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Migration and Movement

Pathways of Pathogens Within, Into, and Out of Urban Centers

Professor David L Smith

Urbanization and Slums: New Transmission Pathways of Infectious Diseases in the Built Environment—A Workshop. Dec 12-13, 2017. Keck Center, Washington, DC 20001

UNIVERSITY of WASHINGTON

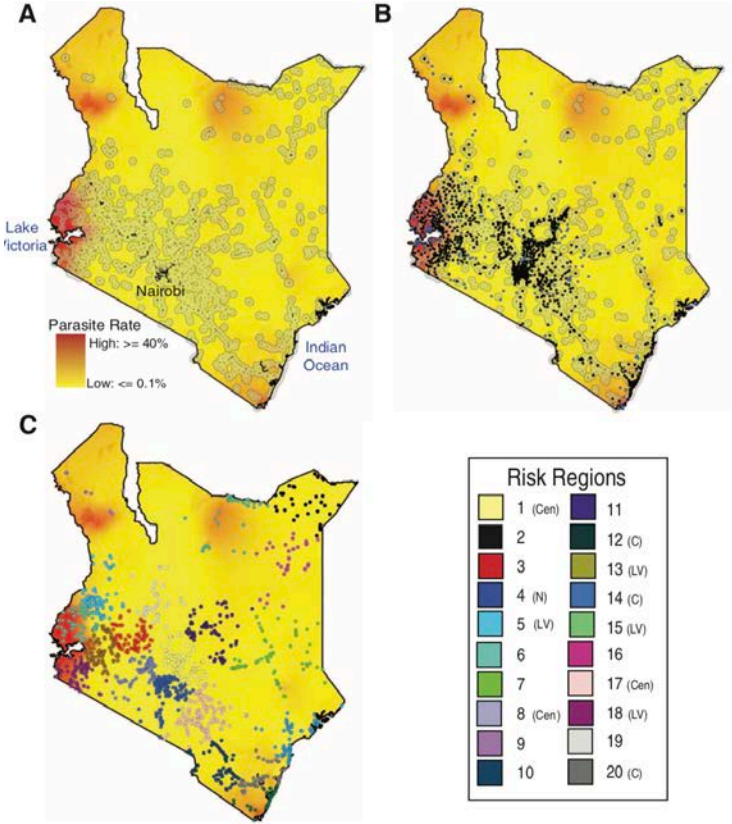
Institute for Health Metrics and Evaluation

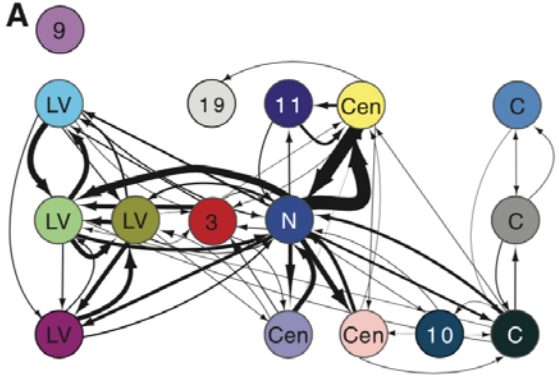
Nairobi, Kenya

Nairobi National Park

Kibera

Quantifying the Impact of Human Mobility on Malaria
Amy Wesolowski *et al.*
Science **338**, 267 (2012);
DOI: 10.1126/science.1223467





Mobile Phones

- >1B CDR over ~1 yr
- ~15M anonymyzed users
- ~12k cell towers

Malaria Atlas Project

- 2009 Endemicity
- Bayesian Geostatistical Model

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Flows of Malaria

- Nairobi is a hub for travel.

