

SUMMARY

Mobile phone data allows for the direct observation of population-scale mobility. In this study, the movements of populations in Senegal in 2013 were quantified using anonymised mobile phone data. Movement patterns among populations groups were extracted and visualised, which resulted in a series of mobility profiles from different regions of Senegal. These mobility profiles were compared with agricultural cycles and livelihoods of each region. Results of this analysis showed that for vulnerable population groups, changes in mobility patterns could indicate changes in livelihoods or coping strategies, or exposure to new shocks. Monitoring such changes in vulnerability in real time could be a powerful humanitarian early warning mechanism for informed decision-making and rapid response.

BACKGROUND

Patterns of population movements are often related to their livelihoods. For example, pastoralists migrate according to the grazing needs of their livestock, while other groups migrate to cities for work and then back to the country to prepare their land before the rainy season begins. Sudden changes in mobility patterns of vulnerable groups can indicate exposure to new shocks such as floods, loss of employment opportunities or adverse weather patterns. The growing ubiquity of mobile phones, especially among vulnerable populations, provides a new opportunity to analyse mobility patterns and create new early warning tools.

Livelihoods in Senegal show a strong correlation with geographical location. Thirteen livelihood zones have been mapped to show where people broadly share the same livelihood patterns. For example, people who live near the ocean generally pursue fishing, while people in the inland regions are agro-pastoralist.

Conventional methods of food security monitoring provide a detailed picture of mobility and livelihood patterns using historic survey data, but do not provide real-time information, which can be critical for timely response to shocks and early warning of emerging vulnerabilities.

In this context, Global Pulse worked with the UN World Food Programme (WFP) and Universidad Politecnica de Madrid to explore how mobile phone data can be used to support food security early warning in Senegal.

EXTRACTING MOBILITY PATTERNS FROM MOBILE PHONE ACTIVITY DATA

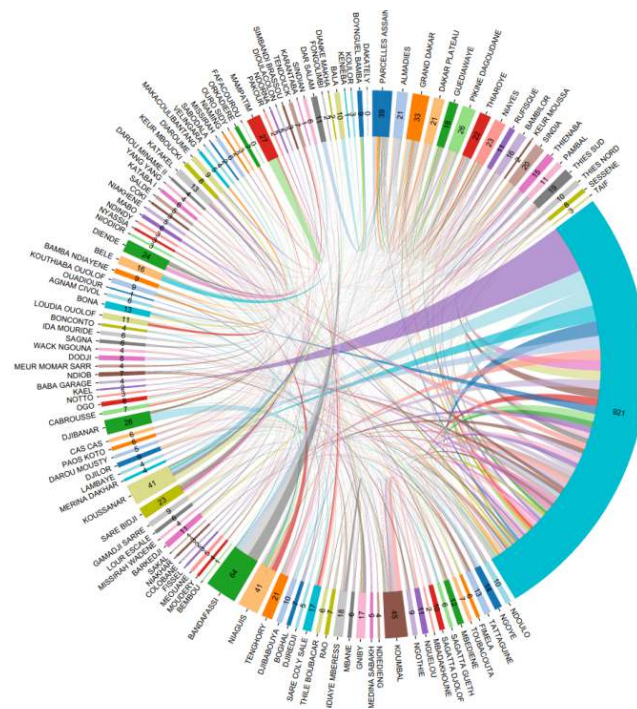
Anonymised mobile phone data can be used to analyse population mobility by measuring the distances between the cell towers from where calls are made, which indicates movement of the caller. When these measurements are aggregated, patterns in mobility can be revealed at a population level.

In order to explore how mobility patterns vary across seasons in Senegal, Global Pulse was provided access to one year of

anonymised mobile phone data from Senegal in 2013 by French

mobile network operator Orange through the Data for Development (D4D) Challenge. The analysis was performed at two time scales:

- Daily:** The population's daily movements between arrondissements (administrative districts) were computed and visualised to reveal the effects of particular events on mobility and geographic distribution of population movements throughout 2013. The figure below shows people returning home following the celebration of Grand Magal, an annual festival in the holy city of Touba.
- Monthly:** Longitudinal mobility data was anonymised and aggregated to a monthly scale to analyse different migration patterns in each livelihood zone and arrondissement. An algorithm was used to group individuals in each livelihood zone who showed similar movement trajectories throughout the year, revealing several distinct 'mobility profiles.'

