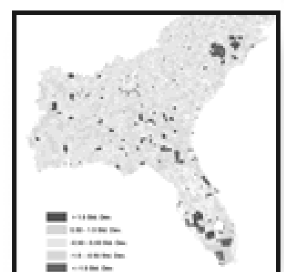
IWR White Paper

February 2013

Social Vulnerability Analysis: A Comparison of Tools



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Social vulnerability analysis is one of the most important and widely used methods for informing and addressing Other Social Effects in the Corps water resources planning process.

The U.S. Army Corps of Engineers Institute for Water Resources (IWR) has recently published a handbook on social vulnerability analysis that provides two practical methods for performing it (Dunning and Durden 2011).

The purpose of this whitepaper is to provide the rationale for the choice of the Social Vulnerability Index (SoVI) as the foundational social vulnerability method for characterizing social vulnerability as employed in the IWR handbook. To accomplish this goal four SVA tools are compared and contrasted in the whitepaper: the SoVI; Social Vulnerability Mapping Tools; the NOAA Roadmap for Adapting to Coastal Risk workshop process; and the ESRI USA-Social Vulnerability thematic mapping application.

Social Vulnerability Analysis: A Comparison of Tools

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February 2013

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Social Vulnerability Analysis: A Comparison of Tools

Abstract

Social vulnerability analysis (SVA) is one of the most important and widely used methods for informing and addressing Other Social Effects in the Corps water resources planning process. The Corps of Engineers' Institute for Water Resources (IWR) has recently published a handbook on SVA that provides two practical methods for performing SVA (Dunning and Durden 2011). The purpose of this whitepaper is to provide the rationale for the choice of the Social Vulnerability Index (SoVI) as the foundational SVA method for characterizing social vulnerability as employed in the IWR handbook. To accomplish this goal four SVA tools are compared and contrasted in the whitepaper: the SoVI; Social Vulnerability Mapping Tools; the NOAA Roadmap for Adapting to Coastal Risk workshop process; and the ESRI USA-Social Vulnerability thematic mapping application. The following information is provided for each tool/method: brief overview and description, data and methods employed to derive social vulnerability information, and general relevance to Corps of Engineers water resources planning requirements. A summary section compares and contrasts each tool. The conclusion of the whitepaper is that while all of the tools can profitably be used for Corps water resources planning applications the SoVI, with its extensive history of development and improvement; its wide recognition in peer-reviewed articles and reports as the standard for social vulnerability characterization; and continuing support by its originators at the University of South Carolina to extend and improve the tool, justifies its selection in the handbook as the primary tool for Corps SVA applications.

Introduction

Social vulnerability *refers to "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, or recover from the impact of a hazard" (Wisner et al. 2004). Social vulnerability is most apparent after a hazard event has occurred, when different patterns of suffering and recovery are observed among certain groups in the population, e.g., the aged, the poor, minorities (Cutter et al. 2000, Heinz Center 2000, Cutter and Finch 2003, Warner 2007). Such groups may not only be least prepared for an emergency but also may often live in more hazardous locations, in substandard housing, have the fewest resources, and lack knowledge and/or sense of political efficacy to claim access to resources to assist in recovery (National Research Council 2006, p. 73).* ***Social Vulnerability Analysis (SVA)*** *describes the relationship between social characteristics and vulnerability to hazards (better documenting who is at risk) and the distribution of tangible and intangible hazard effects (primarily focusing on impacts described in the Other Social Effects account)*

(Dunning and Durden, 2011, p. 2)

Social Vulnerability Analysis (SVA) has emerged as one of the most important and widely used methods for addressing Other Social Effects (OSE) concerns. While social vulnerability is a subset of the issues that would likely be addressed in a full OSE analysis it is one of the most compelling and important areas to consider (see Text Box 1). Since 2010 the Institute for Water Resources has been working to provide Contemporary analytic tools and methods to facilitate social vulnerability analysis on Corps of Engineers projects. Early in this process the team developing the overall SVA approach selected the “Social Vulnerability Index” (SoVI) as its basic method for characterizing social vulnerability. The primary purpose of this whitepaper is to provide the rationale for the choice of this method by comparing and contrasting the SoVI with several other approaches for addressing social vulnerability issues in planning situations.

Text Box 1

Social Vulnerability Factors and Their Implications During and After a Hazard Event

Social impacts of hazard exposure often fall disproportionately on the most vulnerable people in a society – the poor, minorities, children, the elderly, and the disabled. These groups often have the fewest resources to prepare for a flood, live in the highest-risk locations in substandard housing, and lack the knowledge or social and political connections necessary to take advantage of resources that would speed their recovery. Some of the most commonly referenced vulnerability characteristics are summarized in the table below.

Vulnerability Factor	During Event	Recovery
Low income/Poverty Level	Lack of resources may complicate evacuation	Lack of resources may hinder ability to recover
Elderly/Very Young	Greater difficulties in evacuation, more health and safety issues, potential for higher loss of life	May lack resources, willingness, ability to rebound
Disabled	Greater difficulties in evacuation, special health and safety issues, potential for higher loss of life	Lack of facilities and medical personnel in aftermath may make it difficult to return
Female-headed Households	Lack of resources and special needs may complicate evacuation	Lack of resources may hinder ability to recover
Minorities	Lack of influence to protect interests; lack of connections to centers of power or influence	Lack of influence to protect interests; lack of connections to centers of power or influence
Occupants of Mobile Homes/ Renters	Occupy more vulnerable housing	Potential displacement with higher rents
Transient/Homeless	Difficult to locate and provide information to; difficult to estimate numbers	

Source: Dunning and Durden, 2011, p. 8.

Tools Described in this Paper

The four tools discussed in this paper all offer valuable insights about social vulnerability; however, each have different strengths and weaknesses for water resources planning applications.

The following tools are profiled in this paper:

- Social Vulnerability Index (SoVI) (University of South Carolina, Hazards and Vulnerability Research Institute)
- Social Vulnerability Mapping Tools (Texas Coastal Planning Atlas)
- Roadmap for Adapting to Coastal Risk (NOAA, Coastal Services Center)
- USA – Social Vulnerability Thematic Maps (ESRI)

The following information is provided for each tool:

- Developed by (who developed the tool, and internet reference information)
- Overview (summary description of the tool)
- Data and methods (social vulnerability data used by the tool, and pertinent information about data transformations employed)
- Implications for application in water resources planning application (general considerations for use of the tool in Corps water resources planning)

Social Vulnerability Index (SoVI)

Developed by:

Susan Cutter and associates at the University of South Carolina, Hazards and Vulnerability Research Institute. Internet reference: http://webra.cas.sc.edu/hvri/products/sovi.aspx

Overview and Purpose:

The Social Vulnerability Index, originally formulated by Cutter et al. (2003), is a comparative metric that provides a snapshot of an area's relative social vulnerability to a range of hazards. The index is created by synthesizing socio-economic variables through a process called *principal components analysis*[1]. The variables employed to create the index were selected based on extensive disaster and social science research. Additionally, the research team led by Susan Cutter at the University of South Carolina's Hazards and Vulnerability Research Institute continually researches social vulnerability methods and concepts to improve and update the index. The index has been extensively tested and referenced in numerous peer-reviewed journals, and is the most widely referenced index for social vulnerability assessments (Tate, forthcoming).

