The Social Vulnerability Index and Toolkit

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April 30, 2013

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Topics to be Discussed

- Background and rationale for the creation of the Social Vulnerability Index (SVI)
- Data and methods used
- Components of the SVI Toolkit
- SVI Products and Users
- The Road Ahead

Background & Rationale

*Risk = Hazard * (Vulnerability – Resources)*

- ***Risk*** **is the likelihood or expectation of loss**
- ***Hazard*** **is a condition posing the threat of harm**
- ***Vulnerability*** **is the extent to which persons, places, or things are likely to be affected**
- ***Resources*** **are those assets in place that will diminish the effects of hazards**

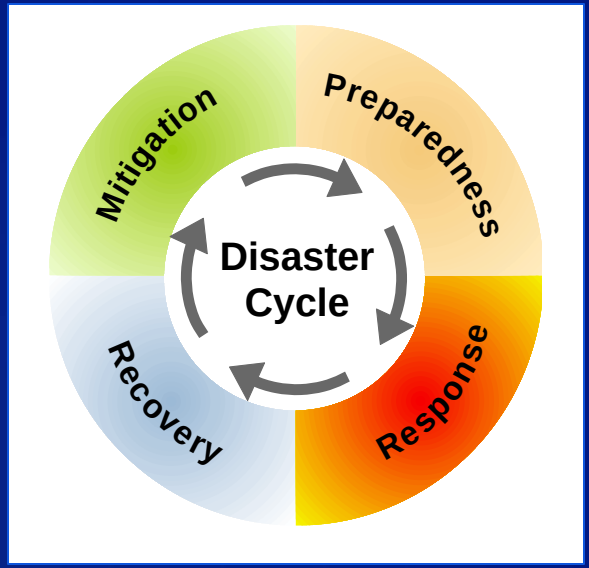
Background & Rationale

- Social vulnerability refers to the demographic and socioeconomic factors that affect the resilience of communities
- Studies have shown the socially vulnerable are more likely to be adversely affected, i.e. they are less likely to recover from a disaster event and more likely to die
- Effectively addressing social vulnerability decreases human suffering and reduces post-disaster expenditures for social services and public assistance

Background & Rationale

- GRASP developed a Social Vulnerability Index (SVI) to help identify the locations of vulnerable populations.

- The SVI may aid disaster management officials in all phases of the disaster cycle



Data & Methods

- **From US census 2000 we identified 15 variables closely associated with varying social vulnerability to disaster.* We then grouped the variables into four themes to create the 2000 SVI:**

1) Socioeconomic status (4 variables)
2) Household composition and disability (4 variables)
3) Minority status and language (2 variables)
4) Housing and transportation (5 variables)

* **Fourteen variables for SVI 2010.**

Data & Methods

- **A goal was to keep the statistical methods simple to provide an easily understandable index for SVI users**

- **We used census tract level data**
  - SF1 100% counts and SF3 estimates
  - Tracts are small subdivisions of counties
  - Designed to be demographically homogeneous
  - Having an optimum population of 4000 (though varies greatly)

- **Year 2000 N = 65,081 tracts***

***Year 2010 N = 73,989 tracts**

Data & Methods

- Percentage calculations for the 15 census variables were ordered from most vulnerable to least vulnerable
- A percentile rank was calculated for each tract: for each of the 15 variables, for the 4 themes, and overall
- A higher percentile rank represents greater vulnerability, with a percentile rank of 0.00 meaning the least vulnerable and 1.00 meaning the most vulnerable

Data & Methods

- To account for the smoothing effect that occurs when high tract percentile rankings are averaged with low tract percentile rankings, we flagged tracts with percentile rankings of 0.90 or higher on any variable
- For each tract, we summed flags for the variables to arrive at both a theme flag count and an overall flag count

