Epidemiologists Become Demographers in a Disaster:

Health and demographic estimation after Hurricane Katrina

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Introduction

- *Useful* health research needs a denominator after a disaster
    - Relative measures: which group has greater need?
    - Absolute measures: how much need is there?

- Household demographic estimates in New Orleans after Hurricane Katrina
    - Describe survey methods used
    - Consider population estimates produced
    - Comparison of methods

Rationale

☐ After a disaster, population estimation is uniquely challenging and crucially important decision-support function.

☐ Demographic estimates guide all sectors of disaster response and recovery planning.

☐ Planners want estimates that are GOOD, FAST & CHEAP.

Context

- Hurricane Katrina makes landfall on August 29, 2005.

- Mass migration of city residents results
  - Loss or damage to 71% of city's housing stock [1]
  - Estimated 373,206 city residents affected by damage or flooding [2]

- Complete and prolonged collapse of public infrastructure and services.

- Census population and demographics data COMPLETELY obsolete after Katrina.

Context

- ☐ City of New Orleans (CNO) Emergency Operations Center (EOC) is information and planning hub

- ☐ No data sources to estimate population

- ☐ Requested technical assistance from US Centers for Disease Control and Prevention (CDC)
  - ▪ Local team with RELEVANT experience conducting population estimates in refugee camps

Context

- Three CNO-EOC population estimates produced with CDC assistance
  - ≈2 months after Katrina (October 29-30, 2005)
  - ≈3 months after (November 11-December 4, 2005)
  - ≈5 months after (January 28-29, 2006)

- State of Louisiana authorizes expanded survey across 18 hurricane-affected parishes
  - 2006 Louisiana Health and Population Survey (LHPS) (Orleans, June-October, 2006)

Methods

Housing unit method

☐ Household (HH), persons per household (PPH), and group quarters (GQ) are building blocks [3]:

$$P_t = \left(HH_t \times PPH_t \right) + GQ_t$$

☐ Key methodological questions in designing household *population* survey

- How do you select representative sample of housing units?
- When does a housing unit equal a household (habitability & occupancy)?

Sampling

Stratified spatial sampling design (Oct 29-30, 2005)

- City divided into two strata:
  - West Bank – no appreciable flooding
  - East Bank – heavy flooding

- Geographic Information Systems (GIS) to randomly select 82 waypoints per stratum