[1] Principal component analysis (PCA) involves a mathematical procedure that transforms a number of possibly correlated variables into a smaller number of uncorrelated variables called *principal components*. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible (Dunteman 1989).

Data and Methods:

The original SoVI (termed SoVI 2000) formulation used county-level census data from the 2000 Census and employed 42 variables for county-level information. For smaller areas such as census tracts SoVI 2000 employed 32 variables owing to the lack of census data coverage at smaller units (see, Cutter, et al., 2009). After the release of the 2000 Census the Census Bureau introduced the American Community Survey (ACS) to collect, by sampling, some of the small area data that had previously been collected in the decennial census. These data are collected using small area samples and are aggregated over a five-year period. The first SoVI developed to utilize these new data collection procedures is termed SoVI 2005-2009 to reflect the five-year period of data collection in the variables presented. This SoVI is comprised of 30 variables. With the release of the 2010 Census, a SoVI 2006 – 2010 has been released and is comprised of ACS 2006-2010 small area sample information and 2010 decennial census information. Table 1 specifies the 30 variables employed in the SoVI 2006-2010.

Table 1. SoVI 2006-2010 Variables

VARIABLE	**DESCRIPTION**
QBLACK	Percent Black
QNATAM	Percent Native American
QASIAN	Percent Asian
QHISP	Percent Hispanic
QAGEDEP †	Percent of Population Under 5 years Old or 65 and Over
QFAM †	Percent of Children Living in Married Couple Families
MEDAGE	Median age
QSSBEN	Percent of Households Receiving Social Security
QPOVTY	Percent Poverty
QRICH200K	Percent of Households Earning > $200,000 Annually
PERCAP	Per Capita Income
QESL †	Percent Speaking English as a Second Language with Limited English Proficiency
QFEMALE	Percent Female
QFHH	Percent Female Headed Households
QNRRES	Percent of Population Living in Nursing and Skilled-nursing Facilities
HOSPTPC	Hospitals Per Capita (County, Tract Levels ONLY)
QNOHLTH †	Percent of Population Without Health Insurance
QED12LES	Percent with Less Than 12th Grade Education
QCVLUN	Percent Civilian Unemployment
QURBAN	Percent Urban Population (County, Tract Levels ONLY)
POPDENS	Population per Square Mile (Block Group Level ONLY)
PPUNIT	People Per Unit
QRENTER	Percent Renters
MDHSEVAL †	Median House Value
MDGRRENT †	Median Gross Rent
QMOHO	Percent Mobile Homes
QEXTRCT	Percent Employment in Extractive Industries
QSERV	Percent Employment in Service Industries
QFEMLBR	Percent Female Participation in Labor Force
QNOAUTO †	Percent of Housing Units with No Car
† Denotes new variables included in the SoVI 2006-2010	

Figure 1 shows a SoVI distribution computed for census tracts in the Corps' South Atlantic Division (SAD) using the SoVI 2000 formulation. The census tracts colored pink or red have SoVI scores that place them at the upper ends of the distribution of social vulnerability (i.e., greater vulnerability). In contrast, the tracts colored light blue or dark blue have social characteristics that place them on the lower end of the distribution for social vulnerability. The interpretation of the SoVI is that, other things being equal, a red or pink-colored tract has more of the characteristics associated with social vulnerability that would place it at higher risk of incurring more and/or more severe negative social impacts should a hazard event occur than the tracts colored light or dark blue. Figure 2 illustrates this concept using the normal distribution and z-scores[2]. Using the criteria shown in the map in Figure 1 (i.e., scores ≥ .5 standard deviation), approximately 30 percent of tracts would be classified as having more of the characteristics associated with higher social vulnerability than the other tracts.[3]

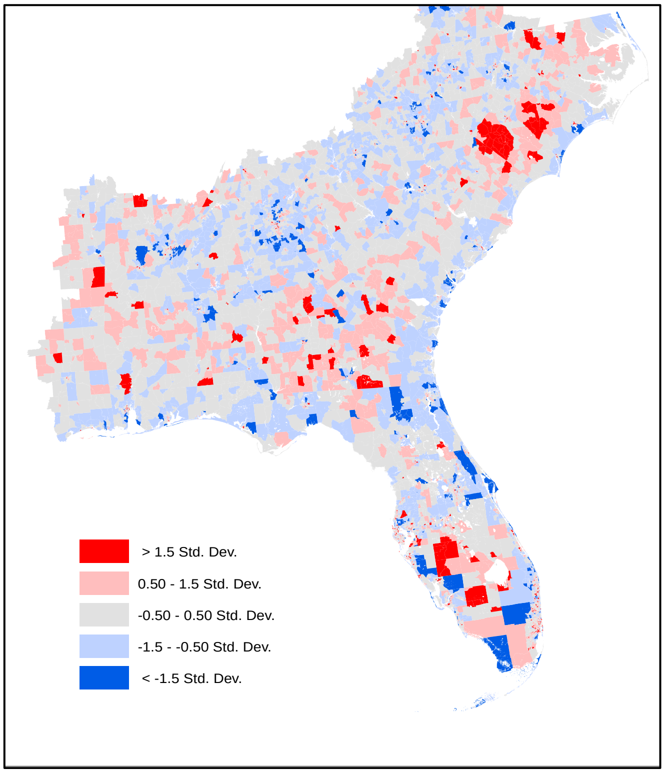


Figure 1. South Atlantic Division Census Tract SoVI (2000) Scores

[2] Z-scores indicate how many standard deviations an observation is above or below the mean and provide a way of identifying unusually vulnerable or unusually invulnerable areas.

[3] The choice of the z-score level to differentiate highly vulnerable areas from areas of "average" vulnerability is arbitrary. While common scientific usage considers scores of ± 2 σ to be in a "normal" range, and restricts the extraordinary to 5 percent (or fewer) of cases, the SoVI methodology generally employs a less restrictive score to call attention to a greater number of potentially vulnerable areas.

