

Mobile operator data for migration statistics

Linus Bengtsson MD, Ph.D.

Paris 16 January 2018

Flowminder Foundation: Non-profit foundation working with data providers and international/government agencies to operationalize and scale applications in support of vulnerable populations and sustainable development.

WorldPop Programme: Research Program led by Prof. Tatem improving the spatial demographic evidence base for low and middle income countries

~ 60 staff focused on data science and integration in spatial demography

Academic partners:



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All methods are open and published in peer reviewed journals for validation and transparency

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SCIENTIFIC DATA

OPEN: High-resolution gridded population datasets for Latin America and Caribbean in 2010, 2015, and 2050

SUBJECT CATEGORIES: Geography, Malaria, Sustainability, Environmental sciences

Alessandro Soricchia^{1,2}, Graeme M. Hornby³, Forrest R. Stevens⁴, Andre Catherine Linard^{5,6} & Andrew J. Tatem^{1,7,8}

Received: 16 June 2015
Accepted: 07 August 2015
Published: 05 September 2015



Malaria in China, 2011–2015: an observational study

Shengjie Lai,¹ Zhongjie Li,² Nicola A Wardrop,³ Junling Sun,³ Michael G Head,⁴ Zhuojie Jianxing Yu,⁵ Zike Zhang,¹ Shui-Sen Zhou,⁶ Zhigui Xia,⁶ Rubo Wang,⁹ Bin Zheng,⁹ Yao Ru Nong Zhou,⁹ Andrew J Tatem⁸ & Hongjie Yu⁸

Objective To ascertain the trends and burden of malaria in China and the costs of interventions for 2011–2015. **Methods** We analysed the spatiotemporal and demographic features of locally transmitted and imported malaria surveillance data on malaria from 2011 to 2015, covering the range of dominant malaria vectors in China. The malaria elimination were calculated by funding sources, interventions and population at risk. **Findings** A total of 17 745 malaria cases, including 123 deaths (0.7%), were reported in mainland China, with 17 cases, mainly from Africa and south-east Asia. Almost all counties of China (2855/2858) had achieved their ellir locally transmitted cases dropped from 1469 cases in 2011 to 43 cases in 2015, mainly occurring in the region *Anopheles minimus* and *An. dirus* are the dominant vector species. A total of United States dollars (US\$) 134.6 to eliminate malaria during 2011–2015, with US\$ 57.2 million (43%) from the Global Fund to Fight AIDS, T, US\$ 77.3 million (57%) from the Chinese central government. The mean annual investment (US\$ 27 million) p was US\$ 0.05 (standard deviation 0.03). **Conclusion** The high level of malaria elimination in China is a challenge to address the

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ARTICLE

038/nature 2040

Virus genomes reveal factors that spread and sustained the Ebola epidemic

A list of authors and their affiliations appears at the end of the paper

The 2013–2016 West African epidemic caused by the Ebola virus was of unprecedented magnitude, duration and impact. Here we reconstruct the dispersal, proliferation and decline of Ebola virus throughout the region by analysing 1,610 Ebola virus genomes, which represent over 5% of the known cases. We test the association of geography, climate and demography with viral movement among administrative regions, inferring a classic “gravity” model, with intense dispersal between larger and closer populations. Despite attenuation of international dispersal after border closures, cross-border transmission had already sown the seeds for an international epidemic, rendering these measures ineffective at curbing the epidemic. We address why the epidemic did not spread into neighbouring countries, showing that these countries were susceptible to substantial outbreaks but at lower risk of introductions. Finally, we reveal that this large epidemic was driven by the associated collection of transmission clusters of varying size, duration and connectivity.

