ONLINE
AFRICAN SCHOOL
on Migration Statistics

2–4 December 2020

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IOM UN MIGRATION

GMDAC IOM Global Migration Data Analysis Centre

SCB

African Union

MODULE 4

Mapping migration using alternative data sources

Marzia Rango, *Data Innovation and Capacity-Building Coordinator, Global Migration Data*
Andrew Tatem, *Professor, World Pop, University of Southampton*

PART 1

Harnessing data innovation for migration analysis

Marzia Rango
Data Innovation and Capacity-Building Coordinator, Global Migration Data

Module 4: Mapping migration using alternative data sources

Part 1: Harnessing data innovation for migration analysis_Marzia Rango

Outline

1. **What**
   - Big data, data innovation
2. **Why**
   - The global context
   - The potential
3. **How**
   - Case-study: social media data to estimate ‘migrant’ stocks
   - The challenges
   - The Big Data for Migration Alliance (BD4M)

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Module 4: Mapping migration using alternative data sources

Part 1: Harnessing data innovation for migration analysis_Marzia Rango

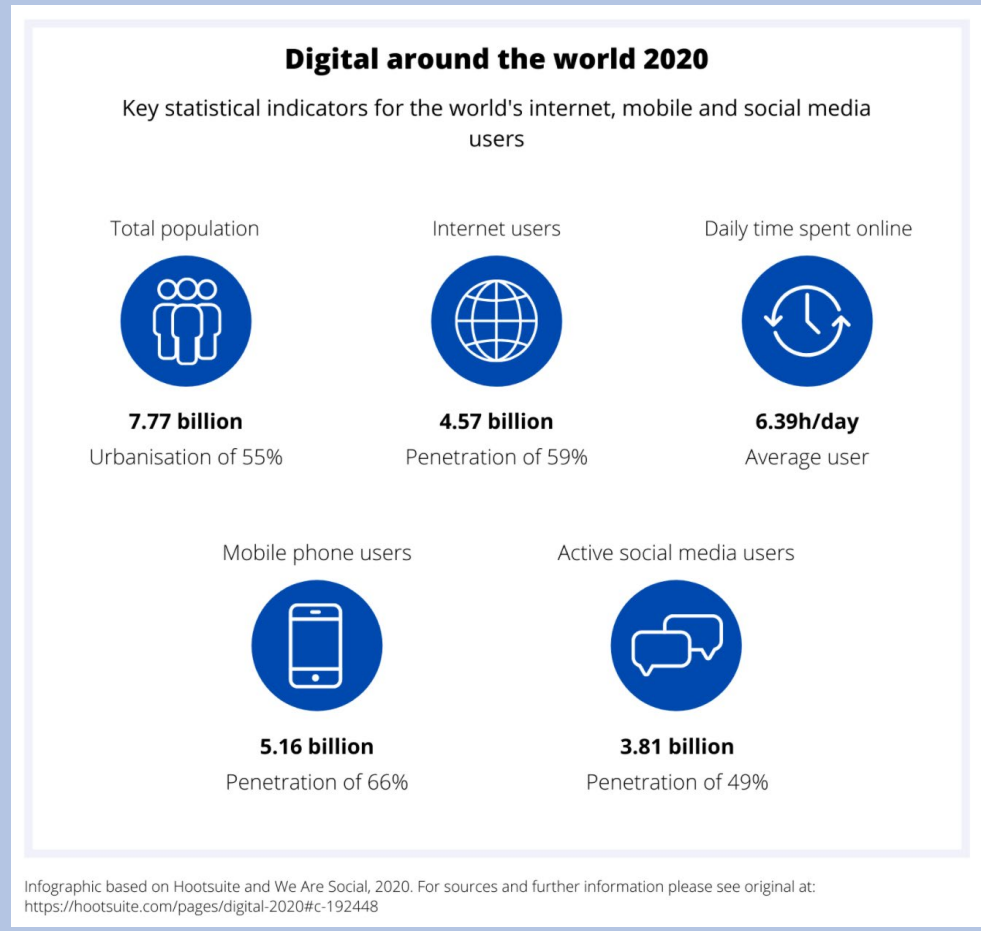
‘Big data,’ data innovation

Data innovation

- The universe of alternative data sources and methods
- Includes combination of traditional and new sources
- Sometimes also administrative/operational data

Big data

- Data generated automatically by users of mobile phones, social media, internet-based platforms, digital sensors
- Volume, velocity, variety (the “3 Vs”; Hilbert, 2013)
- Specific technology and analytical methods to extract insights and create value (de Mauro et al., 2014)



Infographic based on Hootsuite and We Are Social, 2020. For sources and further information please see original at: https://hootsuite.com/pages/digital-2020#c-192448

migrationdataportal.org/themen/big-data-migration-and-human-mobility

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Part 1: Harnessing data innovation for migration analysis_Marzia Rango

The global context

Huge progress made in discussions about data innovation for migration

- Renewed calls (needs) for evidence on migration: the SDGs and the GCM
- Limitations of traditional data sources
- Impact of COVID-19

Need for ethically responsible and privacy-safeguarding collaboration frameworks

- Re-using existing data (big data are already there!)
- Integrating ‘Big’ and ‘small’ data

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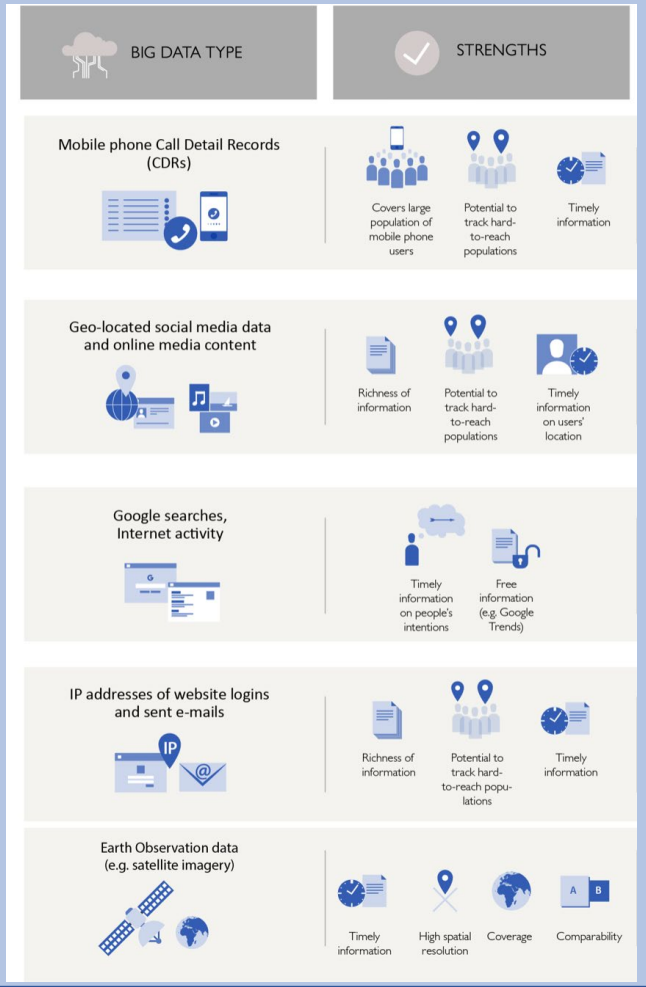
Part 1: Harnessing data innovation for migration analysis_Marzia Rango

The potential

- High spatial resolution
- High frequency of update
- Timeliness (virtually real-time)
- Wide coverage (hard-to-reach populations)
- Larger sample size compared to surveys
- Richness of information
- Relatively low cost (access!)



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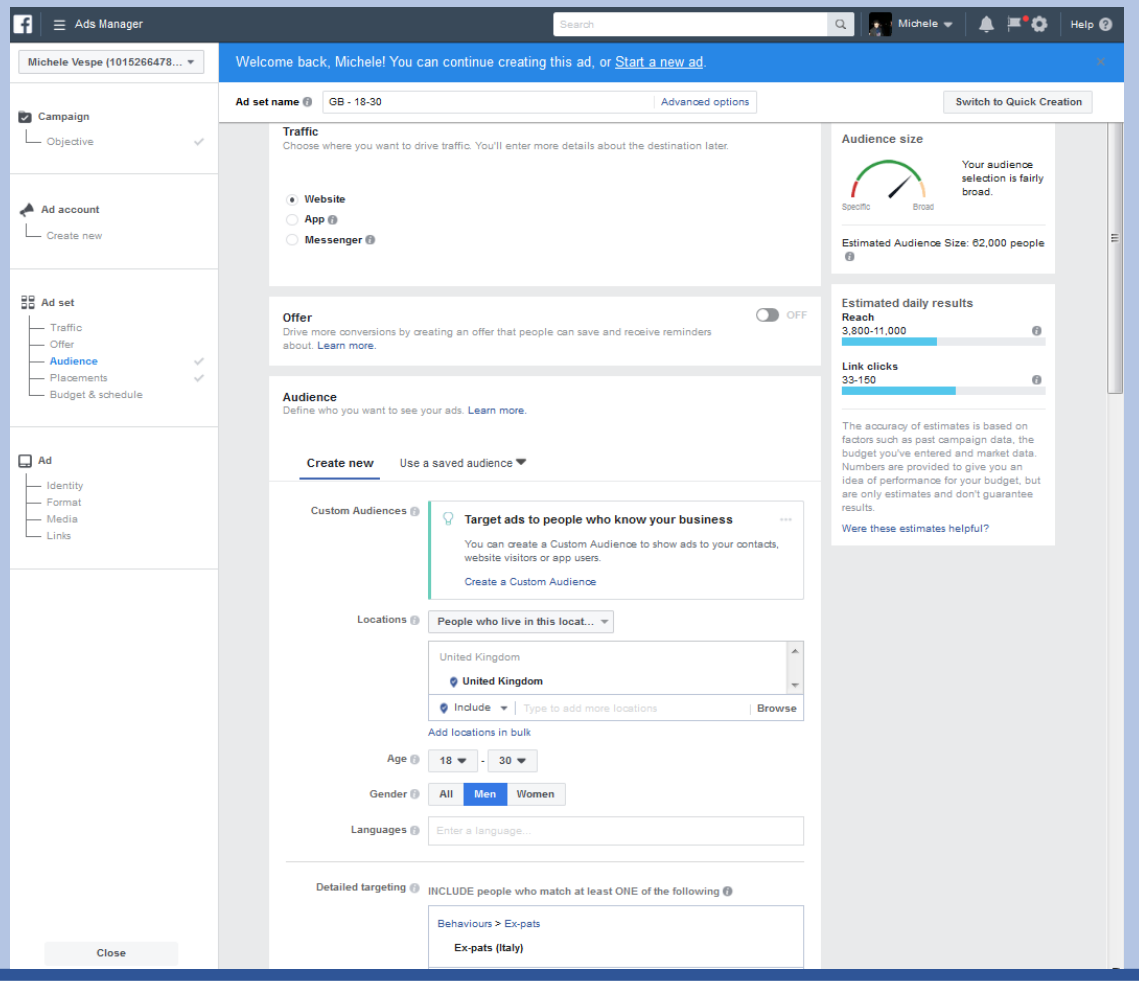
Social media advertising platforms

- A “real time census”?
- ‘Inexpensive’
- Disaggregation → ‘used to live in country X’

BUT

- Reliability (often self-reported)
- Definitions (proprietary)
- Aggregations/rounding (proprietary)
- Penetration rate/selection bias
- Fake or double accounts



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Understanding the bias

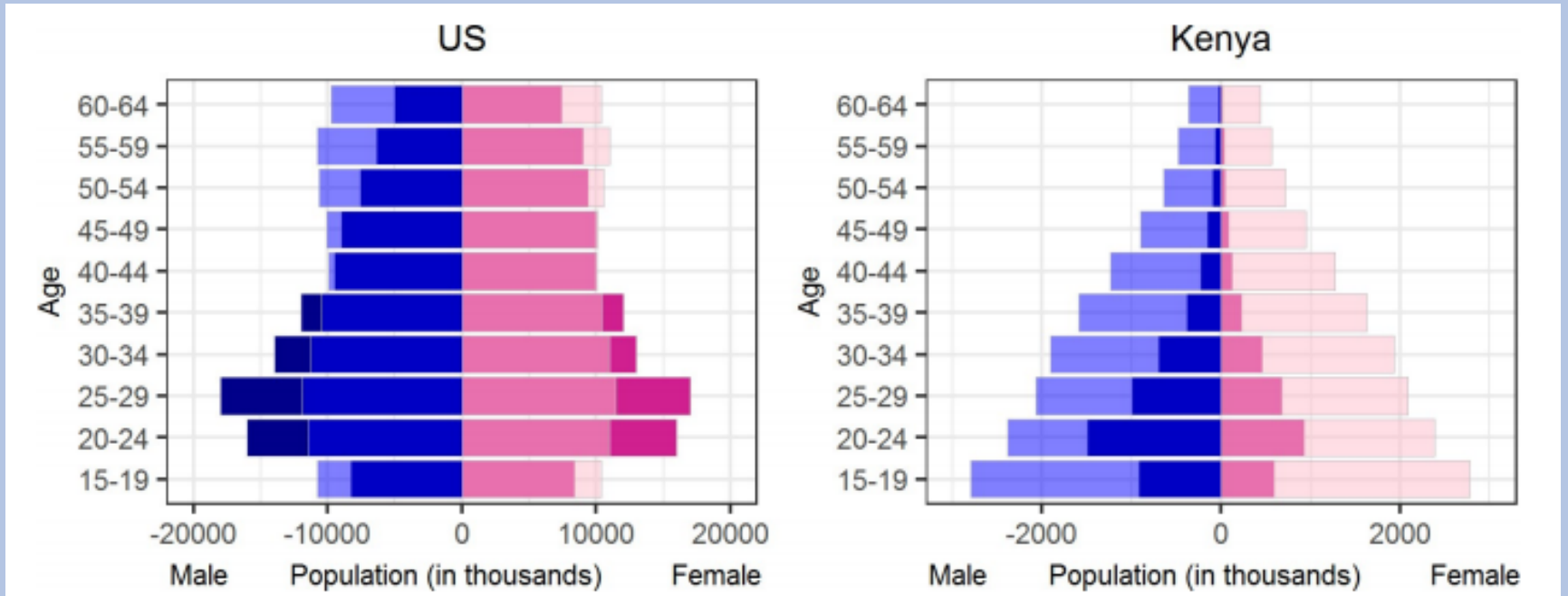

Fig 2. UNDESA population and FN users in the US and Kenya by age and sex/gender. Light shading = UNDESA population, mid shading = UNDESA & raw FN users, and dark shading = raw FN users.

Source: Spyratos S, Vespe M, Natale F, Weber I, Zagheni E, Rango M (2019) Quantifying international human mobility patterns using Facebook Network data. PLoS ONE 14(10): e0224134. https://doi.org/10.1371/journal.pone.0224134

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‘Nowcasting’

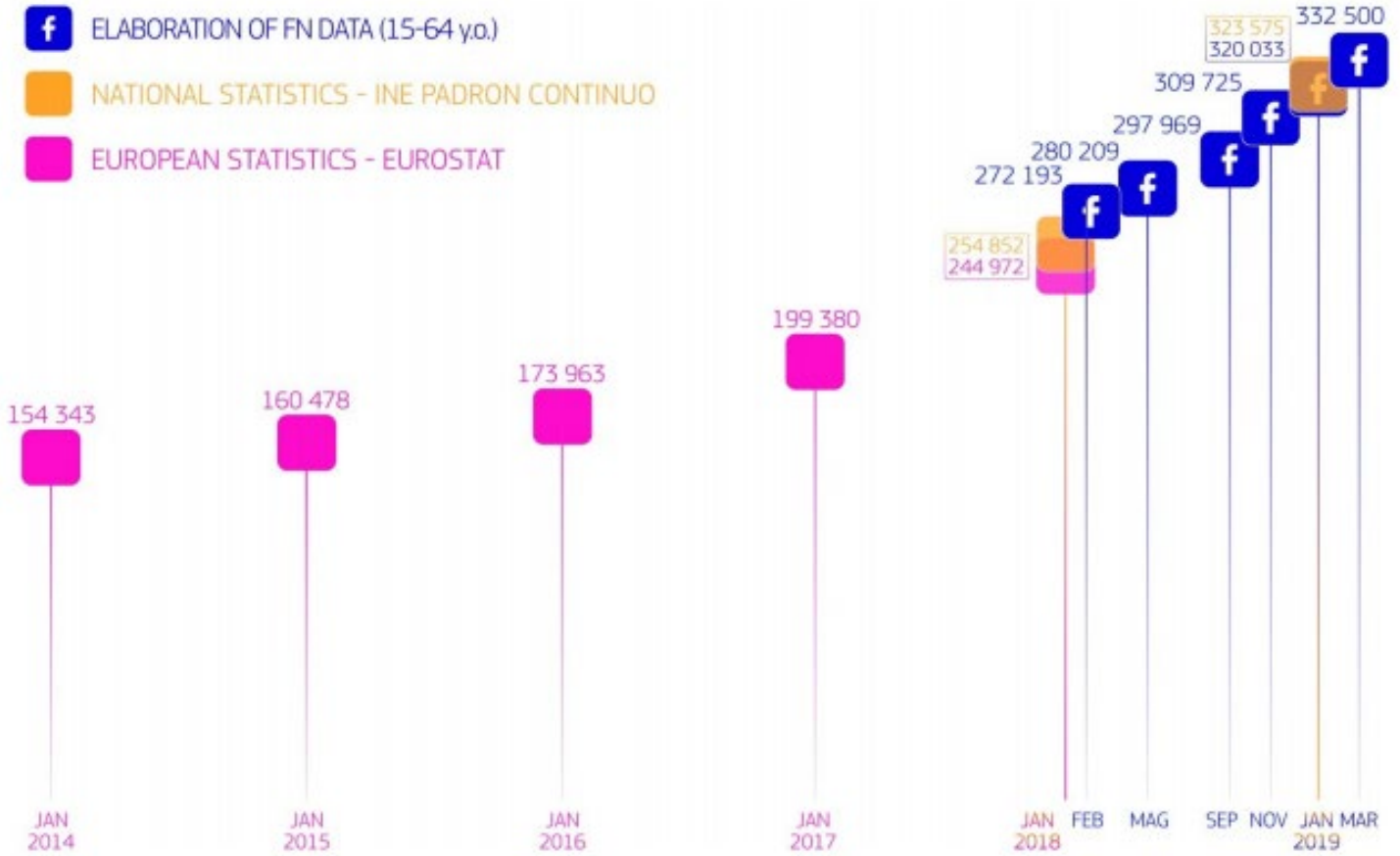

Fig 8. Stocks of international migrants and FN migrants from Venezuela in Spain. The national and Eurostat statistics refer to all ages, while the FN-derived estimates refer to ages 15–64.

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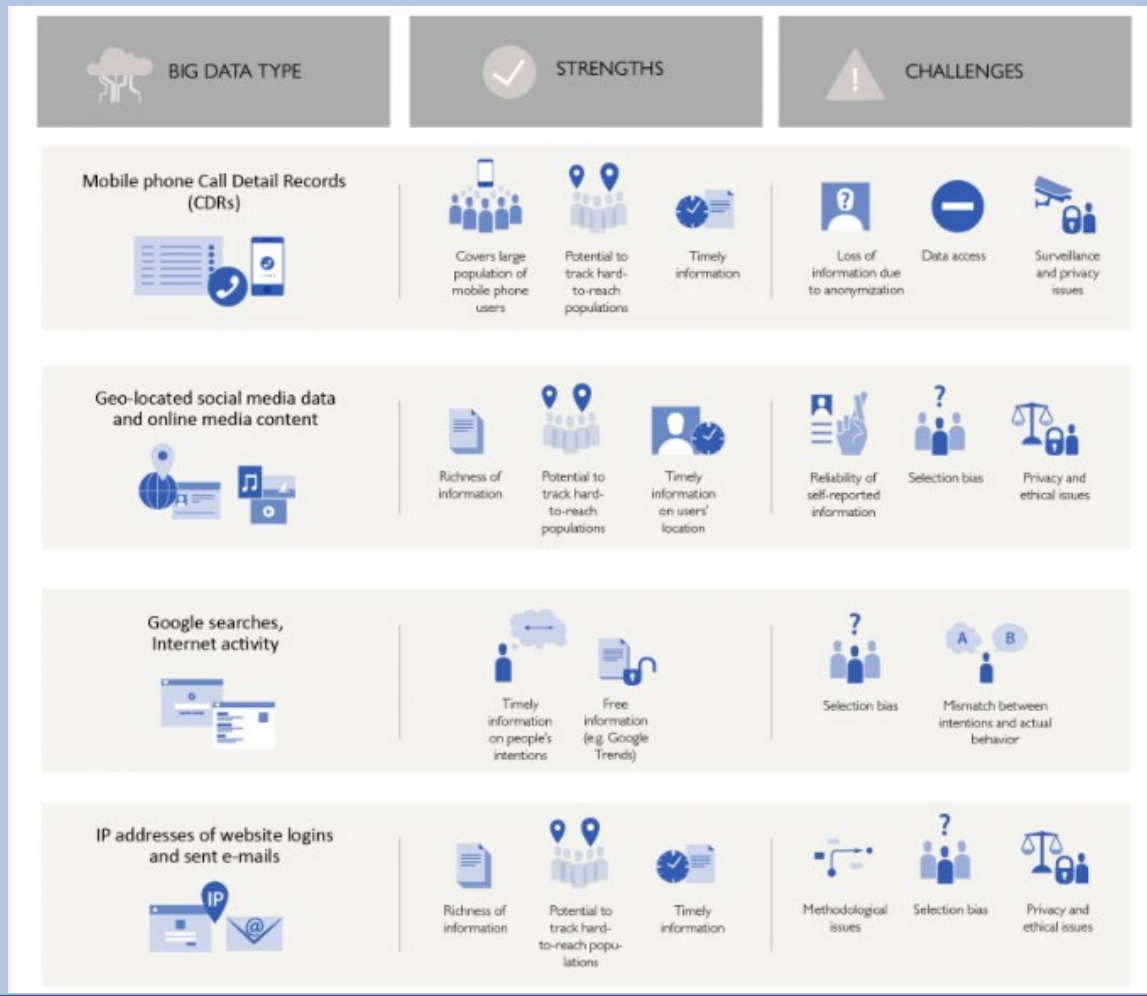
Part 1: Harnessing data innovation for migration analysis_Marzia Rango

The challenges

- Data access, continuity, independence
- Confidentiality
- **Security/Ethical issues**
- Methodology (selection bias)
- Reliability
- Definitions
- Fragmentation of applications



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The Big Data for Migration Alliance (BD4M)

Launched in 2018, convened by:

- IOM's GMDAC
- The European Commission's KCM
- The GovLab at NYU

data4migration.org/

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The Big Data for Migration Alliance (BD4M)

A network of individuals and organizations across sectors that aims to:

