v 2017-01-16

Mobile phone data in humanitarian contexts

Christophe Cloquet

Jan 2017

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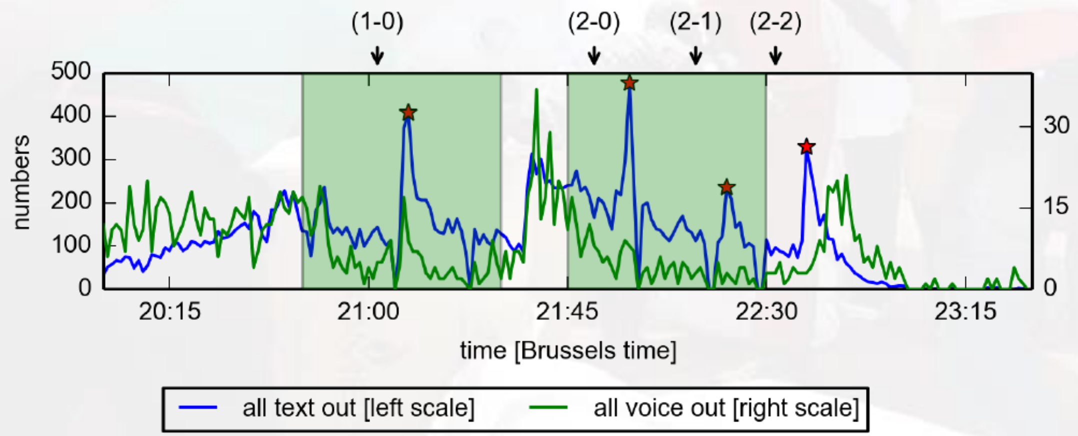
Richness of the data : dynamics

Text messages and phone calls during the international soccer match Belgium-Ivory Coast (March 5, 2014).



Forecasting event attendance with anonymized mobile phone data

C. Cloquet[1], V. D. Blondel[1]

Census

Dynamic population mapping using mobile phone data

Pierre Deville[a,b,c,1], Catherine Linard[c,d,1,2], Samuel Martin[e], Marius Gilbert[c,d], Forrest R. Stevens[f], Andrea E. Gaughan[f], Vincent D. Blondel[a], and Andrew J. Tatem[g,h,i]

[a]Department of Applied Mathematics, Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium; [b]Center for Complex Network Research and Physics Department, Northeastern University, Boston, MA 02115; [c]Fonds National de la Recherche Scientifique, B-1000 Brussels, Belgium; [d]Biological Control and Spatial Ecology, Université Libre de Bruxelles, B-1050 Brussels, Belgium; [e]Université de Lorraine CNRS, Centre de Recherche en Automatique de Nancy, UMR 7039, 54518 Vandoeuvre-lès-Nancy, France [f]Department of Geography and Geosciences, University of Louisville, Louisville, KY 40292; [g]Department of Geography and Environment, University of Southampton, Southampton SO17 1BJ, United Kingdom; [h]Fogarty International Center, National Institutes of Health, Bethesda, MD 20892; and [i]Flowminder Foundation, 17177 Stockholm, Sweden

Edited by Michael F. Goodchild, University of California, Santa Barbara, CA, and approved September 15, 2014 (received for review May 8, 2014)

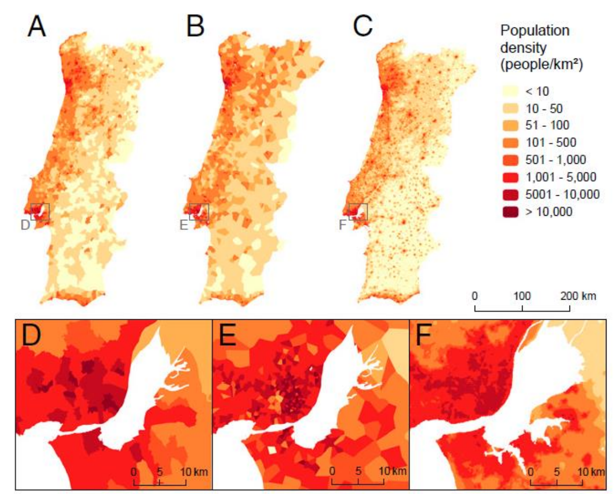


Fig. 1. Comparison of predicted population density datasets with baseline data for mainland Portugal. (*A*) Population density as calculated from the national census at administrative unit level 5 (ADM-5; freguesia). (*B*) Population density at the level of Voronoi polygons, as estimated by the MP method. (*C*) Population density at the level of 100 × 100-m grid squares, as estimated by the RS method. (*D*–*F*) Close-ups around the capital city Lisbon.

