

Mobility analysis to support the Government of Ghana in responding to the COVID-19 outbreak

Initial insights into the effect of mobility restrictions in Ghana using anonymised and aggregated mobile phone data

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Anonymised and aggregated data from Mobile Network Operators (MNOs) is a key data source for understanding the mobility patterns of populations, and improving decision-making and scenario planning during the COVID-19 epidemic. This data can be analysed in near real-time and provide an overview of mobility patterns across all of Ghana. Flowminder is working with Ghana Statistical Service (GSS) to produce mobility indicators from data provided by Vodafone Ghana, whilst fully preserving the privacy of Vodafone Ghana's subscribers. These indicators can be used by the government and public health experts to inform response efforts.

In this initial report, we describe the preliminary analyses that have been generated. The work has been conducted within a very short timeframe to provide timely, high-level insights into a fast-changing situation. The aim is to facilitate discussion amongst government ministries, departments, and agencies that could benefit from having access to the type of information that is presented here, in order to inform decisions about interventions. In the coming weeks, we will perform more detailed and rigorous analyses, which will contribute to an in-depth understanding of the situation and answer specific requests from decision makers.

For this current report, we have focused on assessing how the recently-imposed government restrictions have affected people's movements. The first set of restrictions - [closing schools and banning public gatherings](#) - were introduced on [Monday 16th March, 2020](#). A second set of restrictions - [lockdown in some parts of the Greater Accra Metropolitan Area and the Greater Kumasi Metropolitan Area](#) - were announced on [Friday 27th March, 2020](#) and came into force on [Monday 30th March, 2020](#).

In the first two analysis sections, we look at how the number of phone subscribers within each district or region has been affected by the restrictions. In the third and fourth sections, we show how travel between districts and regions has been affected. In the fifth section, we focus on the effect that the announcement of lockdown, and the lockdown itself, has had on the Greater Accra and Ashanti regions.

GSS' Government Statistician, Professor Samuel Kobina Annim said: "This initial analysis presents an opportunity for the government. It will enable it to, among other policy derivatives, review the number of districts under lockdown within a region, the effectiveness of the scope and timing of the lockdown and the adherence of the restrictive measures across districts and regions.

"Data is an extremely powerful tool, particularly in times like these. We hope that Ghana will be able to fully harness the data presented in this analysis in the fight against the pandemic.

"The GSS is grateful to Vodafone Ghana and Flowminder for their support in this project, funded by the William and Flora Hewlett Foundation and the Vodafone Foundation, and hope further collaborative opportunities will enable us to widen the scope of these anonymised and aggregated data to help save lives."

Understanding the graphs

In all of the figures in this report, we show the time period between Monday 17th February and Tuesday 31st March. This corresponds to a period starting four weeks before the first restrictions were introduced and ending on the second day of lockdown. The vertical dashed black lines in each figure indicate the dates when the restrictions were implemented (Monday 16th March and Monday 30th March), and the date when the lockdown restrictions were actually announced (Friday 27th March). We refer to the four weeks prior to the first restrictions as the 'baseline' period, which is used to determine what 'normal' behaviour looked like, before any restrictions were introduced. The values for all metrics are displayed as a percentage of the average baseline value.

1. Changes in the number of subscribers in each district

The change in the count of active subscribers in a district, on a particular day, can be used as a proxy for the change in the total number of people that were present in that district during some period of the day.

The count includes subscribers that live in the district, and subscribers that live elsewhere but who have travelled outside of their home district for reasons such as work and social activities. During normal periods, we would expect that the number of resident subscribers in a district remains fairly constant, whilst the number of non-resident visitors will change according to the day of the week, special occasions, and other factors.