INTERFACE

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Mapping poverty using mobile phone and satellite data

Jessica E. Steele^{1,2}, Pål Roe Sundsay¹, Carla Pezullo¹, Victor A. Alegana¹, Tomas J. Bird¹, Joshua Blumenstock³, Johannes Bjelland³, Kenth Enga-Monsen², Yves-Alexandre de Montjoye⁴, Asif M. Iqbal⁵, Khandakar N. Hadiuzzaman⁶, Xin Lu^{2,7,8}, Erik Wetter⁹, Andrew J. Tatem^{1,2,10} and Linus Bengtsson^{2,7}

Research

Check for updates

Read this article: Steele *et al.* 2017

Mapping poverty using mobile phone and

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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,1,2}, Nathan Eagle^{a,g}, Janeth Kombich^a, Bryan T. Grenfell^h, Ottar N. Bjørnstadⁱ, Justin Lessler^j, Andrew J. Tatem^{k,l,1}, and Caroline O. Buckee^{a,b,c}

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Edited by Kenneth W. Wachter, University of California, Berkeley, CA, and approved July 21, 2015 (received for review December 11, 2014)

Changing patterns of human aggregation are thought to drive annual and multiannual outbreaks of infectious diseases, but the plan public health measures and understand the dynamics of these infectious diseases.

THE LANCET

Articles

Spread of yellow fever virus outbreak in Angola and the Democratic Republic of the Congo 2015–16: a modelling study

Moitt U G Kraemer, Nuno R Faria, Robert C Beiner Jr, Nick Golding, Birgit Nikolaj, Stephanie Steiner, Michael A Johansson, Henrik Salje, Ousmane Faye, G R William Wint, Matthias Niedrig, Freya M Shearer, Sarah C Hill, Robin N Thompson, Donald Bissanzu, Nuno Taveira, Heinrich H Nac, Bary S R Pradeek, Elaine O Noone, Nicholas R Murphy, Isaac I Bogoch, Kamran Khan, John S Brownstein, Andrew J Tatem, Tullio de Oliveira, David L Smith, Amadou A Sall, Oliver G Pybus, Simon I Hay, Simon Cauchemez

Summary
Background Since late 2015, an epidemic of yellow fever has caused more than 7334 suspected cases in Angola and the Democratic Republic of the Congo, including 393 deaths. We sought to understand the spatial spread of this outbreak to optimise the use of the limited available vaccine stock.

ISSN 0140-6736

DOI: 10.1016/S0140-6736(15)00800-0

Published Online December 23, 2015

Pioneered Anonymised Mobile Network Data for Infectious Disease (2008 Zanzibar, 2012 Haiti, 2013 Namibia, Indonesia) and Crisis Response (Haiti Earthquake and Cholera, Nepal Earthquake)



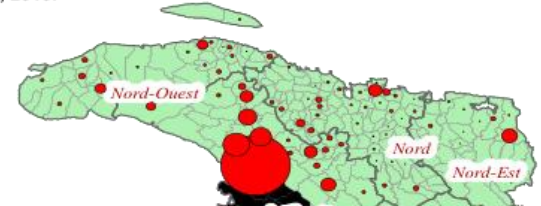
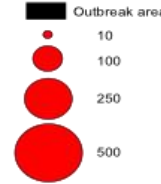
REPORT

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}, Abdisalman M. Noor^{9,10}, Robert W. Snow^{9,10}, Caroline O. Buckee^{4,11,*}