Poverty indices

Estimating Food Consumption and Poverty indices with Mobile Phone Data

Adeline Decuyper[1], Alex Rutherford[2], Amit Wadhwa[3] Jean Martin Bauer[3] Gautier Krings[1,4] Thoralf Gutierrez[4] Vincent D. Blondel[1] Miguel A. Luengo-Oroz[2,*]

GLOBAL PULSE

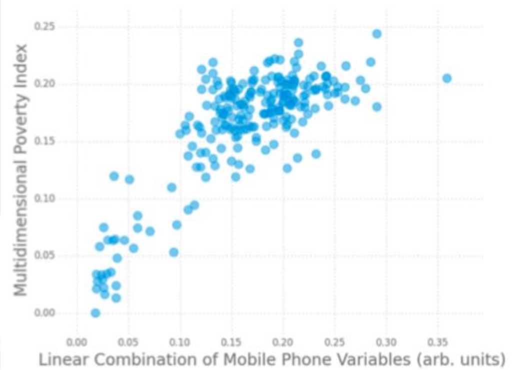
USING MOBILE PHONE DATA AND AIRTIME CREDIT PURCHASES TO ESTIMATE FOOD SECURITY

PARTNERS: UN WORLD FOOD PROGRAMME, UNIVERSITÉ CATHOLIQUE DE LOUVAIN, REAL IMPACT ANALYTICS

PROGRAMME AREA: FOOD SECURITY & AGRICULTURE

WFP
wfp.org

FOOD ITEM (VARIABLE)	CORRELATION RANGE
Vitamin-rich vegetables (carrot, orange, sweet potato), rice, wheat, bread, sugar, meat	[0.7–0.8]
Eggs, oil, milk, butter, organ meat	[0.5–0.6]
Sorghum, ground nuts, seeds, fish, fruits, cooking banana, green leafy vegetables, beans, peas, maize, white roots, tubers, pumpkin, squash, cassava	[0.0–0.4]
White sweet potato	-0.4



The scatterplot graph above shows the correlation between the Multidimensional Poverty Index and a linear combination of mobile phone variables (including airtime credit expenditures).

Malaria

Tatem *et al. Malaria Journal* 2014, **13**:52
http://www.malariajournal.com/content/13/1/52

MALARIA JOURNAL

RESEARCH **Open Access**

Integrating rapid risk mapping and mobile phone call record data for strategic malaria elimination planning

Andrew J Tatem[1,2*], Zhuojie Huang[3,4], Clothilde Narib[5], Udayan Kumar[4,6], Deepika Kandula[7], Deepa K Pindolia[3,4], David L Smith[2,8], Justin M Cohen[7], Bonita Graupe[9], Petrina Uusiku[5] and Christopher Lourenço[5,7]

One year of aggregated movement patterns for over a million people across Namibia are analyzed, and linked with case-based risk maps built on satellite imagery.

These maps can aid the design of targeted interventions to maximally reduce the number of cases exported to other regions while employing appropriate interventions to manage risk in places that import them

Quantifying the Impact of Human Mobility on Malaria

Amy Wesolowski,[1,2] Nathan Eagle,[3,4] Andrew J. Tatem,[5,6,7] David L. Smith,[6,8] Abdisalan M. Noor,[9,10] Robert W. Snow,[9,10] Caroline O. Buckee[4,11]*

Human movements contribute to the transmission of malaria on spatial scales that exceed the limits of mosquito dispersal. Identifying the sources and sinks of imported infections due to human travel and locating high-risk sites of parasite importation could greatly improve malaria control programs. Here, we use spatially explicit mobile phone data and malaria prevalence information from Kenya to identify the dynamics of human carriers that drive parasite importation between regions. Our analysis identifies importation routes that contribute to malaria epidemiology on regional spatial scales.

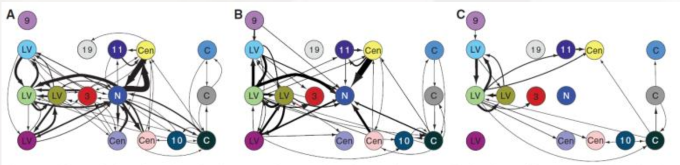


Fig. 2. Travel networks of people and parasites between settlements and regions. (**A**) Average monthly travel between regions (nodes), with edges weighted by volume of traffic. For clarity, the top 50% of routes are shown with arrows indicating the direction of movement (humans or parasites) from a primary settlement to a visited settlement. (**B**) Average monthly parasite importation by returning residents, by region. (**C**) Average monthly parasite importation by visitors, where importation is only considered if the destination is receptive to onward transmission (*14*). Nodes are colored and labeled as described in Fig. 1.