In Figure 1, we have chosen one district - Ayawaso West (Greater Accra region) - as an example, and show the number of subscribers that used their phone there each day. We see that for the first few days after the first restrictions were introduced, the number of subscribers decreased, but to a number that was still similar to the previous week. However, in the second half of the week, we observe a much more dramatic decrease that took the number of subscribers far below the numbers seen in the previous weeks. On Monday 30th March, **when lockdown was introduced, we observe that an even further decrease occurred, reducing the number to around only 30 percent of what was typically observed during the baseline period.**



In further analysis, we will be able to establish the degree to which these changes were influenced by a **decrease in the number of non-resident subscribers visiting the district**, versus **residents of the district relocating to other districts**. This will provide additional information about whether mobility restrictions are having the desired effect (a decrease in non-resident visitors), as well as information on whether the size of the resident population of the district has changed significantly as a result of the restrictions. The latter is important from the perspective of planning the allocation of public health resources.

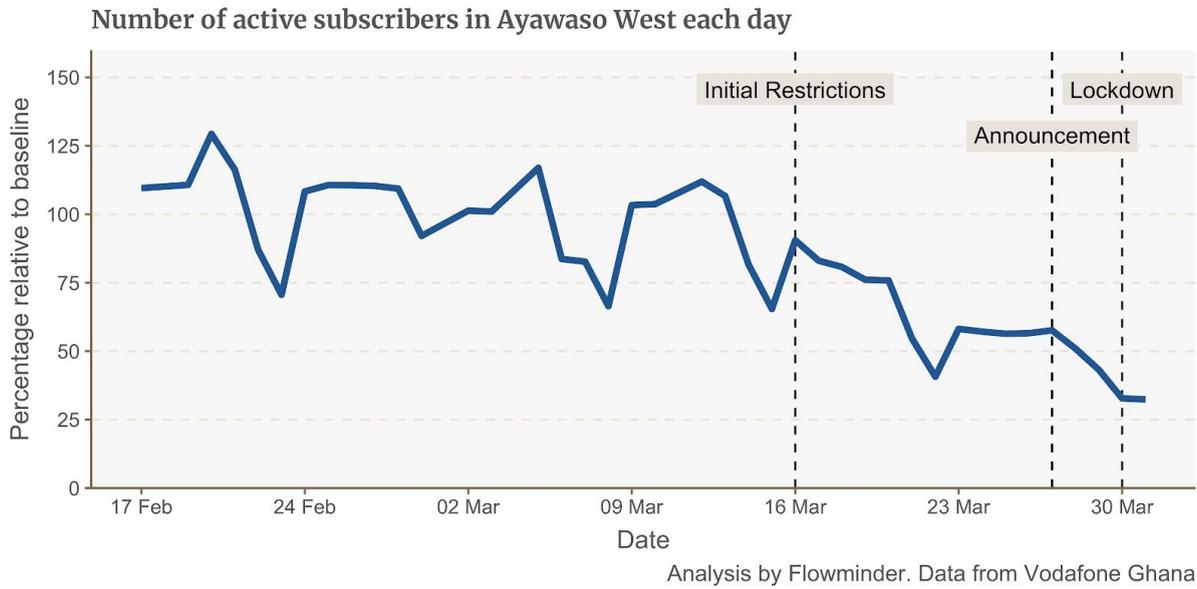


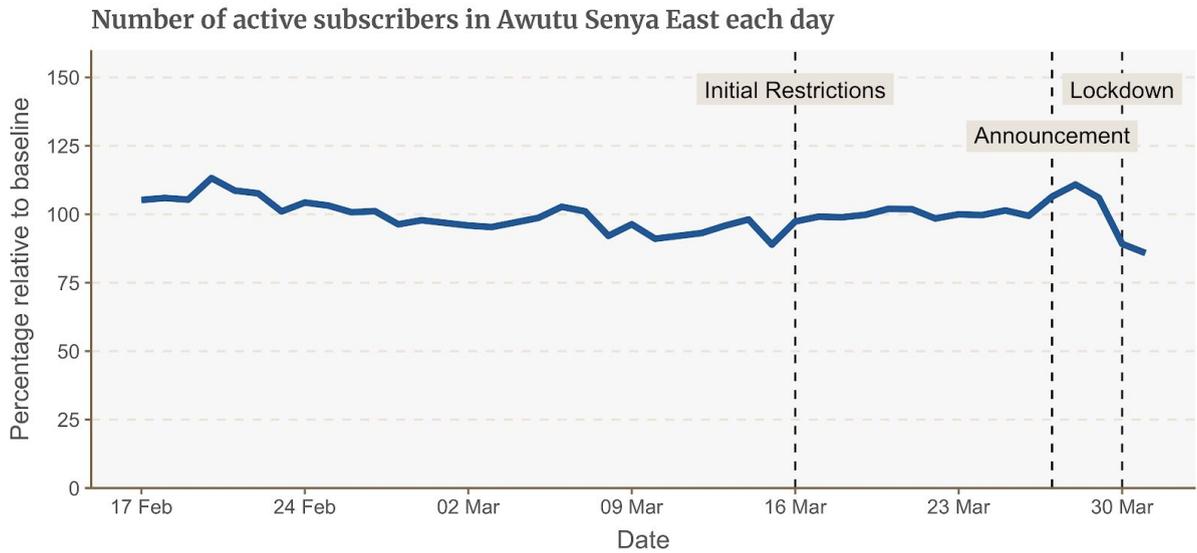
Figure 1: Number of active subscribers in Ayawaso West each day

