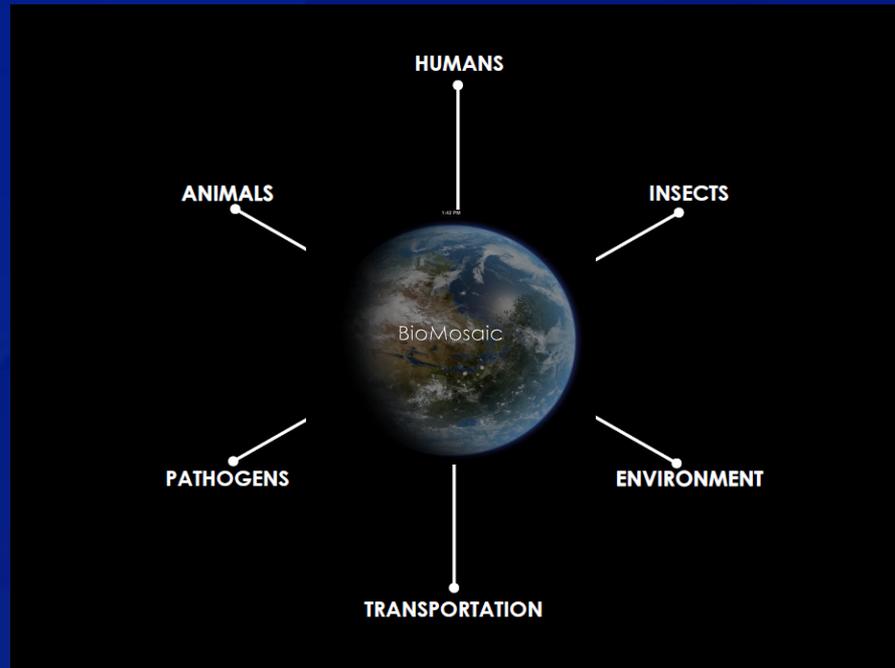
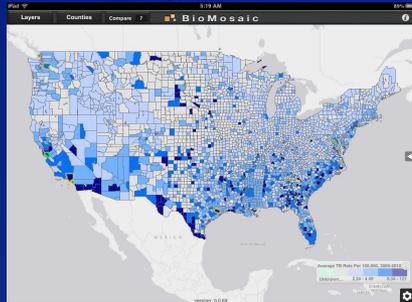


# BioMosaic of Globalization: Big Data Meets Public Health



**Martin Cetron, MD**  
**IOM Global Workshop, Sept. 2013**

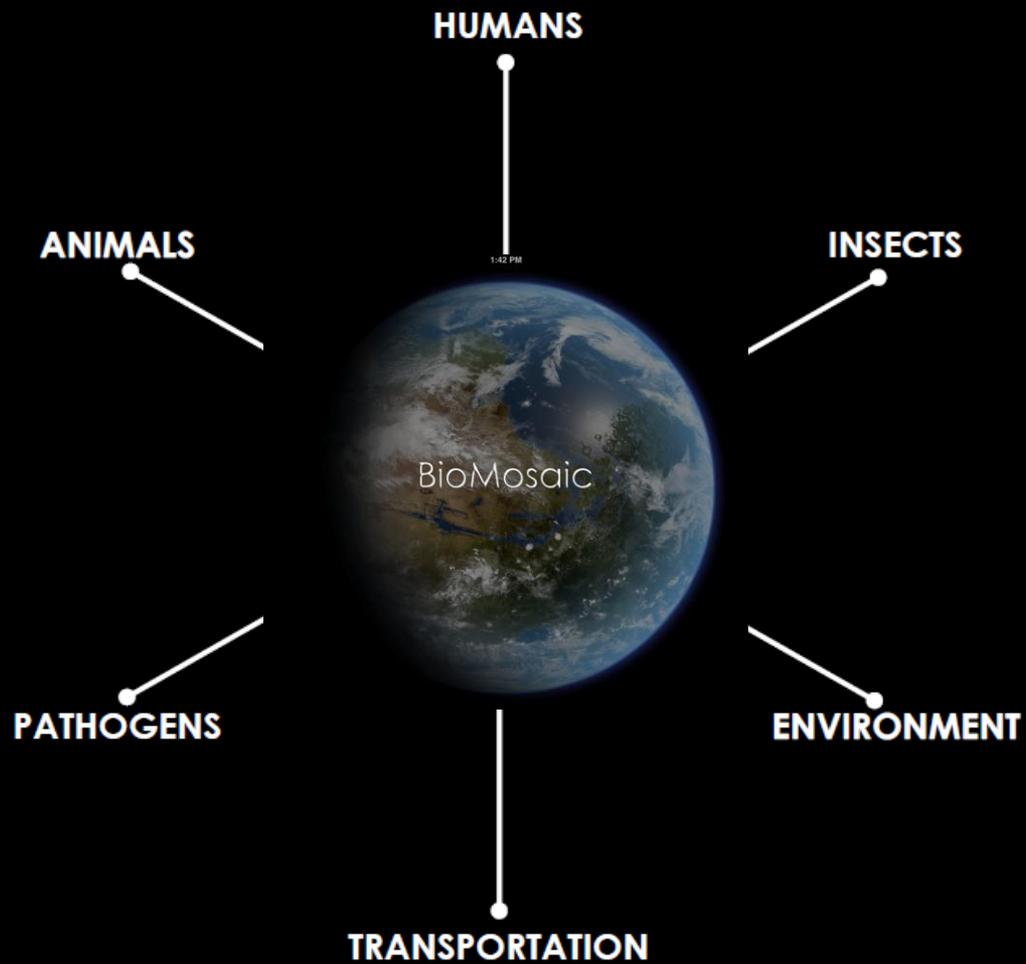
National Center for Emerging and Zoonotic Infectious Diseases  
Division of Global Migration and Quarantine



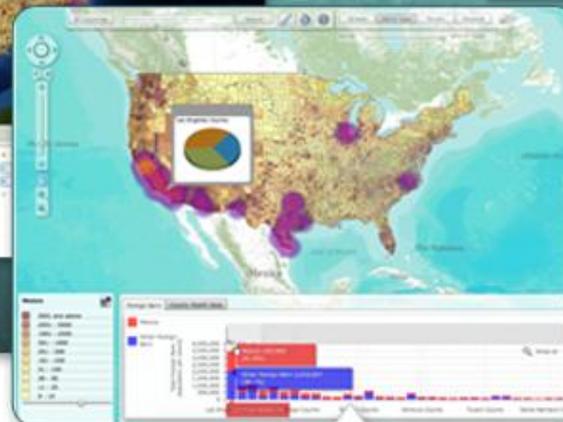


A satellite-style image of Earth from space, showing the Americas and surrounding oceans. The text "BioMosaic" is overlaid in the center.

BioMosaic







Launch Application

Adobe Flash Player is required

## About BioMosaic

The US is currently made up of a diverse population with varied health outcomes and disease risk. Approximately 12% of the US population is foreign-born, defined as being born abroad and neither parent a US citizen. Known health disparities between US- and foreign-born populations are affected by differing rates of endemic disease, obesity, travel patterns, and infectious disease exposure. The BioMosaic project aims to help public health practitioners better understand and assist foreign-born populations through the use of interactive maps containing demographic information as well as data on socio-economic status, migration and infectious diseases.



# Bio.Diaspora



# Our Partners



- Bio.Diaspora (St. Michael's Hospital, University of Toronto)
  - BioDiaspora provides an internet-based application that enhances situational awareness of infectious disease threats in the world
  - Uses geographic visualization to communicate geographic patterns and trends and disseminate public health and travel information to the public
  - Combines mapping technology, commercial aviation data and real time epidemic intelligence





# Our Partners

- HealthMap (Children's Hospital, Harvard University)
  - HealthMap is an interactive website designed for use by public health professional and others
  - It is publicly available and mines over 50,000 sites hourly 24/7
  - The system extracts over 1,800 disease patterns and categorizes them to identify diseases that could potentially indicate a significant health event







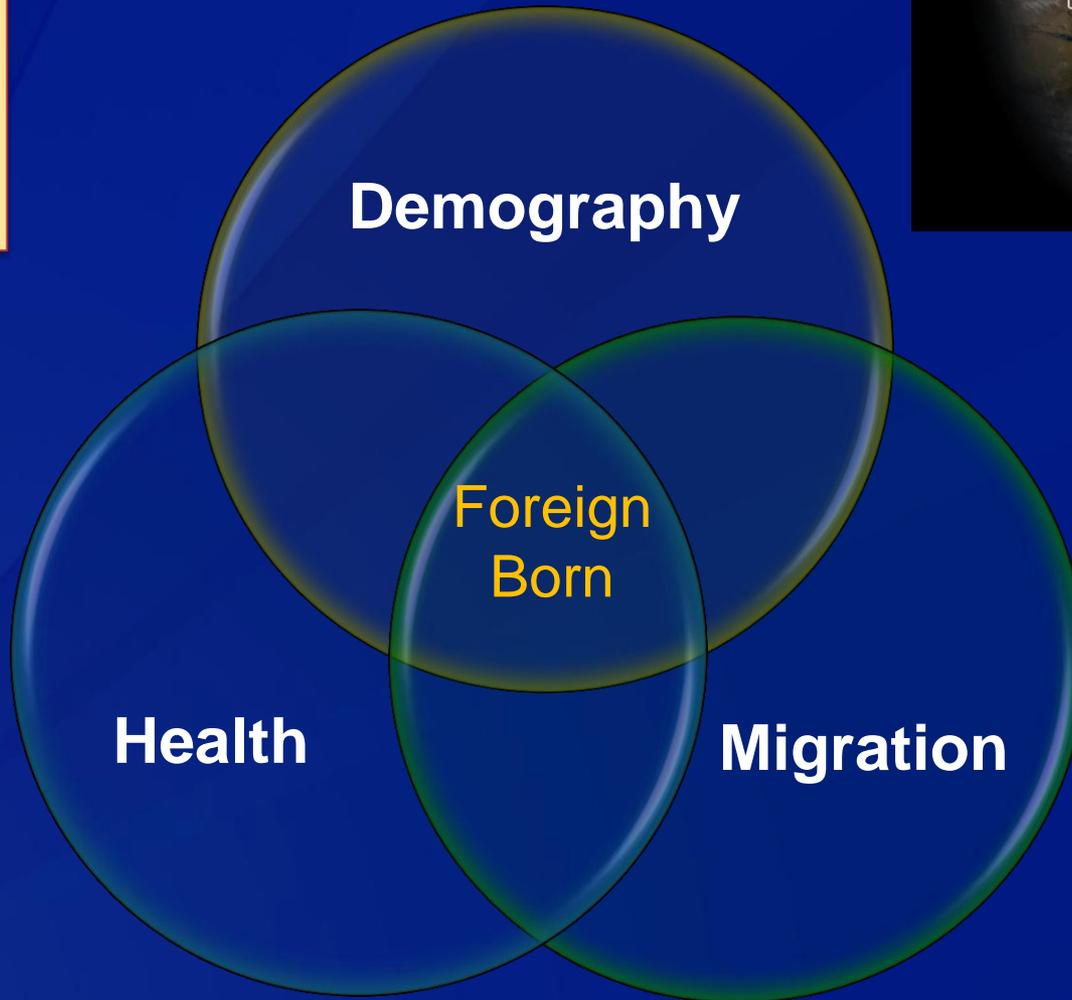
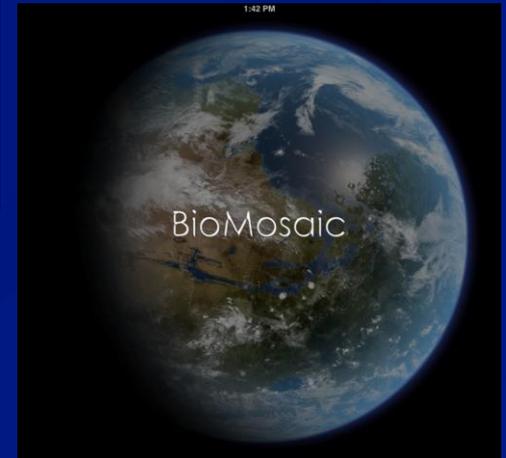
Harvard University



UNIVERSITY OF TORONTO

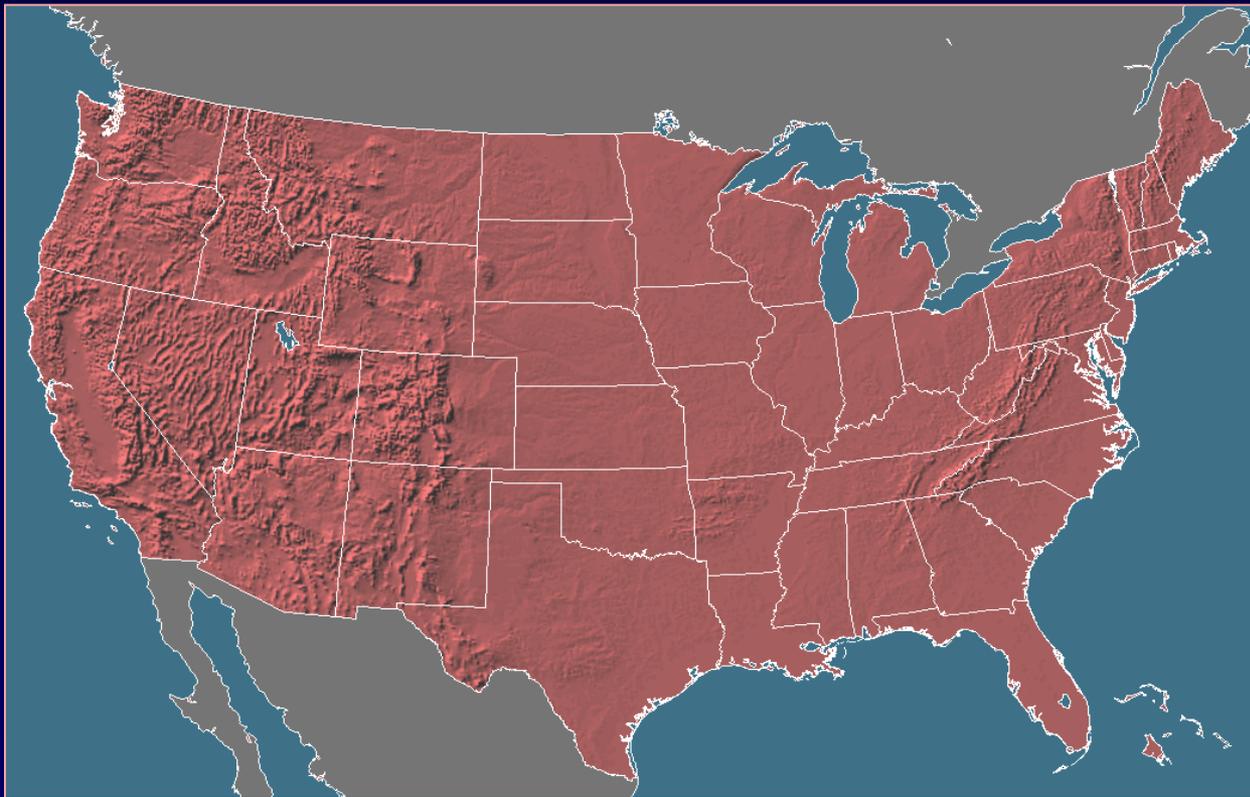


BIOMOSAIC

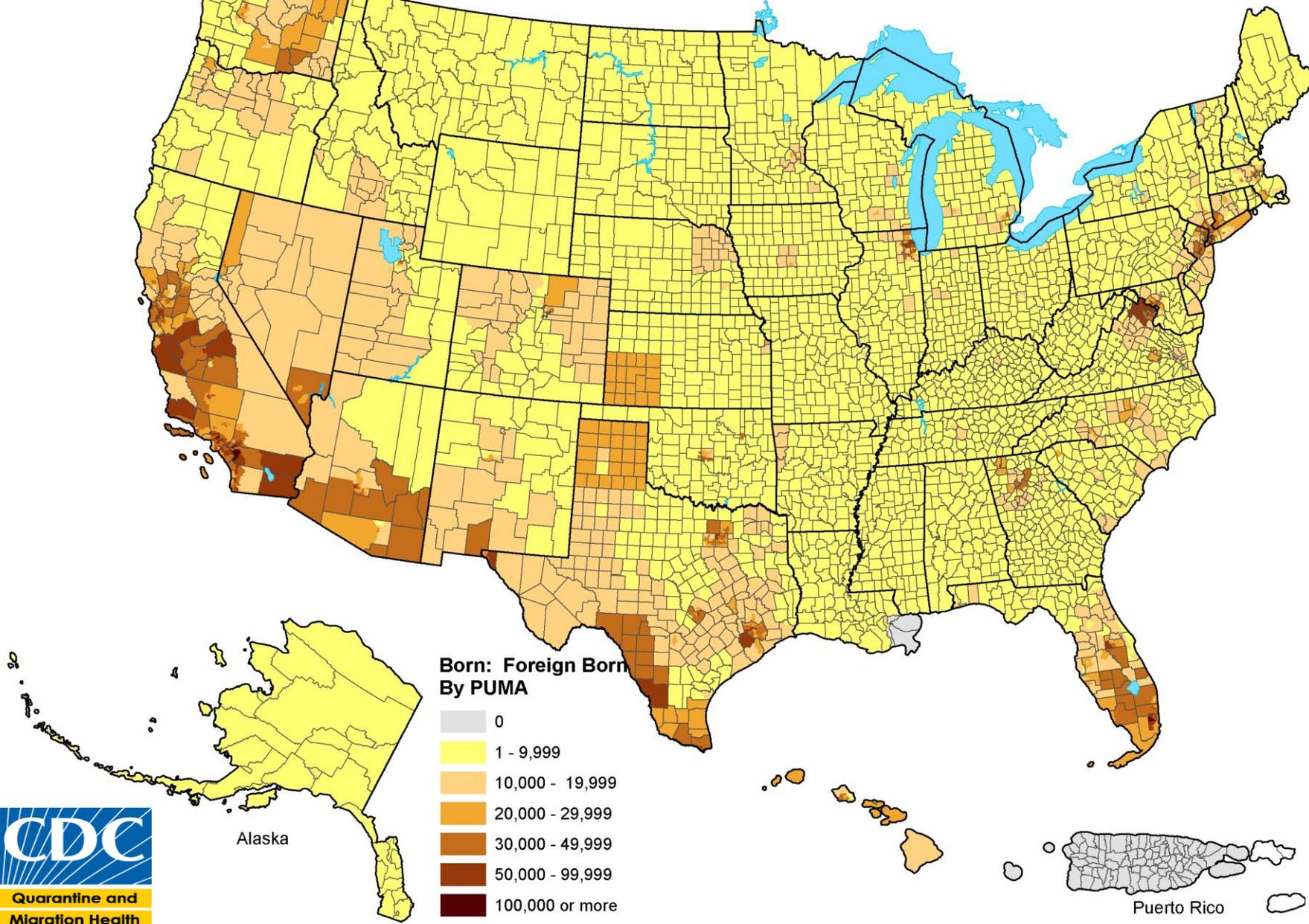


# U.S. Foreign Born Picture

Who is Waldo?  
Where's Waldo?