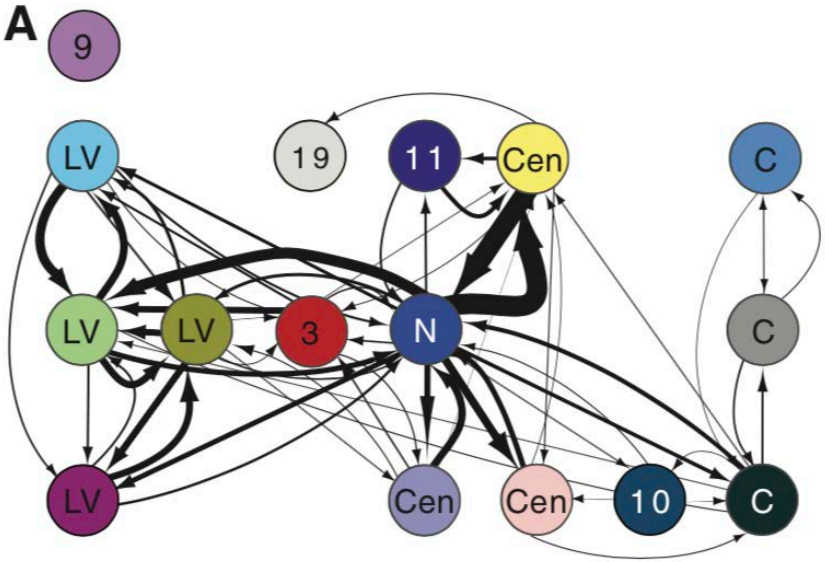
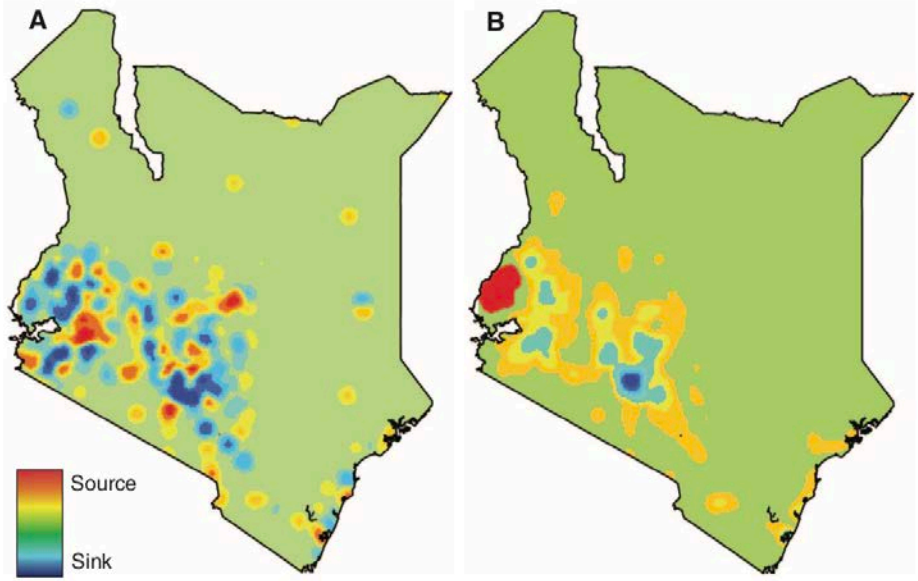


Fig. 3. Sources and sinks of people and parasites. Kernel density maps showing ranked sources (red) and sinks (blue) of human travel and total parasite movement in Kenya, where each settlement was designated as a relative source or sink based on yearly estimates. (**A**) Travel sources and sinks. (**B**)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