This analysis can be repeated for any district. Different districts will exhibit different trends, depending on a number of factors, including how many people typically travel there to work or socialise, compared to the number of people who live there.

For contrast, we show a second example district in Figure 2 - Awutu Senya East (Central region). We see a very different pattern to what we observed in Ayaso West.

The number of subscribers in Awutu Senya East had been decreasing in the weeks before the first restrictions, and started to increase as soon as restrictions were imposed. The number **reached a peak on Saturday 28th March - the day after impending lockdowns were announced** - indicating that many people may have decided to travel to Awutu Senya East as a result of the announcement. However, note that this number was still slightly lower than the peak seen in mid-February at the start of the baseline period.





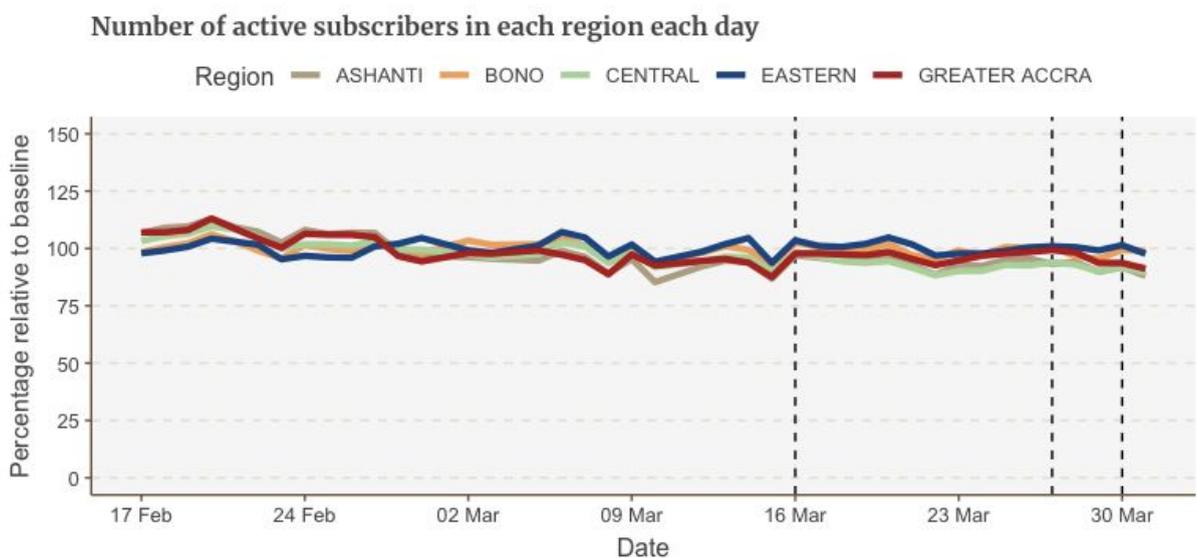
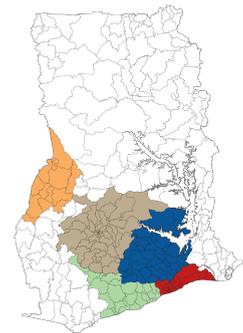
Analysis by Flowminder. Data from Vodafone Ghana

Figure 2: Number of active subscribers in Awutu Senya each day

2. Changes in the number of subscribers in each region

A similar analysis to Section 1 can be done at the regional level. Figure 3 shows the number of active subscribers each day, in a selection of regions.