- **Explore the potential of new data sources** and the combination of traditional and innovative methods
- **Ensure the ethical use** of data and the **protection of individuals' privacy**
- **Promote and facilitate new forms of partnerships** across the business, policy and scientific communities
- **Support peer-to-peer learning**, including by facilitating the sharing of good practices and building capacities

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How we work

- Building the **knowledge base** for data innovation and collaboration

  → New **Data Innovation Directory**

- Identifying and **sourcing demand** and questions for data innovation

  → **100 Questions Initiative**

- **Building** data innovation **capacities**

- Promoting the use of data innovation to **address the demand** for policy-relevant analysis

- **Connecting** key stakeholders – data users, providers and policymakers

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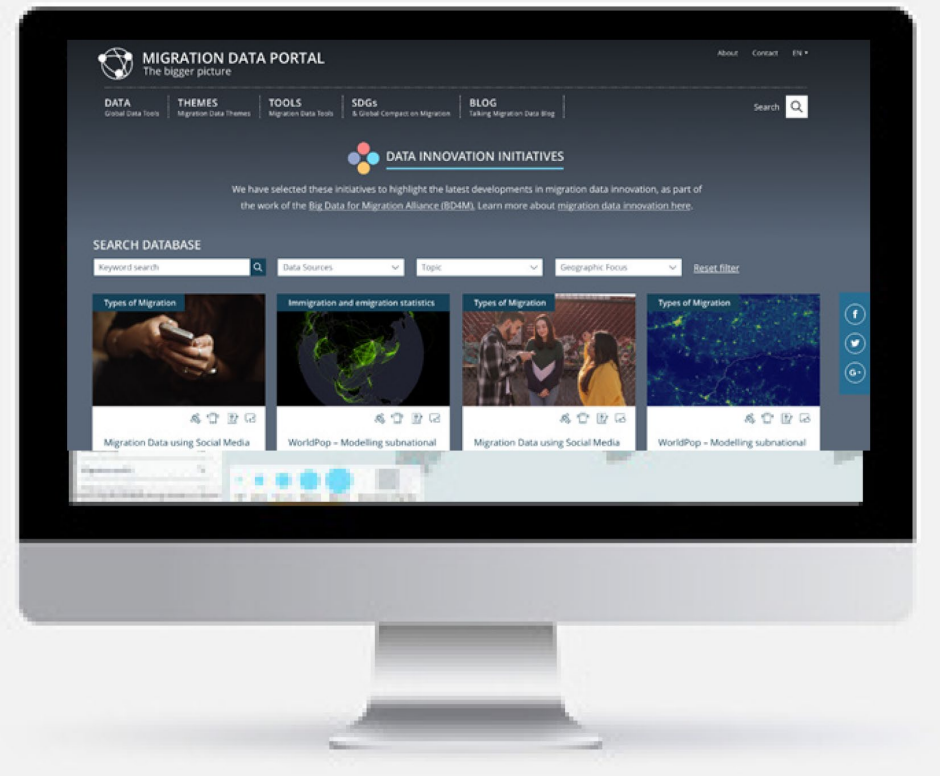
The Data Innovation Directory (DID)

- Overview of existing projects and applications of new data sources in relation to migration/mobility
- 50+ projects by more than 70 different organizations (9 related to COVID-19)
- Sources: publicly available information/interviews, validation process

→ To feature relevant projects: did@iom.int



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BD4M: ongoing activities

- **'Studios' around key migration questions**
  Dedicated workshops gathering representatives from businesses and policy
- **BD4M Guidebook *Harnessing Data Innovation for Migration Policy***
  With contributions from BD4M members and partners
- **BD4M webinar series (since Nov. 2020)**
- **Research project with the University of Liverpool**
  on episodes of xenophobia pre/post-COVID-19 based on Twitter data

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Contact

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PART 2

Andrew Tatem
Professor, World Pop, University of Southampton

Module 4: Mapping migration using alternative data sources

Part 2: Andy Tatem

Contents

- ‘Traditional’ vs ‘Novel/Big/Alternative’ data sources
- Case study 1: Geospatial data integration for subnational sex-disaggregated migration mapping
- Case study 2: Mobile phone data for migration statistics

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TRADITIONAL VS ALTERNATIVE DATASETS FOR MIGRATION MAPPING

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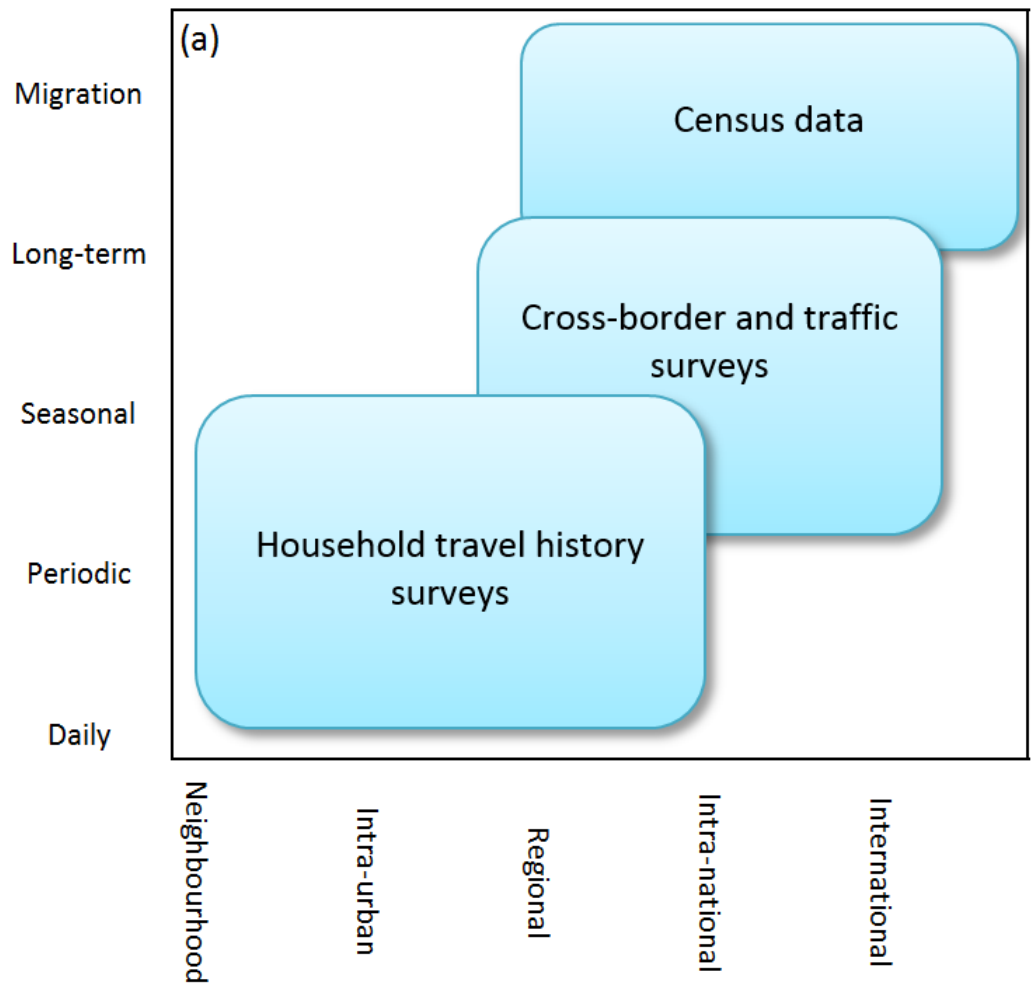
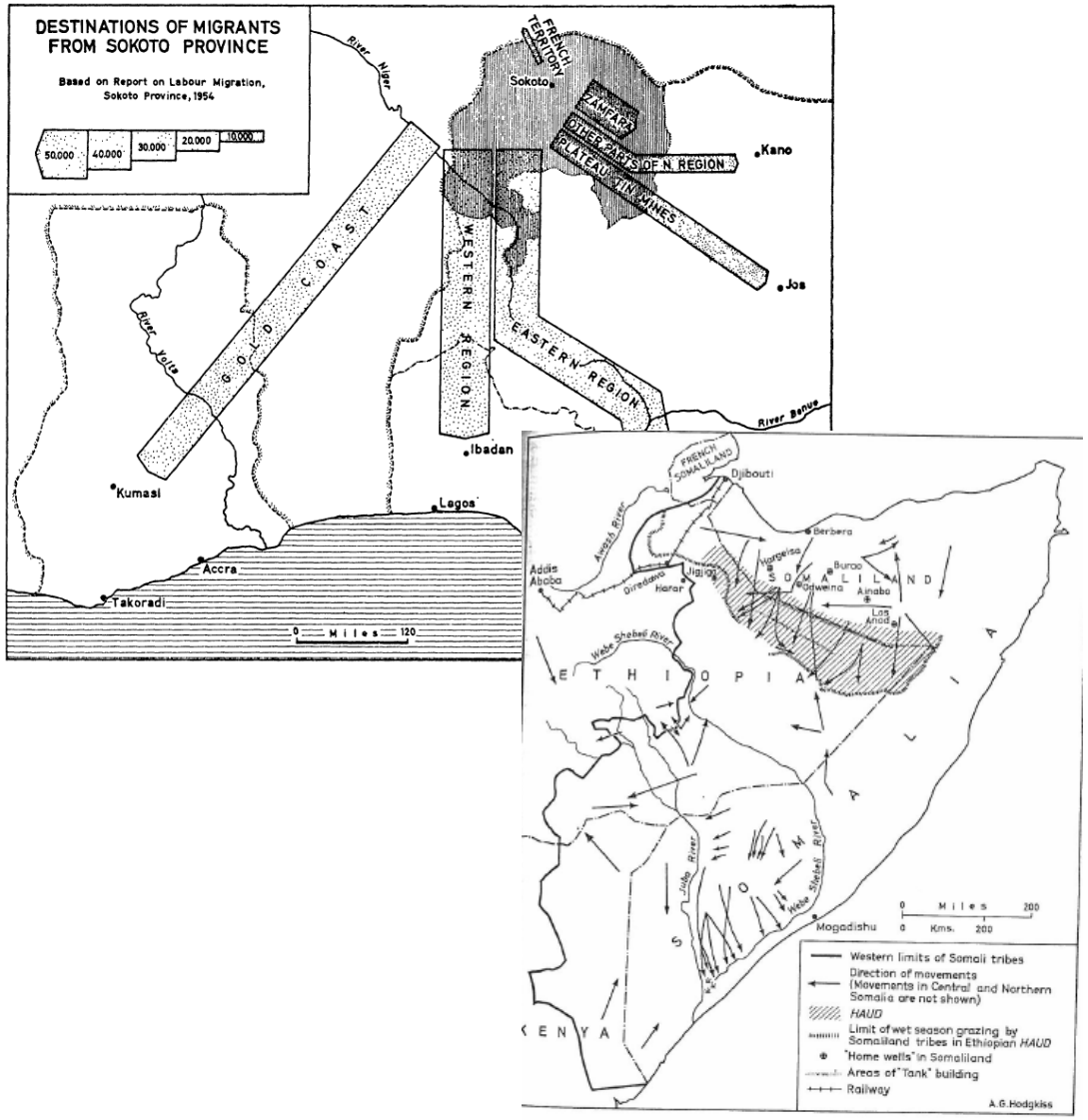
Data for measuring population movements/migrations

Traditional

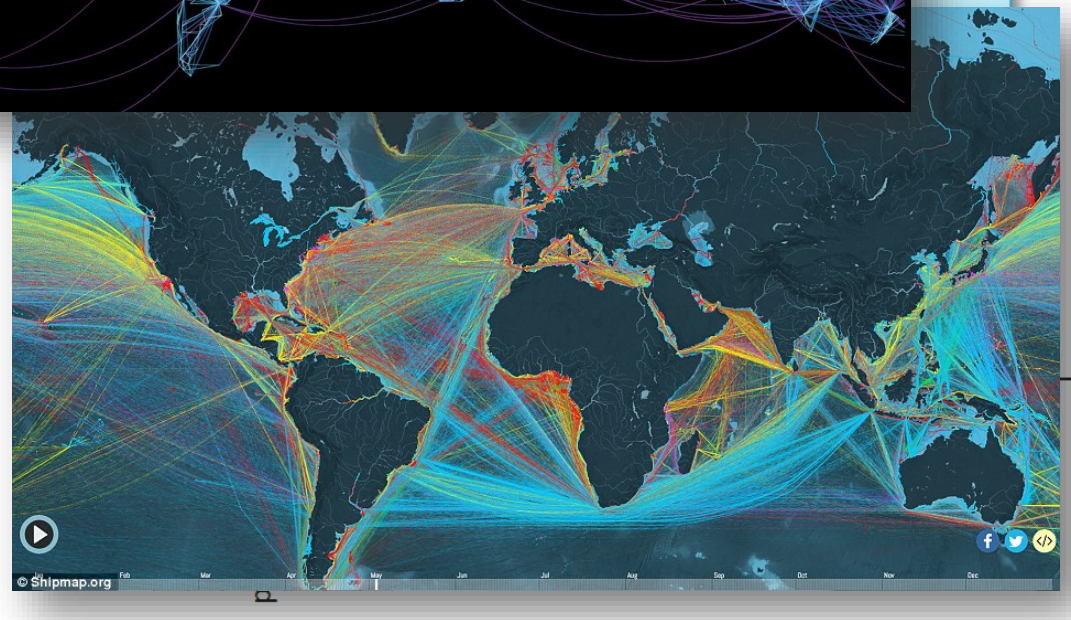


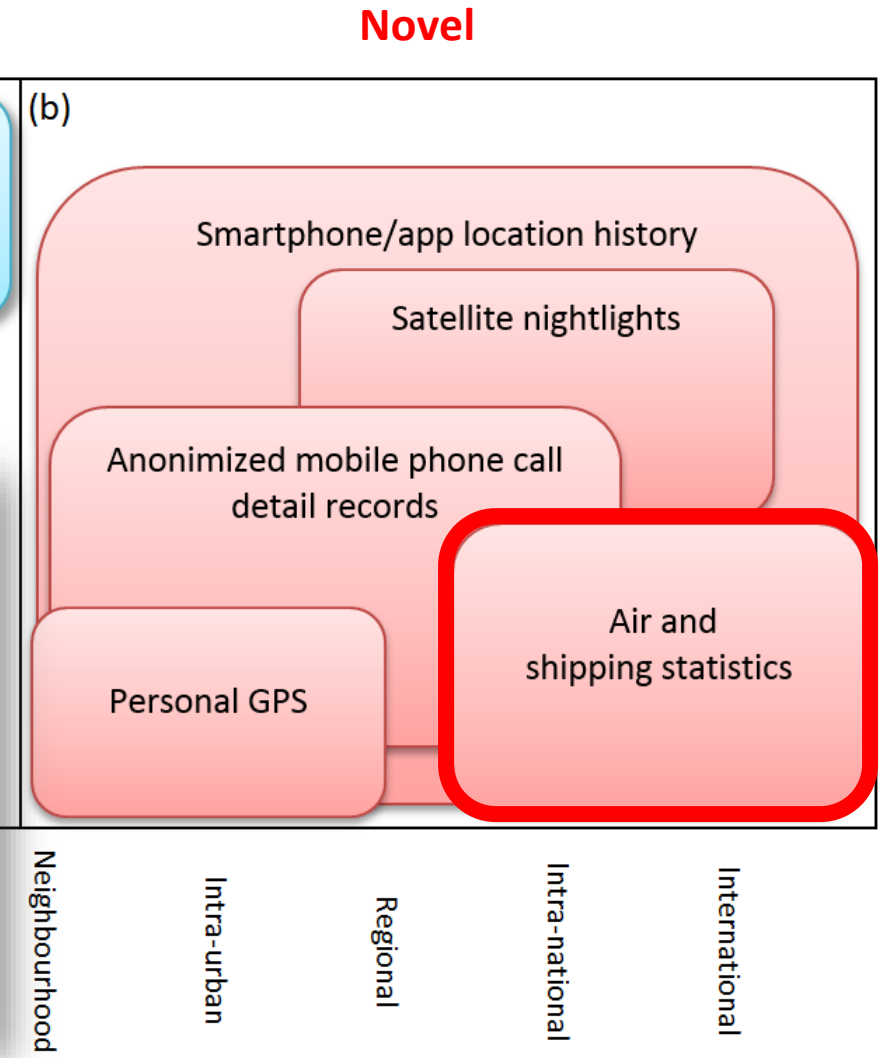


Tatem, *Int Health*, 2014; Ruktanonchai et al, *IJHG*, 2018

Prothero, JIAI 1957; Bull WHO 1961

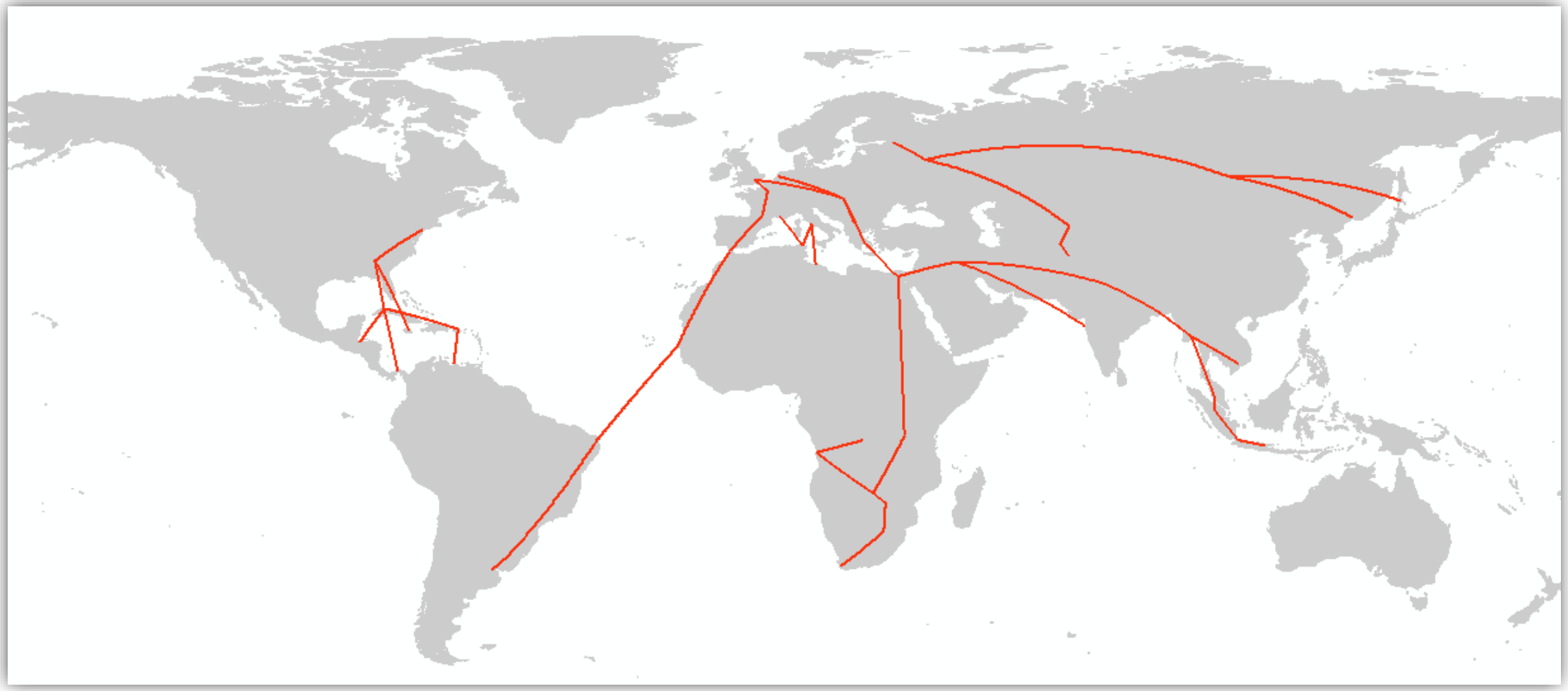
Data for measuring population movements/migrations





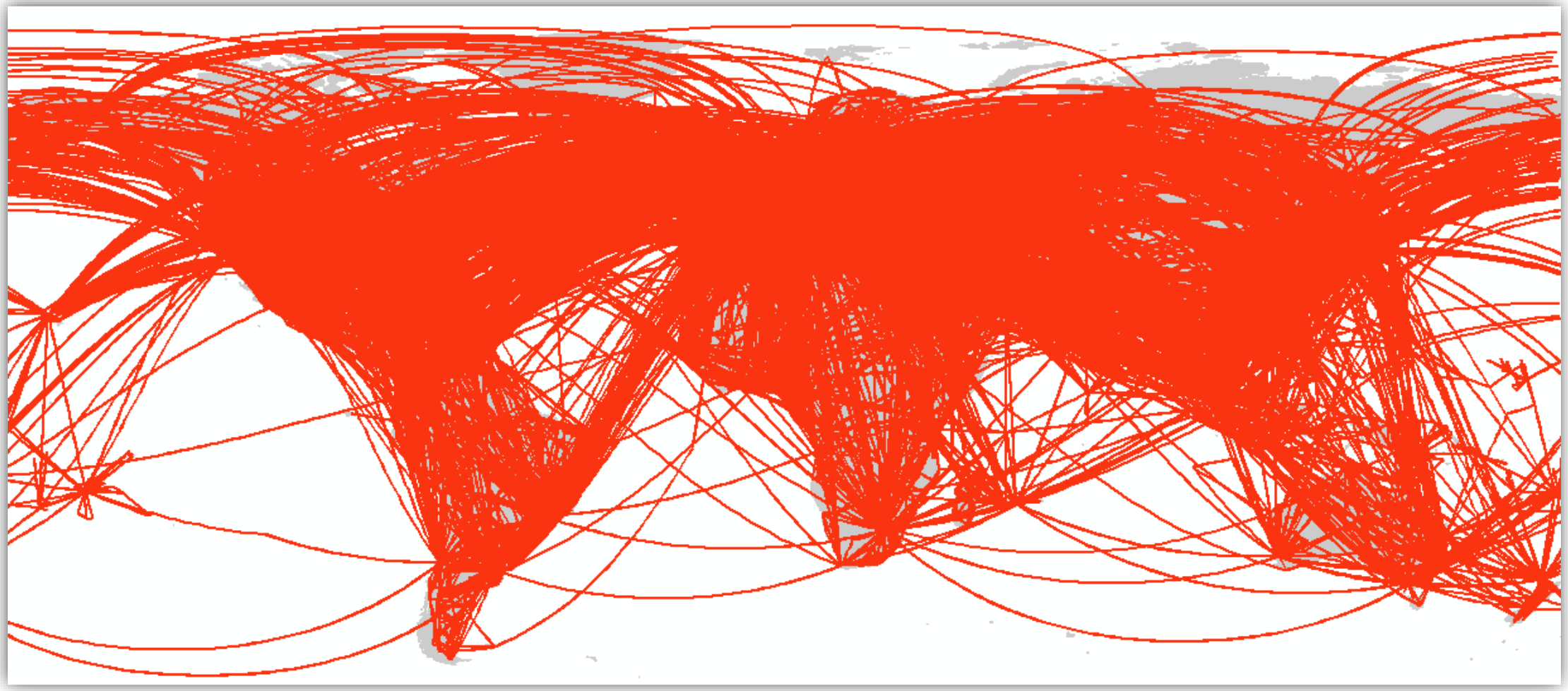
Tatem, *Int Health*, 2014; Ruktanonchai et al, *IJHG*, 2018