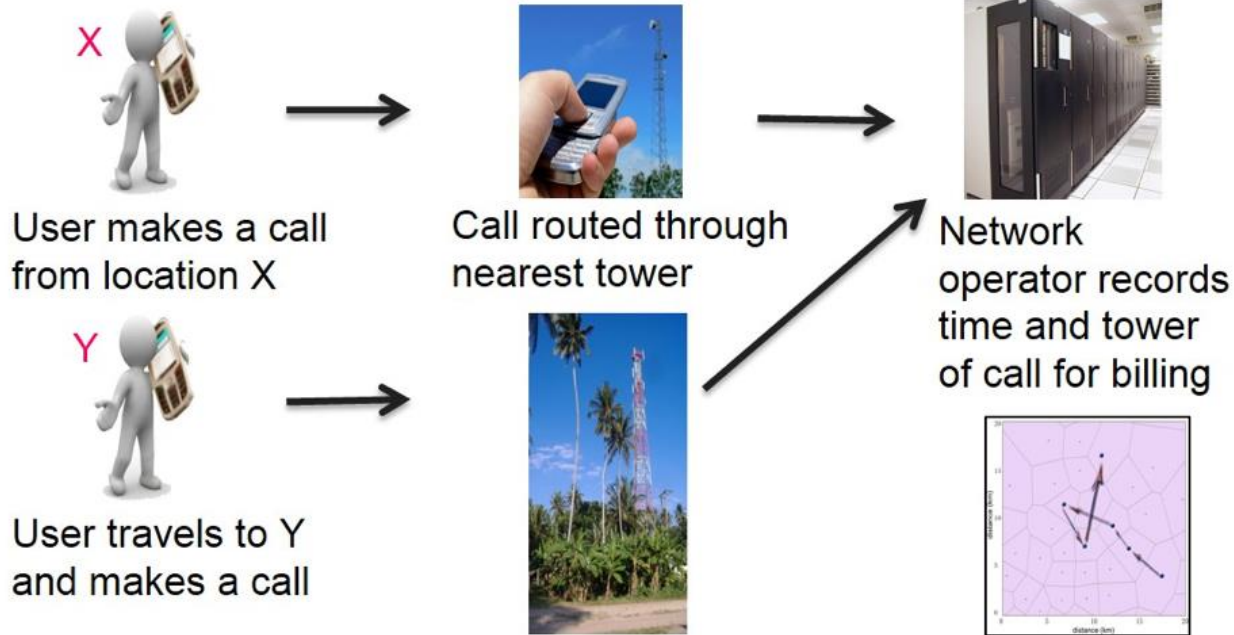


Average daily numbers of sims that moved out from the communal sections surrounding Saint-Marc, Oct 15 to Oct 23, 9:00 am, 2010.



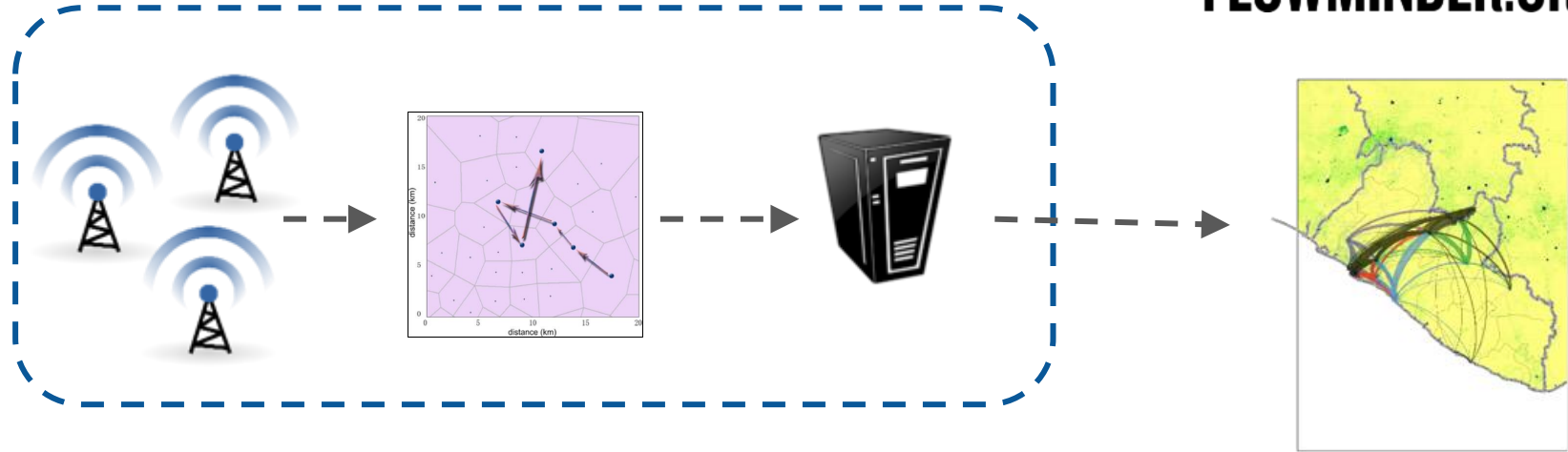
Call detail records

Aggregated call detail records (CDRs) + survey data + satellite/GIS data to model characteristics and mobility



Preserving User's Privacy

Compliance with GSMA data integrity guidelines: Data never leaves mobile operator's system to avoid any privacy, commercial concerns.

