Exploring the use of mobile phone data for national migration statistics

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world pop
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UNIVERSITY OF Southampton

PNAS

Spatially disaggregated population estimates in the absence of national population and housing census data

N. A. Wardrop[a,b,1], W. C. Jochem[a,b,1], T. J. Bird[a,b], H. R. Chamberlain[a,b], D. Clarke[a,b], D. Kerr[a,b], L. Bengtsson[a,b], S. Juran[c], V. Seaman[d], and A. J. Tatem[a,b,2]

GRID3

GEO-REFERENCED INFRASTRUCTURE AND DEMOGRAPHIC DATA FOR DEVELOPMENT

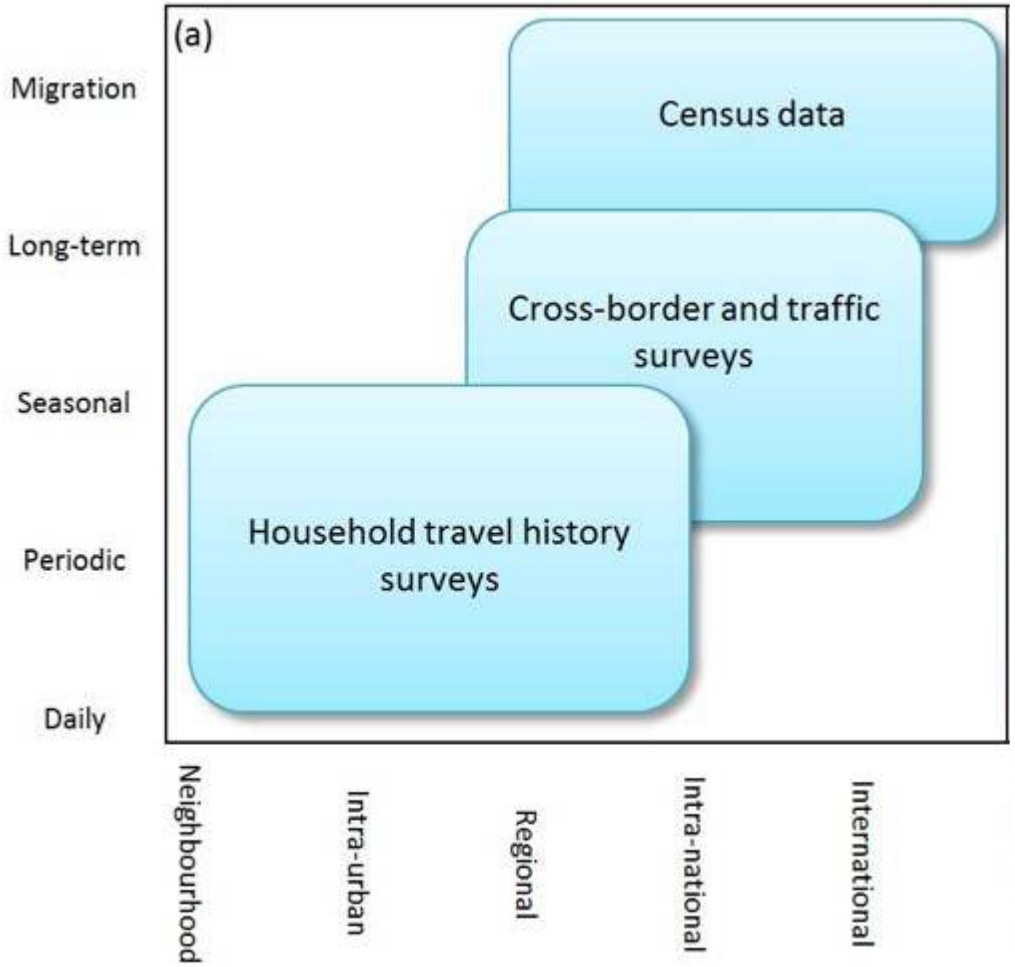
Tatem (2017) Nature Sci Data


People don’t stay still….
Movements via air travel

The UCL–*Lancet* Commission on Migration and Health: the health of a world on the move

Data for measuring population movement

"Traditional"



Data for measuring population movement

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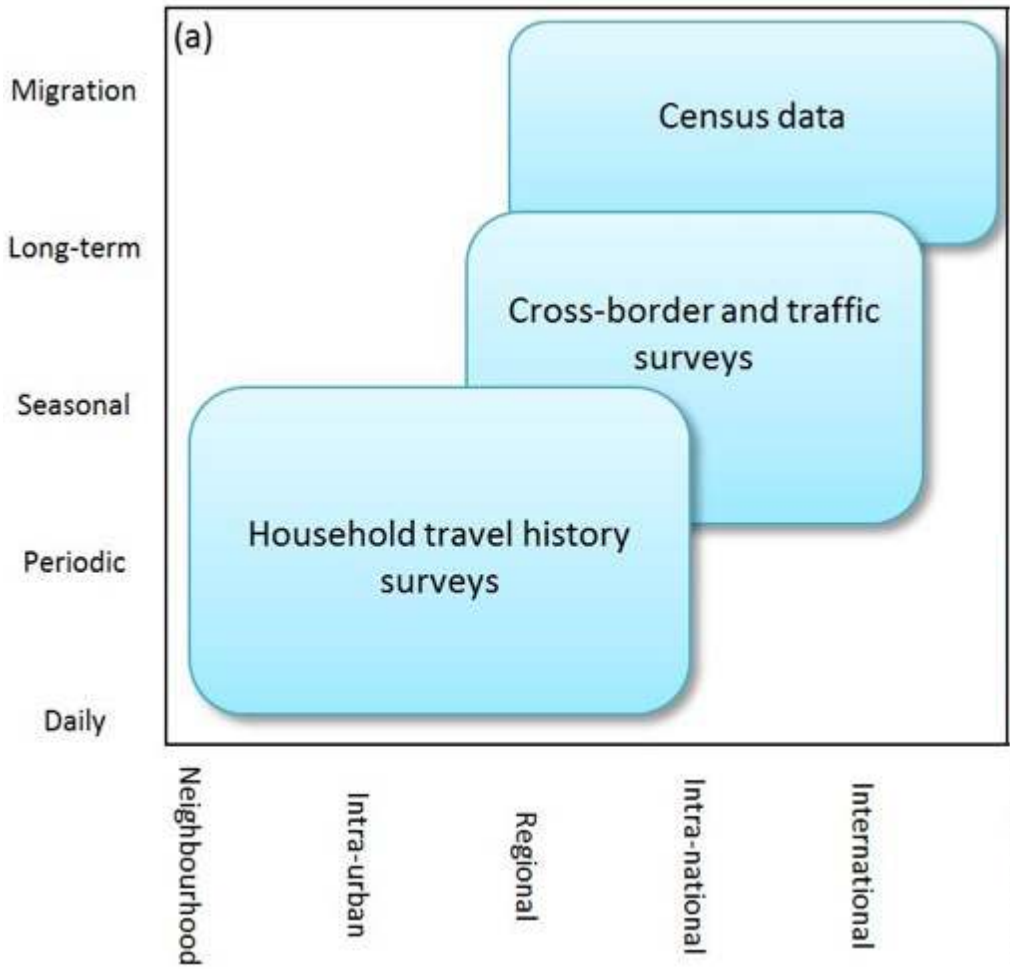

