 2017–2018, at 86% and 85% for 2020–2021, and the lowest for 2018–2019 and 2019–2020 (both at 82%). This narrow range suggests that the retention of payroll teachers is not changing noticeably over time.

Formal reporting of the retention rates in Africa is rare — but in Rwanda, it is estimated that every year 20% of teachers leave their jobs (an 80% retention rate). Of this 20%, 11% exit the public-sector teaching workforce (↕Zeitlin, 2021).[17] Attrition figures for the USA and England are often outdated but are estimated at 11–13% and 7–8%, respectively, despite three decades of efforts to reduce attrition and enhance recruitment (↕Fessehatsion & Peng, 2020). This places our findings slightly higher than the rates in the USA and the UK but lower than in Rwanda.

[17] Available at: https://doi.org/10.1093/jae/ejaa013

Figure 6. *School retention rates, year to year, 2015–2021*



3.2.1. School retention rates by type of school

We observed substantial differences in retention rates by school level, as shown in Table 7.

Primary schools have the highest retention — with an average year-to-year retention rate of 85% — while senior secondary schools have the lowest — with a retention rate of 74% — which means that one teacher in every four moves each year.

Table 7. *Year-to-year and six-year-term retention rates by educational level*

	Year-to-year retention						Six-year retention
	2015–2017	2017–2018	2018–2019	2019–2020	2020–2021	Average	
Pre-primary	0.82	0.87	0.85	0.81	0.86	0.84	0.50
Primary	0.84	0.87	0.83	0.83	0.87	0.85	0.49
Junior Secondary	0.81	0.80	0.80	0.78	0.79	0.79	0.42
Senior Secondary	0.73	0.77	0.73	0.75	0.74	0.74	0.36
Total	0.83	0.86	0.82	0.82	0.85	0.84	0.47

If we look at the sample of schools in the data in all years, then we find the six-year retention figures to be very low. In secondary schools, nearly

two-thirds of teachers would change over this period, while in primary schools, half the teachers would change. This has important implications for long-term planning — it means that for a child starting school, half the teachers would have moved on by the time the child finishes schooling. Given the importance of teachers knowing children, this can undermine the creation of strong bonds and pastoral care.

3.3. Retention rates by school location

As the teacher labour market appears localised, to help better target support and policy, we wanted to know if any locations have particularly high or low rates of staff retention in their schools.

To do this, we first looked broadly at remote schools to see if they had lower retention rates. We define 'remoteness' on the basis of three criteria:

1. Distance from the schools to the district headquarters
2. Distance from the schools' nearest neighbours
3. The type of settlement for the schools' locations (as defined by ↑GRID3 (2021).

We then considered the context of Sierra Leone's administrative areas — districts and chiefdoms. Finally, we used a hotspot analysis to look for clusters across the country.

3.3.1. School retention rates in remote areas

In this section, we consider how retention rates vary by school location. In particular, we were interested in understanding if remote schools struggle to retain payroll teachers. For the distance to the district's headquarter (HQ) town, the average year-to-year and six-year retention rates are given in Table 8 alongside figures for tests of significance.

Across all schools, the further a school is from the district's HQ town, the higher its year-to-year retention rates. However, the point estimate differences are small (with the highest difference of 4 p.p. between schools in town and those between 21 and 50 km away from the district's HQ). For six-year retention rates, there are no significant differences by distance to the district's HQ. We observed a similar pattern for one-year retention rates for pre-primary and primary schools. At the secondary level, however, a significant difference exists with schools located more than 50 km away from the HQ. However, these schools have a lower one-year retention rate

— approximately 4 p.p. lower than schools located in town. For the six-year retention rate, we observed a significant difference for schools located less than 5 km away in relation to those in town. The sample size is, however, very small (49 schools).

Table 8. *Retention rates by school distance to district headquarters and education level*

Distance to district headquarters	One-year retention	Diff		N	Six-year retention	Diff		N
A. All schools								
In town (ref)	0.82			2,928	0.47			1,731
Less than 5 km	0.83	0.01		484	0.44	-0.03		302
5–10 km	0.83	0.01		672	0.47	0.00		456
11–20 km	0.84	0.02	***	729	0.47	0.00		501
21–50 km	0.86	0.04	***	943	0.49	0.02		645
More than 50 km	0.86	0.03	***	892	0.50	0.02		601
Total	0.84			6,648	0.47			4,236
B. Pre-primary and primary								
In town (ref)	0.84			2,124	0.49			1,332
Less than 5 km	0.85	0.01		394	0.46	-0.02		253
5–10 km	0.84	0.00		566	0.48	-0.01		393
11–20 km	0.85	0.01	**	596	0.49	0.01		429
21–50 km	0.87	0.03	***	813	0.49	0.00		582
More than 50 km	0.87	0.03	***	810	0.51	0.02		564
Total	0.85			5,303	0.49			3,553
C. Junior and Senior Secondary								
In town (ref)	0.77			804	0.42			399
Less than 5 km	0.74	-0.03		90	0.31	-0.11	**	49
5–10 km	0.78	0.00		106	0.40	-0.02		63
11–20 km	0.79	0.02		133	0.37	-0.05		72
21–50 km	0.80	0.03		130	0.47	0.04		63
More than 50 km	0.74	-0.04	*	82	0.35	-0.08		37
Total	0.77			1,345	0.41			683

Note. *** p<0.01, ** p<0.05, * p<0.1. In town is the reference group (highlighted)

We also define remoteness as the difference from each school to its nearest neighbour, assuming that the greater the distance from the nearest neighbour, the more remote the school is. We found no reliable correlations with either year-to-year retention (r=0.002, p=0.84) or long-term retention (r=0.015, p=0.21).

Finally, we explored how retention rates vary according to the type of settlement, as shown in Table 9 below. We find that, across all schools, those in built-up areas have the lowest one-year retention rates, and

schools located in hamlets have the highest — with a difference of 4 p.p. between them. Pre-primary and primary schools drive this pattern.

For the six-year retention rate, we observed a significant difference of 3 p.p. between schools in hamlets and those in built-up areas and small settlements. This pattern does not hold for different education levels. Secondary schools, particularly schools in small settlements, have a significantly lower retention rate than schools in built-up areas (5 p.p.). However, schools in hamlets have a similar rate to schools in built-up areas. These results are in line with those observed by distance to district HQ.

Table 9. *Retention rates by settlement area*

	One-year retention	Diff		N	Six-year retention	Diff		N
A. All schools								
Built-up area (ref)	0.81			2,120	0.47			1,138
Small settlements	0.84	0.03	***	2,947	0.47	0.01		2,104
Hamlets	0.85	0.04	***	1,265	0.49	0.03	*	818
Total	0.83			6,332	0.48			4,060
B. Pre-primary and primary								
Built-up area (ref)	0.83			1,457	0.48			821
Small settlements	0.86	0.03	***	2,490	0.49	0.01		1,849
Hamlets	0.86	0.03	***	1,092	0.50	0.02		728
Total	0.85			5,039	0.49			3,398
C. Junior and senior secondary								
Built-up area (ref)	0.77			663	0.43			317
Small settlements	0.76	-0.01		457	0.38	-0.05	**	255
Hamlets	0.80	0.02		173	0.42	-0.01		90
Total	0.77			1,293	0.41			662

Note. *** p<0.01, ** p<0.05, * p<0.1. Built-up area is the reference group (highlighted)

3.3.2. Differences across administrative areas

To look at regional differences, we used the school locations to identify regions where retention rates are high (hotspots) or low (coldspots). We started by aggregating the data to the district and chiefdom levels before using spatial correlations to identify spatial clusters of schools with statistically significant high or low retention levels.

At the district level, for primary schools, Western Area Urban and Koinadugu have the lowest retention rates for both one-year retention and long-term retention. Nearly one in four teachers leave each year in Western Area Urban, which leads to only two in five teachers staying at the same

school across the six-year period. In contrast, Falaba and Kailahun have the highest one-year retention rates, and Falaba and Pujehun have the highest six-year retention rates.

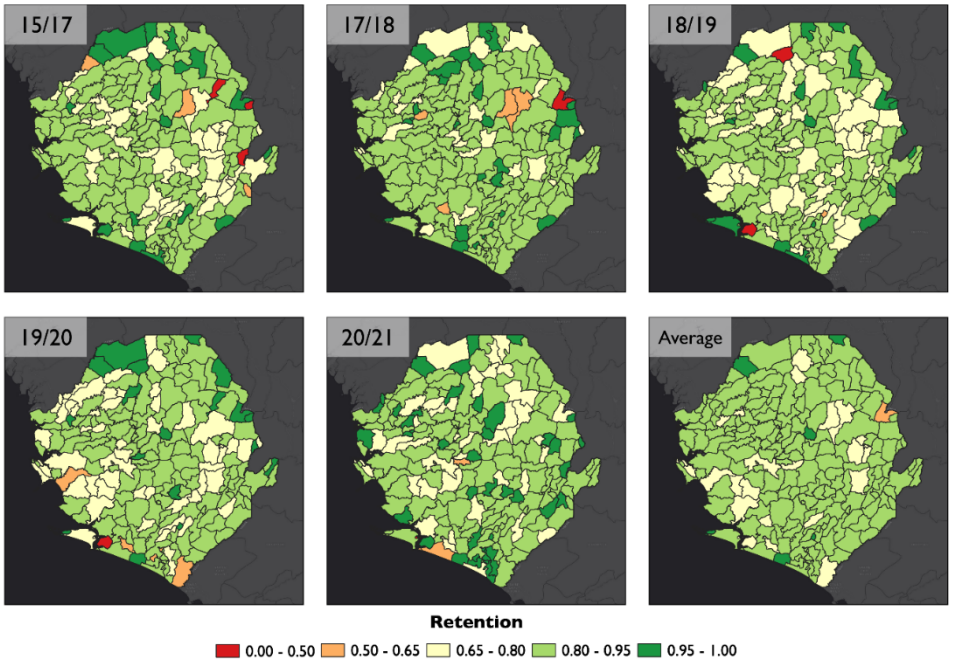
For secondary schools, Moyamba and Kono have very low retention rates — with three in ten teachers leaving each year — leading to very low six-year retention rates. In Kono, the retention rate of 27% suggests that only one in four teachers from 2015 were still teaching in that school in 2021. Falaba and Bombali, on the other hand, have the highest retention rates for secondary school teachers, with four in five teachers staying in post year to year. Unlike the primary schools, secondary schools in the Western Area Urban have one of the highest six-year retention rates, together with Falaba and Kenema. However, the rates are still very low, with less than half of secondary teachers remaining in the same schools from 2015 and 2021.