Data & Methods

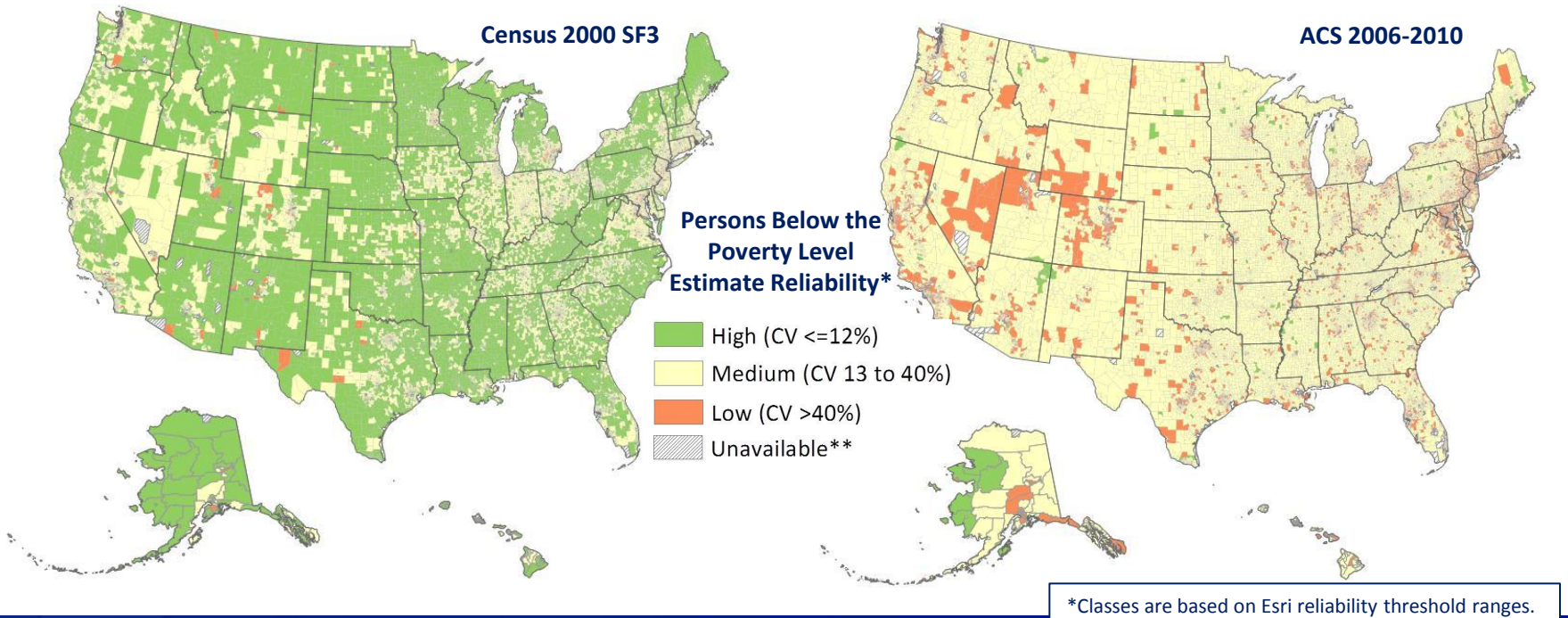
- Percentile rankings and flags were determined for the U.S. as a whole, to use for U.S.-wide or multi-state comparisons
- Percentile rankings and flags were also determined for individual states, to use for within-state comparisons

Data & Methods
SVI 2010

- SF3 estimates are no longer available, so we used a combination of Census 2010 100% count data (SF1) and 2006-2010 American Community Survey (ACS) estimates.
- Disability estimates were not available at tract level for 2006-2010, so are not included in SVI 2010.
- The smaller sample size of the ACS led to concerns about higher levels of error.

Data & Methods
SVI 2010

Visualization of error due to smaller sample size



*Classes are based on Esri reliability threshold ranges. The National Research Council recommends a CV no higher than 12%.

** When a poverty percentage estimate is 0, the CV cannot be calculated because of a 0 denominator in the equation.

The coefficient of variation (CV), a measure of error, for 2000 SF3 vs 2006-2010 ACS poverty data.

Data & Methods
SVI 2010

- **We cannot definitively rank ACS estimates because we do not know true variable values.**
- **Concern about the high level of error in the ACS estimates led us to rank the data in two ways:**
  - Using the 2000 percentile method
  - Incorporating probabilities into the ranking

Data & Methods
SVI 2010

- **In the probability method, a tract estimate ranking is assigned based on the position of the estimate on a cumulative probability curve.**
  - For a selected tract, the position on the probability curve tells us the percentage of tract estimates that will likely be lower than our selected tract.
  - We assign the percentage as a ranking (e.g. 10% of tracts are likely lower than our selected tract).

SVI Toolkit Components
SVI 2010

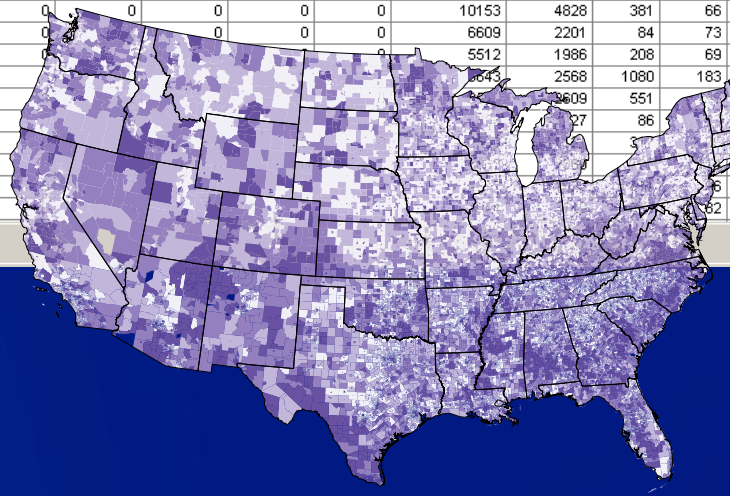
- **Raw census numbers, by tract, for each variable. ACS variables include margins of error (MOEs).**
- **Original proportion calculations. All derived variables based on ACS include MOEs.**
- **SVI calculations –**
  - Percentile rankings using 2000 method
  - Rankings using probability method
  - Flags