Global air network: 1933



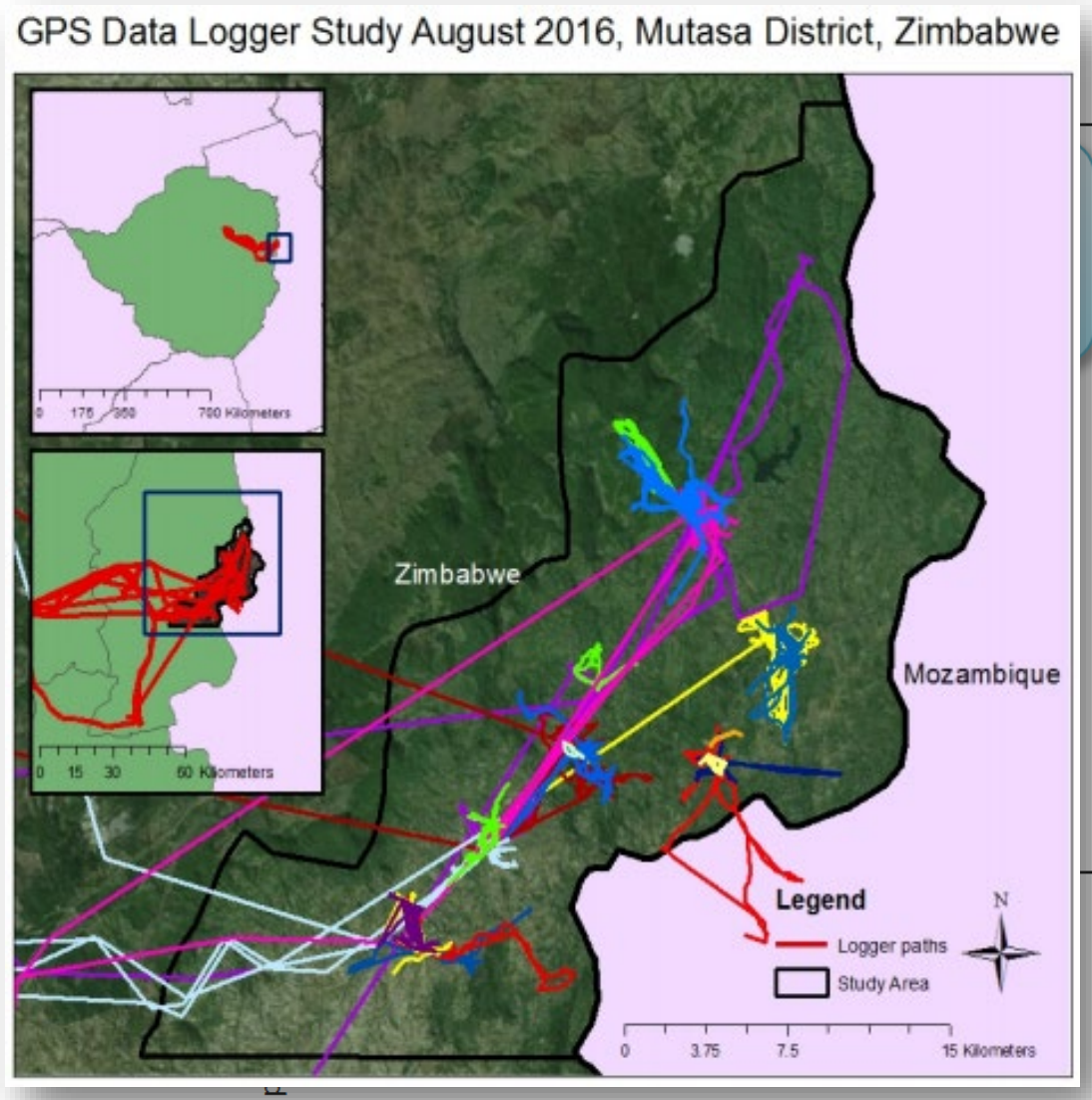
Tatem (2014) Int Health

Global air network: Today

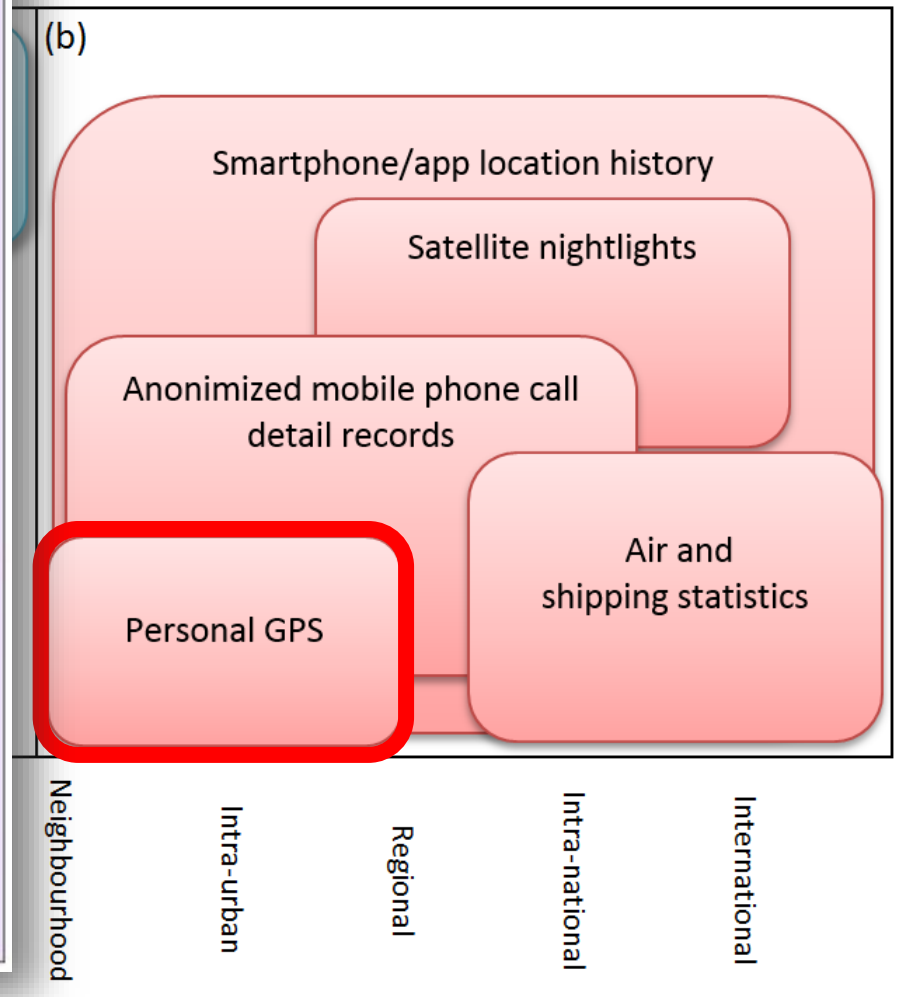


Tatem (2014) Int Health

Data for measuring population movements/migrations

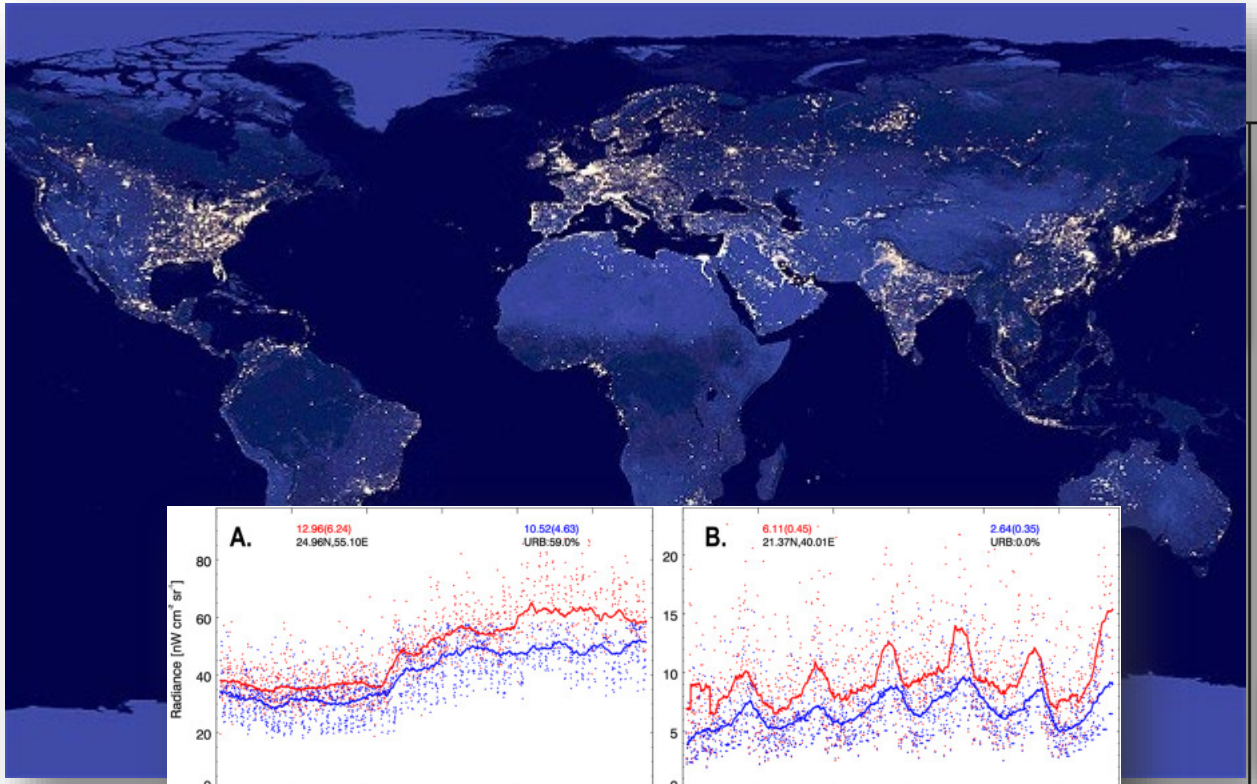


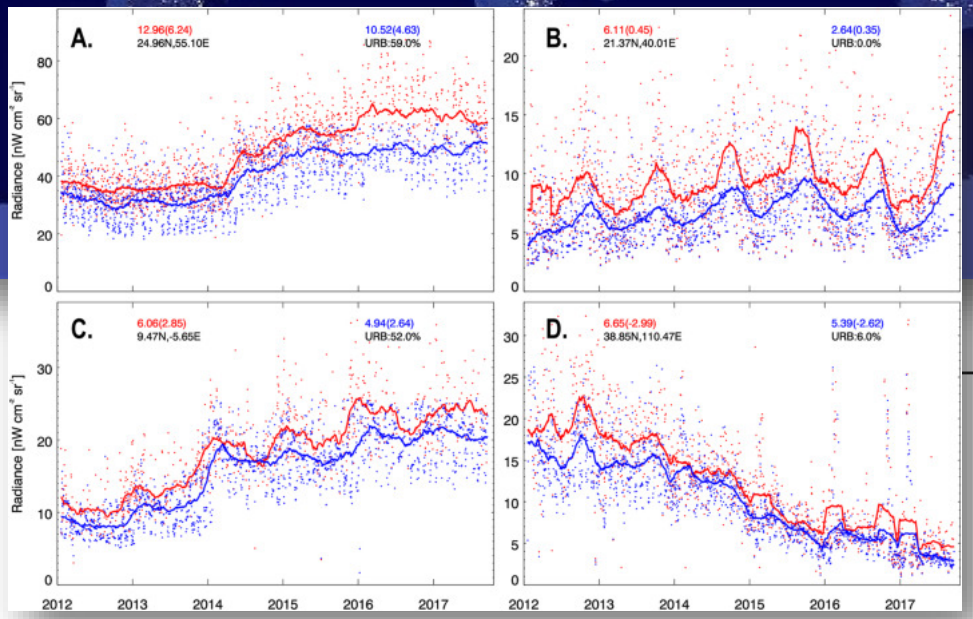
Novel

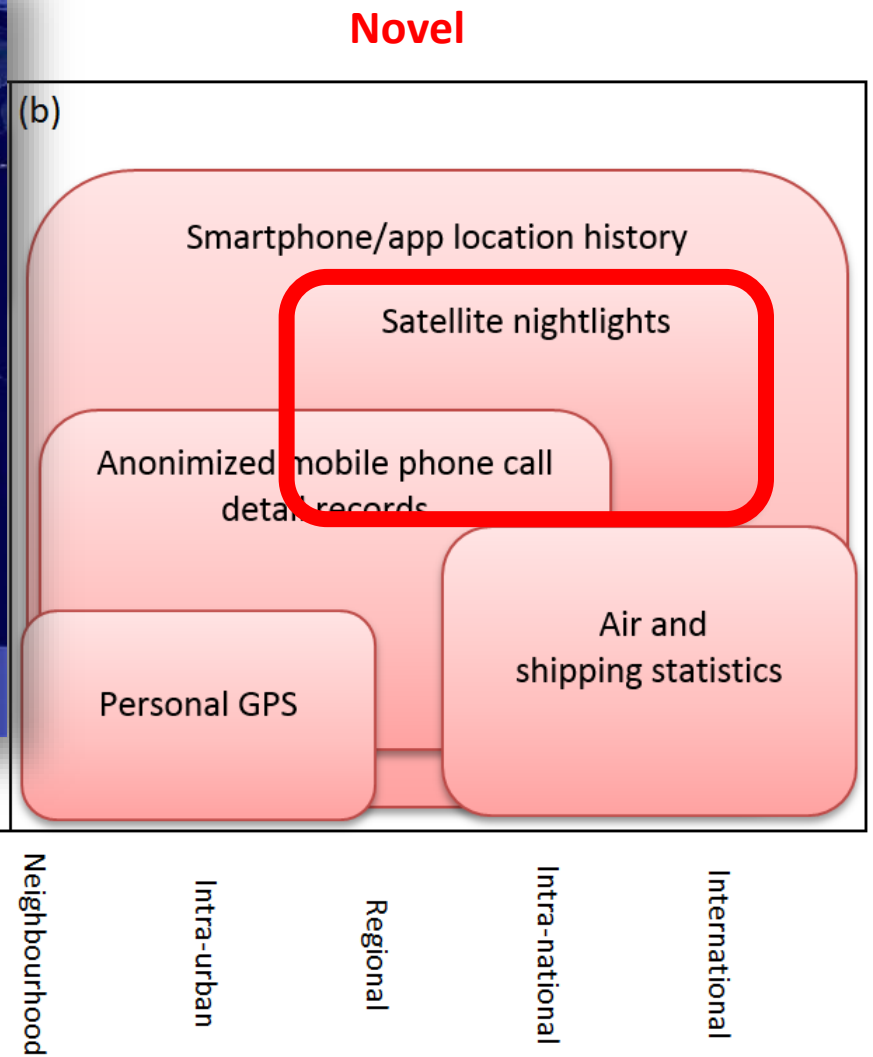


Tatem, *Int Health*, 2014; Ruktanonchai et al, *IJHG*, 2018

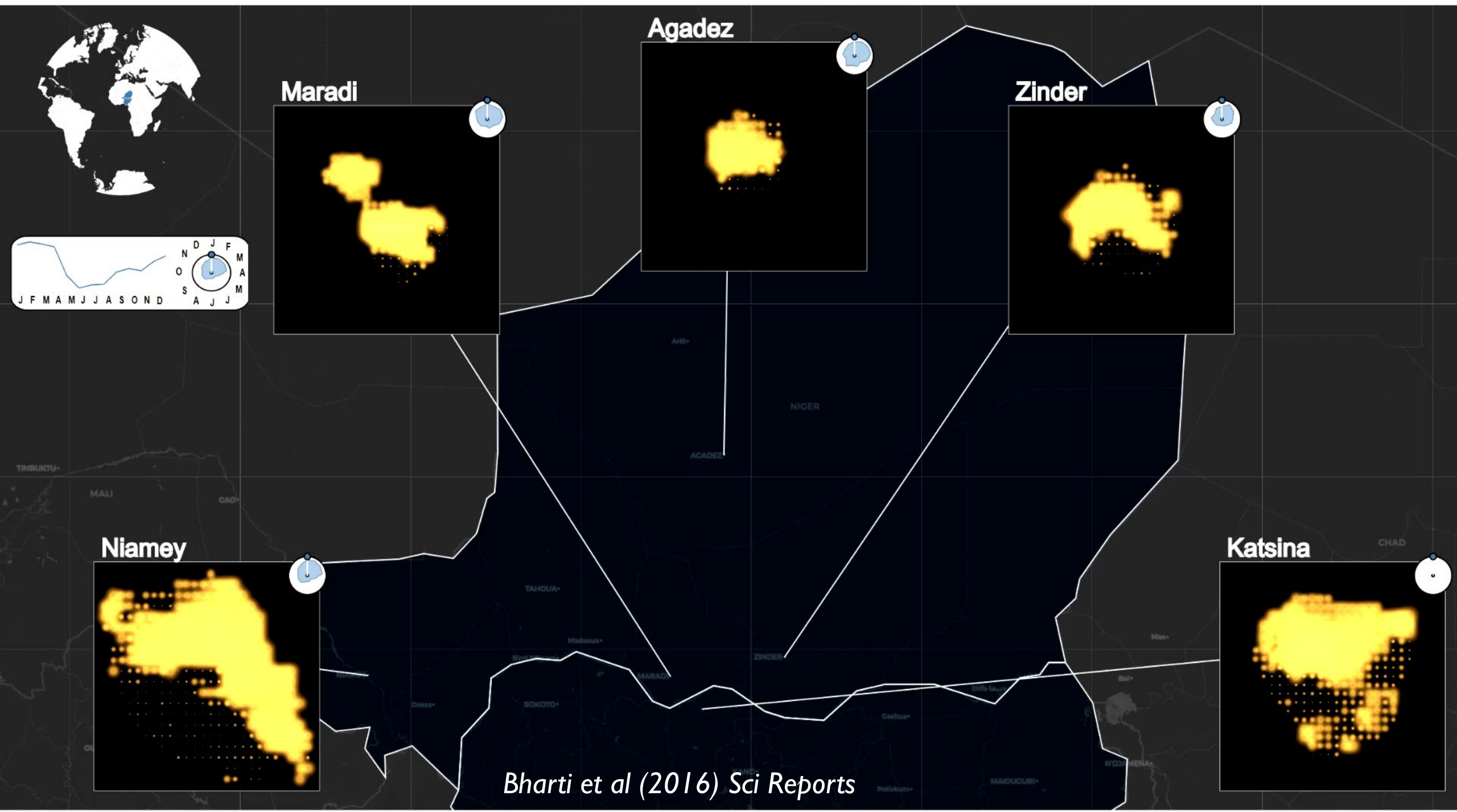
Data for measuring population movements/migrations





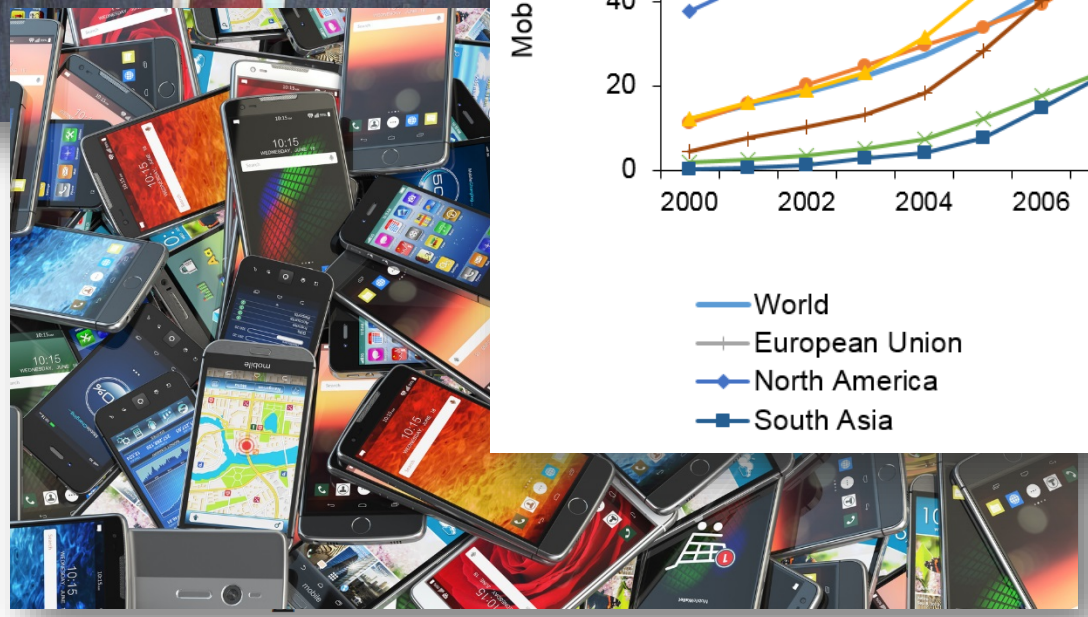


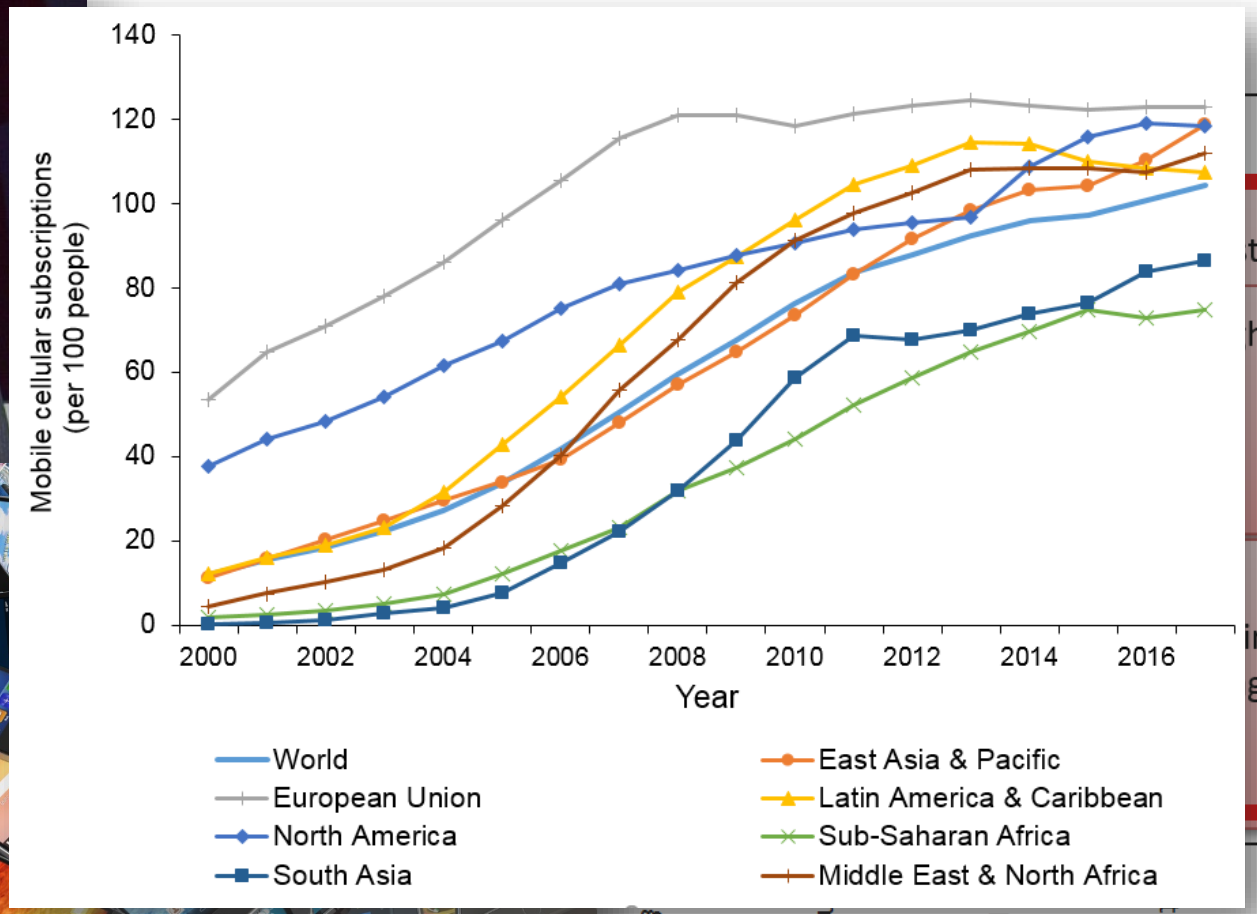
Tatem, *Int Health*, 2014; Ruktanonchai et al, *IJHG*, 2018