Table 10. *District level retention rates*

District	Pre-primary and Primary		Junior and Senior Secondary	
	One-Year retention	Six-Year retention	One-year retention	Six-year retention
Bo	0.86	0.49	0.76	0.38
Bombali	0.85	0.50	0.82	0.43
Bonthe	0.86	0.50	0.70	0.21
Falaba	0.89	0.59	0.83	0.49
Kailahun	0.89	0.51	0.80	0.38
Kambia	0.85	0.46	0.79	0.44
Karene	0.86	0.52	0.80	0.38
Kenema	0.86	0.50	0.77	0.48
Koinadugu	0.81	0.40	0.77	0.34
Kono	0.85	0.41	0.72	0.27
Moyamba	0.85	0.48	0.71	0.35
Port Loko	0.85	0.51	0.80	0.45
Pujehun	0.87	0.56	0.76	0.42
Tonkolili	0.85	0.47	0.79	0.44
Western Area Rural	0.84	0.54	0.76	0.44
Western Area Urban	0.77	0.42	0.79	0.48

Looking at chiefdoms, we see no immediate pattern in terms of high or low retention areas across the years. Within each district, there are areas of high retention, and areas of low retention — with more urbanised chiefdoms having lower retention rates.

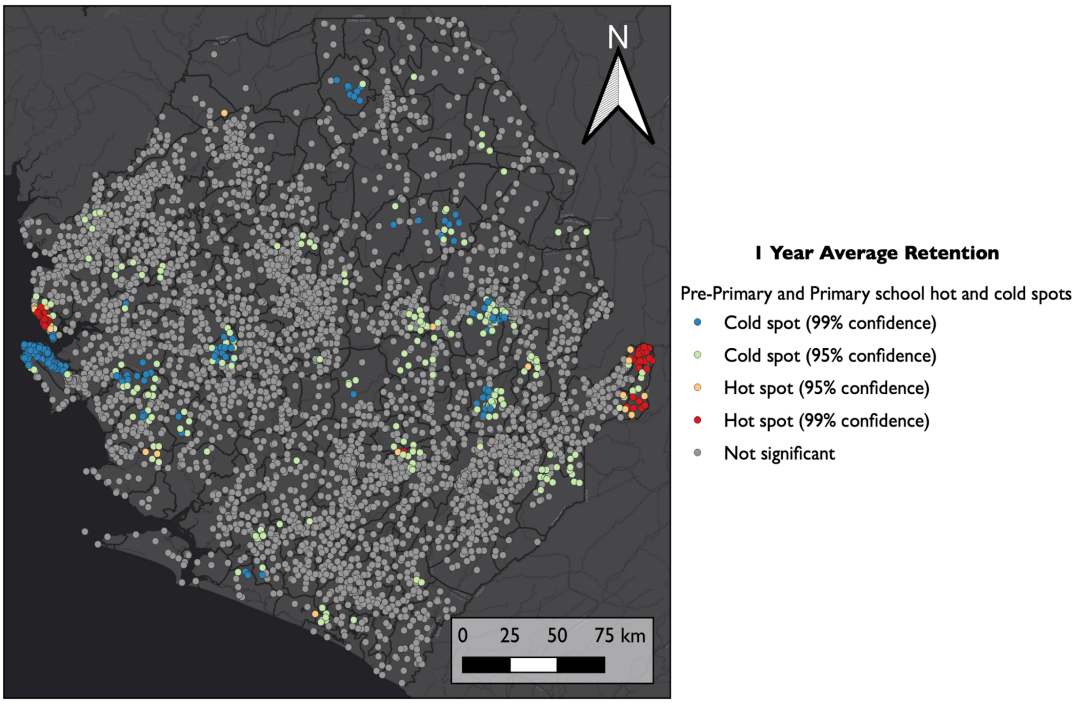
Figure 7. *Map 2: Chiefdom year-to-year retention rates*

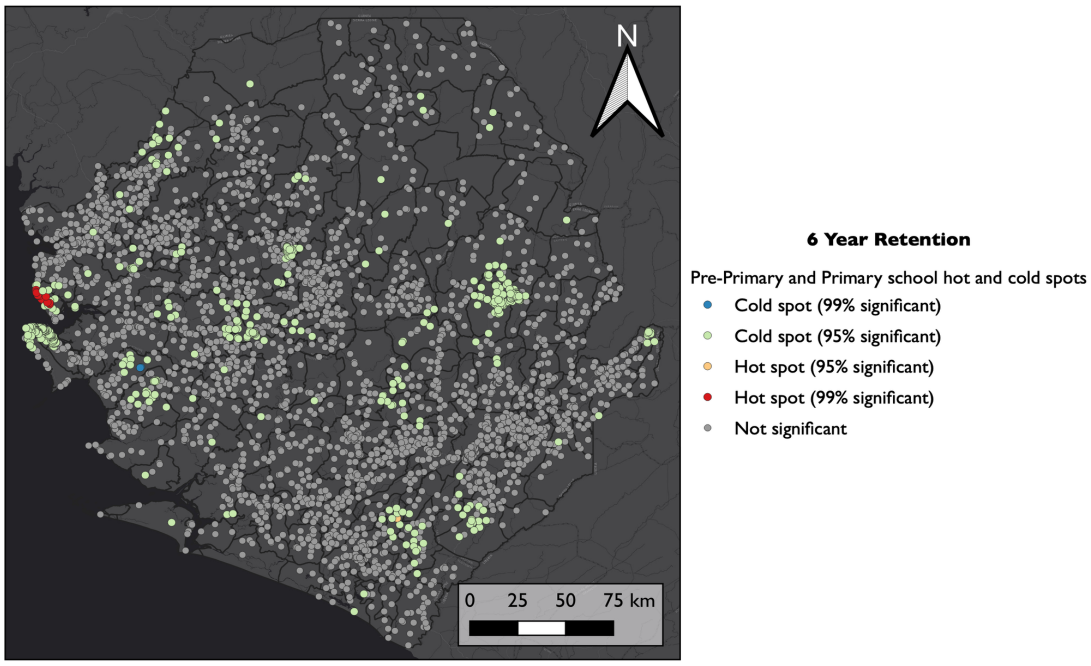


When we look at the chiefdom school level map (Figure 7), we can see schools with high and low retention rates scattered across the country. However, there is considerable 'noise' in the map — to help disentangle this, we used the Getis-Ord Gi* (Gi*) statistic to see if we could identify any 'hotspots' or 'coldspots' where the retention rates are significantly higher or lower.

For every school, the Gi* tells us how similar it is to its neighbours. It does this by comparing the retention rate in a particular school with the national average and then taking a weighted sum of the values for its neighbours, with those closest getting a higher value. Therefore, if a school has a high retention rate, but its neighbours have average rates, the school would not be considered to be in a hotspot; however, if all neighbouring schools had high retention rates, that area would be a hotspot.

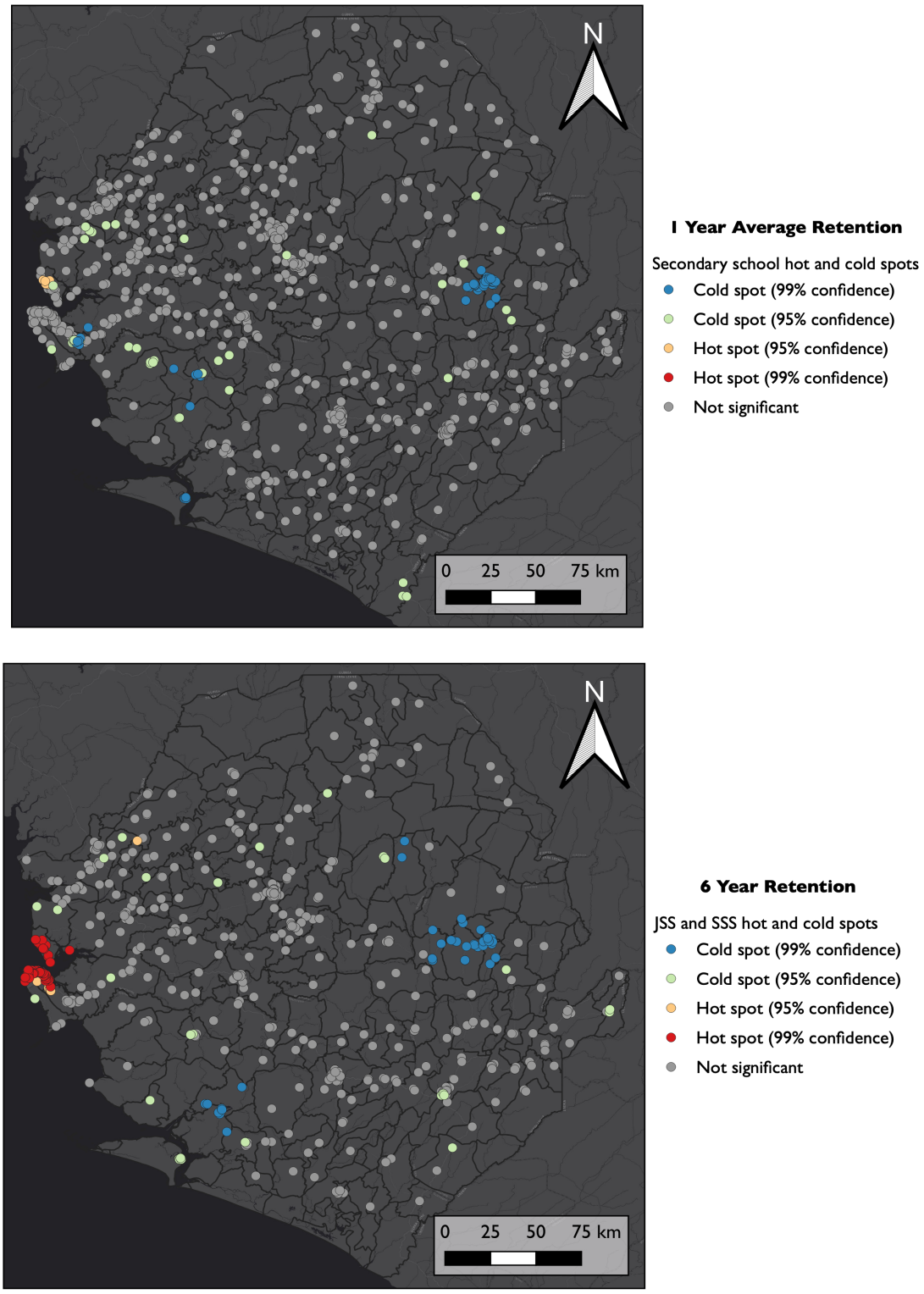
Figure 8. *Map 3: Pre-primary and primary Schools*





