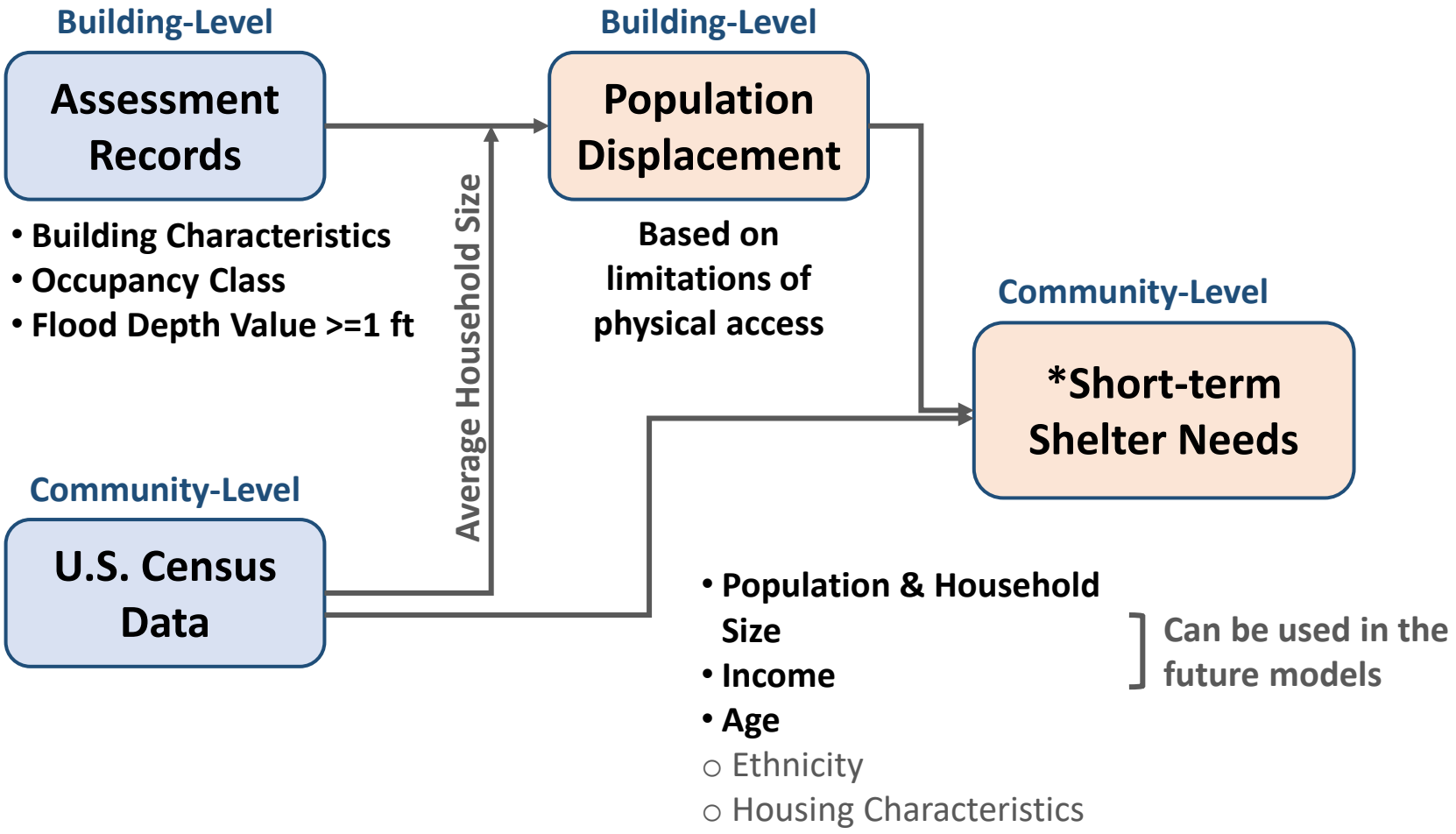
Berkeley County– Proposed Shelter Model



*According to FEMA (2017), *"A Short-Term Shelter is in an existing facility (or facilities), such as a school, community center, convention center, or church temporarily converted to provide safe, accessible, and secure short-term housing for disaster survivors."* It provides safe and accessible locations with a wide range of services for the survivors for up to two weeks.