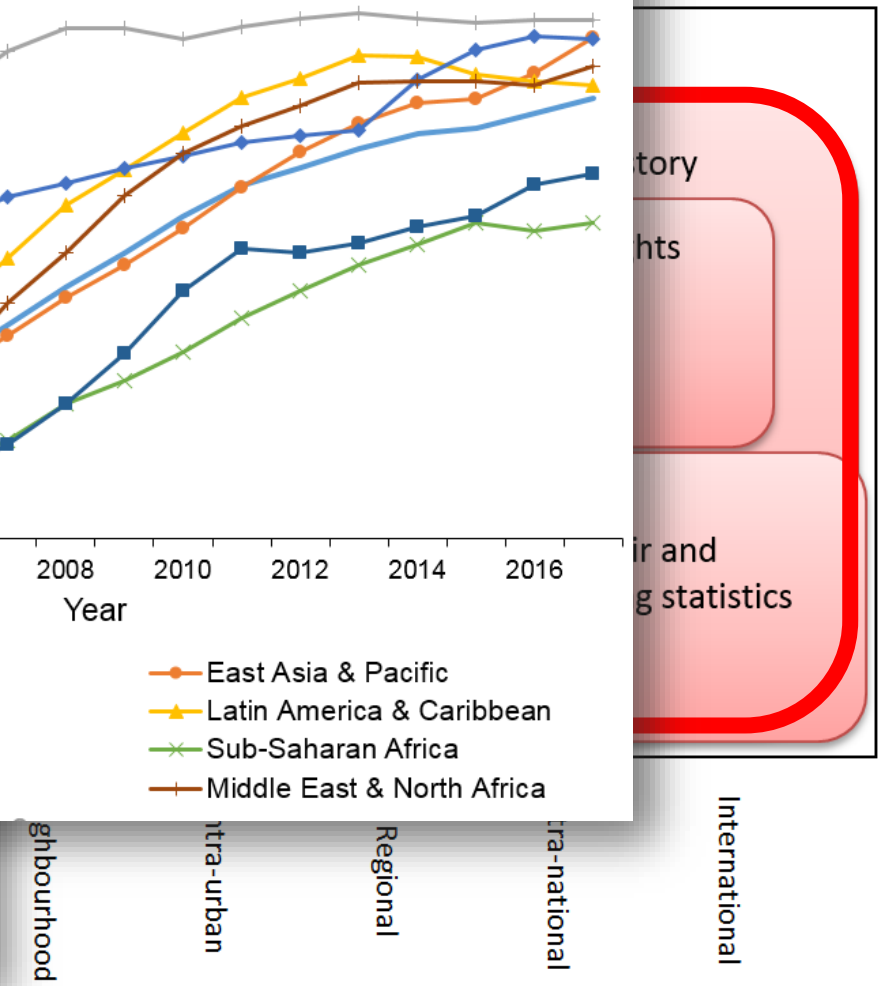


Bharti et al (2016) Sci Reports

Data for measuring population movements/migrations







Tatem, *Int Health*, 2014; Ruktanonchai et al, *IJHG*, 2018

Mobile phone call detail records

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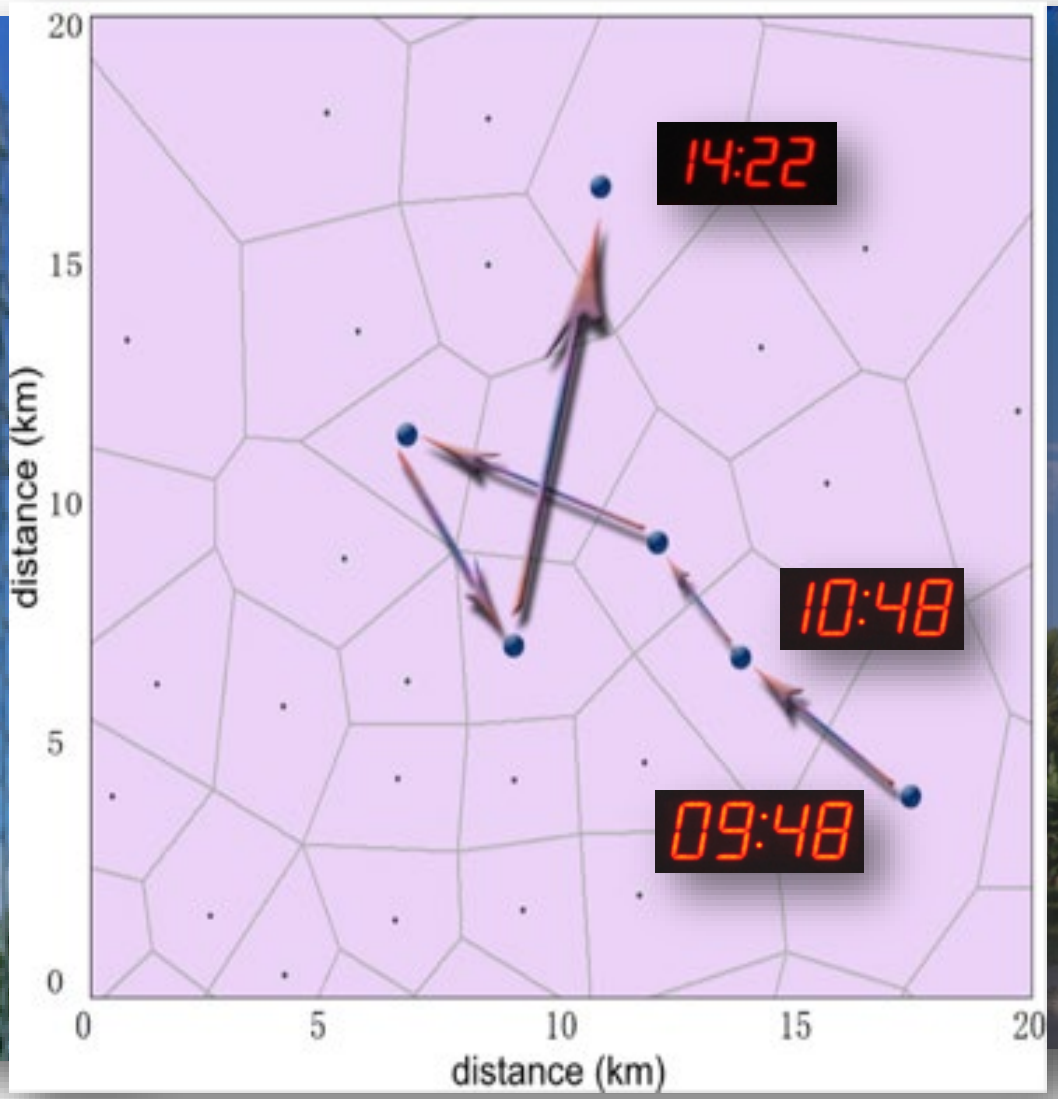

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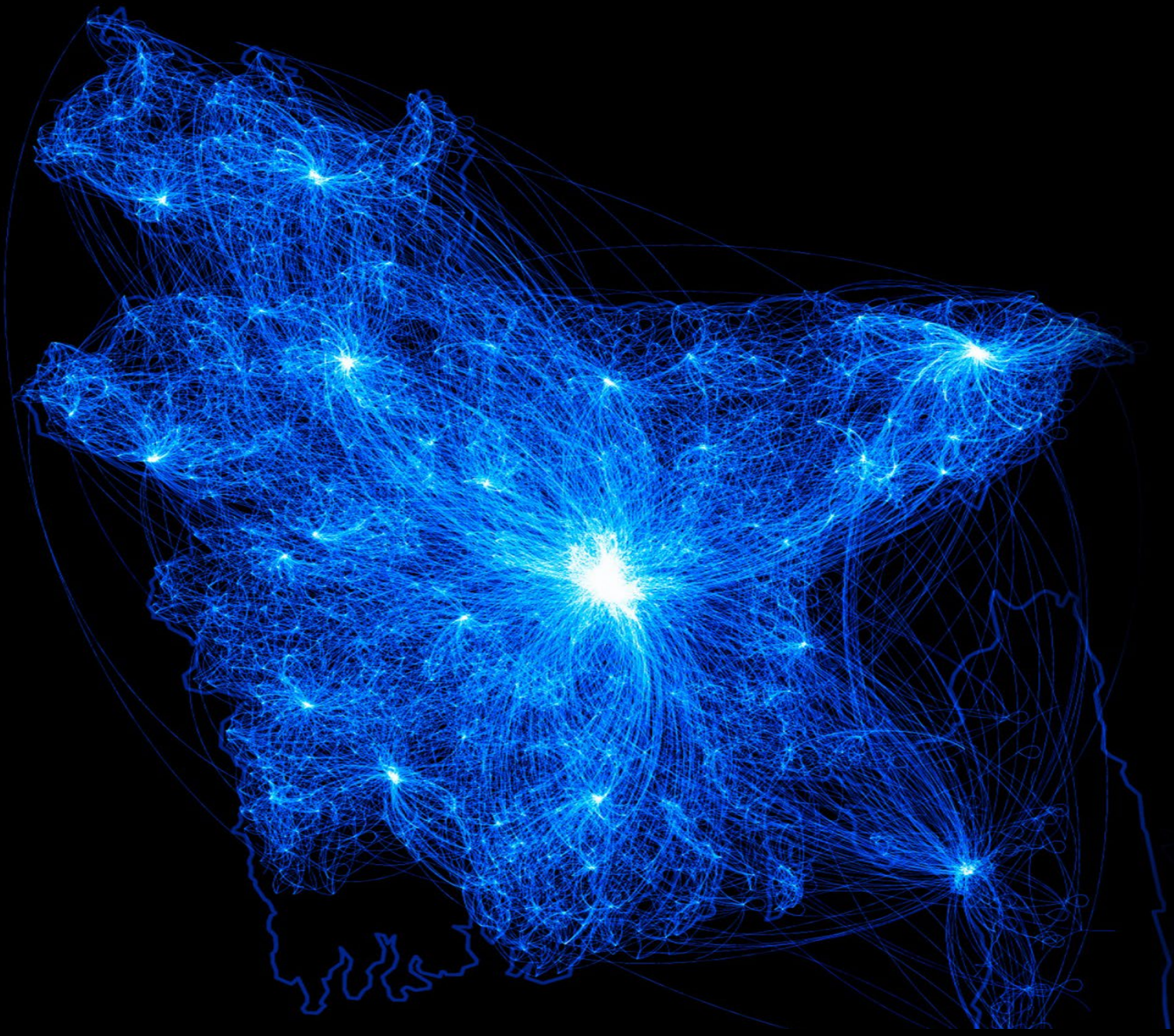

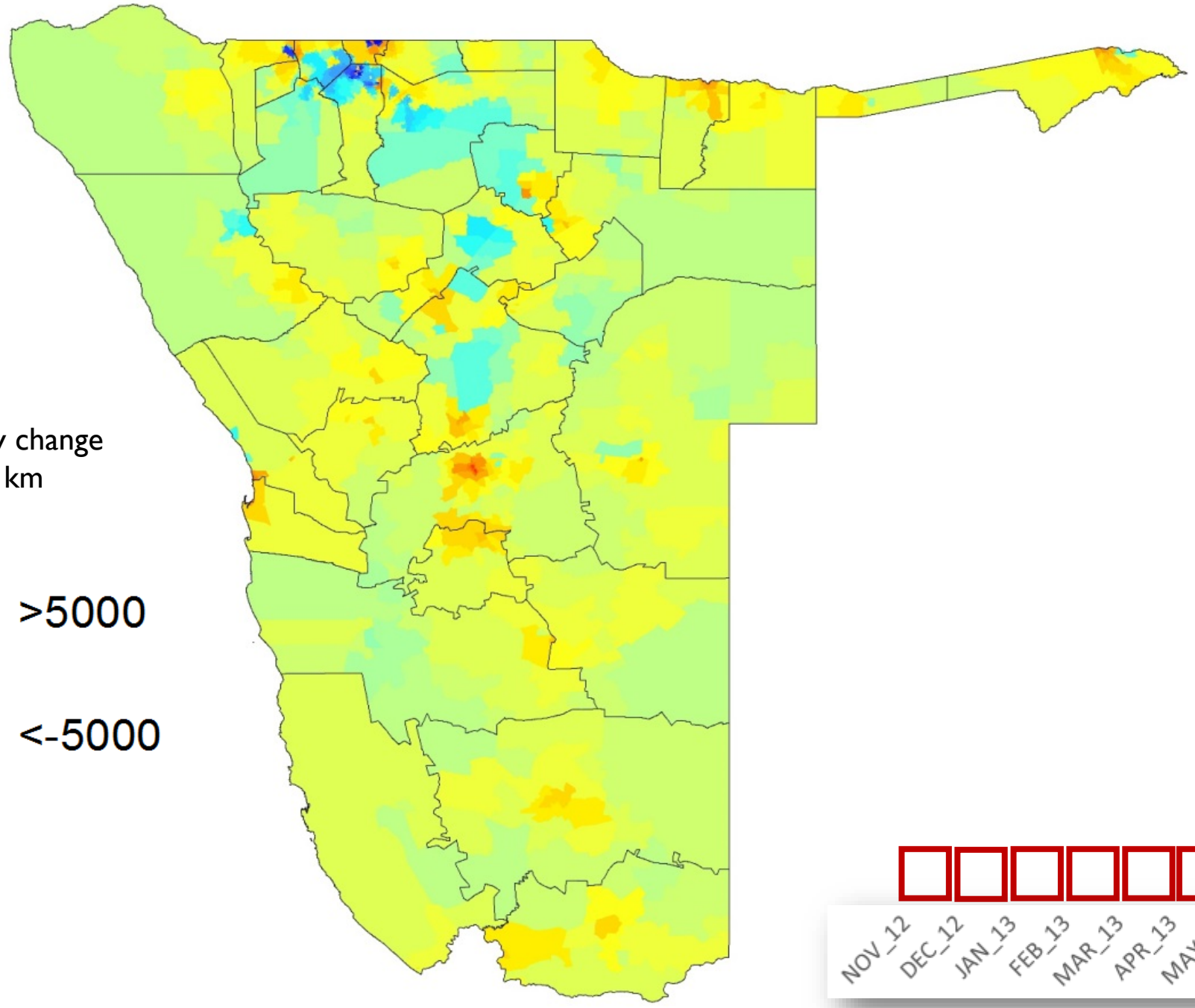
Pop density change
per square km
>5000
<-5000
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Smartphone/app location histories

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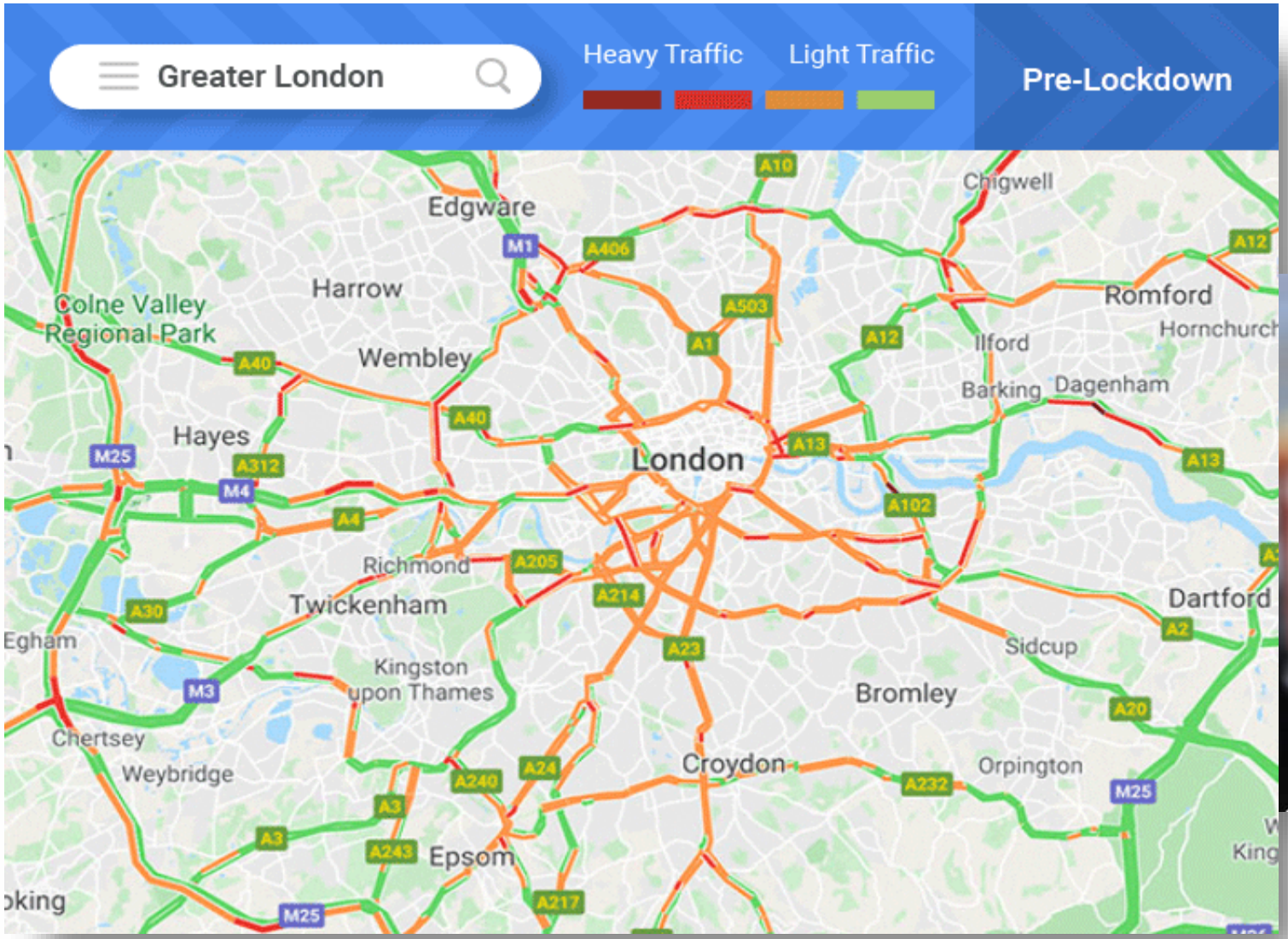
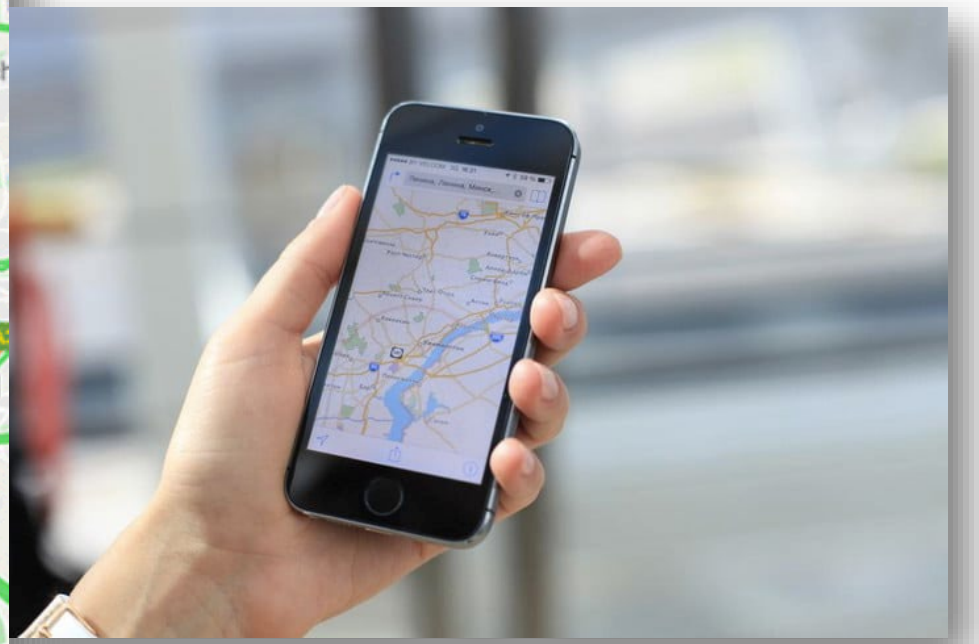
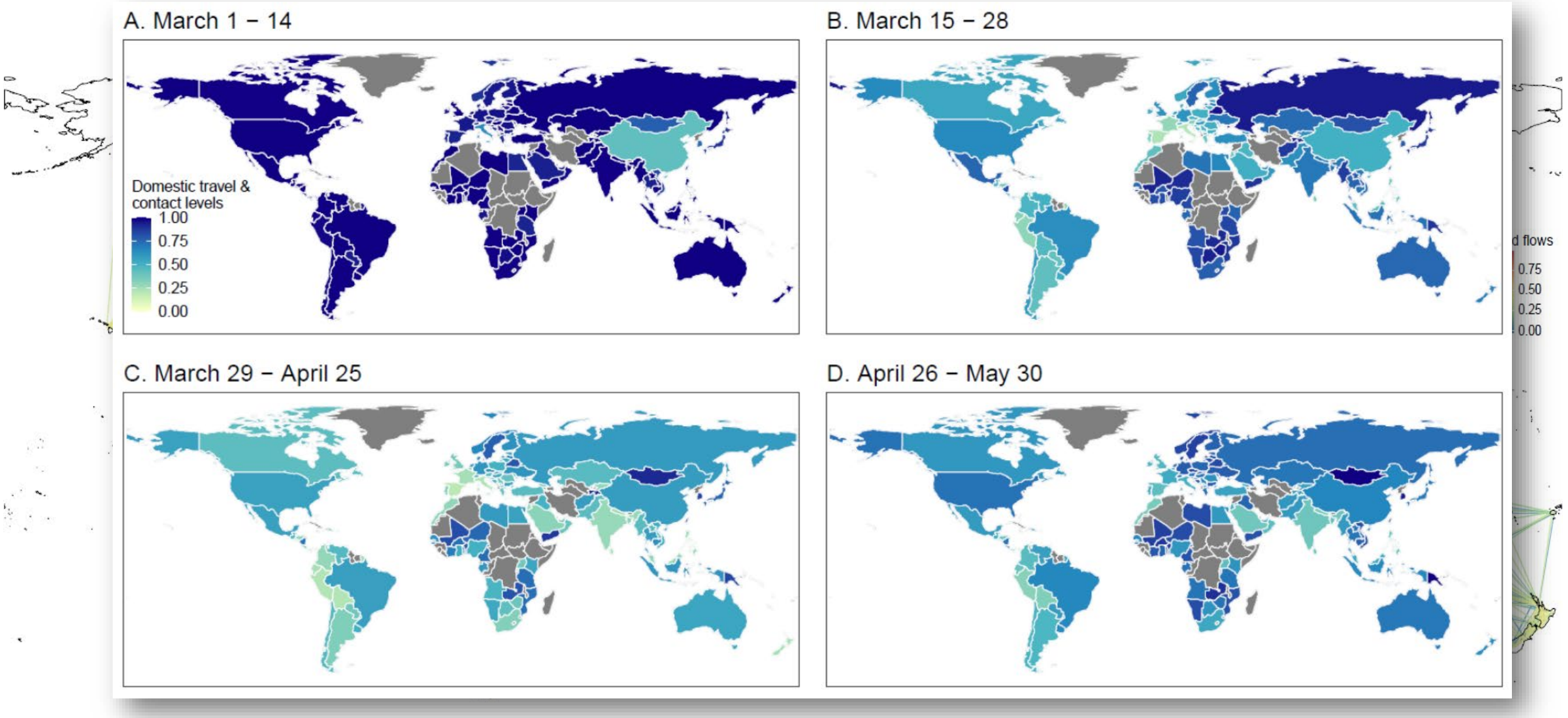




Ruktanonchai et al (2018) IJHG

Smartphone/app location histories



Lai et al (2020) MedArXiv

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https://covid19.apple.com/mobility

Maps

Mobility Trends Reports

Learn about COVID-19 mobility trends. Reports are published daily and reflect requests for directions in Apple Maps. Privacy is one of our core values, so Maps doesn't associate your data with your Apple ID, and Apple doesn't keep a history of where you've been.

https://www.google.com/covid19/mobility/

Google COVID-19 Community Mobility Reports

See how your community is moving around differently due to COVID-19

As global communities respond to COVID-19, we've heard from public health officials that the same type of aggregated, anonymized insights we use in products such as Google Maps could be helpful as they make critical decisions to combat COVID-19.

