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Hazus: Earthquake Global Risk Report

Region Name: EQPlan_Summerville

Earthquake Scenario: M6.0-SCEMD Summerville Regional Scenari

Print Date: September 27, 2018

Disclaimer:

*This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.*

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 8 county(ies) from the following state(s):

South Carolina

Note:

Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 7,405.20 square miles and contains 221 census tracts. There are over 361 thousand households in the region which has a total population of 925,552 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 389 thousand buildings in the region with a total building replacement value (excluding contents) of 105,760 (millions of dollars). Approximately 93.00 % of the buildings (and 80.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 19,198 and 7,091 (millions of dollars) , respectively.



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Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 389 thousand buildings in the region which have an aggregate total replacement value of 105,760 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 68% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 21 hospitals in the region with a total bed capacity of 2,933 beds. There are 323 schools, 112 fire stations, 33 police stations and 8 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 3,804 hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 26,289.00 (millions of dollars). This inventory includes over 1,903.26 miles of highways, 1,775 bridges, 77,465.70 miles of pipes.

Table 1: Transportation System Lifeline Inventory

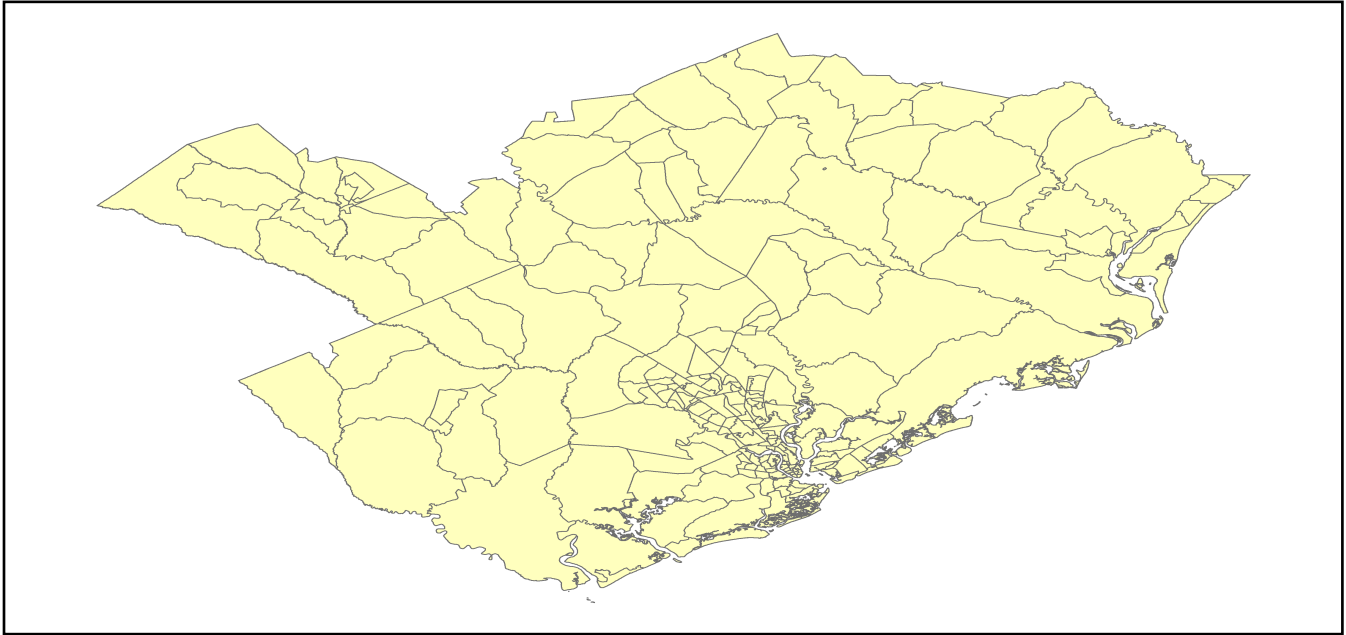
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	1,775	2496.4112
	Segments	705	14665.7363
	Tunnels	0	0.0000
	Subtotal		17162.1475
Railways	Bridges	2	3.2004
	Facilities	12	31.9560
	Segments	581	955.1356
	Tunnels	0	0.0000
	Subtotal		990.2920
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		0.0000
Bus	Facilities	6	5.3628
	Subtotal		5.3628
Ferry	Facilities	7	9.3170
	Subtotal		9.3170
Port	Facilities	86	171.7420
	Subtotal		171.7420
Airport	Facilities	13	138.4630
	Runways	19	721.3160
	Subtotal		859.7790
		Total	19,198.60