- Spin bottle and select housing unit in the direction indicated
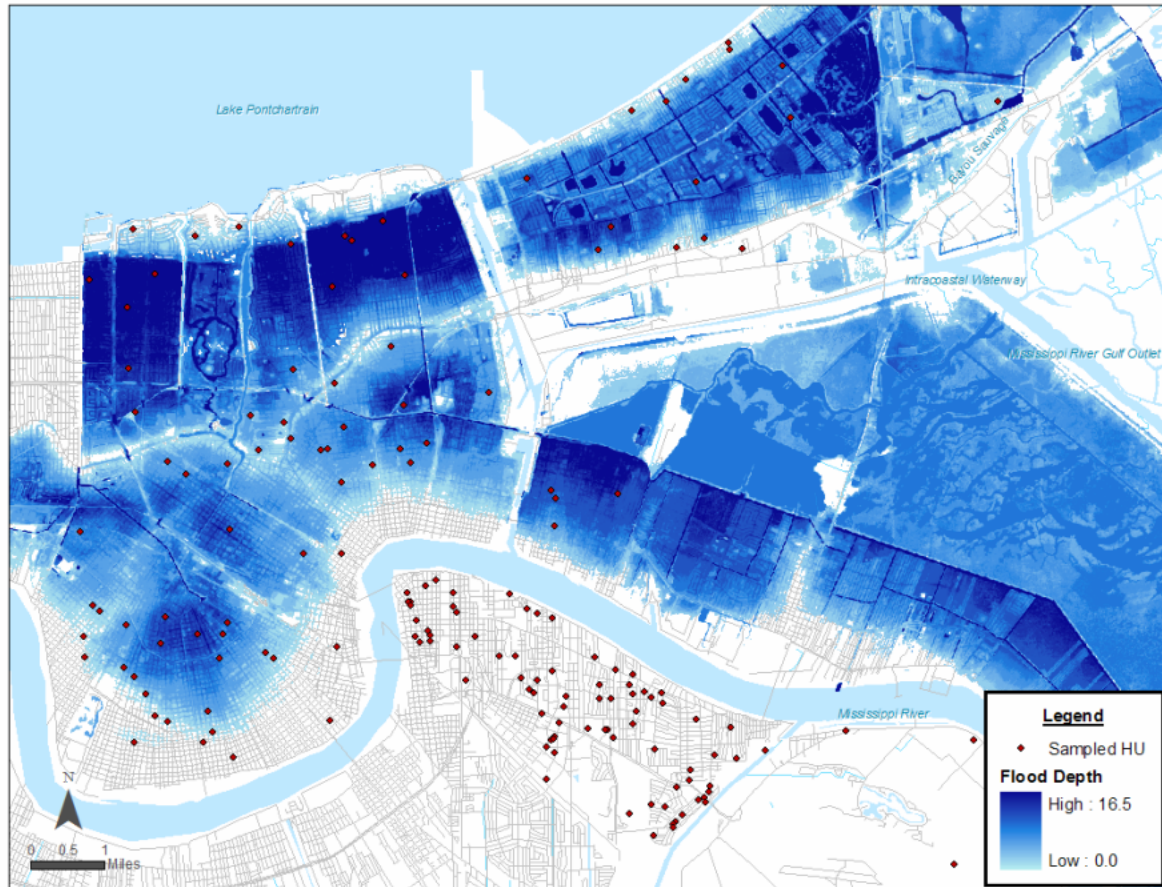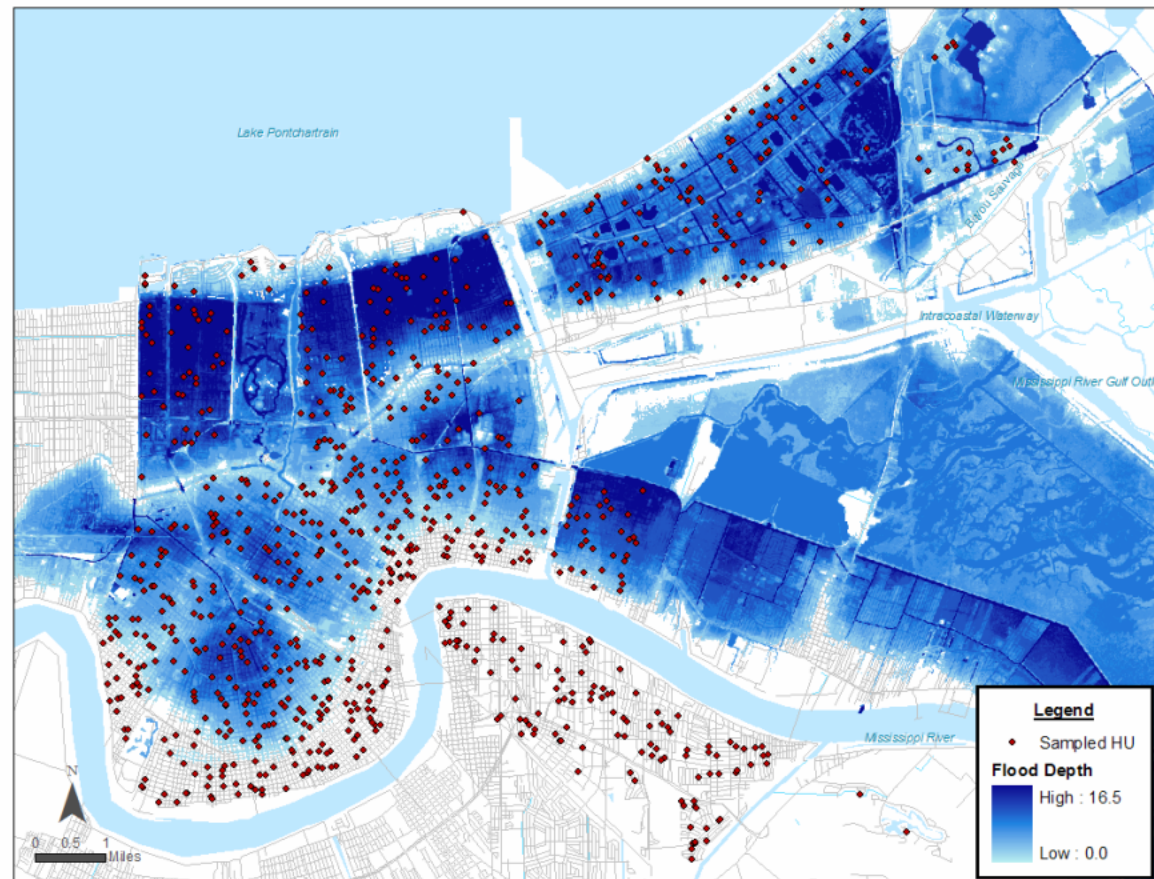
Sampling

