

# GIS and Public Health

Special thanks to Dr. Kimberly Brouwer and Adrienne Perry for content/slide contributions

# Back in the old days...

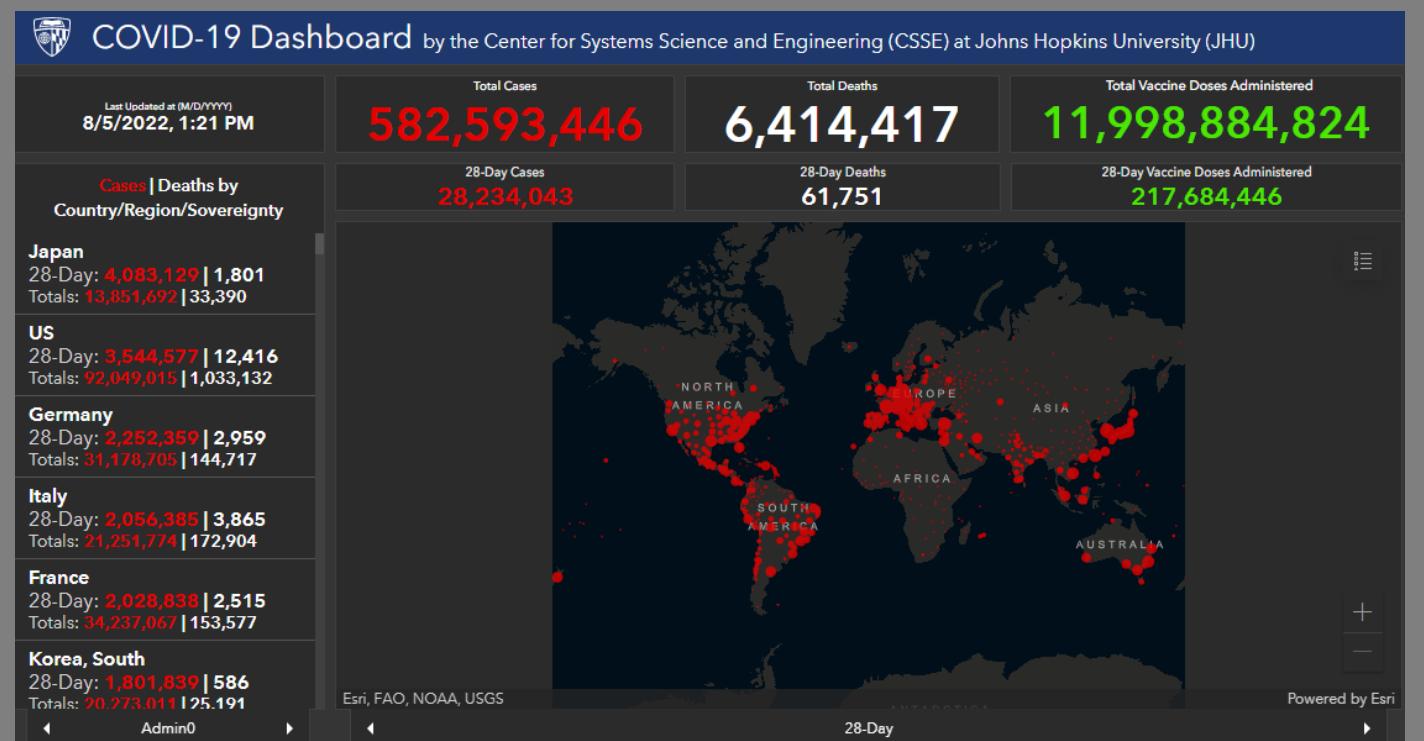
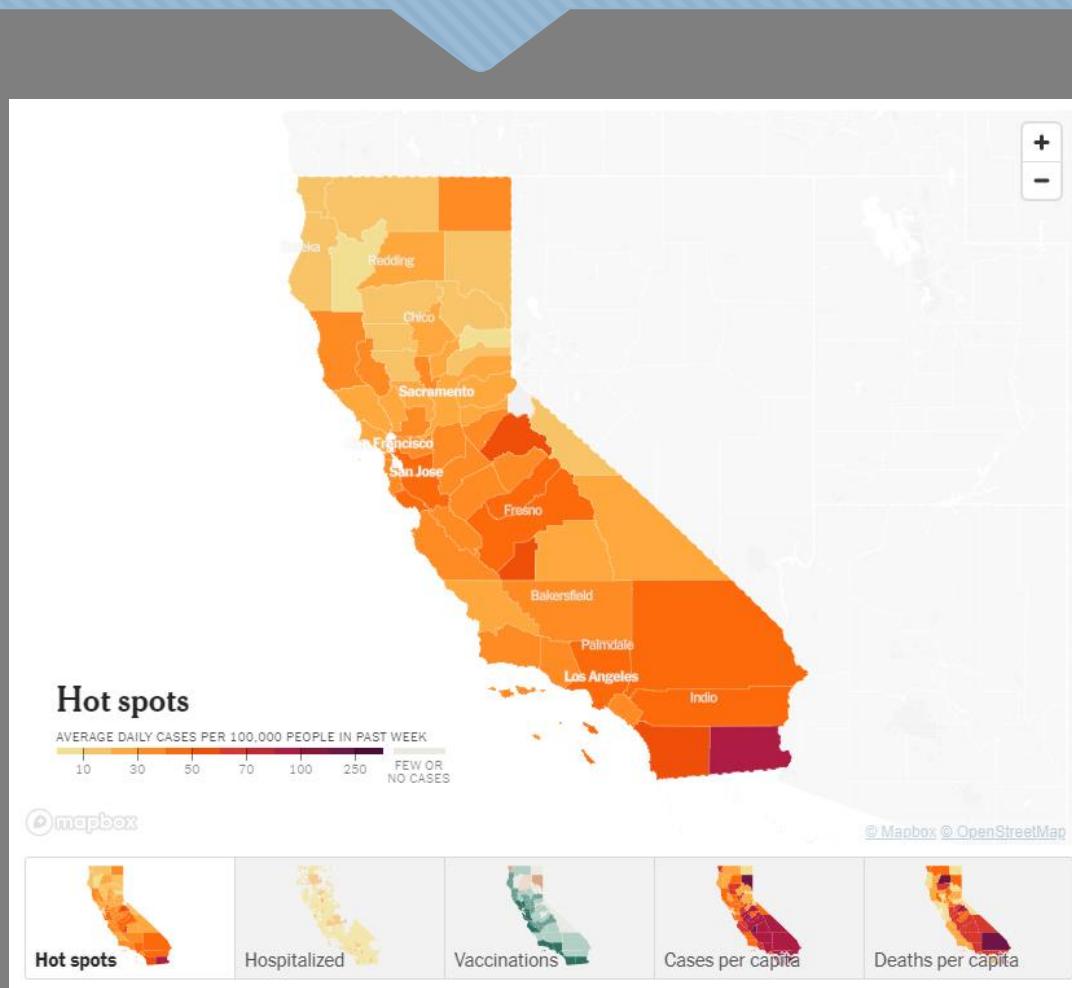
“Looking toward the 21<sup>st</sup> century, we anticipate that health planning, particularly at the community level, will be substantially improved by developments in informatics... believe that geographic information system (GIS) technology will be an important part of the toolkit to support this capability, but only if epidemiologic principles and methods provide the foundation for the data analyses to be displayed in GIS maps.”

“In a 1997 survey of state Vital Statistics Project Directors, only 21 of 49 respondents reported that their states had some type of automated geocoding of vital statistics.”

[Geographic Information Systems and Public Health: Mapping the Future](#)

THOMAS B. RICHARDS, MD, CHARLES M. CRONER, PHD, GERARD RUSHTON, PHD, CAROL K. BROWN, MS, LITTLETON FOWLER, DDS

# And today...



# Urban Planning & Public Health

## Urban Planning and Public Health at CDC

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Making Great Communities Happen

### Planning for Public Health

Across the U.S., local governments are beginning to include goals and objectives that promote public health into their comprehensive plans. These long-term plans impact how people make choices of where to live and how to get around, their ability to access healthy foods and opportunities for physical activity, and affect broader issues of social equity, clean air and water, and more.



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### Media centre

### Urban planning essential for public health

News release

7 APRIL 2010 | GENEVA - Urban settings have a direct impact on the health of the people who live there. On World Health Day WHO is launching a campaign to highlight urban planning as a crucial link to building a healthy 21st century. In particular, the Organization calls upon municipal authorities, concerned residents, advocates for healthy living and others to take a close look at health inequities in cities and take action.

# Intersection of Urban Planning & Public Health

Creation of **green space** to promote physical activity, social integration, and better mental health

Prevent infectious diseases through community infrastructure (e.g. sewage)

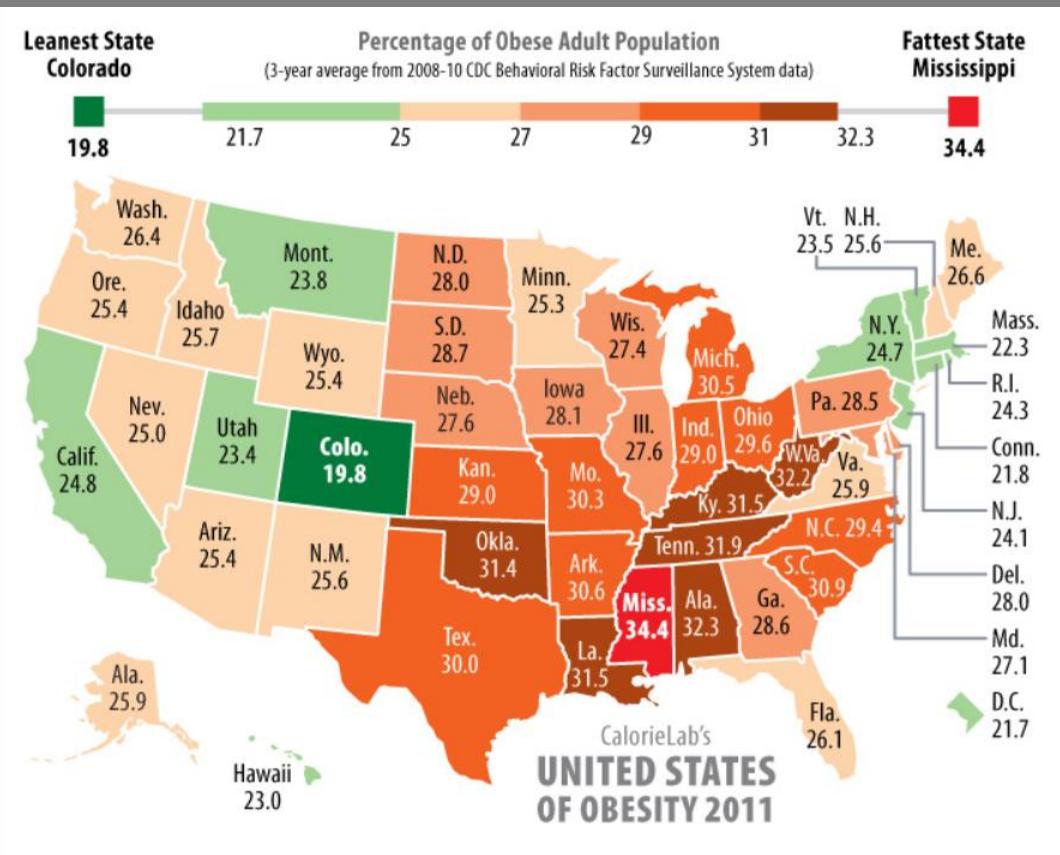
Protection from hazardous industrial **exposures** and injury risks through land-use and zoning ordinances

Transportation planning to improve air quality and promote wellness

Effects of community design on **energy use** and greenhouse gases

Emergency preparedness (e.g., evacuation planning) and **access to health care**

# Spatial Epidemiology



Field of study involving the description and analysis of geographic variations in disease with respect to demographic, environmental, behavioral, socioeconomic, genetic, and infectious risk factors

# Why map health data?

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Examine geographical extent of problem

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Accustom community to research team