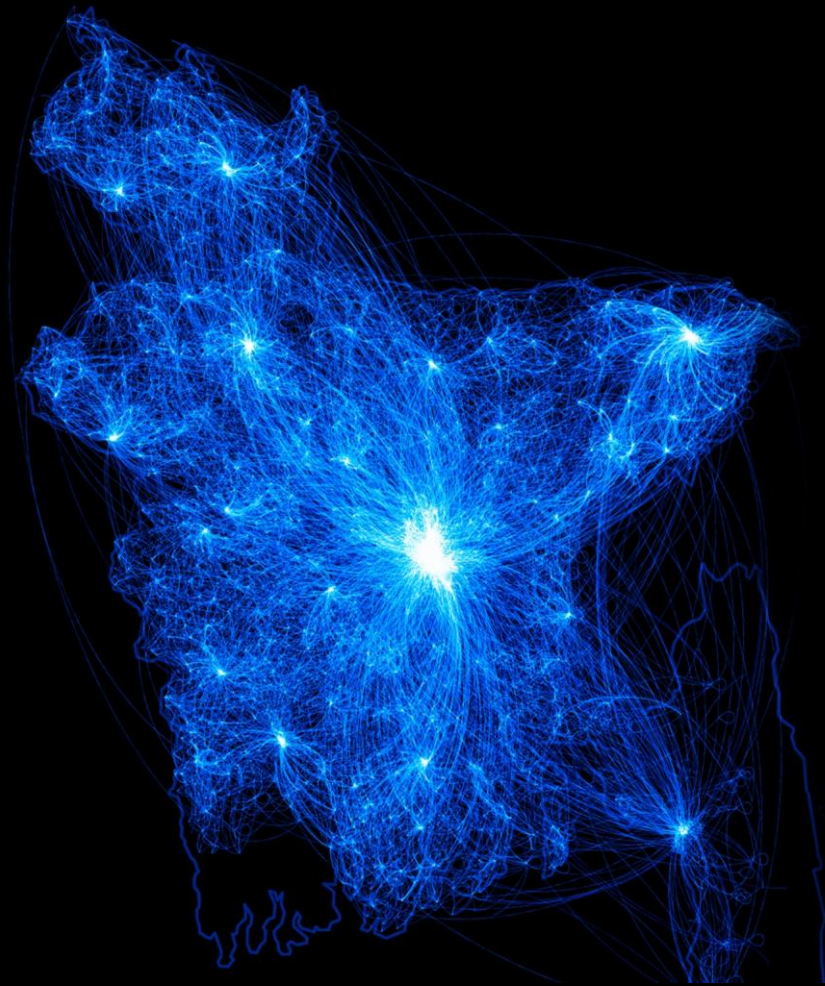


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Mobile operator firewall

Key advances for unveiling previously hidden migration statistics

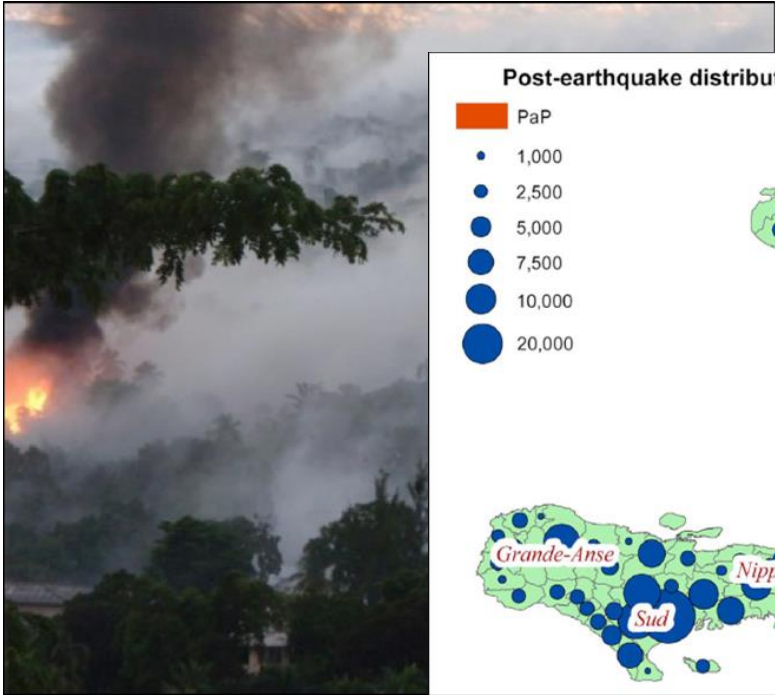