Stratified simple random sampling design (Nov 11-Dec 4, 2005 & Jan 28-29, 2006)

- East Bank stratum divided into:
  - Flooded
  - Unflooded

- Each stratum proportionally sub-stratified by census tract based on number of housing units

- Sampling frame composed of 174, 227 water meter addresses
  - Select one if multiple units at address

Sampling

Stratified cluster sampling design (Jun-Oct 2006)

- 'Block clusters' composed of one or more census blocks [4]

- Stratified based on:
    - Above/below parish percent nonwhite
    - Above/below parish ratio of owners vs. renters
    - Presence of one or more damaged block according to FEMA inspections
    - East Bank/West Bank of Mississippi River

- Enumeration of housing units in each selected block cluster

- Sample five (5) habitable units per cluster
    - If large increase in number of units vs. Census 2000, sample more

Survey Methods

- Stratified spatial and stratified simple random designs (CNO-EOC surveys)
  - Three (3) weekend survey visits
  - If no answer, survey left on doorknob
  - If no contact, obtain proxy response
  - No habitability determination; Unit determined *unoccupied* if no answer after three visits unless proxy indicates otherwise

- Stratified cluster design
  - Survey left on doorknob with return envelope after unit selection
  - If no mail response, minimum of four (4) survey visits
    - Weekdays, evenings, and weekends

- 'Resident' defined as sleeping 15 of the last 30 days

Data Analysis

- Stratified spatial and stratified simple random designs (CNO-EOC surveys)
  - PPH (estimate) × [occupancy rate (estimate) × households (Census 2000)]

- Stratified cluster design
  - Household, and person-level sampling weights calculated based on inverse of selection probability