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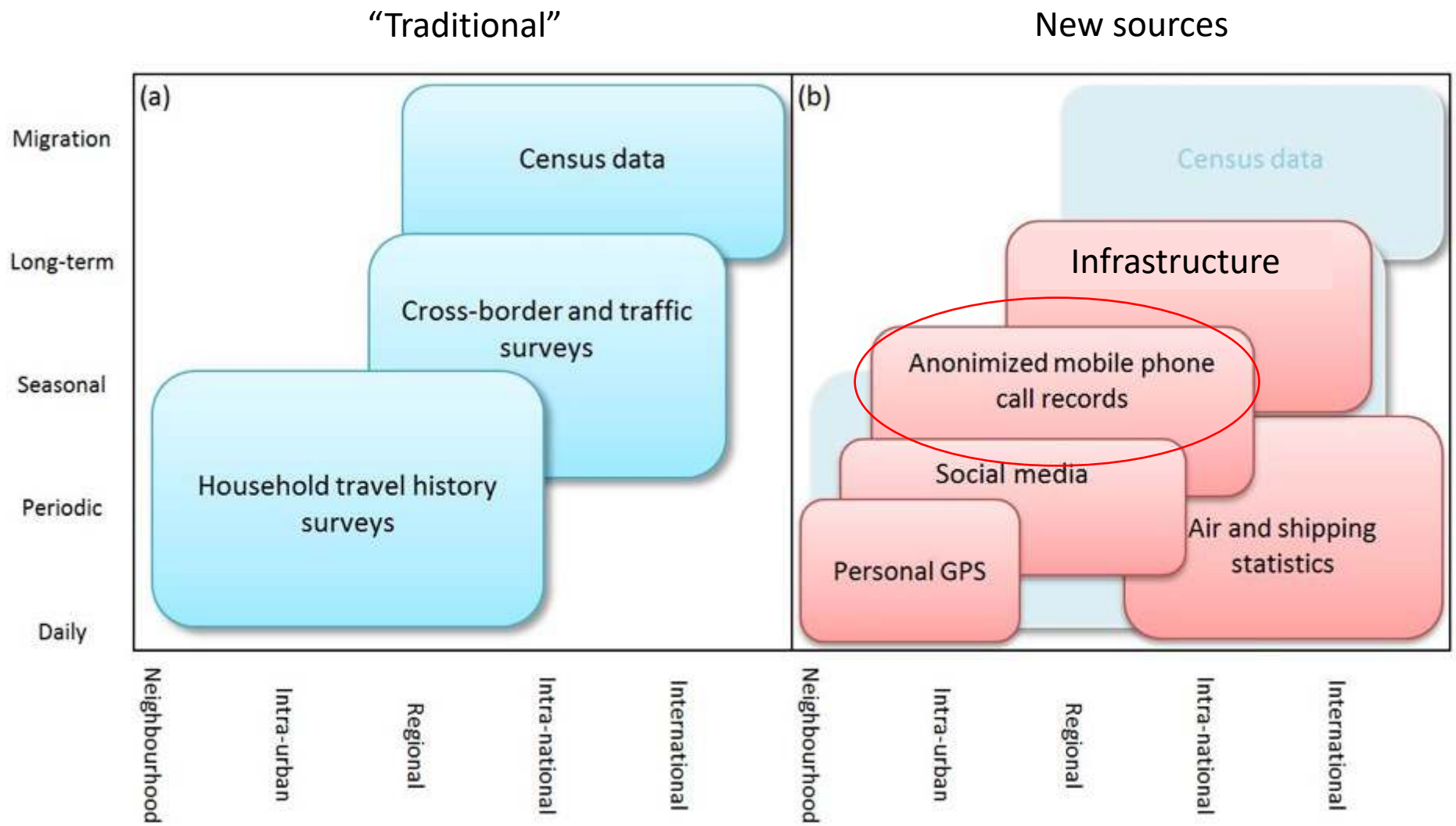


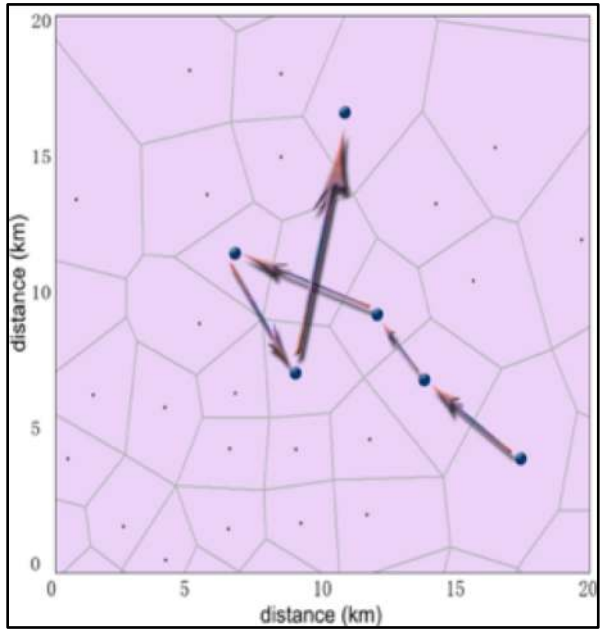
Mobile phone call detail records (CDRs)

User makes a call from location X

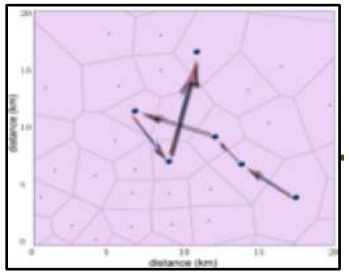
Call routed through nearest tower

User travels to Y and makes a call

Network operator records time and tower of call for billing



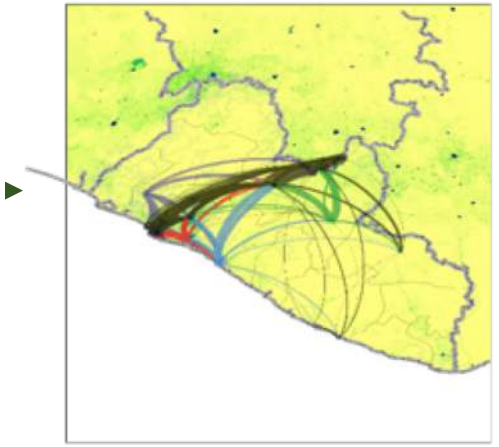
Preserving confidentiality



Operators Call Detail Records' (CDRs) including low-resolution location data (nearest tower location) anonymized on separate server hosted by operator.

We conduct analyses under operator supervision, anonymous raw data always behind operator firewall