We do not observe any large changes as we did for the districts shown in Section 1. This indicates that even before the introduction of travel restrictions, **people's movements between regions were likely to be limited to essential and infrequent travel only.**



Analysis by Flowminder, Data from Vodafone Ghana

Figure 3: Number of active subscribers in each region each day

3. Changes in the number of subscribers travelling between districts

We can monitor the volume of movements across districts by counting the number of trips made between two districts. Many of these trips correspond to frequent journeys made within urban areas, for example to commute between work and home.

In Figure 4, we show the total number of trips made between any pair of districts, on each day. We can see that **the number of trips started to decrease in the days after the first restrictions were imposed, but to a level that was not unusual when compared to the baseline period.** However, **in the second half of the week, there was a more prominent decrease** that reached its minimum on Sunday 22nd March. This was 70 percent of the baseline average - lower than any level seen during the previous weeks. **Once lockdown was imposed on Monday 30th March, the number of trips fell sharply to slightly over half of what was typically observed during the baseline period.**

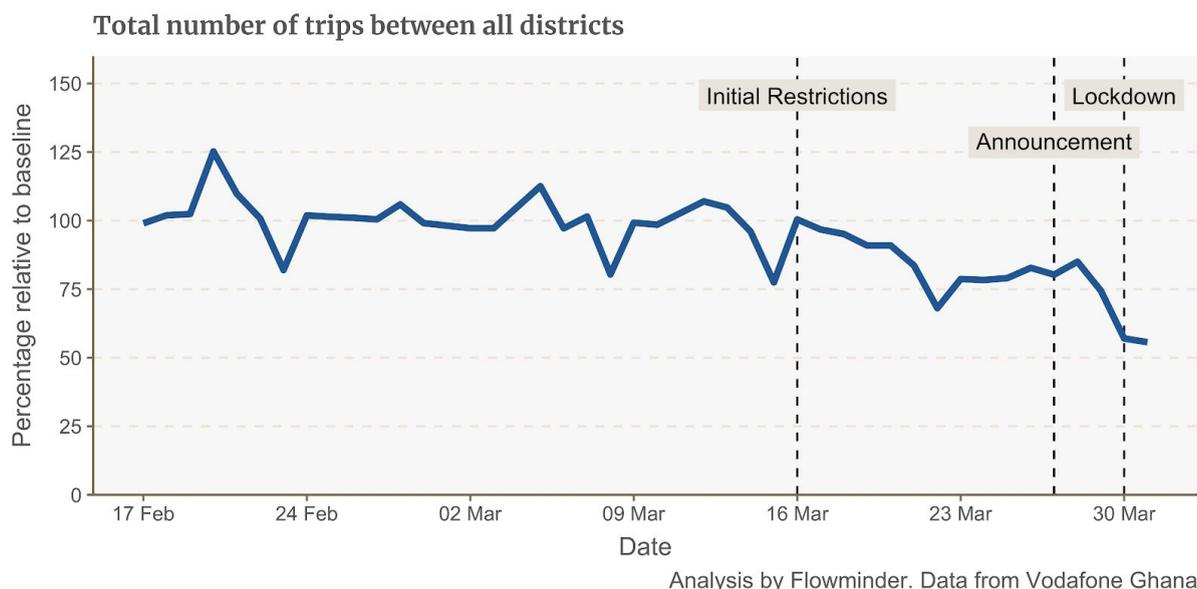


Figure 4: Total number of trips between all districts

4. Changes in the number of subscribers travelling between regions

We repeat the analysis in Section 3 at the regional level, showing the results in Figure 5. Journeys between regions are typically longer than journeys between districts, and are often made infrequently for 'special' reasons such as visiting family. We see a similar pattern to what we observed at the district level, with **a decrease in the number of inter-regional trips starting on Monday 16th March.** However, the minimum number of trips between regions was reached on a different date to the inter-district minimum - Tuesday 24th March instead of Sunday 22nd March. We again observe **a sharp decrease on Monday 30th March, reducing the number of trips to around 60 percent of what was normally observed** during the baseline period.