1. Fine resolution data with national coverage



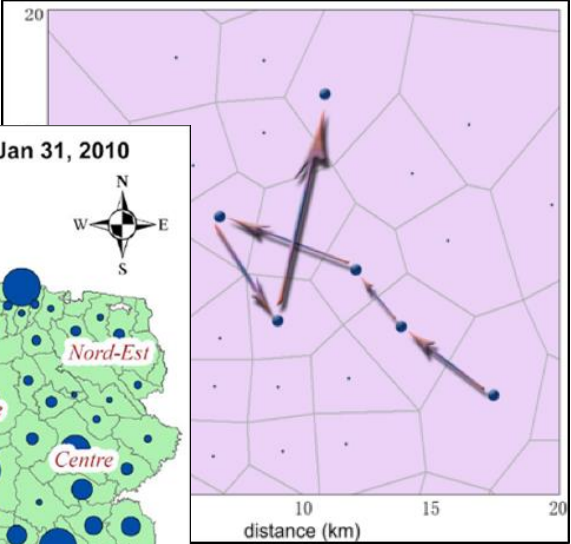
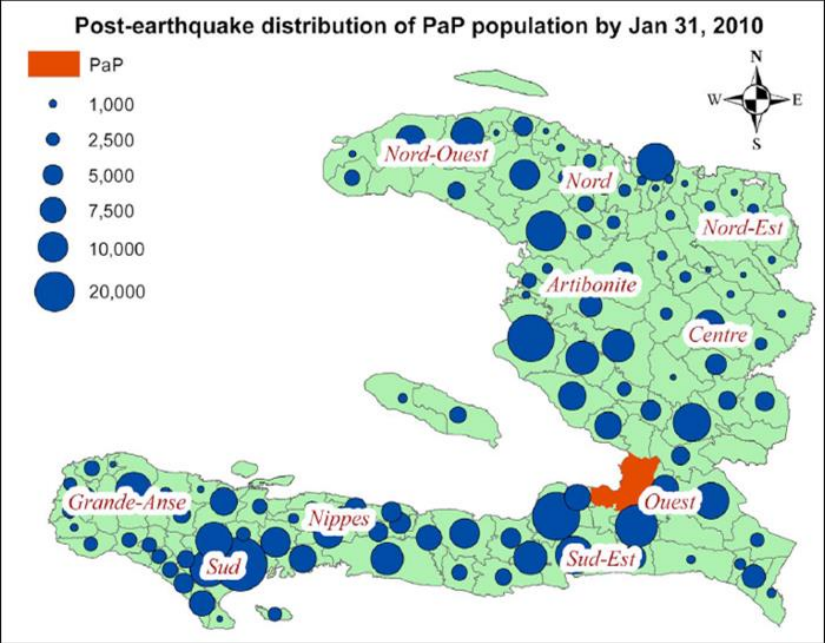
Key advances for unveiling previously hidden migration statistics