SVI Toolkit Components

Attributes of GRASP_SVI.SDEADMIN.USNational_SVI

FIPS	G1V1R	G1V2R	G1V3R	G1V4R	USG1V1P	USG1V2P	USG1V3P	USG1V4P	USG1TP	USTP	USG1V1F	USG1V2F	USG1V3F	USG1V4F	USG1TF	Totpop2000	Totalhu	G1V1N	G1V2N	G1V4N
48203020402	0.2743	0.1542	13855	0.036813	0.882	0.937	0.809	0.683	0.873	0.839	0	1	0	0	1	5117	2095	1202	318	893
48203020500	0.1593	0.0637	18280	0.054595	0.7	0.647	0.537	0.842	0.73	0.723	0	0	0	0	0	7819	3483	1227	228	955
48203020601	0.1056	0.0588	19510	0.037132	0.525	0.604	0.464	0.688	0.601	0.451	0	0	0	0	0	9330	3633	985	265	846
48203020602	0.0856	0.0475	17796	0.035921	0.435	0.481	0.565	0.671	0.563	0.473	0	0	0	0	0	8004	3337	685	188	765
48205950200	0.0658	0.0115	18067	0.023701	0.332	0.028	0.549	0.435	0.306	0.396	0	0	0	0	0	5537	1760	270	24	938
48207950300	0.2523	0.0496	14853	0.024898	0.86	0.507	0.755	0.463	0.69	0.677	0	0	0	0	0	3845	2344	944	79	810
48207950400	0.1881	0.0552	15028	0.030725	0.766	0.568	0.745	0.586	0.712	0.541	0	0	0	0	0	2248	1211	423	53	435
48209010100	0.1956	0.0868	20257	0.030215	0.78	0.789	0.426	0.576	0.686	0.451	0	0	0	0	0	1936	908	360	112	195
48209010200	0.4686	0.1629	5866	0.011236	0.98	0.945	0.995	0.132	0.814	0.432	1	1	1	0	3	5656	669	642	546	36
48209010301	0.4029	0.2074	11078	0.103567	0.962	0.972	0.916	0.97	0.981	0.673	1	1	1	1	4	10148	4098	3980	1345	772
48209010302	0.2987	0.0843	11884	0.037418	0.904	0.777	0.891	0.691	0.863	0.653	1	0	0	0	1	4326	1696	1287	214	578
48209010400	0.1121	0.0273	18713	0.0271	0.551	0.189	0.51	0.513	0.439	0.627	0	0	0	0	0	4343	1716	464	61	758
48209010500	0.1973	0.0492	11604	0.059057	0.783	0.502	0.9	0.866	0.814	0.953	0	0	1	0	1	2783	991	546	71	634
48209010600	0.0887	0.0267	23972	0.01643	0.449	0.18	0.275	0.248	0.247	0.241	0	0	0	0	0	7904	3039	697	121	489
48209010700	0.2845	0.0614	19087	0.013683	0.892	0.628	0.488	0.183	0.574	0.469	0	0	0	0	0	8113	3616	2228	305	178
48209010801	0.0415	0.014	29471	0.019042	0.184	0.042	0.145	0.316	0.102	0.245	0	0	0	0	0	12908	4718	531	97	648
48209010802	0.0382	0.013	27016	0.018427	0.163	0.036	0.191	0.3	0.103	0.32	0	0	0	0	0	10153	4828	381	66	521
48209010901	0.0127	0.0191	28799	0.017586	0.024	0.084	0.156	0.277	0.063	0.041	0	0	0	0	0	6609	2201	84	73	188
48209010902	0.0378	0.0224	24097	0.020205	0.161	0.122	0.271	0.346	0.166	0.265	0	0	0	0	0	5512	1986	208	69	376
48209010903	0.1257	0.0441	14108	0.068347	0.601	0.437	0.796	0.903	0.733	0.758	0	0	0	0	0	8643	2568	1080	183	5
48209010904	0.0687	0.0285	17670	0.053821	0.348	0.207	0.573	0.838	0.506	0.666	0	0	0	0	0	3609	551			1184
48211950100	0.1064	0.0262	20852	0.027356	0.528	0.173	0.397	0.519	0.393	0.188	0	0	0	0	0	27	86			54
48211950200	0.1321	0.0335	15682	0.043577	0.622	0.282	0.706	0.759	0.628	0.666	0	0	0	0	0	3				386
48213950100	0.1266	0.0457	18155	0.008667	0.604	0.458	0.543	0.087	0.417	0.57	0	0	0	0	0					856
48213950200	0.1524	0.0452	16263	0.029316	0.682	0.451	0.667	0.559	0.624	0.609	0	0	0	0	0				6	782
48213950300	0.1234	0.0266	19551	0.02544	0.592	0.179	0.462	0.476	0.422	0.554	0	0	0	0	0				82	1229

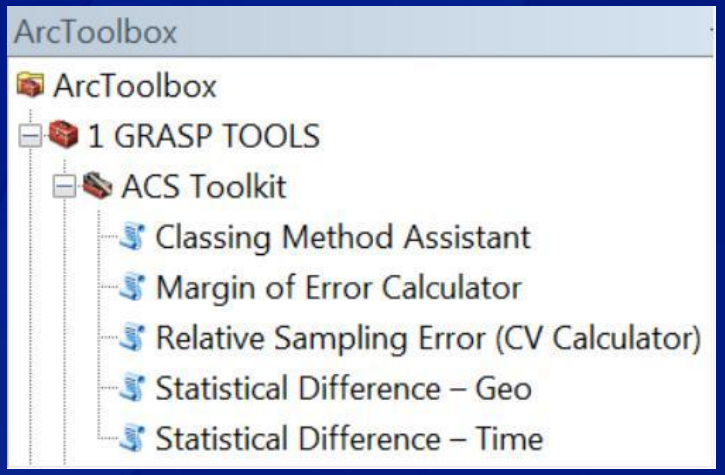
Record: 65081 Show: All Selected Records (0 out of 65081 Selected) Options