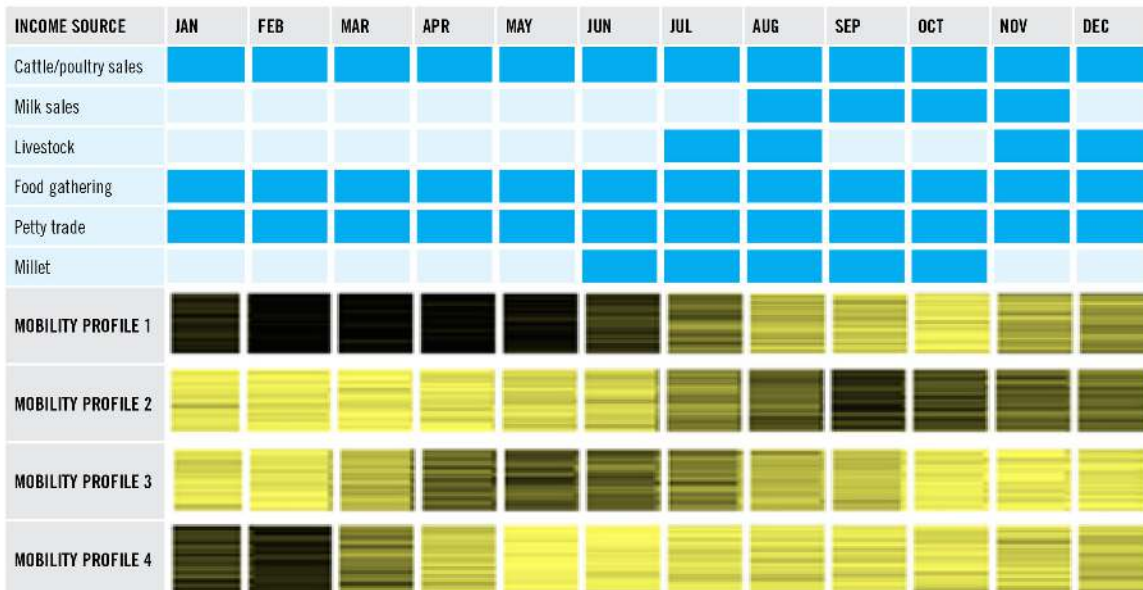


Line width is proportional to the number of people moving home. The size of each outer slice represents the people leaving each district. The large blue slice shows the majority of movement was from the district of Ndiaye, where the Grand Magal celebrations took place in Touba.

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ZONE 6: SYLVO-PASTORAL ZONE



The figure above shows an annual calendar of income generating activities mapped against the four most representative mobility profiles of population subgroups obtained from mobile phone data in the sylvo-pastoral livelihood zone in 2013. Each horizontal line inside the Mobility Profile boxes corresponds to an individual staying within (yellow) or traveling outside (black) this livelihood zone. Each Mobility Profile groups together individuals with similar mobility behaviours. Therefore, if over the course of the year, the boxes go from black to yellow, that population subgroup is entering the livelihood zone, while transition from yellow to black means that the subgroup is moving out of the zone.

Monthly rainfall data was also calculated for each livelihood zone at different geographical and temporal resolutions using remote sensing data from NASA. This data was included in the dashboard and also compared against the mobility profiles, showing how population movements are related to rainfall levels.

INSIGHTS & OUTCOMES

The tool developed in this study could provide a detailed picture of the mobility patterns of populations as a function of their livelihoods. For example, this tool could be used to measure the relative size of the different populations that moved into the peanut production zone in central Senegal from other regions during the planting season.

Within each livelihood zone, there are well-studied patterns of seasonal activities and population movements. For vulnerable population groups, changes to these known mobility patterns can indicate either changes in livelihoods or coping strategies, or exposure to new shocks. Hence, monitoring such changes can be a powerful early warning mechanism for decision-making and response.

CONCLUSIONS

Mobility patterns extracted from the data were visualised as mobility calendars in the same framework as seasonal monitor reports to ensure usability of the tool. Analysing this data could also help quantify short-term and unexpected population movements.

As this study was conducted using data from 2013, a longer-term study using additional sources of data from multiple years is needed to fully develop the methodology and build a more robust baseline of seasonal mobility.

IMPLICATIONS & RECOMMENDATIONS

- This project demonstrates how anonymised mobile phone data can be used to monitor human mobility. New early warning tools could be created with mobile data made available for development and humanitarian interventions.
- It is recommended that a long-term study be conducted to establish a clear data baseline and methodological framework.
- It is recommended to continue exploring a new policy framework for the use of mobile data for development and humanitarian action.

REFERENCES

- WFP Activities in Senegal (2014) UN World Food Programme. <http://www.wfp.org/countries/senegal/operations>
- Senegal Livelihood Zones (2011) WFP et al. http://www.fews.net/sites/default/files/documents/reports/SN_Livelihoods.pdf
- Livelihood Zone Descriptions (2011) WFP/FAO/SE-CNSA/FEWS, Comprehensive Food Security and Vulnerability Analysis. www.fews.net/sites/default/files/documents/reports/sn_livelihoodzonedescriptions2011_en.pdf

FOR MORE INFORMATION ON THE D4D CHALLENGE VISIT:

<http://arxiv.org/abs/1407.4885>

DATA VISUALISATIONS CAN BE VIEWED AT:

<http://pulselabkampala.ug/d4d-senegal>

THE FULL TECHNICAL REPORT IS ACCESSIBLE AT:

P. Zufiria et al. Mobility profiles and calendars for food security and livelihoods analysis (2015) D4D Challenge proceedings, Netmob 2015.