Since we only show percentages and not absolute counts in the graphs, we will point out here that **there were roughly one-tenth as many inter-regional trips as inter-district trips.** This is consistent with our

observations in Sections 1 and 2, where we noted that there is significantly more movement between the districts within a single region, than between regions.

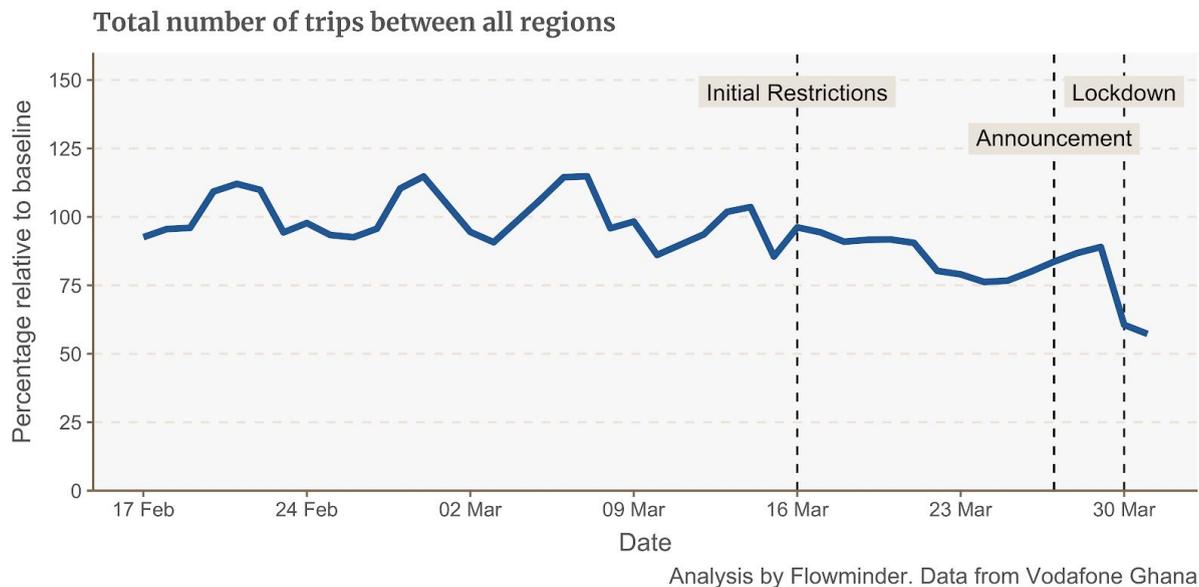


Figure 5: Total number of trips between all regions

5. Changes in Greater Accra and Ashanti following lockdown announcement

On Friday 27th March, the government announced that lockdown measures would be imposed over parts of the Greater Accra Metropolitan Area and the Greater Kumasi Metropolitan Area and contiguous districts, starting on Monday 30th March. We can use the data to see how the announcement of the lockdown, and the lockdown itself, affected travel within and out of the affected regions.

Figure 6 (upper) shows the total number of trips made between any two districts in Greater Accra. We compare this with Figure 6 (lower) which shows the total number of trips that started from a district in Greater Accra, and ended in a district in another region. We see from the upper panel that after the first restrictions were introduced, the number of trips within Greater Accra followed a similar trend to the total number of trips between all districts (Section 3). That is, that the number of trips gradually decreased over a week to a level below the baseline level, then increased slightly the following week to reach a level that was consistent with the lowest levels seen during the baseline period. **The announcement of lockdown did not appear to have any significant effect, whereas the lockdown itself did result in a sudden reduction to below half of the baseline level.**