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	1246.6915
	Facilities	309	1060.6872
	Pipelines	0	0.0000
	Subtotal		2307.3787
Waste Water	Distribution Lines	NA	748.0149
	Facilities	809	114.8484
	Pipelines	0	0.0000
	Subtotal		862.8633
Natural Gas	Distribution Lines	NA	498.6766
	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		498.6766
Oil Systems	Facilities	8	14.3008
	Pipelines	0	0.0000
	Subtotal		14.3008
Electrical Power	Facilities	66	3370.2350
	Subtotal		3370.2350
Communication	Facilities	35	37.9660
	Subtotal		37.9660
	Total		7,091.40

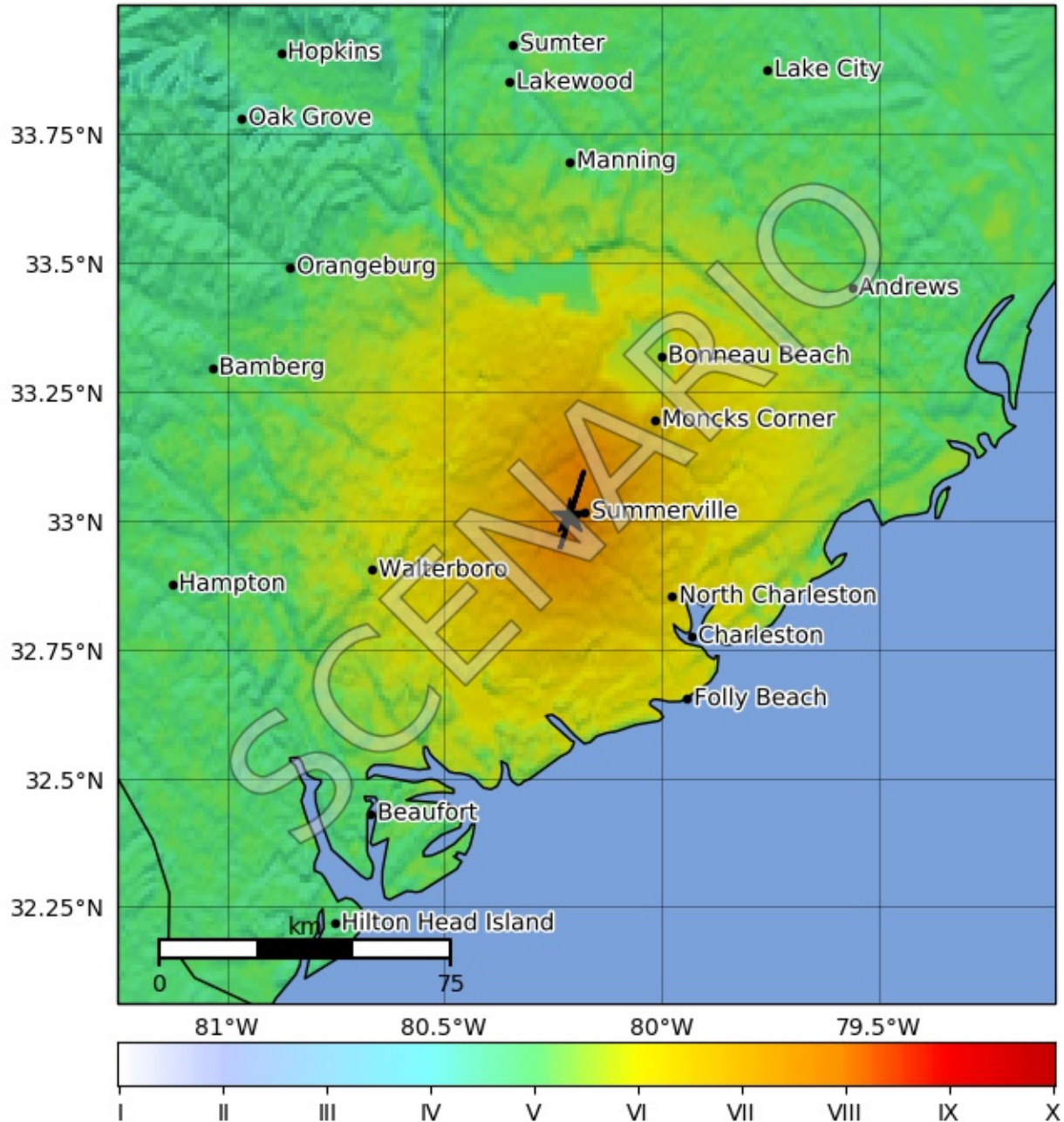
Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	M6.0-SCEMD Summerville Regional Scenari
Type of Earthquake	
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	0.00
Latitude of Epicenter	0.00
Earthquake Magnitude	6.00
Depth (km)	0.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	