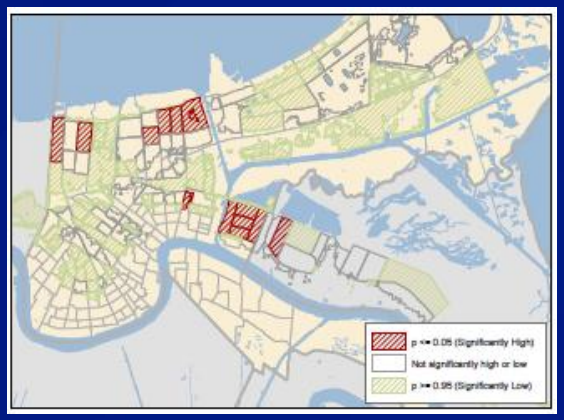


SVI Toolkit Components

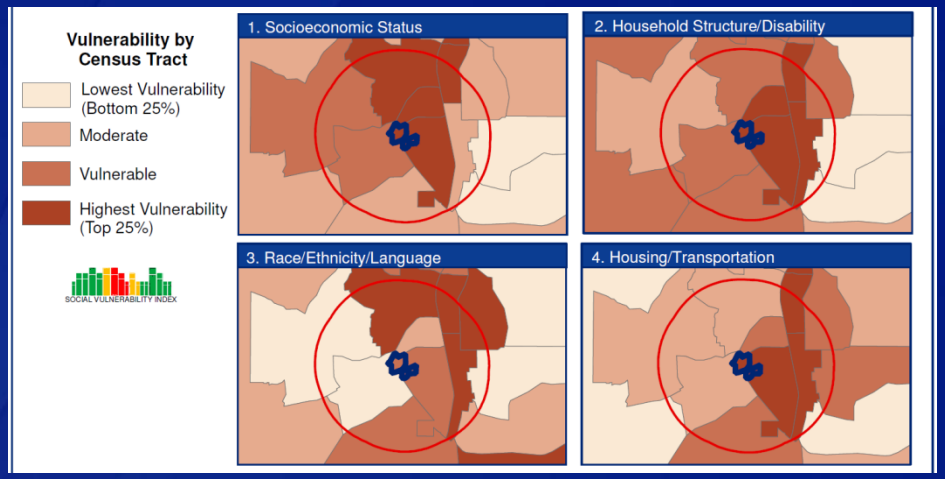
- **GRASP Tools (ArcGIS required) – among others:**