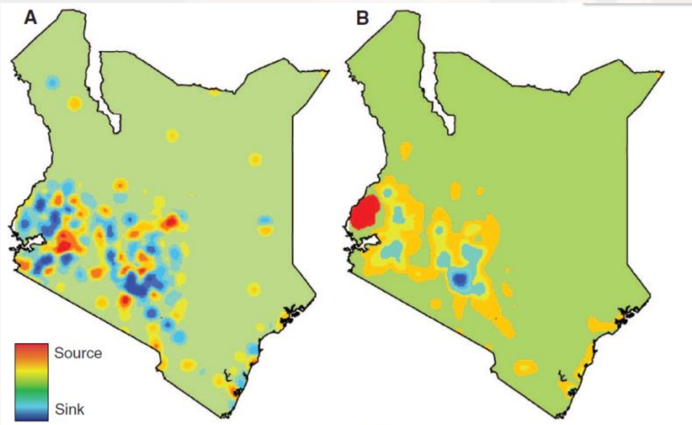


Fig. 3. Sources and sinks of people and parasites. Kernel density maps showing ranked sources (red) and sinks (blue) of human travel and total parasite movement in Kenya, where each settlement was designated as a relative source or sink based on yearly estimates. (**A**) Travel sources and sinks. (**B**) Parasite sources and sinks.

Cited By...

- The ethics of big data as a public good: which public? Whose good?
- Perspectives on the role of mobility, behavior, and time scales in the spread of diseases
- Mass Drug Administration for Malaria: A Means to What end?
- Connecting Mobility to Infectious Diseases: The Promise and Limits of Mobile Phone Data
- Leveraging contact network structure in the design of cluster randomized trials
- Assessing reliable human mobility patterns from higher order memory in mobile communications
- Calling in sick: impacts of fever on intra-urban human mobility
- Mobile phone data highlights the role of mass gatherings in the spreading of cholera outbreaks
- Differential and enhanced response to climate forcing in diarrheal disease due to rotavirus across a megacity of the developing world
  - Malaria Parasitemia Among Febrile Patients Seeking Clinical Care at an Outpatient Health Facility in an Urban Informal Settlement Area in Nairobi, Kenya
  - Virus evolution and transmission in an ever more connected world
  - Impact of human mobility on the emergence of dengue epidemics in Pakistan
  - Quantifying seasonal population fluxes driving rubella transmission dynamics using mobile phone data
  - Malaria genotyping for epidemiologic surveillance
  - Modeling infectious disease dynamics in the complex landscape of global health
  - Advancing digital methods in the fight against communicable diseases
  - Modeling internal migration flows in sub-Saharan Africa using census microdata
  - Unique in the shopping mall: On the reidentifiability of credit card metadata

Use cases

Ebola

MIT Technology Review

Topics+ Top S

SOLVE Submit an idea. Change the w

Biomedicine

Cell-Phone Data Might Help Predict Ebola's Spread

Mobility data from an African mobile-phone carrier could help researchers recommend where to focus health-care efforts.

by David Talbot August 22, 2014

Other infectious

The Journal of Infectious Diseases

(2016)

Connecting Mobility to Infectious Diseases: The Promise and Limits of Mobile Phone Data

Amy Wesolowski[1,2], Caroline O. Buckee[1,2], Kenth Engø-Monsen[3] and C. J. E. Metcalf[4,5]

Big Data for Infectious Disease Surveillance and Modeling

Shweta Bansal[1,2], Gerardo Chowell[1,3], Lone Simonsen[1,4], Alessandro Vespignani[5] and Cécile Viboud[1]

PNAS

Quantifying seasonal population fluxes driving rubella transmission dynamics using mobile phone data

Amy Wesolowski[a,b,c,1,2], C. J. E. Metcalf[d,e,f,1,2], Nathan Eagle[a,g], Janeth Kombich[h], Bryan T. Grenfell[d,e], Ottar N. Bjørnstad[i], Justin Lessler[j], Andrew J. Tatem[c,f,k], and Caroline O. Buckee[a,b,c]

[a]Department of Epidemiology, Harvard School of Public Health, Boston, MA 02115; [b]Center for Communicable Disease Dynamics, Harvard School of Public Health, Boston, MA 02115; [c]Flowminder Foundation, SE-113 55 Stockholm, Sweden; [d]Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ 08544; [e]Woodrow Wilson School, Princeton University, Princeton, NJ 08544; [f]Fogarty International Center, National Institute of Health, Bethesda, MD 20892; [g]Department of Computer Science, Northeastern University, Boston, MA 02115; [h]Department of Biological Sciences, University of Kabianga, Kericho Country, Kenya; [i]Center for Infectious Disease Dynamics, The Pennsylvania State University, State College, PA 16801; [j]Department of Epidemiology, Johns Hopkins Bloomberg School