USGS ShakeMap (MMI): SCEMD Summerville Regional Scenario
Aug 29, 2018 00:00:00 UTC M6.0 N33.01 W80.21 Depth: 10.0km
ID:scemd2018_summerville_se



Direct Earthquake Damage

Building Damage

Hazus estimates that about 47,853 buildings will be at least moderately damaged. This is over 12.00 % of the buildings in the region. There are an estimated 2,097 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

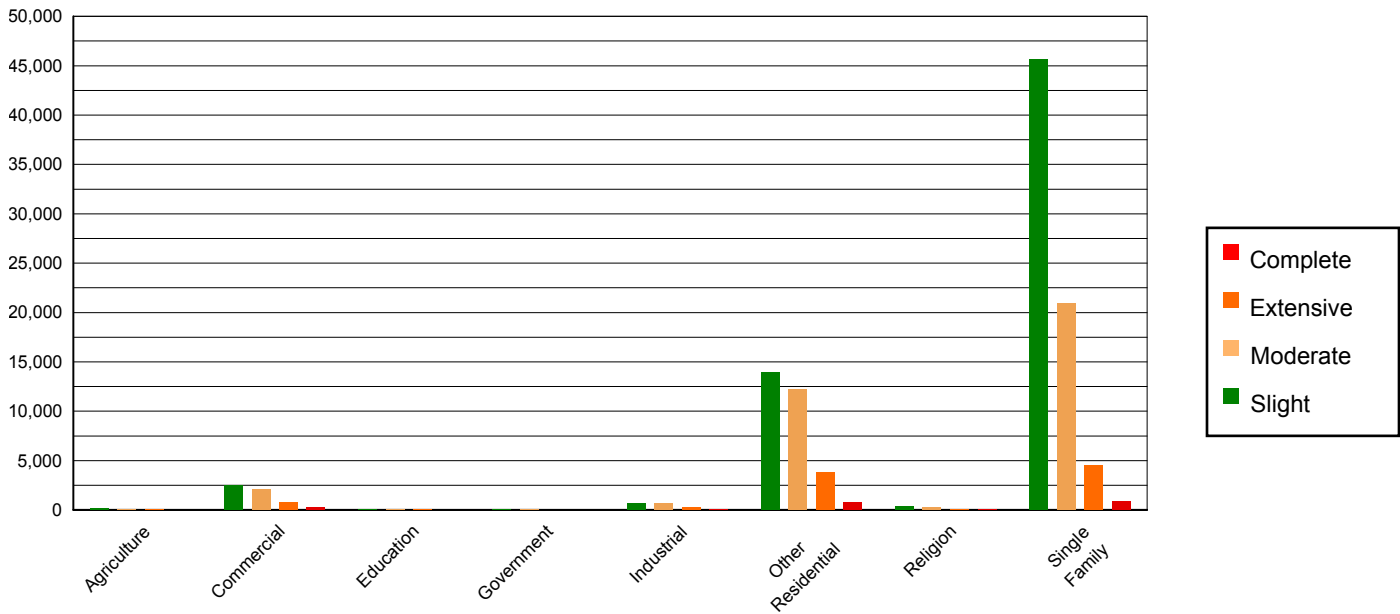


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	927.52	0.33	148.03	0.23	92.09	0.25	28.79	0.30	7.58	0.36
Commercial	12927.72	4.64	2478.16	3.92	2041.19	5.64	783.84	8.22	239.09	11.40
Education	543.07	0.19	98.07	0.15	81.93	0.23	29.88	0.31	9.04	0.43
Government	431.36	0.15	70.73	0.11	57.60	0.16	19.95	0.21	5.37	0.26
Industrial	3333.44	1.20	639.15	1.01	604.85	1.67	251.49	2.64	77.08	3.68
Other Residential	60292.61	21.64	13917.16	21.99	12223.09	33.75	3837.34	40.22	815.79	38.90
Religion	1689.86	0.61	320.95	0.51	220.85	0.61	80.89	0.85	24.45	1.17
Single Family	198460.67	71.23	45610.40	72.07	20893.15	57.69	4509.15	47.26	918.63	43.81
Total	278,606		63,283		36,215		9,541		2,097	

Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	196839.03	70.65	44401.32	70.16	18695.05	51.62	3237.21	33.93	342.16	16.32
Steel	9291.60	3.34	1462.83	2.31	1405.35	3.88	548.64	5.75	162.57	7.75
Concrete	1664.18	0.60	291.72	0.46	290.40	0.80	100.36	1.05	26.45	1.26
Precast	558.23	0.20	100.23	0.16	130.94	0.36	72.68	0.76	14.59	0.70
RM	2602.84	0.93	359.08	0.57	423.94	1.17	202.95	2.13	24.87	1.19
URM	18306.66	6.57	5225.94	8.26	4447.82	12.28	1955.51	20.50	812.85	38.76
MH	49343.72	17.71	11441.52	18.08	10821.25	29.88	3423.97	35.89	713.53	34.03
Total	278,606		63,283		36,215		9,541		2,097	

*Note:

- RM Reinforced Masonry
- URM Unreinforced Masonry
- MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 2,933 hospital beds available for use. On the day of the earthquake, the model estimates that only 1,826 hospital beds (62.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 78.00% of the beds will be back in service. By 30 days, 92.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	21	2	0	16
Schools	323	38	0	220
EOCs	8	1	0	5
PoliceStations	33	3	0	27
FireStations	112	8	0	80

