Monitoring the impact of the 2020-2021 COVID-19 mobility restrictions: Flowminder CDR analysis in seven low- and middle-income countries

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Abstract

Introduction

During the COVID-19 pandemic, many countries imposed mobility restrictions to reduce transmission and control the spread of the disease. Anonymised and aggregated mobile operator data, such as call detail records (CDRs), can provide near-real time insights into population mobility with high spatial and temporal resolution, across a whole country. Such data are useful for monitoring the impact of these restrictions on mobility and therefore help assess their potential impact on the spread of COVID-19. Flowminder supported the global response to the COVID-19 pandemic by working with mobile network operators, governments, and development actors, throughout 2020-2021 to rapidly generate CDR-derived insights related to population distribution and mobility changes caused by the pandemic and the associated mobility restrictions in seven countries (Curaçao, the Democratic Republic of the Congo (DRC), Ghana, Haiti, Namibia, Papua New Guinea, and Sierra Leone). Here, we detail the key analyses conducted to assess the impact of the response to the pandemic and mobility restrictions on mobility and the key learnings on rapid analysis of fast varying mobility indicators in multiple countries.

Data and Methods

We used anonymised CDR aggregates from 7 countries to produce indicators determining how mobility patterns changed during the COVID-19 pandemic and, in particular, in response to the announcement, implementation and lifting of mobility restrictions by governments.

We introduced a systematic classification at the time of short- and longer-term mobility indicators. Short-term indicators included: presence, the number of unique subscribers observed in an area (i.e. made a call routed by a cell site in that area) during a given period of time (e.g. hour, day); trips, the number of unique subscribers observed in an area having been previously observed in another area during a given time period (e.g. day); and the average number of areas visited by a subscribers each day. Longer-term indicators included residents, the number of subscribers whose home location (i.e. the area containing the cell site that most commonly routed a subscribers last call of the day) is assigned to an area; and relocations, the number of subscribers whose home location changed to an area from another area in a given period of time (e.g. week, month).

Using these indicators, Flowminder was able to generate insights into how mobility and population distributions changed, relative to a pre-pandemic baseline, following different government interventions. These included: how much has travel decreased; to what extent are people staying home more; how the distribution of population between different areas (e.g. urban vs rural) has changed; and how much has population mixing reduced (or increased) as a result of the measures.

Results

The mobility indicators derived from CDR data show a substantial, sharp reduction in mobility immediately following government restrictions in all seven countries (e.g. Fig.2), which may have helped control the spread of the disease as intended. However, the lifting of restrictions resulted in slow recovery of mobility towards the pre-pandemic baseline, suggesting a longer term impact of mobility restrictions on the economy. For example, in Namibia, the population in the core economic areas around Windhoek similarly remained below the pre-pandemic baseline beyond September 2020.

Mobility restrictions may also have unintended impacts which facilitated the spread of the disease. In both Haiti and Ghana we observed people relocating from urban to rural areas particularly in between the announcement and implementation of restrictions. We also note the redistribution in Haiti (Fig. 3) was similar to that usually observed around the Christmas period, suggesting that people returned to family homes outside of the cities. In Namibia, there was also a sharp increase in mobility following the announcement of the restrictions, prior to their implementation.

Discussion

Our multi-country COVID-19 response was significant in the development of Flowminder work on population mobility. It allowed us to test and implement a new way of analysing mobile operator data (through assisting mobile operators with running our code) and highlighted the need for a systematic categorisation of mobility indicators to support analysts and decision-makers to access relevant and impactful insights and compare them across countries and contexts. Also the large amount of data we analysed enabled us to explore limitations in our methodologies, particularly the impact of changes in phone use behaviour on the mobility information extracted from CDRs. For example, changes to tariffs in Namibia led to a reduction in mobility indicators, in fact mainly driven by a reduction in phone usage. Disentangling phone usage effects from mobility is of on-going development but is already more robust as a result of this work. This limitation is also more problematic when assessing routine mobility rather than large scale unusual changes such as those triggered by the COVID-19 mobility restrictions.

In conclusion, anonymised CDR aggregates can provide useful insights into both the short- and long-term impacts of mobility restrictions implemented by governments in LMICs. These can support decision-makers to monitor and evaluate the effectiveness of interventions to limit mobility, and therefore the spread of infectious disease, and to assess recovery of mobility after restrictions are lifted and the associated economic impact on economic activity.