American Community Survey Tool



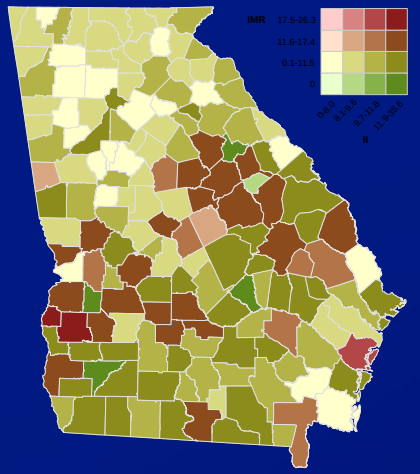


Poisson Probability Calculations

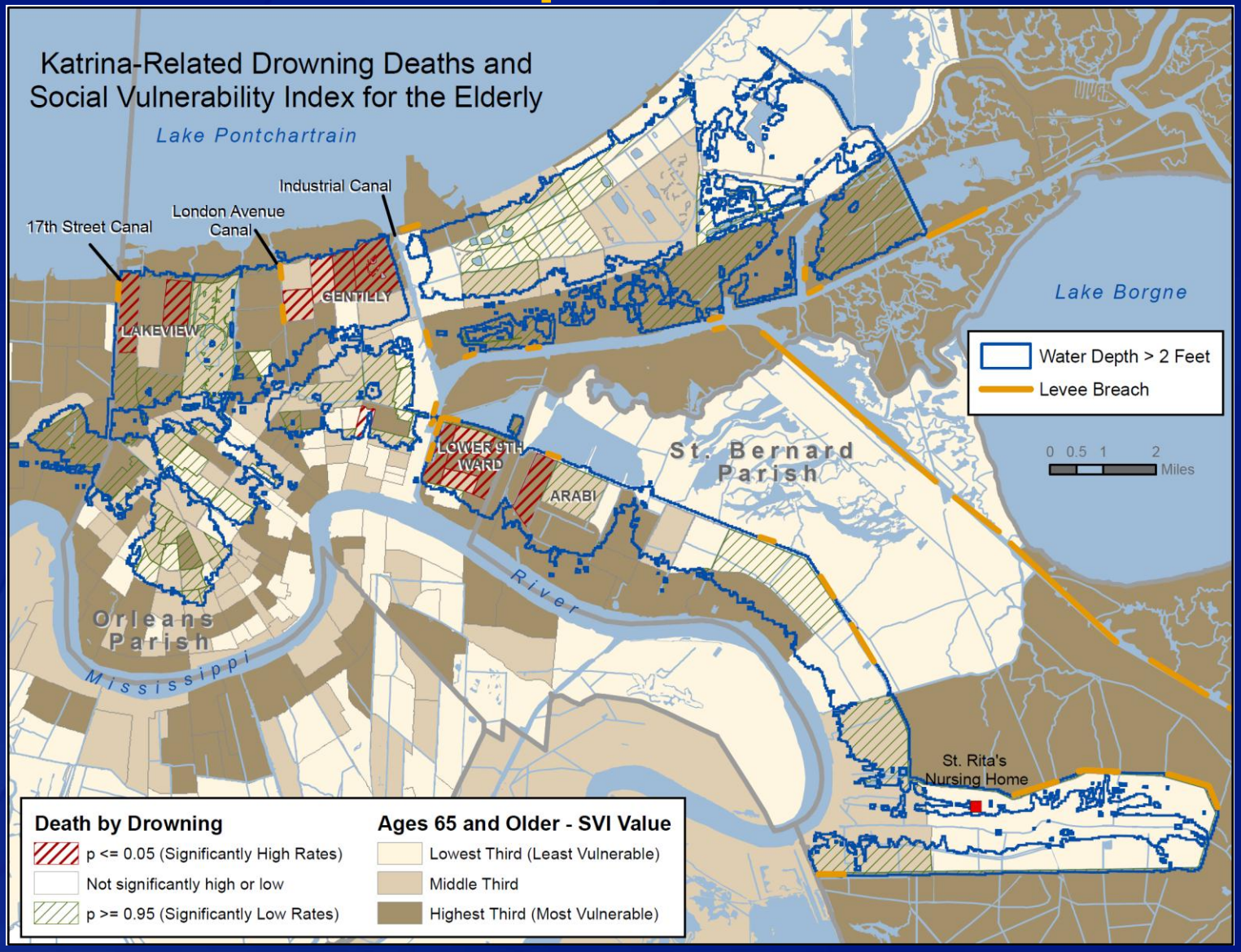


Area Proportion Estimation

Bivariate Choropleth Mapping

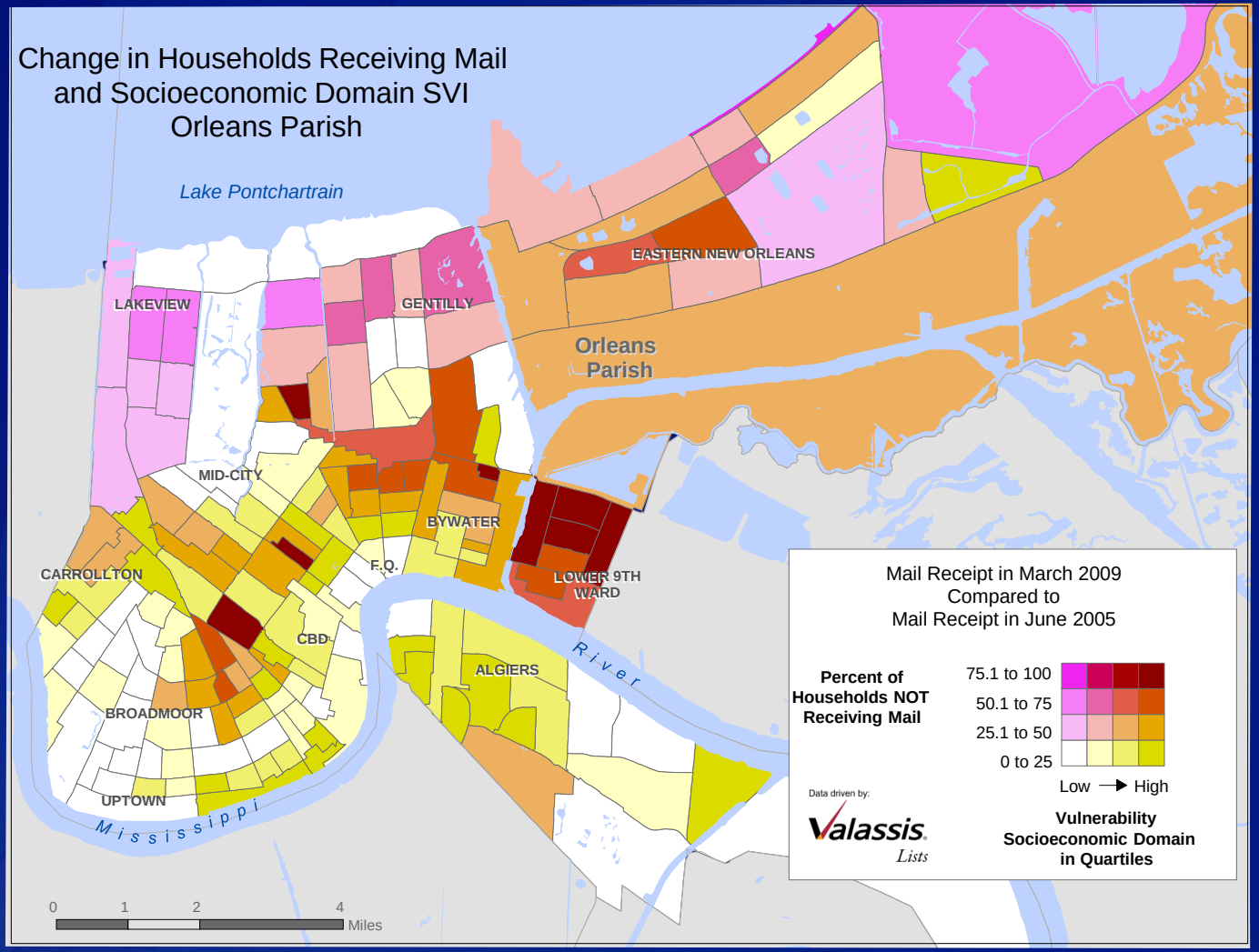


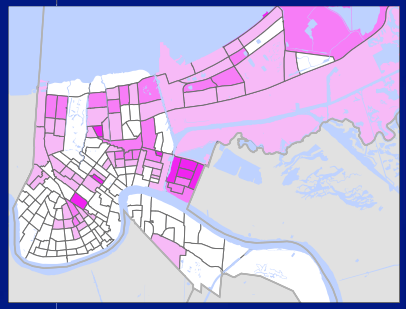
SVI products



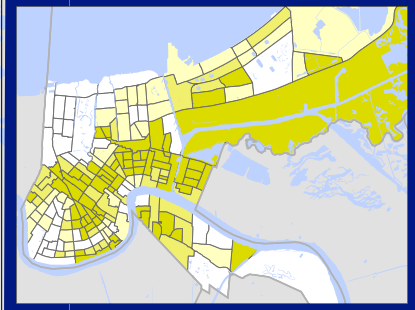