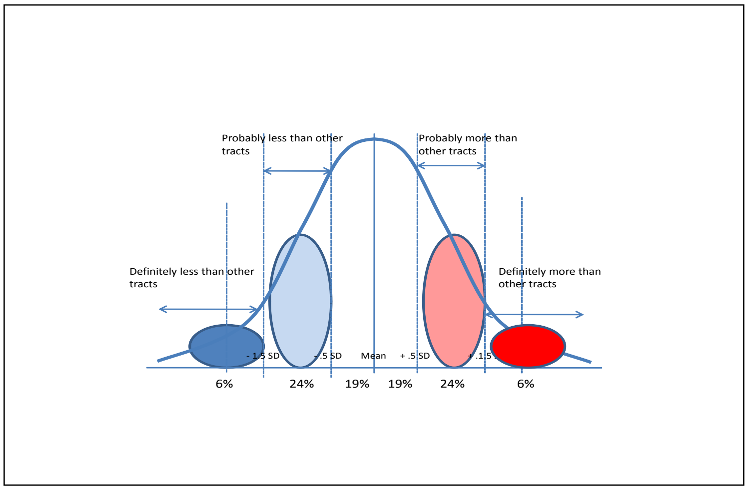


Figure 2. Using Z-Scores to determine social vulnerability categories

A powerful feature of the SoVI is its ability to break down the overall SoVI score into subcomponent "drivers" of vulnerability thus allowing a more detailed understanding of social vulnerability factors. For example, Table 2 shows a hypothetical study area comprised of 27 census tracts,. Examining the scores on the particular dimensions comprising the total SoVI score can yield important insights into determinants of vulnerability in the study area. For example, eight tracts have a high factor score on an *Elderly* dimension comprising census variables P*ercent of Population 65 or over*, P*ercent of Population Collecting Social Security Benefits,* and M*edian Age,* while eight tracts (some of them the same, some different from those with high-elderly populations) have high scores on a *Race and Class* dimension comprising variables P*ercent Living Below Poverty Level, Percent African American, and Percent Female-headed Households.* Finally, seven tracts have a summed social vulnerability score that identifies them as being highly socially vulnerable areas.

Table 2. SoVI Scores Showing Drivers of Vulnerability for Example Study Area Census Tracts

Census tract	Popula-tion	Race and class	Elderly	Housing tenure	Gender	Urban/ rural	Unemployed-female-headed households	Hospitals	Extractive industry	SoVI score
1	1215					X	X	X	X	X
6.01	4034	X	X			X			X	X
32	1111	X	X	X			X			X
33.01	1995	X	X	X	X	X				X
33.02	1851	X	X	X	X					X
36.01	3000	X		X		X				
40.02	3891							X	X	
41	2066			X						
42.02	8312					X			X	
42.05	9888			X				X		

Census tract	Popula-tion	Race and class	Elderly	Housing tenure	Gender	Urban/ rural	Unemployed-female-headed households	Hospitals	Extractive industry	SoVI score
42.06	1693			X	X					
101.01	2084	X		X			X			X
101.02	3738							X		
105.01	4720	X				X			X	
106.01	5685									
106.03	1848									
107	4484	X	X	X		X				
108.04	8331			X		X			X	
108.05	9241									
109.01	3652									
109.02	1170				X					
110.02	6958		X	X			X			X
110.03	6161			X	X				X	
110.04	3767		X	X	X					
111.01	7952									
111.03	3696		X							
111.05	9325			X	X					
TOTAL	123756									

Note: An X in a cell indicates that the SoVI score was at least ≥0.5, indicating higher levels of social vulnerability for the dimension or total SoVI score

Source: Dunning and Durden 2011, Table 8.

Implications for Planning Application:

The SoVI is widely used and cited in hazard research and management. The University of South Carolina's Hazards and Vulnerability Research Institute (HVRI) maintains a SoVI website (http://webra.cas.sc.edu/hvri/products/sovi.aspx) that provides information on the index and where it is being used. The method helps focus attention on critical social vulnerability issues and by so doing can better ensure that such concerns are addressed in the planning process. The information on drivers of social vulnerability provided by the SoVI dimensions can be particularly useful in helping to identify factors that may need to be addressed in planning. While the computation of the method can be somewhat daunting, the HVRI offers assistance and consultation. Because of its wide use the SoVI results may be capable of being compared and contrasted with other cases where it was employed to focus on issues of key drivers of vulnerability, and changes in vulnerability over time. The SoVI has been selected as the foundational method employed in the IWR SVA handbook: (www.**iwr**.usace.army.mil/Portals/70/docs/**iwr**reports/2011-R-07.pdf).

The SoVI, however, does present some challenges for use in a public planning context. First, the method is complex and uses a statistical procedure that is not easily communicated to a nonspecialized audience. Additionally, the relative nature of the SoVI's values can be difficult to understand, and results can be misinterpreted or misrepresented[4]. Members of the public may expect definitive answers about social vulnerability issues and might be less satisfied with answers that have to be couched as comparisons among areas.

Texas Coastal Planning Atlas: Social Vulnerability Mapping Tools

Developed by:

Walter Gillis Peacock, Himanshu Grover, Joseph Mayunga, Shannon Van Zandt, Samuel D. Brody, and Hee Ju Kim at the Hazard Reduction and Recovery Center, College of Architecture, Texas A&M University. Internet reference: http://archone.tamu.edu/hrrc/Publications/ResearchReports/

Overview & Purpose:

Social vulnerability (SV) mapping for the Texas Coastal Planning Atlas builds upon work performed by Susan Cutter and others to map social vulnerability. The mapping tool developed for the Texas Coastal Planning Atlas uses census block group-level information, to understand social vulnerability at a resolution that will allow planners and emergency managers to easily identify and potentially target areas of socially vulnerable populations. As Peacock, et al note:

Community vulnerability, in its broadest sense, describes the susceptibility of a community or, importantly, its constituent parts to the harmful impacts of disasters. Variation in existing vulnerabilities influences the exposure of households, businesses, and communities to effects of natural hazards as well as the capacity and resources available to respond to and recover from disasters. In other words, storms like Ike were and are not "equal impact" events—they affect different groups, sub-populations and neighborhoods in different ways. While some can easily anticipate and respond to hazard threats by putting up hurricane shutters or evacuating to relatives and friends further inland, others find it more difficult if not impossible. And then, in the aftermath of a devastating disaster, recovery can be highly uneven, with some parts of a community recovering relatively more quickly as insurance companies respond more readily, expediting their abilities hire contractors or builders to have their homes repaired

[4] See for example, the *Washington Post* article of April 5, 2008, "Terrorism Study Drops a Bomb on Boise" (Layton and Surdin, 2008) which notes, somewhat tongue-in-cheek, that a vulnerability study using the SoVI had concluded that Boise, Idaho, had ranked first among 132 American cities as most vulnerable in the event of a terrorist attack: *"Quick: Name the Western U.S. city most vulnerable to a terrorist attack. Is it Los Angeles, with its crowded roads that make quick escape impossible? San Francisco and its iconic bridge? Or Seattle with its Space Needle and busy port? Try Boise, Idaho, with its, um, potatoes."* The article included quotes that suggest that the research was suspect, since it placed targets such as San Francisco and Los Angeles further down the list. The researchers at HVRI responded by noting that the SoVI examines those pre-existing and past conditions/characteristics of people and places that influence an urban area's potential for harm from hazards and its ability to recover from hazards and that it was inappropriate to confuse threat and vulnerability.

or rebuilt, while others neighborhoods lag behind. The uneven nature of recovery can jeopardize the overall vitality and resiliency of a community and bring into question its future.