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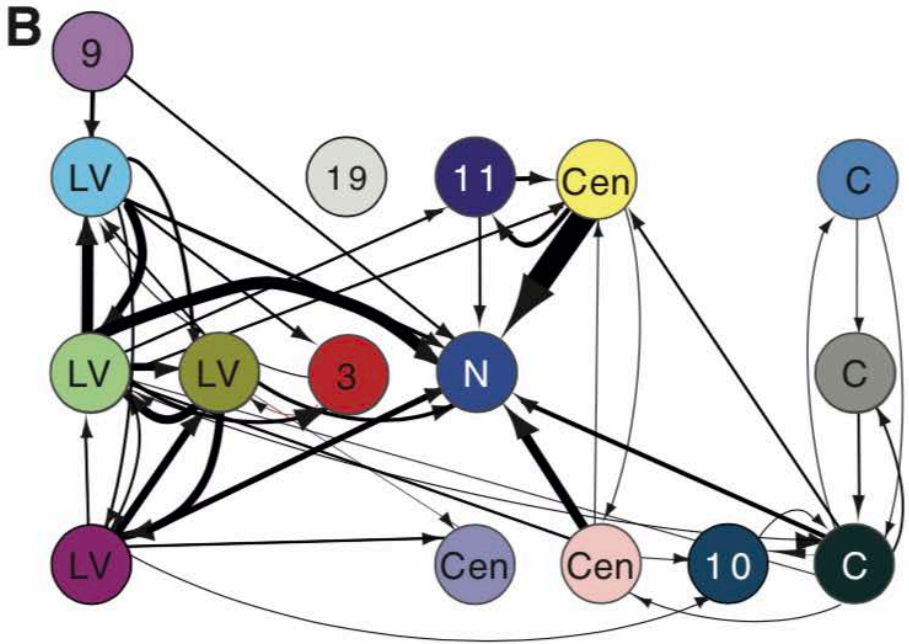
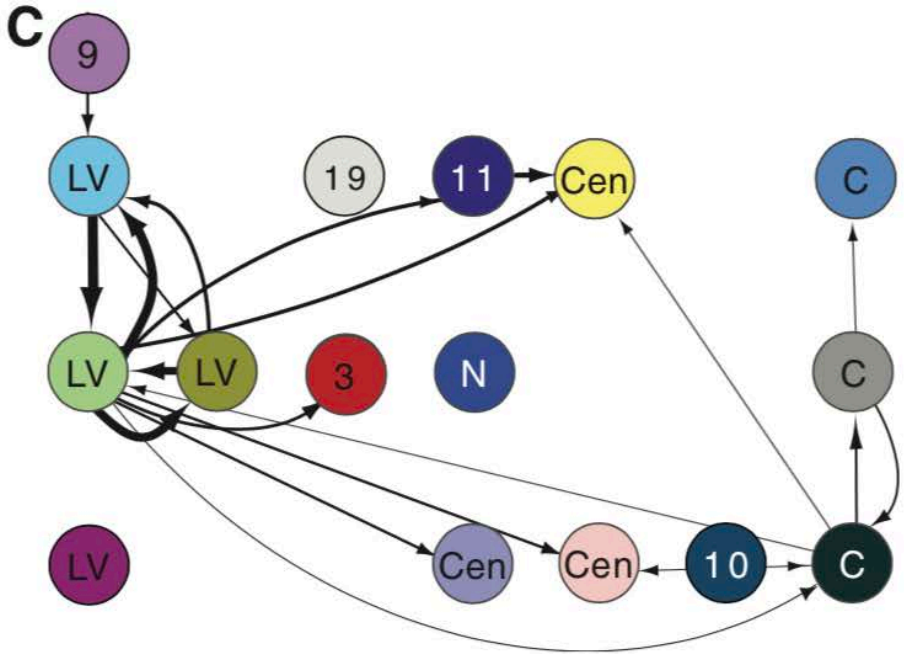
People Traveling and Getting Infected



Infected People Traveling and Getting Bitten



Vector-Transmission in the Built Environment

- Most vector species tend to decline and disappear from urban centers
- Malaria prevalence tends to be much lower in urban centers

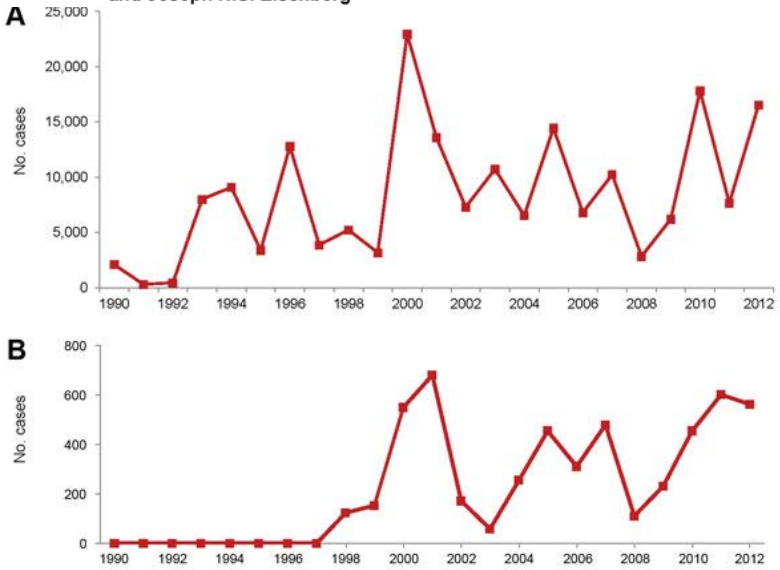
- *Aedes aegypti* tends to thrive in these urban centers
- Arboviral transmission is a growing problem in urban centers