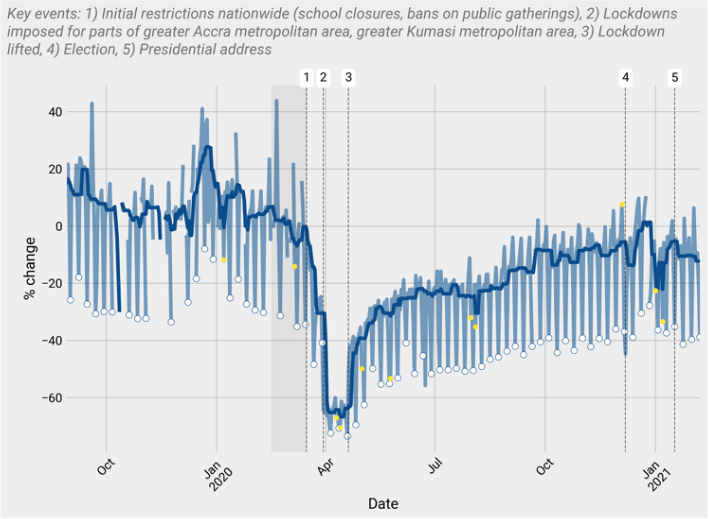

Figure 1. **Ghana. Percentage change in the number of trips between any two districts in Greater Accra**, each day, relative to the baseline value, overlaid with a seven day rolling average. Yellow and white dots denote public holidays and weekends, respectively, and the baseline period is indicated by the shaded region. The restrictions led to an immediate drop in mobility, followed by a slow recovery continuing long after the restrictions were lifted.

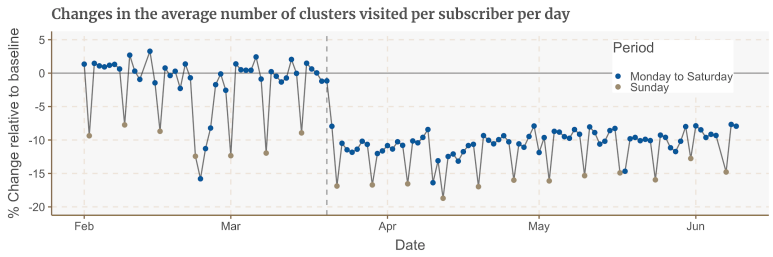

Figure 2. **Haiti. Percentage change in the mean number of locations (clusters of cell sites) visited per subscriber, each day,** relative to a pre-pandemic baseline period. The dotted line represents the introduction of mobility restrictions in Haiti. Covid-19 restrictions lead to an immediate drop in mobility, comparable to that of a normal Sunday.

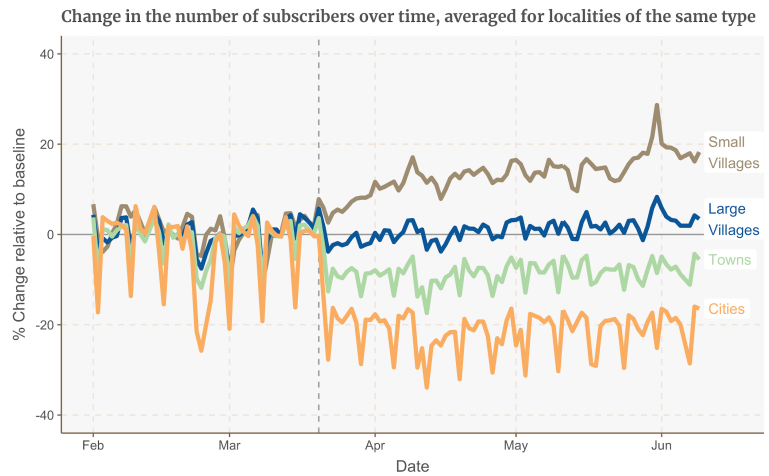

Figure 3. **Haiti. Average percentage change in the number of subscribers in localities of different levels of urbanisation** (cities, towns, large villages, small villages), each week. The dotted line represents the introduction of mobility restrictions in Haiti. Restrictions lead to a redistribution of the population, from the cities to the villages, similar to what is observed in Haiti during the end of year period.