Mobile operator firewall

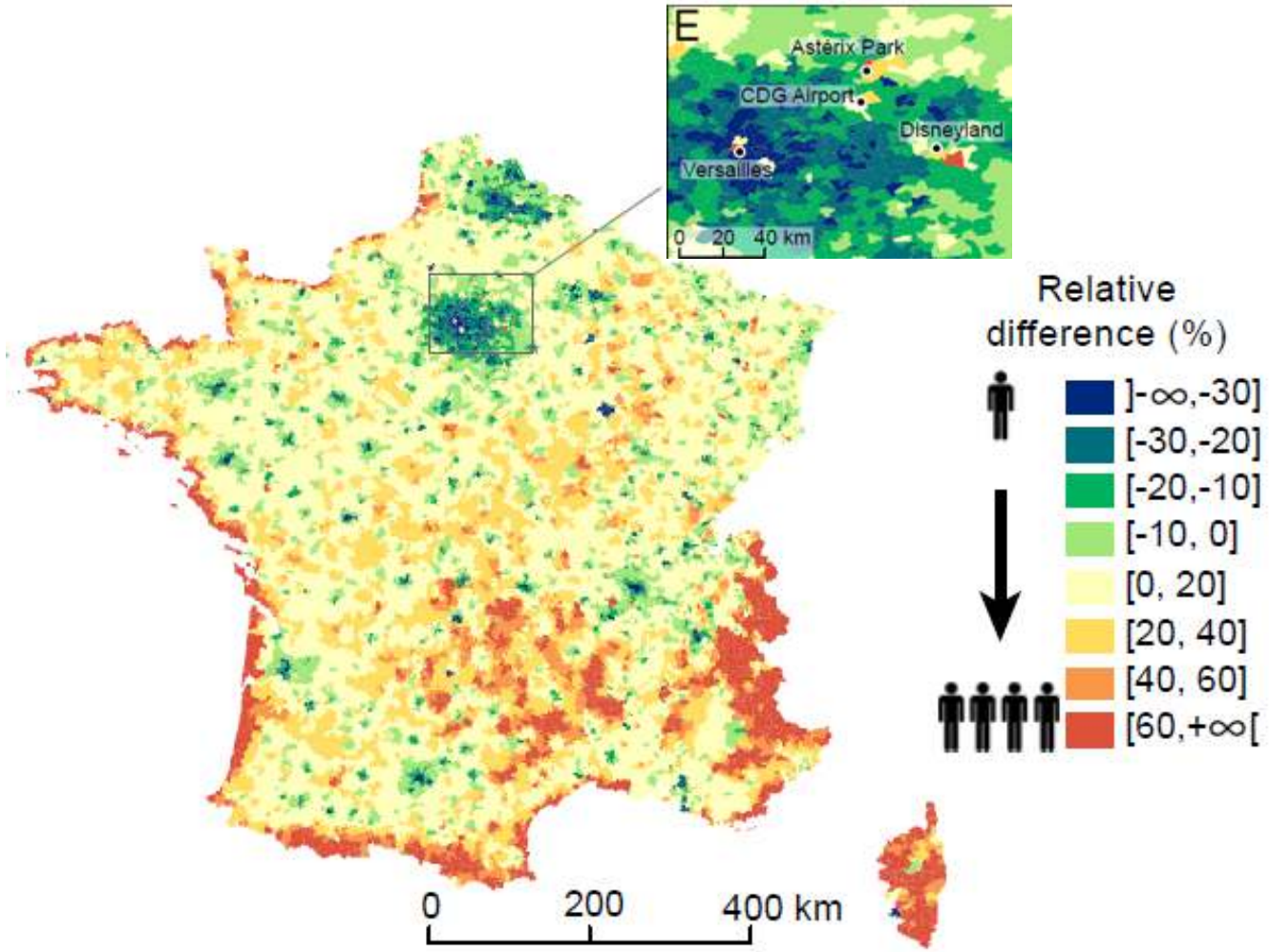


Aggregated mobility estimates are exported and made open access - can be used with other mobility estimates, epidemiological data

Raw data never leaves mobile operator's system to avoid any privacy, commercial concerns.

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]



Deville et al (2014) PNAS

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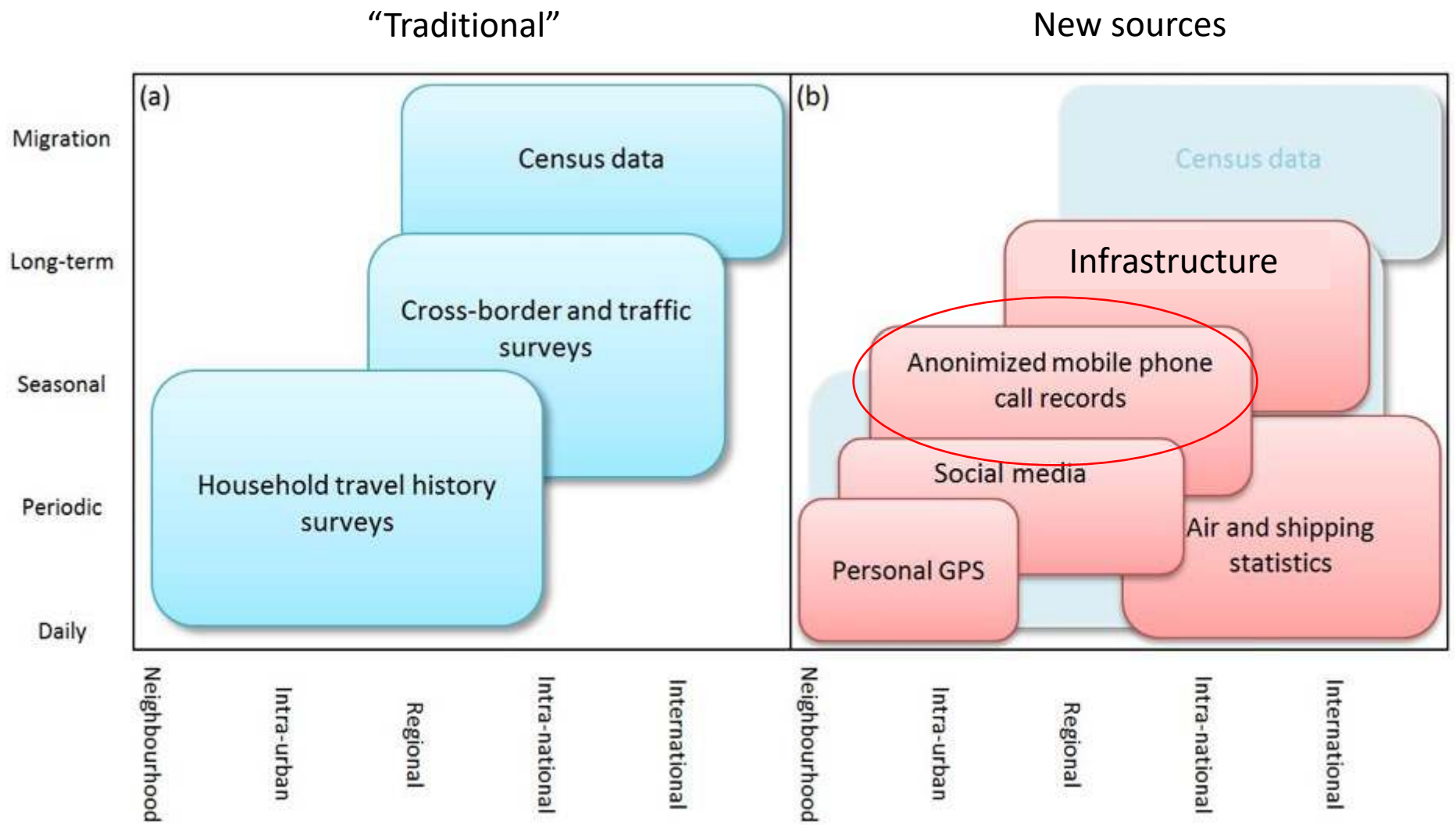
This is France