SVI products

Hurricane Katrina





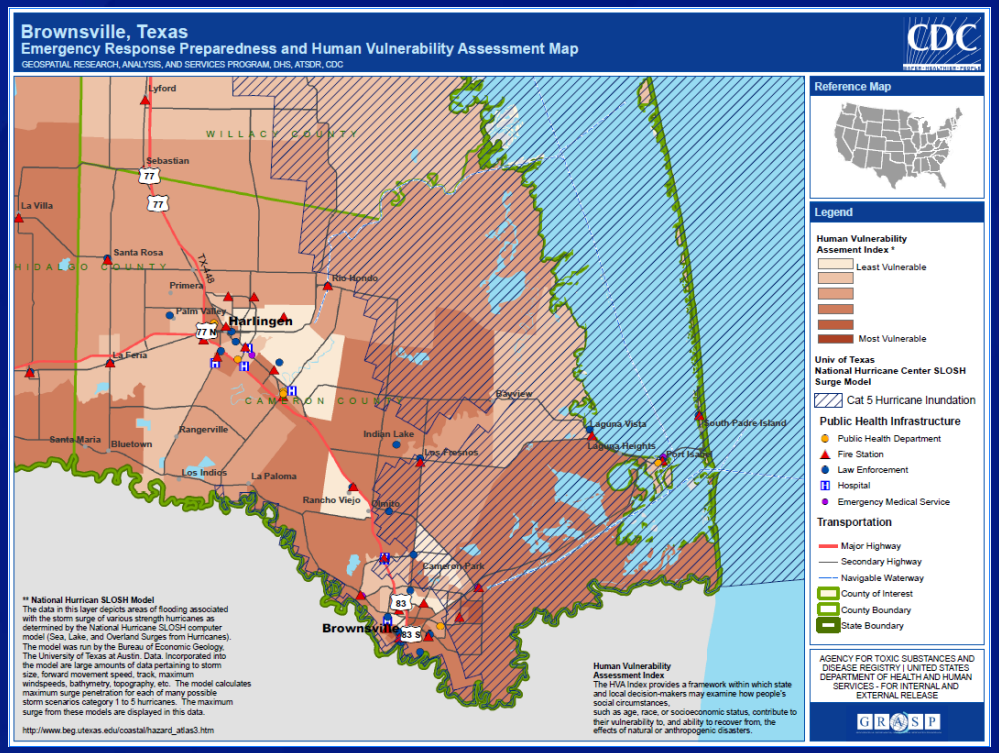
Change in Mail Receipt



SVI Socioeconomic Theme

SVI Users

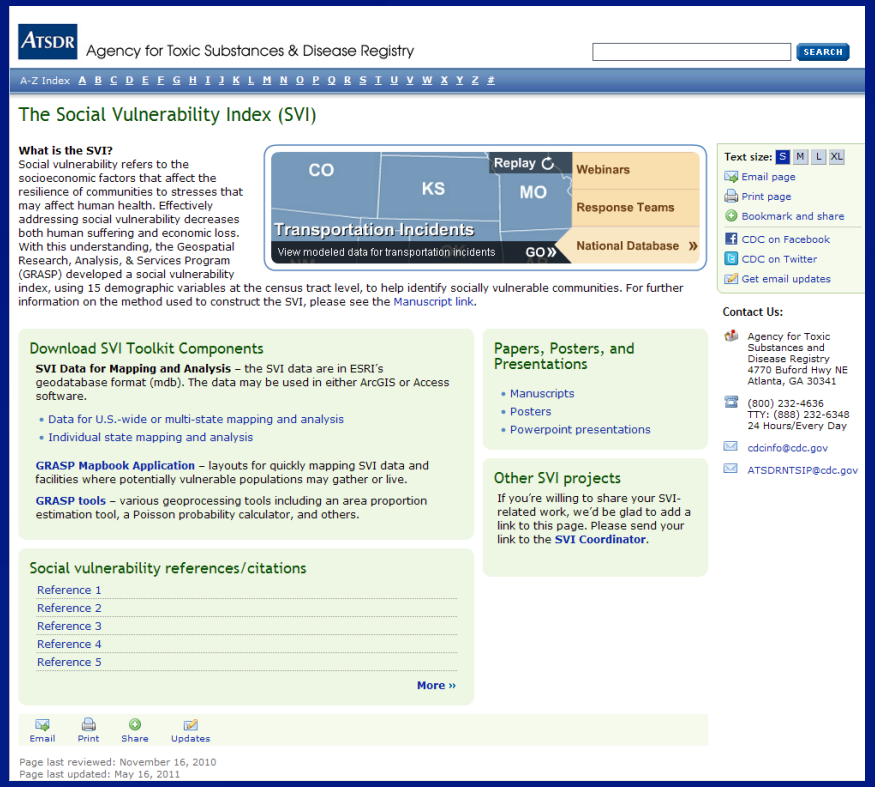
- CDC Emergency Operations Center
- NTSIP (Work at CDC and in Louisiana and Tennessee)
- UNC Center for Public Health Preparedness
- Others