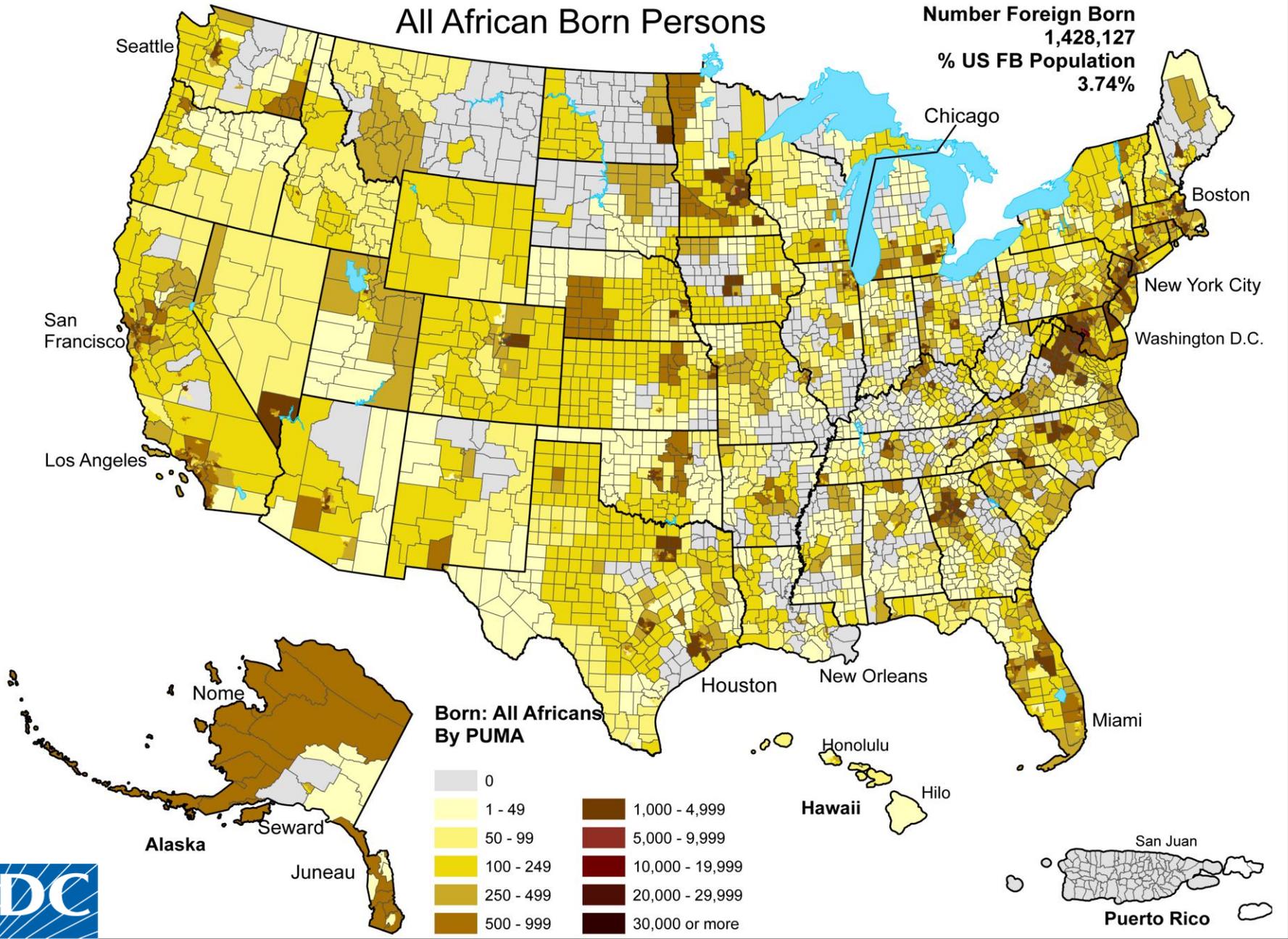


# Foreign Born Persons 38M (12.5% US Pop.)

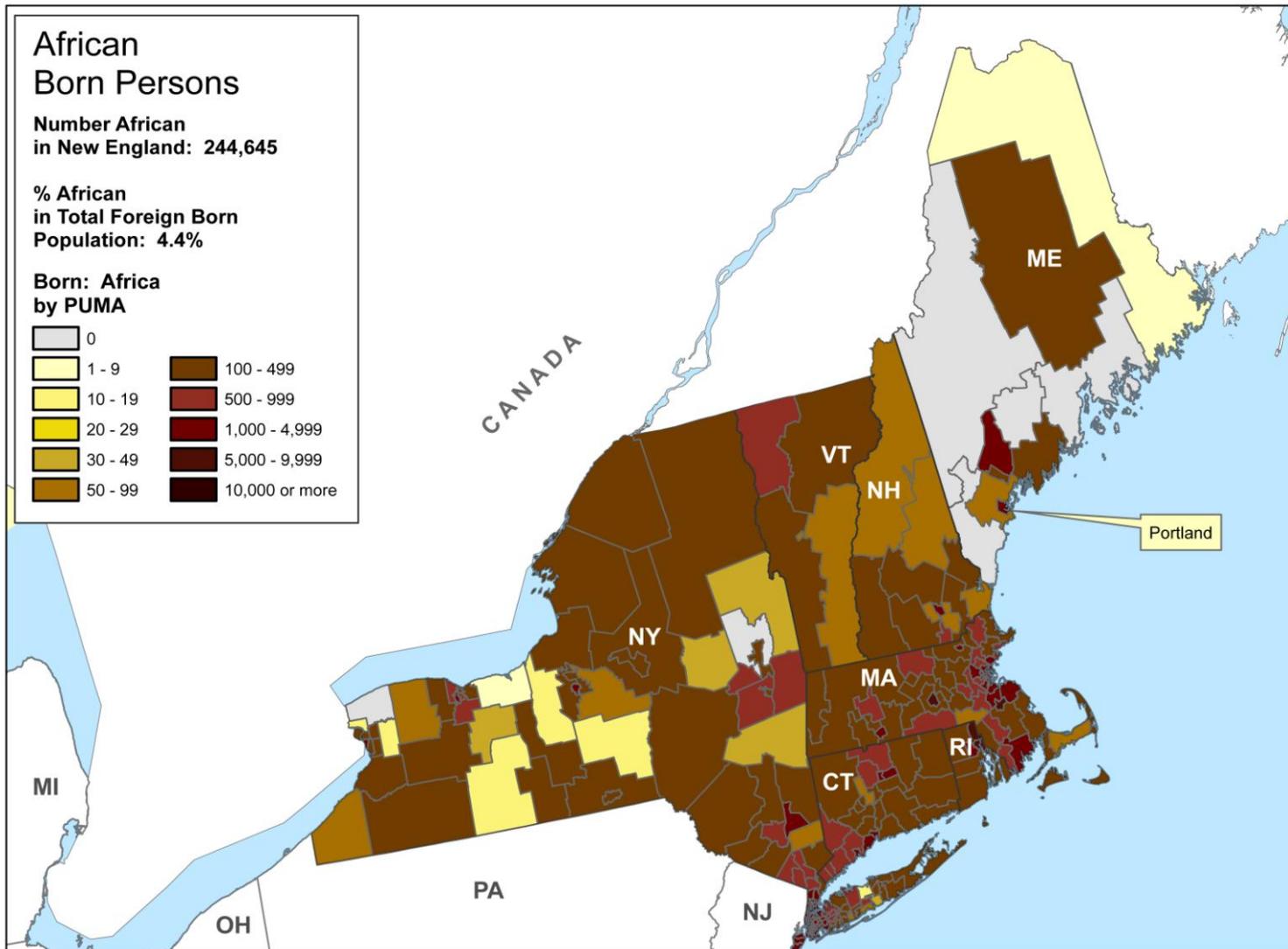


# All African Born Persons

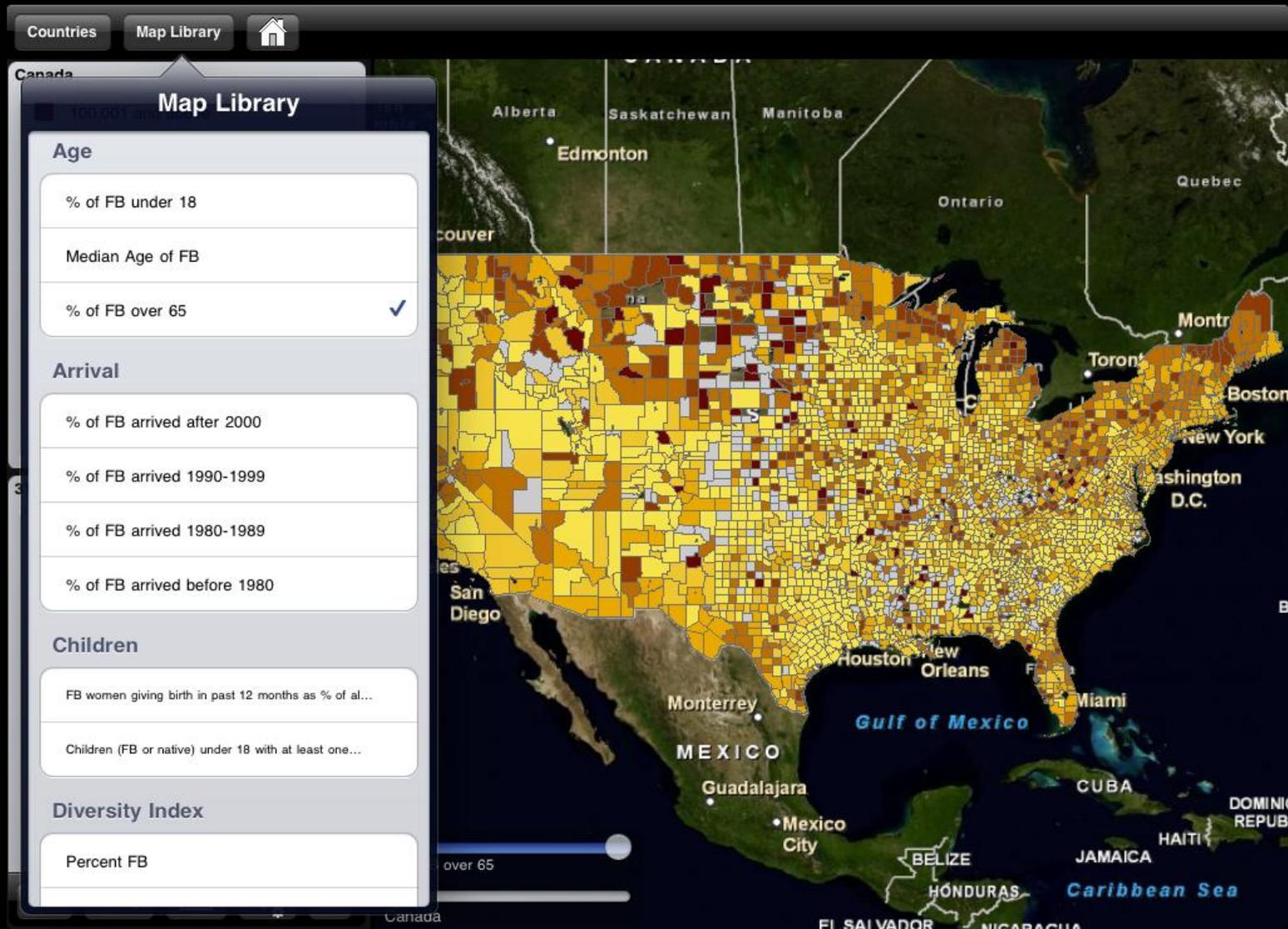
Number Foreign Born  
1,428,127  
% US FB Population  
3.74%



# New England: African-born



# Mobile Tablet



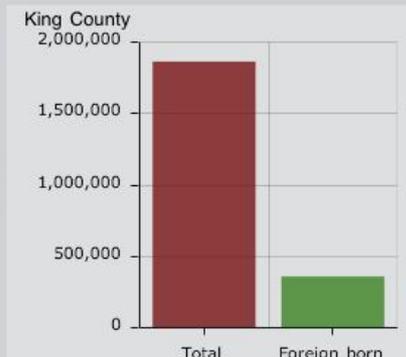
# Mobile Tablet

Countries
Map Library

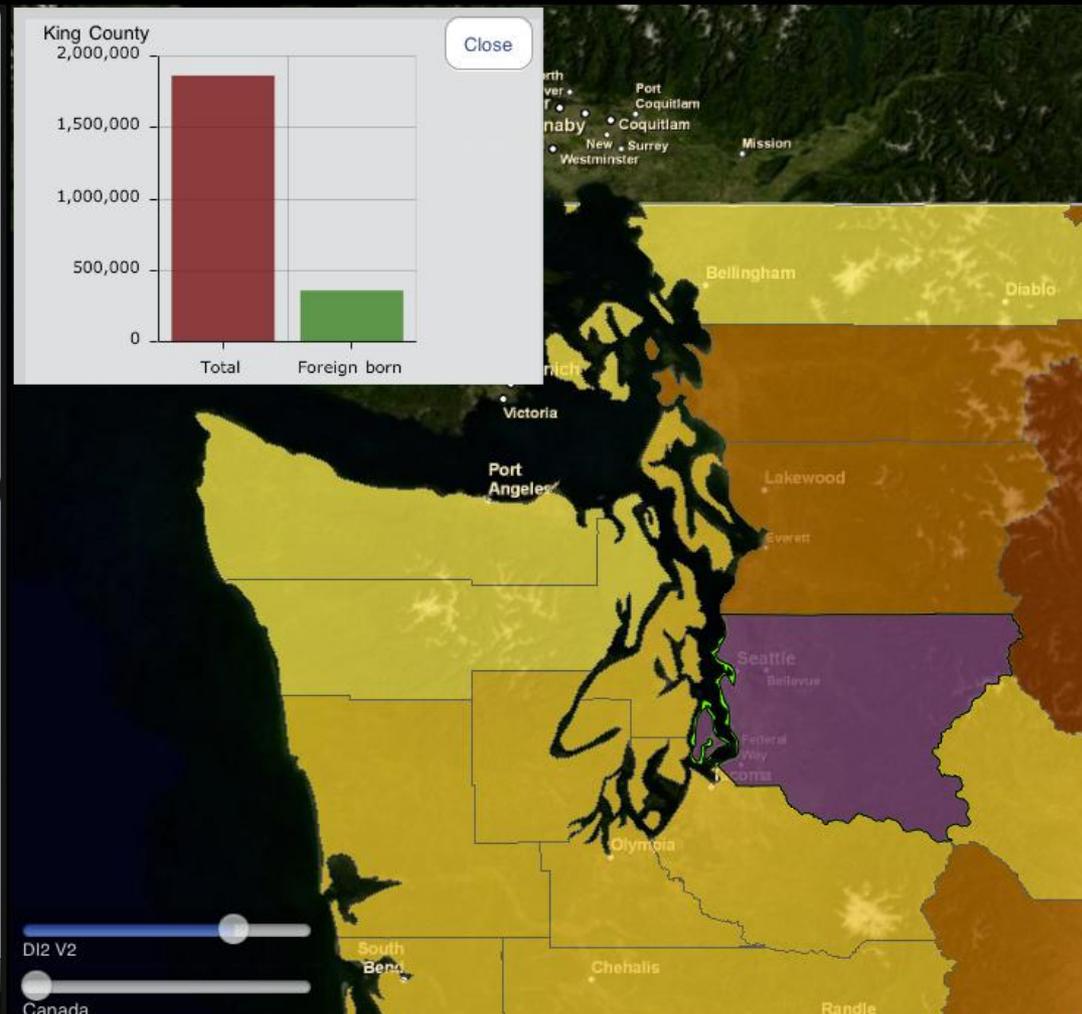

**Canada**

- 100,001 and above
- 25,001 - 100,000
- 10,001 - 25,000
- 5001 - 10,000
- 2501 - 5000
- 1001 - 2500
- 501 - 1000
- 101 - 500
- 1 - 100
- Zero