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Better distribute services

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Confirm data

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Inform decision making

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Advocacy

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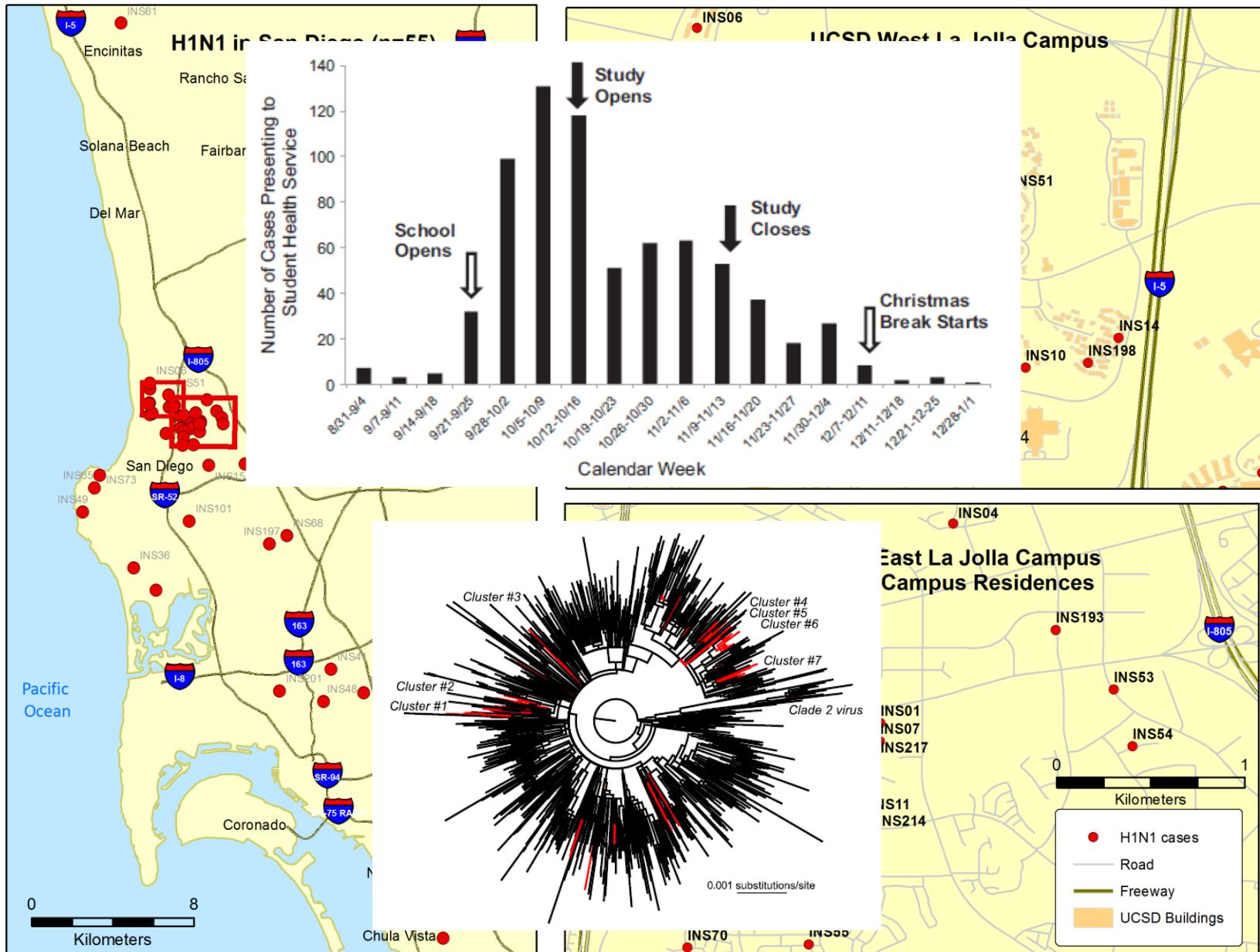
Assist health workers

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Track disease associations

# Applying mapping in public health studies

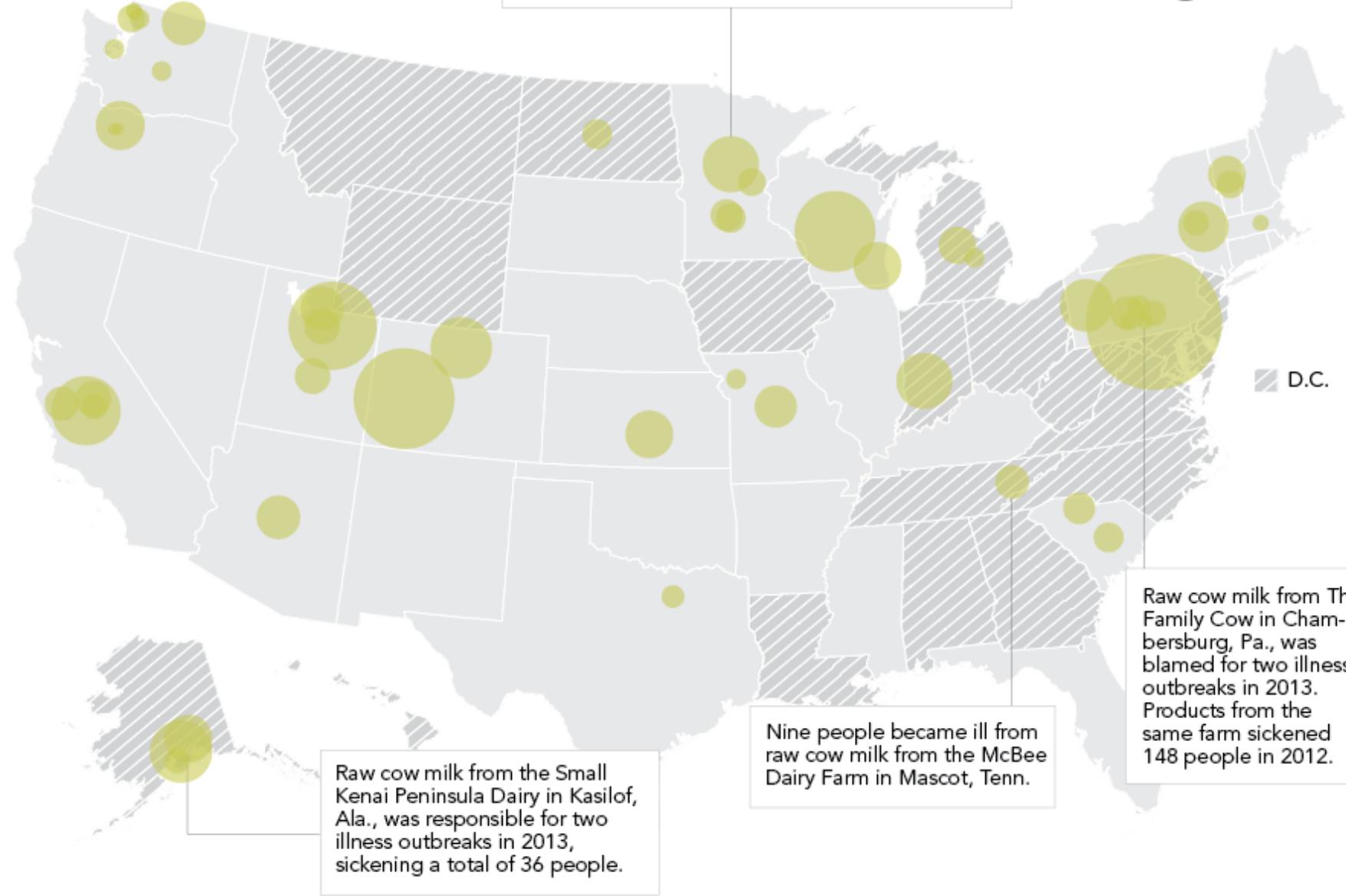
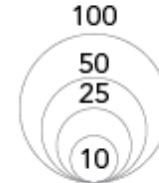
- Infectious Diseases
- Chronic Diseases
- Health Services
- Environmental Health



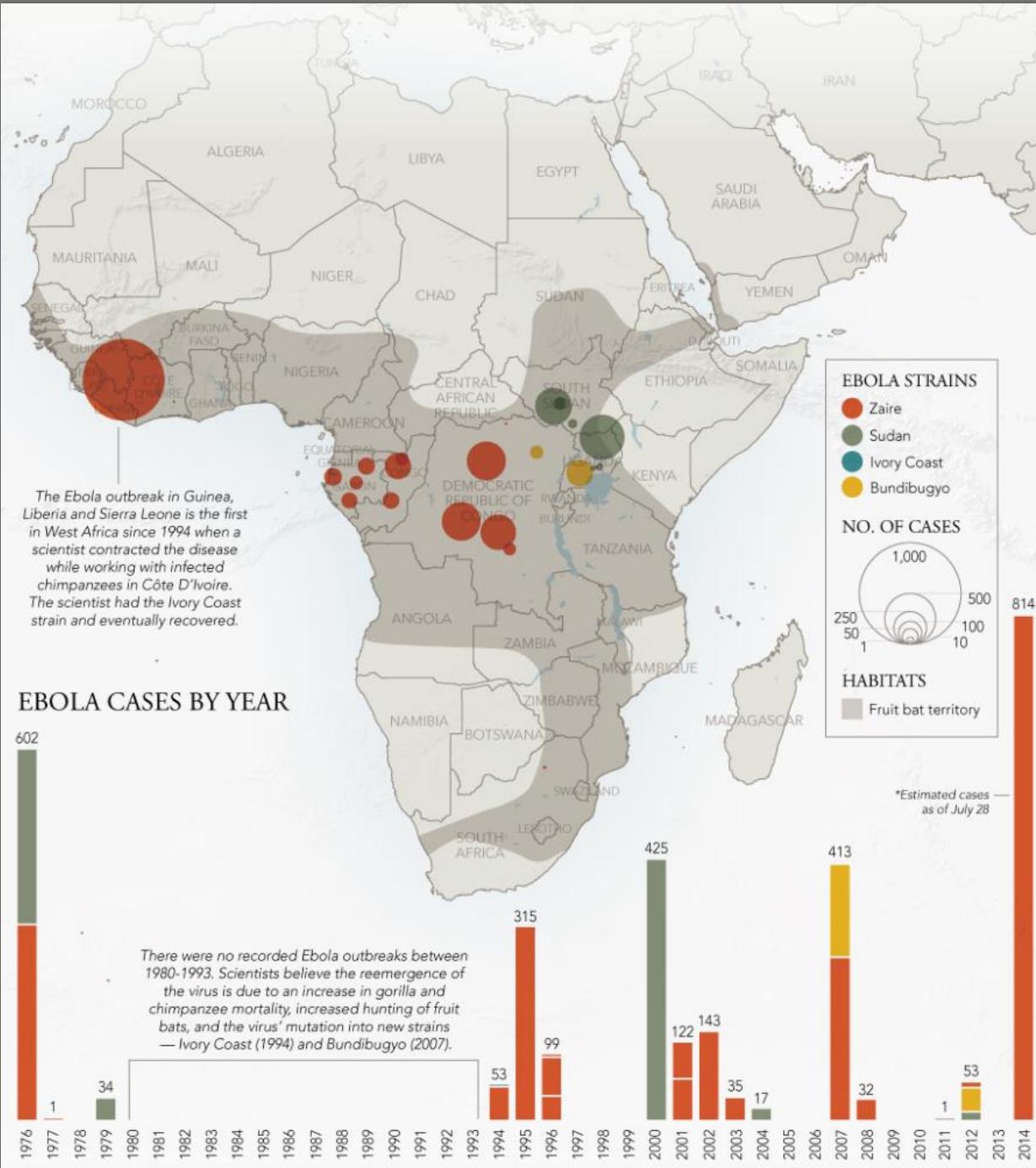
## 2009-2013 outbreaks linked to raw milk or raw milk products

Number of people sickened

- Outbreaks tied to raw milk or its products
- States where sales of some kind are legal
- States where sales are illegal\*