These Community Mobility Reports aim to provide insights into what has changed in response to policies aimed at combating COVID-19. The reports chart movement trends over time by geography, across different categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential.

FACEBOOK Data for Good

Public Datasets | Tools for Nonprofits | Impact | Approach

We use data to address some of the world's greatest humanitarian issues.

Flattening the COVID-19 curve is a challenge that takes all of us. People are distancing to protect their communities, healthcare workers are saving lives on the front lines, and public health systems are looking to put the right guidelines in place. To do that, they need better information on whether preventive measures are working and how the virus may spread. We offer maps on population movement that researchers and nonprofits are already using to understand the coronavirus crisis, using aggregated data to protect people's privacy.

https://dataforgood.fb.com/

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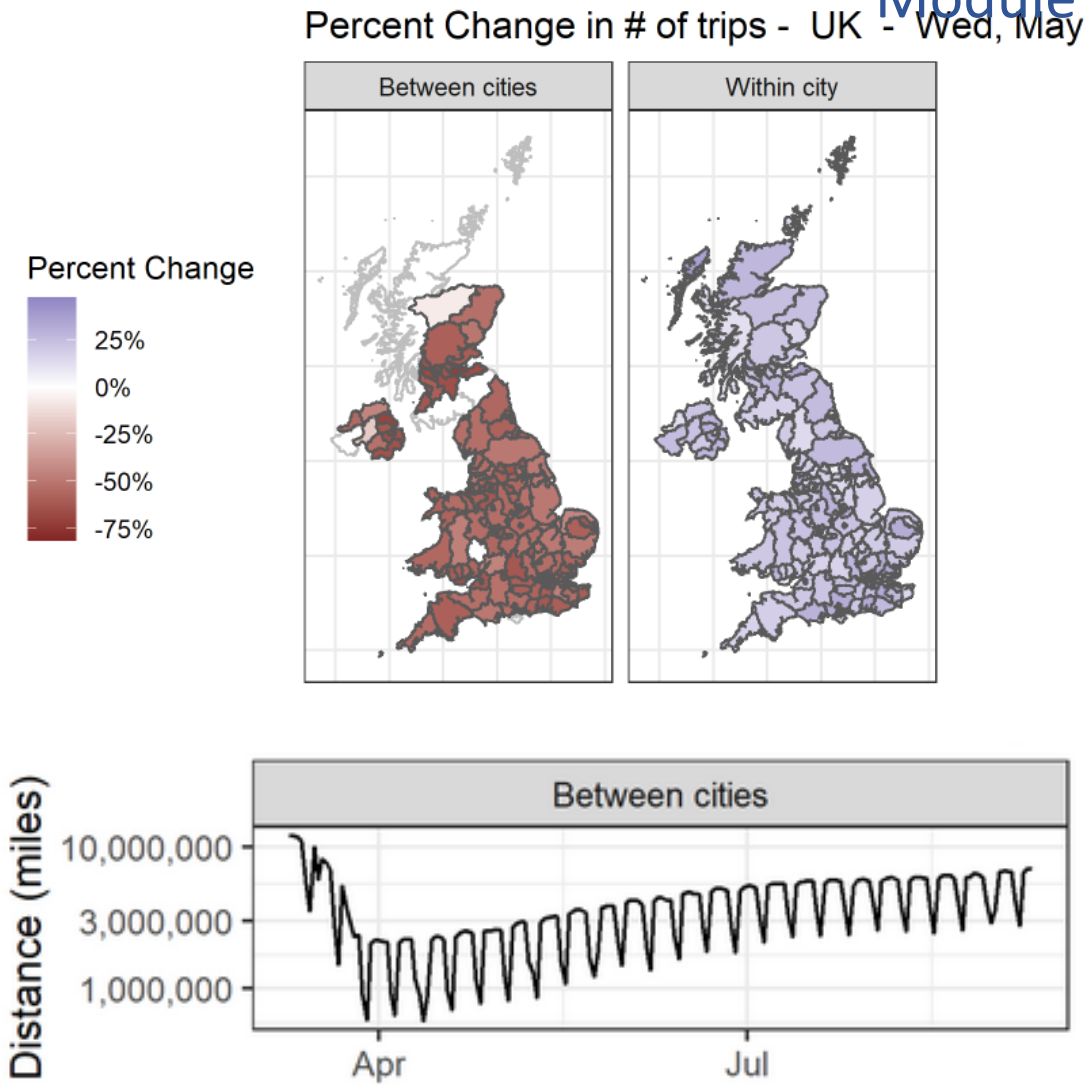

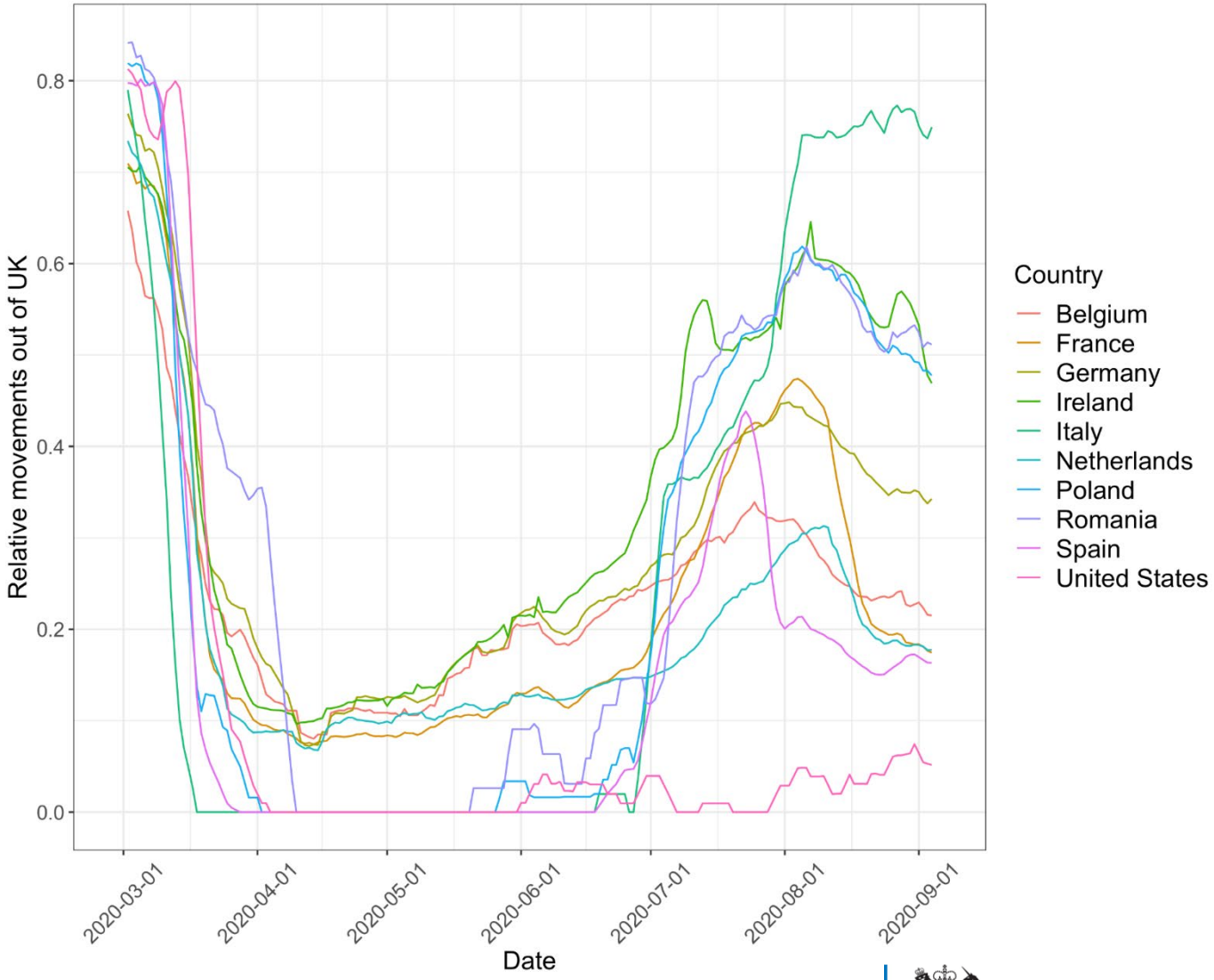

Office for National Statistics

FACEBOOK Data for Good

Cabinet Office

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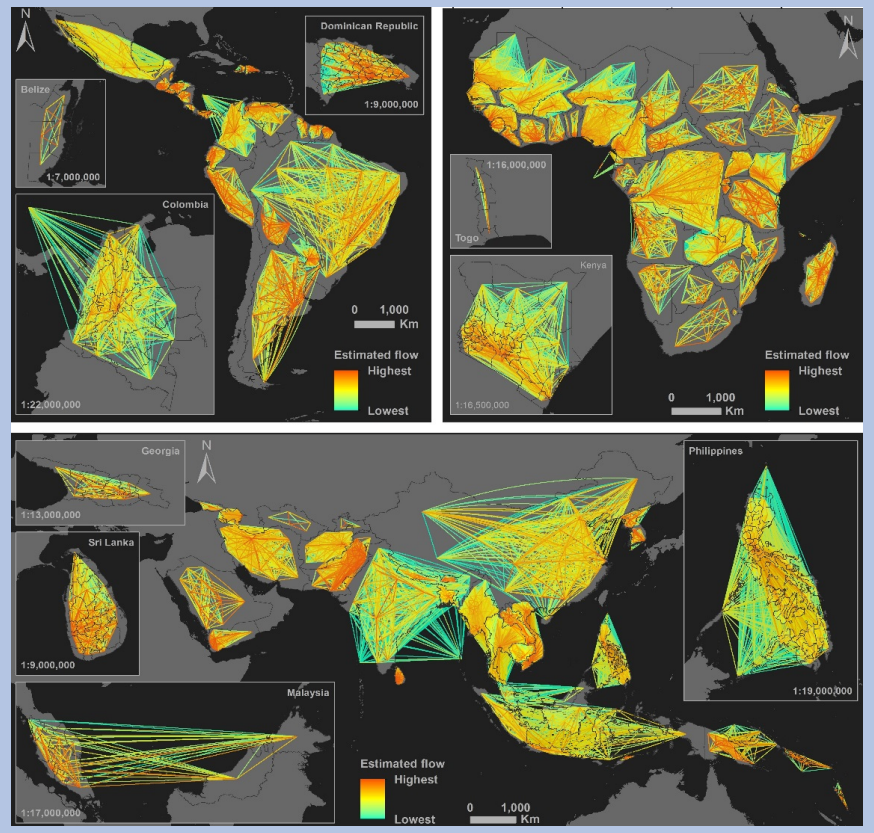
GEOSPATIAL DATA INTEGRATION FOR SUBNATIONAL SEX-DISAGGREGATED MIGRATION MAPPING



www.nature.com/scientificdata

SCIENTIFIC DATA

OPEN

SUBJECT CATEGORIES
» Malaria
» Geography
» Public health
» Environmental impact

Data Descriptor: Mapping internal connectivity through human migration in malaria endemic countries

Alessandro Sorichetta[1,2,3], Tom J. Bird[1,2], Nick W. Ruktanonchai[1,2], Elisabeth zu Erbach-Schoenberg[1,2], Carla Pezzulo[1,2], Natalia Tejedor[1,2,4], Ian C. Waldock[4], Jason D. Sadler[4], Andres J. Garcia[5], Luigi Sedda[6] & Andrew J. Tatem[1,2]

MIGRATION STUDIES 2014 • 1–22 1 of 22

Modeling internal migration flows in sub-Saharan Africa using census microdata

Andres J. Garcia[†,‡,*], Deepa K. Pindolia[†,‡,§], Kenneth K. Lopiano[**,††] and Andrew J. Tatem[‡‡,§§,***]

Quantifying Global International Migration Flows

Guy J. Abel* and Nikola Sander*†

Made possible with funding from the Federal Ministry of the Interior, Building and Community, Germany, represented by the Federal Office for Migration and Refugees (BAMF).

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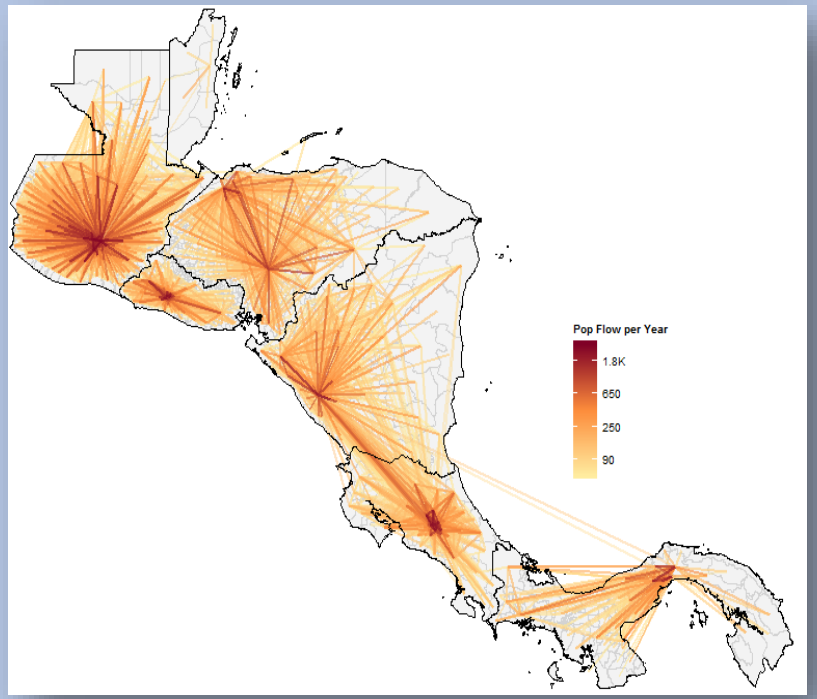
BACKGROUND AND AIMS

- No consistent subnational data on migration flows across low/middle income settings exists
- Utilize census microdata and geospatial covariates to build regional models and fill data gaps
- Understand relative importance of some key migration drivers



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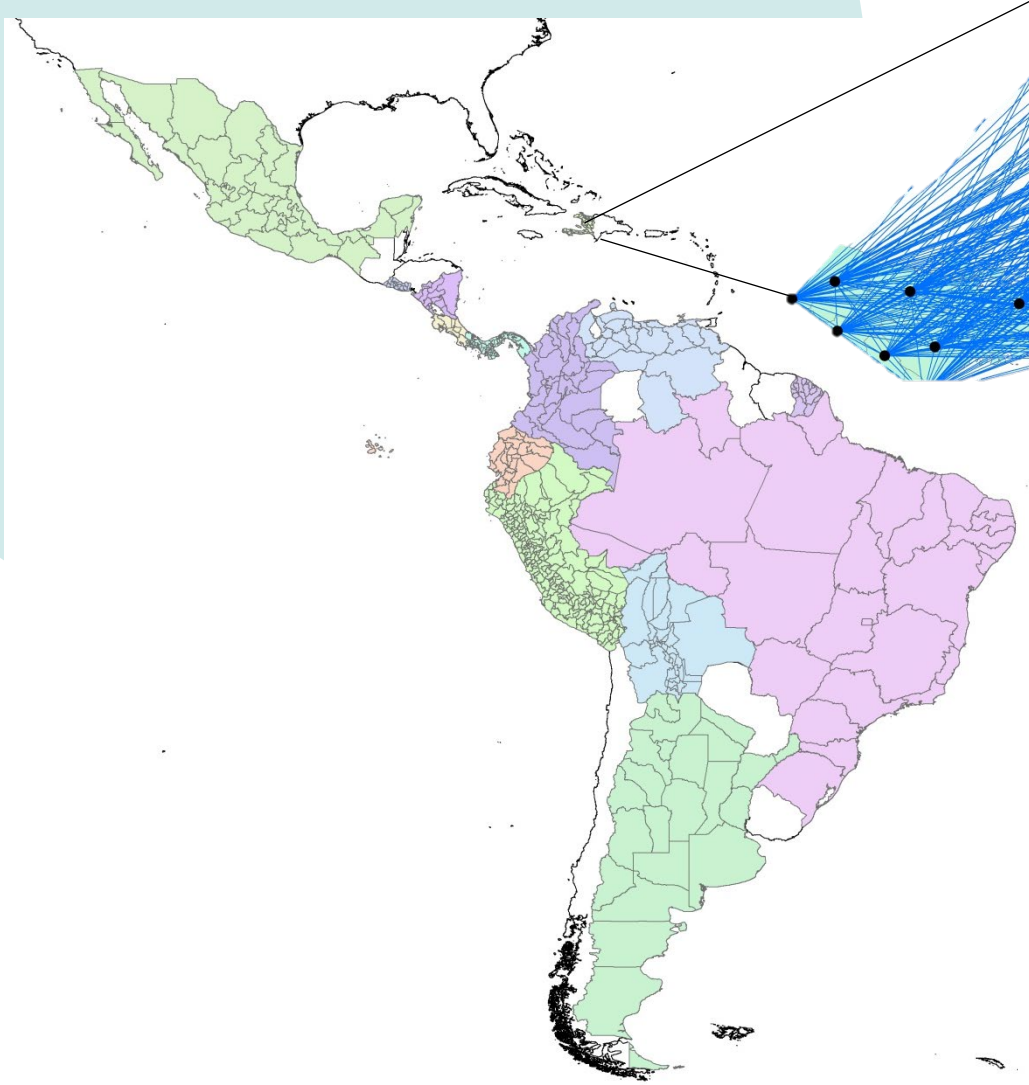
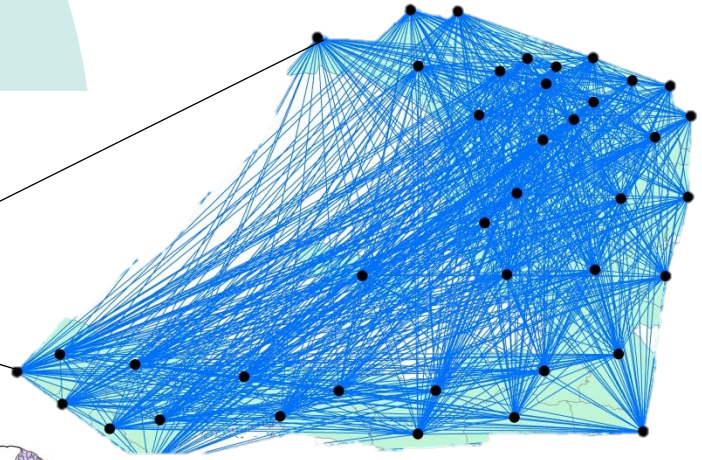
Assembling subnational migration data





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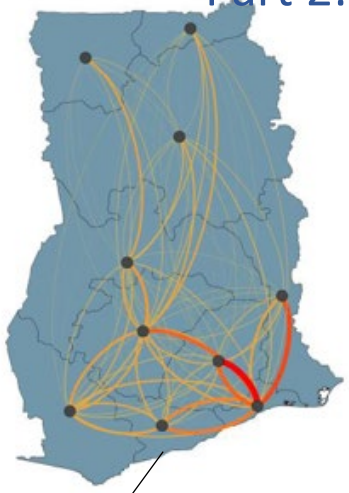