Peacock, et al, p.3

Key Data & Methods:

Seventeen first order social vulnerability indicators selected on the basis of hazards and social vulnerability literature are employed (Table 3). Each of the indicators was transformed into a proportion by dividing it by an appropriate base. For example, indicator 1 below, the proportion of single parent households with children was derived by dividing the number of single parent households with children in each census block group by the total households in that block group. The first order indicators are combined to form 5 second order social vulnerability measures. The second order variables were computed by averaging the proportions of the first order indicators. For example, the proportions obtained for indicators 3 and 4 in Table 3 below were averaged to derive the second order social vulnerability measure of "Potential Elder Care Needs."The second order vulnerability measures identify populations with specific needs during emergency response, disaster recovery, or for considering mitigation programs. Finally, the 17 first-order social vulnerability indicator proportions can be averaged to calculate a **Social Vulnerability Composite Index**. This metric allows planners and emergency managers to identify a community's social vulnerability hotspots which can be overlaid with storm surge and other hydrologic data. Figure 3 illustrates a SV composite index for the Texas Coast.

Table 3. Social Vulnerability Indicators Used in Coastal Planning Atlas

Table 1. Social Vulnerability Indicators and 2nd and 3rd Order SV Measures

Base Social Vulnerability Indicators (percentages)	2nd Order	3rd Order
1. Single parent households with children/Total Households 2. Population 5 or below/Total Population	Potential Child care Needs	Socially Vulnerable Hotspot
3. Population 65 or above/Total Population 4. Population 65 or above & below poverty/Pop. 65 or above	Potential Elder Care Needs	
5. Workers using public transportation/Civilian pop. 16+ and employed 6. Occupied housing units without a vehicle/Occupied housing units (HUs)	Potential Trans. needs	
7. Occupied Housing units/Total housing units 8. Persons in renter occupied housing units/Total occupied housing units 9. Non-white population/Total population 10. Population in group quarters/Total population 11. Housing units built 20 years ago/Total housing Units 12. Mobile Homes/Total housing units 13. Persons in poverty/Total population	Potential Housing Needs (Temporary Shelter and housing recovery)	
14. Occupied housing units without a telephone/Total occupied HUs 15. Population above 25 with less than high school/Total pop above 25 16. Population 16+ in labor force and unemployed/Pop in Labor force 16+ 17. Population above 5 that speak English not well or not at all/Pop > 5	Potential Civic Capacity needs	

Source: Peacock, et al 2011

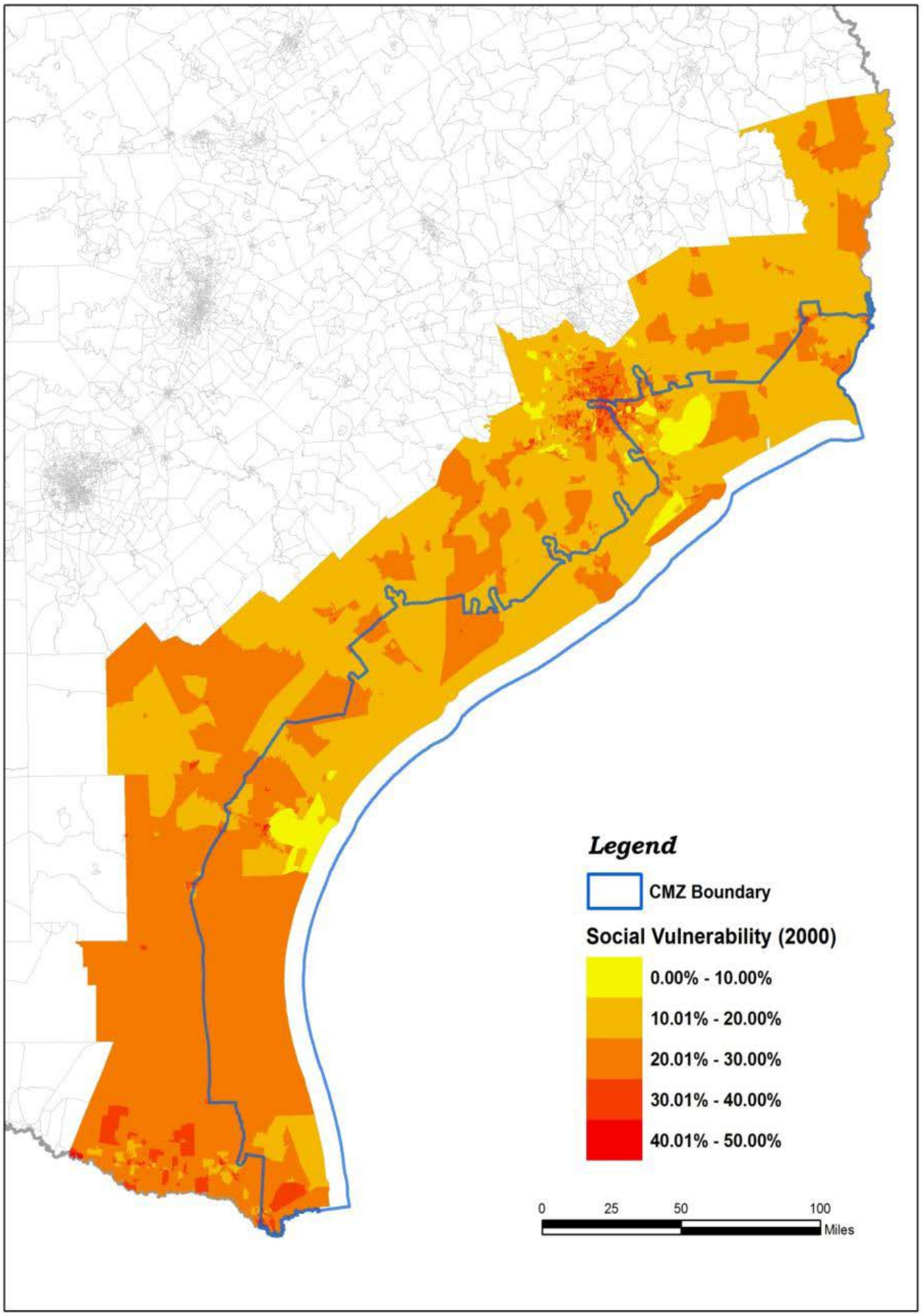


Figure 3. Social Vulnerability Measure for the Texas Coast
Source: Peacock, et al, p. 19