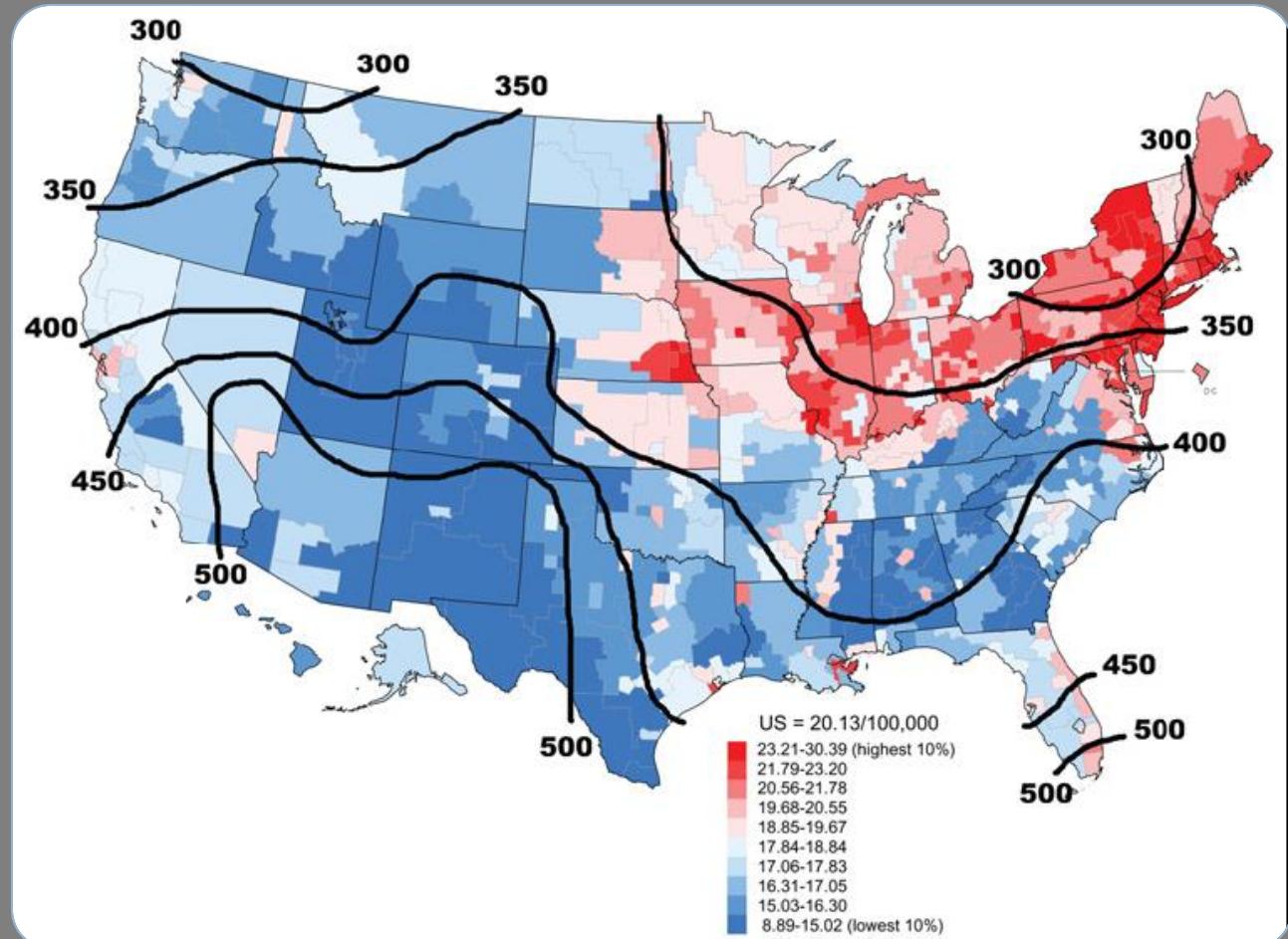


# EBOLA'S DEADLY SPREAD



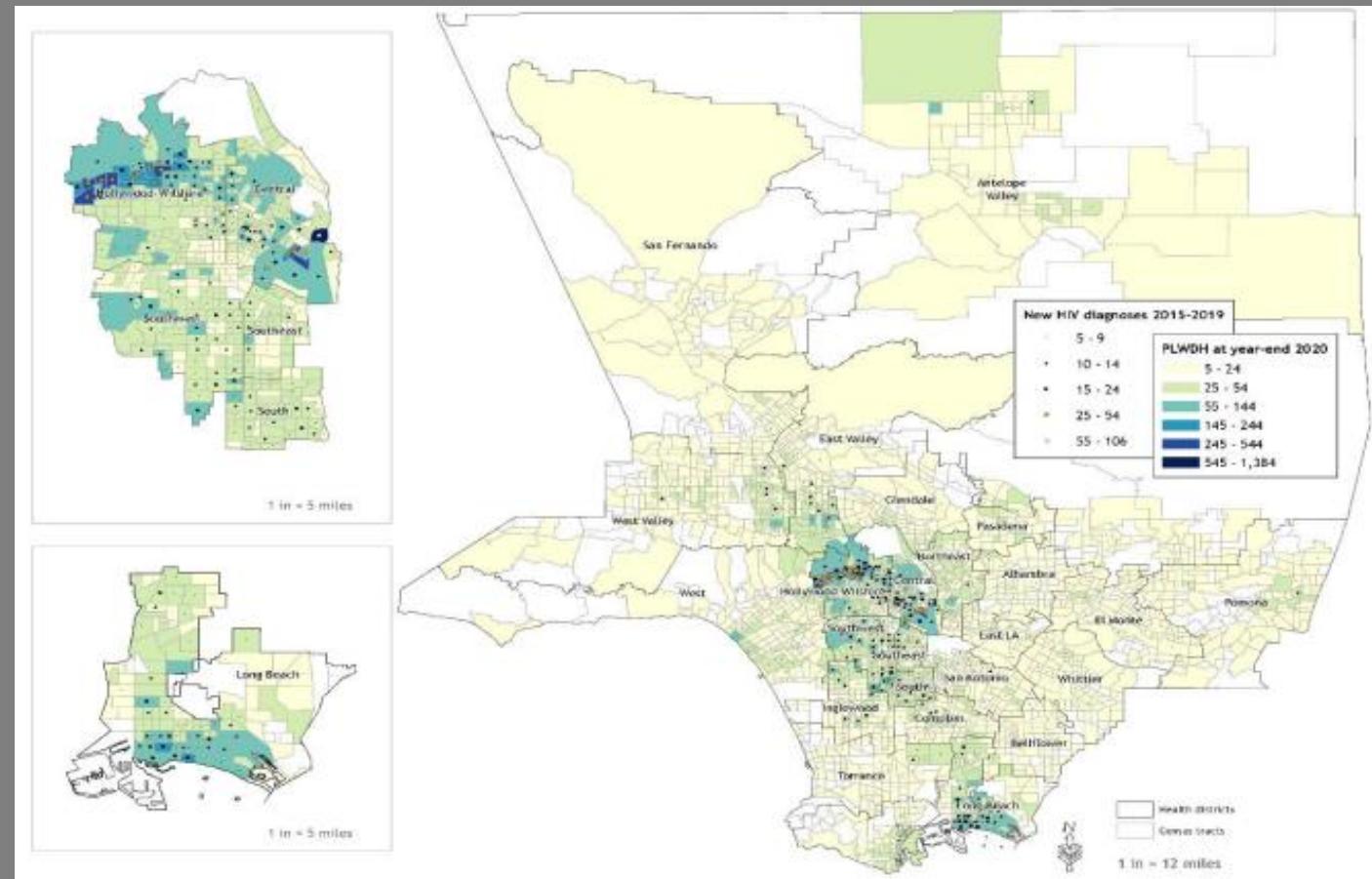
# Colon cancer mortality rates & solar irradiance

- Mortality rates age-adjusted by county
- Annual mean daily solar irradiance in Langleys (calories/cm<sup>2</sup>)
- United States, 1970–1994



# Spatial Distribution of HIV Risks & Service Access Patterns in LA County

- Explore the spatial distribution of HIV risk factors and access to care in Los Angeles County.
  - Funded by California HIV/AIDS Research Program, CH05-Drew616
- More about LA County Health Mapping:  
<http://www.publichealth.lacounty.gov/dhsp/Mapping.htm>



# Literature on Vitamin D

- Vitamin D has a beneficial effect on risk of several types of cancer
- Ultraviolet B radiation is needed to synthesize Vitamin D
- Residents in northern latitudes receive less solar ultraviolet B radiation
  - In Northeast, not enough UVB to synthesize Vitamin D from November-March
- HOW WOULD YOU USE GIS TO STUDY THIS??



FROTH AND BUBBLE

## UCSD Leads Team To Build Geographic Information System To Assess Toxic Hazards From Katrina

San Diego CA (SPX) Oct 07, 2005

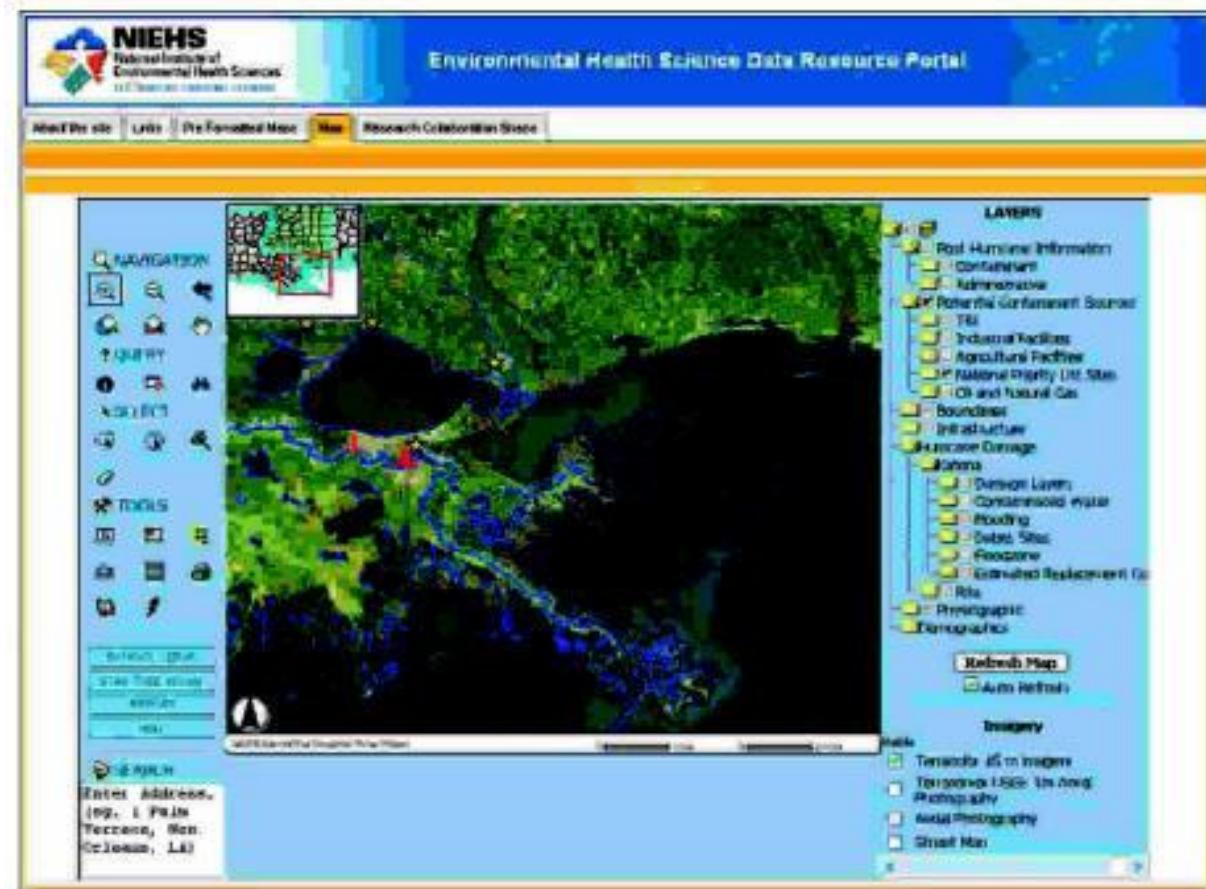
Researchers at the University of California, San Diego (UCSD) have been awarded \$760,000 from the National Institute of Environmental Health Sciences (NIEHS) to build a Geographic Information System (GIS).

This system will link to the NIEHS Hurricane Katrina Information Website, providing workers in the field and researchers with up-to-date information regarding toxicant exposure and human health.

The supplemental grant was awarded by the NIEHS to the UCSD Superfund Basic Research Program (SBRP), directed by Robert Tukey,

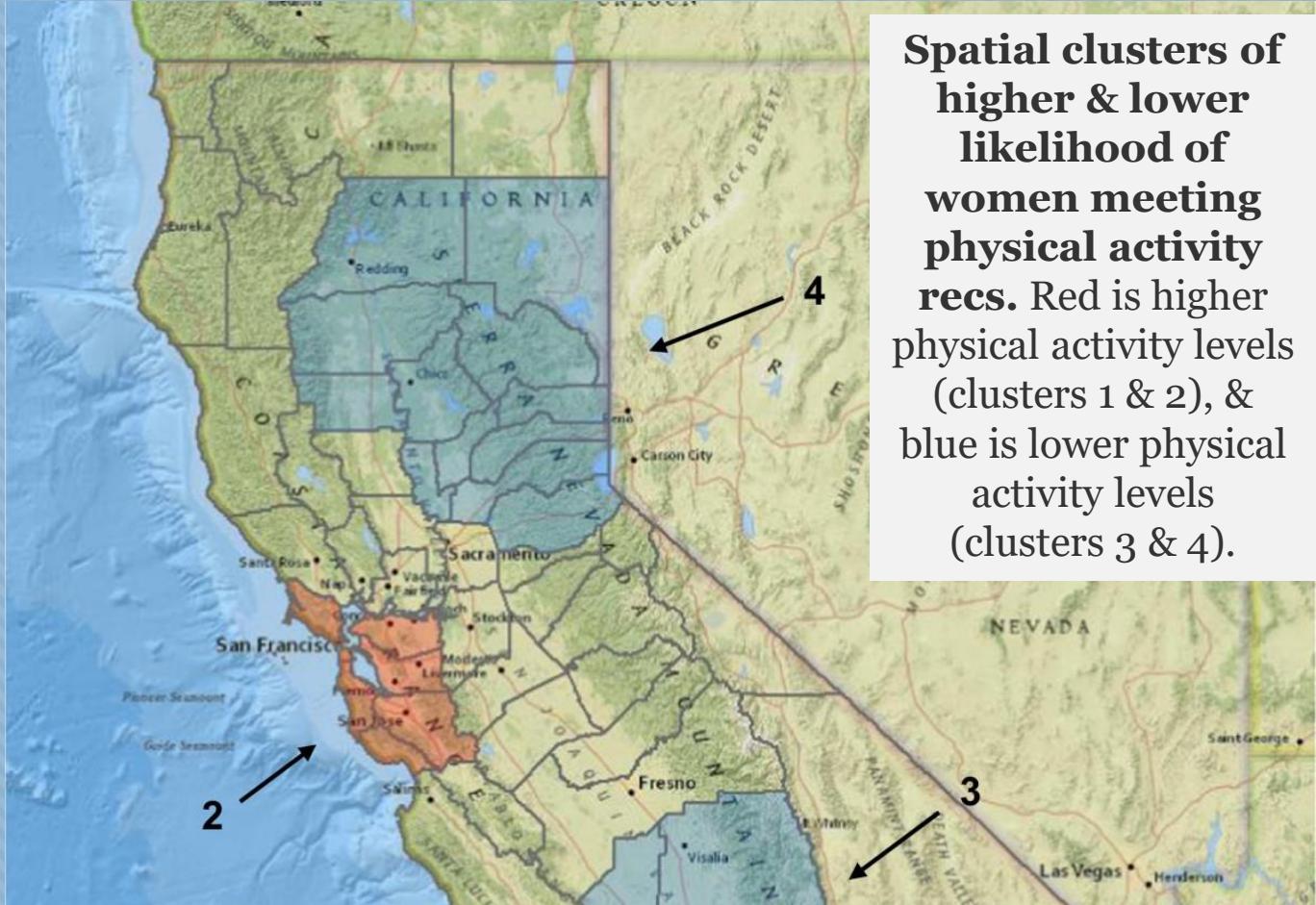


"Within days of the hurricane hitting New Orleans and the Gulf Coast, we realized that a one-stop shop for data, knowledge and tools would be valuable to