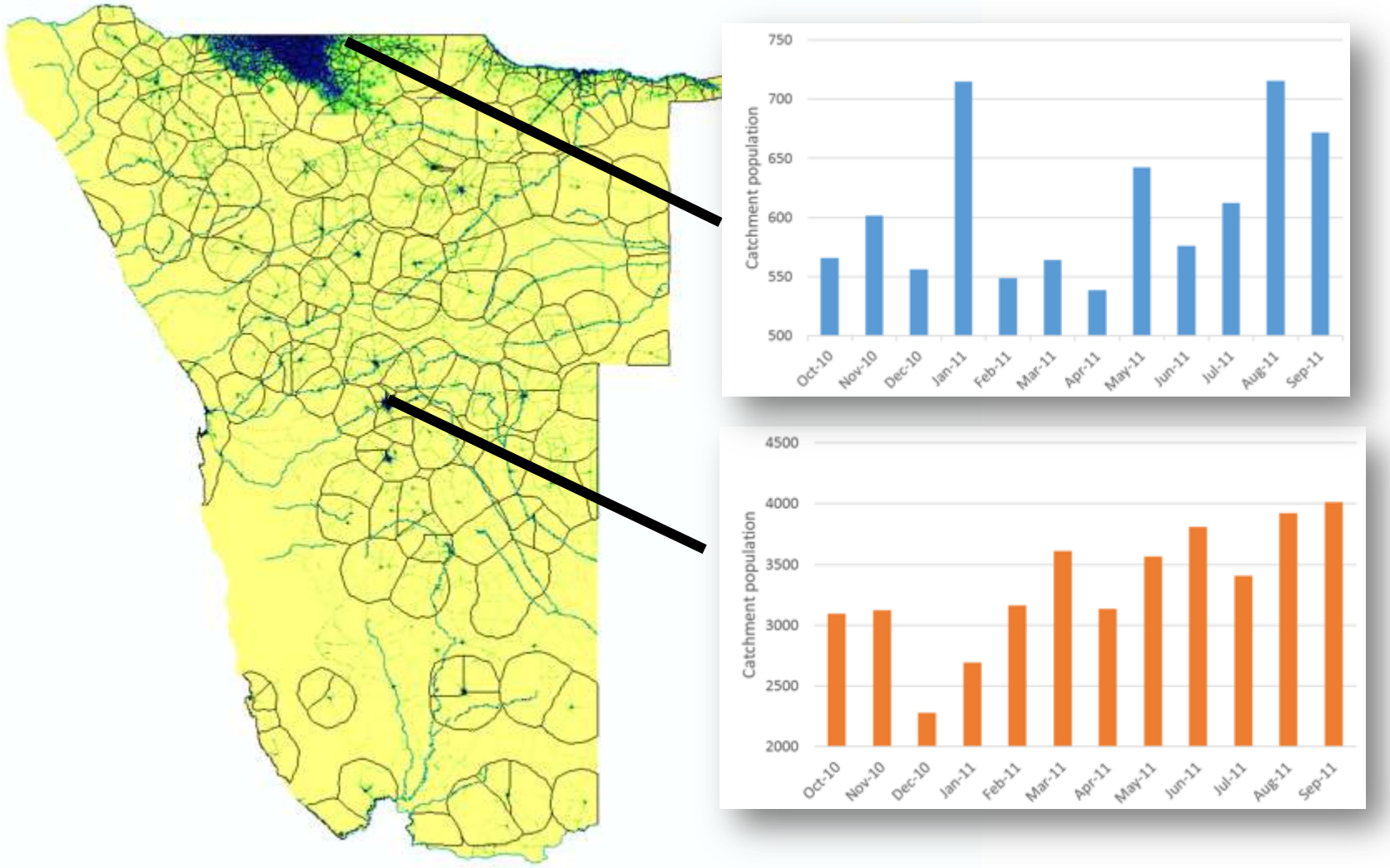
Deville et al (2014) PNAS

Measuring migration by using CDRs?



CDR-derived catchment populations

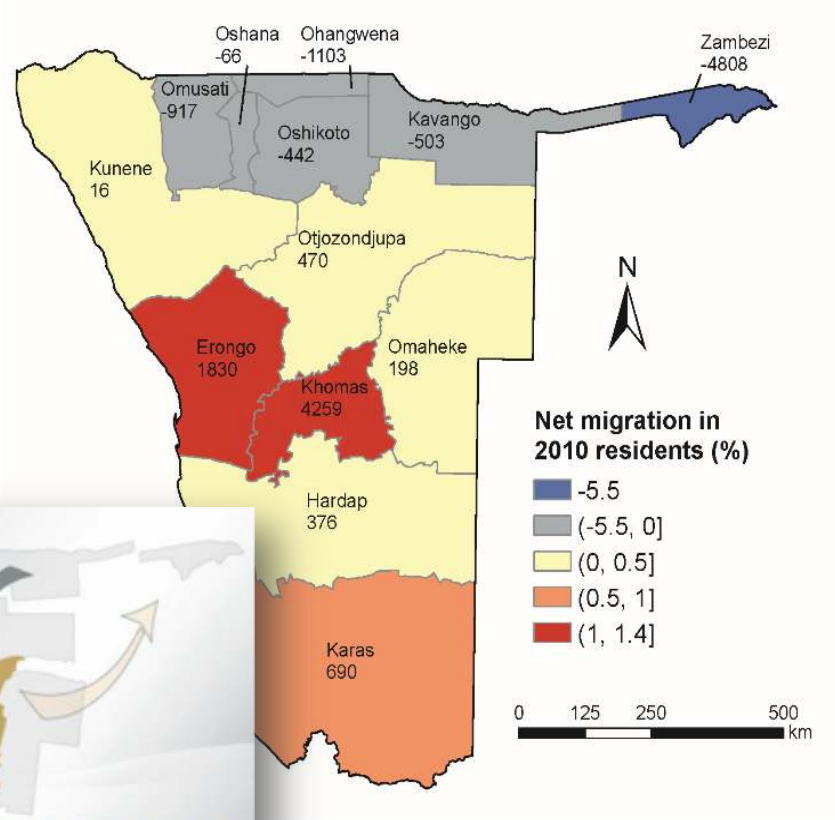
- A large dataset of anonymized 72 billion CDRs between October 2010 and April 2014 from MTC, the leading network operator in Namibia with a 76% market share.



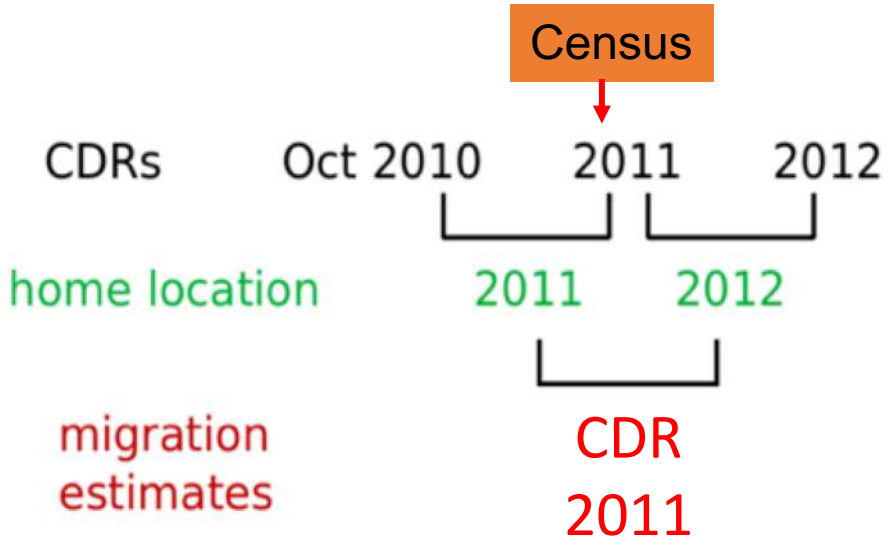
Erbach-Schoenberg et al (2017); Wesolowski et al (2017)

2011 Census in Namibia

- 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 since September 2010?