Transportation Lifeline Damage

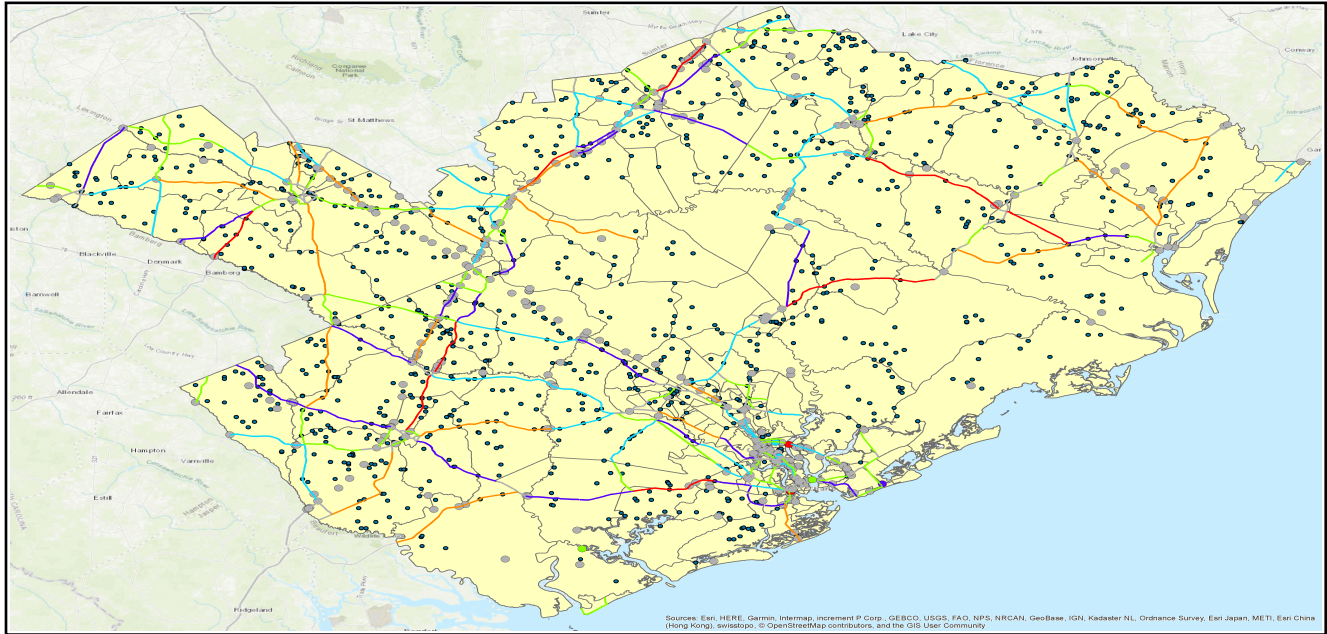


Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations_				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 %	
					After Day 1	After Day 7
Highway	Segments	705	0	0	705	705
	Bridges	1,775	12	0	1,761	1,775
	Tunnels	0	0	0	0	0
Railways	Segments	581	0	0	581	581
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	12	1	0	12	12
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	6	0	0	6	6
Ferry	Facilities	7	0	0	7	7
Port	Facilities	86	0	0	86	86
Airport	Facilities	13	1	0	12	13
	Runways	19	0	0	19	19