# ANALYZING HEALTH & PHYSICAL ACTIVITY

Spatial clustering of physical activity and obesity in relation to built environment factors among older women in three U.S. states



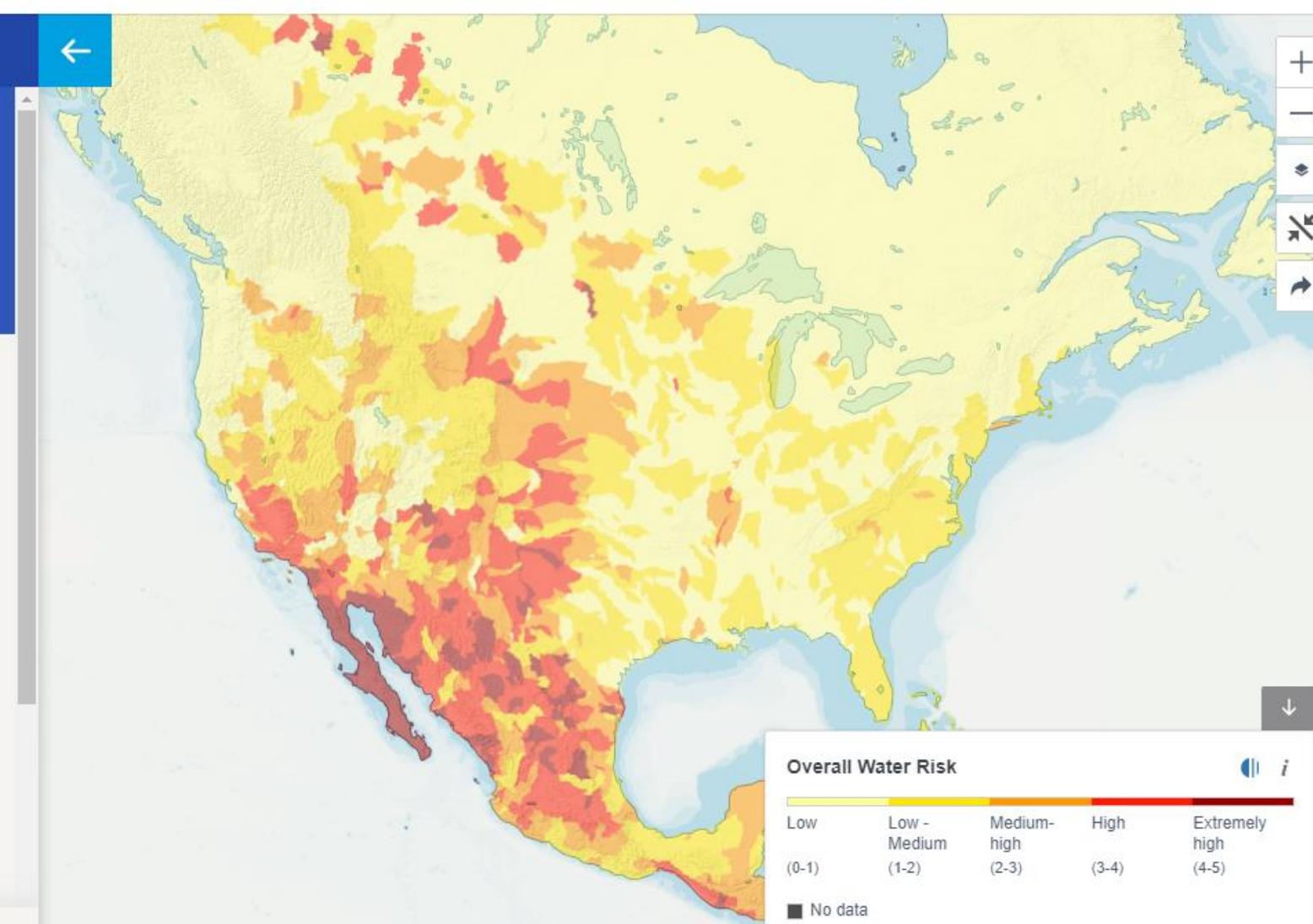
	Area: Counties	Radius (km)	Participants	Cases <sup>a</sup>	Relative risk	P-value
<b>Physical activity clusters in California</b>						
Cluster 1	<b>Coastal area:</b> San Luis Obispo, Santa Barbara	96.74	232	88	1.51	0.0024
Cluster 2	<b>Bay Area:</b> San Francisco, Santa Clara, Santa Cruz, Alameda, San Mateo, Marin, Contra Costa	73.19	1837	527	1.17	0.035
Cluster 3	<b>South inland:</b> Tulare, Kern Kings	121.09	129	14	0.42	0.0027
Cluster 4	<b>North inland:</b> Lassen, Shasta, Tehama, Plumas, Butte, Glenn, Sierra, Yuba, Nevada, Placer, Sutter, El Dorado	139.21	385	71	0.71	0.047

BASELINE FUTURE PRIORITIZE BASINS

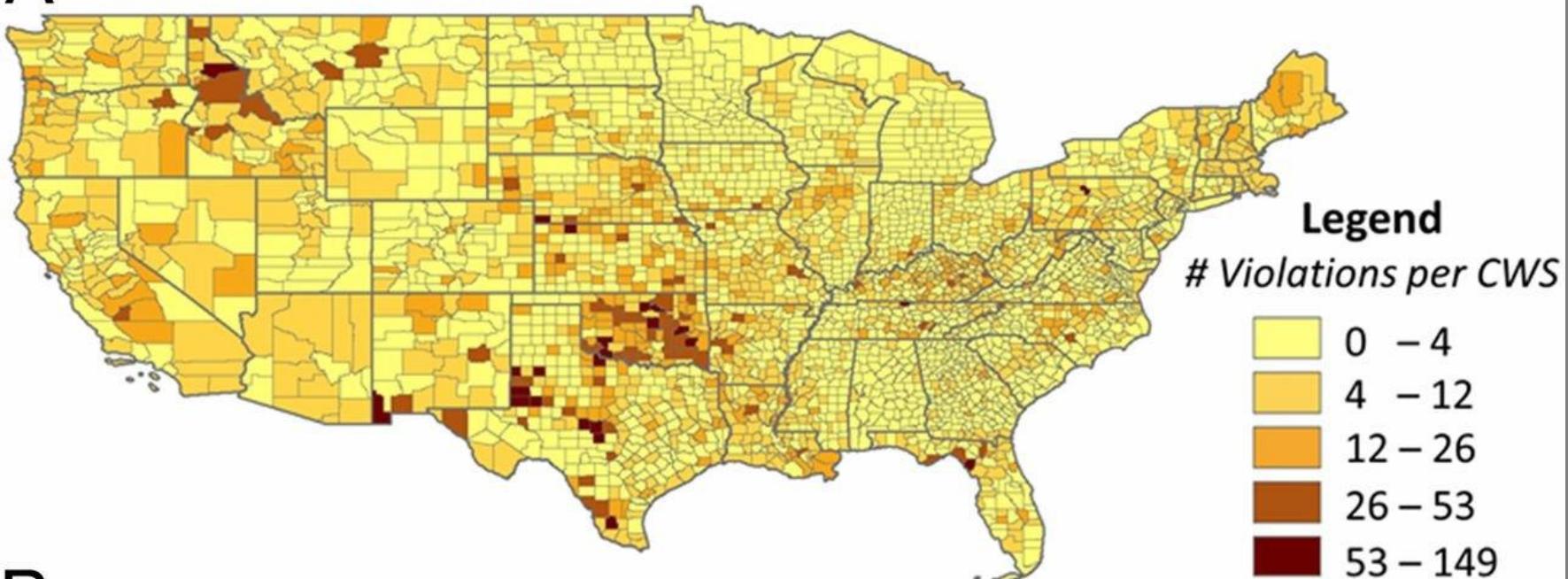
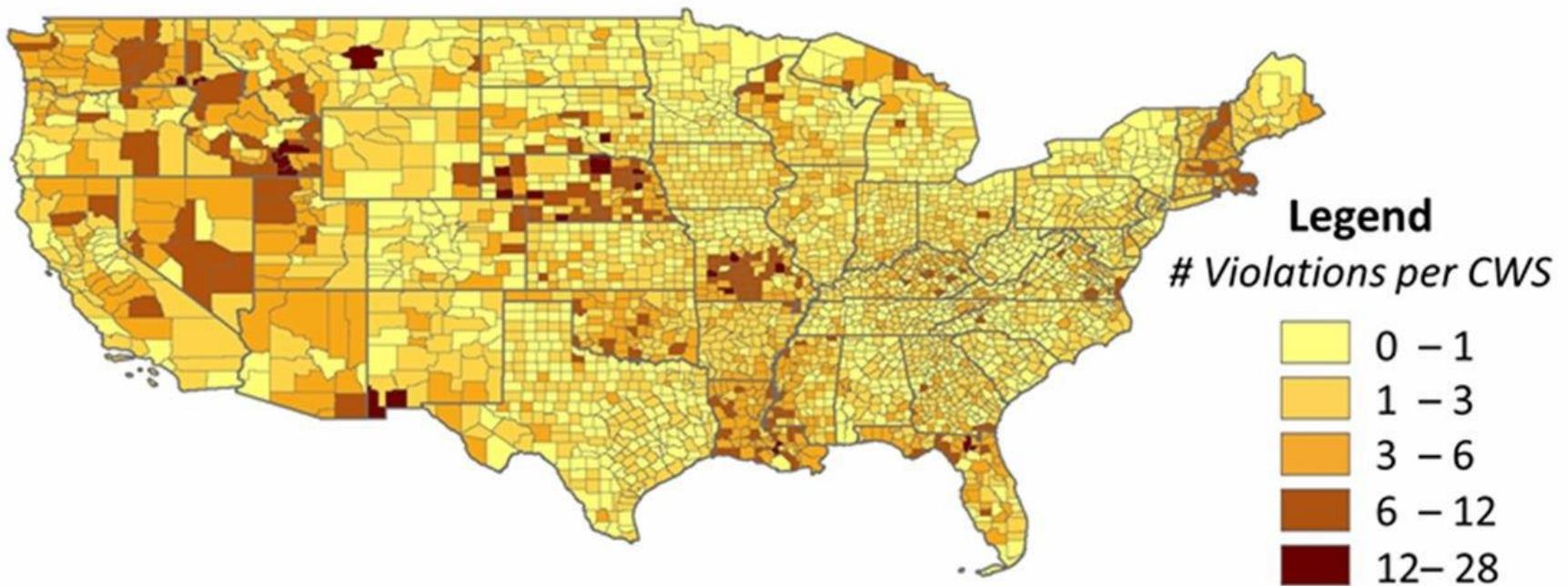
Temporal resolution ?

 Annual  Monthly

Indicators

Change Indicators and Weightings  OVERALL WATER RISK ? PHYSICAL RISKS QUANTITY ? Water Stress ? Water Depletion ? Interannual Variability ? Seasonal Variability ? Groundwater Table Decline ? Riverine flood risk ? Coastal flood risk ? Drought Risk ?

Overall water risk measures all water-related risks, by aggregating all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories. Higher values indicate higher water risk.

**A****B**

# National trends in drinking water quality violations

**1982-2015**

Number of violations per CWS, 1982–2015, by county. (A) Total violations. (B) Total coliform violations. Intervals in legend are selected based on the Jenks natural breaks classification method.