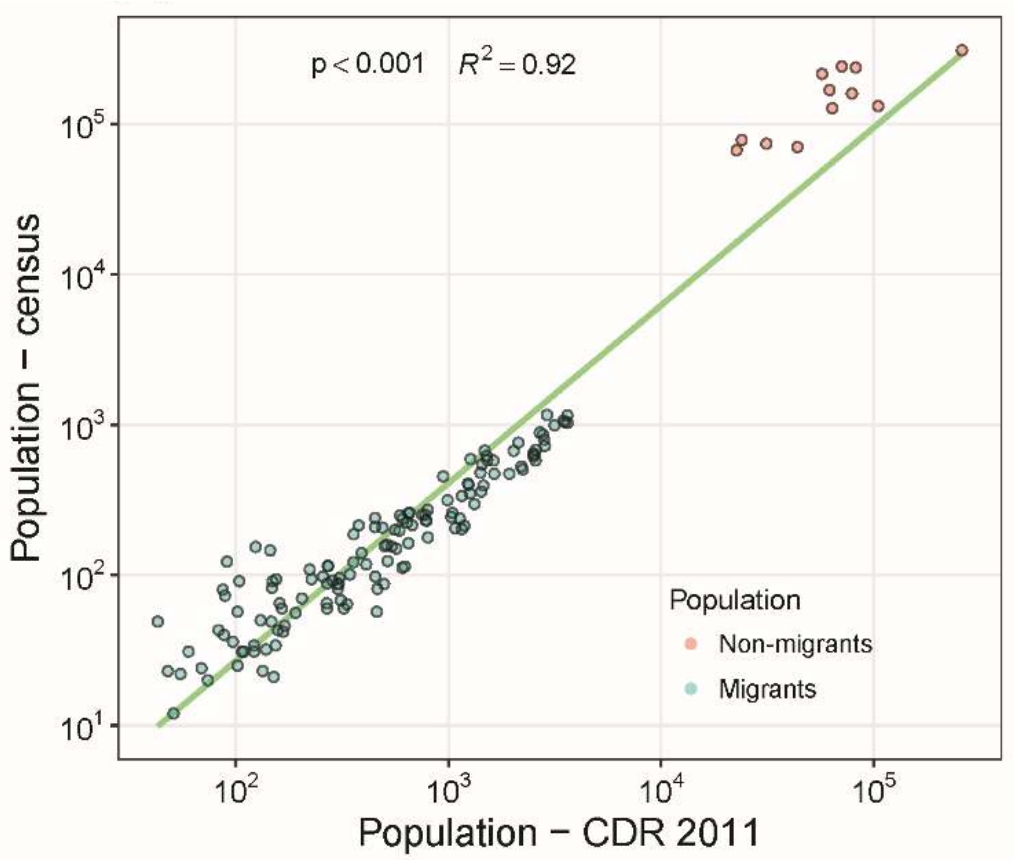


CDR users vs census population



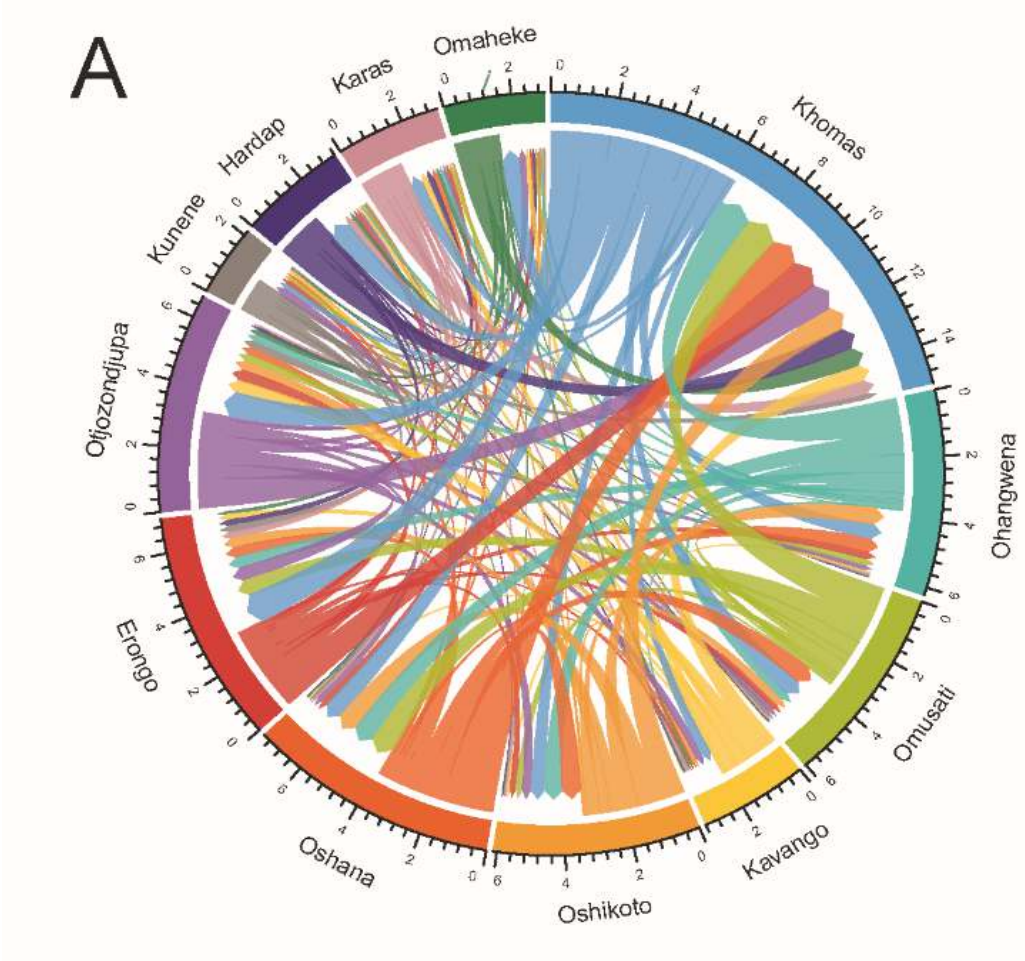
- Census population: 2,013,671
- Period 2011: 1,049,379 users (SIMs)*

*Only included any user who was active for more than 30 days each year (12 months)