In contrast, we see in the lower panel of Figure 6 that in the first week after the initial restrictions were introduced, travel between Greater Accra and all other regions decreased to a level that was similar to the lowest levels seen during the baseline period. At the end of this week, the level fell below the range seen during the baseline period. **The announcement of lockdown then seems to have prompted a sudden increase back to a relatively 'normal' baseline level, before the lockdown itself resulted in a very sharp reduction to slightly over half of the baseline level.**

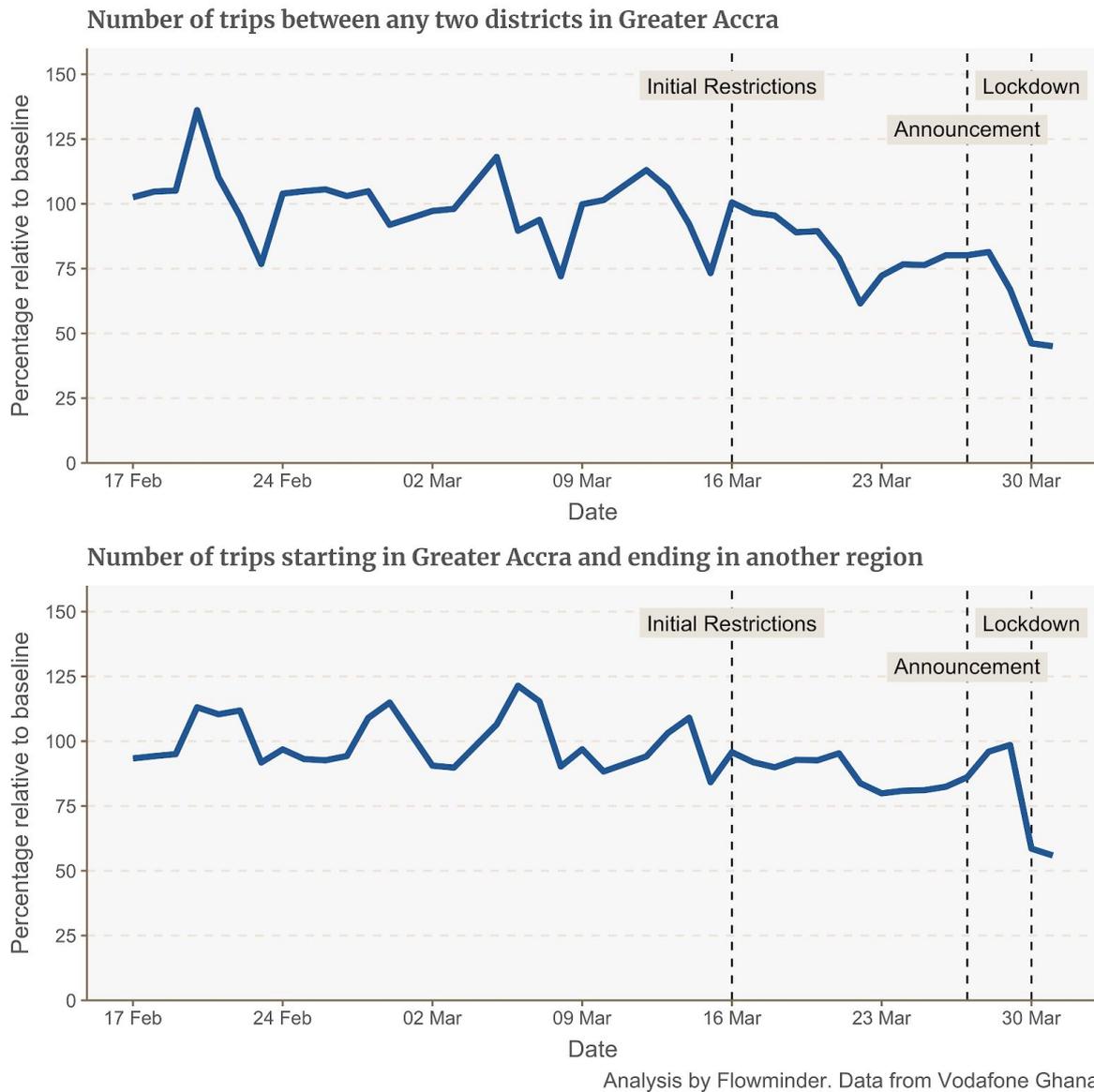


Figure 6: Number of trips between two districts in Greater Accra (upper), and from Greater Accra to another region (lower)

We repeat the comparison for Ashanti, showing movements within Ashanti in Figure 7 (upper), and movements starting from Ashanti and ending in another region in Figure 7 (lower). We observe similar patterns as for Greater Accra.