**King County**



Total      Foreign born



**21 counties within view**

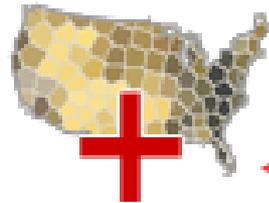
<span style="display: inline-block; width: 15px; height: 15px; background-color: #800000; margin-right: 5px;"></span>	King County, WA Population : 1,858,788 Foreign Born Population : 353,384 Canada <b>17,764</b>	<input checked="" type="checkbox"/>
<span style="display: inline-block; width: 15px; height: 15px; background-color: #A52A2A; margin-right: 5px;"></span>	Whatcom County, WA Population : 192,886 Foreign Born Population : 20,710 Canada <b>5,776</b>	<input type="checkbox"/>
<span style="display: inline-block; width: 15px; height: 15px; background-color: #C85130; margin-right: 5px;"></span>	Snohomish County, WA Population : 673,709 Foreign Born Population : 85,621 Canada <b>5,485</b>	<input type="checkbox"/>
<span style="display: inline-block; width: 15px; height: 15px; background-color: #E69A00; margin-right: 5px;"></span>	Pierce County, WA Population : 774,339 Foreign Born Population : 68,238 Canada <b>3,838</b>	<input type="checkbox"/>
<span style="display: inline-block; width: 15px; height: 15px; background-color: #FFC000; margin-right: 5px;"></span>	Thurston County, WA	<input type="checkbox"/>

Sort
Query




DI2 V2

Canada



# BIO MOSAIC

Layers Search

Layer Theme: U.S. Demography (default)

**Theme Layers**

- Places/Boundaries
- U.S. Point Features
- U.S. Census - American Community Survey (ACS)

**Base Layers**

- Aerial Imagery
- Topographic Atlas
- Terrain Imagery
- Base Map

**Legend**

Search by Content Search by Geography

Select Variable:

- Age by Birthplace
- Education by Birthplace (Population  $\geq 25$  Years)
- Individual Income in Past Year by Birthplace (Population  $\geq 15$  Years)
- Birthplace (Foreign-Born)
- Year of Entry into US by Citizenship Status (Foreign-Born)
- Geographical Mobility in Past Year (Foreign-Born)
- Ability to Speak English (Individual)
- Ability to Speak English by Language Spoken at Home
- Ability to Speak English (Household)

Demography

BRAZIL

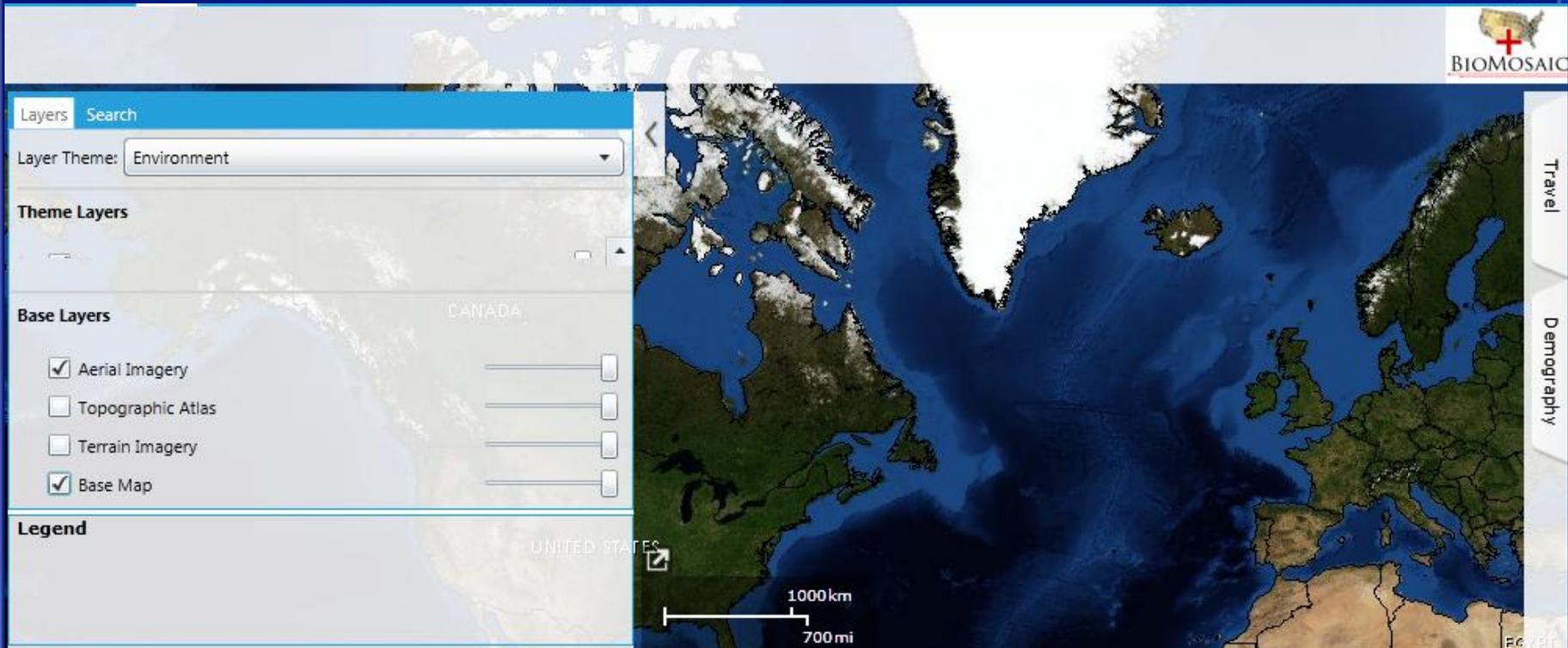
EGYPT

2000km

1000mi

Travel

## BioMosaic Web Application



- Focuses on the characterization and response to international health events esp. infectious diseases.
- Provides access to relevant contextual information in the country of origin, global airline transportation data and at-risk foreign-born populations in U.S.
- Provides complex analytical capability



# How Can BioMosaic Help?

## 1. Surveillance

- Sort through event based surveillance from HealthMap or other sources

## 2. Evaluation of Source Conditions

- Measure human population around event source
- Assess environmental conditions (e.g. rainfall, temperature, animals etc.)
- Analyze deviations from historic averages

## 3. Evaluation of transportation networks from event source into U.S.

- Analysis of flight schedule and capacity
- Analysis of passenger level flight data and final passenger destinations

## 4. Evaluation of conditions in the U.S.

- Map of risk areas
- Visualize distribution of foreign born – identify top counties of settlement
- Perform demographic analysis (English proficiency, education level etc.)

## 5. Analysis to determine where CDC intervention is needed

CDC Home  
Centers for Disease Control and Prevention  
Your Online Source for Credible Health Information

A-Z Index: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Travelers' Health

Home - Specific Groups & Settings

Haiti Earthquake and Travel

A 7.0 magnitude earthquake struck Haiti on Tuesday afternoon, January 12, 2010, close to the nation's capital of Port-au-Prince. Conditions in the area remain hazardous, including extensive damage to buildings, roads, and other infrastructure.

Information for Healthcare Providers  
Inform Recommendations for the Medical and Psychological Evaluation of Individuals Arriving From Haiti  
Last updated: February 12, 2010

Guidance for Healthcare Providers Assisting Travelers Preparing for Haiti Earthquake Response  
Last updated: February 12, 2010

Health Alert Notice for Clinicians Caring for Persons Arriving from Haiti  
Last updated: February 12, 2010

Inform Recommendations for Initial Domestic Medical Screening of Haitian Orphan Facilities  
Last updated: February 12, 2010

Information for People Traveling to or from Haiti  
Guidance for Relief Workers and Others Traveling to Haiti for Earthquake Response  
Last updated: February 18, 2010

Search (keyword): Guidance for Relief Workers and Others Traveling to Haiti for Earthquake Response  
Last updated: February 18, 2010

Portuguese (Portuguese): Guidance for Relief Workers and Others Traveling to Haiti for Earthquake Response  
Last updated: February 18, 2010

Chinese: Guidance for Relief Workers and Others Traveling to Haiti for Earthquake Response  
Last updated: February 17, 2010

Health Alert Notice for Persons Leaving Haiti  
Last updated: February 11, 2010

French (French): Health Alert Notice for Persons Leaving Haiti  
Last updated: February 11, 2010

Czech: Health Alert Notice for Persons Leaving Haiti  
Last updated: February 11, 2010

Questions and Answers: Haitian Earthquake Victims Seeking to Bring Pets into the United States  
Last updated: January 21, 2010

Important Health Information for Parents Adopting Children from Haiti during the 2010 Earthquake Response  
Last updated: January 20, 2010

Guidance for U.S. Residents in Haiti  
Last updated: January 14, 2010

French (French): Guidance for U.S. Residents in Haiti  
Last updated: January 14, 2010

Travel Health Warning: Major Earthquake in Port-au-Prince, Haiti  
Avoid Nonessential Travel to Haiti  
Last updated: January 13, 2010

CDC Health Information for Travelers to Haiti  
General information about CDC's response to the earthquake: CDC Emergency Preparedness and Response, Earthquakes

HHS Resources Haiti  
Get Widget

Page last reviewed: January 27, 2010  
Page first published: February 12, 2010  
Page created: January 27, 2010  
Content source:  
Division of Global Migration and Quarantine,  
National Center for Preparedness, Detection, and Control of Infectious Diseases

Home A-Z Index Site Map Policies About CDC.gov Link to Us All Languages CDC Mobile Contact CDC

Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA  
800-CDC-INFO (800-232-6346) TTY: (888) 232-6348, 24 Hours/Every Day cdcinfo@cdc.gov



# 1. Surveillance

## Public and proprietary data sources

HealthMap Global Health, Local Knowledge

Global Local News

About Projects Mobile Donate Feedback Eng

Search cholera haiti Advanced Search

53 Alerts Now Showing  
Date: 10 Aug 2012 - 18 Aug 2012 Diseases: Cholera (53) Places: all

Source	Date	Summary	Disease	Location
	16 Aug 2012	July 3 cases of cholera outbreak in Jiangsu no deaths	Cholera	Jiangsu Province
	16 Aug 2012	3 cases of cholera outbreak in Jiangsu No deaths were reported in July	Cholera	Jiangsu Province
	16 Aug 2012	Cholera outbreak: Ovo gov provides toilet facilities for affected ...	Cholera	Nigeria

CDC Home  
Centers for Disease Control and Prevention  
Your Online Source for Credible Health Information

A-Z Index: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Travelers' Health

Destinations  
Yellow Book  
Travel healthy this flu season!  
See site FAQ and Useful Links.

Travelers' Health Topics

Destinations  
Health information for travel to over 200 international destinations

Vaccinations  
General information about vaccinations for travel

Diseases  
Diseases related to travel, including malaria and yellow fever

Bleess & Injury Abroad  
Prepare for your trip

2010 Yellow Book  
Travel health reference, includes updates to the online edition

Find a Clinic  
Locate a travel health specialist or yellow fever vaccination clinic

Stay Healthy & Safe  
Insect protection, safe food & water, survival guide

References & Resources  
Travel health journals & articles; domestic & international partners

News & Announcements

Guidance for U.S. Residents in Haiti Feb 18, 2010

New! Guidance for Relief Workers Traveling to Haiti for Earthquake Response Feb 18, 2010

New! Guidance for Healthcare Providers Assisting Travelers Preparing for Haiti Earthquake Response Feb 12, 2010

New! Feb 11, 2010

New! sandal pasteur Places Ordering Limits on Single Dose Yellow Fever Vaccine Nov 3, 2009

More »

Information for Specific Groups & Settings

2009 H1N1 Flu and Travel  
Traveling with Children  
Traveling with Special Needs  
Traveling with Pets  
Air & Cruise Ship Travel  
Healthcare Provider Presentations  
Students Abroad  
Disaster Relief Workers

Haiti Earthquake and Travel  
Air & Cruise Ship Travel  
Healthcare Provider Presentations  
Students Abroad  
Disaster Relief Workers

Page last updated: February 11, 2010  
Content source:  
Division of Global Migration and Quarantine  
National Center for Preparedness, Detection, and Control of Infectious Diseases

Home A-Z Index Site Map Policies About CDC.gov Link to Us All Languages CDC Mobile Contact CDC

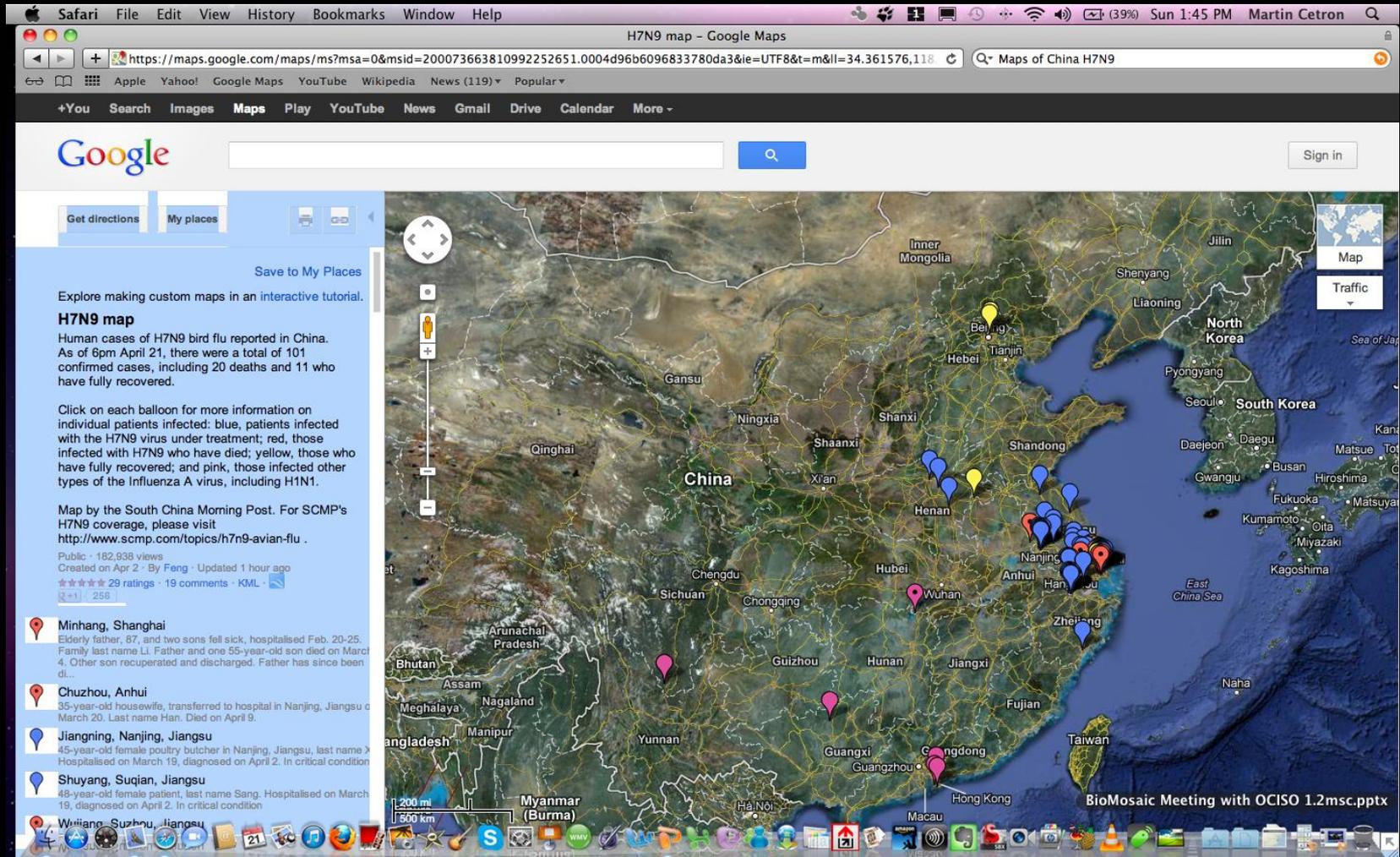
Centers for Disease Control and Prevention 1600 Clifton Rd. Atlanta, GA 30333, USA  
800-CDC-INFO (800-232-6346) TTY: (888) 232-6348, 24 Hours/Every Day cdcinfo@cdc.gov