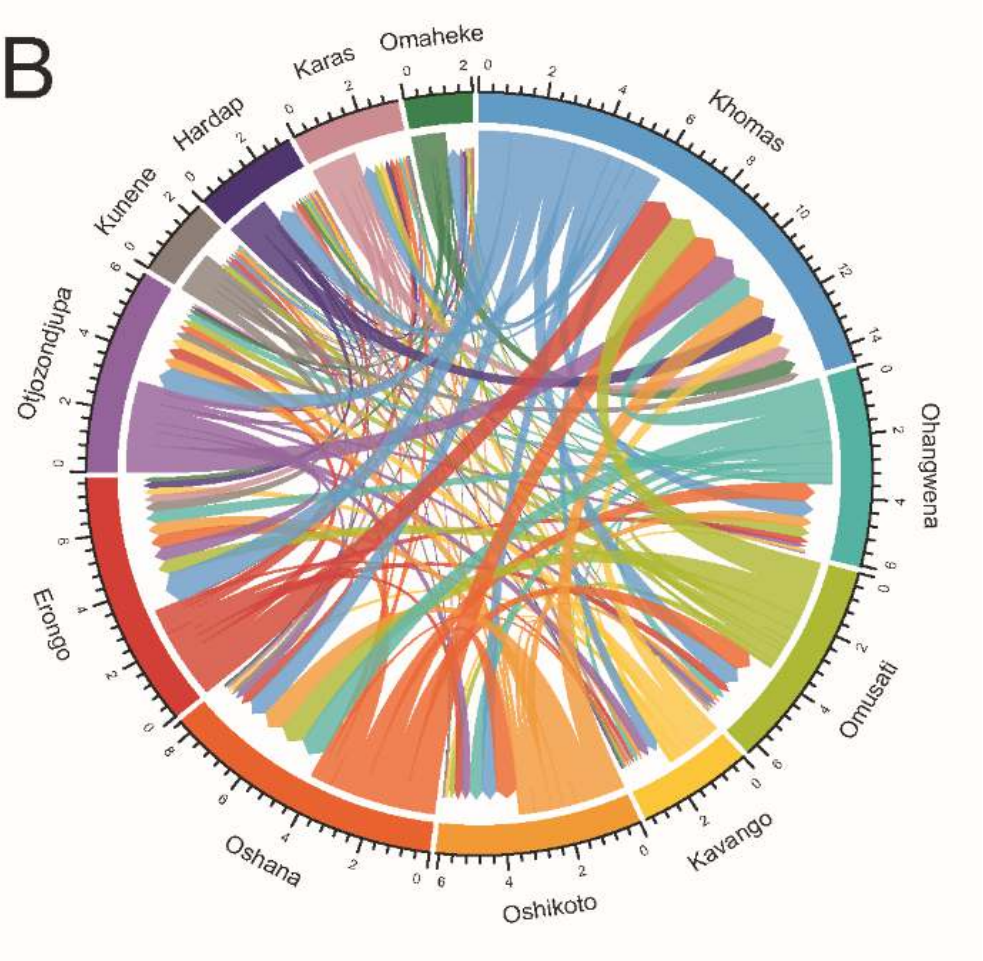


CDR-derived internal migration

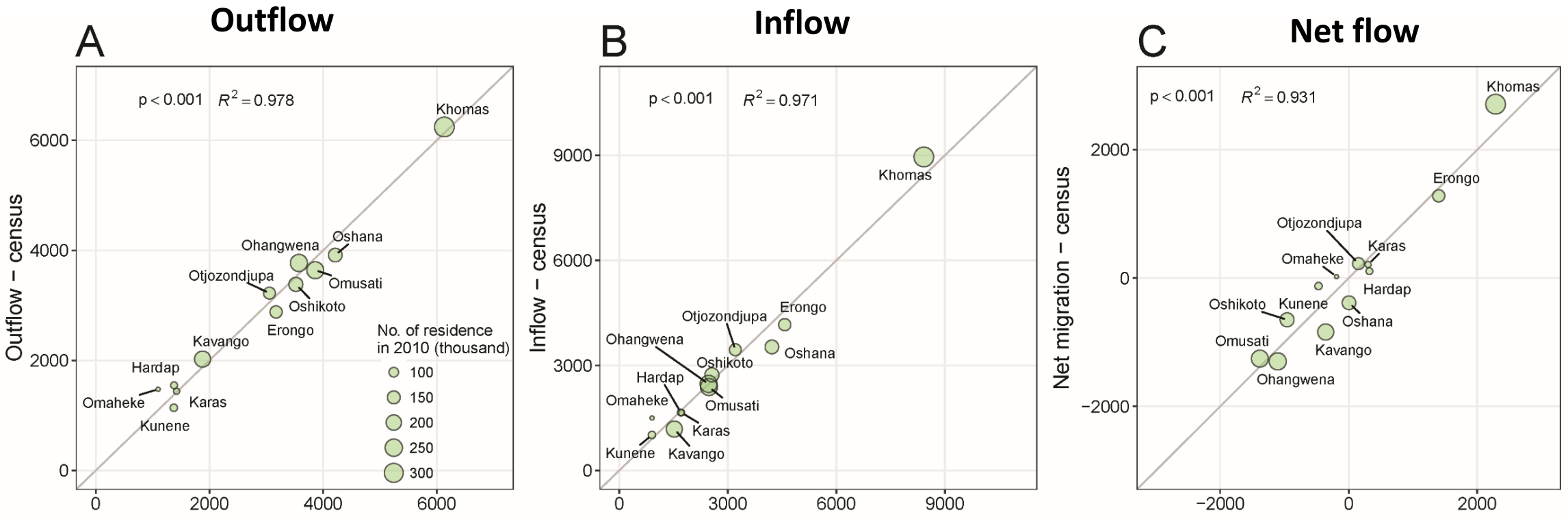
Census



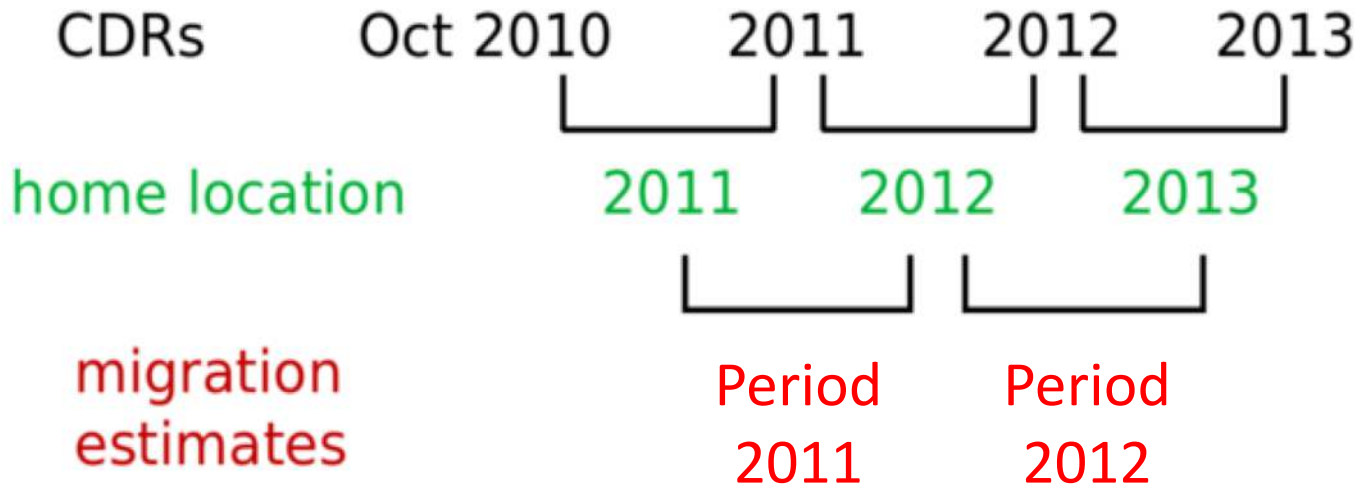
CDR-derived



CDR vs Census-derived migration

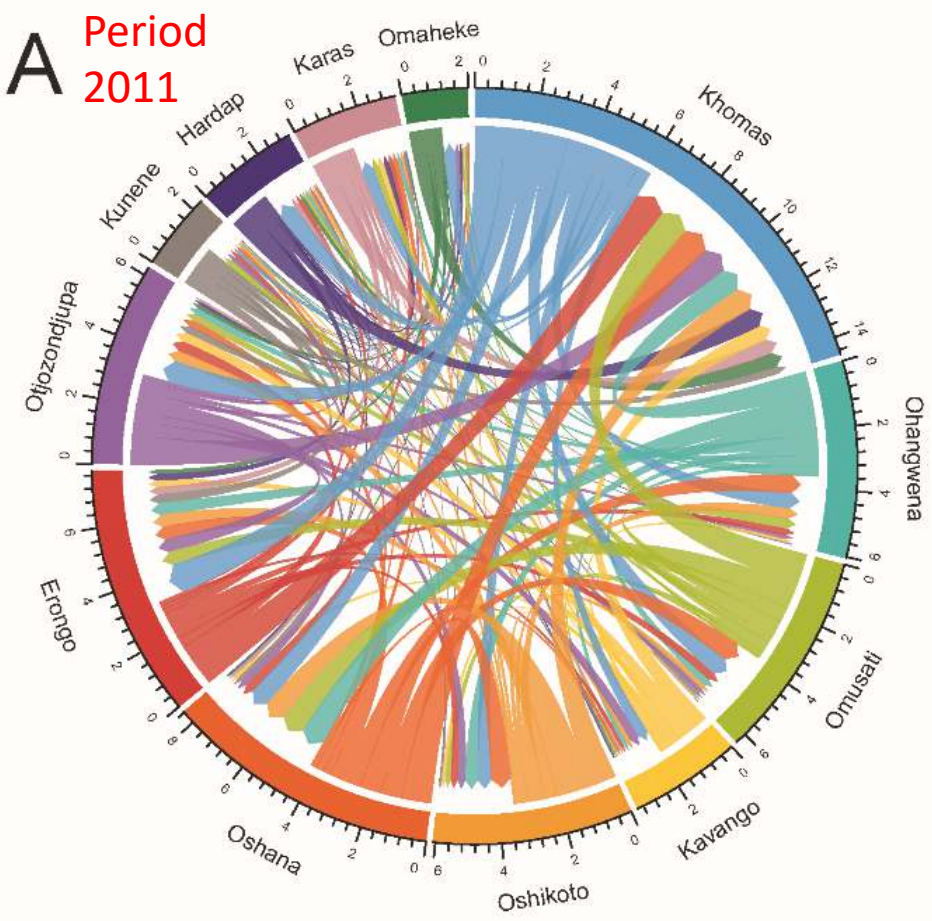


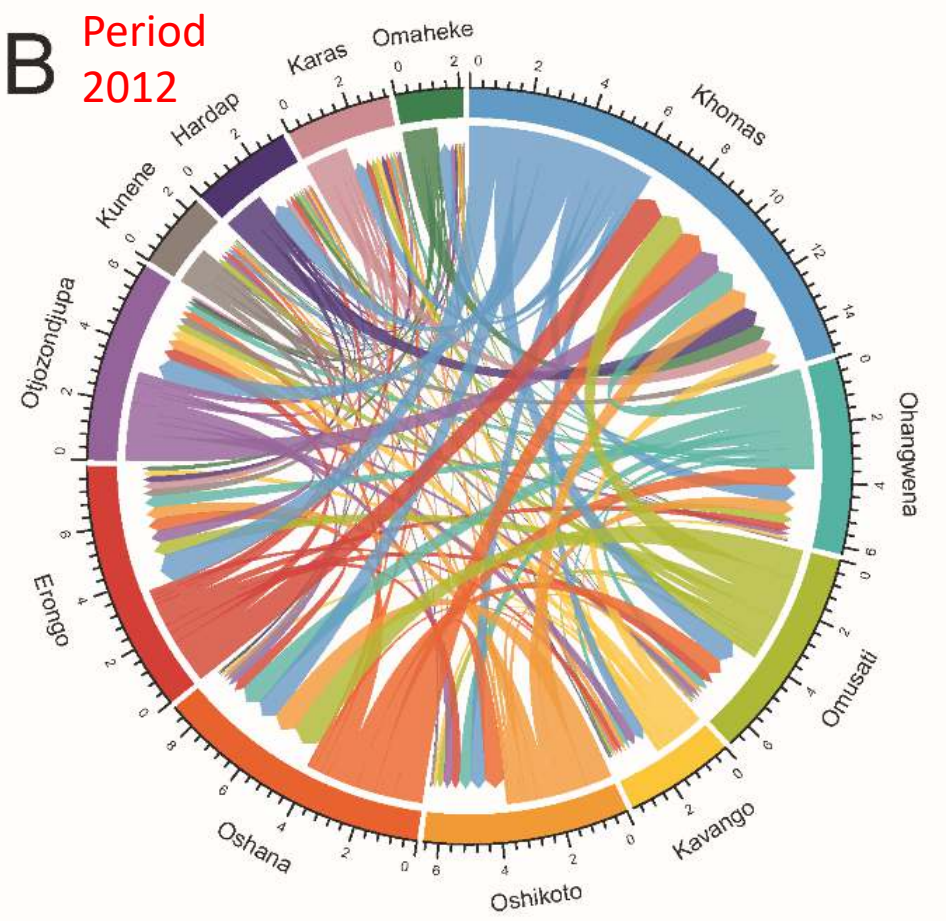