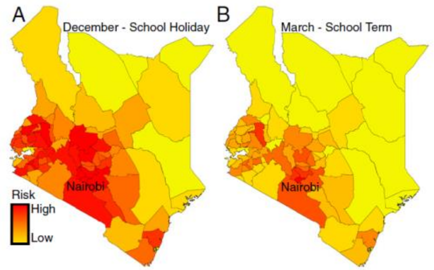


Fig. 3. The seasonal variability in the risk of importation. We analyzed the average amount of population flux per district during (*A*) the major holiday and a school term break (December) and (*B*) during a school term (March). As highlighted in Fig. 1, there are large amounts of population flux and consequently the risk of importation during school breaks (*A* and *B*). In contrast, there is a decrease in the risk of importation during the school term. During the course of the year, the districts with the largest risks vary with higher risks to western Kenya during school breaks. However, Nairobi (shown in red in both maps) consistently remains at a high risk of importation from the large population fluxes.

Use cases

Other infectious

The Journal of Infectious Diseases

SUPPLEMENT ARTICLE

IDSA Infectious Diseases Society of America · hivma hiv medicine association · OXFORD

Big Data for Infectious Disease Surveillance and Modeling

Shweta Bansal,[1,2] Gerardo Chowell,[1,3] Lone Simonsen,[1,4] Alessandro Vespignani,[5] and Cécile Viboud[1]

[1]Fogarty International Center, National Institutes of Health, Bethesda, Maryland; [2]Department of Biology, Georgetown University, Washington D.C.; [3]School of Public Health, Georgia State University, Atlanta; [4]Department of Public Health, University of Copenhagen, Denmark; and [5]Network Science Institute, Northeastern University, Boston, Massachussets

We devote a special issue of the *Journal of Infectious Diseases* to review the recent advances of big data in strengthening disease surveillance, monitoring medical adverse events, informing transmission models, and tracking patient sentiments and mobility. We consider a broad definition of *big data* for public health, one encompassing patient information gathered from high-volume electronic health records and participatory surveillance systems, as well as mining of digital traces such as social media, Internet searches, and cell-phone logs. We introduce nine independent contributions to this special issue and highlight several cross-cutting areas that require further research, including representativeness, biases, volatility, and validation, and the need for robust statistical and hypotheses-driven analyses. Overall, we are optimistic that the big-data revolution will vastly improve the granularity and timeliness of available epidemiological information, with hybrid systems augmenting rather than supplanting traditional surveillance systems, and better prospects for accurate infectious diseases models and forecasts.

Use cases

Natural disaters : Haïti

OPEN ACCESS Freely available online PLoS MEDICINE

Improved Response to Disasters and Outbreaks by Tracking Population Movements with Mobile Phone Network Data: A Post-Earthquake Geospatial Study in Haiti

Linus Bengtsson[1]*, Xin Lu[1,2], Anna Thorson[1], Richard Garfield[3], Johan von Schreeb[1]

1 Department of Public Health Sciences, Karolinska Institutet, Stockholm, Sweden, 2 Department of Sociology, Stockholm University, Stockholm, Sweden, 3 Schools of Nursing and Public Health, Columbia University, New York City, United States of America

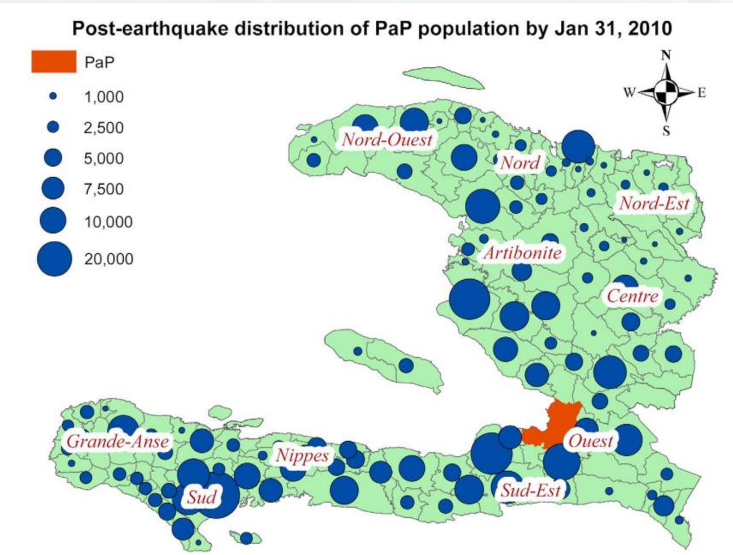


Figure 2. Estimated distribution of persons who were in PaP on the day of the earthquake but outside PaP 19 d after the earthquake. Circles are shown for communes that received at least 500 persons.
doi:10.1371/journal.pmed.1001083.g002