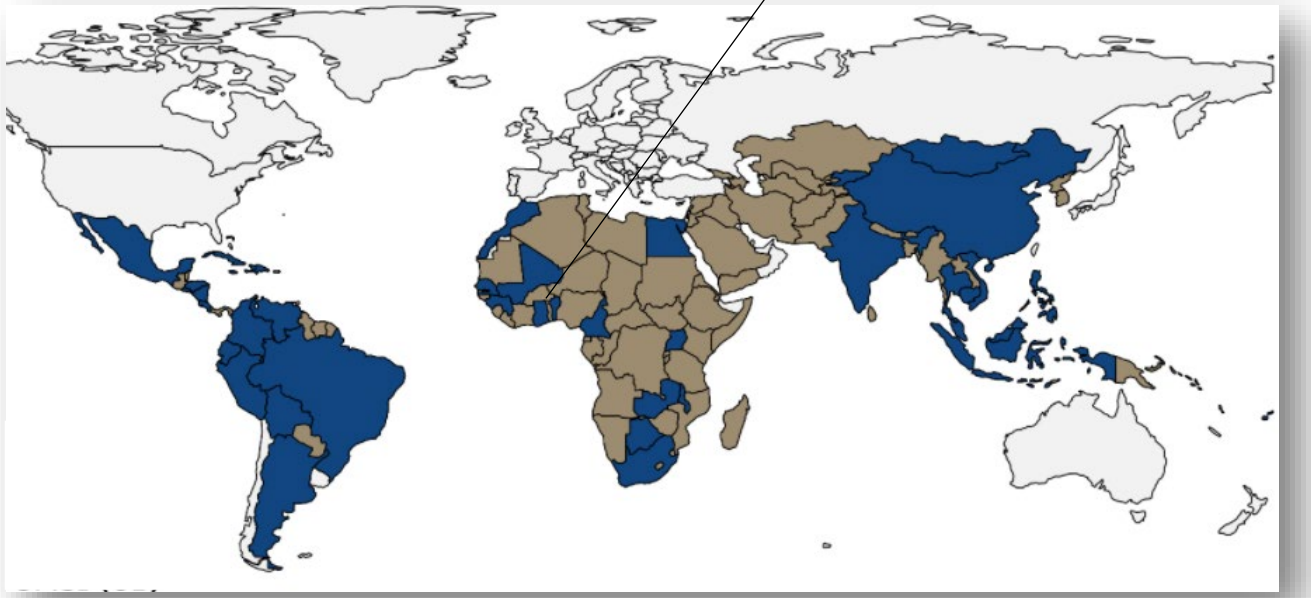

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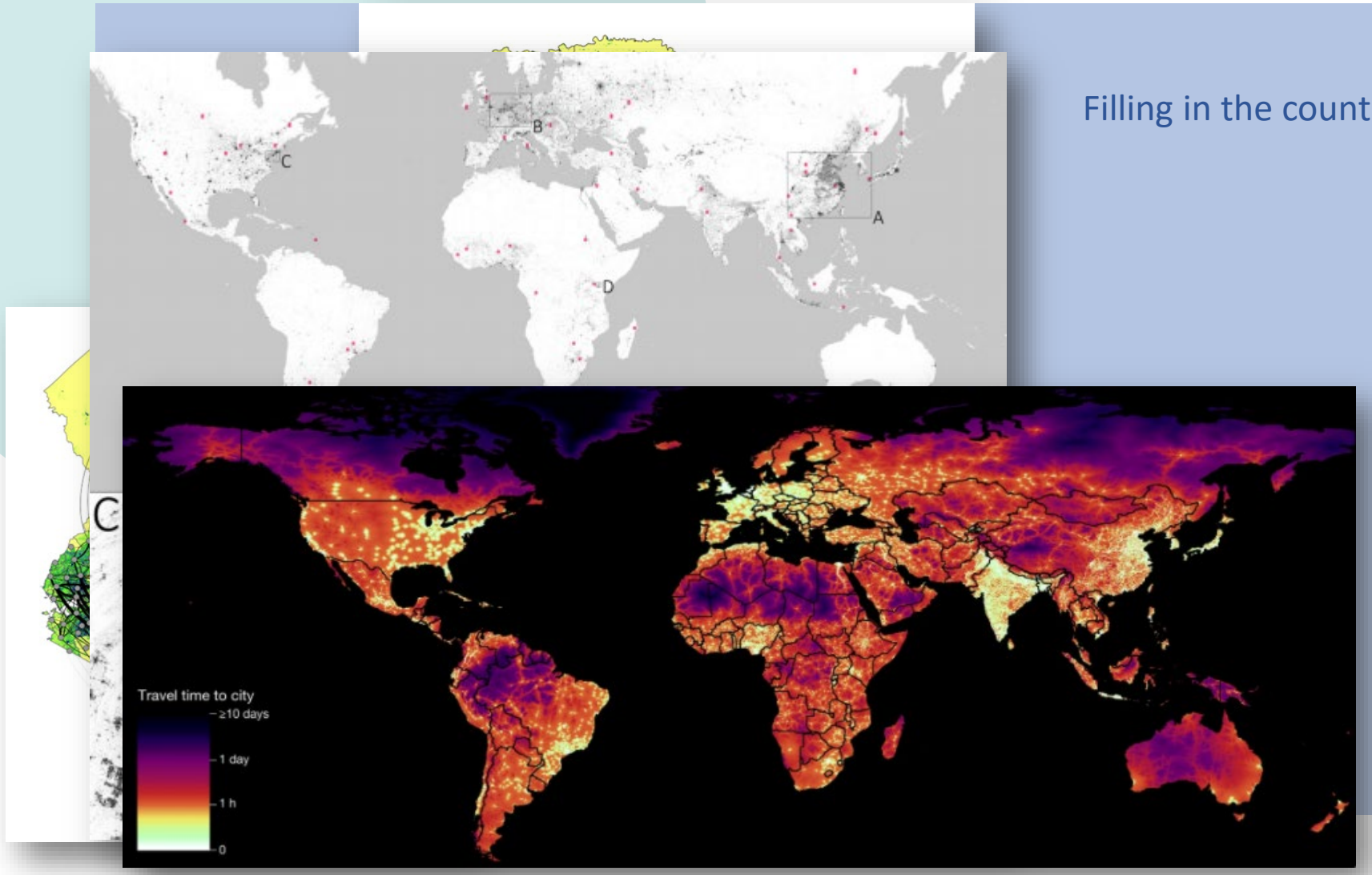

Filling in the country gaps

-Proportion urban
-Proportion economically active
-Proportion male
-Drought/conflict indicators
-Economic output
-Accessibility
-Ethnicity

Garcia et al (2014) Mig Studies; Sorichetta et al (2016) Nature Sci Data

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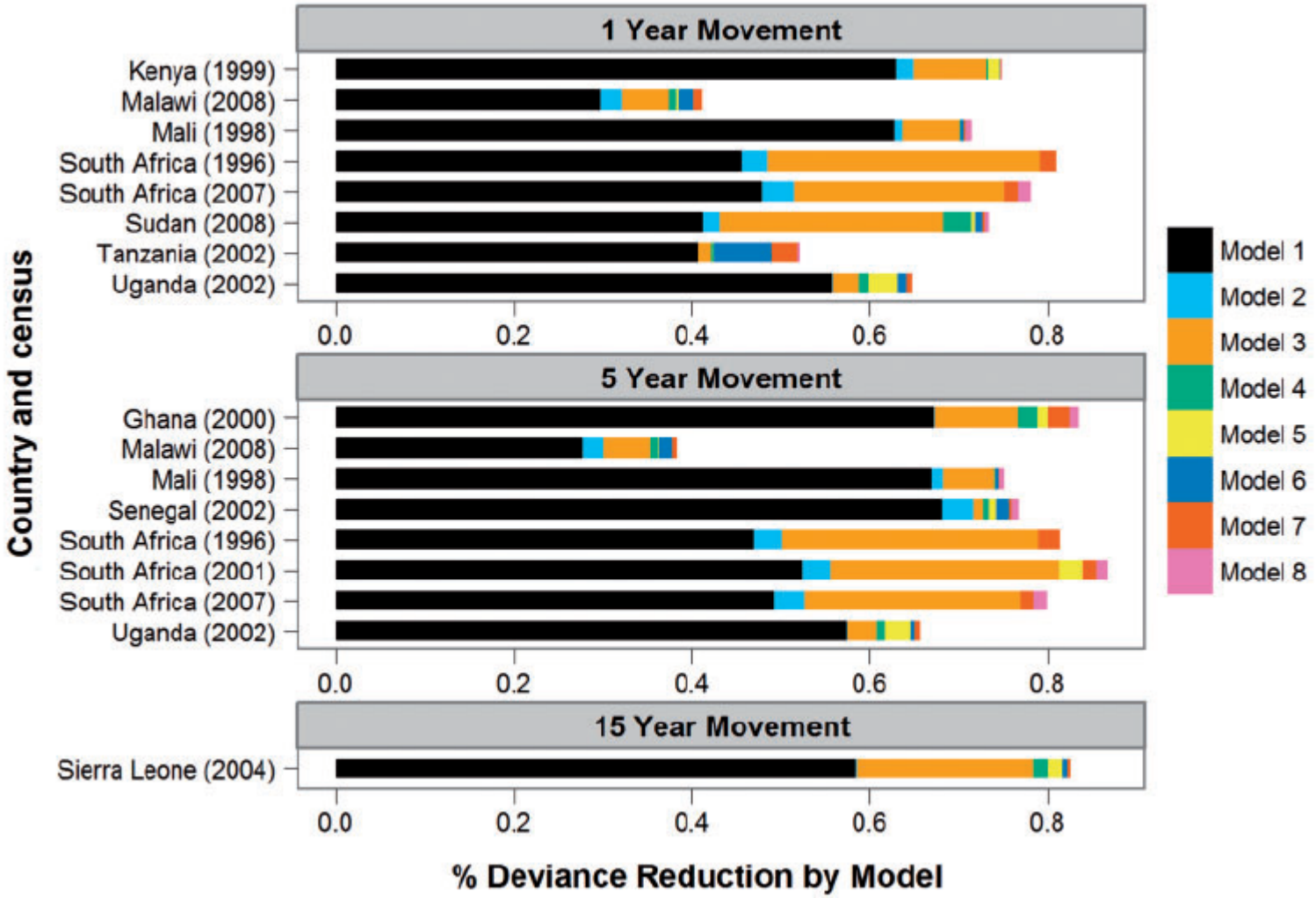
Model	Model description
Model 1	ln(POPI) + ln(POPJ) + ln(DISTIJ)
Model 2	Model 1 + CONTIG
Model 3	Model 2 + URBANPROPI + URBANPROPJ
Model 4	Model 3 + ACTIVEI + ACTIVE J
Model 5	Model 4 + MALEPROPI + MALEPROPJ
Model 6	Model 5 + MEDAGEI + MEDAGEJ
Model 7	Model 6 + DROUGHTI + DROUGHTJ
Model 8	Model 7 + RAINVARI + RAINVARJ



Garcia et al (2014) Mig Studies; Sorichetta et al (2016) Nature Sci Data

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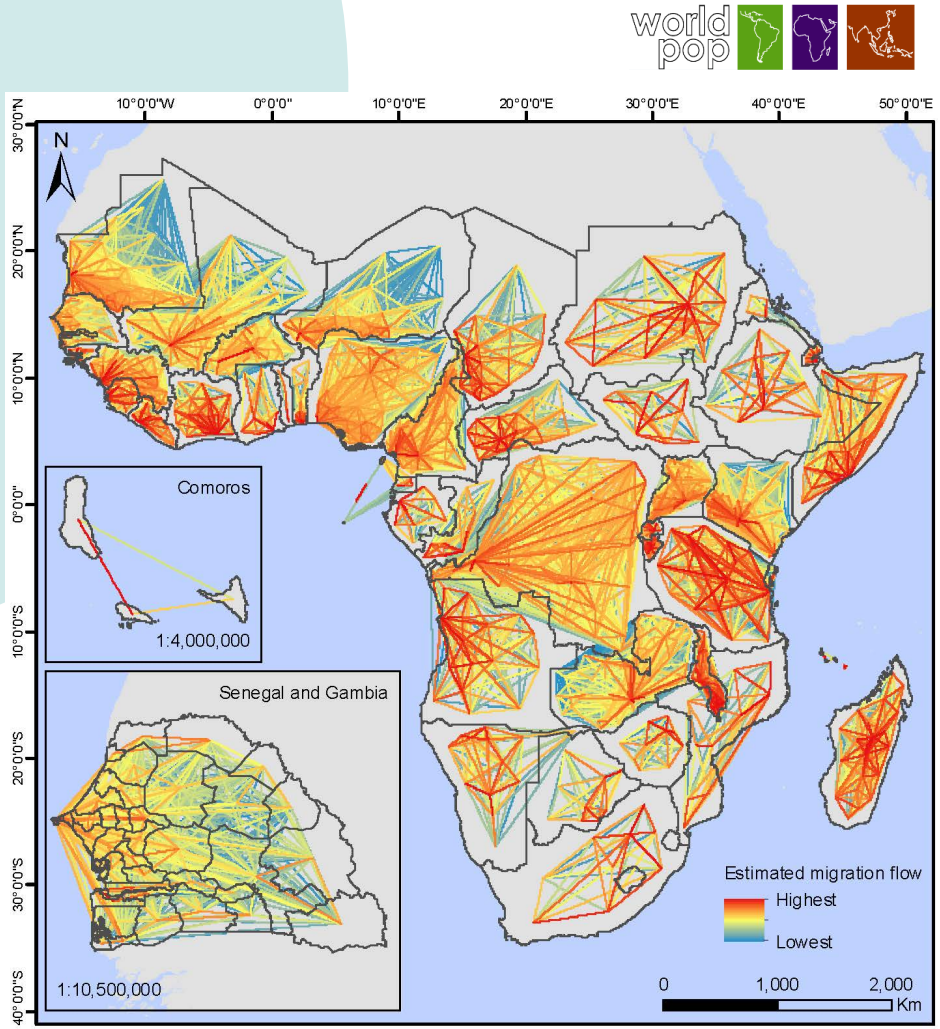
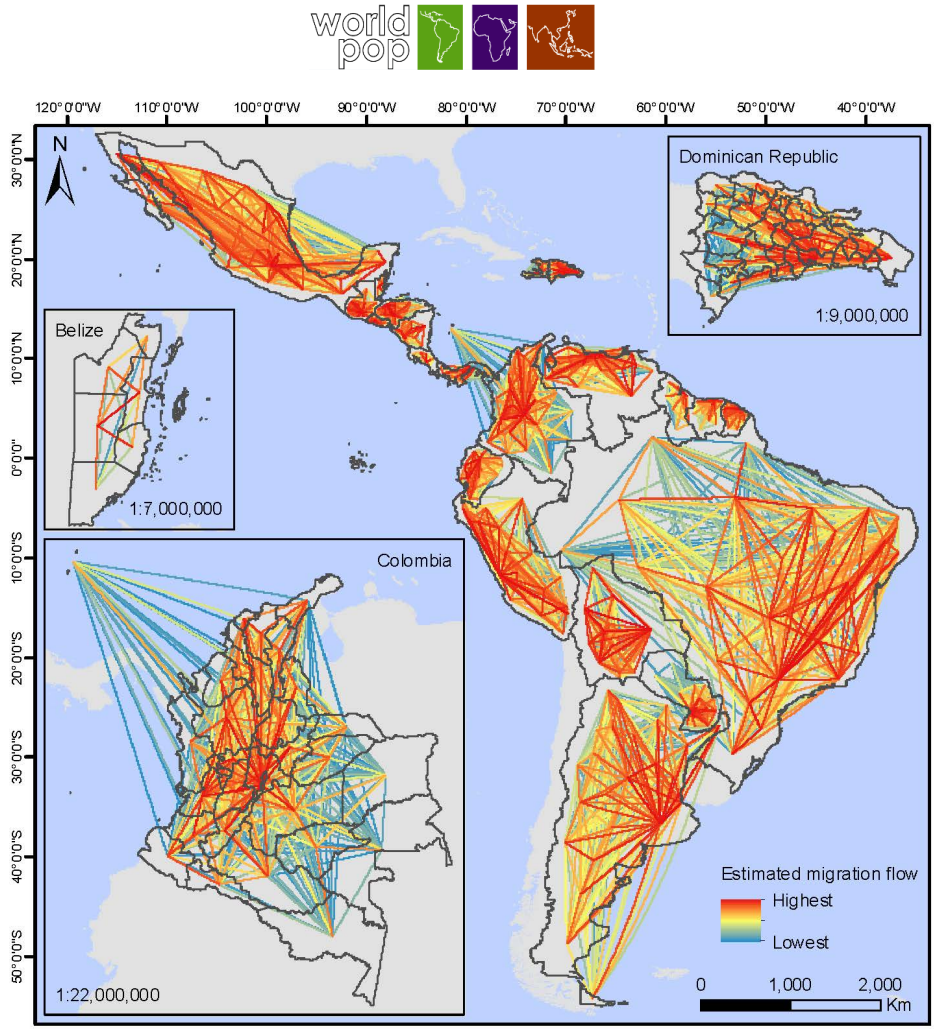
Internal Migration Estimates





Sorichetta et. al. (2016)

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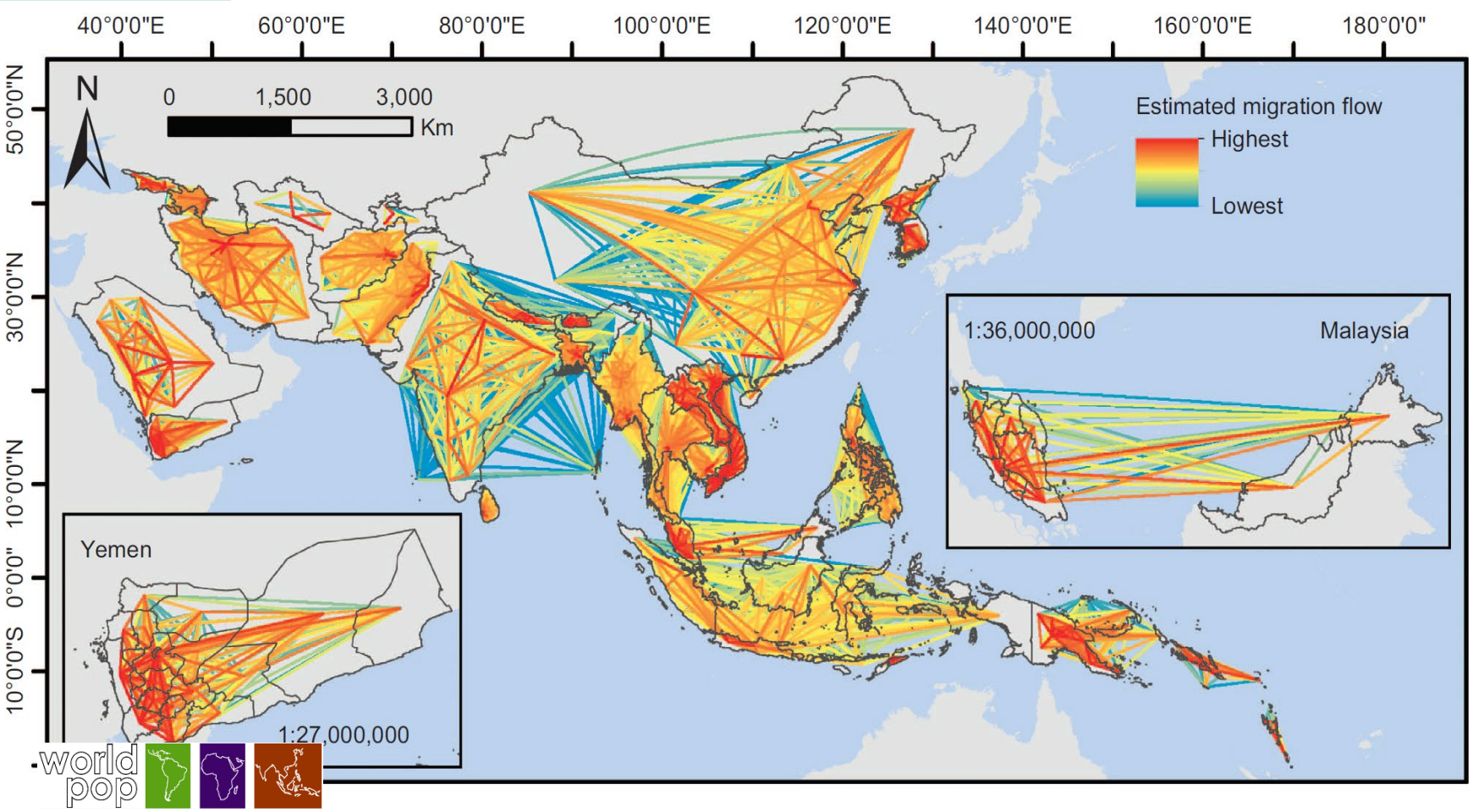
Internal Migration Estimates



Sorichetta et. al. (2016)