# How has GIS been used in San Diego County Health and Human Services Agency?

- Provide Reference
- Map Quantities
- Map Densities
- Determine Proximity
- Map Change
- Spatial Statistical Analysis
- Business Analytics

# HHSA CASE STUDIES

*Aging and  
Independence*

*Child Welfare  
Services*

*Foster Care*

*Contracted  
Social Services*

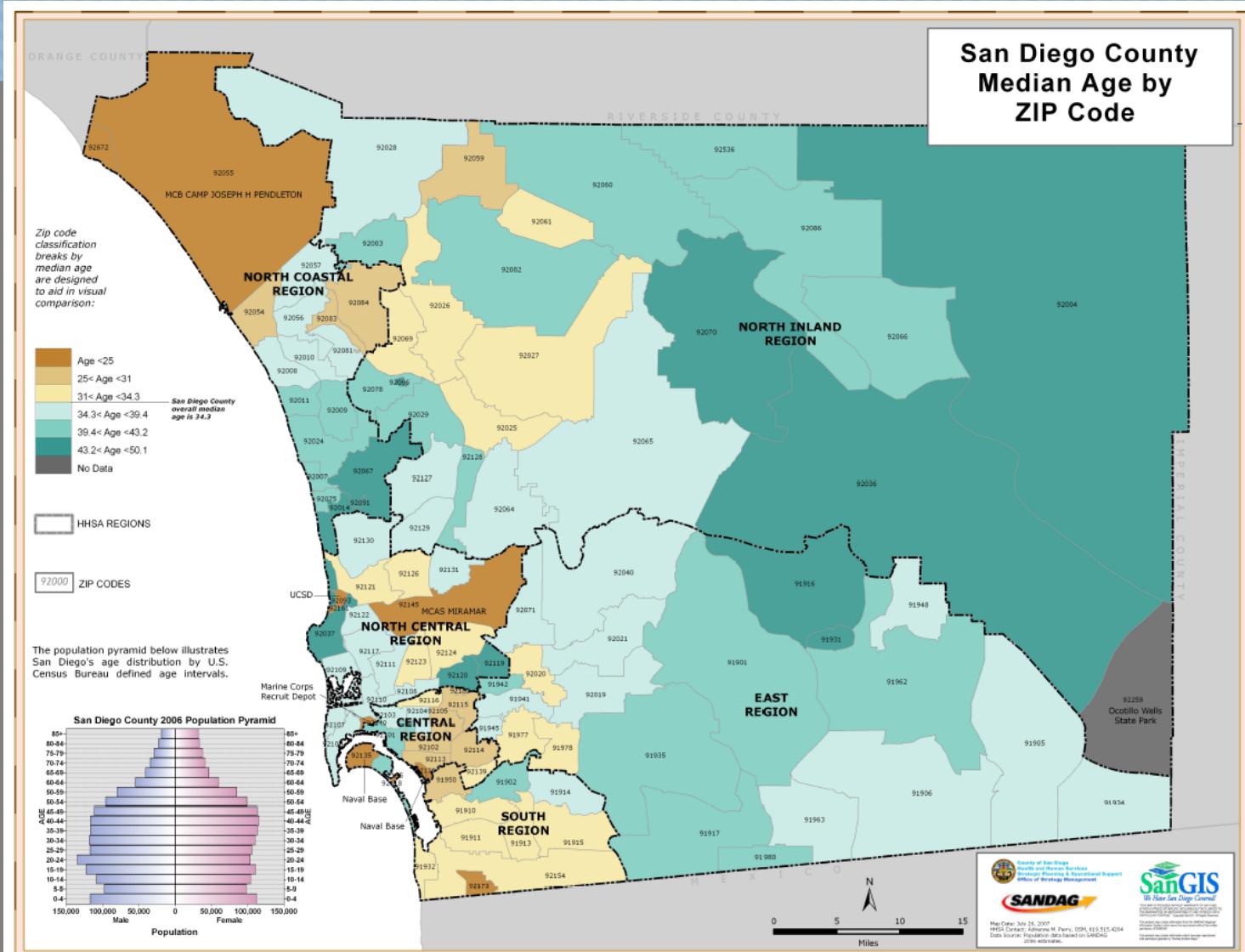
*Food Stamp  
Eligible  
Population*

*Health  
Promotion*

*Emergency  
Response and  
Recovery*

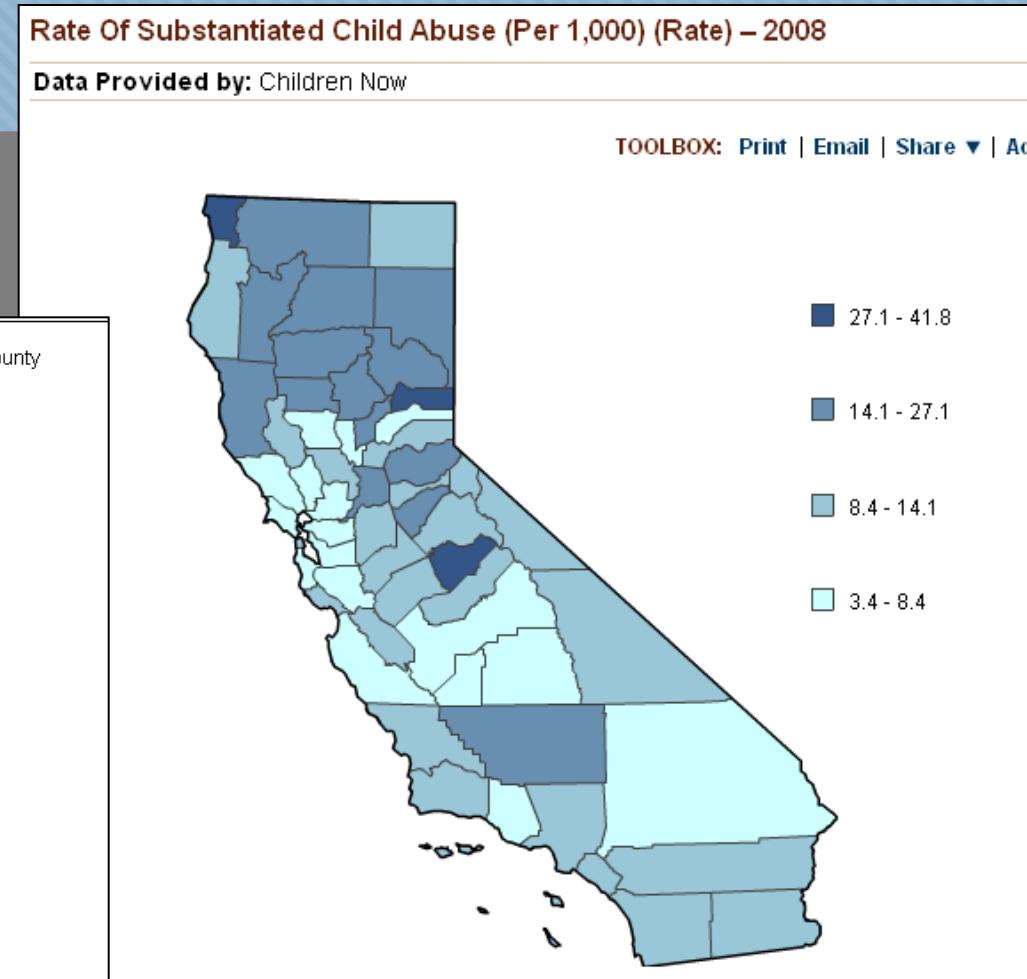
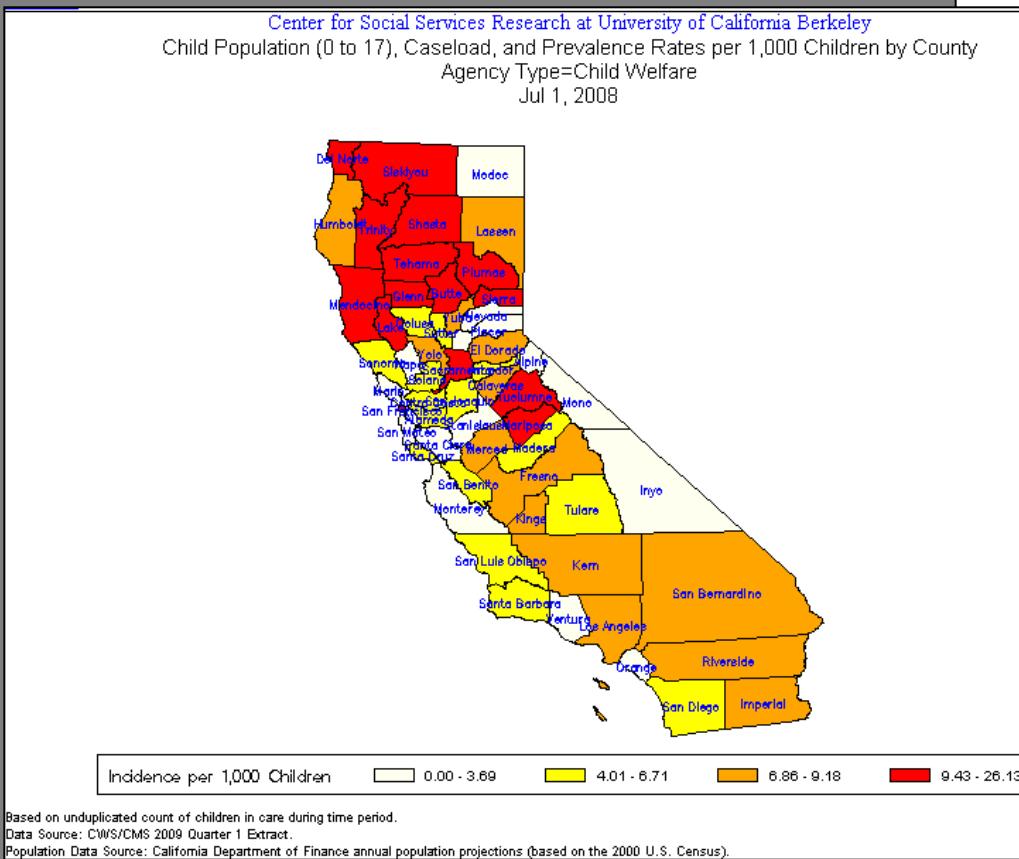
# AGING AND INDEPENDENCE