Source: GRASP, 2008. Map integrating SVI and SLOSH (Sea , Lake, and Overland Surges from Hurricanes) Model

The Road Ahead…

- **SVI Website**
  - Facilitate data/tool sharing and promote a community of SVI data users
  - Interactive SVI mapping application
  - Downloadable SVI Data for 2000 and 2010
  - Downloadable SVI Toolkit
  - Publications, presentations, references, citations and other materials
  - SVI Community projects



Project Team

- **Geospatial Research Analysis & Services Program (GRASP) Team:**
  - Andrew Dent, MA, MBA; Program Director
  - Barry Flanagan, PhD; Geographer
  - Elaine Hallisey, MA; Geographer/GIS Analyst – SVI Contact
  - Brian Lewis, BS; Statistician
  - Caitlin Mertzlufft, MPH; GIS Analyst

Comments and Questions

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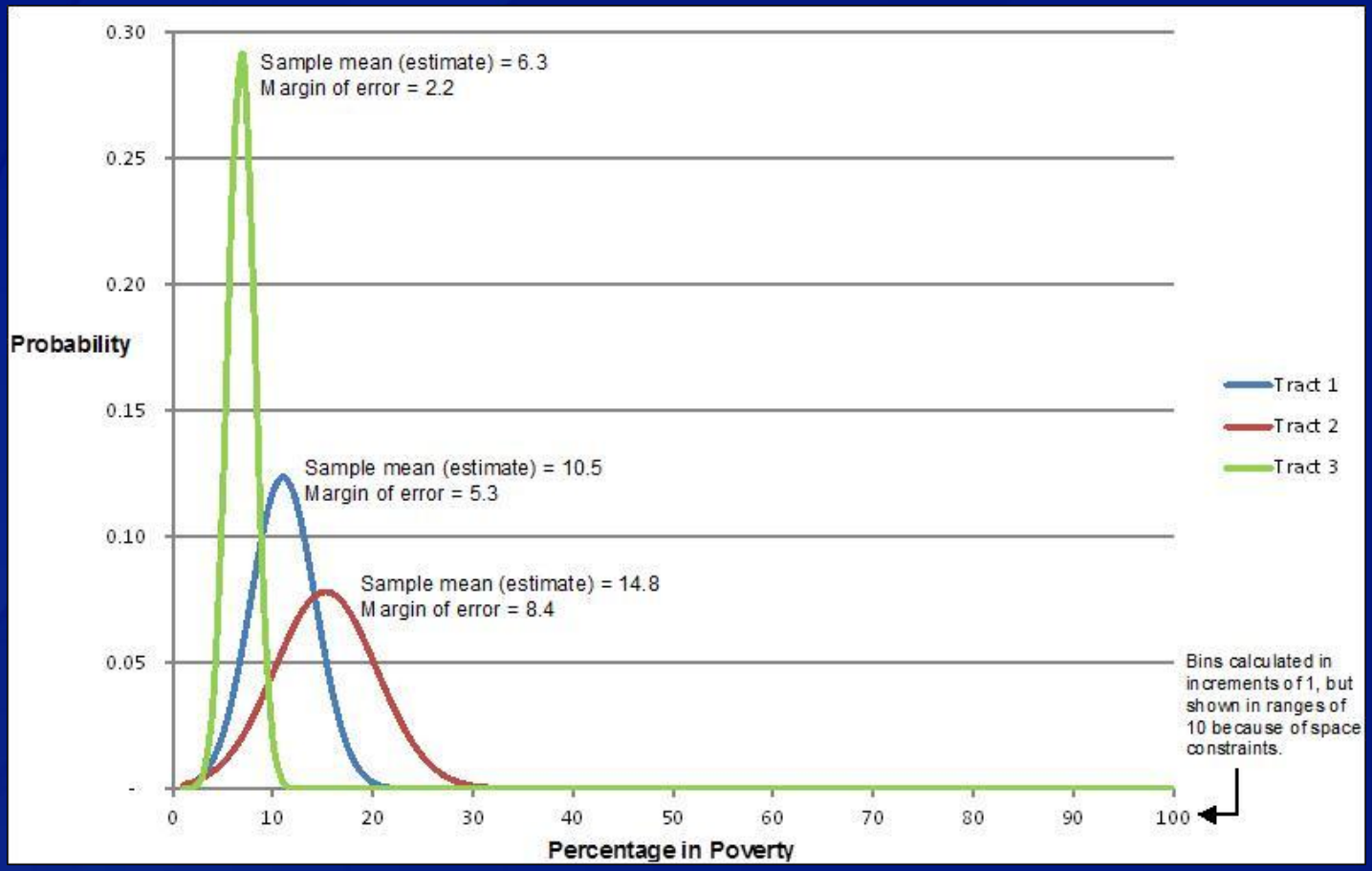
Data & Methods
SVI 2010