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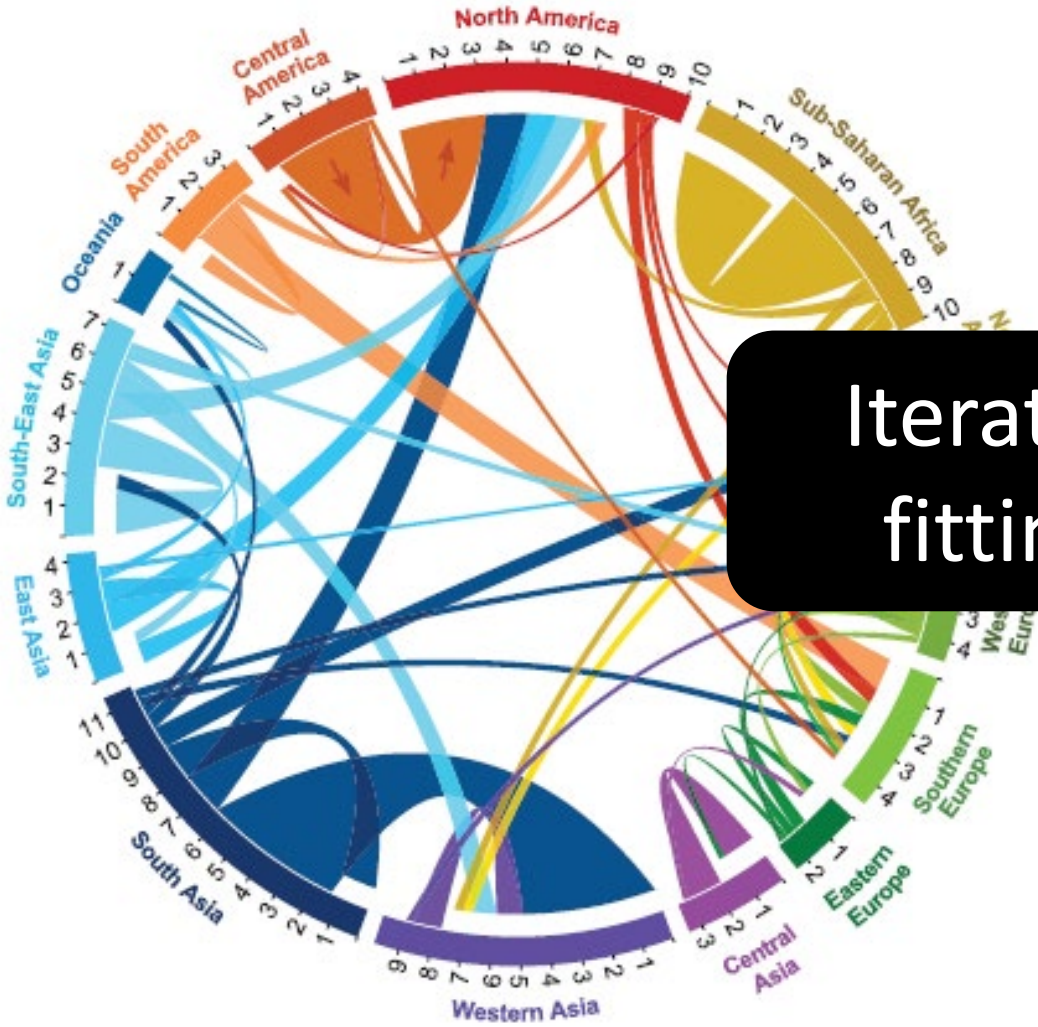
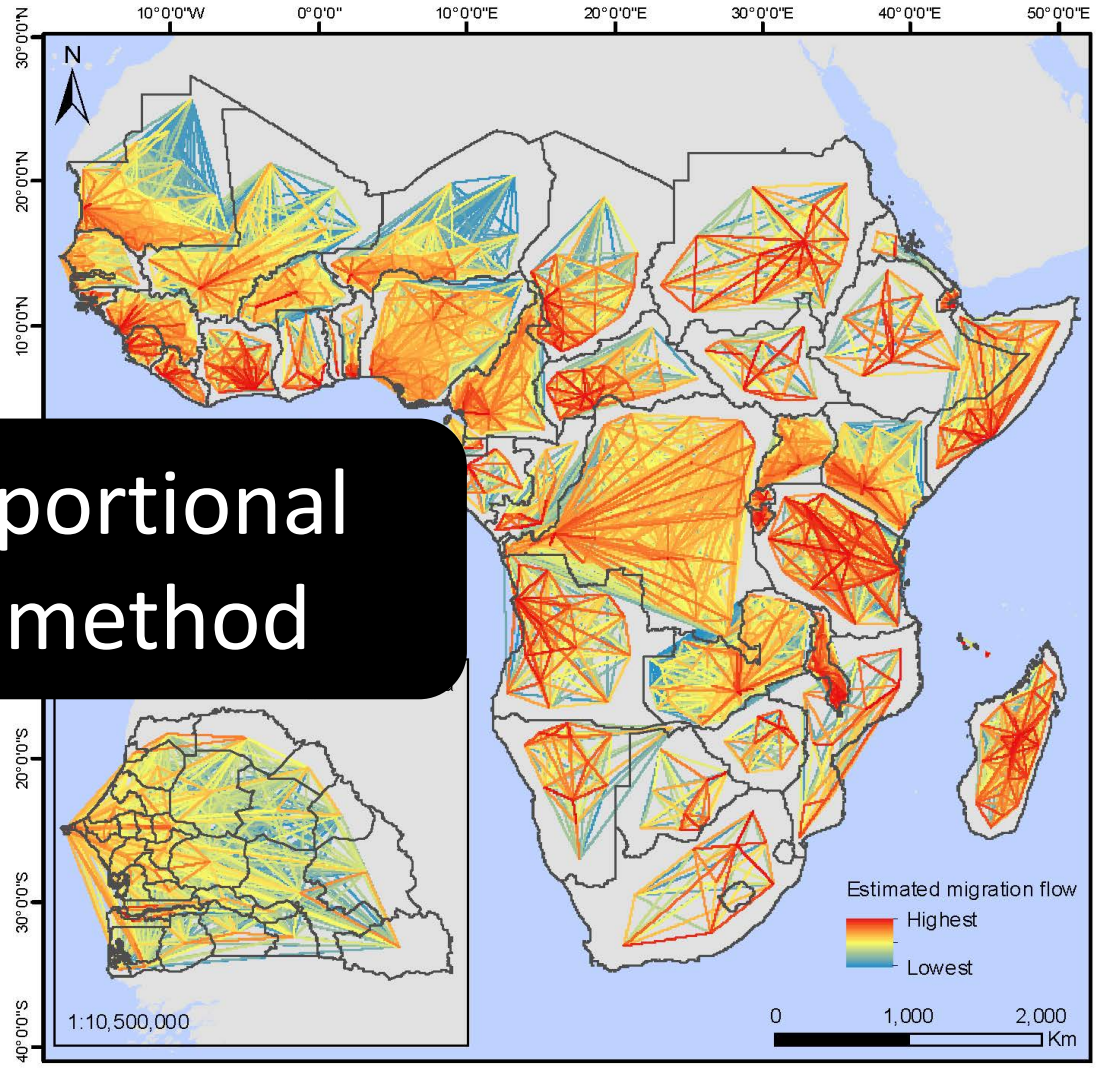
Integrating internal and international migration data

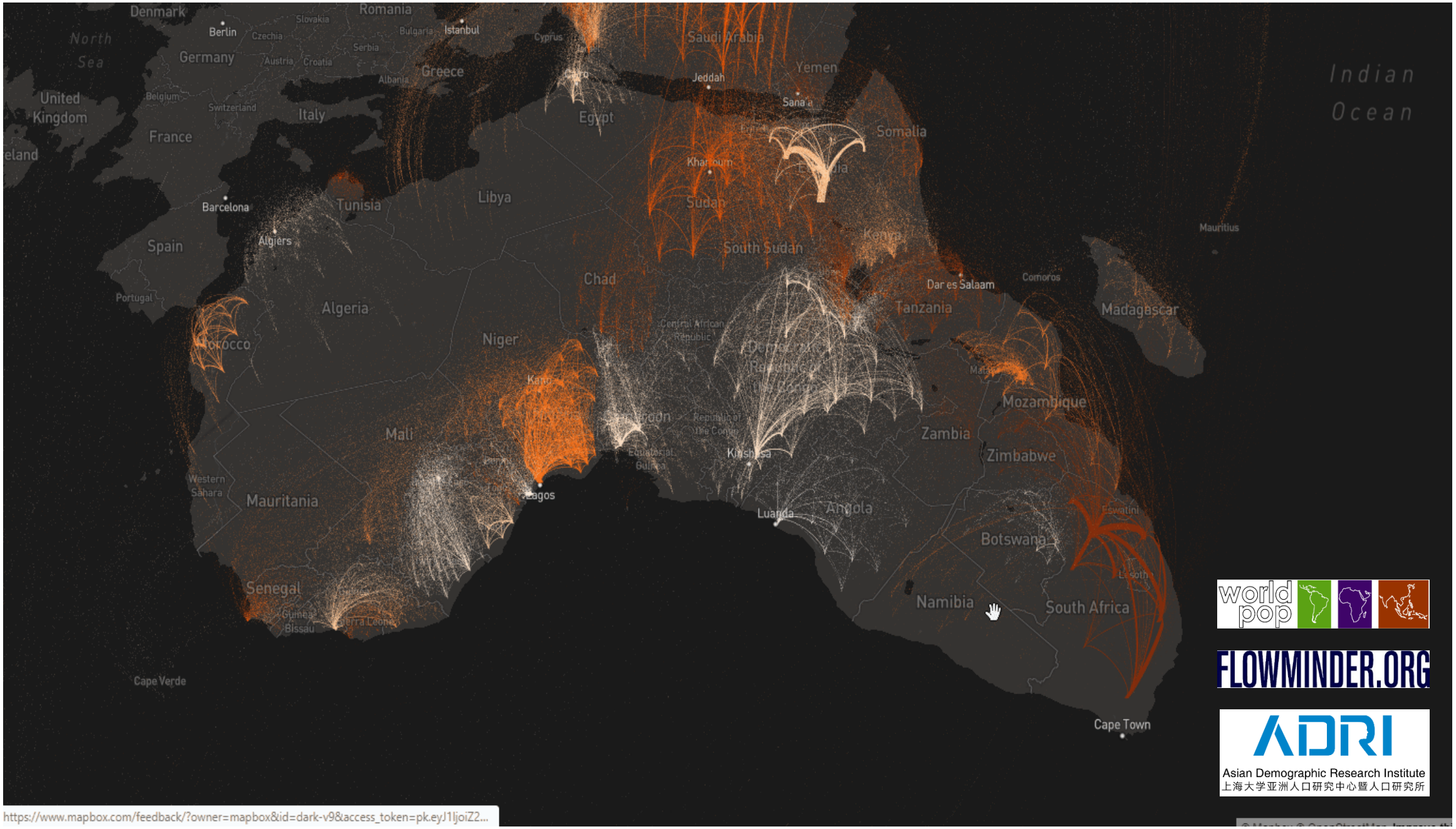


Abel & Sander 2014 (Science)

Iterative proportional fitting (IPF) method



Sorichetta et al 2016 (Nature Sci Data)



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ADRI
Asian Demographic Research Institute
上海大学亚洲人口研究中心暨人口研究所

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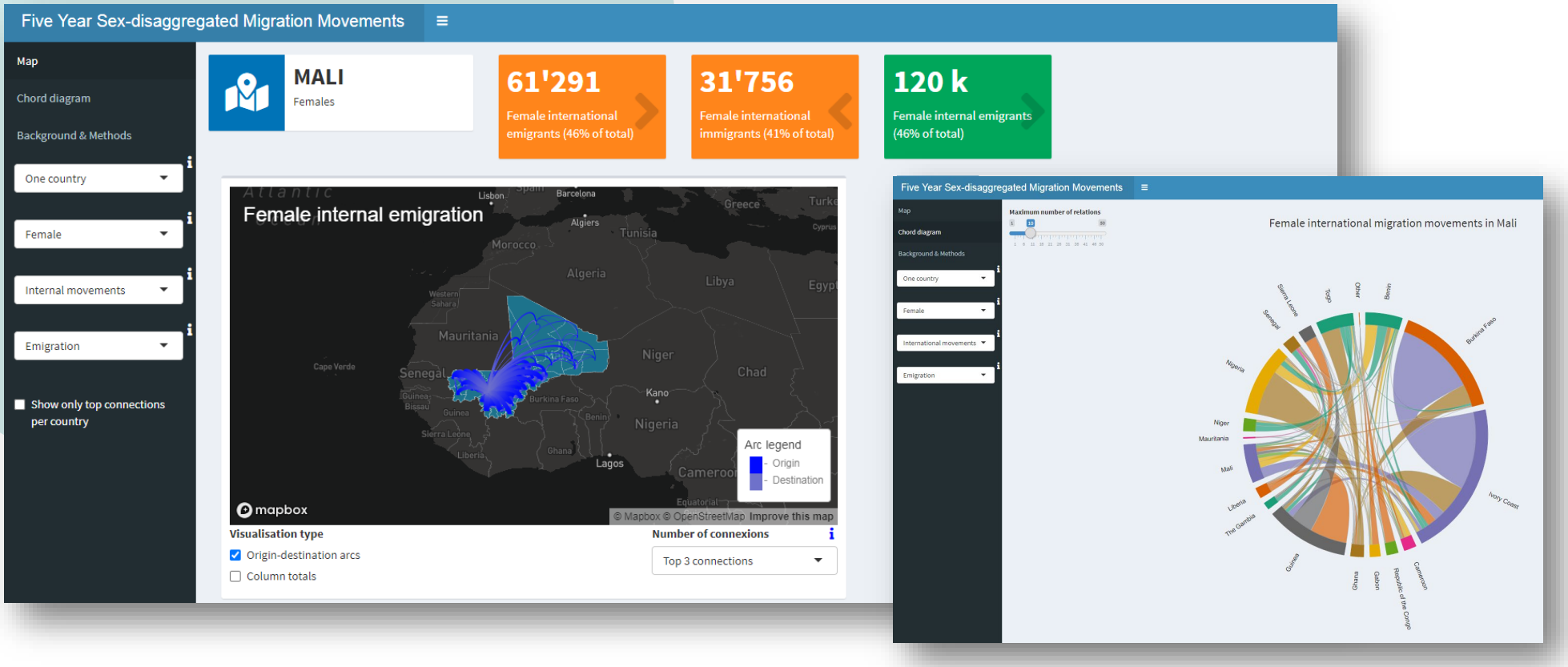

https://gravier.shinyapps.io/fdfa_01_dev_v4/

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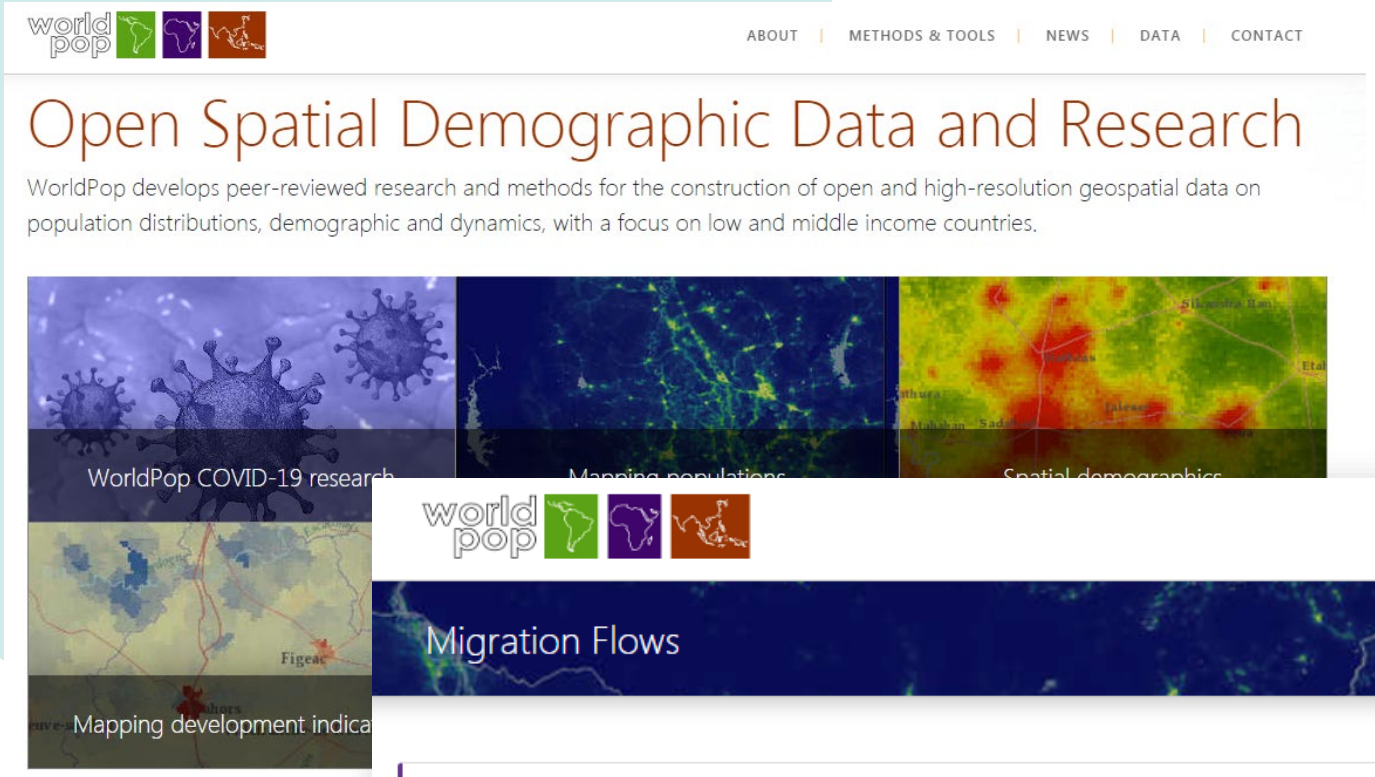

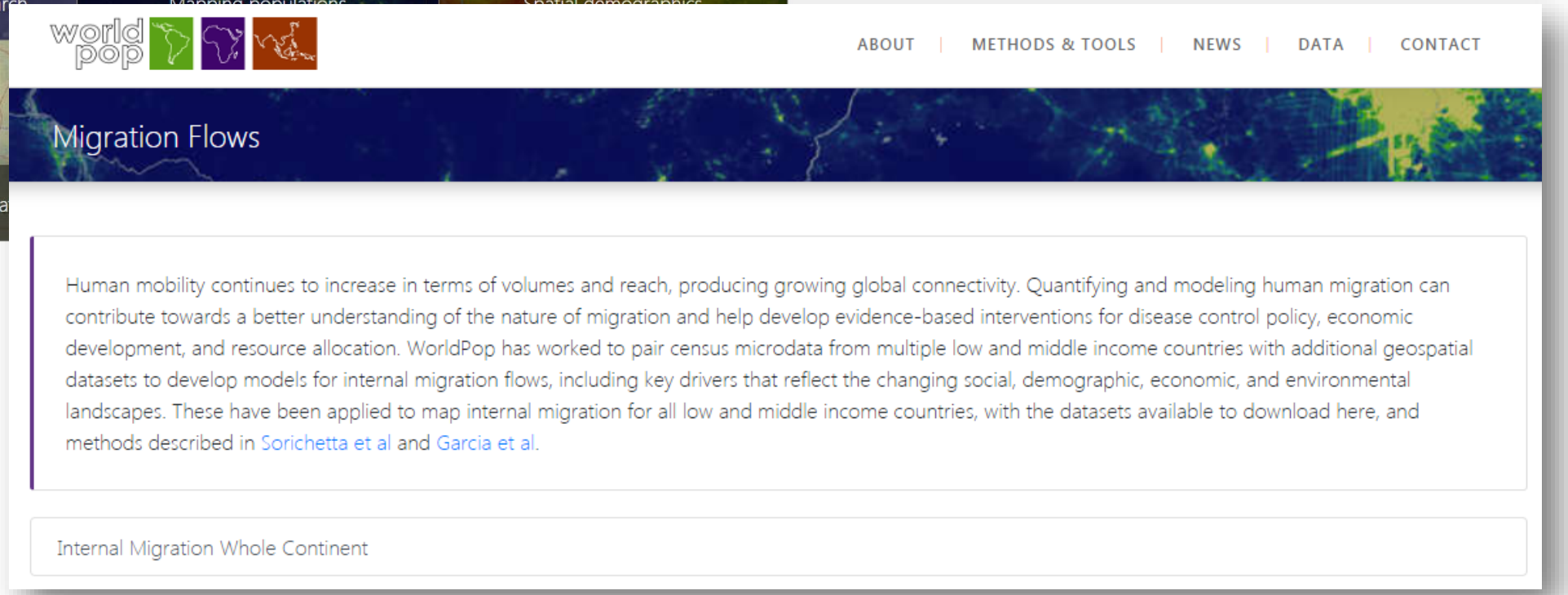

https://www.worldpop.org/project/categories?id=11

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MOBILE PHONE DATA FOR MIGRATION STATISTICS

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ARTICLE

https://doi.org/10.1057/s41599-019-0242-9 OPEN

Exploring the use of mobile phone data for national migration statistics

Shengjie Lai[1,2,3], Elisabeth zu Erbach-Schoenberg[1,2], Carla Pezzulo[1], Nick W. Ruktanonchai[1,2], Alessandro Sorichetta[1,2], Jessica Steele[1], Tracey Li[2], Claire A. Dooley[1,2] & Andrew J. Tatem[1,2]

PNAS

Dynamic population mapping using mobile phone data

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

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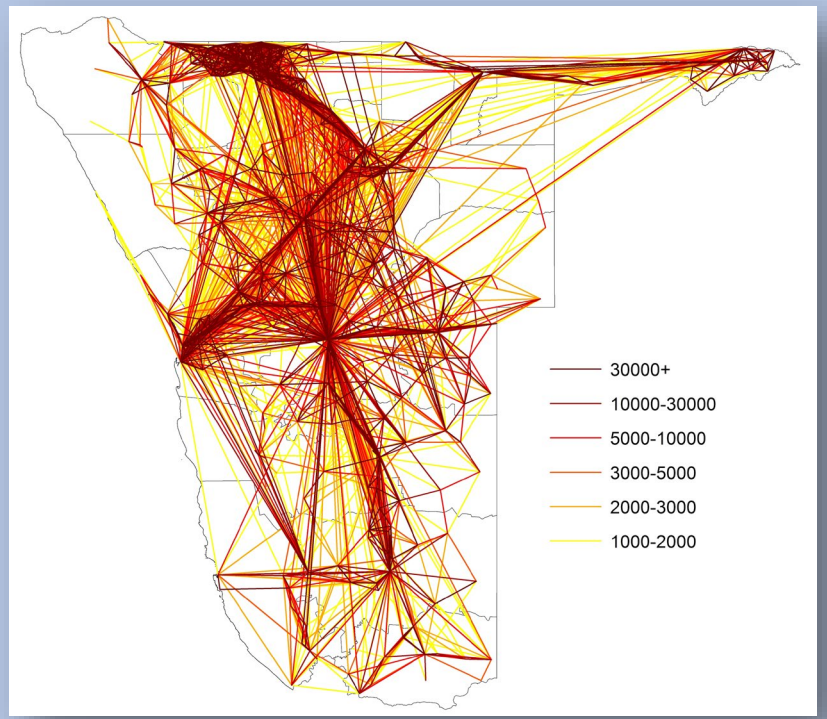
BACKGROUND AND AIMS

- Population and housing censuses with migration questions are conducted every 10 years and sometimes longer
- Substantial changes to migration patterns can occur during inter-censal periods
- Mobile phone call detail records capture elements of national movements regularly and may be a valuable source for migration statistics, but are biased
- **How well do models based on CDRs line up with census-based migration statistics?**