Results

## Housing Unit Occupancy (Jan 28-29, 2006)
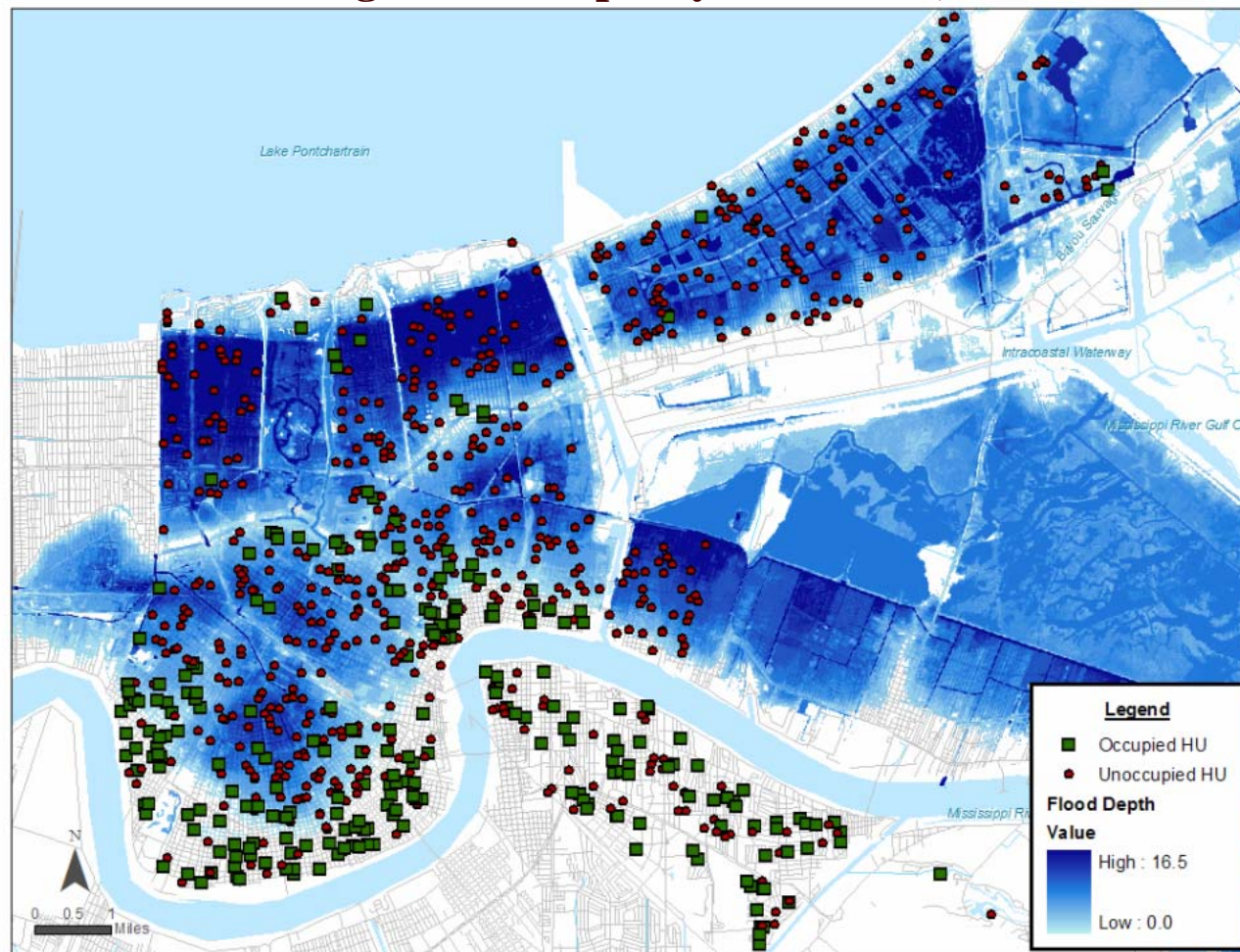
Results

Household Survey	Approximate no. of months since Hurricane Katrina	No. sampled units	Household population estimate	Margin of error	Percent of population at 2000 Census
Oct 29-30, 2005	2	162	104,900	49.4%	22.5%
Nov 11-Dec 4, 2005	3	409	135,500	16.5%	29.0%
Jan 28-29, 2006	5	902	181,400	11.5%	38.8%
Jun-Oct 2006	8-12	1157	191,100	9.8%	40.9%

Results

Plot of population estimates from household surveys and US Census Bureau
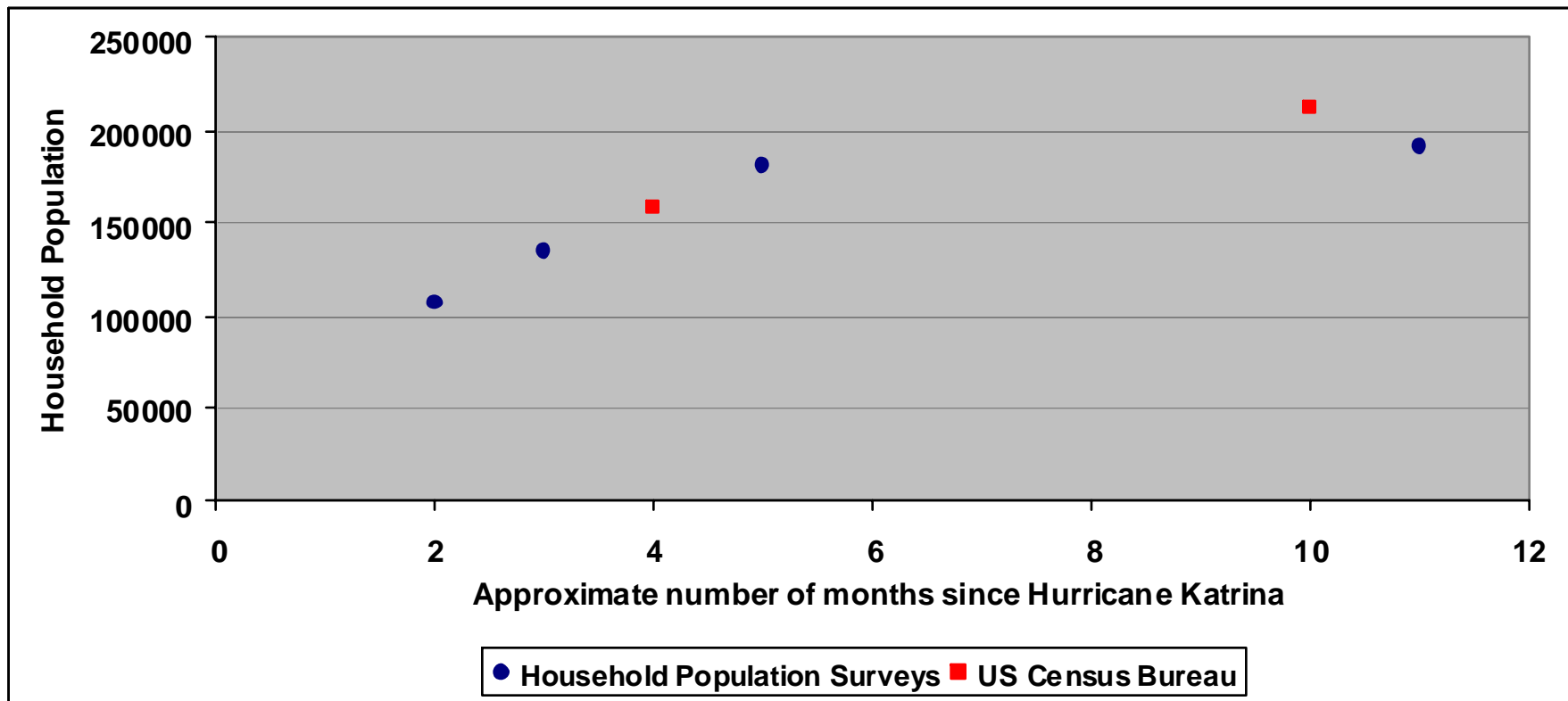
Source: *Special population estimates for impacted counties in the Gulf Coast area*, gulfcoast_impact_estimates.xls, 2006, U.S. Census Bureau: Washington, D.C.; *County Population Datasets, CO-EST-ALLDATA.csv. 2007,U.S. Census Bureau: Washington, D.C.*