2011 vs 2012 CDR-derived migration



- Period 2011: 1,049,379 users (SIMs)
- Period 2012: 1,238,124 users (SIMs)

2011 vs 2012 CDR-derived migration





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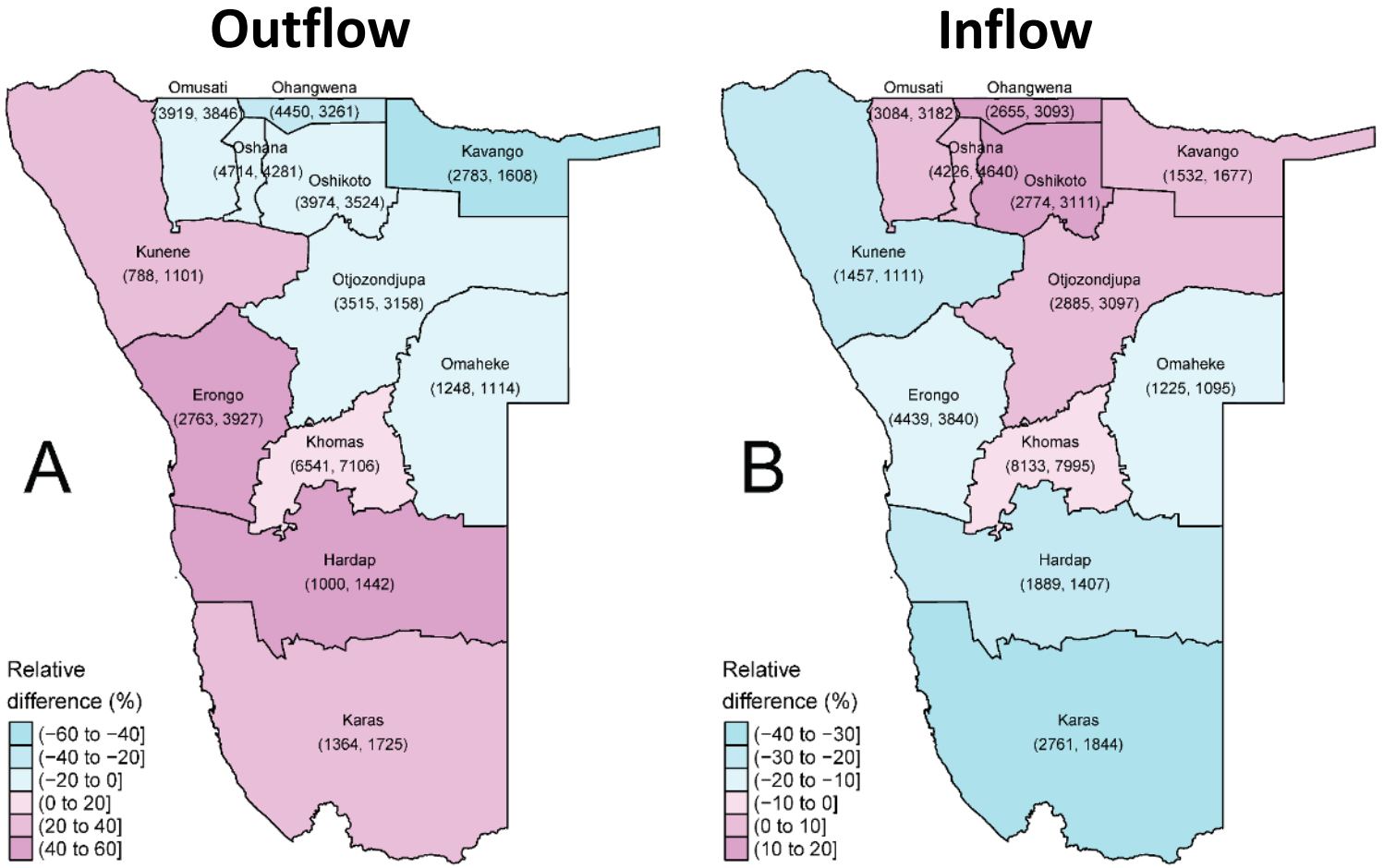
Based on CDRs and adjusted for increasing users between Periods 2011 and 2012