USA.gov  
U.S. GOVERNMENT  
Your Online Source for Government Information

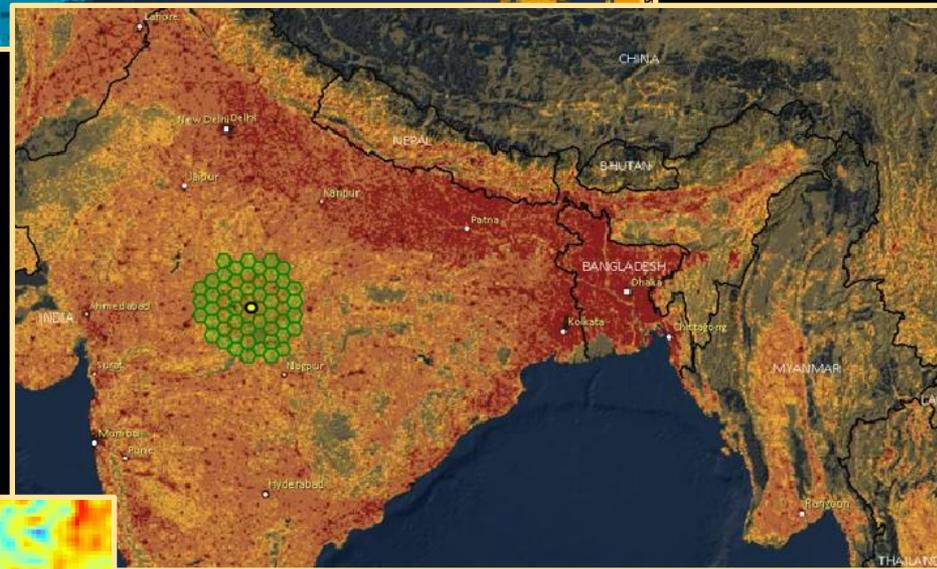
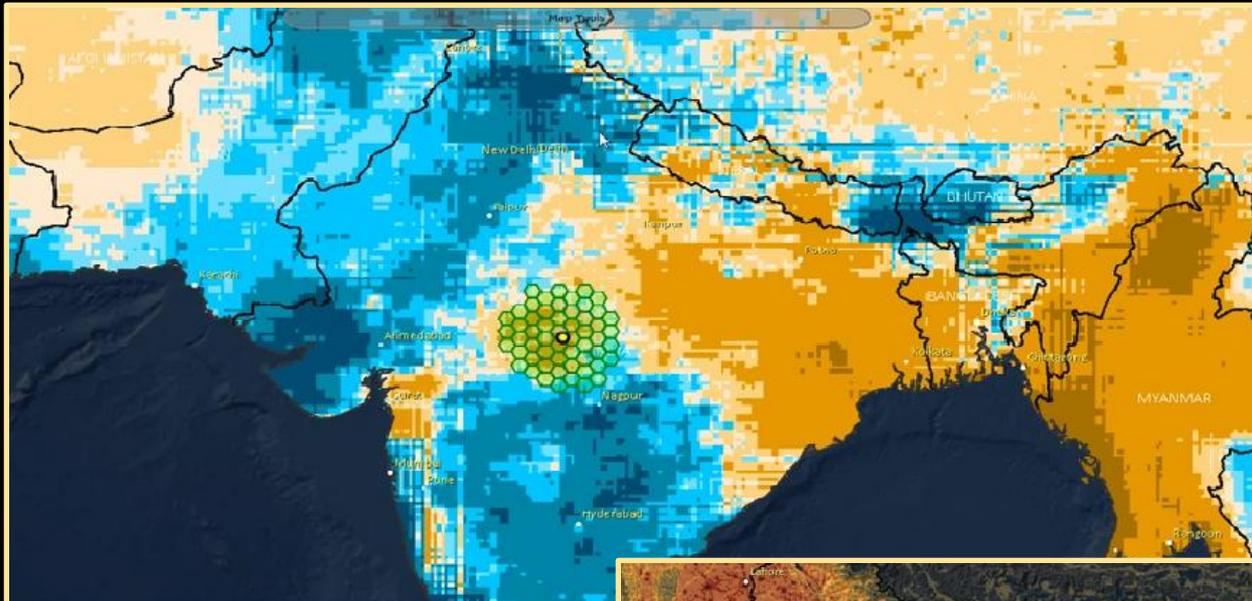


# Human Cases H7N9 Flu in China

N= 102 cases / 20 deaths (~20%)

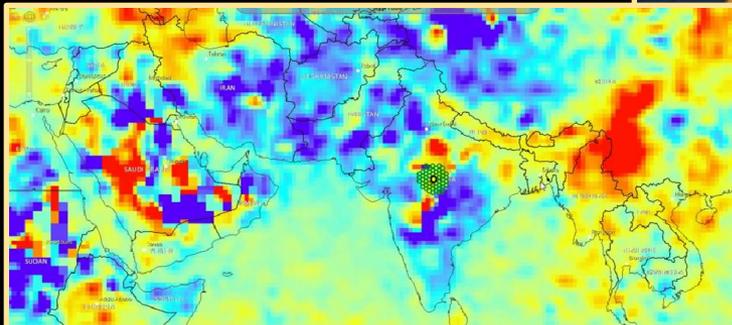


## 2. Evaluation of Source Condition

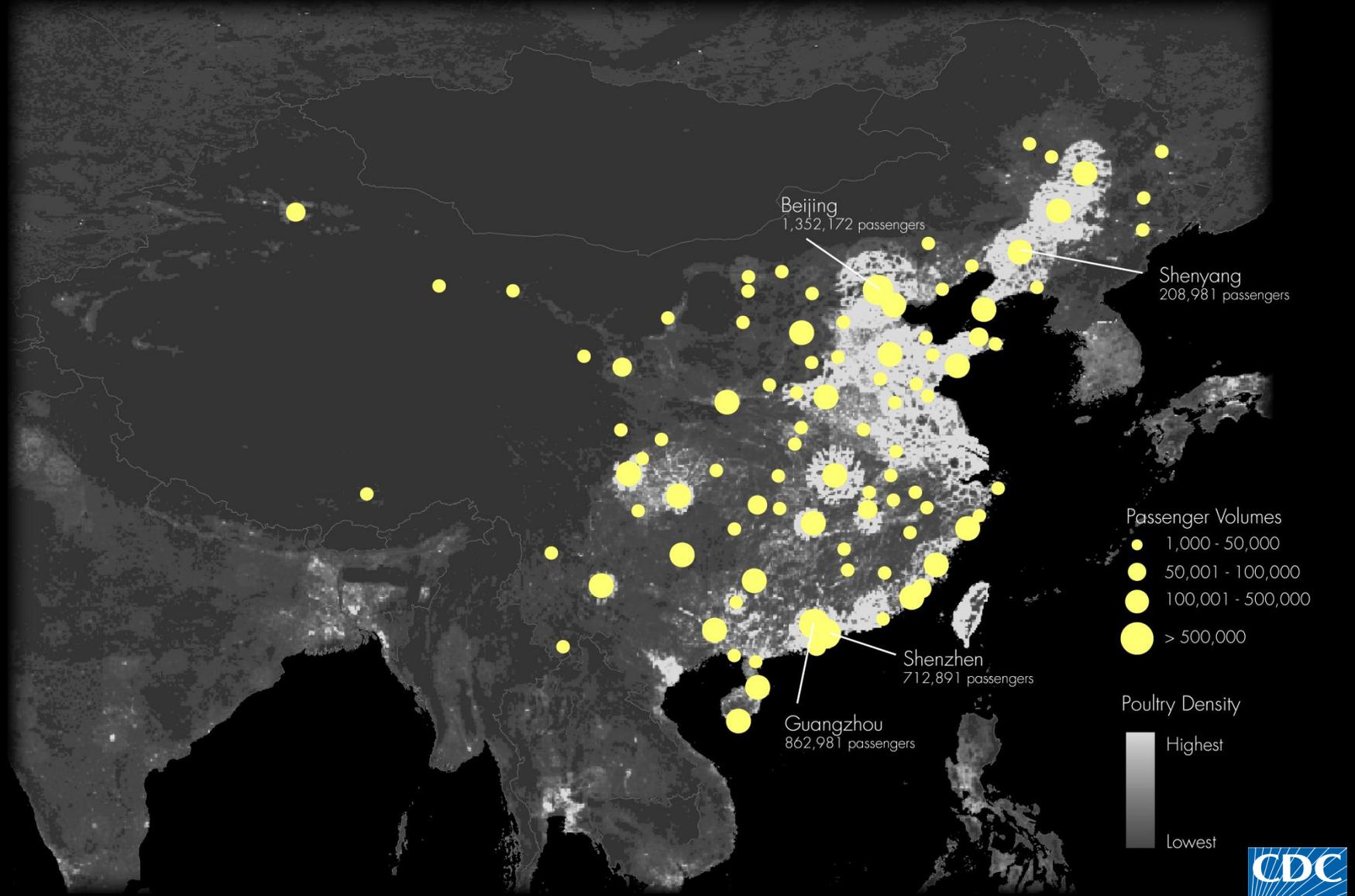


Show hexagons  
Drawn area: 92,475 km<sup>2</sup> (max 500,000 km<sup>2</sup>)

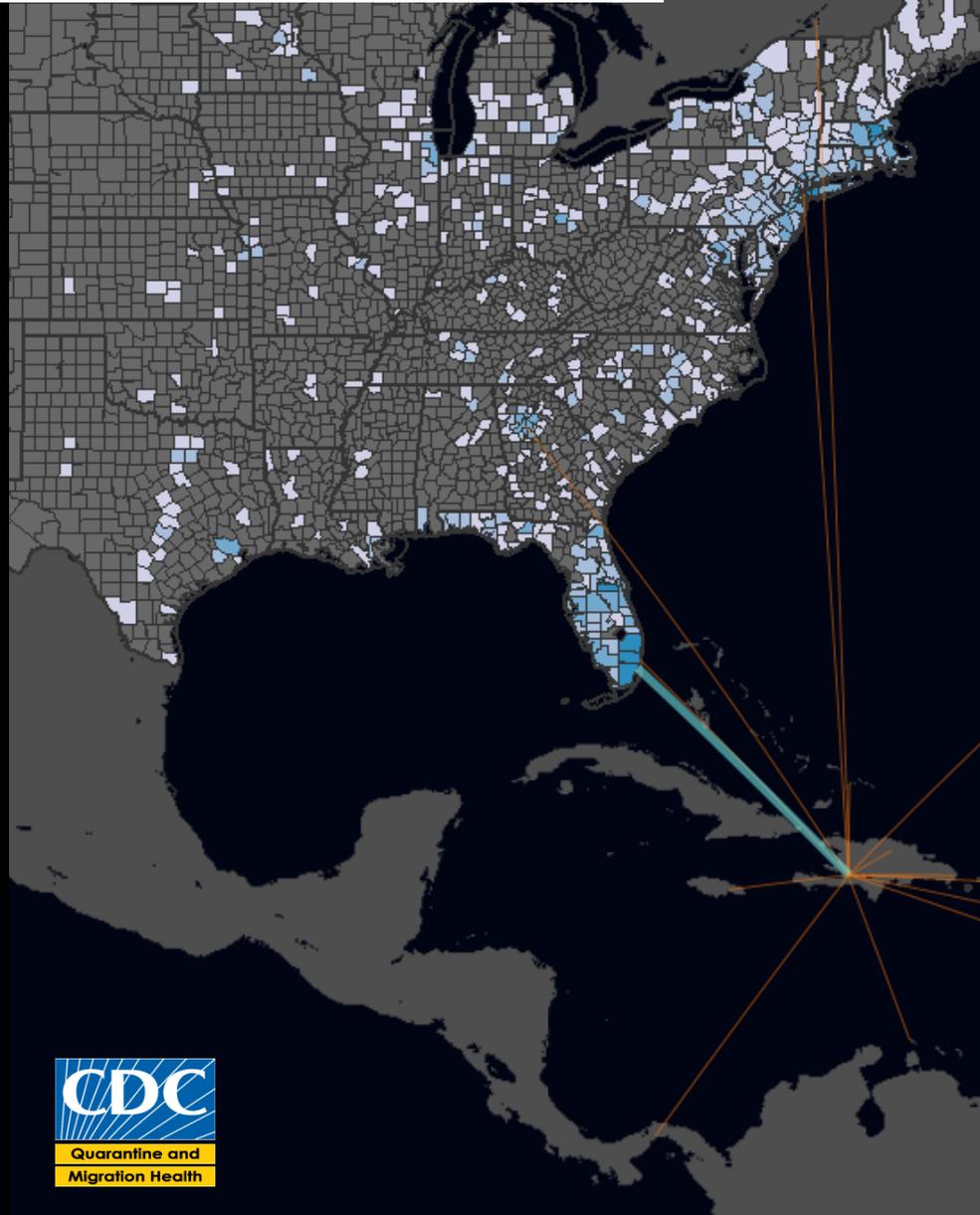
Actual Area (km <sup>2</sup> ):	Total	Density / km <sup>2</sup>
Population	13,398,491	110.5
Urban Population	2,194,220	2,408.0
Bovine	219,254	1.8
Buffalo	40,608	0.3
Cattle	125,458	1.0
Goat	42,721	0.4
Pig	2,836	0.0
Poultry	35,633	0.3
Small Ruminants	45,853	0.4



# Domestic Air Travel within China from Shanghai, Hangzhou, Nanjing, and Wuxi (April - June) With Poultry Density



# 3. Transportation Networks



International Passengers
International Flight
US Domestic Passengers

Outbound: →

Inbound:

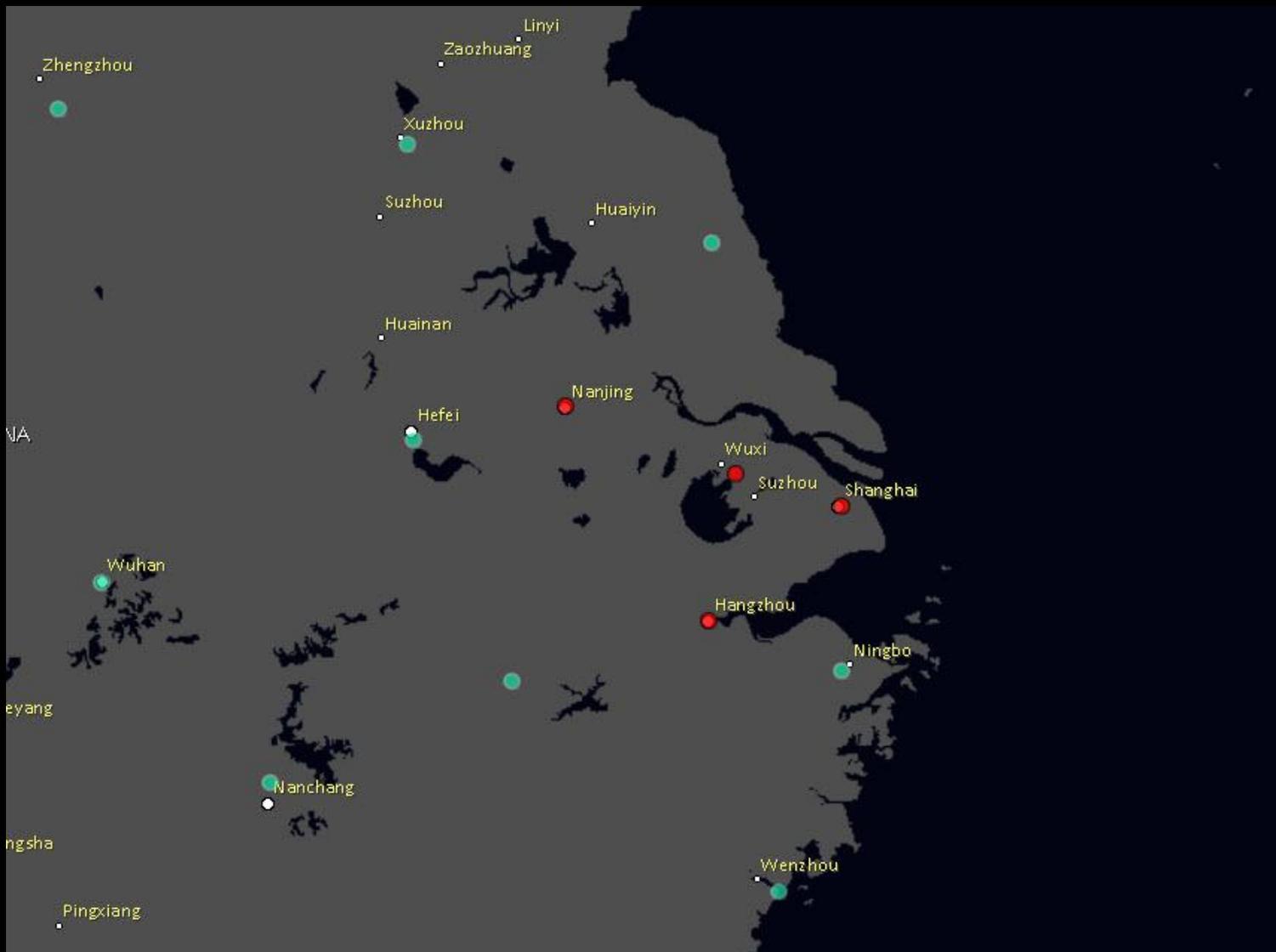
Search: 
 Seats

Direct international flights from Port au Prince, Haiti to:

City	Country	Distance (km)	Fly Time	Seats	Rank
Aruba	Aruba	741	3h, 50m	1,178	16
Montreal	Canada	3,603	4h, 20m	10,972	8
Santo Domingo	Dominican Republic	271	45m	35,346	5
Santiago	Dominican Republic	211	45m	2,489	11
Punta Cana	Dominican Republic	442	2h, 45m	2,147	12
Paris	France	9,579	8h, 50m	5,744	10
Pointe-a-Pitre	Guadeloupe	1,229	1h, 45m	56,134	4
Kingston	Jamaica	501	1h, 30m	1,200	15
Fort de France	Martinique	1,334	2h, 30m	1,870	14
St Maarten	Netherlands Antilles	1,037	1h, 40m	15,600	7
Panama City	Panama	1,359	2h, 14m	22,140	6
Providenciales	Turks & Caicos Islands	384	45m	1,980	13
Miami	United States	1,235	2h, 15m	331,516	1
New York	United States	2,876	4h, 15m	166,092	2
Fort Lauderdale	United States	1,262	2h, 10m	152,416	3
Atlanta	United States	2,323	3h, 22m	5,784	9



BIOMOSAIC



Airports in Proximity of the Area of China Affected by H7N9



## 4. Evaluation of Conditions in the U.S.

### Map of foreign born population from Haiti by County

Layers Search

Layer Theme: U.S. Demography (default)