1. Fine resolution data with national coverage
2. **Rapid changes in population movements**

Haiti Earthquake Response



Digicel
haiti



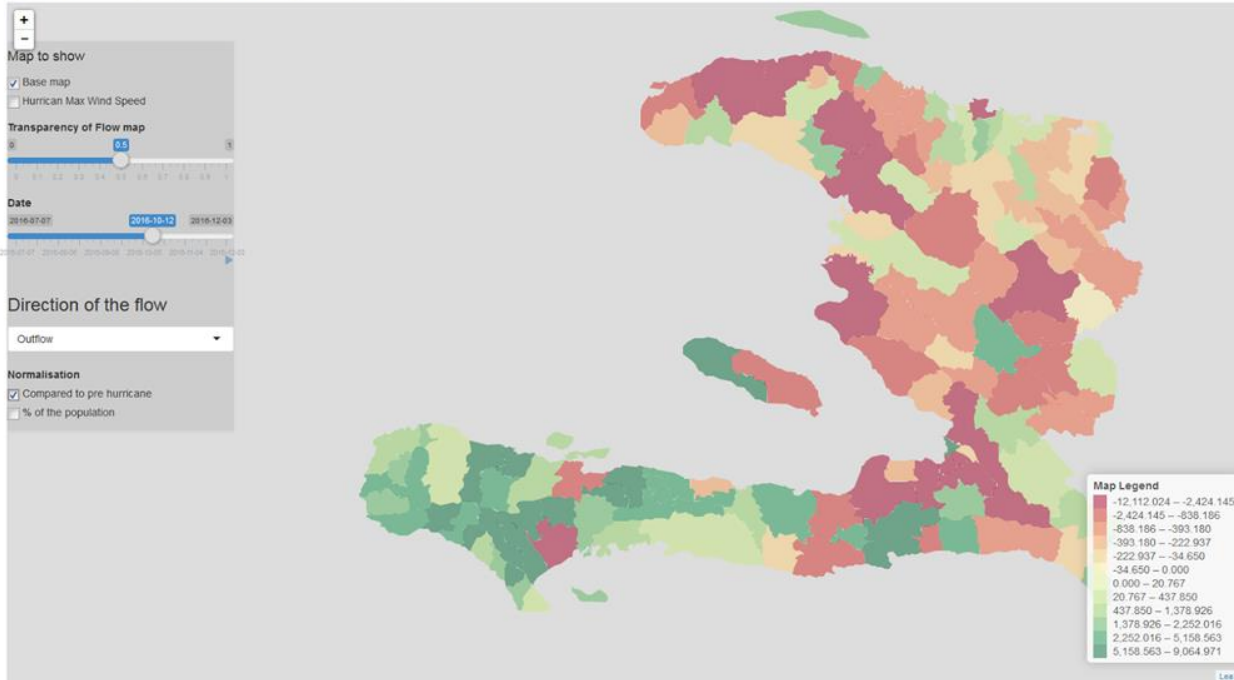
Ref: Bengtsson et al. PLoS Medicine 2011; Bengtsson et al. Nature Sci. Rep. 2016;

Haiti Hurricane Matthew Response

Mobile phone data and population displacement following hurricane Matthew

tab-9316-1 tab-pane active tab-9316-2

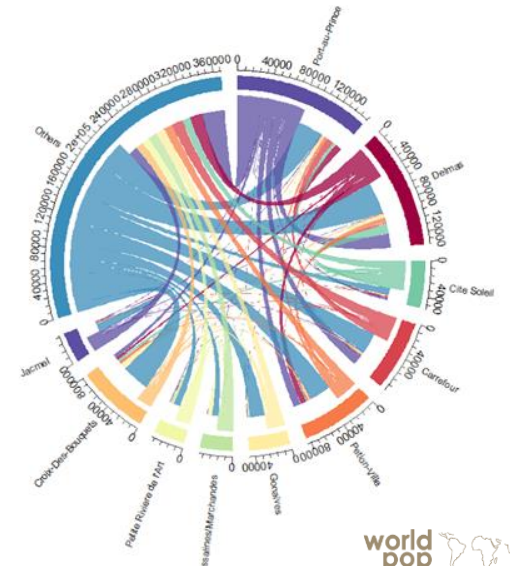
Outflow of people : compared to pre-hurricane