Of particular note is that Peacock's team also conducted personal interviews with 550 residents and was then able to perform a correlation analysis between experiences reported by residents aggregated by block group and the social vulnerability characteristics displayed at block group levels. An example of a correlation analysis is shown in Table 4 below. This table shows statistically significant relationships were present between a number of social vulnerability characteristics and rate of evacuation, as well as with the number of hours before landfall that residents evacuated. For example, block groups having high proportions of single family households with children present had lower evacuation rates (r= -.3021), block groups having high proportions of households without a vehicle were less likely to evacuate (r=-.238), and that similarly, block groups having high proportions of several social vulnerability characteristics were more likely to have evacuated with fewer hours to spare than other block groups (e.g. block groups having higher proportions of renter-occupied housing were more likely to have evacuated with fewer hours to spare, r= -.2499, etc.).

Table 4. Correlations between SV Indicators and Evacuation Response Data

Table 6. Correlations between SV indicators and Evacuation Response Data

	Evacuated	Evacuation time
SV Composite Measure	-.2463**	-.2909**
1st Order or Base Indicators		
Percent Single parent households with children	-.3021**	-.1618
Percent population 65 or older	.1124	-.1557
Percent Elders below poverty level	-.0900	-.0686
Percent employed dependent on public transportation	-.1961*	-.1893*
Percent occupied housing units without a vehicle	-.2380**	-.1763*
Percent population in renter occupied housing units	-.3776**	-.2499**
Percent non-white population	-.2231**	-.2532**
Percent pop. group housing	-.2041**	-.0348
Persons in poverty	-.2265**	-.2244**
Percent occupied housing units without a telephone	-.1284	-.1591
Percent population 25 or older w/o high school	-.1641	-.1330
Percent labor force unemployed for age above 16	-.0679	-.2303**
Percent 5 or older not speaking English well or not at all	-.1016	.0180
2nd Order Indices		
Public transportation needs	-.2492**	-.1962*
Civic capacity	-.1670*	-.1838*

Note: * indicates one-tail p≤.1; ** one-tail p≤.05.

Source: Table 6, Peacock, et al, p. 38

Implications for Planning Application:

Peacock's work illustrates how social vulnerability analysis can be productively applied using relatively easy to compute social vulnerability (SV) measures to address planning for disaster management and response issues. The correlation analysis demonstrates that SV measures are associated with the kind of outcomes of disasters that one would expect, thereby providing greater assurance in the validity of the SV measures and their utility in the planning process. As Peacock, et al note:

Results indicate that neighborhoods with higher percentages of single parent households, renters, households in poverty, and non-white households experienced lower evacuation rates. Not surprisingly, areas with higher concentrations of households without a vehicle and with workers dependent upon public transportation also saw lower evacuation rates. Many of these same vulnerabilities were associated with later evacuation times. Specifically, neighborhoods with higher proportions of renters, households in poverty, and minorities were more likely to have gotten off the island closer to the arrival time of the storm, which greatly jeopardized their evacuation, since water began creeping on the Island well in advance of the storm's impact, cutting off many evacuation routes.(p. 38).

On the whole, the ….Atlas's SV strategy and mapping tools can be utilized by coastal community planners and emergency managers to effectively identify areas within their own communities which, due to their social vulnerability characteristics, are going to have lower levels, capacities and abilities to, "anticipate, cope with, resist and recover from the impacts of natural hazards." (p. 49).

Roadmap for Adapting to Coastal Risk
National Oceanic and Atmospheric Agency (NOAA), Coastal Services Center

Developed by:

NOAA, Coastal Services Center. Internet reference:
http://www.csc.noaa.gov/digitalcoast/training/roadmap

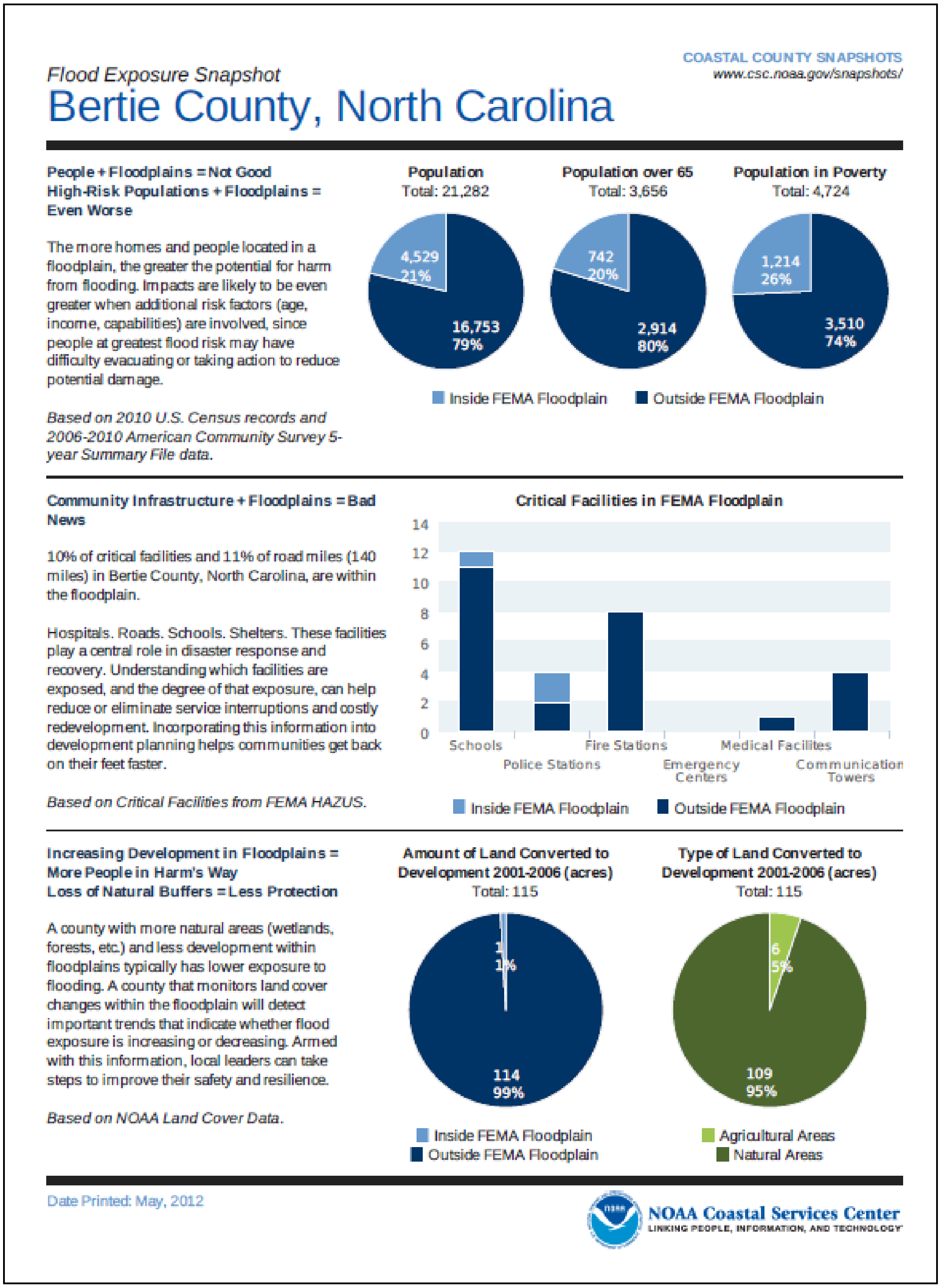
Overview & Purpose:

The Roadmap for Adapting to Coastal Risk is a participatory process for community planning that provides an opportunity to address hazards and climate change vulnerabilities in community development. The approach focuses on existing vulnerability issues such as water availability, stormwater management and runoff, and infrastructure maintenance and placement and indentifies how hazards and climate change can intensify these issues. Social vulnerability information is introduced as one of several factors that citizens and planners should consider in developing adaptive management strategies for coping with coastal risks. Through a collaborative process stakeholders evaluate potential hazard and climate impacts, learn how to plan for these impacts, and identify opportunities to improve resilience.

Key Data & Methods:

NOAA has developed a three-hour online training course to introduce the "Roadmap" approach and help communities understand their vulnerability to current and future hazards and climate threats and to assess how planning and policy efforts can help address these issues. The Roadmap website provides links to resources to help communities perform their own risk and vulnerability assessments including a section devoted to a Coastal Inundation Toolkit that provides communities with information to understand and address coastal flooding, identify risks, communicate risk and vulnerability information, and learn what others are doing to address the issue.

The “Roadmap” website provides “Flood Exposure Snapshots” (Figure 4) which provide a brief overview of county “populations at risk” based on age and wealth. Additionally, the website provides a link to the Social Vulnerability Index (SoVI) website (see SoVI description above) so that participants in the training workshop can obtain finer-grained detail on the composition and location of the most vulnerable portions of their populations.



Flood Exposure Snapshot

COASTAL COUNTY SNAPSHOTS
www.csc.noaa.gov/snapshots/

Bertie County, North Carolina

People + Floodplains = Not Good
High-Risk Populations + Floodplains = Even Worse

The more homes and people located in a floodplain, the greater the potential for harm from flooding. Impacts are likely to be even greater when additional risk factors (age, income, capabilities) are involved, since people at greatest flood risk may have difficulty evacuating or taking action to reduce potential damage.

Based on 2010 U.S. Census records and 2006-2010 American Community Survey 5-year Summary File data.

Community Infrastructure + Floodplains = Bad News

10% of critical facilities and 11% of road miles (140 miles) in Bertie County, North Carolina, are within the floodplain.

Hospitals. Roads. Schools. Shelters. These facilities play a central role in disaster response and recovery. Understanding which facilities are exposed, and the degree of that exposure, can help reduce or eliminate service interruptions and costly redevelopment. Incorporating this information into development planning helps communities get back on their feet faster.

Based on Critical Facilities from FEMA HAZUS.

Increasing Development in Floodplains = More People in Harm's Way
Loss of Natural Buffers = Less Protection

A county with more natural areas (wetlands, forests, etc.) and less development within floodplains typically has lower exposure to flooding. A county that monitors land cover changes within the floodplain will detect important trends that indicate whether flood exposure is increasing or decreasing. Armed with this information, local leaders can take steps to improve their safety and resilience.

Based on NOAA Land Cover Data.

Date Printed: May, 2012

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

Figure 4. NOAA Flood Exposure Snapshot provides a quick look at demographic and infrastructure information within flood zones.

Facilitated workshop:

A Roadmap workshop engages participants in answering the following questions:

- What are current hazard concerns?
- What are future hazard concerns?
- What are the impacts to populations, infrastructure, and natural resources based on current and future hazards and climate change concerns?
- What plans or policies could be better informed with this risk and vulnerability information and results?
- What actions could be taken to lessen these risks and their impacts?

Participants use maps and multimedia materials (news stories, photos, etc.) to develop storyboards highlighting specific vulnerabilities they are most concerned about. Participants evaluate the storyboards and community vulnerabilities to develop potential solutions to the issues. Figure 5 shows an example of a Roadmap workshop.

Figure 5. Example of Roadmap Workshop (source: Roadmap website, Miami-Dade Workshop)

The Roadmap workshop is often viewed as an important first step for translating the large, sometimes overwhelming climate adaptation goals into useful, "actionable" tasks for county managers. Some of the key outcomes of a Roadmap workshop include:

- Shared knowledge among participants about biological processes, infrastructure development, and planning techniques
- Identification of vulnerabilities that were unknown to many of the participants
- New solutions (many innovative, simple, and cheap) identified to help resolve issues and increase the sustainability of the county
- Use of the information and relationships forged through the workshop as a catalyst to evaluate current plans and identify opportunities for implementing improved sustainable land use, infrastructure, capital improvement, social programs, and environmental protection.

Implications for Planning Application

The Roadmap for Adapting to Coastal Risk is more a planning exercise than an explicit social vulnerability tool. The workshop process is not unlike many Corps planning workshops that are already routinely carried out in the course of planning studies. The flood exposure snapshots provide useful information about older and less affluent populations at risk in counties; however this level of detail may not conform to study area requirements. Nevertheless the approach provides a very useful and appealing model for integrating social vulnerability information into a planning process through engaging with a community.