Movements between districts in Ashanti decreased slightly in the days after the first restrictions, but most of the time remained within the range seen during the baseline period. **After the lockdown announcement, a sudden increase occurred, followed by a sharp decrease to slightly over half the baseline level when lockdown was introduced.**

For movements between Ashanti and another region, we see that the **initial restrictions caused travel to decrease over the following week, and drop far below the baseline level by the end of the first week.** This drop was larger for Ashanti than Greater Accra. **The lockdown announcement prompted a spike in travel out of the region on Sunday 29th March, although still within the range observed during the baseline period. The lockdown then caused travel to decrease to below half of the baseline value.**

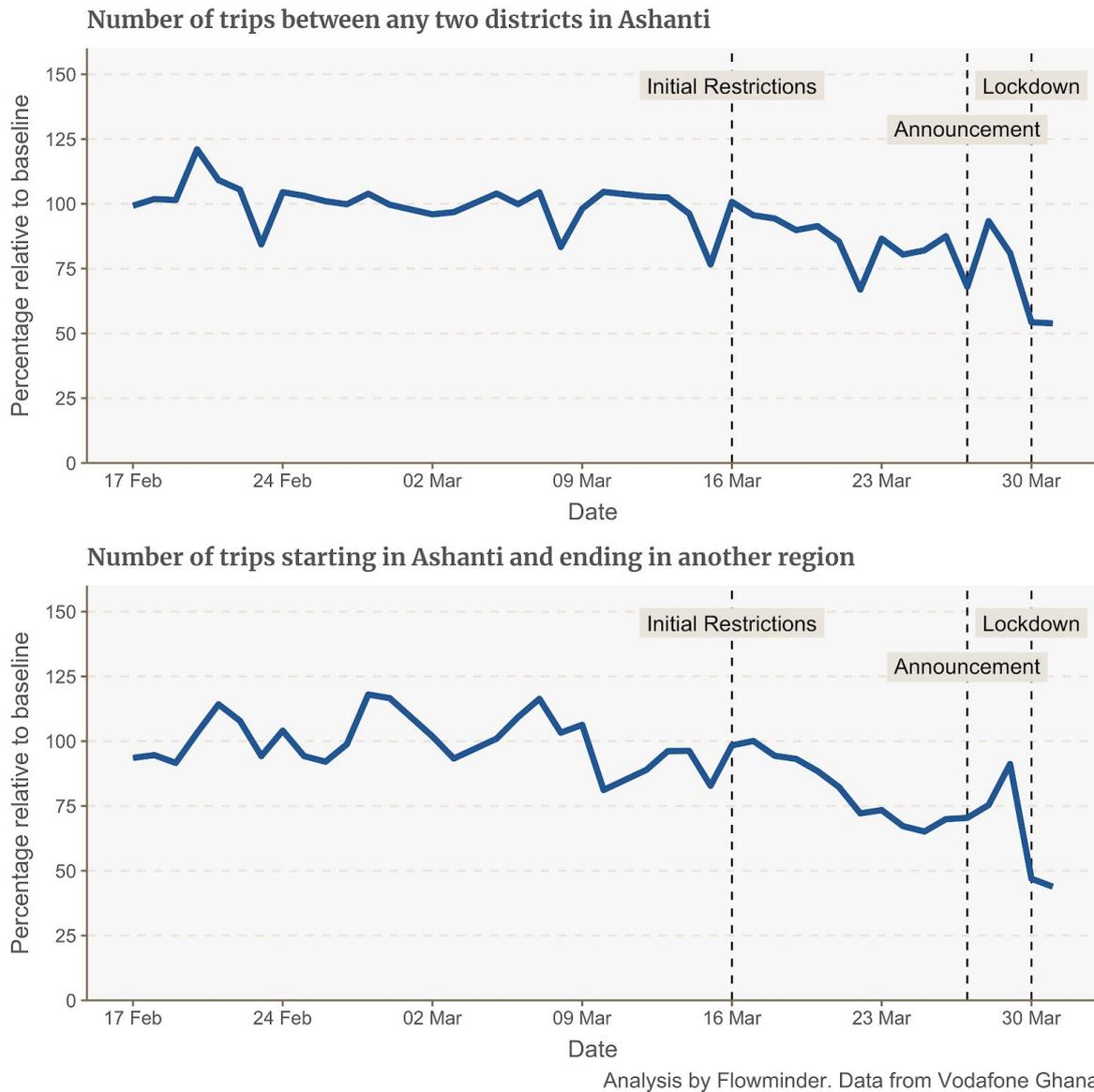


Figure 7: Number of trips between two districts in Ashanti (upper), and from Ashanti region to another region (lower)

It should be noted that although the announcement of lockdown seems to have prompted a larger increase in travel out of Greater Accra/Ashanti than within Greater Accra/Ashanti, the absolute number of trips out of Greater Accra/Ashanti is far smaller than the number of trips within Greater Accra/Ashanti. It should also be noted that **although the travel levels observed during the weekend after the lockdown announcement were higher than in the days immediately preceding the announcement, they were consistent with the levels observed during the pre-restriction baseline period.**

In further analysis, we will be able to assess which destinations have received an increased number of visitors as a result of the lockdown measures. We will also be able to assess whether people remain at their first destination, or travel on to other destinations as the lockdown continues in Greater Accra and Ashanti. This will inform authorities as to whether any alterations need to be made to resource provisioning plans. We can also study whether people have moved to a location that they regularly visit,

or to a location that they have rarely or never visited, in order to understand better how people react to lockdown measures.

Future work

This report has shown how mobile telecommunications data can be leveraged to provide timely and relevant insights during a crisis. The analyses presented here were performed within a very short timeframe and are intended to provide a high-level overview of a fast-moving situation. The work also serves to demonstrate the types of insights that can be extracted from the data, in order to engage with stakeholders that are involved in the COVID-19 response and whose work could benefit from these insights.