Berkeley County– Displacement

BASE MODEL: Flood Model Hazus-MH Technical Manual
MODIFICATIONS: **Scale of calculations changed to buildings**

DATA:

- ***Hazard Occupancy Code*** and ***Flood Depth Value*** from assessment data of Berkeley County at the scale of buildings (Building Inventory)
- ***Average Household Size*** of the communities from census data (2017 American Community Survey (ACS) 5-Year Estimates downloaded from "American Fact Finder“)

METHOD:

- Extraction of the ***buildings*** located in flood zones with the depth value of 1 ft or more
- Estimating the number of the ***residential units*** in each building using the occupancy code
- Calculation of the estimated ***residing population*** in each building using the average household size of the community
- Adding the population of the buildings in each community

Berkeley County– Displacement

DEFINED EQUATION:

$$\#\mathbf{DI_{IN}} = \sum_{\mathbf{j=1}}^{\mathbf{n}} (\mathbf{ResUNIT_{IN}} \times \mathbf{AveHHSize_{COMM}})$$

Where:

$\#\mathbf{DI_{IN}}$ = the number of displaced individuals as a result of inundation with the depth equal or more than 1 foot

$\mathbf{ResUNIT_{IN}}$= the number of residential units in each building located within the area of inundation with the depth equal or more than 1 foot

$\mathbf{AveHHSize_{COMM}}$= the average household size of the community where the building is located

$\mathbf{j}$= the number of residential buildings within the flooded area with the depth equal or more than 1 foot

OBJECTID	Lat	Long	Flood Depth Value	Hazard Occupancy Code	Residential Units FLD Zones	Ave HH Size	Residing Population	Displaced Population 1ft or More	TRACTCE10	Block Group ID	BLOCKCE10	GEOID10	NAME10
535	39.2876158	-77.86459387	1	RES1	1	2.49	2.49	2.49	972505	540379725051	1047	540379725051047	Block 1047
536	39.2875983	-77.86462745	1	RES1	1	2.49	2.49	2.49	972505	540379725051	1047	540379725051047	Block 1047
537	39.2876014	-77.8647403	1.1	RES1	1	2.49	2.49	2.49	972505	540379725051	1047	540379725051047	Block 1047
538	39.2875286	-77.8648382	1.1	RES3A	2	2.49	4.98	4.98	972505	540379725051	1047	540379725051047	Block 1047
539	39.2868605	-77.86563603	N/A	RES1	1	2.49	2.49	0.00	972501	540379725011	1089	540379725011089	Block 1089
540	39.2867933	-77.86543516	1.4	RES1	1	2.49	2.49	2.49	972501	540379725011	1089	540379725011089	Block 1089
541	39.2864864	-77.86500677	0.1	RES1	1	2.49	2.49	0.00	972501	540379725011	1089	540379725011089	Block 1089
542	39.2870223	-77.86477163	0.4	RES1	1	2.49	2.49	0.00	972501	540379725011	1089	540379725011089	Block 1089
543	39.2871321	-77.86495628	0.2	RES1	1	2.49	2.49	0.00	972501	540379725011	1089	540379725011089	Block 1089

A part of the population displacement table at building level

Berkeley County– Shelter Needs

BASE MODEL: Flood Model Hazus-MH Technical Manual

MODIFICATIONS: **Income classes updated based on the inflation rate**

DATA:

- ***Displaced Population*** estimated in the previous part
- ***Household Income*** and ***Age*** from census data (2017 American Community Survey (ACS) 5-Year Estimates downloaded from "American Fact Finder“)

METHOD: Based on "Flood Model Hazus-MH Technical Manual", Chapter 13, at the scale of communities:

- Calculation of the percentage of households in the ***income classes***:
  - IM1: **HH Income per year < $20,000**
  - IM2: **$20,000 <= HH Income per year < $30,000**
  - IM3: **$30,000 <= HH Income per year < $50,000**
  - IM4: **$50,000 <= HH Income per year < $60,000**
  - IM5: **$60,000 <= HH Income per year**
- Calculation of the percentage of individuals in the ***age classes***:
  - AM1: Less than **15** years
  - AM2: **15** to **64** years
  - AM3: **65** years or more

Berkeley County– Shelter Needs

MODIFICATIONS TO INCOME CLASSES:

- The inflation rate of 1990 to 2017 (1.87) was slightly changed while applying to make the intervals match the census data