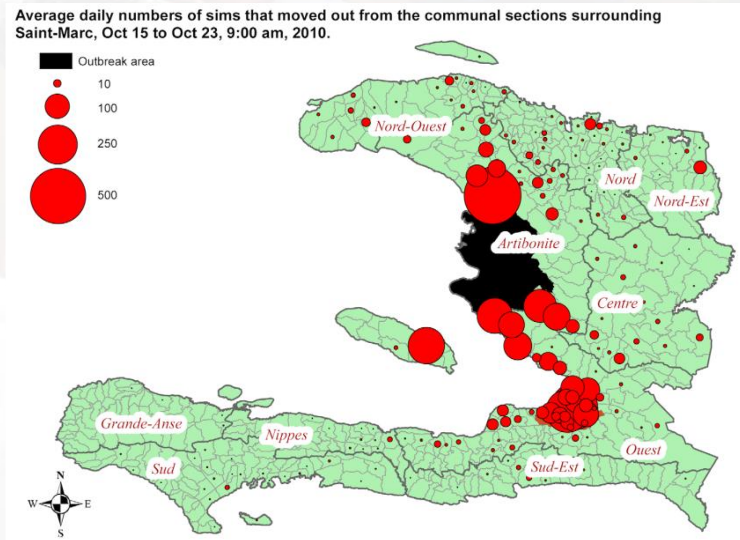


Figure 5. Average daily numbers of SIMs moving out of the cholera outbreak area. October 15 to October 23, 2010, divided per communal section of destination. The data were disseminated to relief agencies at the outset of the outbreak (October 24, 2010).
doi:10.1371/journal.pmed.1001083.g005

Use cases

Natural disasters

USING MOBILE PHONE ACTIVITY FOR DISASTER MANAGEMENT DURING FLOODS

GLOBAL PULSE

PARTNERS: GOV. OF MEXICO, UN WORLD FOOD PROGRAMME, TELEFONICA RESEARCH, UNIVERSIDAD POLITECNICA DE MADRID

PROGRAMME AREA: HUMANITARIAN ACTION

WFP

wfp.org

SUMMARY

Natural disasters affect hundreds of millions of people worldwide every year. Emergency response efforts depend on the availability of timely information, such the movement and communication behaviours of affected populations. As such, analysis of Call Detail Records (CDRs) collected by mobile phone operators reveal 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.

"The most calls were made from the most impacted areas"

"Flooding through the Lens of Mobile Phone Activity." Pastor-Escuredo, D., Morales-Guzmán, A. et al, IEEE Global Humanitarian Technology Conference, GHTC 2014.

Other

The emergent opportunity of Big Data for Social Good
Dr. Nuria Oliver, Telefónica

Emergency Event Detection Using Mobile Phone Data
Didem Gundogdu, University of Trento

oii.ox.ac.uk/events/symposium-on-big-data- and-human-development

Oxford Internet Institute : Big Data for Developement
http://bigdatadevelopment.oii.ox.ac.uk

Poppy

Metho : Big Data == proxies => biases, ...

On the use of human mobility proxies for modeling epidemics

Michele Tizzoni[1], Paolo Bajardi[2], Adeline Decuyper[3], Guillaume Kon Kam King[4], Christian M. Schneider[5], Vincent Blondel[3], Zbigniew Smoreda[6], Marta C. González[5,7], Vittoria Colizza[8,9,10,*]