- *In Home Support Services*
- *Meals on Wheels*
- *Strategic Plan*

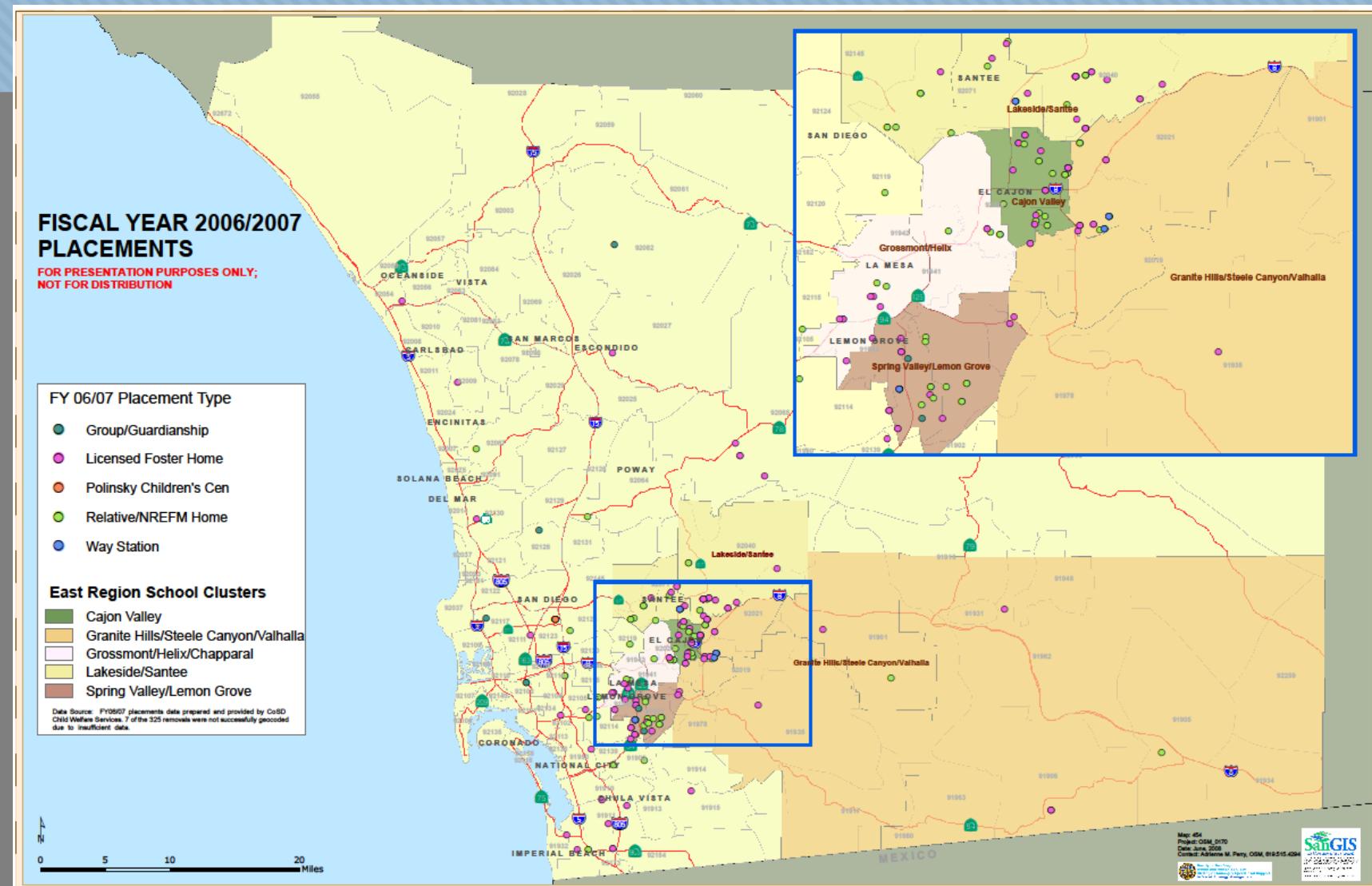


# CHILD WELFARE SERVICES

- *Kids Count*
  - *Berkeley*



# FOSTER CARE



# CONTRACTED SERVICES

*Proximity to Customer*

*Gaps in Service*

*Prospecting for New Site Location*

*Performance Management*

*Emergency Response & Recovery Plan*

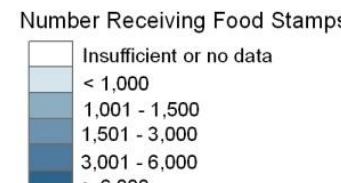
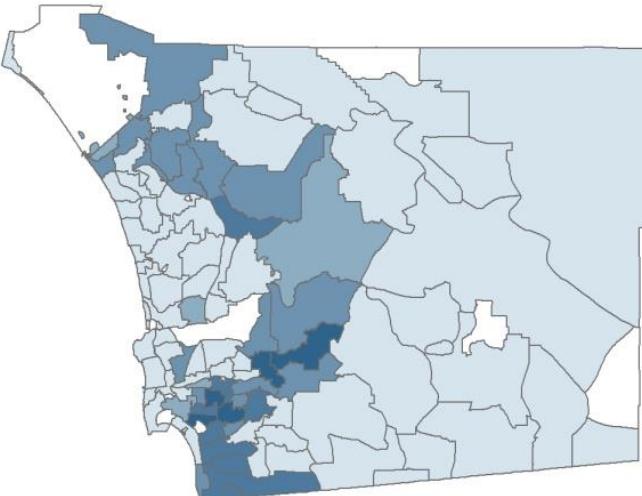
*DUI programs*

# FOOD STAMPS/SNAP

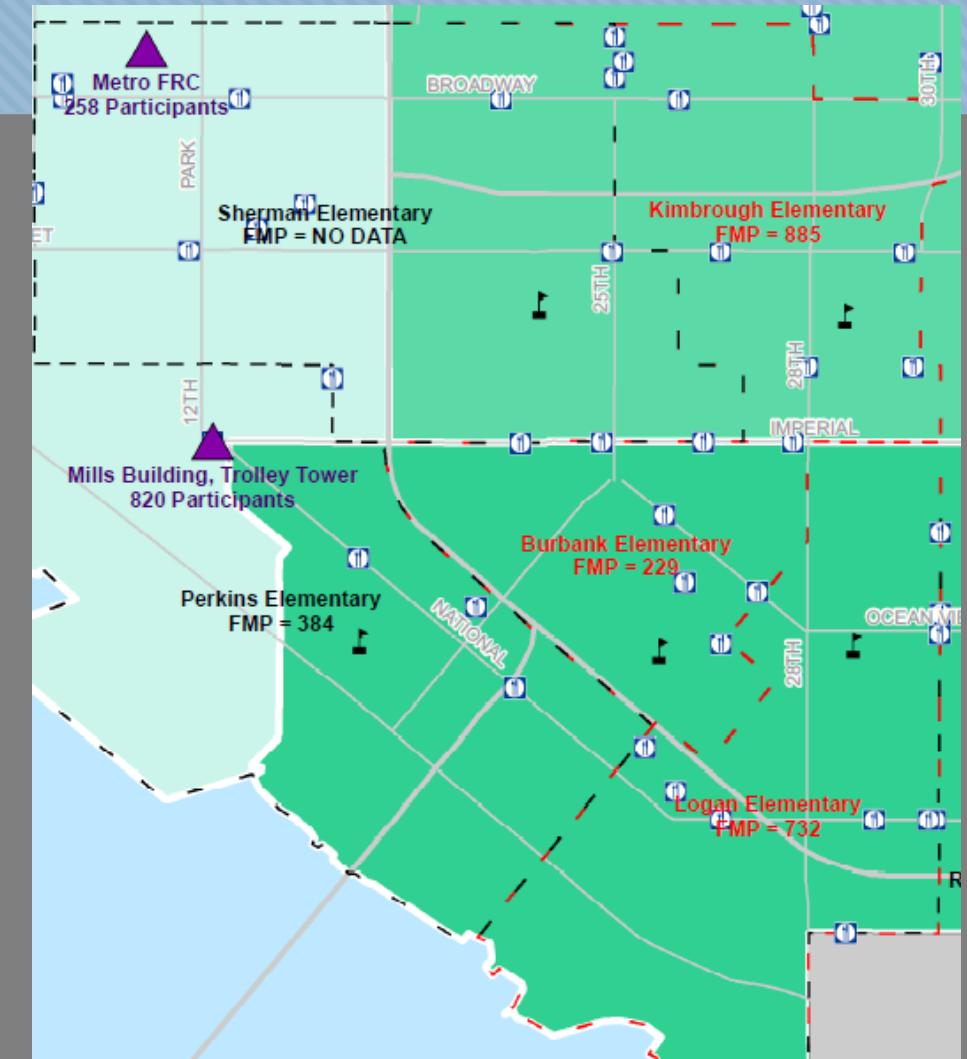
- *Outreach*
- *Education*
- *Performance Indicators*

NUMBER OF FOOD STAMP RECIPIENTS: JULY 2009

The 92105 zip code has the highest number of individuals receiving food stamps.



Total Recipients 145,114

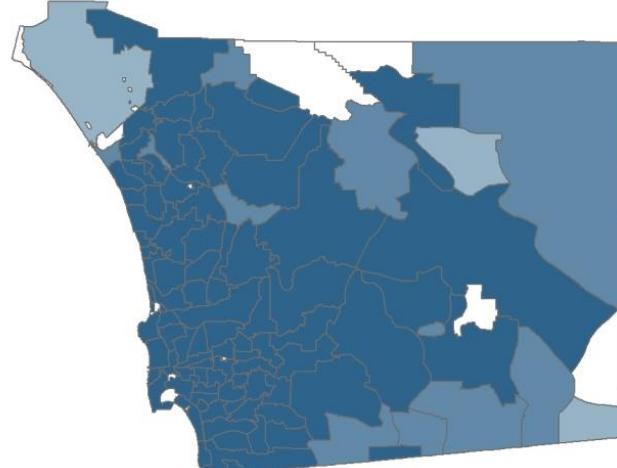


# HEALTH PROMOTION

- *Education*
- *Health Indicators*
- *Service Delivery*

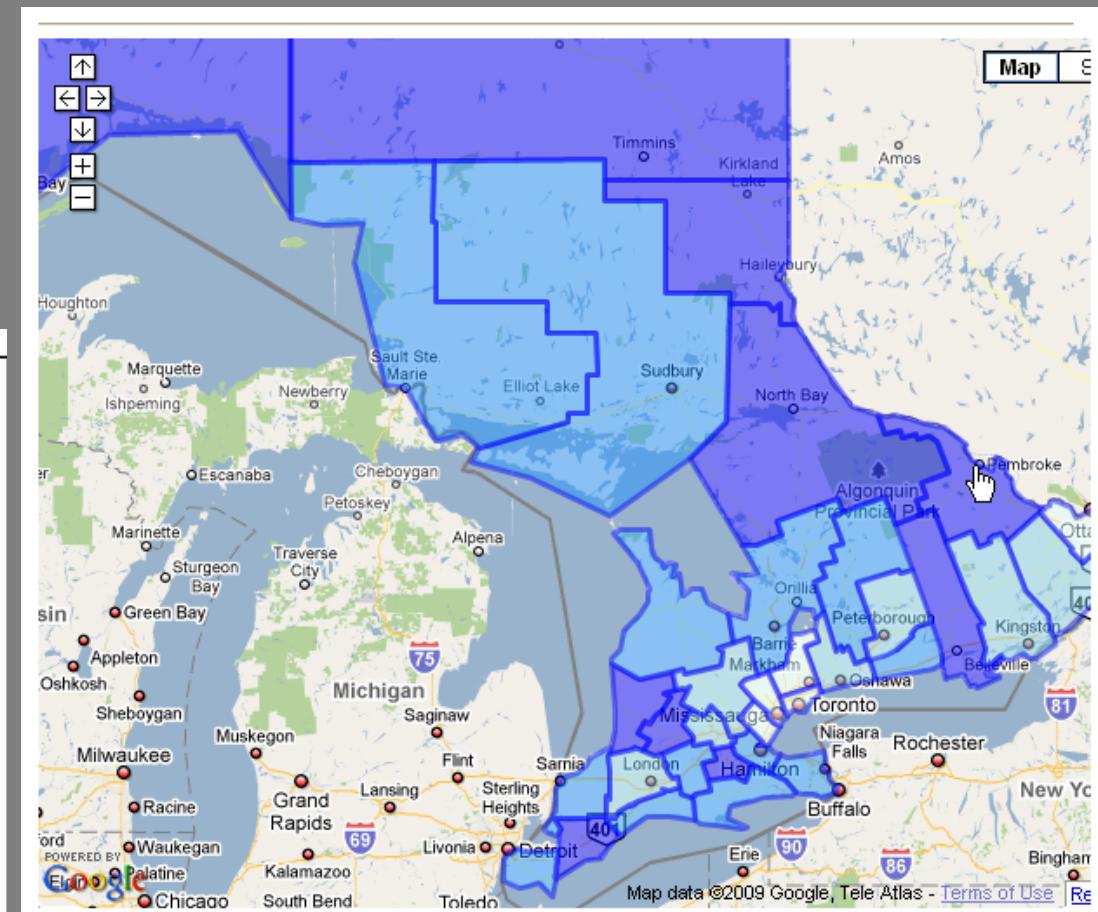
PERCENT OF BIRTHS WHERE MOTHER RECEIVED EARLY PRENATAL CARE: 2004-06

The percent of mothers receiving early prenatal care is highest in zip codes 92091 and 92145.



Overall County % 86.9%  
California State % 86.5%

NOTE: Data from State of California, Dept. of Public Health, Center for Health Statistics, Birth Statistical Master File. Prepared by County of San Diego, HHSA, Maternal, Child and Family Health Services. Data is for births in 2004-2006 with known prenatal care start time. This is a measure of prenatal care initiation, not frequency of care. Data with missing or invalid zip code are excluded from the map (<1%).



# EMERGENCY RESPONSE AND RECOVERY

- *Identify at-risk facilities/services*
- *Facilitate re-location of 24/7 services*
- *Communicate relocation of services to community*
- *Illustrate need for expedited federal emergency funds*
- *Service Delivery/Renegotiation of service areas*

# Ethical Issues relating to GIS and health

- Do no harm
- Informed consent
- Do not include patient identifiers
- Aggregate data
- Create false background
- Show data graphically or in a table

# Field Example

## Spatial Epidemiology of HIV among Injection Drug Users in Tijuana, Mexico

*Spatial Epidemiology of HIV among Injection Drug Users in Tijuana, Mexico.*  
Ann Assoc Am Geogr. 2012;102(5):1190-1199.