2011 vs 2012 CDR-derived migration



Based on CDRs and adjusted for increasing users between Periods 2011 and 2012

Mobile phone ownership bias

	With MP % (N=8,589)	Without MP % (N=1,257)	Total % (N=9,846)	p value*
Gender of household head				0.159
Male	55.7	58.6	56.1	
Female	44.3	41.4	43.9	
Mean age of household head, yrs (SE)	45.5 (0.32)	50.7 (0.76)		<0.001**
Mean number of household members, yrs (SE)	4.4 (0.05)	3.6 (0.12)		<0.001**
Number of under-five children in households				0.019
0	56.2	62.7	57.0	
1-3	41.9	36.1	41.3	
≥4	1.8	1.2	1.8	
Ratio of under 5 yrs in household members (SE)	0.120 (0.002)	0.113 (0.006)		0.257
Household wealth (International Wealth Index, IWI)				<0.001
Non-wealthy	52.4	91.4	56.8	
Wealthy	47.5	8.5	43.1	
Household residence				<0.001
Urban	55.8	22.3	52	
Rural	44.2	77.7	48	
Region				<0.001
Zambezi (Caprivi)	4.8	10.6	5.5	
Erongo	10.1	4.2	9.5	
Hardap	3.8	4.4	3.9	
Karas	4.3	3	4.1	
Kavango	6.2	17.6	7.5	
Khomas	22.1	7.5	20.4	
Kunene	3.1	7.3	3.6	
Ohangwena	8.8	11.5	9.1	
Omaheke	3.2	4.9	3.4	
Omusati	9.7	9.4	9.6	
Oshana	8.8	6	8.4	
Oshikoto	8.3	8.3	8.3	
Otjozondjupa	6.8	5.4	6.6	

	With MP % (N=8,589)	Without MP % (N=1,257)	Total % (N=9,846)	p value*
Education attainment of household head* **				<0.001
No education	13	36.3	15.7	
Incomplete primary	21.4	29.8	22.4	
Complete primary	5.5	8.3	5.8	
Incomplete secondary	30.6	18.1	29.2	
Complete secondary	16.3	4.9	15	
Higher	12.6	2.2	11.4	
Unknown	0.6	0.4	0.6	
Education attainment of female household population (aged 6+)^				<0.001
No education	10.6	28.9	12.2	
Incomplete primary	32	42.2	32.9	
Complete primary	5.5	6.3	5.6	
Incomplete secondary	32.4	18	31.1	
Complete secondary	11.9	3.1	11.1	
Higher	7.4	1.4	6.8	
Unknown	0.2	0.1	0.2	
Education attainment of male household population (aged 6+)^^				<0.001
No education	12	28	13.6	
Incomplete primary	35.7	41.2	36.2	
Complete primary	5.3	6.8	5.4	
Incomplete secondary	28	19	27.1	
Complete secondary	11.2	3.6	10.4	
Higher	7.5	1.2	6.8	
Unknown	0.3	0.3	0.3	

MP: mobile phone. The data were obtained from the Namibia 2013 Demographic and Health Survey (DHS). The ownership was defined as the presence of at least one mobile phone in the household. Percentages were produced using sampling weights and adjusted for the survey design. Where indicated, variables were constructed using the household member dataset. * *p* values were produced using Pearson's Chi-square test, adjusted for the survey design. ** Calculated using a t-test for equality of means. *** Information available for total population, N=9,796. ^ calculated for de facto female household members aged 6 and over by highest level of schooling attended or completed (N=18,230). ^^ calculated for de facto male household members aged 6 and over by highest level of schooling attended or completed (N=16,153).

Summary

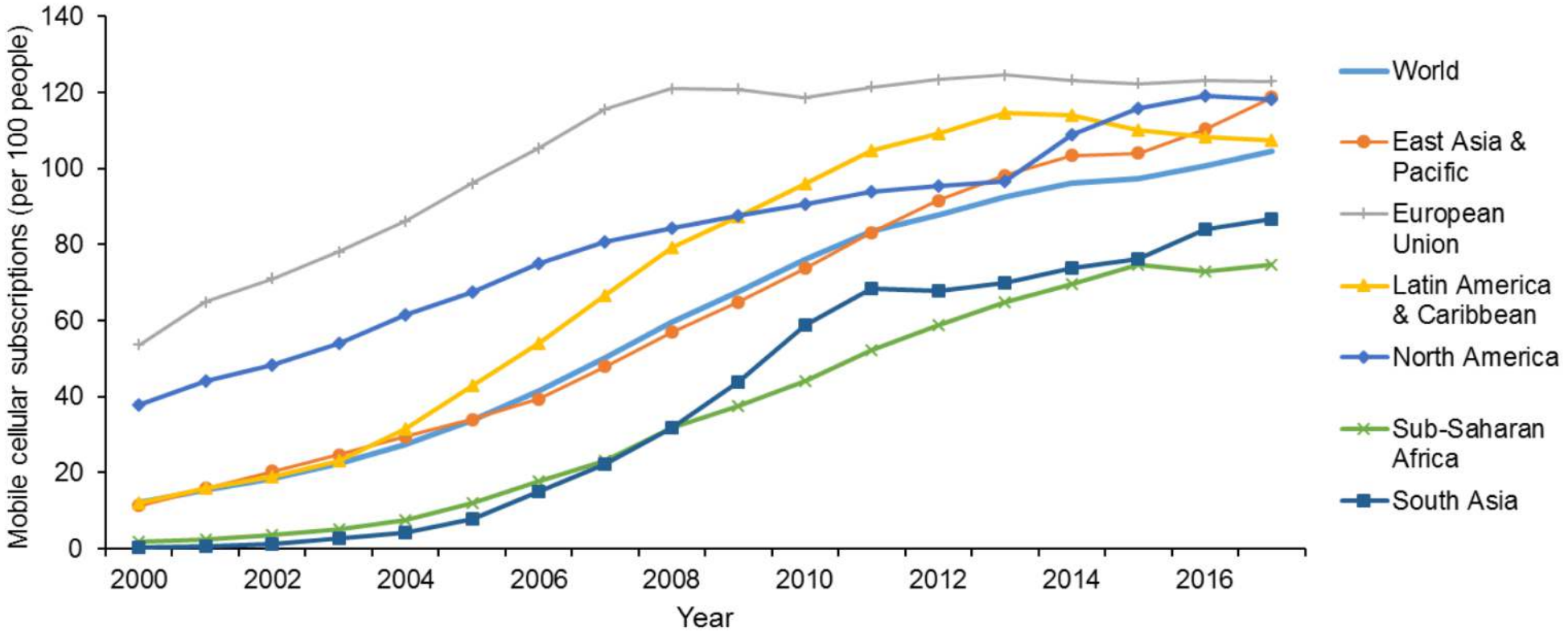
Anonymized, individual-level records of billable cellphone billable events located to cell towers

+ Valuable in providing measurements and subnational detail for human short-term movements and internal migration.

- Difficult to access, biased populations, changing/multiple SIMs, cross-border and demographic info

The integration with other traditional and new sources of data is required to draw on the strengths of each and overcome some of biases.

Penetration rate of mobile cellular subscriptions



World Bank; Lai et al 2019

Acknowledgements

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For more details about this study: Lai S, Erbach-Schoenberg Ez, Pezzulo C, Ruktanonchai NW, Sorichetta A, Steele J, Li T, Dooley CA, Tatem AJ. Exploring the use of mobile phone data for national migration statistics. ***Nature Palgrave Communications*** 2019; 5(1): 34. https://www.nature.com/articles/s41599-019-0242-9

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