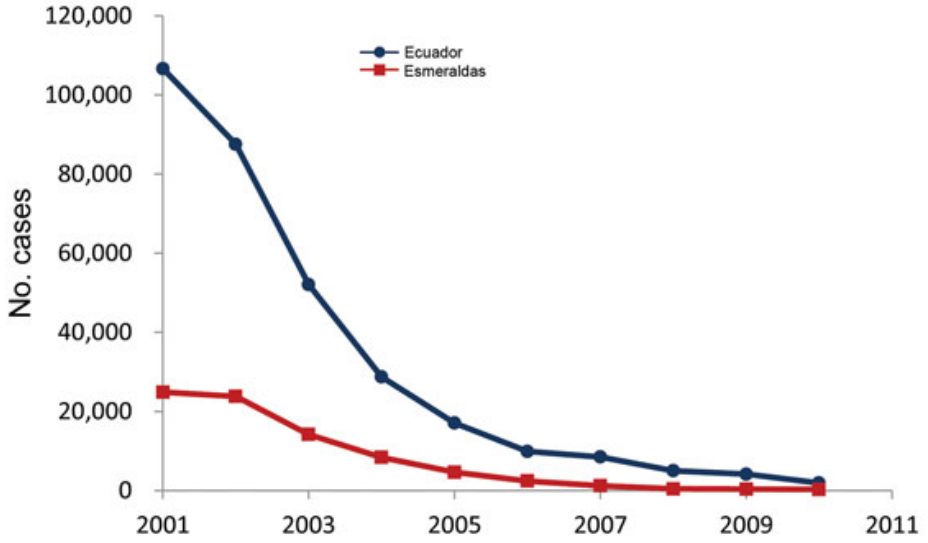
Urban Vector

Rural Vectors

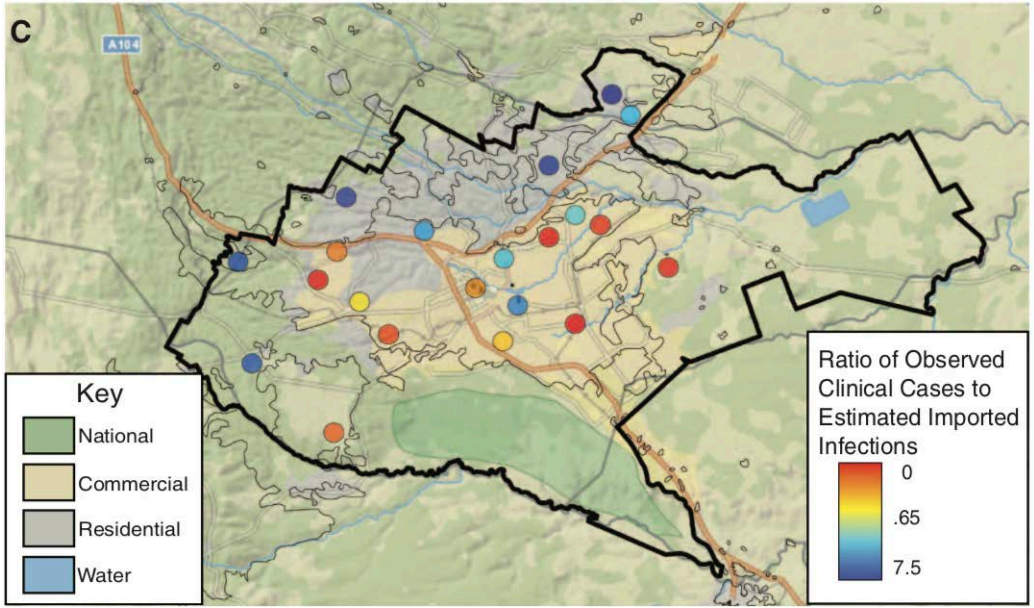
Transition in the Cause of Fever from Malaria to Dengue, Northwestern Ecuador, 1990–2011

Sara G. Cifuentes,[1] James Trostle, Gabriel Trueba, Meghan Milbrath, Manuel E. Baldeón,[1] Josefina Coloma, and Joseph N.S. Eisenberg





Mosquito-borne pathogen transmission in Nairobi?



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CAPITALNEWS

HOME KENYA 2017 ELECTED OFFICIALS ELECTIONS AFRICA

Nairobi put on alert over dengue fever after Mombasa outbreak

May 10, 2017 4:40 pm

Infectious Diseases in the Built Environment

Developing Cities or Modern Slums

- High Population Density & Direct Contact
- Hubs for Travel
- Poor nutrition (under/over)
- Hookworm, parasites, etc.
- Childhood diseases:
  - measles, typhoid, diptheria
- Enteric pathogens:
  - Typhoid
- Epidemics of cholera and plague

The Sanitary Modern City

- High Population Density & Direct Contact
- Hubs for Travel
- Plumbing & sanitation
  - Rise of paralytic polio syndrome (lower force of infection, higher age at infection)
- Habitat change tends to eliminate zoonotic pathogen reservoirs and vectors
  - Rats, pets, & opportunists
  - *Aedes aegypti* & dengue
- Hospitals & public health
  - Antibiotic resistance