JOURNAL OF THE ROYAL SOCIETY Interface

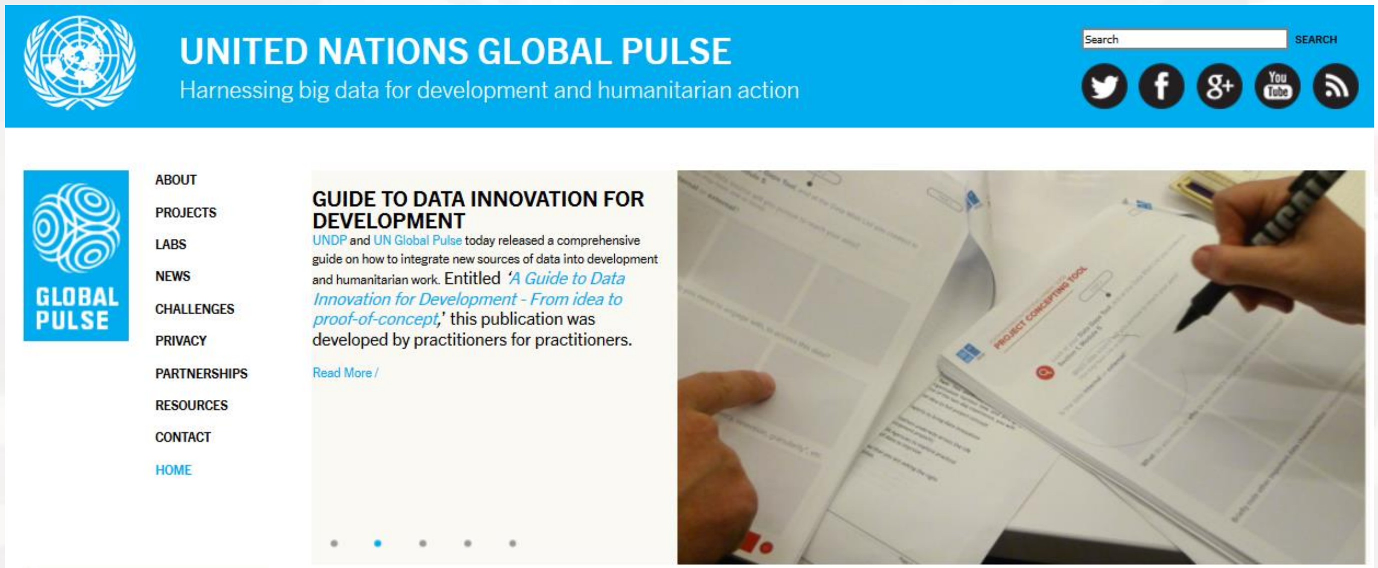
rsif.royalsocietypublishing.org

The impact of biases in mobile phone ownership on estimates of human mobility

Amy Wesolowski[1], Nathan Eagle[2,3], Abdisalan M. Noor[4,5], Robert W. Snow[4,5] and Caroline O. Buckee[3,6]

Méthodo

Global Pulse



unglobalpulse.org

Resources

Challenges D4D

First Prize and Energy Prize: Using mobile phone data for electrification planning

E.A. Martínez-Ceseña [1], P. Mancarella [1], M. Ndiaye [2], and M. Schläpfer [3]

Knowledge of local energy needs is crucial for the electricity infrastructure planning of a country. We have shown that mobile phone data are an accurate proxy of the energy needs and can be used to develop bottom-up demand models. The new methodology supports and prioritizes the electrification plans in areas with scarce information on local activities and energy consumption.

(1)University of Manchester, UK - (2) Ecole supérieure polytechnique de Dakar UCAD, Senegal - (3) Santa Fe Institute, USA

Agriculture Prize: Genesis of millet prices in Senegal: the role of production, markets and their failures

D.C. Jacques [1], R. d'Andrimont [1], J. Radoux (1), F. Waldner [1], and E. Marinho [2]

Information asymmetries are responsible for price differentials in only the few areas where the mobile phone coverage has not yet reached its full potential, which damages both poor producers and food insecure consumers. To address this issue, we have integrated it in a spatially explicit model that simulates the functioning of agricultural markets.

(1) Earth and Life Institute, Université Catholique de Louvain, Belgium - (2) Independent researcher, Rio de Janeiro, Brazil

Health Prize: Uncovering the impact of human mobility on schistosomiasis...

L. Mari [1], R. Casagrandi [1], M. Ciddio [1], S.H. Sokolow [2], G. De Leo [2], and M. Gatto [1]

Schistosomiasis is water based parasitic worm infection with debilitating symptoms affecting millions of people. We show that a relatively simple model can reliably reproduce regional patterns of schistosomiasis prevalence across the country. We use the model to study the role of human mobility on disease dynamics and to analyze intervention strategies aimed at reducing disease burden.

(1)Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano, Italy - (2) Hopkins Marine Station, Stanford University, USA

National Statistics Prize: Virtual Networks and Poverty Analysis in Senegal

N. Pokhriyal, W. Dong, and V. Govindaraju
Computer Science and Engineering, State University of New York at Buffalo, USA

Poverty is a complex phenomenon, but can be approximated by observing mobile phone usages and mobility at regional level and extrapolated at more granular level. Poverty maps showcasing multiple perspectives can provide policymakers with better insights for effective responses for poverty eradication.

Transport Prize: National and Regional Road Network Optimization for Senegal Using Mobile Phone Data

Y. Wang [1], G. Homem de Almeida Correia [1], and Erik de Romph [1,2]

Anonymous mobile phone traces can be filtered with an algorithm to generate a proxy for a trip origin-destination matrix. This is used to develop a gravity model that predicts the future mobility in the country dependent on travel time and number of calls and messages between the departments. This information is then used to improve decision making for road network planning.