In the immediate future, we intend to focus on performing more detailed and rigorous analyses in order to obtain an in-depth understanding of the evolving situation. These cannot be performed as rapidly as the analyses presented in this report, but they will result in a much richer and more thorough picture. We will be able to gain a better understanding of aspects such as what 'normal' behaviour looks like, how interventions have had different effects on different districts and regions, and how the geographic distribution of the population has changed, and continues to change, as a result of the lockdown. Alongside this, we will also continue to perform rapid 'real-time' analyses if these prove to be valuable to decision-makers.

Analysis limitations

The anonymised and aggregated data used in this report is from Vodafone Ghana. This dataset is unlikely to be perfectly representative of the entire population of Ghana because not everyone uses a mobile phone, and not all mobile phone users are subscribed to Vodafone Ghana. In spite of these limitations, the dataset can still provide a good indicator of changes in a population's movements because a significant proportion of the population are included in the dataset. Whilst further work is needed to understand the extent to which analyses of telecommunications datasets result in biased estimates of population movements, the limited studies which exist have shown that such analyses have a high degree of validity. A telecommunications dataset also has the significant advantage that it can be analysed to generate very timely insights about the entire country - information can be made available about the nationwide situation as it was just a few days ago, as demonstrated in this report.

About the authors

This analysis was performed by the Flowminder Foundation, in partnership with Ghana Statistical Service (GSS). Access to de-identified (anonymised) mobile telecommunications data is being provided by Vodafone Ghana. Flowminder, GSS, and Vodafone Ghana have been working together, since 2018, on a Data For Good project that aims to strengthen capacity within GSS in order to enable the types of analysis described in this report to be performed more routinely and easily. The work is being funded by the William and Flora Hewlett Foundation and the Vodafone Foundation.

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