Income Class	Original and Hazus Models	Modified Model
IM1	HH Income < $10,000	HH Income < $20,000
IM2	$10,000 <= HH Income < $15,000	$20,000 <= HH Income < $30,000
IM3	$15,000 <= HH Income < $25,000	$30,000 <= HH Income < $50,000
IM4	$25,000 <= HH Income < $35,000	$50,000 <= HH Income < $60,000
IM5	$35,000 <= HH Income	$60,000 <= HH Income

Berkeley County– Shelter Needs

USED EQUATIONS:

$$\#\mathbf{STP} = \sum_{k=1}^{5} \sum_{m=1}^{3} [\alpha_{km} \times \mathbf{DP} \times \mathbf{HI_k} \times \mathbf{HA_m}]$$

Where:

$\#\mathbf{STP}$ = Number of people using established shelters

α_{km} = a constant calculated as below

$\mathbf{DP}$ = Displaced population by inundation with equal or more than 1 foot depth (from the previous stage)

$\mathbf{HI_k}$ = Percentage of population in the k^{th} income class

$\mathbf{HA_m}$ = Percentage of population in m^{th} age class

$$\alpha_{km} = (\mathbf{IW} \times \mathbf{IM_k}) + (\mathbf{AW} \times \mathbf{AM_k})$$

Where:

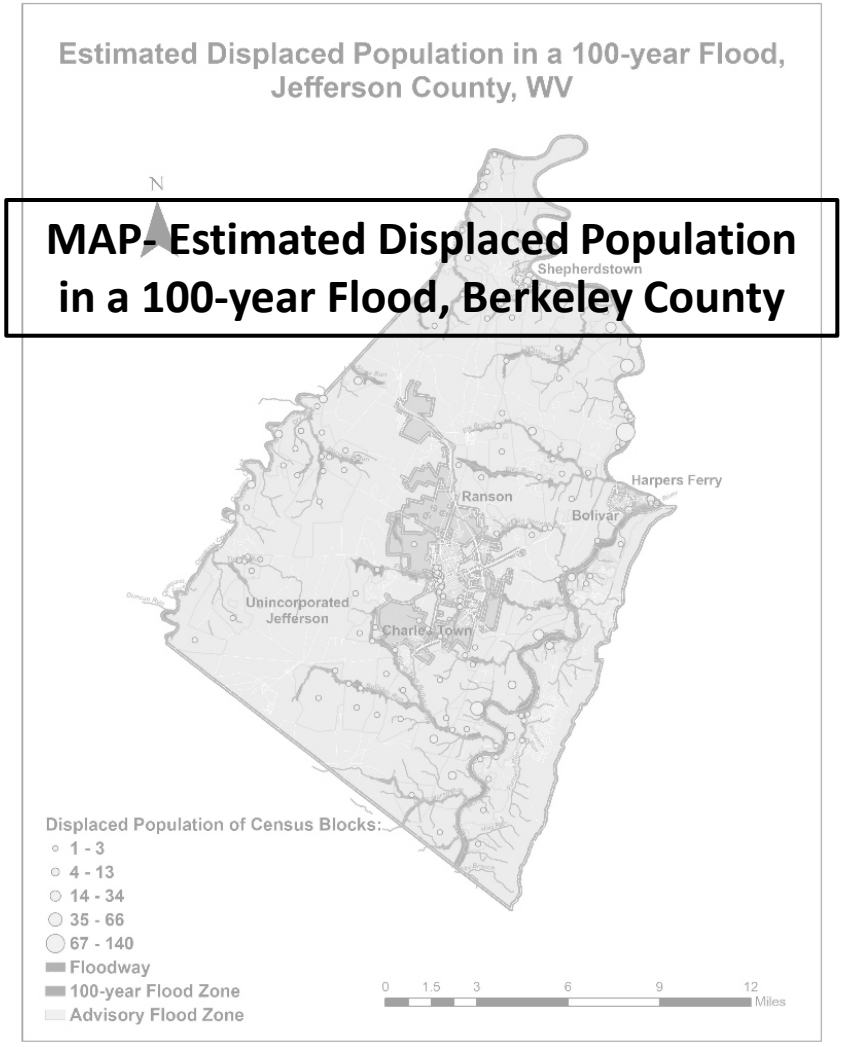
$\mathbf{IW}$ = Shelter category weight for income (0.8)

$\mathbf{AW}$ = Shelter category weight for age (0.2)