(1) Department of Transport and Planning, Delft University of Technology, The Netherlands - (2) DAT.mobility, The Netherlands

Data Crossing Prize: Using mobile phone data for Spatial Planning simulation and Optimization Technologies (SPOT)

S. Gueye [1], B.M. Ndiaye [3], D. Josselin [3], M. Poss [5], R.M. Faye [2], P. Michelon [1], C. Genre-Grandpierre [3], and F. Ciari [4]

We propose a methodology of location and relocation of amenities (home, shop, work, leisure places) for urban planning decision. Our methodology exploits mobile phone data and other variables and point of interest on maps to propose optimal amenity locations to reduce the overall travel time or travel distance.

(1) LIA, Université d'Avignon, France - (2) LTI, ESP - Université de Cheikh Anta Diop, Senegal - (3) LMDAN, FASEG-Université de Cheikh Anta Diop, Senegal - (4) Institute for Transport Planning and Systems (IVT), Zurich, Switzerland - (5) UMR ESPACE, CNRS, Avignon, France

Data Visualization Prize: Data for Development Reloaded: Visual Matrix Techniques for the Exploration and Analysis of Massive Mobile Phone Data

S. van den Elzen, M. van Dortmont, J. Blaas, D. Holten, W. van Hage, J-K. Buenen, J.J. van Wijk, R. Spousta *, S. Sala *, S. Chan *, A. Kuzmickas * University of Technology SynerScope BV Sensemaking Fellowship

Eindhoven University of Technology & SynerScope BV, The Netherlands
* Sensemaking Fellowship (MIT, Harvard University)

In our Visual analytics techniques for the exploration and analysis of massive mobile phone data, users are enabled to identify both temporal and structural patterns such as normal behavior, outliers, anomalies, periodicity, trends and counter-trends.

Practical Application Prize: Mobile Data as Public-Health Decision Enabler: A Case Study of Cardiac and Neurological Emergencies

E. Mutafungwa [1], F. Thiessard [2], M. Pathé Diallo [2], R. Gore [3], V. Jouhet [2], C. Karray [4], N. Kheder [4], R. Saddem [4], J. Hämäläinen [1], G. Diallo [1]

The objective of the study is to show the areas in which the absence of a nearest hospital can result in death or serious squeals. The identification of areas at high risk in case of stroke of myocardial infarction, requiring rapid intervention, could help Public Health decision makers to priorize investments.

(1) Department of Communications and Networks, Aalto University School of Electrical Engineering, Finland - (2) ERIAS INSERM U897, ISPED, Université de Bordeaux, France - (3) Virginia Modeling Analysis and Simulation, Old Dominion University, USA - (4) Faculté des Sciences de Tunis, University of Tunis, Tunisia

Scientific Prize and Ethics Mention: Construction of socio-demographic indicators with digital breadcrumbs

F. Bruckschen [1], T. Schmid [2], T. Zbiranski [1]

We show that socio-demographic indicators such as population, age, literacy, poverty, religion, ethnicity, electricity supply and others can be estimated in unprecedented detail and virtually ad-hoc using antenna-to antenna traffic data only. We offer a uniform approach that can be easily extended to other variables. Results are tested for spatio-temporal robustness and visualized as heat maps.

(1) Humboldt Universität Berlin, Germany - (2) Freie Universität Berlin, Germany

NetMob

NetMob

The main conference on the scientific analysis of mobile phone datasets
5-7 April 2017 Vodafone Theatre, Milan, Italy

PAST EDITIONS OF NETMOB

NetMob 2015

April 7-10, 2015
Media Lab at MIT (Cambridge, MA)
NetMob 2015 program (3MB)
NetMob 2015 Book of abstracts: Oral contributions (131 pages, 28MB)
NetMob 2015 Book of abstracts: Poster contributions (120 pages, 47MB)
Netmob 2015 had a special session on the D4D Orange challenge on mobile phone dataset analysis
The D4D Book of Abstracts: Scientific Papers (298 pages, 83MB) and D4D Book of Abstracts: Posters (56 pages, 53MB) contain copies of all the submissions to the D4D challenge that have been selected for NetMob.

NetMob 2013

May 2-3, 2013
Media Lab at MIT (Cambridge, MA)
NetMob 2013 program (3MB)
NetMob 2013 Book of abstracts (176 pages, 40MB)
Netmob 2013 had a special session on the D4D Orange challenge on mobile phone dataset analysis
The D4D book (850 pages, 122MB) contains copies of all the submissions to the D4D challenge that have been selected for NetMob.