For primary schools, we can see that Freetown is a 'coldspot', where one-year retention rates are significantly lower than other areas in statistical terms. We find clusters of high-retention schools in Port Loko and Kailahun.

Figure 9. *Map 4: Secondary schools*



For secondary schools, we find that Freetown is no different to the rest of the country with a one-year average, and it is a 'hotspot' for higher retention rates over the six-year period.

An outlier in all the hotspots (pre-primary /primary and secondary; for one- and six-year retention rates), is Koidu City in Kono, which is a persistent coldspot (i.e., has lower retention than average).

4. Conclusions

This study has used six waves of Sierra Leone's ASCs (2015–2021) to create a panel dataset of teachers to understand how they move between schools, and the implications this has on the stability of the labour force in schools. We explored who moves, how far they move, and if they prefer to remain in post in a particular type of location.

While we lack a benchmark for 'normal' levels of movement, we discovered levels of mobility which we would consider high, especially when looking at the whole period, when nearly a quarter of our sample moved to different schools.

Female teachers in primary and pre-primary schools move significantly more than male teachers, including those with an HTC (for primary or secondary) and a bachelor's degree.

Secondary school teachers, those with an HTC and / or a bachelor's degree, and those with a postgraduate qualification moved the most. Across the board, teachers with no formal qualifications as educators show the lowest prevalence of moving.

Overall, about 8% of teachers moved to a different school the year after they went onto the government payroll — although this is much lower in the most recent year, following the introduction of a three-year wait period from the TSC. However, even the most recent rate of movement — 4.2% — suggests that 1 in 25 teachers added to the payroll will move to a different school in the following year — this decrease in movement rate suggests the policy has been successful.

We found little evidence of higher mobility from rural schools. In fact, we found the opposite. More remote schools and those further from the district HQ had higher retention rates, particularly for pre-primary and primary schools. Most of the movement in these areas was between schools in the same areas and the same type of settlement. The most unlikely direction of movement is from hamlets to built-up areas.

Over half of the moves were between schools within 5 km of each other, suggesting a localised labour market. Primary school teachers move significantly shorter distances than secondary school teachers. Female teachers move much further at the secondary level — as do those with higher qualifications. Teachers with no formal qualifications are the least likely to move.

We tested our hypothesis of localised teacher labour markets by comparing the observed movements in our sample with distributions derived under the null hypothesis (*teachers have no preference of where they move to*). We made comparisons for different sets of distances. The comparisons showed that teachers have a clear preference for moving to schools that are closer to their current location — preferences that hold for both primary and secondary school teachers.

We looked at the implication of these moves by analysing school retention rates. Overall, year-to-year retention rates are in line with the limited literature on this subject. On average, 84% of payroll teachers stay at the same school for consecutive years. However, this figure is much lower for secondary school teachers (especially for senior secondary). Losing on average 16% of teachers yearly translates to low long-term retention rates, suggesting that children starting each school level are unlikely to have the same cohort of teachers all the way through.

Looking at how the year-to-year retention rate varies across the country, we again find rural schools to have higher retention rates, with urban areas showing lower rates. This holds across districts, although some areas (notably Freetown and Koidu City) warrant further investigation as outliers.

Overall, our data suggests that natural mobility among the (payrolled) teacher workforce in Sierra Leone is quite high, which may have implications for teaching and learning, especially at the foundational levels where children need more support and pastoral care to learn. Given that pastoral care and knowing children's existing learning context is important to ensure content is suitable for them, low retention rates may mean teachers focus on delivering the curriculum rather than also considering classroom needs.

However, it does not suggest that primary schools in rural areas would have a harder time retaining payroll teachers than those in urban areas — which is contrary to perceived wisdom. Focusing on creating payroll spaces in understaffed rural schools for teachers who are already working within the school and who have self-selected to work there would not necessarily result in those teachers migrating to cities. The patterns are less clear for secondary schools, with no apparent spatial patterns for movement or preferences. The higher movement rates for secondary school teachers suggest that the labour markets for primary and secondary teachers are distinct — and therefore, policy should factor in this distinction also.

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Annexes

Annex 1. Data Cleaning

This analysis utilised data from the Sierra Leone Annual School Census (ASC), with information pertaining to teacher characteristics and identifiers for the school(s) they taught at for each year between 2015 and 2021.

Table A1. *Variables used in teacher tracking analysis, colour-coded variables were assigned to the teacher ID.*

Variable	Description and notes
paynum	Government assigned payroll number
fname	First and last names of each teacher, spellings of names were found to change year to year for certain teachers. The Soundex algorithm was applied to the concatenation of these two § strings, to produce a codified, pseudo-anonymised name in the form *A123*.
surname	
sex	Teacher sex
age	Teacher age on ASC year.
service_start_year	Year teacher started teaching
censusyear	ASC year of record
fabid	School teacher taught at for ASC year of record, uses internal ID system for school tracking.
qualification	Maximum qualification achieved by teacher. These include, in increasing order of qualification: 1. No formal training as educator 2. Technical Certificate (TC) / TEC 3. Higher Technical Certificate Primary/Secondary (HTC P/S) 4. Any Bachelors in education 5. Any Masters or PhD in education For analysis, this was generalised to no education, TC, HTC, and higher education.
languages_specialist	Binary classification of teacher's subject speciality teaching discipline, this is a subject measure at the discretion of the person completing the form. Furthermore, teachers can be specialists in multiple disciplines.
maths_specialist	
sciences_specialist	
socsciences_specialist	
arts_specialist	
other_specialist	

Data collection issues for the 2016 ASC resulted in missing data on teachers and an incomplete depiction of teacher statuses for that year.

Hence, we removed data points created in the 2016 census. Furthermore, despite the inclusion of supposedly unique identifiers such as name and payroll number, there were many recorded instances of teachers sharing payroll numbers and / or spellings of names changing from year to year. As a result, it was impossible to track teachers accurately from the information available, and we therefore created a 'Teacher ID' — consisting of a combination of payroll number, sex, and other teacher characteristics, as follows:

J112_123456_Male_Qual_2006_1_0_1_1_1_0_John_Smith

Note. Structure of a typical Teacher ID, note the colour coded elements match the variable descriptions defined in Table A1.

The methodological framework behind the 'Teacher ID' is described below. Ultimately, this produced a unique identifier for each teacher, which could then be used for later tracking purposes. This was also an opportunity to codify teacher characteristic information in the ID, permitting analyses into the characteristics of teachers who moved schools. However, ASC data collection contained multiple records for any one teacher working at multiple schools with differing qualifications, and subject specialism information between years (as outlined in Table A1). For this reason, and on the assumption that the latest information is the most accurate, we only used teacher characteristic information from the 2021 ASC to created IDs. In the instances where any one teacher had multiple records in 2021, we attributed the highest qualification data to the Teacher ID.

Once the unique identifiers were created, the dataset was pivoted using 'Teacher ID' as an identifier variable and each column containing the Fab IDs of schools taught at for each year between 2015 and 2021. An example is shown in Table A2.

Table A2. *Example of pivoting teachers' IDs to create the dataset*

teacher_id	2015	2017	2018	2019	2020	2021
123456_ABC	FabID_1	FabID_1	FabID_1	NaN	NaN	FabID_4
654321_XYZ	NaN	FabID_2, FabID_3	FabID_2, FabID_3	FabID_2	FabID_2	FabID_2

Data cleaning methodology

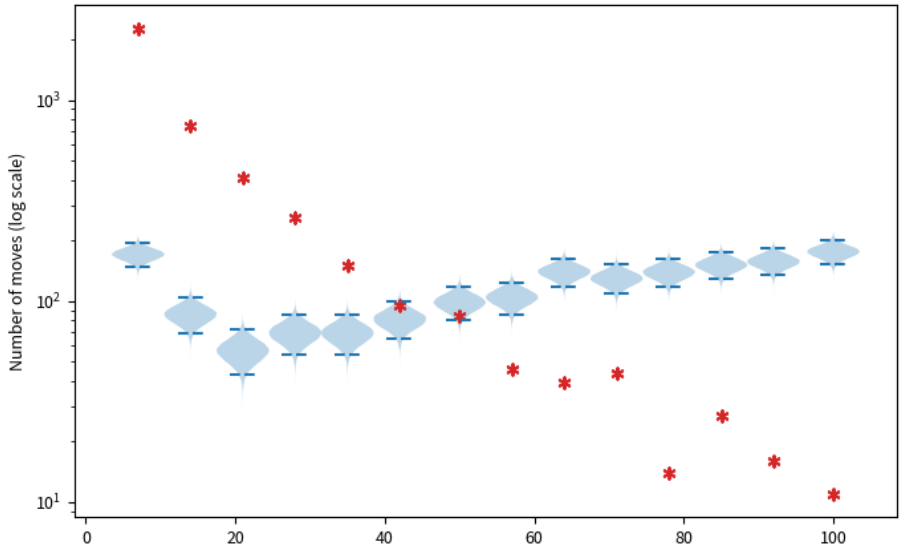
Here we outline the steps taken to clean and arrange the data, using Python Programming Language.