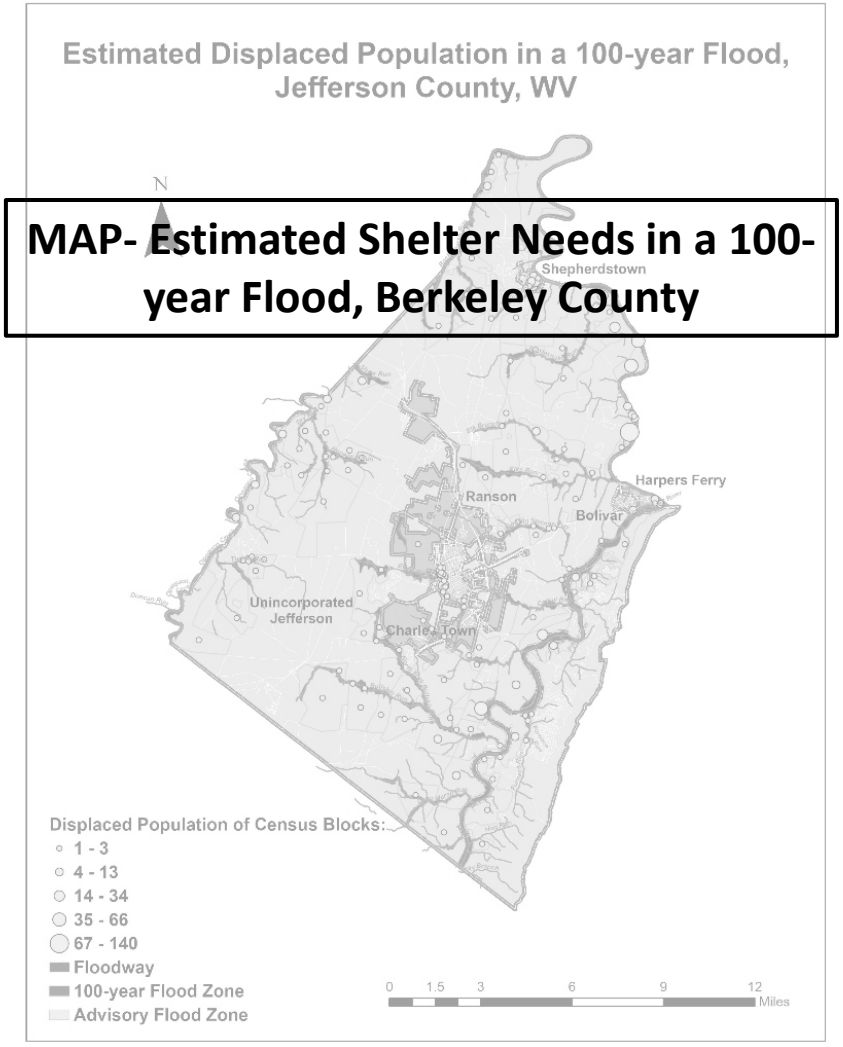
$\mathbf{IM_k}$ = Relative modification factor for income (calculated using table 13.2 in the manual)

$\mathbf{AM_m}$ = Relative modification factor for age (calculated using table 13.2 in the manual)