NetMob 2011

October 10-11, 2011
Media Lab at MIT (Cambridge, MA)
Co-located with the Third IEEE Conference on Social Computing
NetMob 2011 Book of abstracts (127 pages, 16MB)

NetMob 2010

May 11, 2010
Media Lab at MIT (Cambridge, MA)
Co-located with the International Conference on Network Science
NetMob 2010 Book of abstracts (81 pages, 5.5 MB)

netmob.org

Poppy

Non-profits / private companies

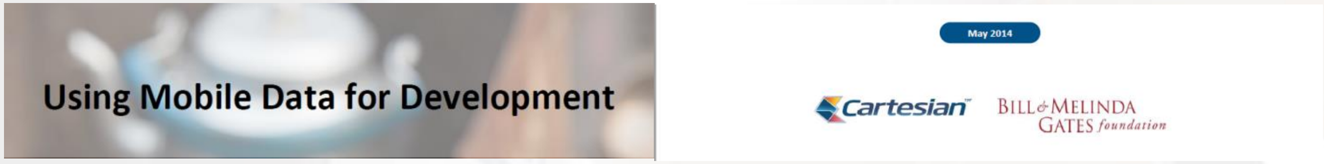
RealImpact
ANALYTICS

dataforgood.fr

data4sdgs.org

Resources

Questions & challenges



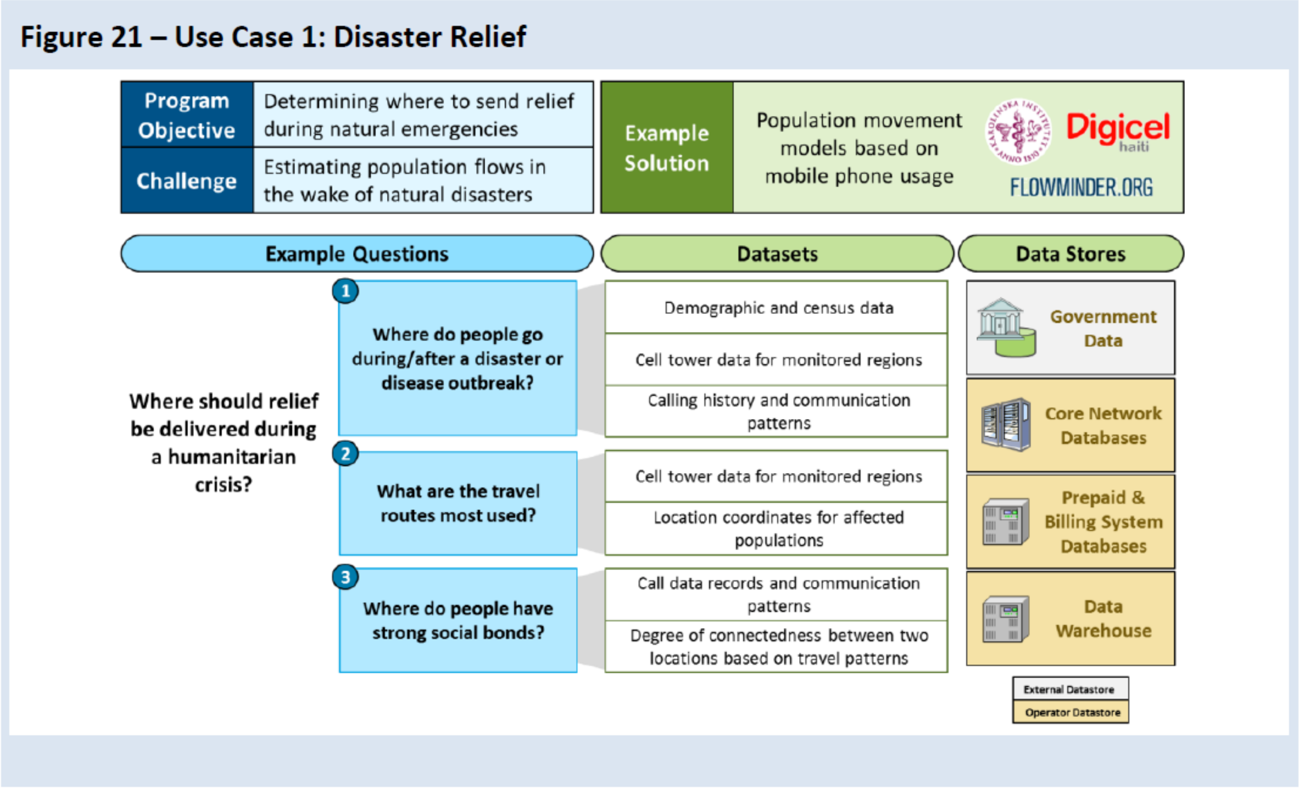


Figure 21 – Use Case 1: Disaster Relief

Challenges

Questions & challenges

Linnet Taylor, *The ethics of big data as a public good: which public? Whose good?*

Ethical review of the Orange D4D Challenge Senegal