Results

- CNO-EOC surveys
  - Four to six weeks
  - No operating budget
    - Approx. $42,000 ($47 per sampled unit), if volunteer contribution budgeted

- LHPS
  - Five and a half months
    - Concurrent data collection in several parishes
  - Approx. $1million for 18 parishes ($97 per sampled unit)
    - Not including hours of technical assistance from CDC and Census

Discussion

- Repopulation narrative
  - First six month period
    - Rapid repopulation
    - Flooded neighborhoods reopen (Nov and Dec)
    - Utility services restored (Dec and Jan)
    - Schools and universities reopen (Jan)

  - Second six month period:
    - Slower repopulation
    - Decline in recovery zeal
    - Challenges of living in post-disaster setting
      - Public infrastructure
      - High rent and insurance rates
      - Permitting bottlenecks
      - Delay in disbursement of recovery funds
      - Limited health care access
      - Soaring crime and violence
      - Daily reminders of trauma

Discussion

- Comparison of methods
  - Sampling
    - Significant changes in number/distribution of housing units since Census 2000
    - Bottle spinning produced many 'null' samples
    - Water meter addresses
      - Not the same as housing unit
      - Do not have same distribution as housing units (e.g. more multiunit structures downtown)
      - Five (5) percent could not be mapped
    - Section of few clusters to represent many

Discussion

- ☐ Comparison of methods
  - ◼ Survey methods
    - ☐ Consider all units habitable: no estimate of housing stock (CNO-EOC surveys)
    - ☐ Make habitability determination:
      - ◼ Estimate of housing stock
      - ◼ May exclude (high risk) households living in poor conditions
    - ☐ Reliance on proxy responses
    - ☐ Weekend population may differ from workweek
      - ◼ Definition of household resident

Discussion

- Comparison of methods
  - Data analysis
    - Simple sampling design means fast, easy data analysis (CNO-EOC)
    - Complex sampling design means slow, difficult data analysis (LHPS)
  - Results
    - Planners want small area estimates!
    - Stratified simple random sampling design allowed for post-stratification into 7 sub-parish regions

Conclusion

- Health researchers, after a disaster be prepared to provide your own denominator!

References

1. *Current Housing Unit Damage Estimates: Hurricanes Katrina, Rita, and Wilma*. 2006, Office of Policy Development and Research, U.S. Department of Housing and Urban Development: Washington, D.C. p.45

2. Gabe, T., et al., *Hurricane Katrina: Social-demographic characteristics of impacted areas*, in *CRS Report for Congress*. 2005, Congressional Research Services: Washington, D.C. p.29

3. Smith, S.K., *A review and evaluation of the housing unit method of population estimation*. Journal of the American Statistical Association, 1986. 81(394): p.287-296.

4. *Census 2000 Testing, Experimentation, and Evaluation Program*. 2004, Planning, Research, and Evaluation Division, U.S. Census Bureau: Washington, D.C. p.98.

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