Berkeley County– Results



MAP- Estimated Displaced Population in a 100-year Flood, Berkeley County



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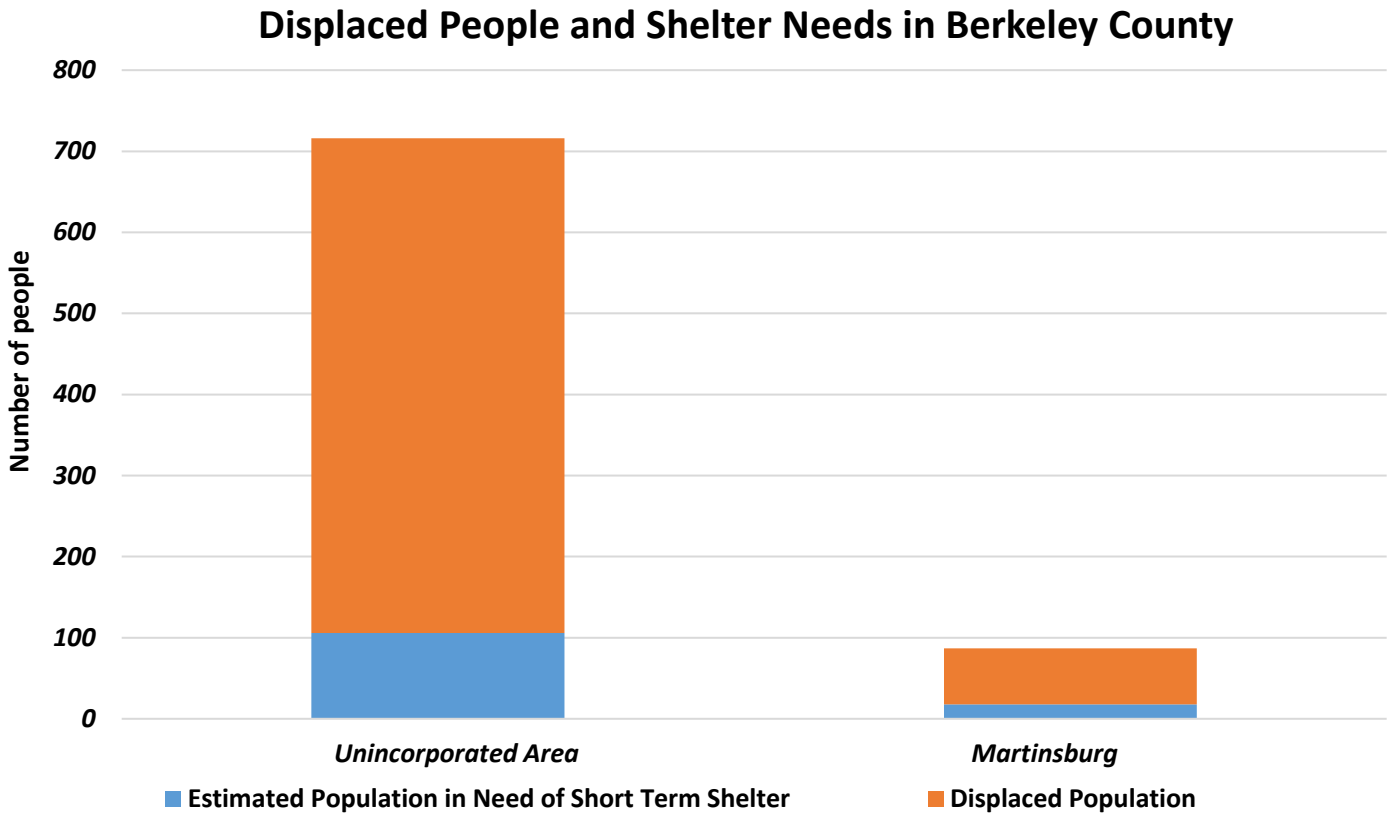
Berkeley County– Results



CID	Community Name	County	Community Type	Total Community Population	Average Residential Household Size	Population Residing in High Risk Flood Zone	Percentage of Population Residing in High Risk Flood Zone	Number of Households with inundation water depth >= 1 foot	Displaced Population	Percentage of Population in Flood Zones Displaced	Estimated Population in Need of Short Term Shelter	Percentage of Population in Flood Zones in Need of Shelter	Companion Dogs Shelter Need	Companion Cats Shelter Need
540282	Berkeley County*	BERKELEY	Unincorporated	93834	2.7	1719.9	2%	265	716	42%	106	6%	15	10
540006	Martinsburg	BERKELEY	Incorporated	17451	2.4	211.2	1%	36	87	41%	18	9%	3	2
Total in County			-	**111285**	**2.628**	**1931.1**	**2%**	**301**	**803**	**42%**	**124**	**6%**	**18**	**12**

Future Directions

- Include more variables relevant to housing characteristics in the shelter model such as:
  - Housing Ownership Type (Owned or Rental)
  - Occupancy Type (Single family, Multi-family, & Mobile Home)
  - Geography: Urban versus Rural
- Research and review the actual shelter data of floods provided by the American Red Cross to test the model
- Data preparation for unincorporated areas missing in the census data by subtracting the demographic data of the communities from those of the county
- Automate data processing of the required variables for displacement and shelter estimations
- Customize Open Hazus "FAST" Flood Assessment Structure Tool including population displacement and shelter needs

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"… the task of estimating and preparing for shelter demand is still very challenging." (Dr. John Harrald, 2019)

"The results of all modeling efforts should be interpreted with a degree of skepticism." (Harrald et al., 1994, p.13)

"Any model is a selective representation of reality." (Harrald et al., 1994, p.14)