1. **Cleaning data**
   - 1.1. Import data via Pandas (Python libraries used to work with data)
   - 1.2. Remove rows with incorrect census years
   - 1.3. Create new 'full name' column, concatenating first and last names, removing trailing spaces, and converting to lower case.
2. **Fuzzy matching and codifying names**
   - 2.1. Subset data by each unique payroll number
   - 2.2. For each payroll number, fuzzy match all names
   - 2.3. Assign most common version of a 'fuzzy name' to common instances of a specific name
   - 2.4. Create phonetic index of each name using the *Soundex* algorithm and assign to a new column.
3. **Creating the Teacher ID**
   - 3.1. Combine Soundex codified names and payroll number.
   - 3.2. Concatenate teacher characteristic information recorded in 2021 to each teacher ID (as shown above). For instances of multiple teacher entries in ASC 2021, the characteristics of the highest qualified iteration of the teacher was considered.
4. **Aggregating tracking data**
   - 4.1. Pivot table using Teacher ID as the index and aggregate school identifiers by census year. (*Note: in cases of multiple schools in a single year, separate Fab IDs by a comma*)
5. **Export data as .csv for analysis**

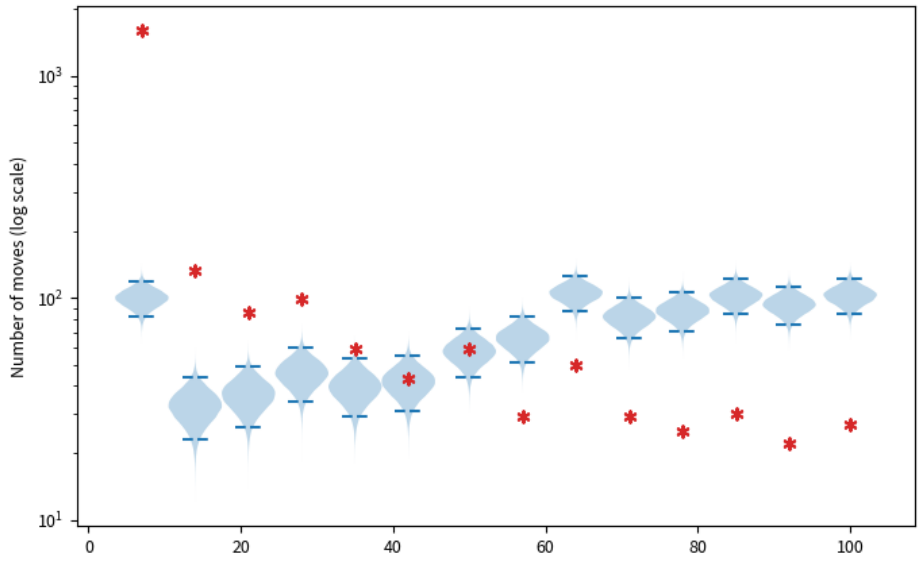
Annex 2. Comparison of observed and expected school-to-school movements

Null hypothesis: No preference primary and secondary schools by distance of movement

Primary schools

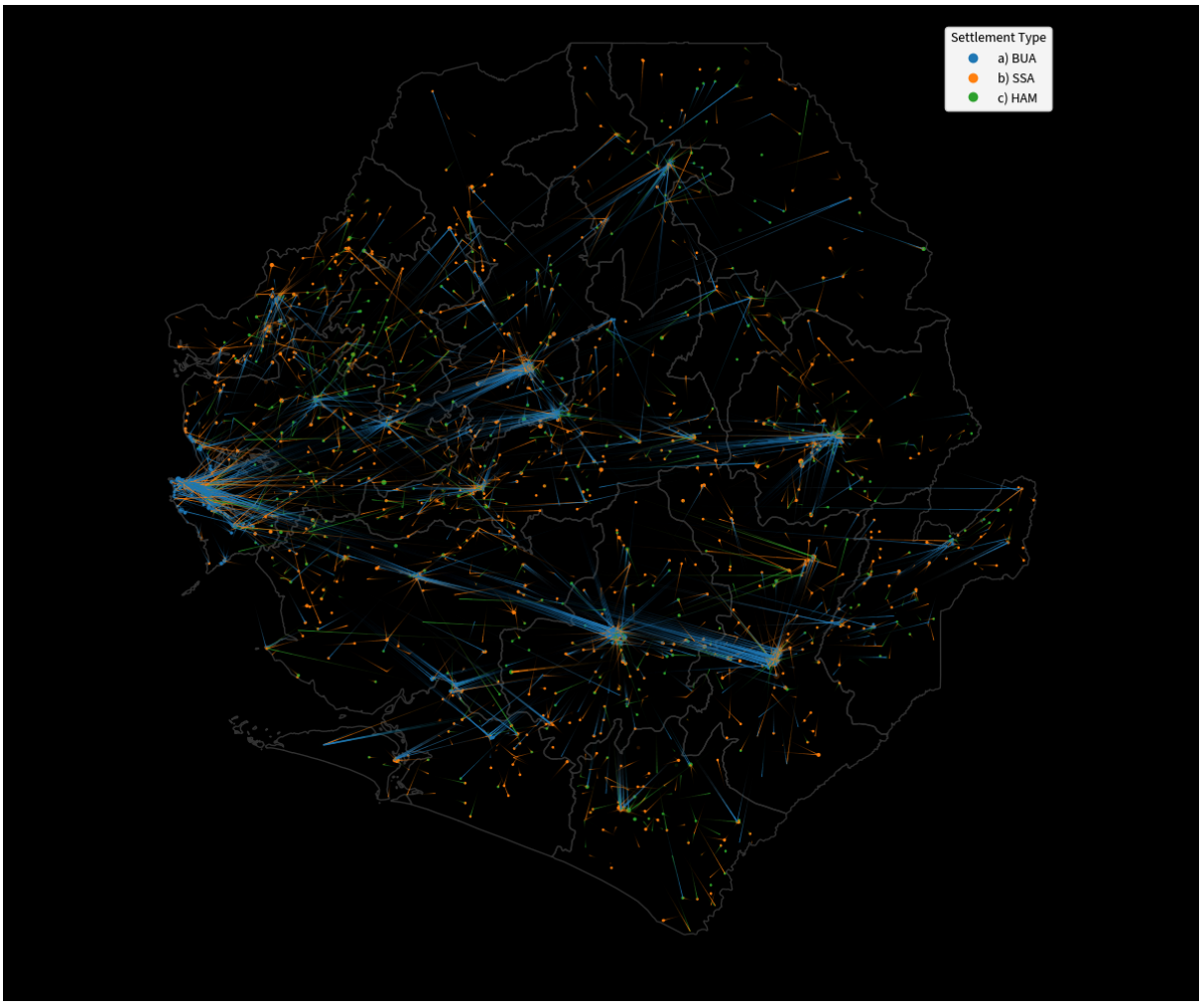


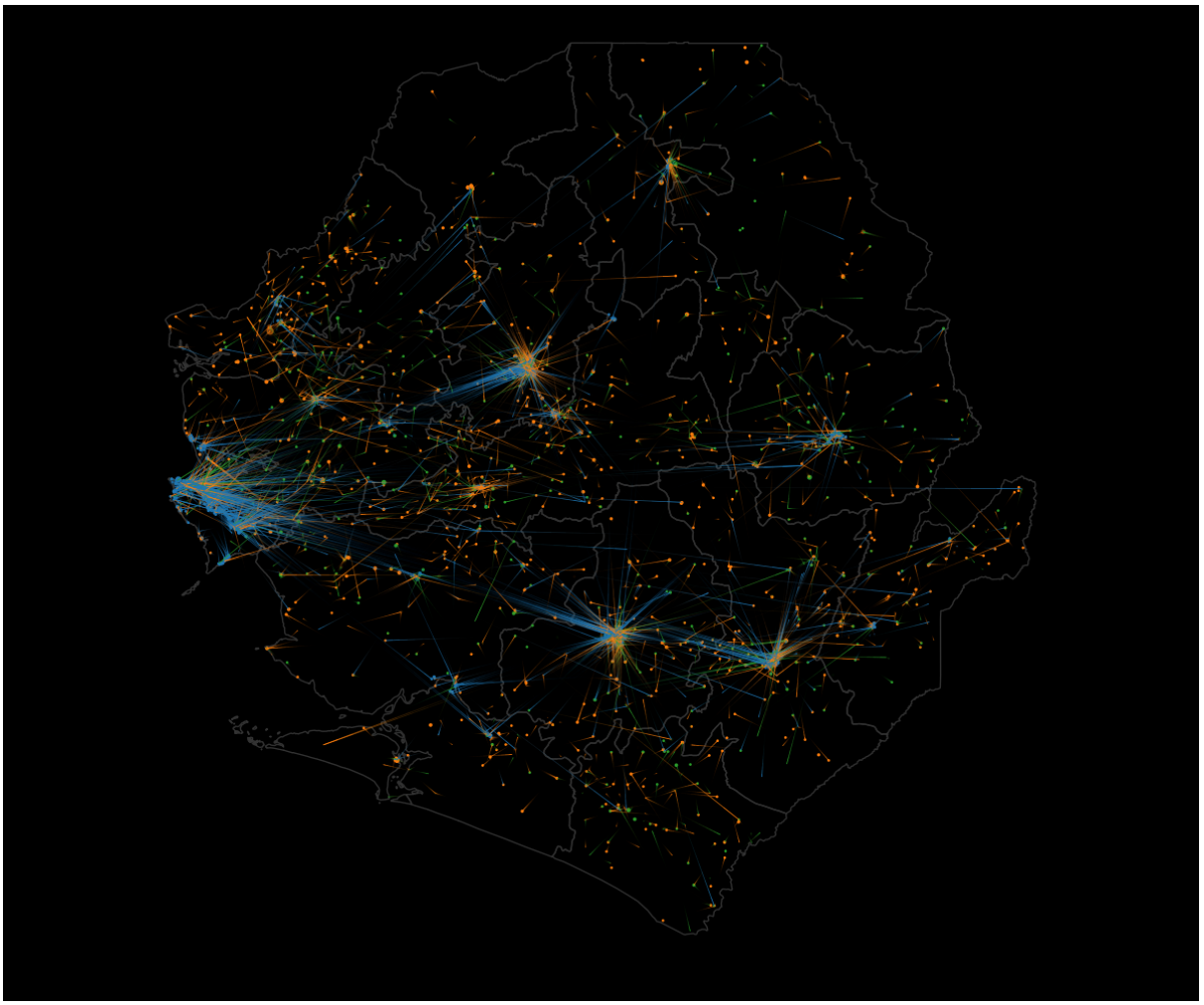
Secondary schools



Annex 3. Direction of movements by settlement area where source and destination schools are located

