SUMMARY

Natural disasters affect hundreds of millions of people worldwide every year. Emergency response efforts depend on the availability of timely information, such as the movement and communication behaviours of affected populations. As such, analysis of Call Detail Records (CDRs) collected by mobile phone operators can provide new, real-time insights about human behaviour during such critical events. In this study, mobile phone activity data was combined with remote sensing data to understand how people communicated during severe flooding in the Mexican state of Tabasco in 2009, in order to explore ways that mobile data can be used to improve disaster response. By comparing the mobile data with official population census data, the representativeness of the research was validated. The results of the study showed that the patterns of mobile phone activity in affected locations during and after the floods could be used as indicators of (1) flooding impact on infrastructure and population and (2) public awareness of the disaster. These early results demonstrated the value of a public-private partnership on using mobile data to accurately indicate flooding impacts in Tabasco, thus improving early warning and crisis management.

MOBILE DATA FOR DISASTER MANAGEMENT

The lack of timely, accurate information about movement and communications of affected populations during natural disasters can limit the effectiveness of humanitarian response. However, the growing ubiquity of mobile phones has revealed new opportunities for accessing such information. Real-time mobile phone data can provide valuable insights about the behaviour of affected populations during a disaster. For example, recent research has demonstrated the potential of mobile phone data to help model malaria outbreaks in Kenya (Wesolowski et al., 2012) and study population movements after an earthquake in Haiti. (Lu et al., 2011)

By examining mobile phone activity data before, during and after a disaster, a baseline understanding of emergency behaviour and capacity to measure the rate of disaster recovery can be established. This research explored how mobile data can be used to understand the impact of floods on human behaviour using the 2009 floods in Tabasco, Mexico, as a case study.

A MULTIDISCIPLINARY CONSORTIUM

Starting on 31 October 2009, the state of Tabasco received four days of record-breaking rainfall (800mm, which was four times the November average). The resultant floods affected more than 200,000 people, and the state lost over USD 190 million in property damage.

Access to timely data about how the floods were affecting the population would have been useful in allocating emergency supplies, understanding where to target public warnings and how people were responding to the flooding.

Global Pulse worked with the Government of Mexico and several cross-sector partners to explore the potential of mobile data to provide such real-time information and access contextual information such as ground truth data from the Tabasco region, civil protection information and census data. Expert partners in data analysis and humanitarian aid were engaged to execute the project.

Telefonica Research, division of a major telecommunications company in Mexico, collaborated with data scientists from the Technical University of Madrid to conduct research under the guidance of Global Pulse and with expert advice from the UN World Food Programme (WFP) specialists on humanitarian programmes and remote sensing.

USING CALL RECORDS TO UNDERSTAND REACTIONS TO FLOODS

This study used mobile phone data combined with remote sensing data (satellite images), rainfall data, census and civil protection data. The data was provided by local mobile network operators in the form of Call Detail Records (CDRs), which are digital records of phone transactions. CDRs are generated when a phone connected to the mobile network makes or receives a phone call, or uses a service such as SMS.

The data used in the study covered the geographical area affected by the floods—Tabasco and part of Veracruz state—for nine months (July 2009 to March 2010). In order to protect customers’ privacy, the CDRs were aggregated and anonymised.

Regional mobile phone activity during the Tabasco floods was compared with a baseline level of activity calculated with data collected the month prior to the floods from the same cell phone towers. Variation in the numbers of calls during floods compared to the baseline helped to show how affected populations behave in response to flooding.

OUTCOMES & INSIGHTS

This research demonstrated that mobile phone data has the potential to provide real-time information on human behaviour for improved emergency management and humanitarian response.
Insights gained from CDR analysis could also serve as a potential proxy indicator for flood impact and risk awareness.

Several specific insights emerged from the study:

- **Mobile phone data can be highly representative of the population:** The results of the CDR study were compared with the population distribution data from the 2010 census to measure the representativeness of the sample analysed using CDRs. The comparison showed a strong linear relation between official population statistics and population estimates based on CDR data. This validation shows the possibility of using mobile phone data as a proxy indicator of population in areas where other data sources are not available or reliable.

- **Civil protection warnings are not necessarily an effective way to raise awareness:** A civil protection warning was issued on the day of highest rainfall. One might expect such a warning to boost communications activity, but big spikes in activity were only observed in two cell phone towers along the most affected road (both also suffered power outages soon after the warning was issued, making the finding somewhat inconclusive). This result did show that emergency warnings did not cause a significant increase in communication activity in the affected areas.

- **Mobile activity can provide signals of flooding impact:** In the cell phone towers that did not show a spike in mobile activity during the emergency warning (which would indicate people making calls to spread the alert), the delay between highest rainfall and peak mobile activity was typically four days. This could mean that people communicated more as a result of the initial impacts of flooding, while the civil protection warning did not generate similar levels of awareness. This finding reveals important behavioural insights for emergency responders on how and when affected populations are made aware of a disaster.

- **The most calls were made from the most impacted areas:** When analysed against the baseline activity, it was found that cell phone towers with higher variations in the number of calls made during the floods were located in the most affected locations. (For the sake of comparison, on Christmas there were similar variations in activity compared to the baseline, but across the entire Tabasco region as opposed to specific locations.) This shows that the population does communicate more than usual in the wake of a disaster.

CONCLUSIONS

The research findings demonstrated that real-time data on flood risk and public awareness is obtainable through CDRs, and could be a beneficial source of information for both emergency management and resilience assessment.

Analysing mobile activity during floods could be used to potentially locate damaged areas, efficiently assess needs and allocate resources (for example, sending supplies to affected areas). Identifying cell phone towers in the most affected areas of flooding might also serve to improve and target public communications and safety alerts, as well as help measure the effectiveness of such early warning announcements.

While it is clear that there is a need for further exploration and development of the methods used in this study, operationalizing data-driven decision making requires institutional capacities, policy frameworks and technological infrastructure that may not be in place within local or national disaster management offices.

Further research is recommended to explore how long it takes for mobile activity to stabilize and return to normal levels after a disaster, as a potential indicator of the rate of recovery for resilience measurement. It could also add dimension to decision makers’ understanding of vulnerability and behaviour to combine analysis of CDRs with crowdsourced data from disaster-affected communities (for example, by conducting phone surveys via SMS).

IMPLICATIONS & RECOMMENDATIONS

- Aggregated and anonymised mobile phone data can be used to assess risk awareness, understand the effect of public communications such as disaster alerts and measure the direct impact of floods.

- It is recommended that a more extensive validation of the results be conducted by examining other incidents covering similar disasters in other geographies.

- Assessment of how information provided by mobile phone data could be integrated with the current standard information flows used during emergency response is recommended.

- The study evidenced the potential value of public-private partnerships for mobile data sharing. Therefore it is recommended that a public-private partnership framework for mobile data sharing be developed that could be used in future emergency situations.

REFERENCES


THE FULL TECHNICAL REPORT ON THIS STUDY IS AVAILABLE:


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