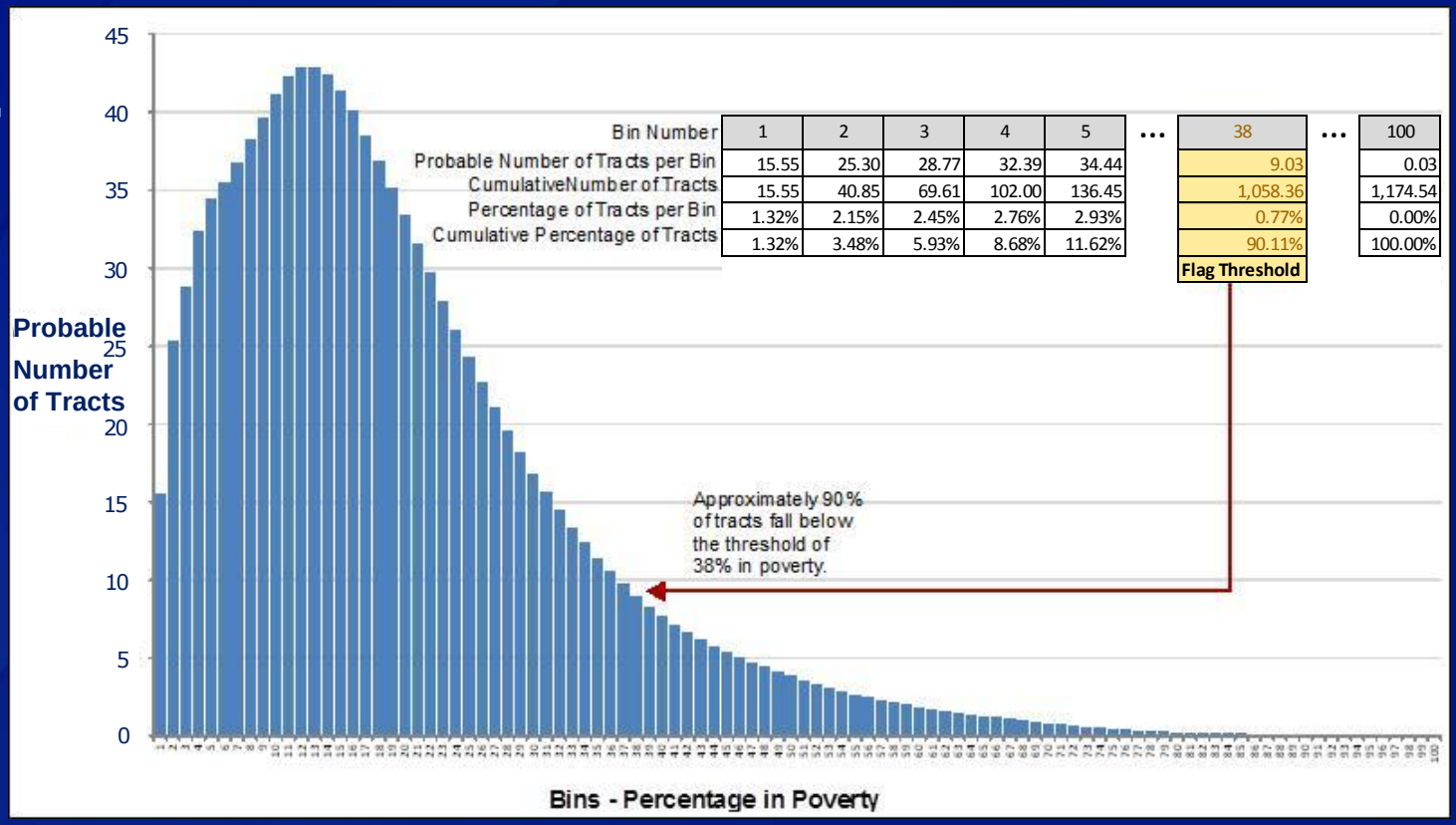
Probability method for ACS data – Step 1:



Probability curves (sampling distributions) based on estimate and margin of error were built for each tract for each ACS variable. Here we show percentage in poverty curves for three sample tracts in Alabama.

Data & Methods
SVI 2010

Probability method for ACS data – Step 2:



Bin Number	1	2	3	4	5	...	38	...	100
Probable Number of Tracts per Bin	15.55	25.30	28.77	32.39	34.44		9.03		0.03
CumulativeNumber of Tracts	15.55	40.85	69.61	102.00	136.45		1,058.36		1,174.54
Percentage of Tracts per Bin	1.32%	2.15%	2.45%	2.76%	2.93%		0.77%		0.00%
Cumulative Percentage of Tracts	1.32%	3.48%	5.93%	8.68%	11.62%		90.11%		100.00%
							Flag Threshold		

Probability curves for all tracts were summed to create a total distribution curve for each ACS variable. Here we see the total distribution curve for poverty in Alabama. The tracts falling in Bin 5, roughly numbering 34, are assigned the Cumulative Percentage of Tracts value for Bin 5, or 11.62, as their probability ranking.