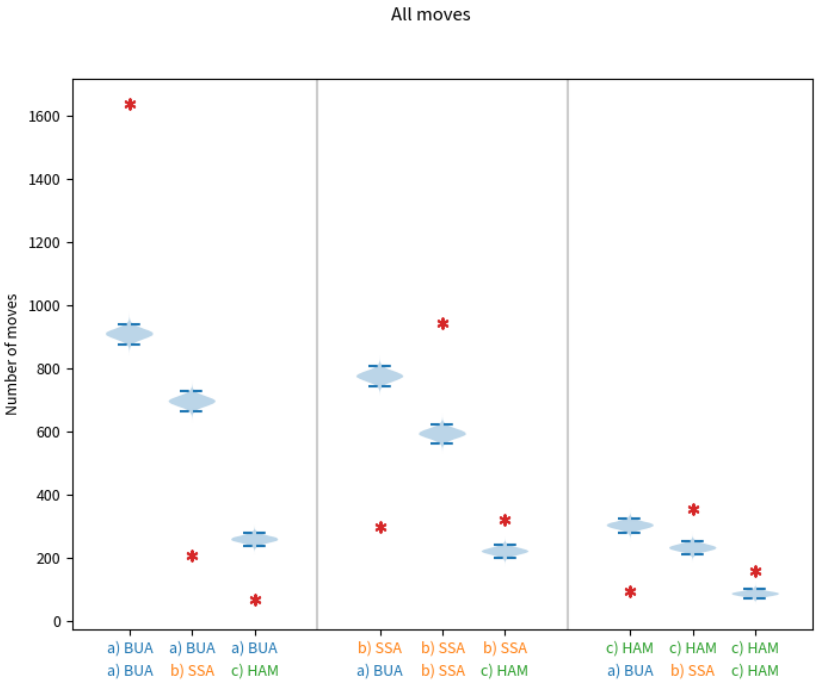
Points are coloured by settlement type and lines are coloured by the settlement type of either (a) the point with source tendency < 0.5 or (b) the point with destination tendency < 0.5. In other words, point colours represent settlement type of the emanating point, line colours represent settlement type of the complementary point in the movement pair.

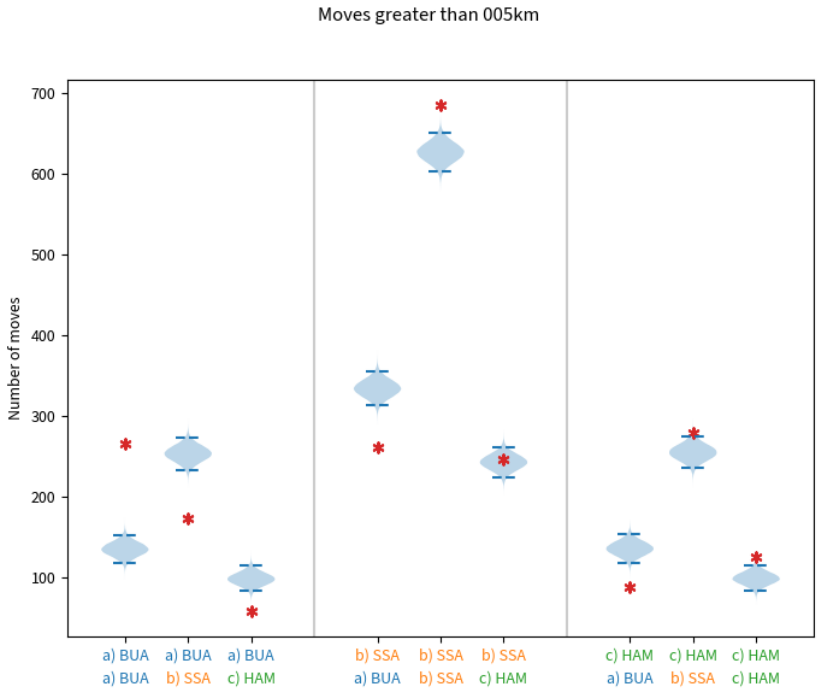


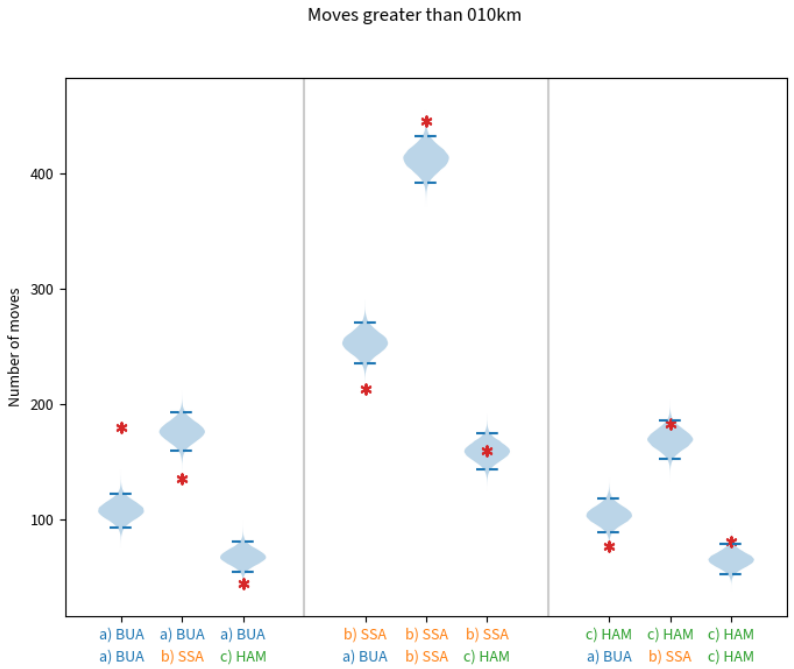


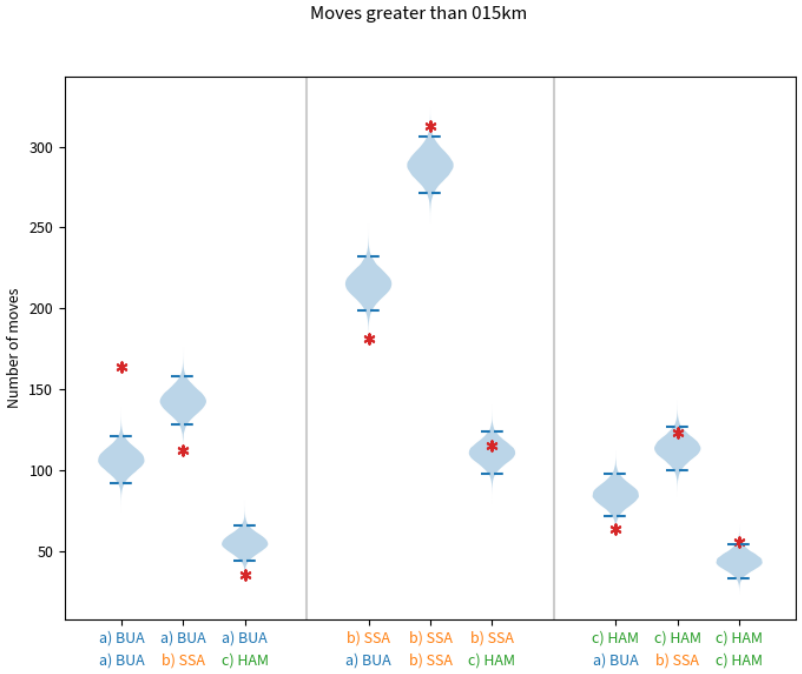
Annex 4. Observed counts of moves and null distributions for movements by type of settlement, conditional on distance