USA – Social Vulnerability

Developed by:

ESRI. Internet reference:
http://www.arcgis.com/home/item.html?id=b5501cc71fe44f8d9a0df362ea6aebb3

Overview and Purpose:

ESRI has created an on-line thematic mapping application that presents a summary of the social vulnerability of the population in each block group in the United States. Social vulnerability is defined on the basis of eight variables that are derived from the early work of Susan Cutter (1997, 2000) (Table 5):

Table 5. ESRI Social Vulnerability Index Variables and Rationale for Inclusion in the Index

Variable	Vulnerability Rationale
-Number of persons < 18 years of age	May require more assistance during a hazard event
-Number of persons > 65 years of age	May require more assistance during a hazard event
-Number of females	Correlated with lack of resources
--Number of housing units	Indicator of where greatest number of people reside
- Number of non-whites	Often correlated with lack of resources. May have less ability to recover after a disaster
-Total population	Indicator of where greatest number of people reside
-Number of mobile homes	Lower structural quality poses increased risk in hazard event
-Mean house value	Surrogate measure for income, lack of resources for recovery

The social vulnerability score is presented as a total summed value of the eight values, and is also shown as a histogram of each of the eight variable scores. Scores for each of the eight social vulnerability variables are presented as a relative value of the block group in comparison to the block groups of the county in which the block group is located, and also in comparison to the block groups in the state in which the block group is located. Scores are computed on the following basis (see, Cutter, 1997, pp 17-18):

- Individual block group percentages (X) for social vulnerability variables are computed as the ratio of the number of persons in the block group with the SV characteristic divided by the total number of persons in the county or state with that SV characteristic:

  X=Number of persons in Block Group with Characteristic/Total number of persons in county/or state with Characteristic

- A block group's relative share of the SV characteristic for the county or state is computed by dividing that individual block group's percentage (X) by the block group having the maximum percentage of the SV characteristic in that county or state:

  Block Group SV Score= Block Group's percentage (X)/Maximum Block Group percentage for X in the county/or state

As noted by ESRI the intent of the application is to provide some insight into answering the following question "Where are the areas of relatively greater potential impact from disaster events within this state or county?" The application produces maps that display color-coded social vulnerability values (Figure 6), and allow users to pan in and zoom out to change scale and resolution.

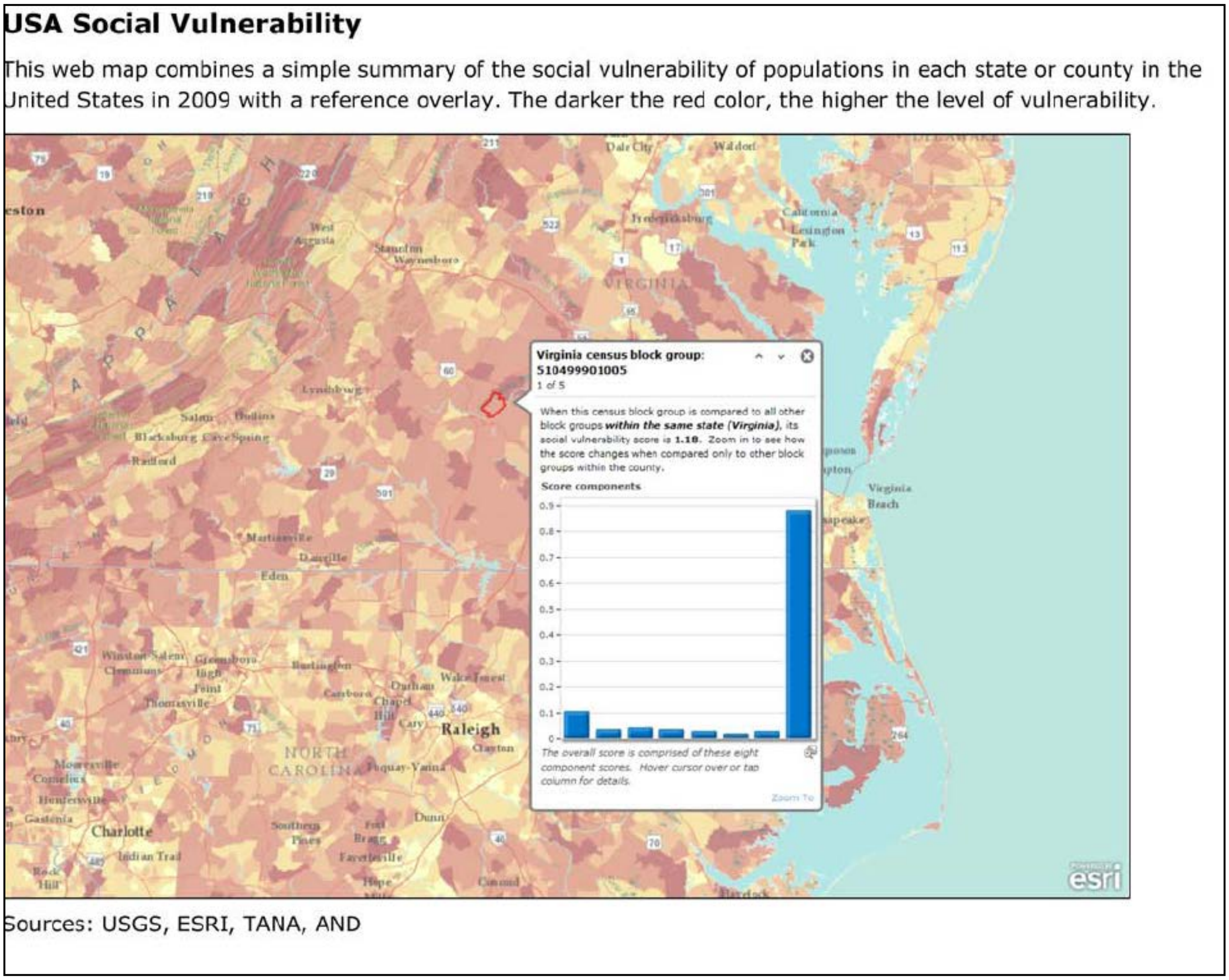


Figure 6. USA Social Vulnerability Map

Key Data and Methods:

The ESRI index uses information obtained from the American Community Surveys (ACS) collected during the period 2005-2009[5]. This data is currently based on 2000 Census geometry rather than the 2010 Census geometry (this discrepancy is likely to be resolved in the near future). As a result there are likely

[5] It is important to note that the census changed the way it collects data between the 2000 and the 2010 census, as well as the spatial boundaries of some of its enumeration districts. In the 2000 census a full range of socio-economic variables was collected. After the 2000 census however, the decision was made to only collect basic information about population, ethnicity, and housing characteristics in the 2010 census (this is so-called SF-1 level data which stands for census Summary File 1). Additional information about socio-economic characteristics that was resident in the 2000 census Summary File 3 would only be collected by samples conducted periodically, and presented as a rolling average of five years worth of samples in the American Community Survey (ACS) series.

to be inconsistencies within the data that are presented that having everything expressed in 2010 geometry and the most recent ACS sample data would minimize.