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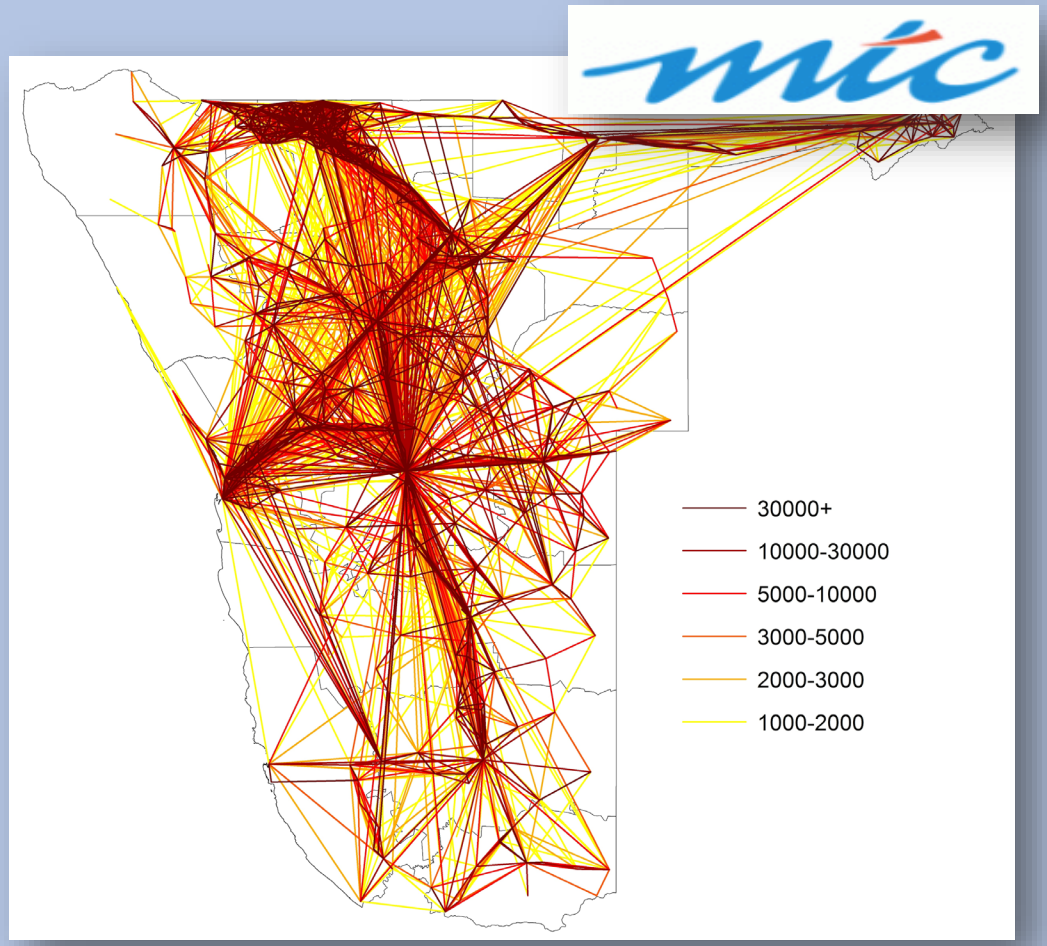
Call detail records

Mobile phone data:

- Dataset of 72 billion anonimized CDRs between October 2010 and April 2014 from MTC, the leading network operator in Namibia with a 76% market share.
- Processed to match as closely as possible time period and categories/geography of census questions



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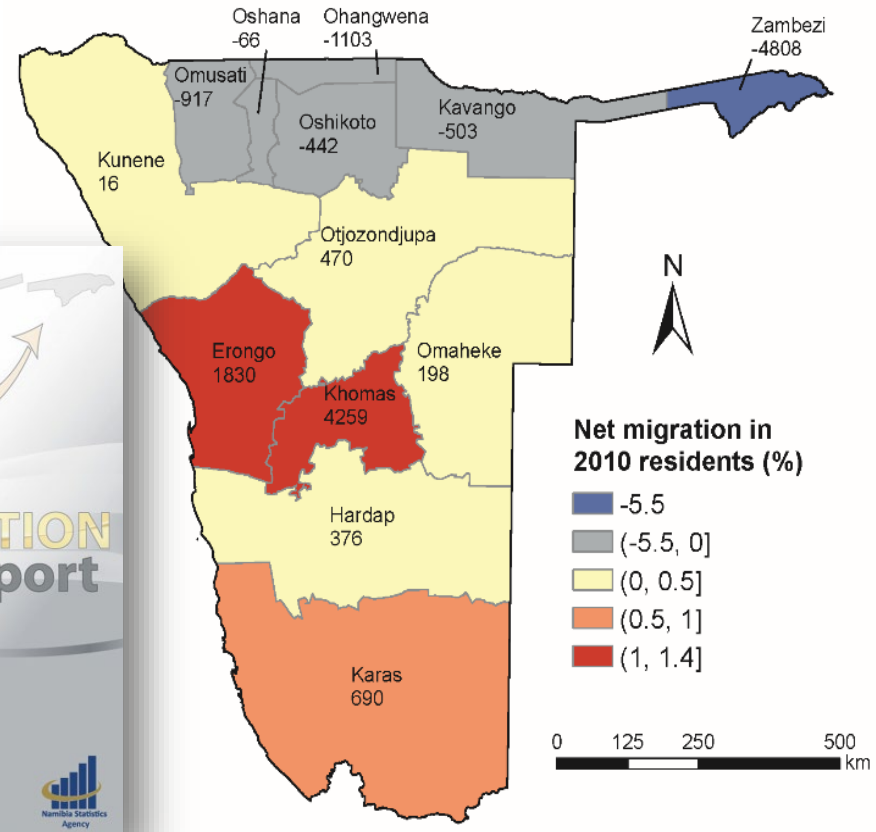
2011 Namibia Census

- The 2011 Census asked about each individual's places of usual and previous residence, with a reference night of 28 August 2011:
  - where does the person usually live?
  - where did the person usually live within 12 months prior to the census?
- An individual will be considered as a short-term migrant if the area of current residence does not match the area of usual residence 12 months prior to the census.

* The place of usual residence refers to the place where a person usually lives for the most part of any year (at least six month).



Population: 2,013,671

Internal short-term migrants: 40,867

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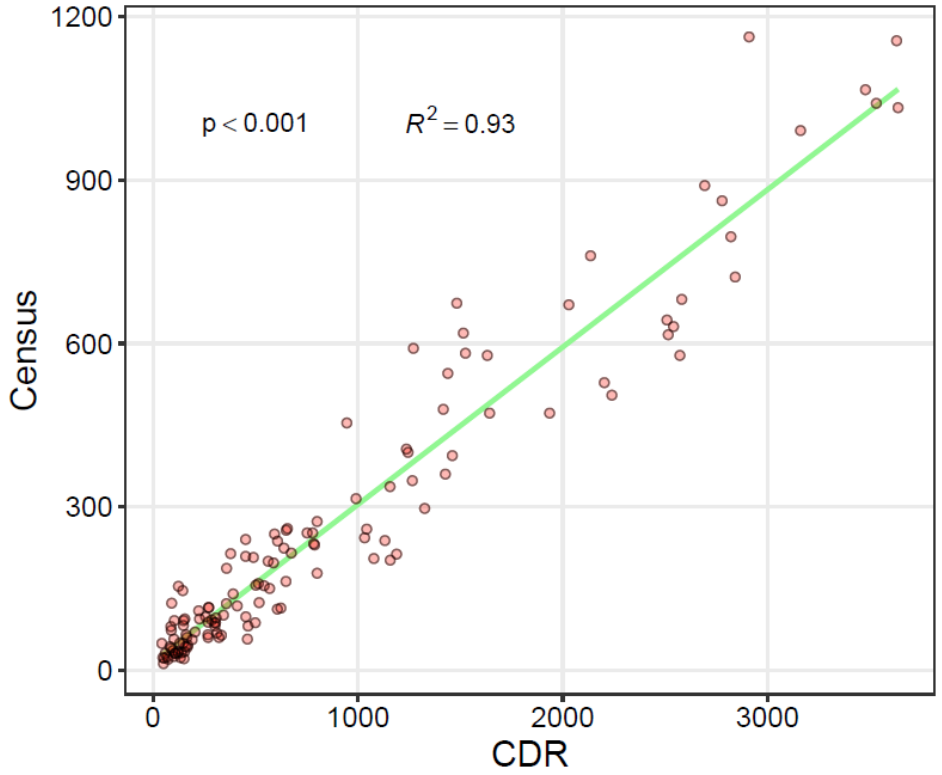
Highly correlation between CDR and census-derived migrations



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Migration Prediction Models

- **CDR-based linear models (CDRLMs)**: simply using CDR-derived migrating user data alone or combined with covariates

$$MIG_{i,j} = \beta_0 + \beta_1 CDR_{i,j} + \vec{\beta}[X]$$

- **Validation and goodness-of-fit indicators**: leave-one-out-cross-validation (LOOCV) approach to calculate the root-mean-square error (RMSE). The model with the lowest RMSE was determined as the best model.

Type	Model	Independent variables	
		CDRs	Other variables
CDR-based linear model (CDRLM)	1	Yes	None
	2		$+ POP_i + POP_j + DIST_{i,j}$
	3[a]		$+ URBAN_i + URBAN_j + DIST_{i,j}$
	4		$+ RAIN_i + RAIN_j + DIST_{i,j}$

POP_i and POP_j : Population of origin i and destination j.
$URBAN_i$ and $URBAN_j$: Proportion of population living in urban areas.
$RAIN_i$ and $RAIN_j$: Annual average precipitation (mm).
$DIST_{i,j}$: Euclidean distance between centroids of origin i and destination j.
[a] Optimal model of each model family for regions except Zambezi, based on the lowest root-mean-square error (RMSE).

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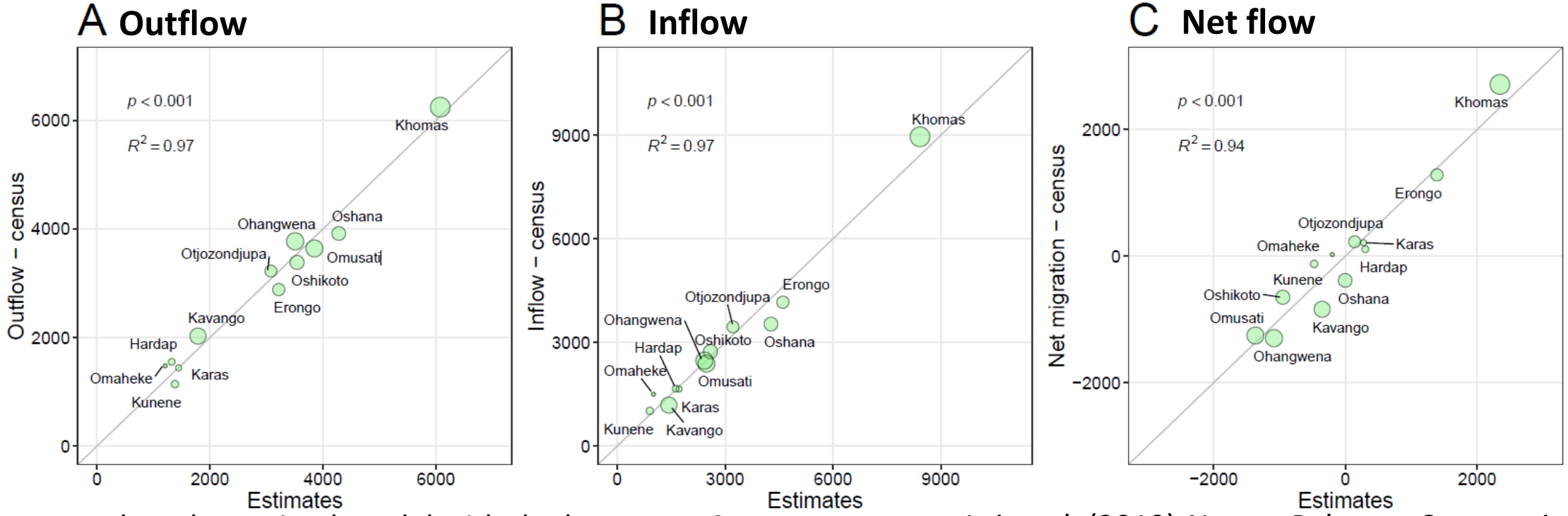
CDRLM vs Census-derived migration



Based on the optimal model with the lowest RMSE

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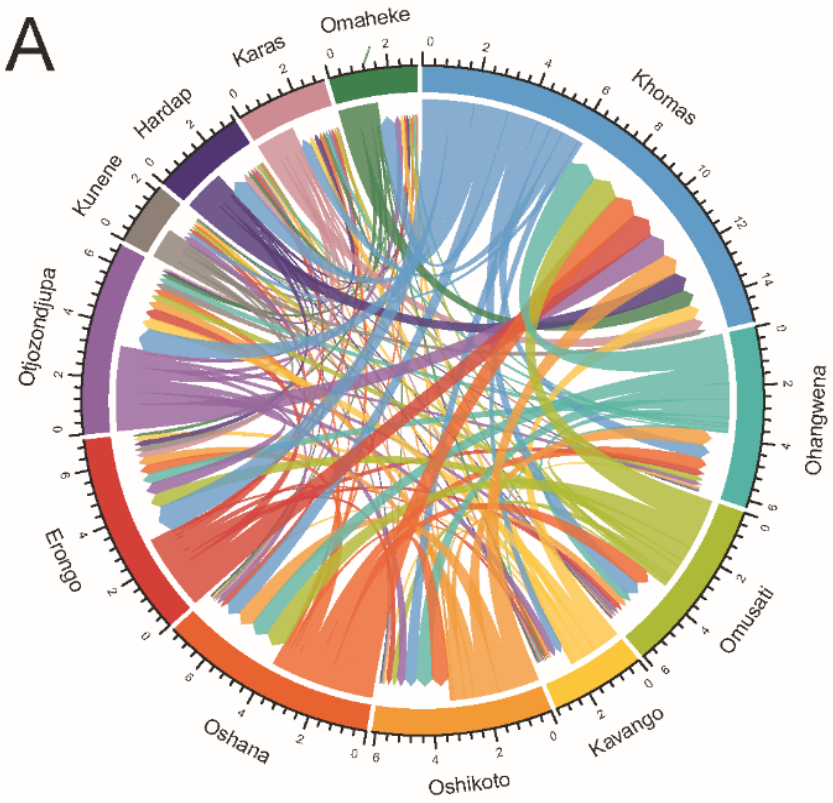
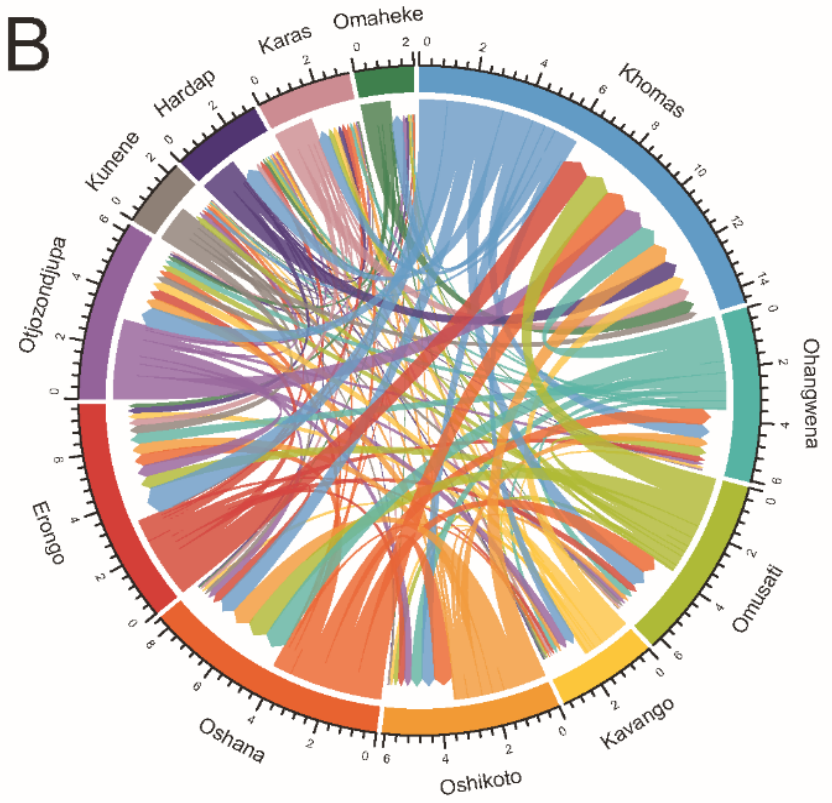
CDRs and census data show very similar migration patterns

Census



CDRLM



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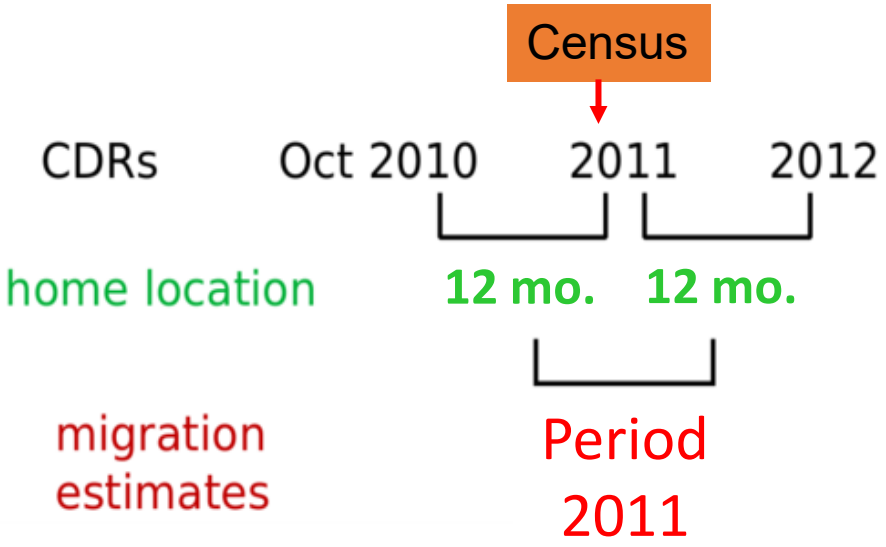
Using mobile phone data to update migration statistics across years?

- The multiannual time series of CDRs in Namibia allows us to assess their potential to be used to update intercensal national statistics and understand the changing patterns of internal migrations by comparing the places of residence across years.
- The migrations in Period 2012 were estimated by the linear model fitted for Period 2011 and using 2012 CDRs adjusted for increasing users across years.



- Period 2011: 1,049,379 users (SIMs); 117,173 migrant users (11.2%)
- Period 2012: 1,238,124 users (SIMs); 144,064 migrant users (11.6%)

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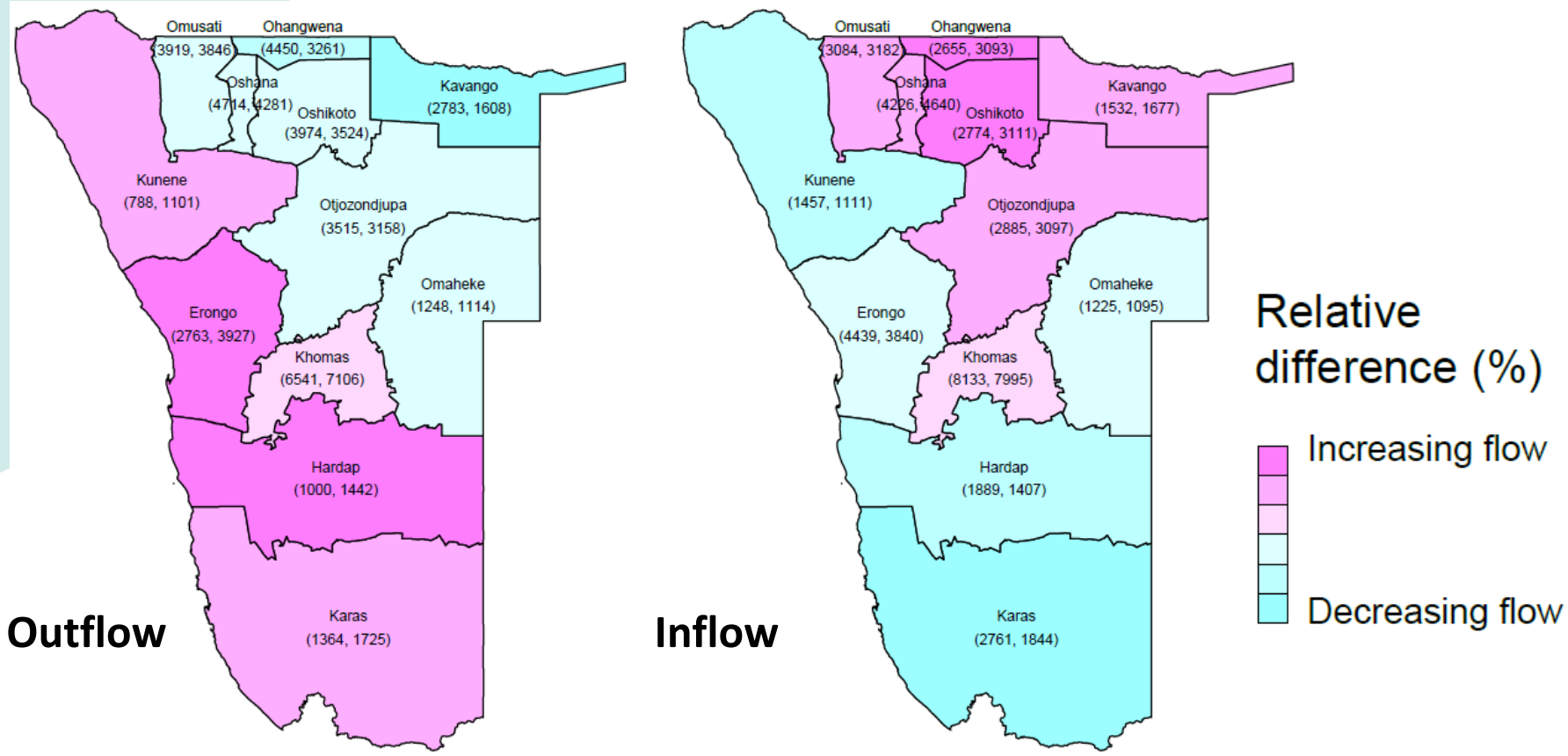
Updating migration statistics across years



Migrants departing and arriving in 2012 compared to 2011

*The Zambezi region as an outlier with limited data was excluded

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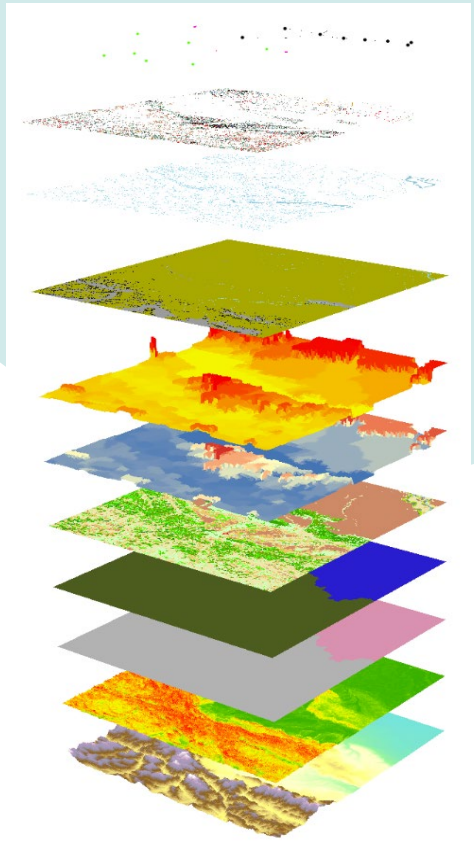
Key messages



Migration patterns are changing continuously and data on these are needed to build effective and equitable evidence-based policies

‘Traditional’ datasources (e.g. census, surveys) remain vital…..

….but they can be outdated, incomplete and unreliable in many low income settings.

‘New’ datasources (e.g. satellites, GPS, phones) can help compliment traditional sources – but they are not perfect: important to compare against traditional data and build models to draw on strengths of different datasources.

Local ownership and engagement with users is key for sustainable uptake and use.

Acknowledgements and further information

www.worldpop.org
@WorldPopProject

COVID-19 work:
www.worldpop.org/covid19

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