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	309	53	0	252	290
Waste Water	809	283	0	353	726
Natural Gas	0	0	0	0	0
Oil Systems	8	0	0	6	8
Electrical Power	66	0	0	43	43
Communication	35	7	0	32	34

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	38,733	1051	263
Waste Water	23,240	528	132
Natural Gas	15,493	181	45
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	361,569	1,184	97	0	0	0
Electric Power		61,852	26,158	6,866	1,098	286

Induced Earthquake Damage

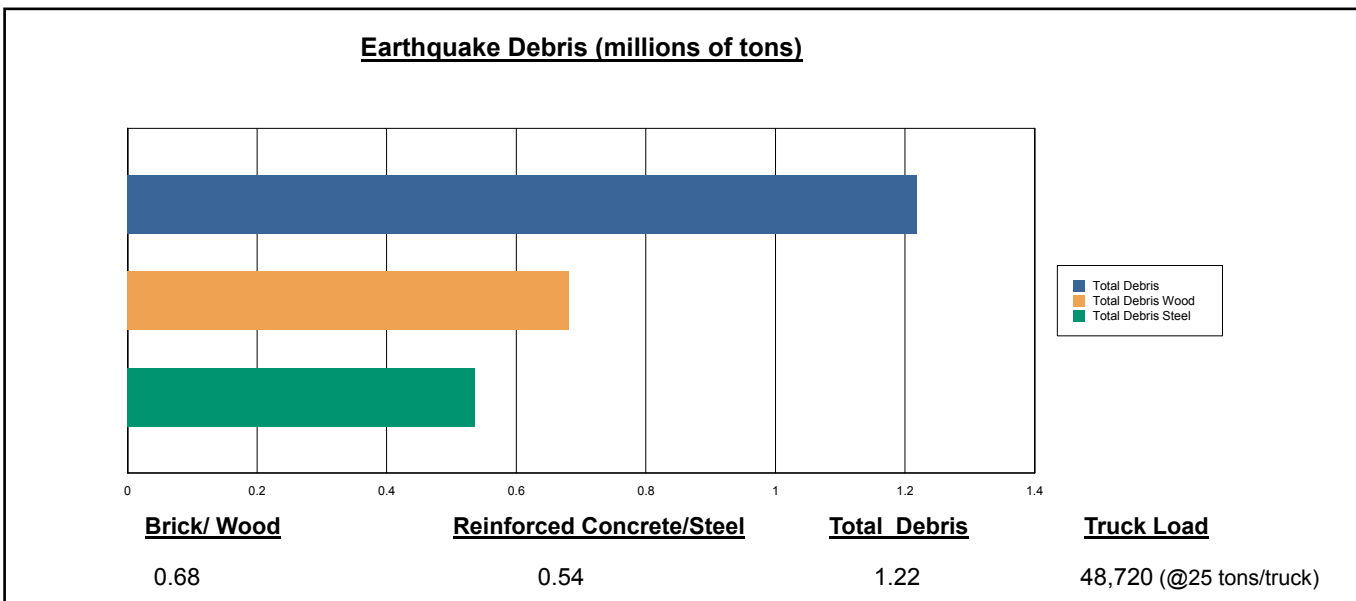
Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