An additional issue that requires some understanding on the part of the user of the ESRI tool is the implication of the choice of the County or the State as the basis for evaluating the significance of social vulnerability differences among block groups that are shown. To illustrate this difference the example in Text Box 2 has been prepared. This example shows that the choice of the “parent area” can affect the magnitude of the social vulnerability scores that are obtained.

Text Box 2

Example Showing Impact of Choice of Parent Area on Social Vulnerability Scores in ESRI USA-Social Vulnerability Method

The use of the county and the state as the base against which relative SV scores are computed introduces considerable variation in SV values. The first table below shows SV scores for four hypothetical block groups (BG) computed using the county in which they are located as the "parent area" (i.e. the population base on which the relative scores are computed). As can be seen BG 1 has a score of 1.00 indicating that it has the highest SV score based on the computational algorithm which compares an individual BG score to the maximum BG score in the parent area. The second table shows the same block groups but uses the state as the parent area where the maximum BG score was based on a BG somewhere in the state having 500 mobile homes. Using the same computational formula it can be seen that the magnitude of SV scores for the block groups are quite different using the state as the parent area.

Block Group	# Mobile Homes in BG	# Mobile Homes in County	BG X	Mobile Home SV Score (BG X/ Max X BG county)
1	125	3,500	0.036	1.00
2	76	3,500	0.022	0.61
3	4	3,500	0.001	0.03
4	21	3,500	0.006	0.17

- Assume maximum number of mobile homes in a block group in the county = 125
- Maximum X county = 125/3,500 = 0.036
- SV Score for BG 1 = BG1/Max X County = 0.036/0.036 = 1.00

Block Group	# Mobile Homes in BG	# Mobile Homes in State	BG X	Mobile Home SV Score (BG X/ Max X BG state)
1	125	162,400	0.00077	0.248
2	76	162,400	0.00047	0.152
3	4	162,400	0.00002	0.0006
4	21	162,400	0.00012	0.0387

- Assume maximum number of mobile homes in a block group in the state = 500
- Maximum X state = 500/162,400 = .0031
- SV Score for BG 1 = BG1/Max X State = .00077/.0031 = .248

Implications for Planning Application:

Ease of access is a compelling feature of the ESRI application. However, questions about the adequacy of information, accuracy of census geometry, completeness of coverage of vulnerability by the measures used in the application, and the suitability of using only the county or the state as the basis for computing vulnerability scores reduce confidence in the use of the tool for detailed planning. In its description ESRI notes that its application provides a simplistic view of social vulnerability, and suggests that the Social Vulnerability Index (SoVI) be considered as a more complete method for determining and displaying social vulnerability, which captures the multi-dimensional nature of social vulnerability across space.

Comparison of Tools

Four social vulnerability analysis tools have been briefly described in this whitepaper. Each has been assessed for its applicability for Corps water resources planning, and each has been found to have strengths and limitations. These are briefly discussed in this section, and summarized in Table 6 below. In describing strengths and limitations it is important to stress that each of the tools described could be profitably used in Corps planning situations. However, it is noteworthy that all the methods described point to the work of Cutter and her colleagues in the development of the SoVI as either the general basis for their social vulnerability method, or as the suggested alternate approach should the user desire a more comprehensive method.

For this reason, the SoVI must be viewed as the standard for identifying social vulnerability information to be used in Corps planning studies. Certainly, the method presents challenges for use in planning studies – chiefly the complexity of developing the index, and difficulties in explaining its derivation and meaning to the public. However, the quality and detail of social vulnerability information it provides coupled with its recognition as the method of choice worldwide lends a great deal of credibility to the social vulnerability information it provides.

The work of Peacock et al, in the development of the Texas Planning Atlas is also exemplary and provides a very useful model for identifying and incorporating social vulnerability information in Corps planning processes. Readers who because of budget or time constraints elect not to employ the SoVI in their studies can easily replicate the methods employed by Peacock, et al. and create social vulnerability profiles for study areas. As noted, the current work of Peacock, et al uses 2000 census information; however, 2010 Census summary file 1 information, as well as American Community Survey information for 2006 – 2010 is now available so users can ensure that they have the most up-to-date information.

As already noted, the NOAA “Roadmap for Adapting to Coastal Risk” tool provides somewhat limited social vulnerability information focused on age and wealth issues at a county level of detail; however, it provides a sophisticated planning workshop process that could be profitably used in Corps planning studies.

Finally, the ESRI USA Social Vulnerability website provides an extremely accessible and easy to use view of several important social vulnerability indicators. In part the ease of use of this tool can also be something of a weakness in that users may be tempted to create social vulnerability profiles and draw conclusions without fully understanding the limitations and background assumptions of the tool. As noted in this paper the ESRI tool draws conclusions about social vulnerability measures on a county or state basis of comparison. For some Corps studies this level of comparison may be appropriate, however, it may be that other parent areas – e.g. the Metropolitan Statistical Area, the watershed, etc. – may be more appropriate, and provide a more accurate picture of the distribution of vulnerability for purposes of the study. Additionally, while the eight social vulnerability indicators provided in the ESRI tool are quite useful it is noteworthy that Peacock, et al use 17 indicators, and the SoVI uses 30 to examine a fuller range of social vulnerability factors.

Table 6. Comparison of SVA Tools Described in This Report

		Water Resources Planning Application	
SVA Tool	**SVA Information**	Strengths	Weaknesses
Social Vulnerability Index (SoVI)	Current version of the SoVI provides 30 census indicators representing common vulnerability issues. Index statistically creates a number (usually 6 – 9) dimensions of vulnerability by a statistical data reduction procedure	Widely used throughout the world for reporting on SV issues -generally recognized as the standard for SV information. HVRI continually researching and updating the method.	Complex method requires specialized knowledge and statistical expertise to implement.
Texas Planning Atlas	17 census indicators representing common vulnerability issues (	Provides an easy-to-replicate, yet powerful, model for addressing SV issues in planning process	Uses 2000 census information
Roadmap for Adapting to Coastal Risk	“Snapshot” profiles of population at risk for coastal counties. Links to Social Vulnerability Index for additional depth	Provides a well-thought out planning process framework for addressing SV issues in the context of building resilience to natural hazards	Planning “snapshots” somewhat limited in SV issues addressed (limited to population aged 65 and over; and population living in poverty).
USA Social Vulnerability	Eight census indicators representing common vulnerability issues	Very easy to access and obtain SV information	Limited coverage of SV information. Census information somewhat out of date. Comparison of social vulnerability to parent county or state may limit utility for planning purposes.

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U.S. Army Engineer Institute for Water Resources

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