# Mexico is bordered by countries with higher adult HIV prevalence

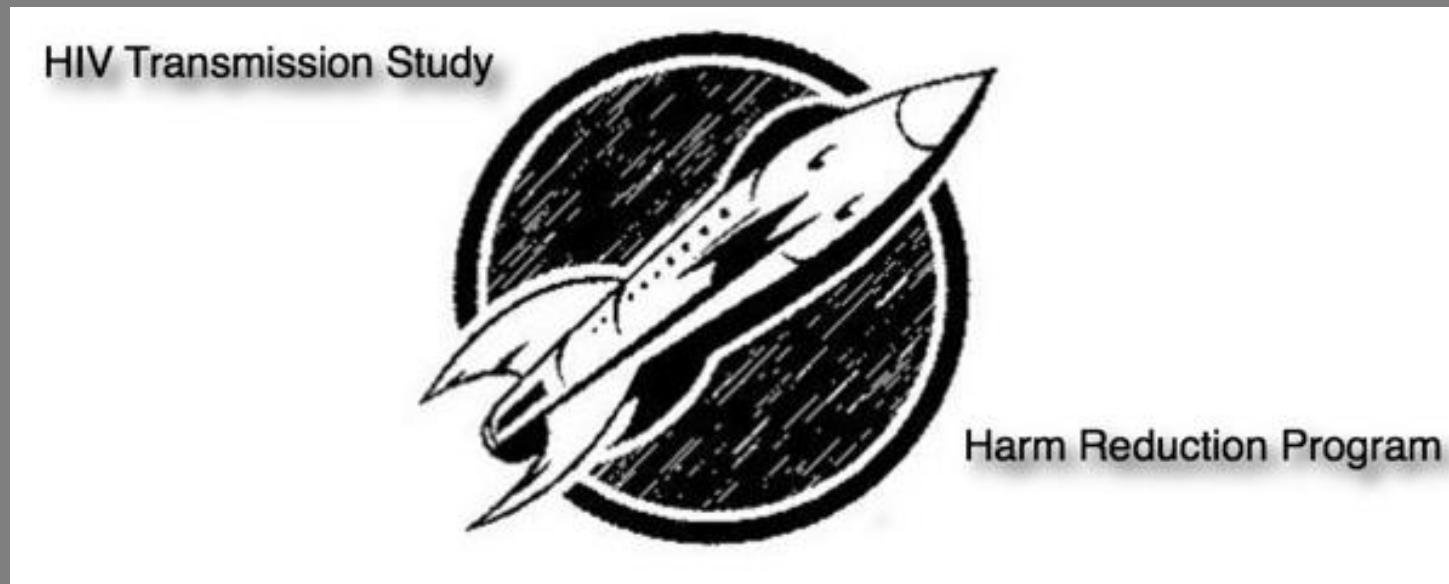


SOURCE: Report on the Global AIDS  
Epidemic, UNAIDS, 2006



Tijuana has one of the fastest growing IDU populations in Mexico, with ~21,000 drug users, and ~10,000 IDUs

# Proyecto El Cuete



HIV Transmission Study

Harm Reduction Program

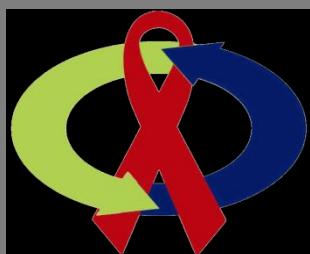
Binational Collaborative Project

CFAR Developmental Grant Funding  
NIDA Grant R01DA019829

# Collaborators & Data Sources



University of California San Diego



**CONASIDA**



**Instituto Nacional de Salud Pública**



**CENSIDA** **Salud**



Hospital  
General de  
Tijuana



**Programa  
COMPAÑEROS**



**El Colegio  
de la Frontera  
Norte**



**Patronato  
Pro-Comusida  
Tijuana A.C.**

# Challenges in Mapping along Mexico/U.S. Border

- No regular system of addresses/street names
- No address database
- Inconsistencies in naming census tracts/ neighborhoods
- Unequal number surveyed per neighborhood
- Transient/mobile population
- Security concerns
- Rapidly growing cities



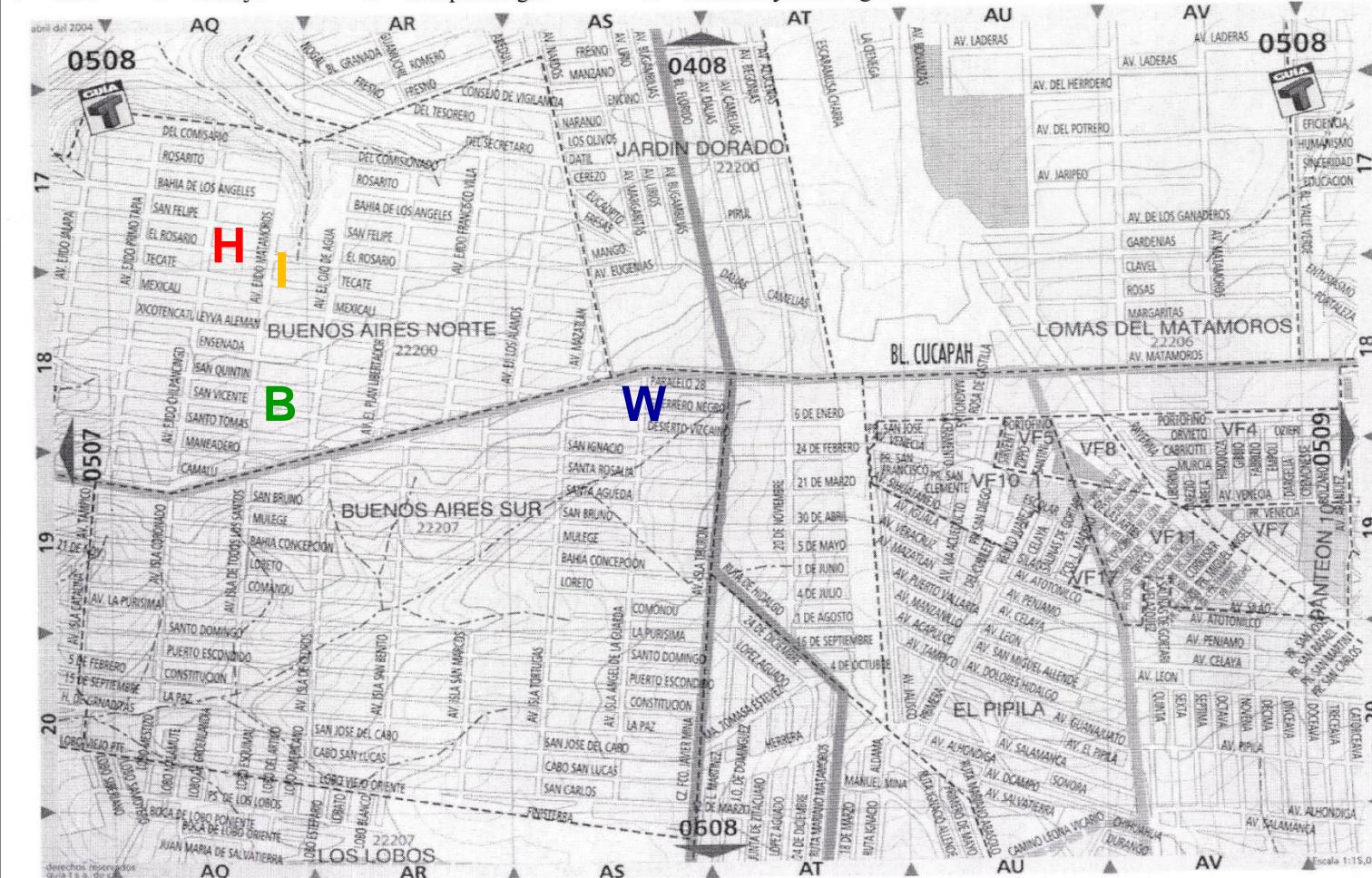
ID DE PARTICIPANTE: \_\_\_\_\_

V = Vive

T = Trabajo

C = Compra drogas

D = Donde inyecta drogas



# GPS: Location & Characteristics

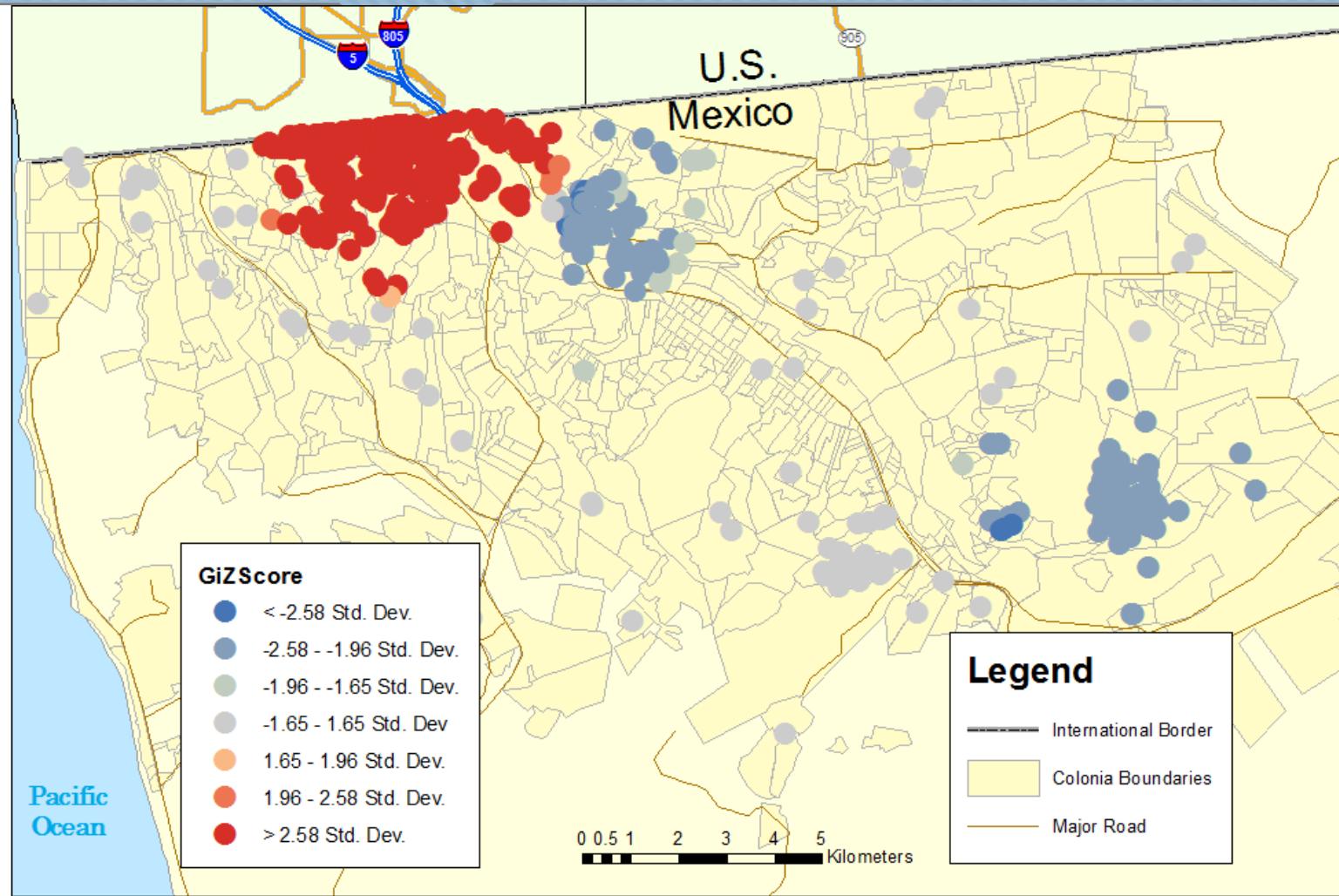
- Drug Treatment Centers
- HIV and other medical Clinics
- Police Stations
- Canal portal numbers
- Verification of data from paper maps



**Worksheet 2:**  
Estimating the local burden of Hib disease  
**Hib meningitis incidence rate method**  
(enter data in light grey cells  
calculated data in dark grey cells)

		Local data
<b>Step 0: Population data</b>		
	Number of children < 5 years old in country	
<b>Step 1: Hib meningitis cases</b>		
1A	Incidence of Hib meningitis (number of cases per 100 000 children < 5 years old)	
1B	Annual number of Hib meningitis cases (1B = 1A / 100 000 x number of children < 5 years old)	
<b>Step 2: Hib meningitis deaths</b>		
2A	Hib meningitis case-fatality rate (enter as a percent)	
2B	Annual number of Hib meningitis deaths in children < 5 years old (1B x 2A)	
<b>Step 3: Estimate the number of Hib pneumonia cases</b>		
3A	Ratio pneumonia:meningitis cases	
3B	Annual number of Hib pneumonia cases (1B x 3A)	
<b>Step 4: Estimate the number of Hib pneumonia deaths</b>		
4A	Hib pneumonia case-fatality rate (enter as a percent)	
4B	Annual number of Hib pneumonia deaths (3B x 4A)	
<b>Step 5: Summary</b> <b>Hib meningitis and pneumonia</b>		
5A	cases (1B + 3B)	
5B	deaths (2B + 4B)	