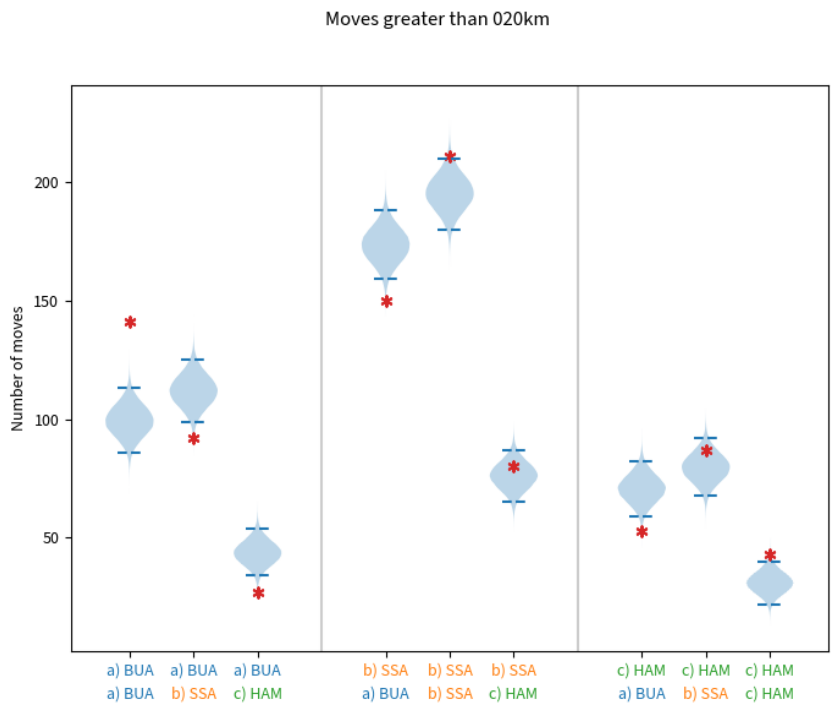
Primary schools



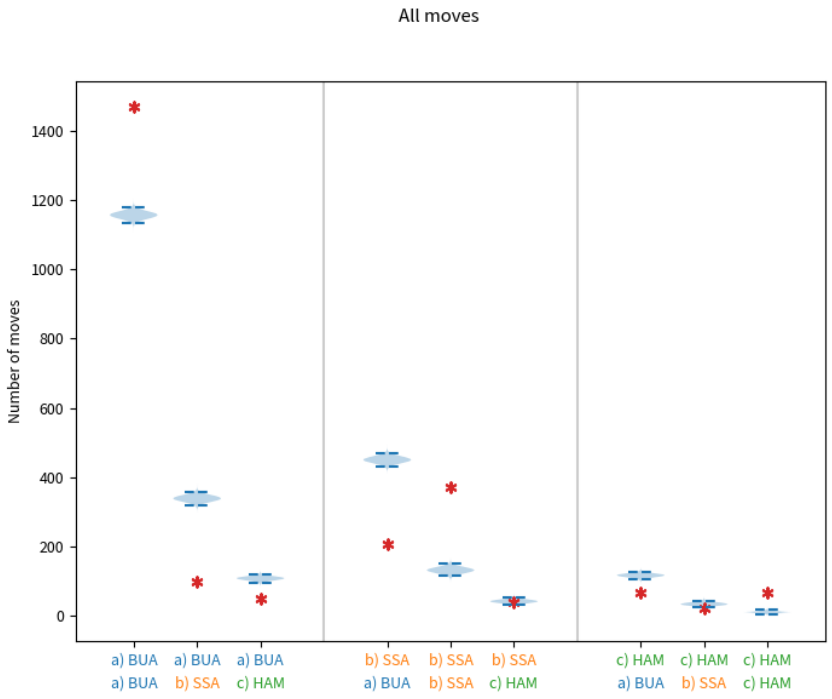


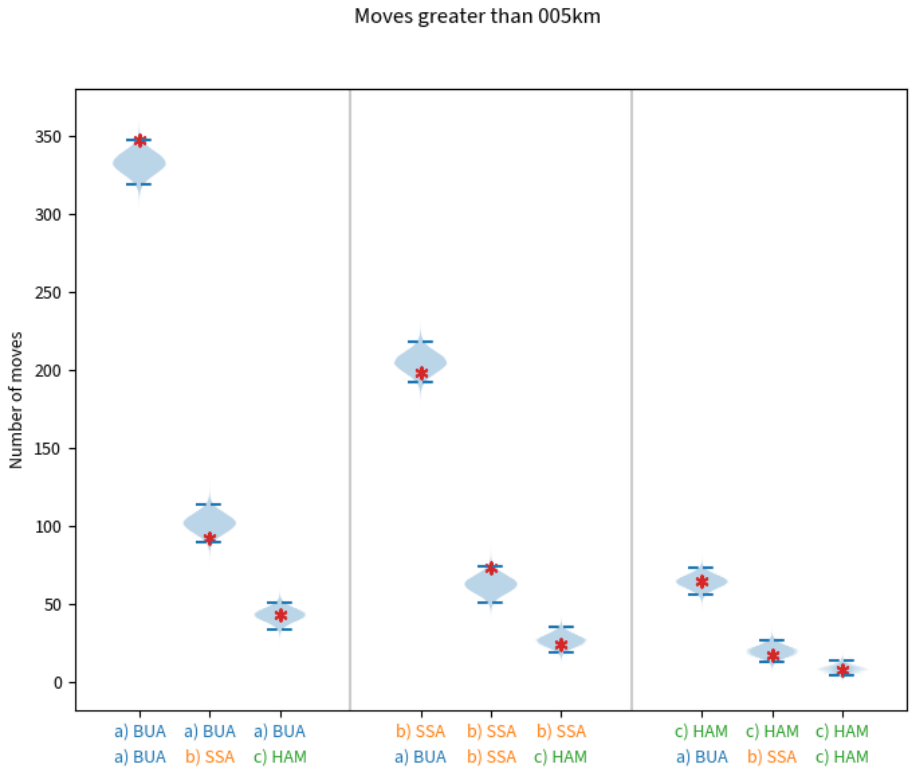

Moves greater than 010km
Number of moves
400
300
200
100
a) BUA a) BUA a) BUA
a) BUA b) SSA c) HAM
b) SSA b) SSA b) SSA
a) BUA b) SSA c) HAM
c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM

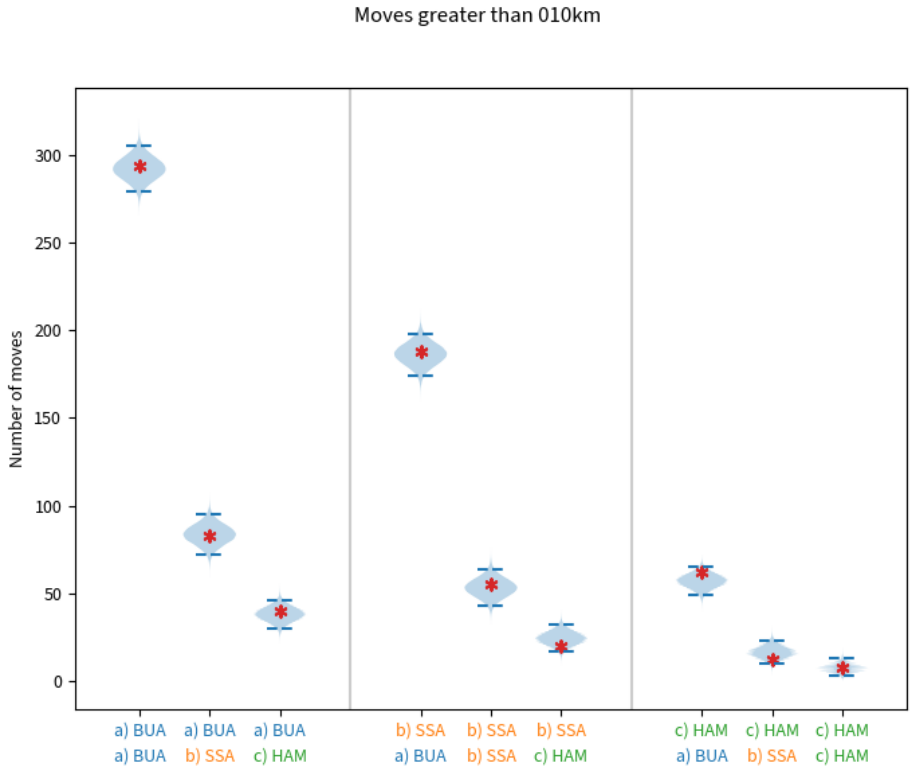

Moves greater than 015km
Number of moves
300
250
200
150
100
50
a) BUA a) BUA a) BUA
a) BUA b) SSA c) HAM
b) SSA b) SSA b) SSA
a) BUA b) SSA c) HAM
c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM



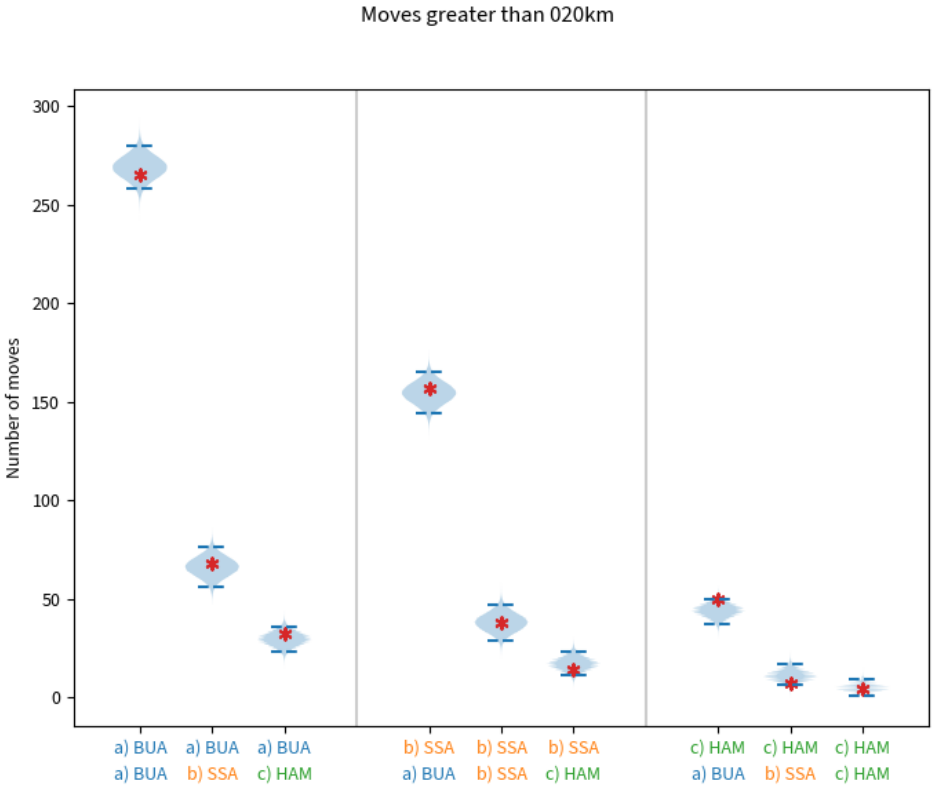
Secondary schools



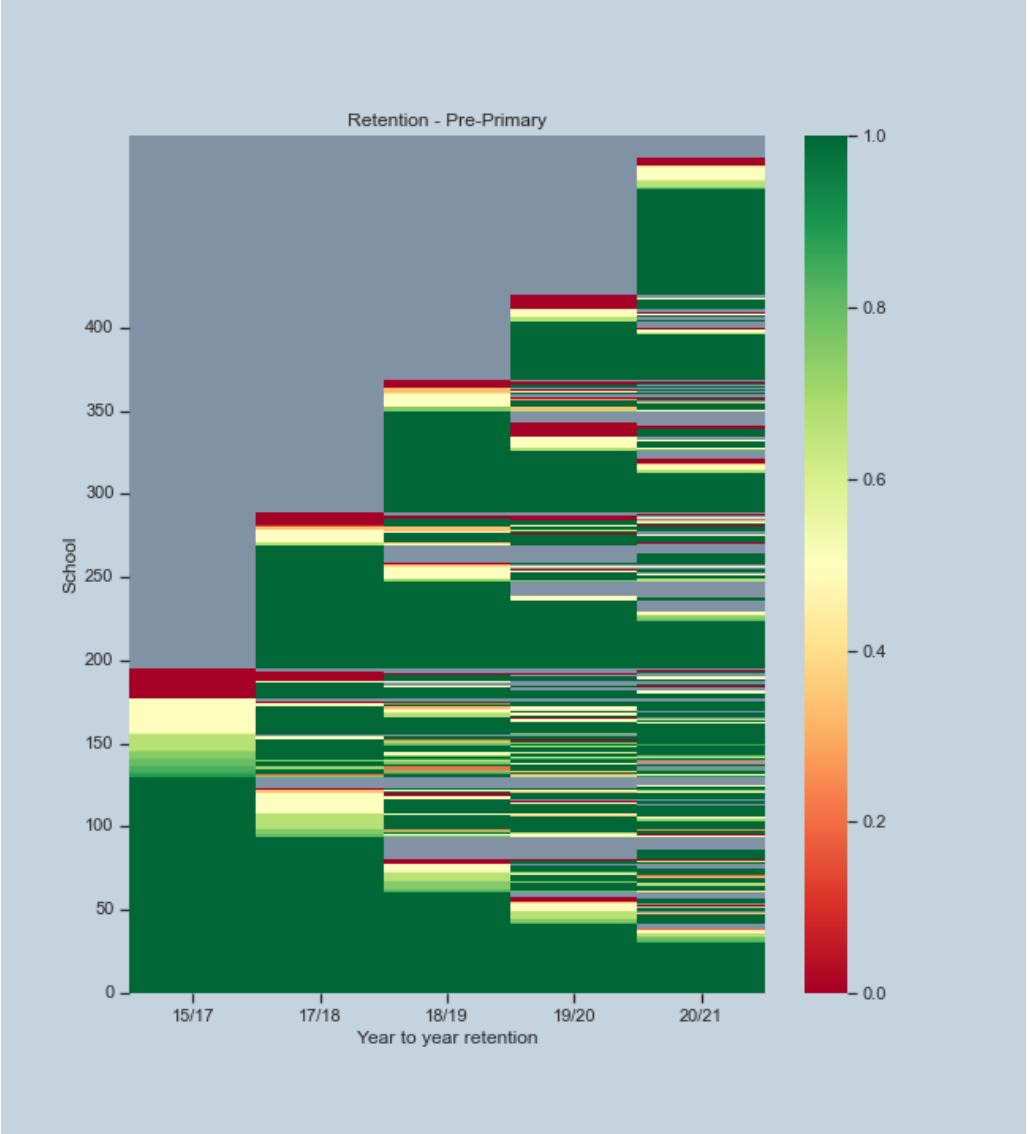

Moves greater than 005km
Number of moves
350
300
250
200
150
100
50
0
a) BUA a) BUA a) BUA b) SSA b) SSA b) SSA c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM a) BUA b) SSA c) HAM a) BUA b) SSA c) HAM

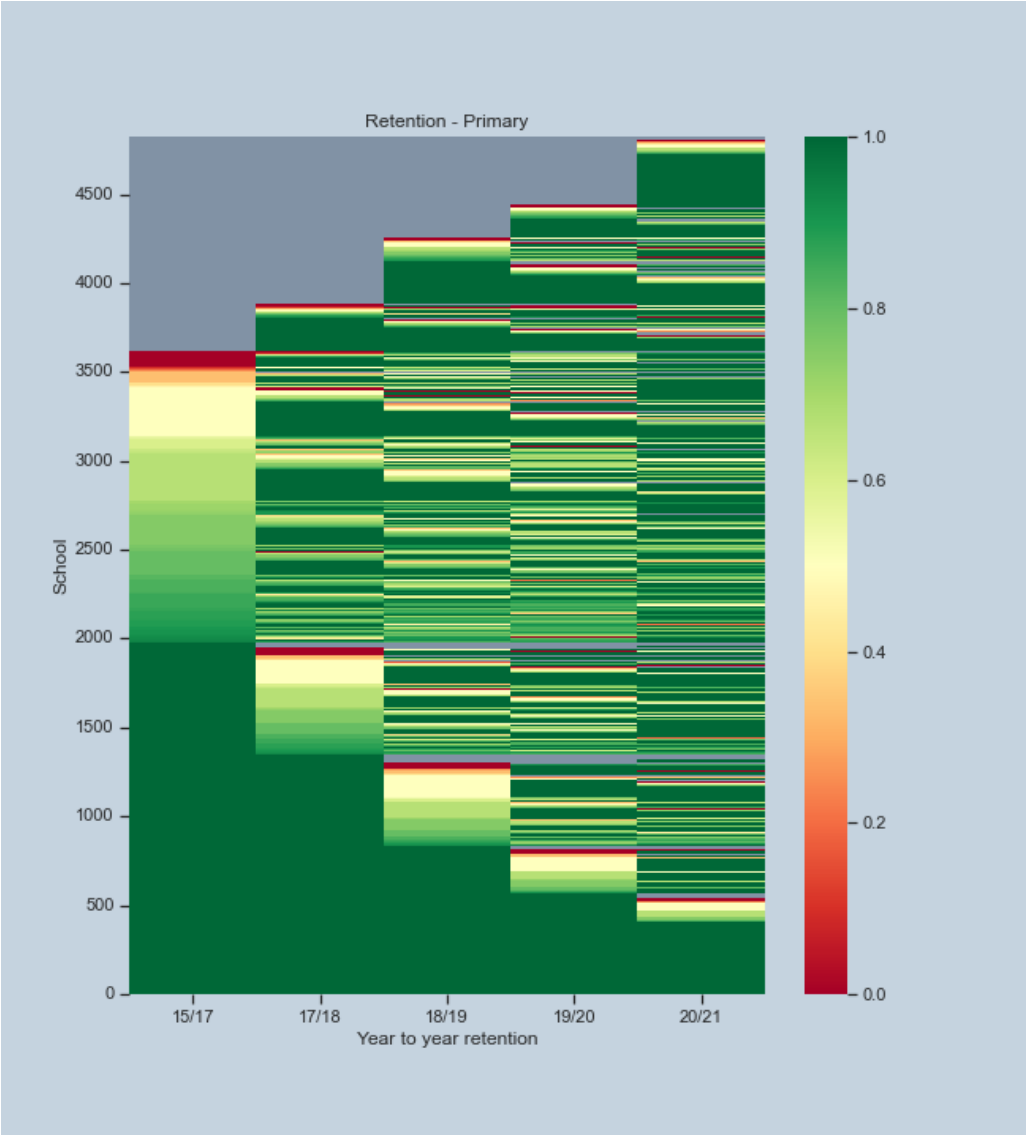

Moves greater than 010km
Number of moves
300
250
200
150
100
50
0
a) BUA a) BUA a) BUA b) SSA b) SSA b) SSA c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM a) BUA b) SSA c) HAM a) BUA b) SSA c) HAM