**Theme Layers**

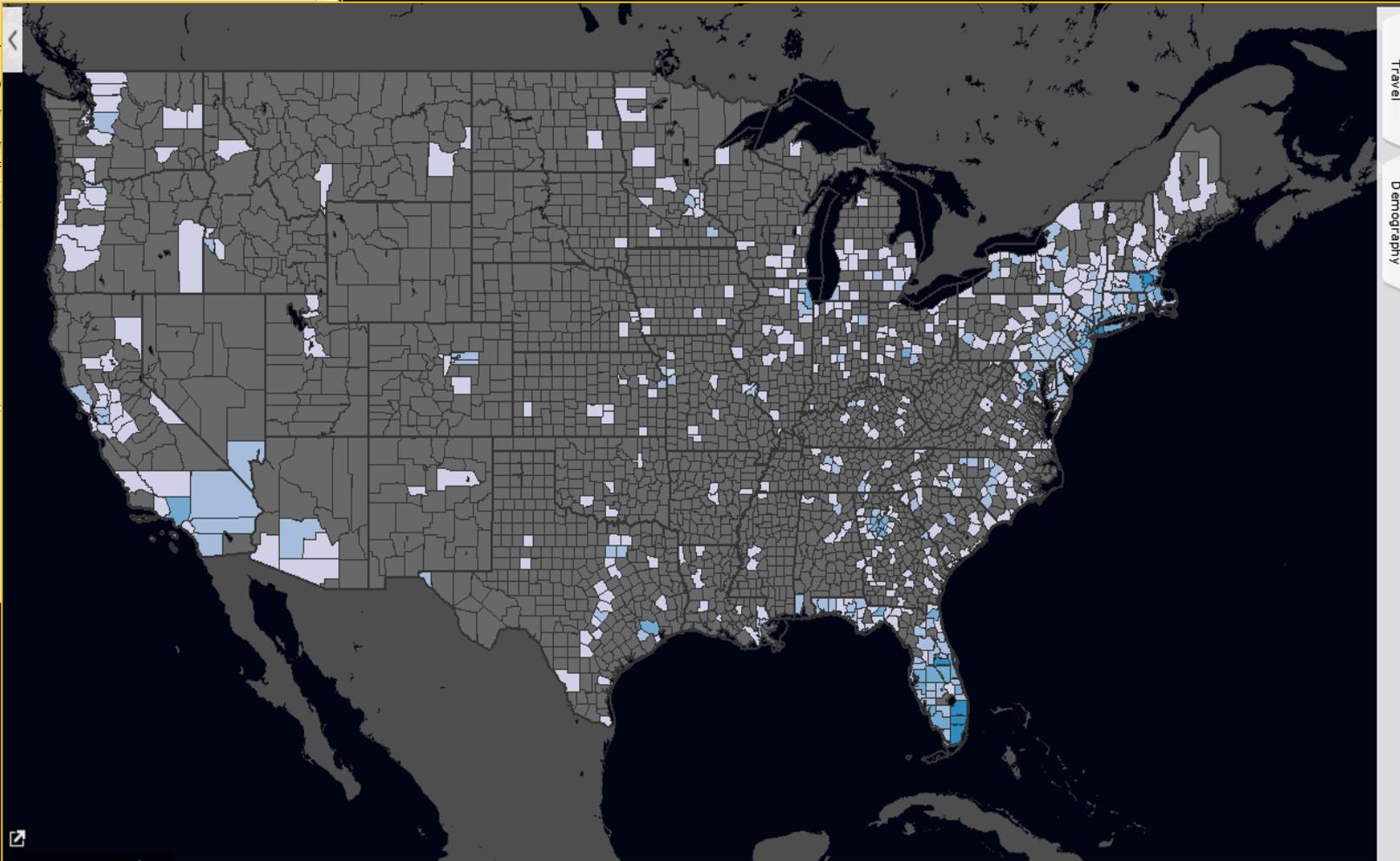
- Places/Boundaries
- U.S. Point Features
- U.S. Census - American Community Survey (ACS)
  - States
  - Counties - Names
  - Counties
  - Census Tracts
- All Foreign Born
- Foreign Born by
  - Foreign Born
  - Foreign Born
    - Haiti - P

**Base Layers**

- Aerial Imagery
- Topographic Atlas
- Terrain Imagery
- Base Map

**Legend**

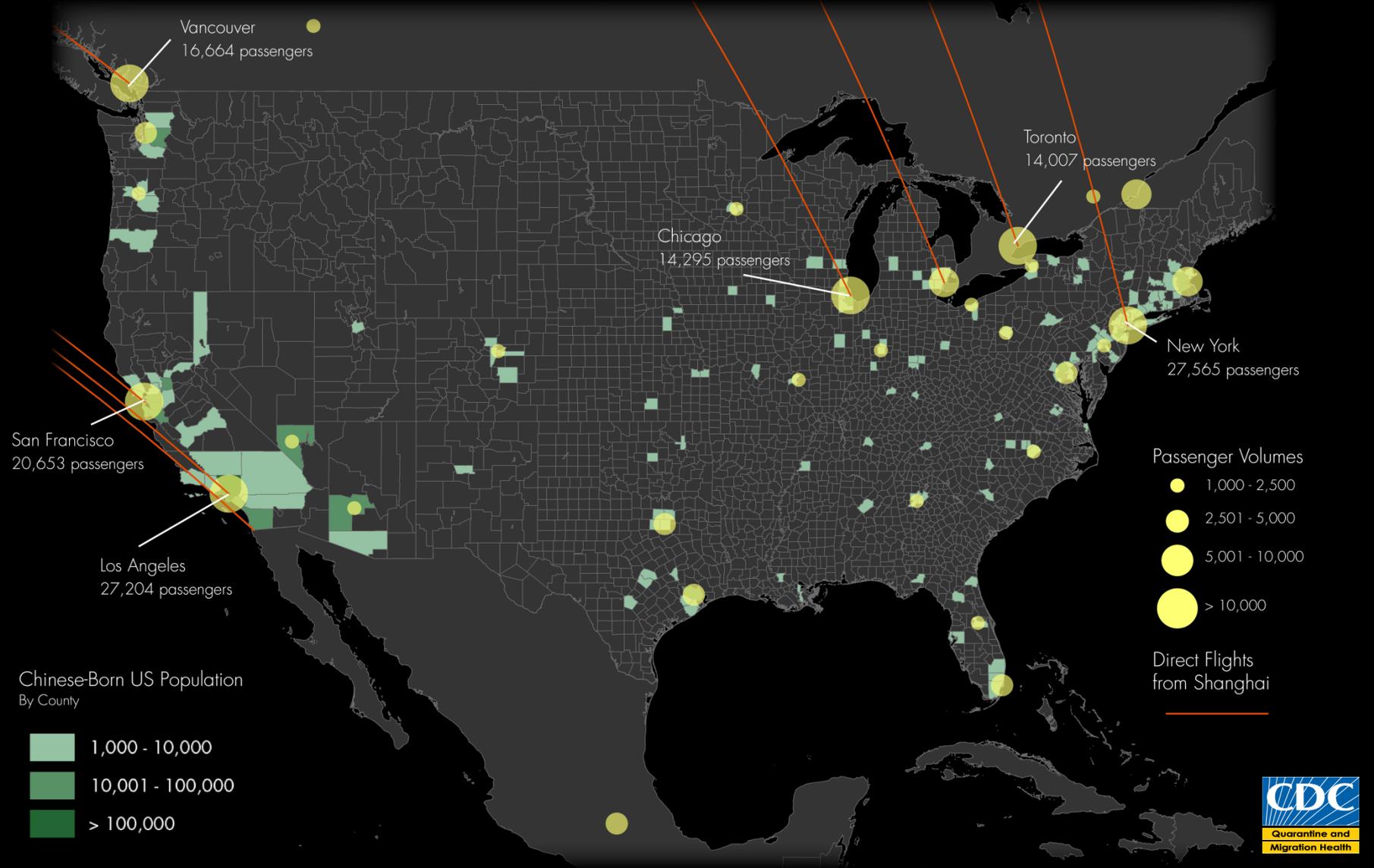
- ▼ States (top layer)
  -
- ▼ Counties
  -
- ▼ Haiti - Pop: County
  - 0



Travel

Demography

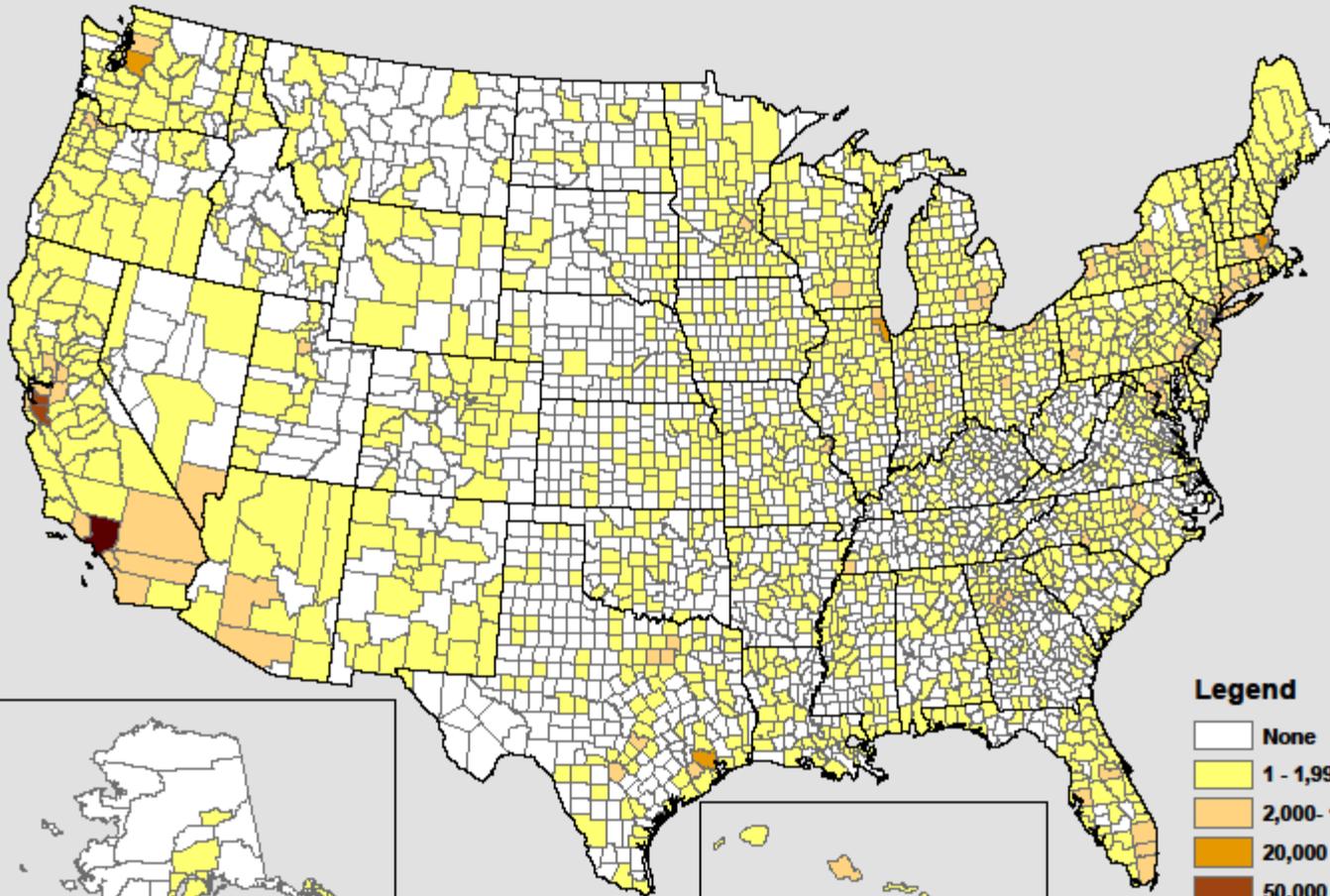
# Passenger Volumes to US & Canada from Shanghai, Hangzhou, Nanjing, and Wuxi (April - June) With Chinese-Born Population by County and Direct Flights from Shanghai





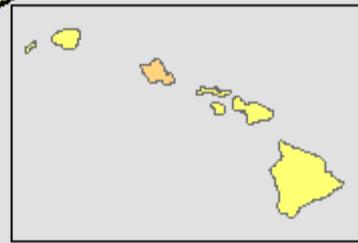
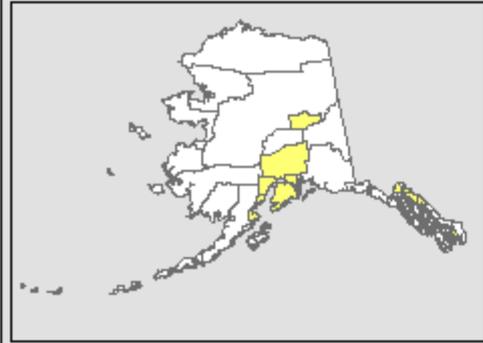
BIOMOSAIC

### Chinese Born in the US by County American Community Survey (2006-2010)



**Legend**

-  None
-  1 - 1,999
-  2,000 - 19,999
-  20,000 - 49,999
-  50,000 - 99,999
-  100,000 or More





Search by Content Search by Geography

Select Variable:

- Age by Birthplace
- Education by Birthplace (Population ≥25 Years)
- Individual Income in Past Year by Birthplace (Population ≥15 Years)
- Birthplace (Foreign-Born)
- Year of Entry into US by Citizenship Status (Foreign-Born)
- Geographical Mobility in Past Year (Foreign-Born)
- Ability to Speak English (Individual)
- Ability to Speak English by Language Spoken at Home
- Ability to Speak English (Household)

Demography

### 4. Evaluation of Conditions in the U.S.

Individual Income in Past Year by Birthplace (Population ≥15 Years)

Select Category:  
 Foreign-Born  US-Born

Select Income Range(s):

\$0	\$1-9,999	\$10,000-14,999
\$15,000-24,999	<input checked="" type="checkbox"/> \$25,000-34,999	\$35,000-49,999
\$50,000-64,999	\$65,000-74,999	\$75,000+

[Data Source](#)

Search:

County	State	Population	County%
Los Angeles	California	355,522	4.6
Miami-Dade	Florida	137,134	6.9
Cook	Illinois	130,842	3.2
Queens	New York	124,946	6.9
Harris	Texas	104,463	3.5
Kings	New York	103,712	5.3
Orange	California	90,685	3.8
San Diego	California	72,610	3.0
Clark	Nevada	72,089	4.8
Broward	Florida	68,133	4.8

Search by Content Search by Geography

Select Variable:

- Age by Birthplace
- Education by Birthplace (Population ≥25 Years)
- Individual Income in Past Year by Birthplace (Population ≥15 Years)
- Birthplace (Foreign-Born)

Select Birth Countries:

- Ghana
- Grenada
- Guyana
- Greece
- Guatemala
- Haiti

Data Source ACS Variable Name: PLACE OF BIRTH BY INDIVIDUAL INCOME IN THE PAST 12 MONTHS (IN 2010 INFLATION-ADJUSTED DOLLARS) IN THE UNITED STATES / PUERTO RICO (Universe: Population 15 years and over)

ACS Table: 6010

Date: 2006-2010

Search:

County	State	Population	FBCounty%	County%	FBNational%
Miami-Dade	Florida	73,837	6.09	3.02	14.33
Broward	Florida	61,379	11.86	3.54	11.91
Kings	New York	58,051	6.34	2.35	11.26
Palm Beach	Florida	38,561	14.42	2.97	7.48
Queens	New York	27,986	2.64	1.27	5.43
Orange	Florida	18,054	9.32	1.62	3.50
Essex	New Jersey	15,515	8.75	1.99	3.01
Suffolk	Massachusetts	13,471	6.94	1.91	2.61
Nassau	New York	12,483	4.72	0.94	2.42
Middlesex	Massachusetts	10,153	3.92	0.69	1.97
Union	New Jersey	8,670	6.09	1.64	1.68
Rockland	New York	8,015	13.10	2.62	1.56
Fairfield	Connecticut	7,596	4.41	0.84	1.47
Suffolk	New York	7,281	3.71	0.49	1.41
Collier	Florida	6,630	9.31	2.09	1.29



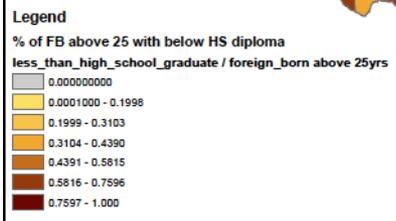
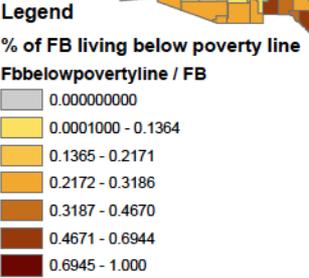
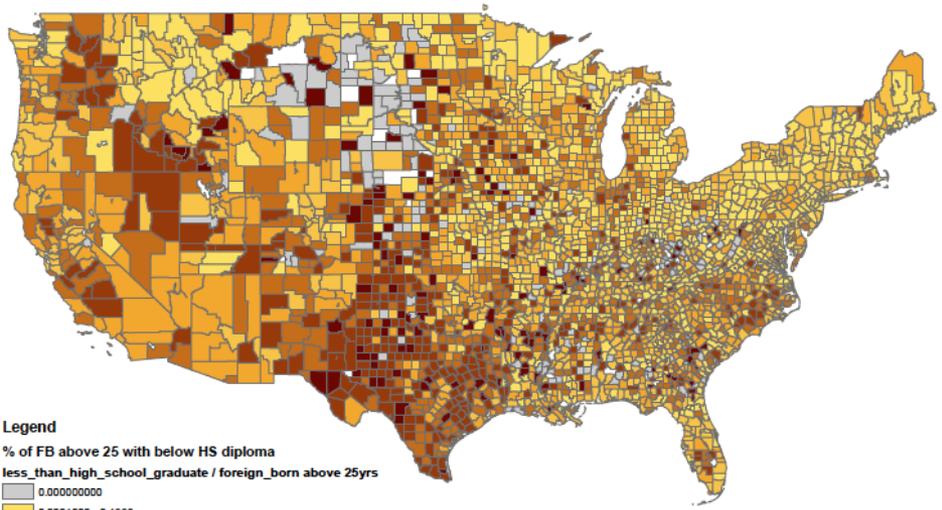
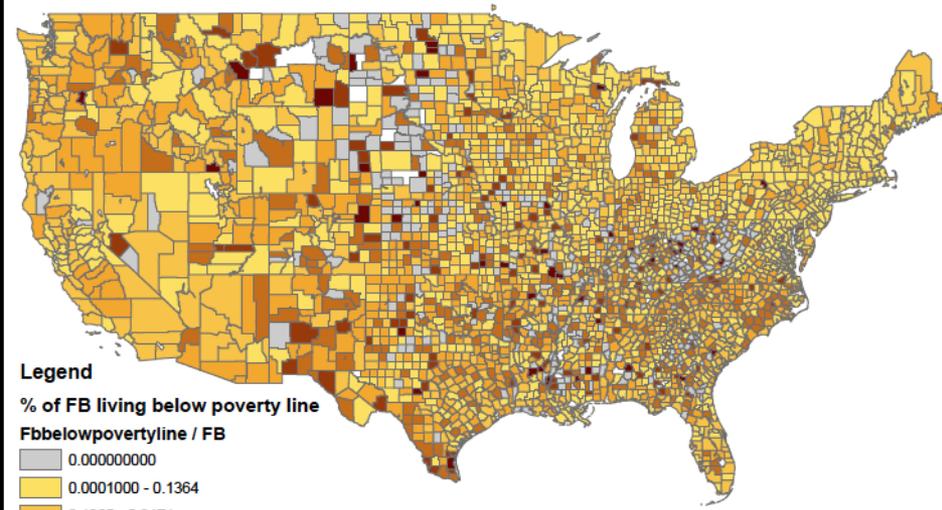
# Identifying Vulnerable FB Populations