# HIV hot & cold spots of injection sites among substance using participants at baseline (n=1056)

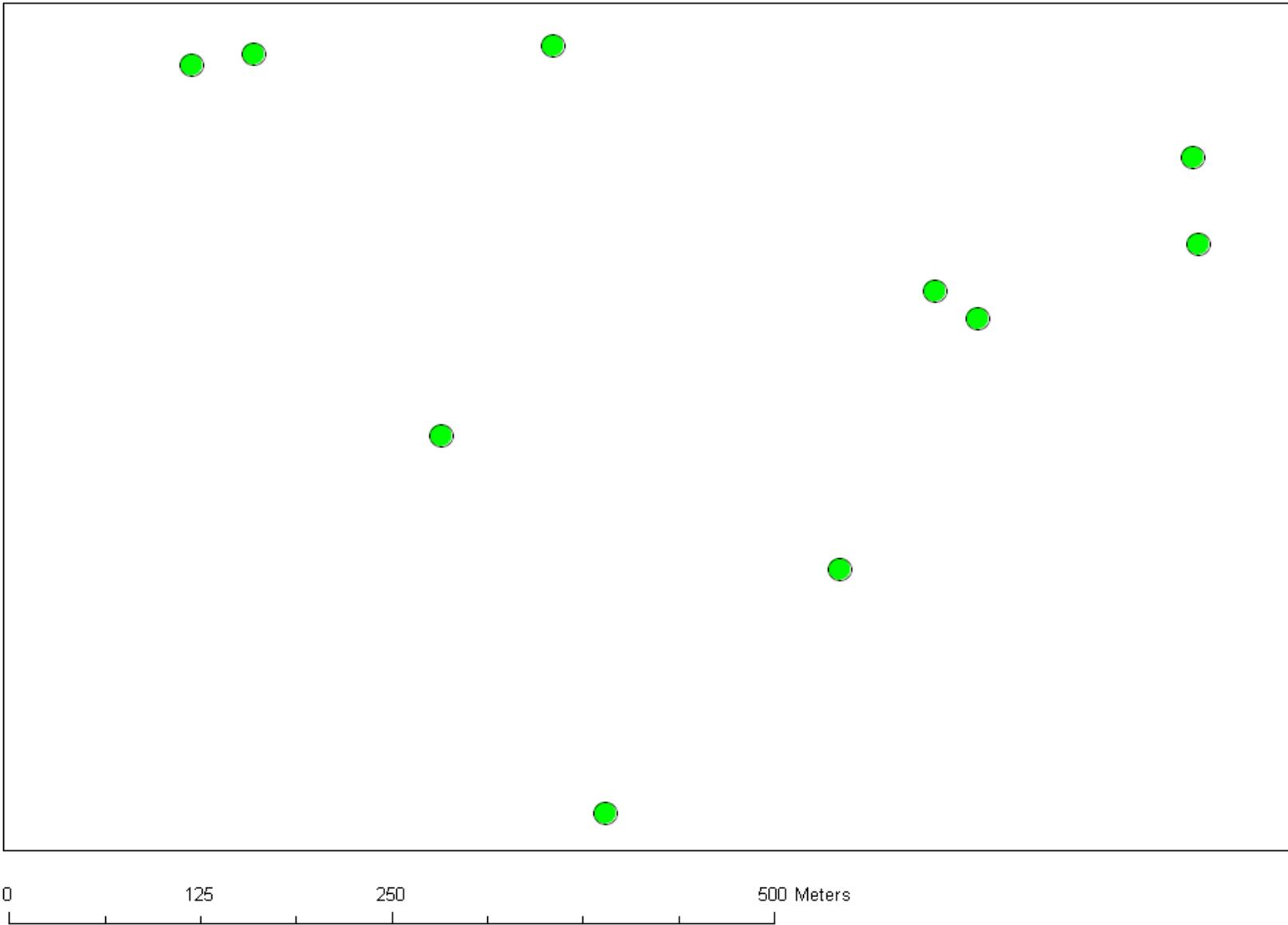


Activity	Z-Score	P-value
Live	-4.447	0.000
Buy Drugs	-2.113	0.035
Inject Drugs	-6.173	0.000
Work	-1.535	0.125

\*Average Nearest Neighbor

Clustering of HIV-positive participants at baseline by activity location (n=47)

## All Incident HIV cases Injected within a 2.5 block radius of each other



Distribution of injection locations of incident HIV cases in the study visit prior to seroconversion. Nearly all incident cases ( $n=11/12$ ) injected within a 2.5 block radius of each other.

# Characteristics of HIV hot v. cold spot colonias

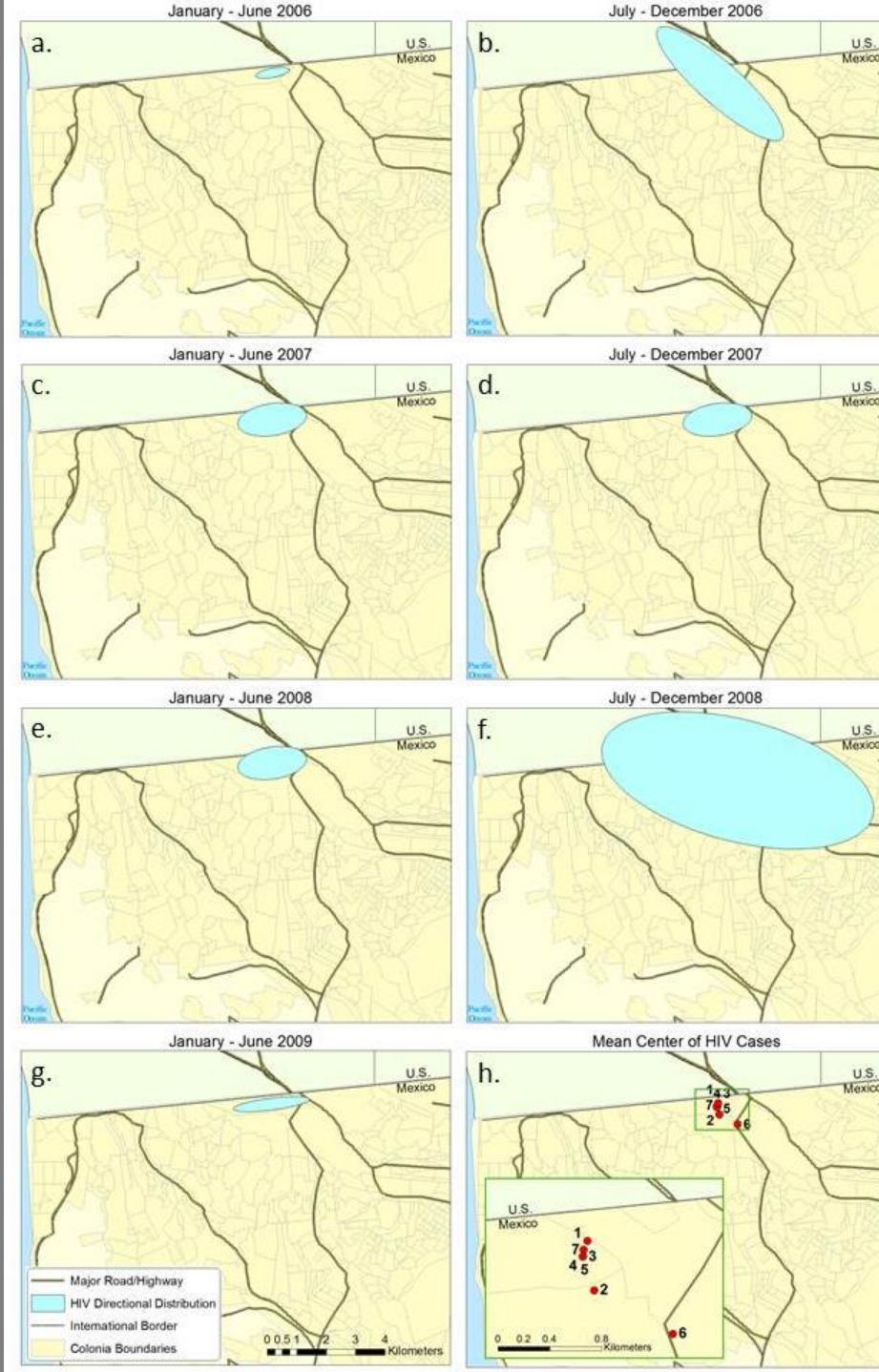
Colonia characteristic	Hot spot	Cold spot 1 <sup>a</sup>	Cold spot 2 <sup>a</sup>	P-value <sup>b</sup>
density per km <sup>2</sup>				
Population density	5452	9501	10451	0.124
Public health centers	0.43	0	0.18	0.298
Drug treatment centers	0.98	0	0.18	0.069
median %				
Colonias considered high crime areas by police	50.0	14.3	50.0	0.165
Divorced	6.3	5.1	4.5	<b>0.003</b>
Population living in female headed households	24.1	22.5	19.5	<b>0.013</b>
Catholic	85.1	84.3	78.6	<b>0.010</b>
Employed	59.6	58.7	62.8	0.102
Home ownership	45.4	54.4	71.4	<b>0.001</b>
Born outside of Baja California	49.5	50.7	56.5	0.556
Residents living in Tijuana at least 5 years	80.9	81.1	76.8	0.655
Adult literacy	97.7	97.2	96.1	0.063
Population >15 yrs with less than 9th grade education	38.2	48.2	56.2	<b>0.005</b>
Population with health insurance	37.4	44.7	50.8	<b>0.007</b>

<sup>a</sup> Cold spot 2 refers to the neighborhoods furthest to the southeast in Figure 1, whereas Cold spot 1 is closer to the HIV hot spot

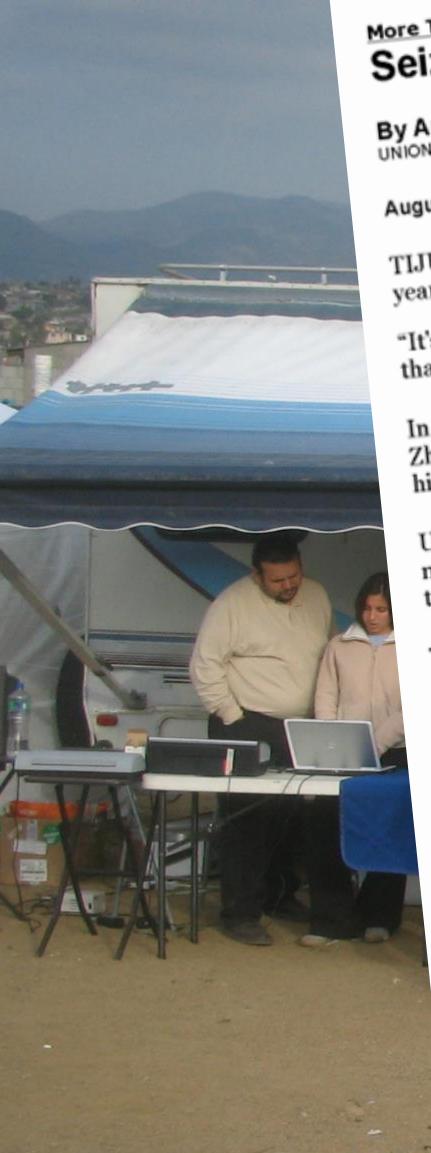
<sup>b</sup> Based on Pearson chi-square or Kruskal-Wallis Test

# Directional trends of HIV Cases

Suggest a very concentrated epidemic until July-Dec. 2008, when HIV cases shifted to the southeast



Supported by NIDA grants:  
R01DA019829, PI Strathdee  
K01DA020364, PI Brouwer



## More Tijuana news Seized drug money will build treatment centers for addicts

By Anna Cearley  
UNION-TRIBUNE STAFF WRITER

August 18, 2007

TIJUANA — Part of the millions of dollars confiscated by Mexican authorities in a high-profile drug case this year will be used to build treatment centers for drug addicts in Baja California, according to state authorities.

"It's a great idea," said José Guadalupe Bustamante Moreno, the state's secretary of health. "I hope all the money that is recovered from the drug traffickers can be used for treatment of addictions."

In March, Mexican authorities confiscated \$207 million from the house of a Chinese-Mexican businessman, Zhenli Ye Gon. The U.S. Drug Enforcement Administration has called it the largest seizure of money in the history of drug enforcement.

U.S. authorities, who arrested Ye Gon in Maryland in July, allege he was involved in the production in Mexico of methamphetamine that was destined for the United States. He's also wanted in Mexico on organized crime, drug trafficking and weapons charges. Ye Gon has said he is innocent.

The Mexican government is distributing part of the confiscated money to build treatment centers around the country. Baja California will receive about \$2 million to build 14 centers, Bustamante said.

He said the states will be responsible for managing the centers, which will provide medical and psychological assistance for addicts.

They won't function as rehabilitation centers where patients stay overnight, he said, but they will serve as starting points for people to seek help.

Health authorities said the community centers will allow them to detect illnesses that are sometimes transmitted through drug use, such as AIDS or hepatitis C. They will offer counseling and support groups and refer patients to comprehensive rehabilitation centers that offer in-patient care, Bustamante said.

So far, the state has decided to place four centers in Tijuana, four in Mexicali, three in Ensenada and one in San Quintin. The state is poring through city maps looking for specific places to put the centers and expects to start construction next month.

"We are looking for the most conflictive areas in crime and addiction," Bustamante said.

José Hector Acosta, who oversees patient services at Tijuana's Centro de Integración Juvenil, which provides in-patient rehabilitation programs, said the extra funds will be helpful.

Drug addicts constitute 1.4 percent — or 42,000 — of the state's population of roughly 3 million, according to statistics he has collected. The number is about twice the national figure, he said.



# GIS & Health Resources

- CDC 500 Cities Health Data  
<https://www.cdc.gov/500cities/>
- EPA Mapper -  
<https://ejscreen.epa.gov/mapper/>