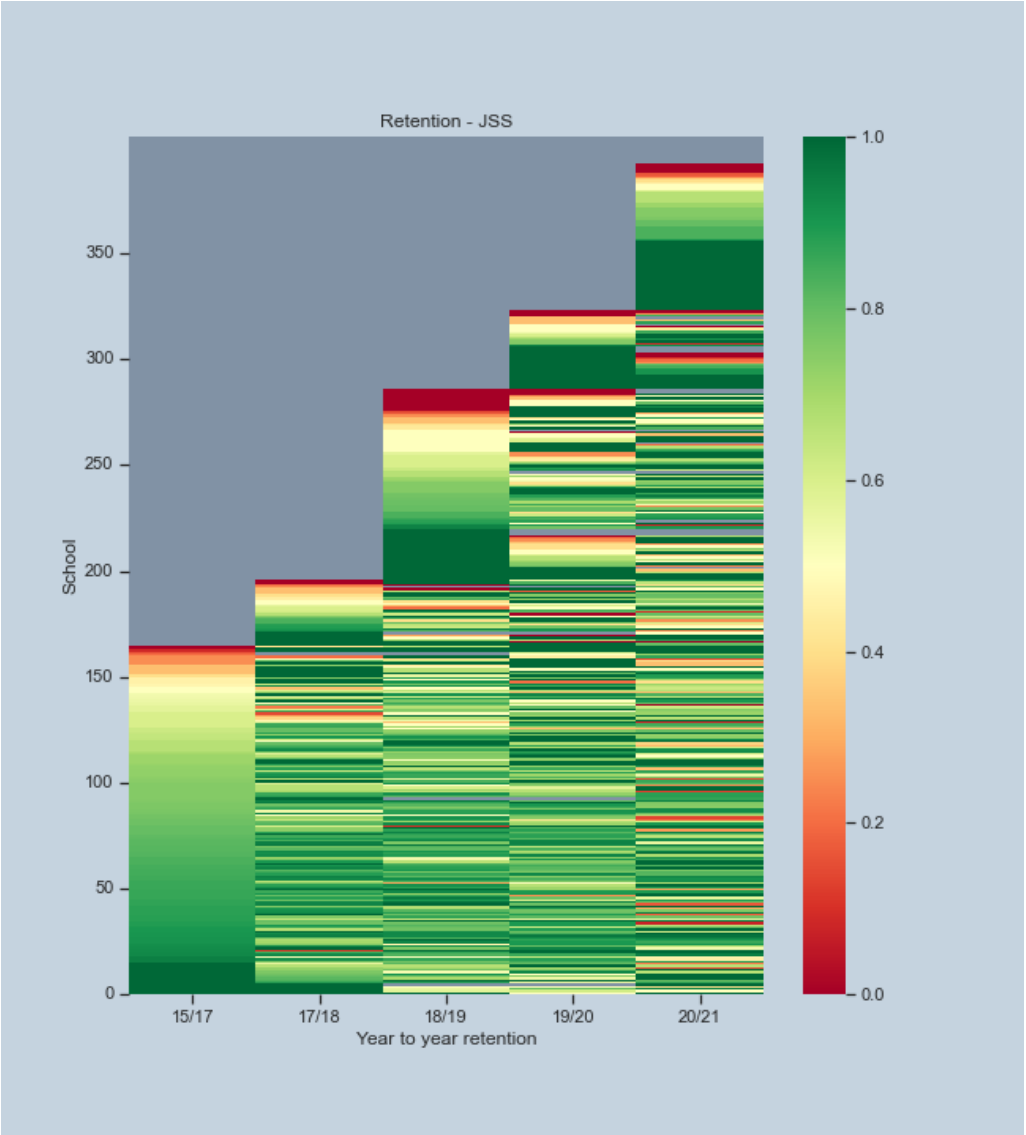

Moves greater than 015km
Number of moves
300
250
200
150
100
50
0
a) BUA a) BUA a) BUA
a) BUA b) SSA c) HAM
b) SSA b) SSA b) SSA
a) BUA b) SSA c) HAM
c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM

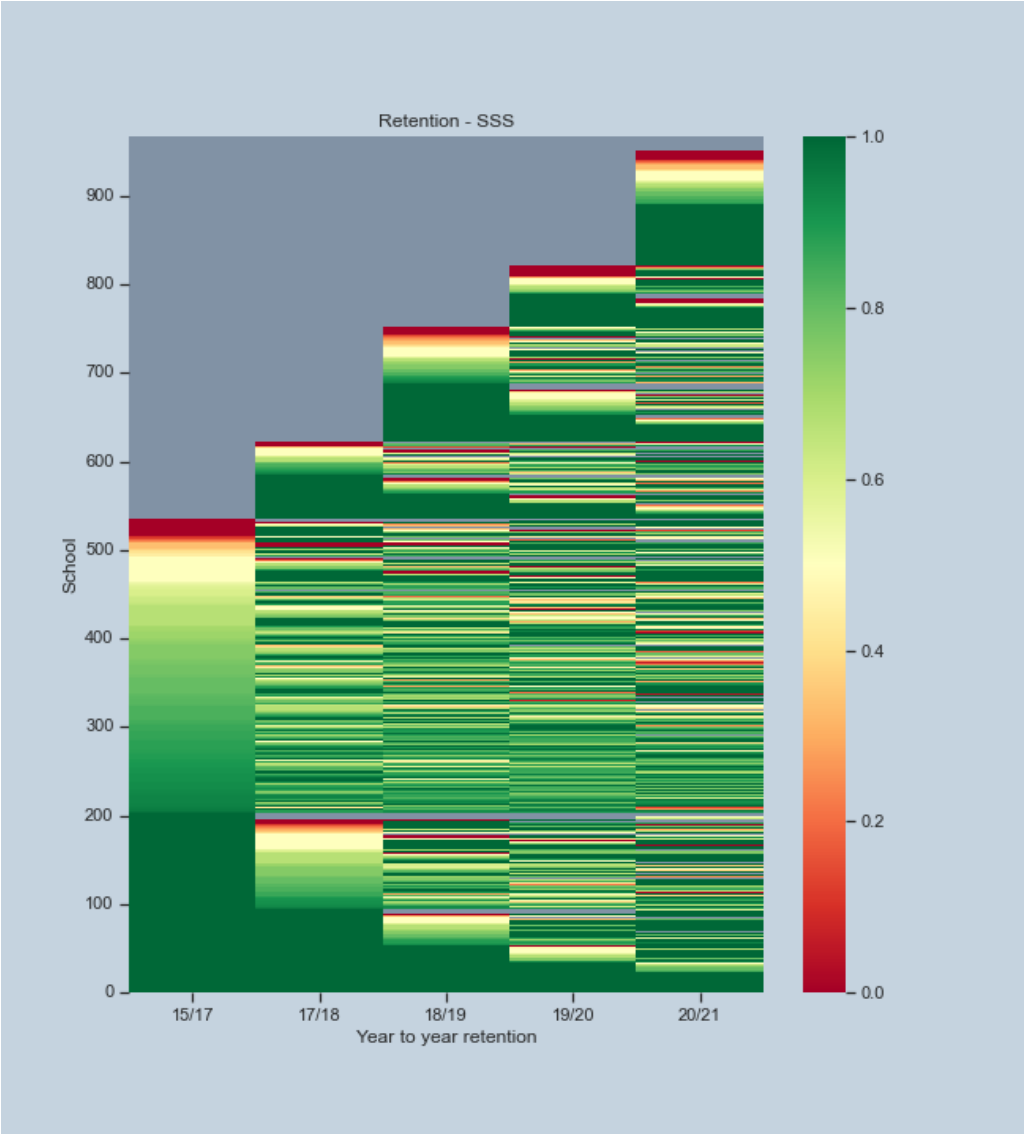

Moves greater than 020km
Number of moves
300
250
200
150
100
50
0
a) BUA a) BUA a) BUA
a) BUA b) SSA c) HAM
b) SSA b) SSA b) SSA
a) BUA b) SSA c) HAM
c) HAM c) HAM c) HAM
a) BUA b) SSA c) HAM

Annex 5. Teacher year-to-year retention rates by educational level



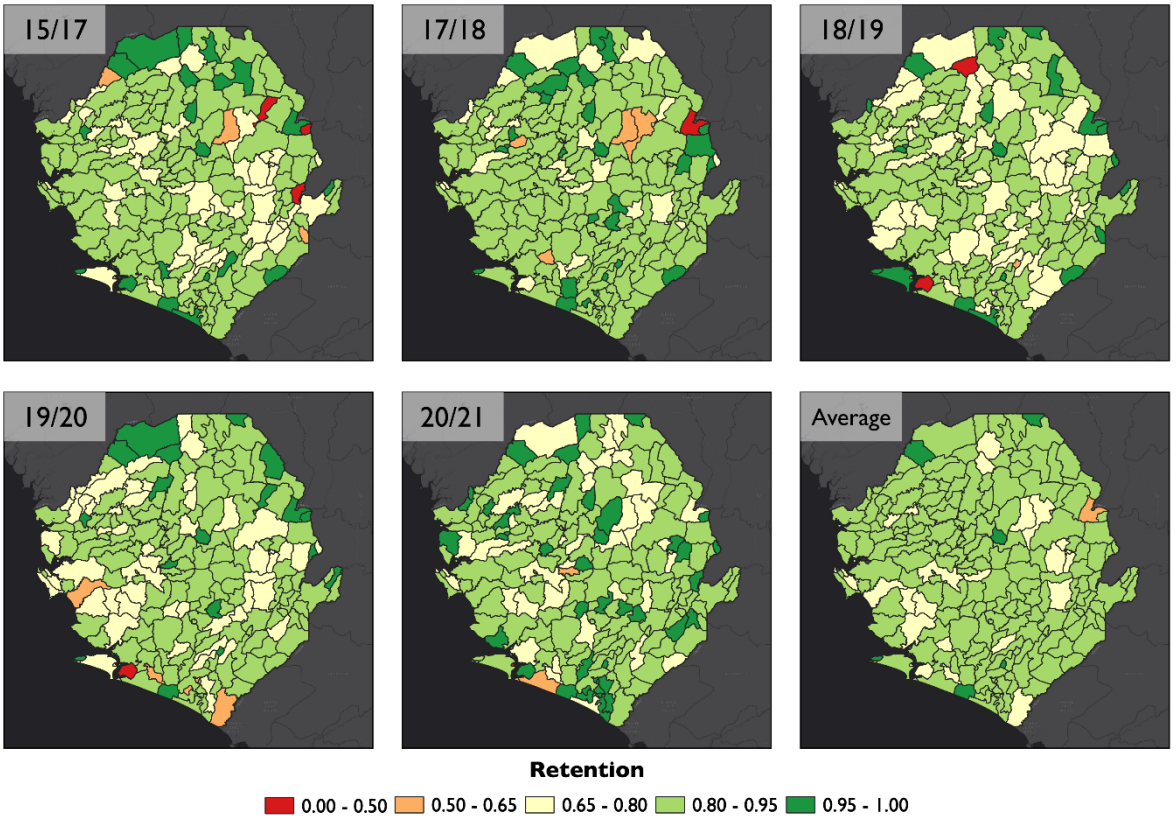

Retention - Primary
School
4500
4000
3500
3000
2500
2000
1500
1000
500
0
15/17
17/18
18/19
19/20
20/21
Year to year retention
1.0
0.8
0.6
0.4
0.2
0.0


Retention - JSS
School
0
50
100
150
200
250
300
350
15/17
17/18
18/19
19/20
20/21
Year to year retention
1.0
0.8
0.6
0.4
0.2
0.0


Retention - SSS
School
900
800
700
600
500
400
300
200
100
0
15/17
17/18
18/19
19/20
20/21
Year to year retention
1.0
0.8
0.6
0.4
0.2
0.0

Annex 6. Retention rates at the chiefdom level

Year-to-year retention rates



Six-year retention rates