## FB Income

## FB Education

% of FB living at or below poverty line

% of FB above 25 with less than HS diploma





## 4. Evaluation of Conditions in the U.S.

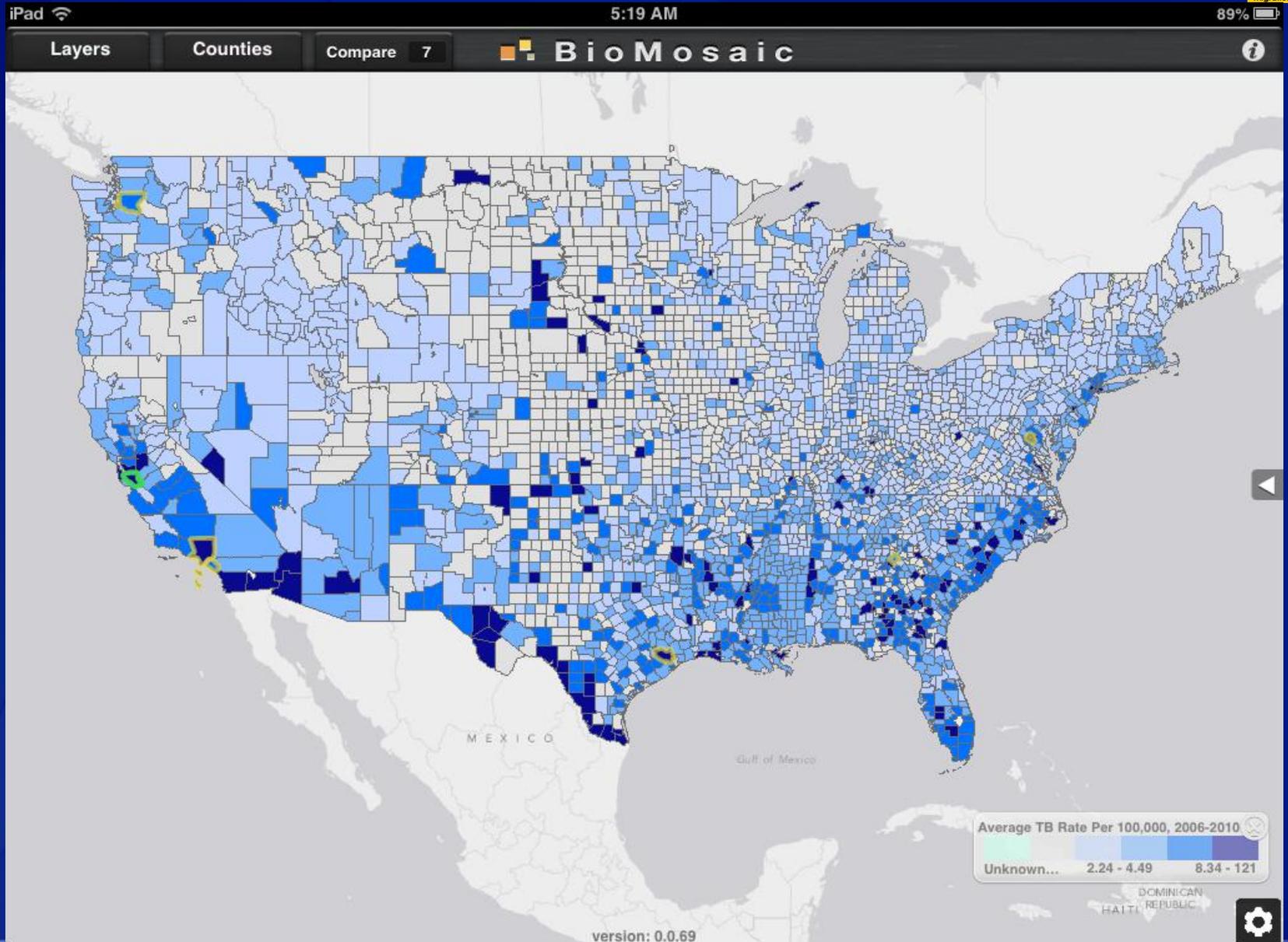
- ❑ The Census estimated there were 478,477 Haitians living in 33 states (138 counties) and the District of Columbia
- ❑ Florida (15 counties) and New York (14 counties) had 384,760 Haitians (79%)
- ❑ Median income for Foreign Born in those counties was \$26,121 compared to overall county median income of \$30,969
- ❑ In the counties with Haitians, there were 33,178,994 children less than 18 living below poverty
- ❑ Of the children living below poverty, 20% were living with 2 foreign born parents



## 5. Analysis to Determine CDC Intervention

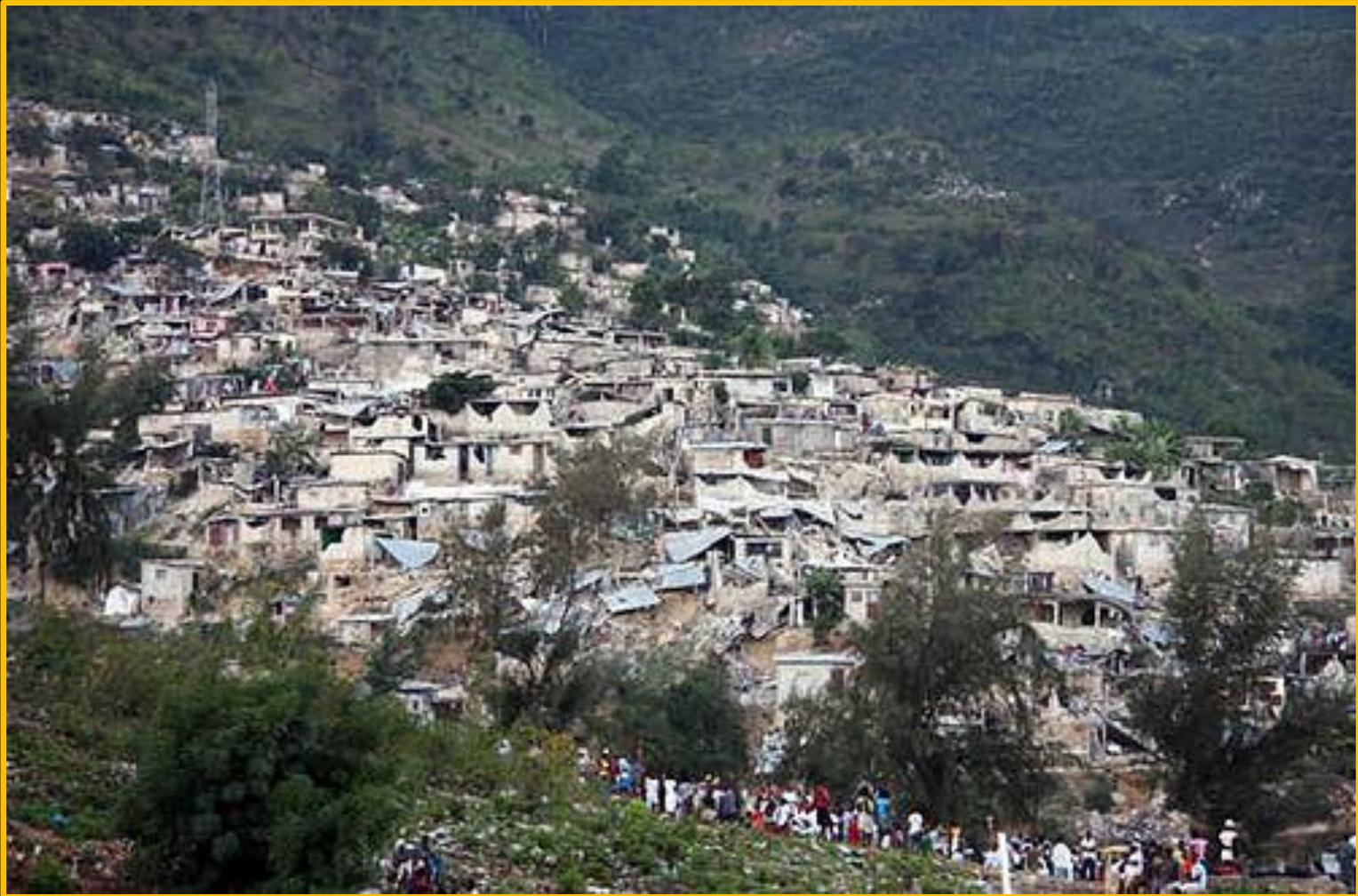
- ❑ Increase the awareness of clinicians to identify cases
- ❑ Perform targeted surveillance and screening activities to selected communities based on their demographics.
- ❑ Provide medical treatment and pre-travel consultation when applicable

# USA County TB rates / 100K 2006-2010

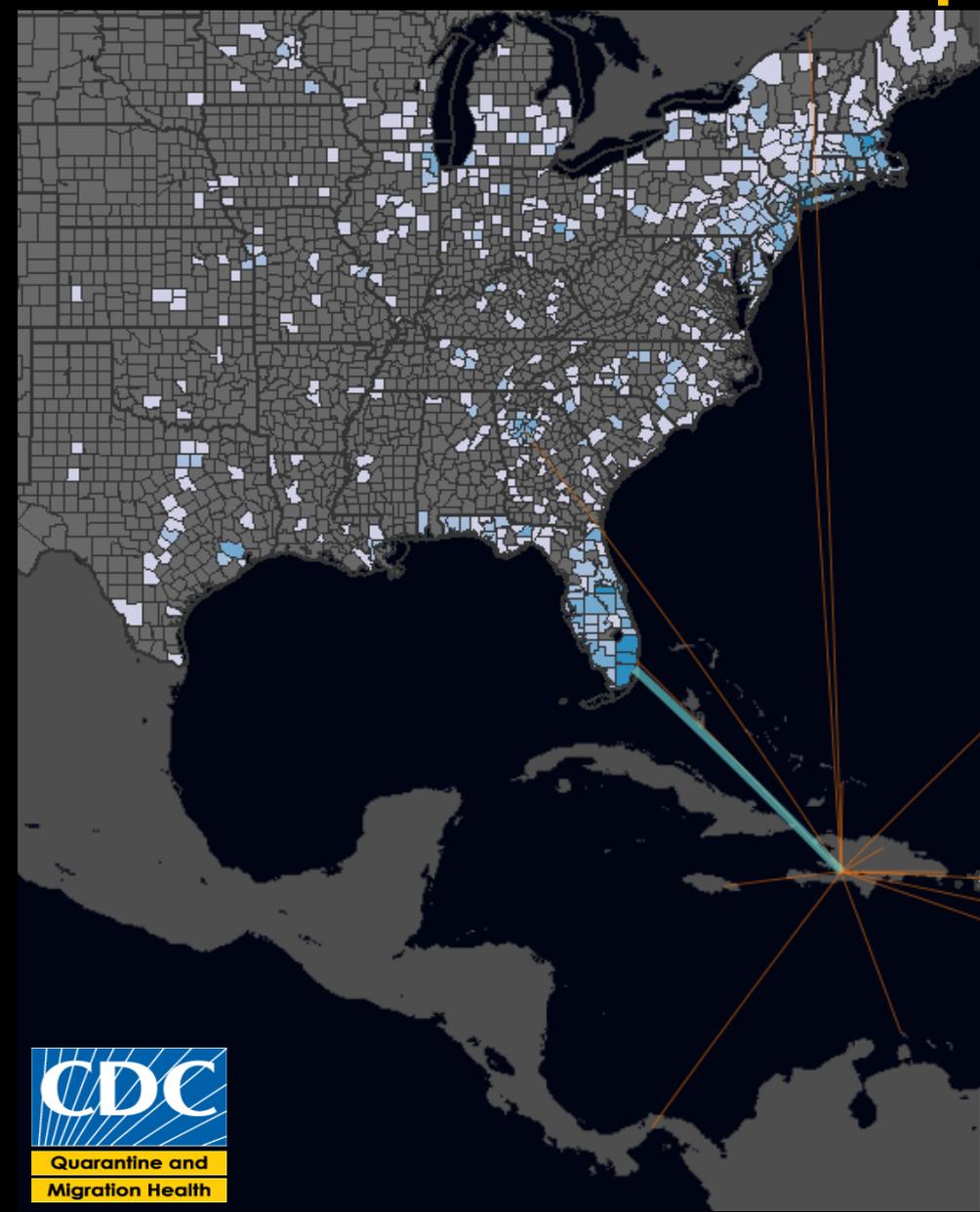


# Haiti 2010-2012

## Earthquake & Cholera Outbreak



# Haiti: Transportation Networks



International Passengers
International Flight
US Domestic Passengers

Outbound: →

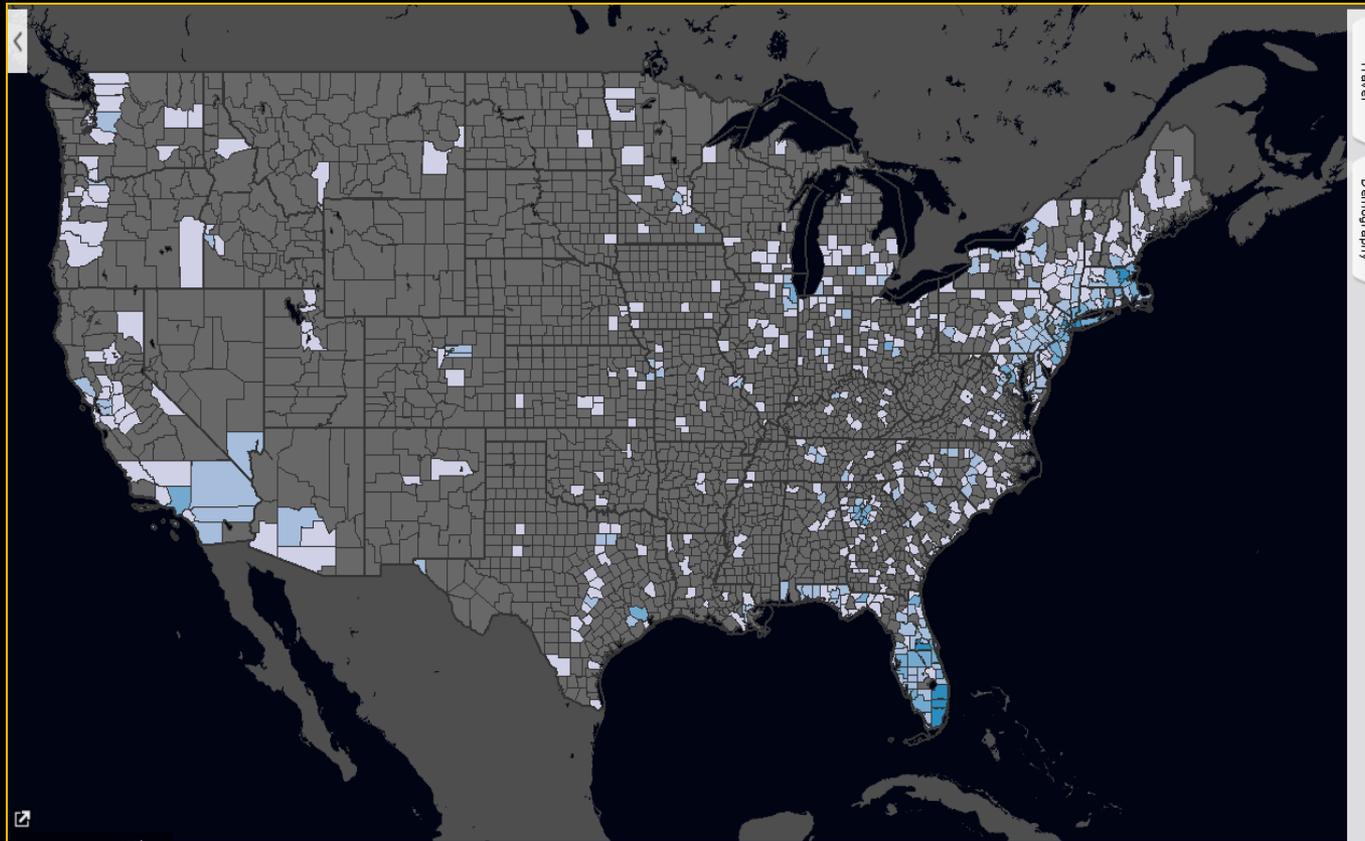
Inbound:

Search: 
 Seats

Direct international flights from Port au Prince, Haiti to:

City	Country	Distance (km)	Fly Time	Seats	Rank
Aruba	Aruba	741	3h, 50m	1,178	16
Montreal	Canada	3,603	4h, 20m	10,972	8
Santo Domingo	Dominican Republic	271	45m	35,346	5
Santiago	Dominican Republic	211	45m	2,489	11
Punta Cana	Dominican Republic	442	2h, 45m	2,147	12
Paris	France	9,579	8h, 50m	5,744	10
Pointe-a-Pitre	Guadeloupe	1,229	1h, 45m	56,134	4
Kingston	Jamaica	501	1h, 30m	1,200	15
Fort de France	Martinique	1,334	2h, 30m	1,870	14
St Maarten	Netherlands Antilles	1,037	1h, 40m	15,600	7
Panama City	Panama	1,359	2h, 14m	22,140	6
Providenciales	Turks & Caicos Islands	384	45m	1,980	13
Miami	United States	1,235	2h, 15m	331,516	1
New York	United States	2,876	4h, 15m	166,092	2
Fort Lauderdale	United States	1,262	2h, 10m	152,416	3
Atlanta	United States	2,323	3h, 22m	5,784	9

# BioMosaic: Cholera Outbreak in Haiti



- ❑ In February 2012 DGMQ received a request from the states asking where Haitians lived in the United States
- ❑ DGMQ monitored reports of diseases in Haiti to determine what may be introduced into Haiti or brought back to the states from travelers to Haiti

# WHO Emergency Committee for MERS-CoV

Analysis of Worldwide Commercial Air Travel Patterns from June - November 2012

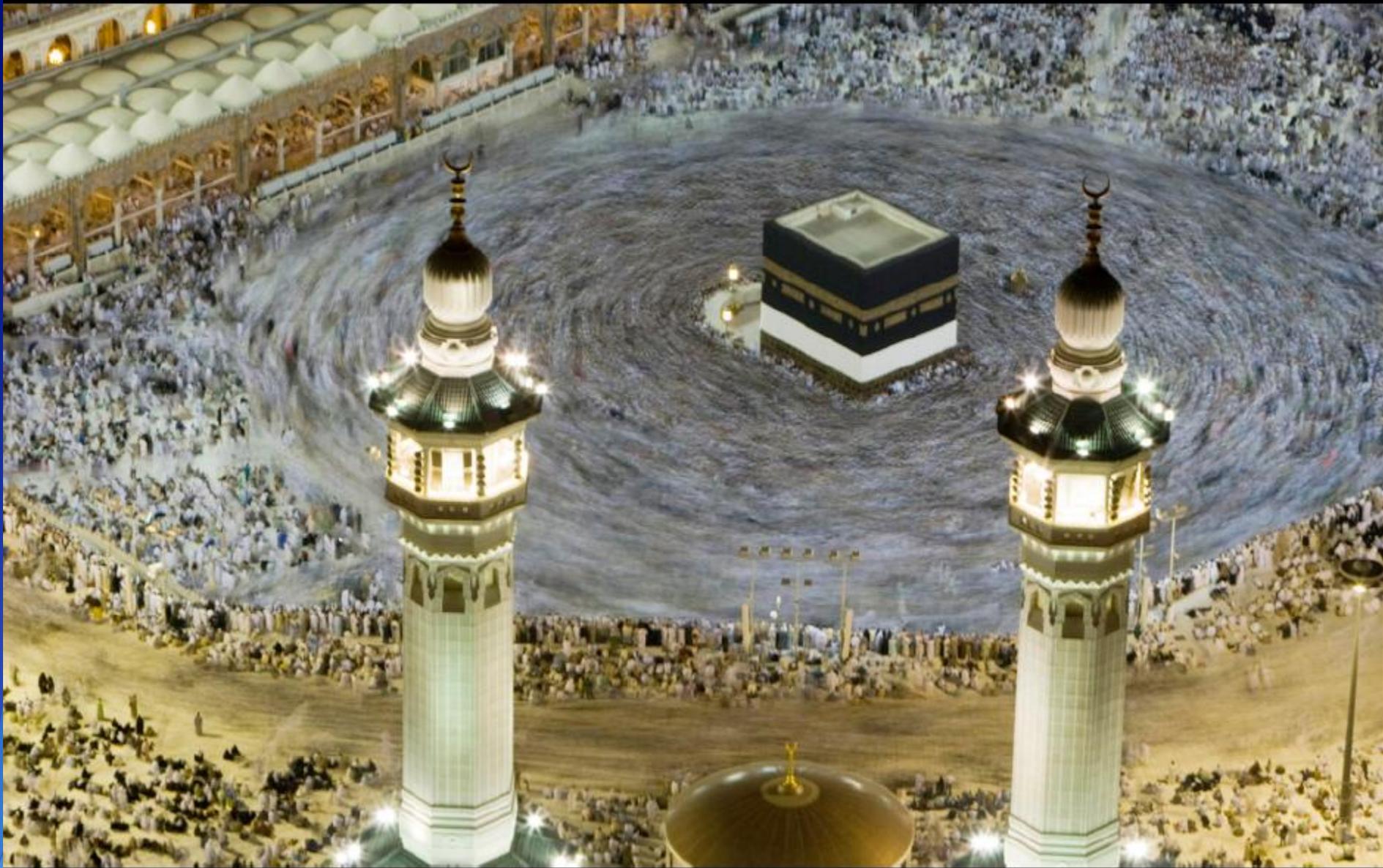


Kamran Kahn et.al.

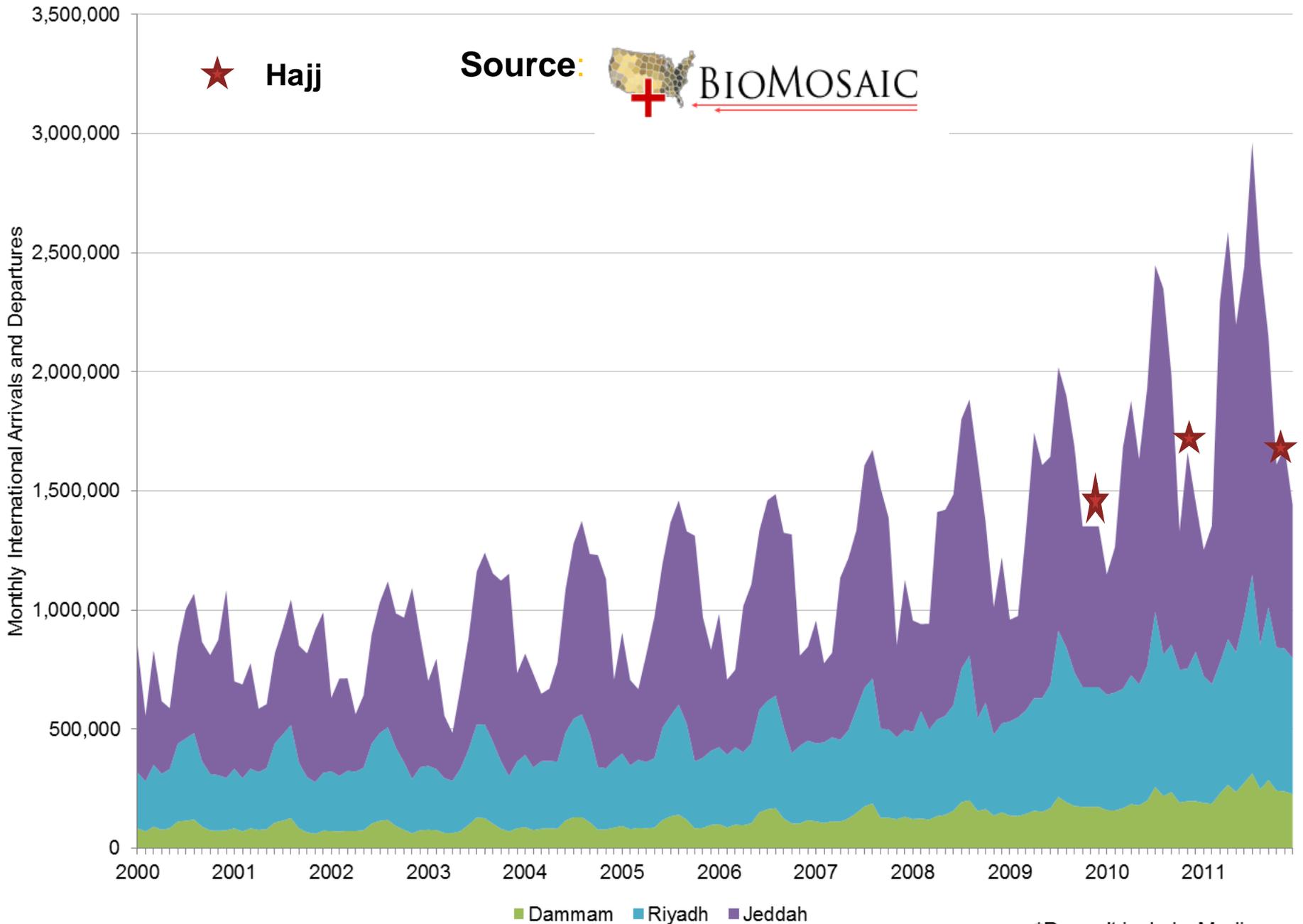
"Potential for the International Spread of Middle East Respiratory Syndrome in Association with Mass Gatherings in Saudi Arabia"

**PLOS Currents Outbreaks: July 17, 2013**





# Saudi Arabia: Historic Trends in International Passenger Traffic

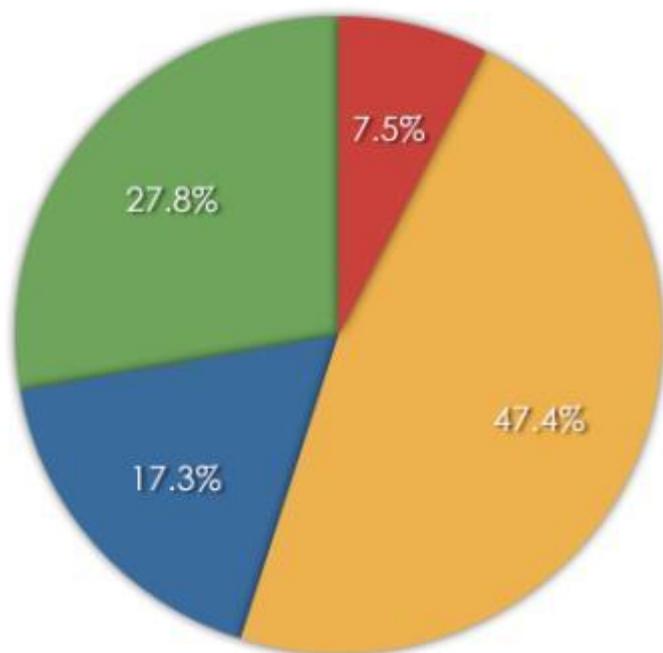


# Methods

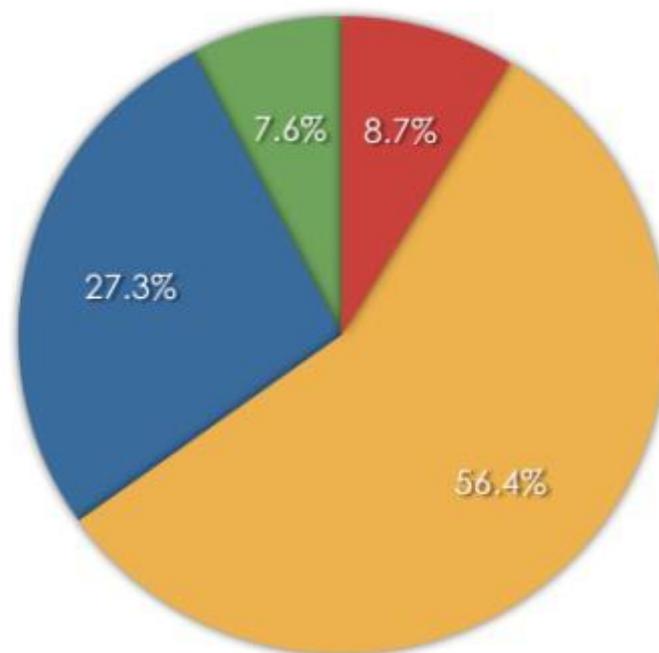
- Worldwide analysis of final city-level destinations of travelers departing any domestic or international airport in Saudi Arabia, Jordan, Qatar and UAE between June and November 2012 using flight itinerary data from International Air Transport Association
- Time frame corresponds to approximately one month before Ramadan and one month after Hajj (Eid-al-Adha) in 2013
- Includes travelers on all commercial and scheduled charter flights but not unscheduled charter flights (often used by Hajj pilgrims)
- Hajj pilgrim volumes derived from Saudi estimates in published literature and Ministry of Hajj national Muslim population estimates
- World Bank Income Classification (2012) and World Bank estimates of Healthcare Expenditures per Capita (2011) included as crude surrogate markers of medical and public health capacity

# Final Destinations of Air Travelers Departing Saudi Arabia, Jordan, Qatar & UAE from June to November 2012 and Origins of Foreign Hajj Pilgrims by World Bank Income Classification

Destinations of Air Travelers  
(N=16.8 million)

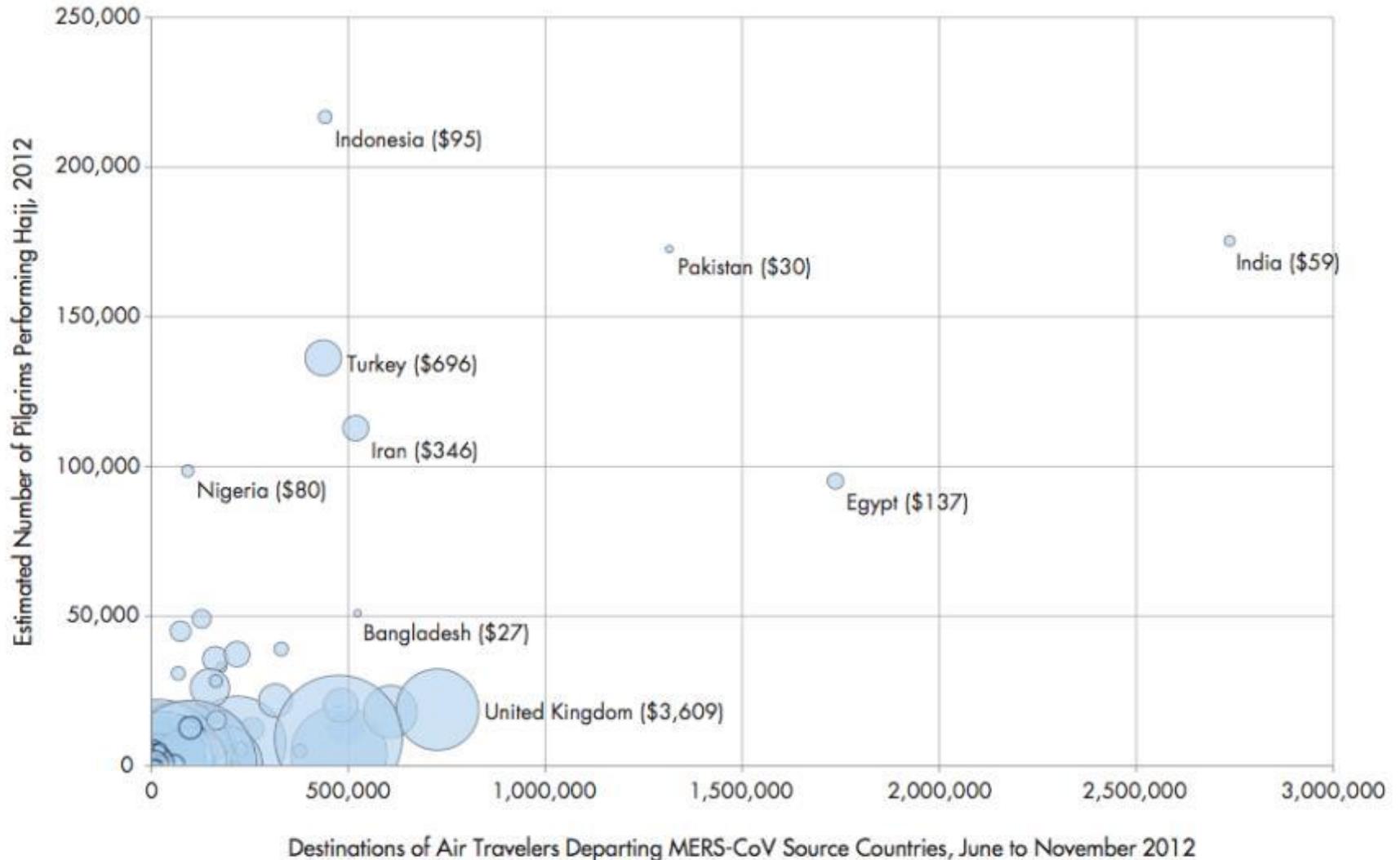


Origins of Foreign Hajj Pilgrims  
(N=1.75 million)