Top 10 flows in Haiti

Only the peninsula Only top relations Show the locations on the map

Legend: The side of ribbon close to the ring is its origin, the one away is its destination



Ref: Flowminder 2016. Hurricane Matthew Hurricane Matthew: Estimated population movements

Nepal Earthquake 2015

First insights within 14 days

Nepal Population Estimates as of May 1, 2015

2.8m

+390,000
(246,000~540,000)

-247,000
(-155,000~-339,000)

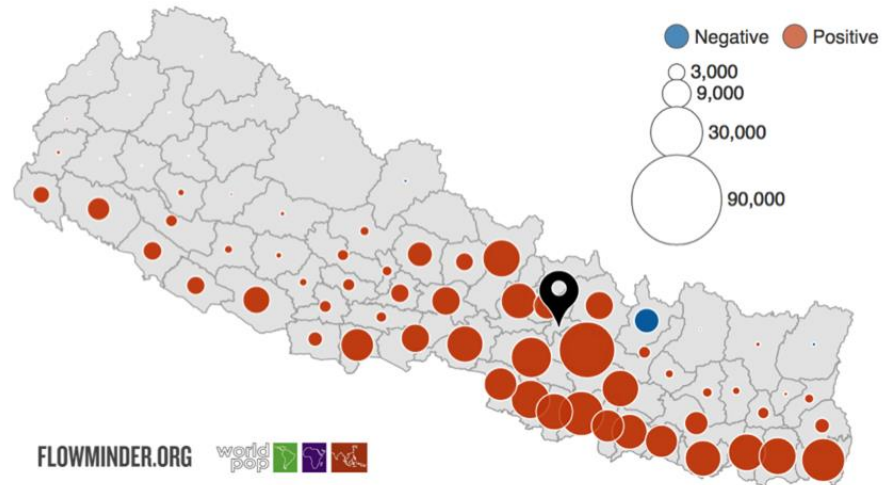
2. Kathmandu Valley

Kathmandu Valley is here defined as the districts Kathmandu, Bhaktapur and Lalitpur. Kathmandu Valley is one of the most densely populated areas in Nepal and home to ca 2.8 m people [1].

Key findings:

- An estimated 390,000 people more than normal had left the Kathmandu valley - comparing May 1 with the day before the earthquake April 24 (ratio to the population: 14%).
- An estimated 247,000 persons less than normal had come into the area during the same period (ratio to the population: 8.8%)
- People leaving Kathmandu Valley went to a large number of areas, notably the populous areas in the south and the Central and West Development Regions.

Above normal flows from Kathmandu Valley to other districts



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Key advances for unveiling previously hidden migration statistics

1. Fine resolution data with national coverage
2. Rapid changes in population movements
3. **Concurrent quantification of migration incidence and migration duration**
4. **Correlation between in- and out-migration**

Predictive modelling

Proceedings of the National Academy of Sciences of the United States of America

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Home > Early Edition > Xin Lu, doi: 10.1073/pnas.1203882109

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Predictability of population displacement after the 2010 Haiti earthquake

Xin Lu^{a,b,1,2}, Linus Bengtsson^{a,1,2}, and Petter Holme^{a,b,c,d}

Author Affiliations

Edited by* H. Eugene Stanley, Boston University, Boston, MA, and approved May 16, 2012 (received for review March 6, 2012)

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Approaching the Limit of Predictability in Human Mobility

Xin Lu, Erik Wetter, Nita Bharti, Andrew J. Tatem & Linus Bengtsson

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Scientific Reports 3, Article number: 2923 | doi:10.1038/srep02923
Received 21 May 2013 | Accepted 19 September 2013 | Published 11 October 2013