● Low Income ● Lower-Middle Income ● Upper-Middle Income ● High Income

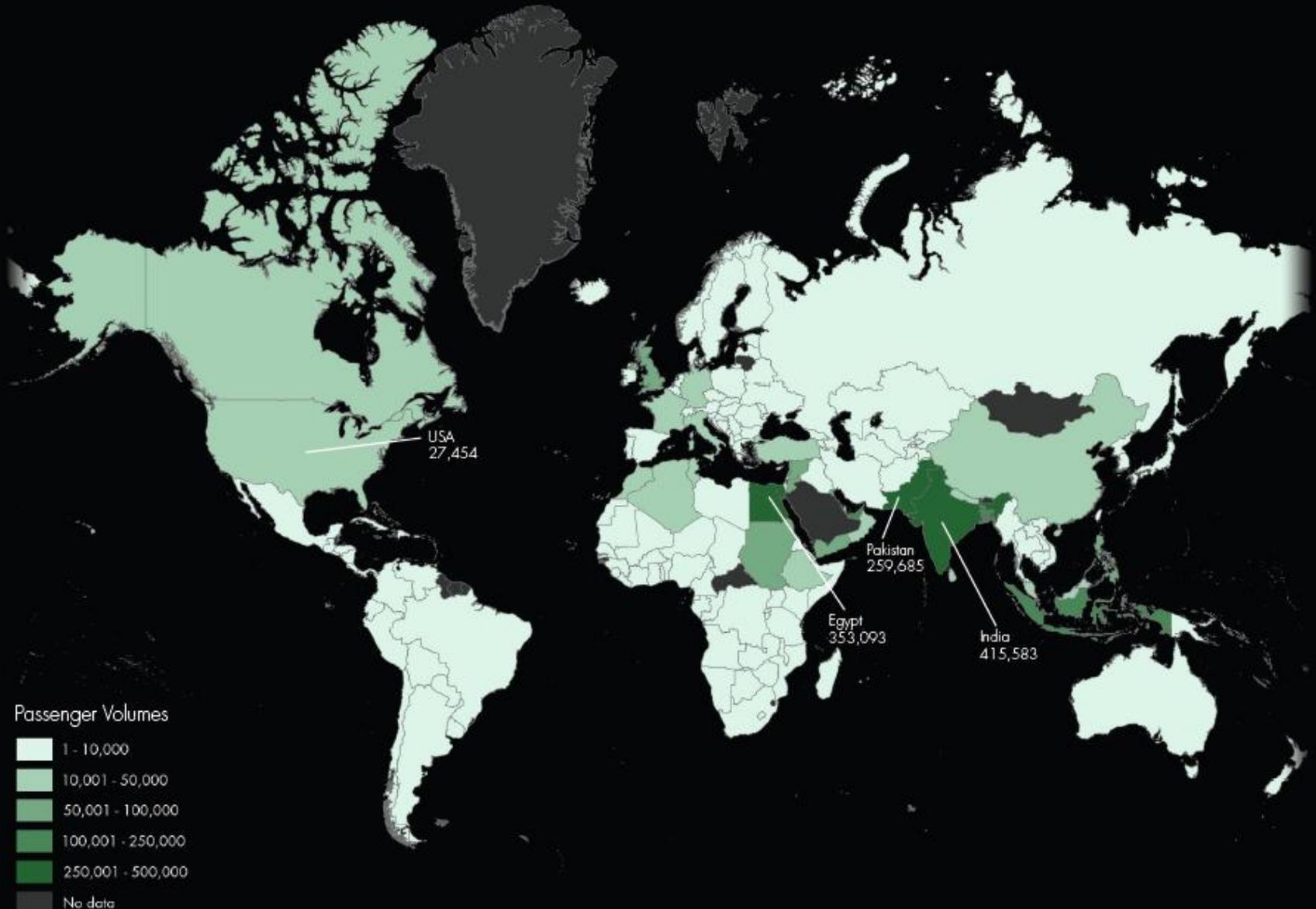
# Final Destinations of Air Travelers Departing Saudi Arabia, Jordan, Qatar, UAE from June to November 2012, Estimated Hajj Pilgrims by Country, and National Healthcare Expenditures per Capita in 2011



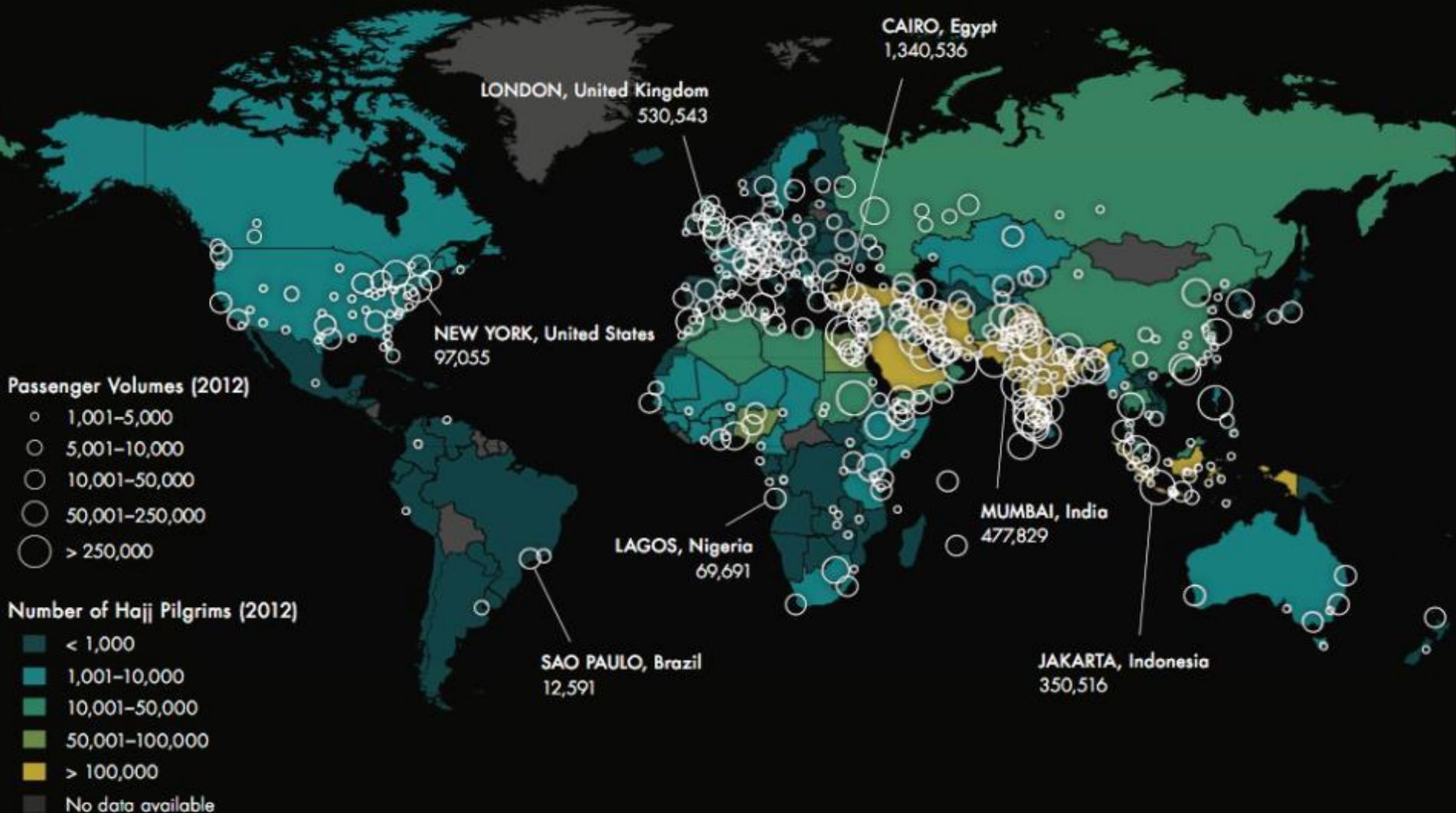
Note: Bubble size represents healthcare expenditure per capita (World Bank, 2011)

# Global Passenger Volumes Departing Saudi Arabia

October - December 2010

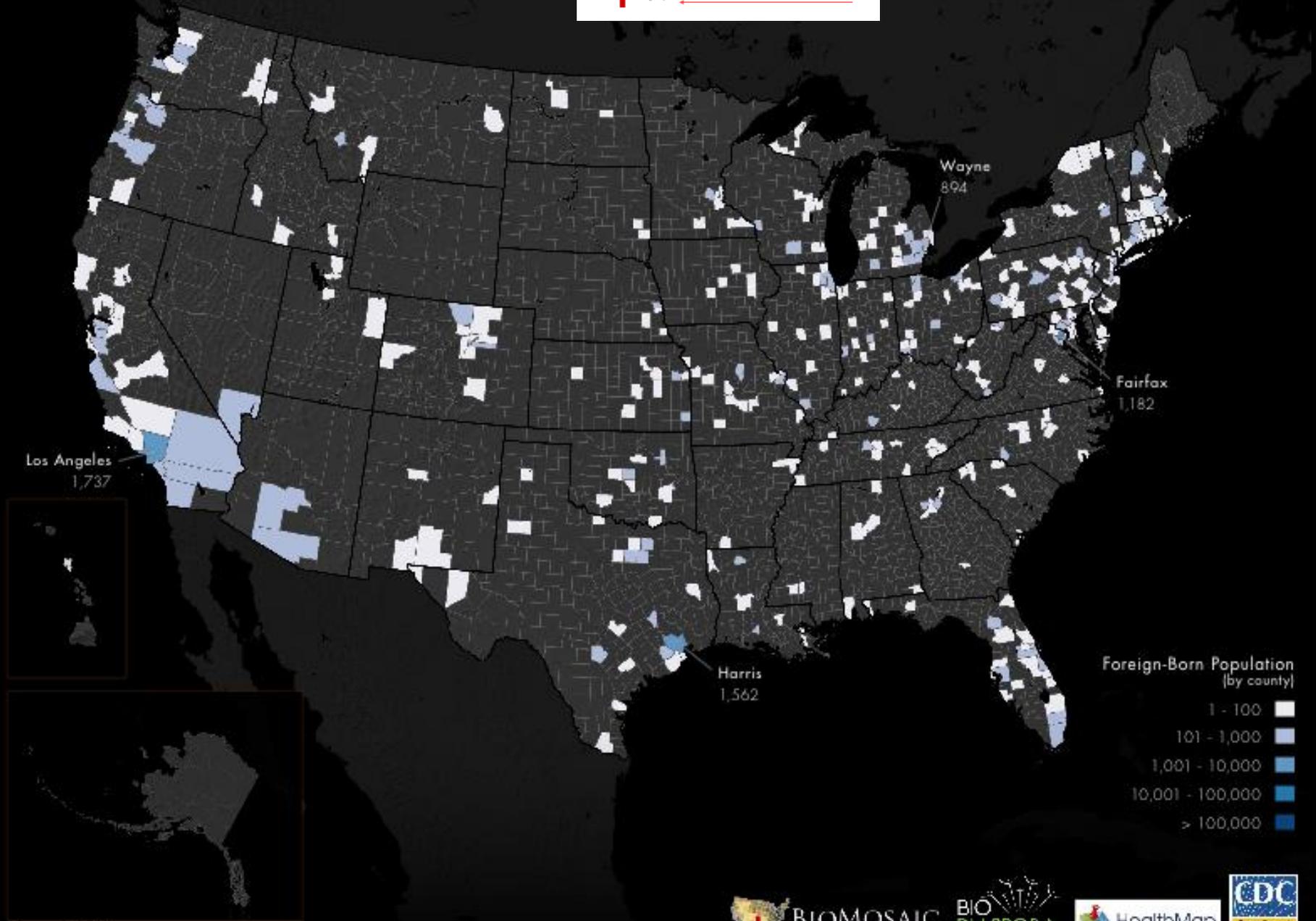


# Final City Destinations of Air Travelers Departing Saudi Arabia, Jordan, Qatar, and UAE from June to November 2012 & Estimated Hajj Pilgrims by Country



# Foreign-Born Population by County

Saudi Arabia



Foreign-Born Population  
(by county)

- 1 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 100,000
- > 100,000

Los Angeles  
1,737

Wayne  
894

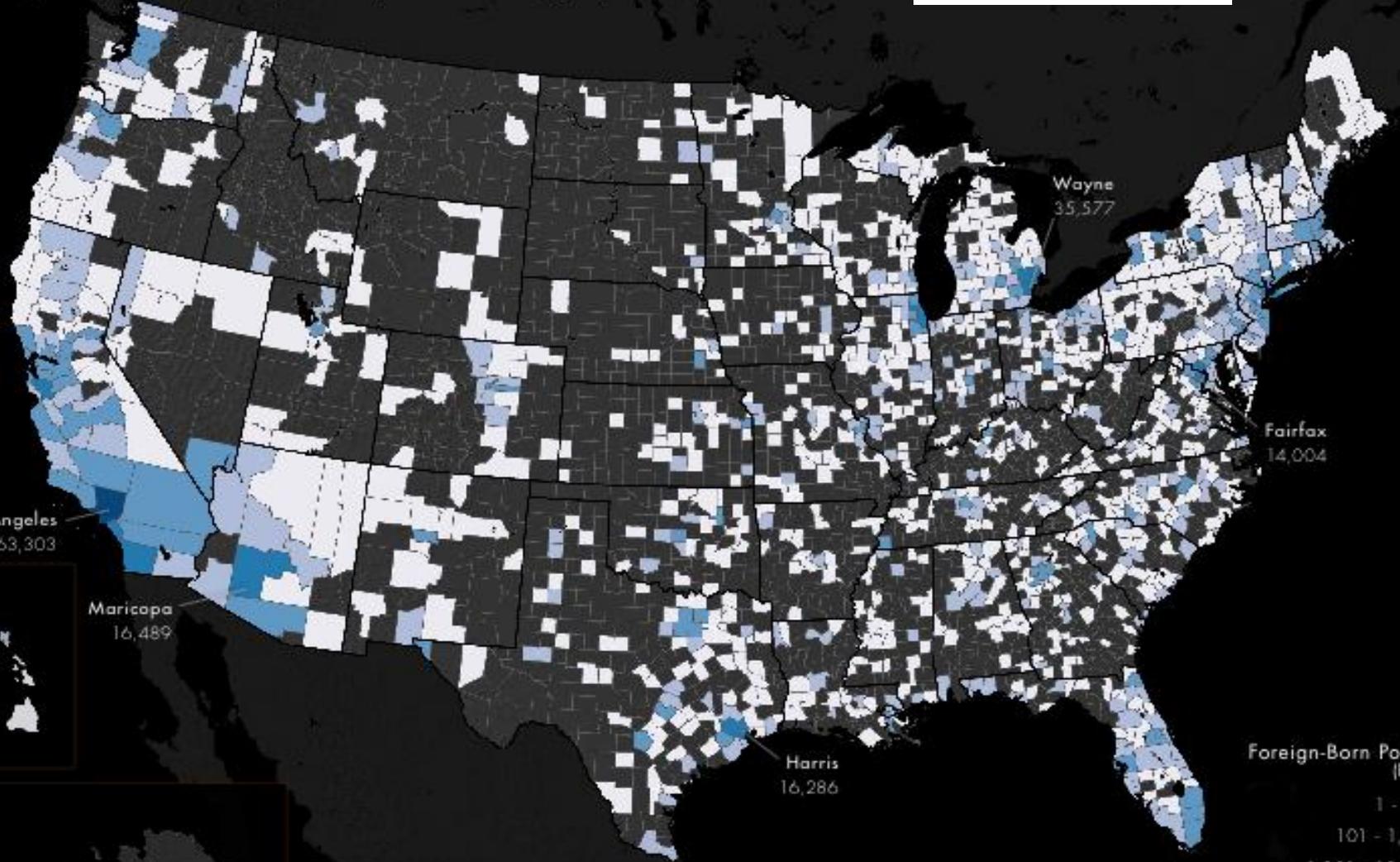
Fairfax  
1,182

Harris  
1,562

Data source: ACS, 2011

# Foreign-Born Population by County

Iraq, Iran, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia, Syria, Yemen



Foreign-Born Population  
(by county)

- 1 - 100
- 101 - 1,000
- 1,001 - 10,000
- 10,001 - 100,000
- > 100,000



Data source: ACS, 2011



# Key Findings

- Of all travelers departing Saudi Arabia, Jordan, Qatar and UAE from June to November 2012 on commercial flights
  - 51.6% had final destinations in 8 countries
  - 27.2% had final destinations in India, Pakistan or Bangladesh, more than 10 times the air traveler volume to Indonesia
  - 54.9% had final destinations in low or lower-middle income countries
- Of all Hajj pilgrims in 2012 an estimated
  - 60.7% had final destinations in 8 countries
  - 65.1% had final destinations in low or lower-middle income countries
  - 400,000 originated from India, Pakistan or Bangladesh, nearly twice the number of pilgrims from Indonesia (world's largest Muslim nation)

# Beware Illusion of Knowledge



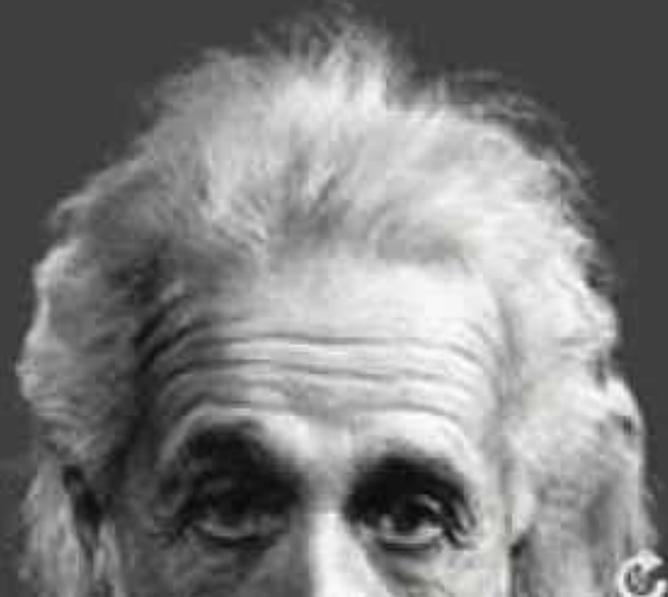
The greatest enemy of  
knowledge is not ignorance,  
it is the illusion of knowledge.

–Stephen Hawking

# Value Simplicity

Any fool can make things bigger, more complex, and more violent. It takes a touch of genius—and a lot of courage—to move in the opposite direction.

$$E=mc^2$$







## CDC / DGMQ



### Marty Cetron, MD (PI)

- Gaby Benenson
- Yoni Haber
- Ginny Lee
- Kevin Liske
- Clelia Pezzi
- Alfonso Rodriguez

## HealthMap



### John Brownstein, PhD (PI)

- James Power
- David Scales

## BioDiaspora



### Kamran Khan, MD (PI)

- Rose Eckhardt
- Langhi Shen
- Graham Smith

# BioMosaic Web Application Demo