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movements. These movements make it difficult for relief d. Understanding and predicting the locations of affected humanitarian relief operations and to long-term societal mobile phone operator in Haiti (Digicel) and analyzed the during the period from 42 d before, to 341 d after the 2010. Nineteen days after the earthquake, population

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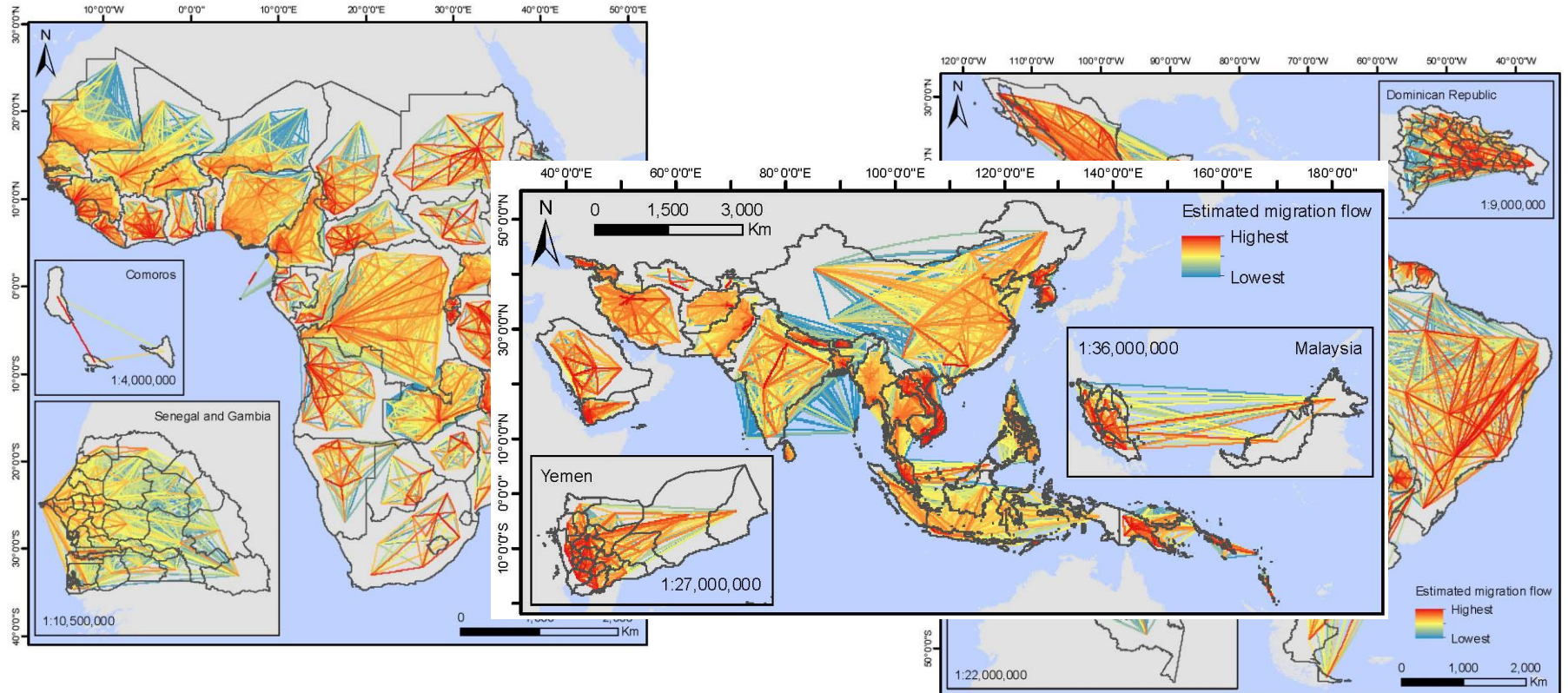
News > Social Sciences > Where Do People Flee When Disaster Strikes?



Displaced. A family departs from Port-au-Prince following the destruction of the magnitude 7.0 earthquake.

Where Do People Flee When Disaster Strikes?

Modelling internal migration globally



Caveats

- Representativity
- Infrastructural damages
- Data access