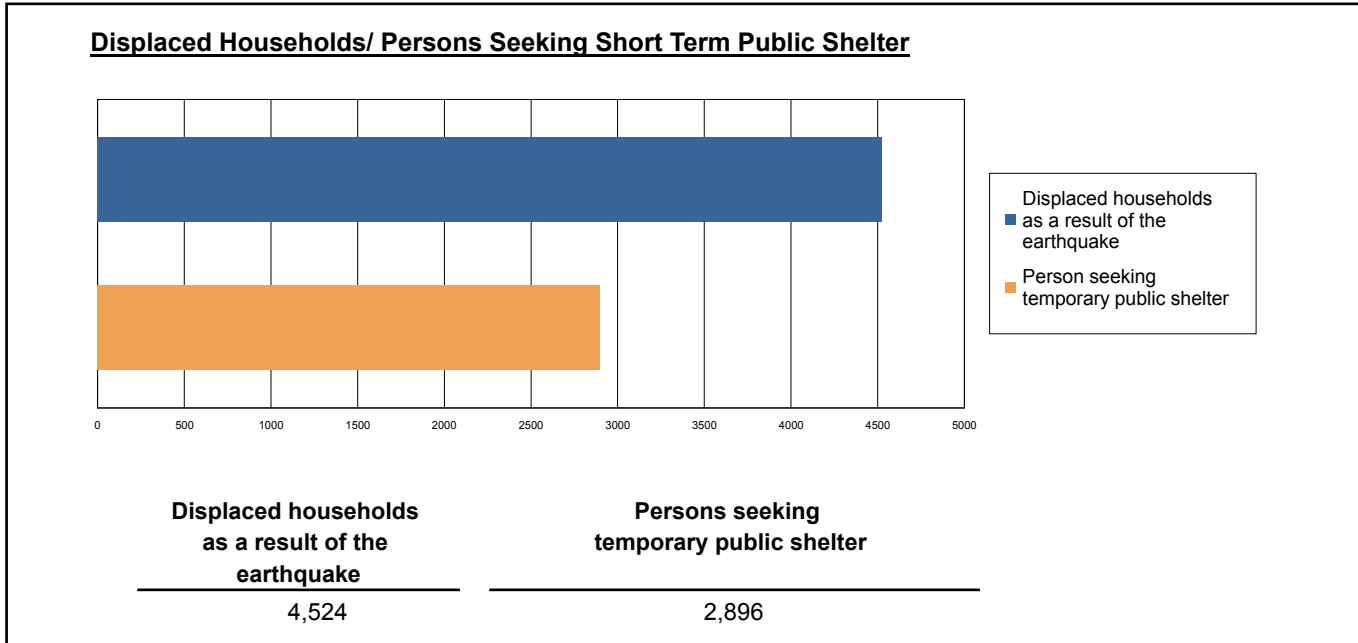
The model estimates that a total of 1,218,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 56.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 48,720 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.



Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 4,524 households to be displaced due to the earthquake. Of these, 2,896 people (out of a total population of 925,552) will seek temporary shelter in public shelters.



Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	15.38	3.64	0.50	0.97
	Commuting	0.07	0.08	0.14	0.03
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	23.69	5.71	0.79	1.55
	Other-Residential	428.97	83.04	8.05	15.24
	Single Family	629.47	119.74	13.25	25.66
	Total	1,098	212	23	43
2 PM	Commercial	892.98	211.78	29.08	56.63
	Commuting	0.59	0.70	1.29	0.24
	Educational	359.66	87.85	12.71	24.68
	Hotels	0.00	0.00	0.00	0.00
	Industrial	175.30	42.39	5.91	11.47
	Other-Residential	85.37	16.65	1.68	3.07
	Single Family	127.31	24.94	2.94	5.39
	Total	1,641	384	54	101
5 PM	Commercial	648.09	155.00	21.59	41.38
	Commuting	10.90	12.82	23.72	4.49
	Educational	29.37	6.88	0.97	1.88
	Hotels	0.00	0.00	0.00	0.00
	Industrial	109.56	26.49	3.69	7.17
	Other-Residential	161.74	32.06	3.31	6.08
	Single Family	249.41	49.02	5.79	10.60
	Total	1,209	282	59	72



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Economic Loss

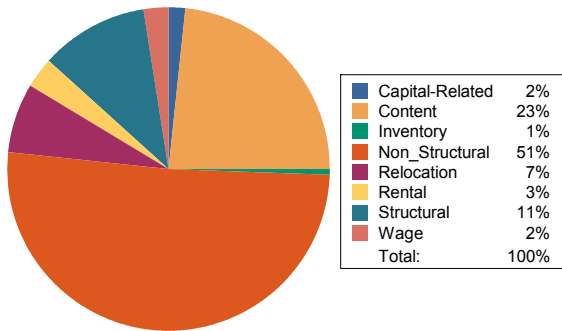
The total economic loss estimated for the earthquake is 6,477.55 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 6,234.15 (millions of dollars); 14 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 71 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Earthquake Losses by Loss Type (\$ millions)



Earthquake Losses by Occupancy Type (\$ millions)

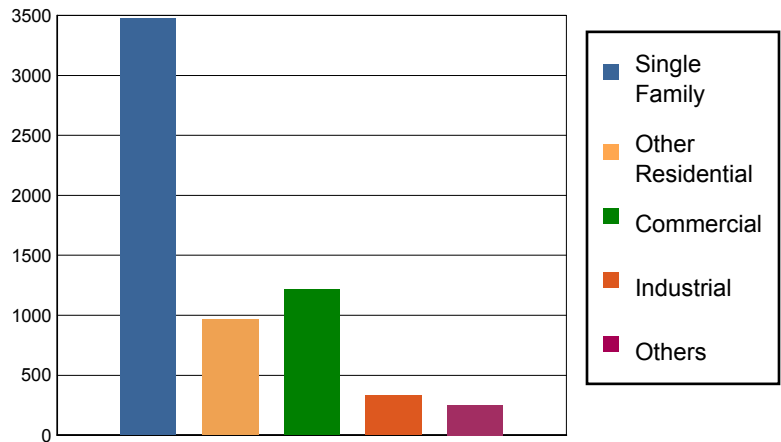


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	13.6282	122.4071	5.9307	8.4682	150.4342
	Capital-Related	0.0000	5.8022	100.8374	3.7021	1.9308	112.2725
	Rental	64.8048	49.7809	64.8620	2.0467	3.8047	185.2991
	Relocation	230.4647	60.4965	101.2734	11.2867	31.1340	434.6553
	Subtotal	295.2695	129.7078	389.3799	22.9662	45.3377	882.6611
Capital Stock Losses							
	Structural	377.6248	105.8380	131.8283	32.8968	31.4125	679.6004
	Non_Structural	1966.3936	557.9472	416.2217	144.0087	104.4413	3,189.0125
	Content	838.5279	168.9032	268.2840	107.3924	68.1856	1,451.2931
	Inventory	0.0000	0.0000	8.4041	22.3160	0.8670	31.5871
	Subtotal	3182.5463	832.6884	824.7381	306.6139	204.9064	5351.4931
	Total	3477.82	962.40	1214.12	329.58	250.24	6234.15

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	14665.7363	0.0000	0.00
	Bridges	2496.4112	8.8934	0.36
	Tunnels	0.0000	0.0000	0.00
	Subtotal	17162.1475	8.8934	
Railways	Segments	955.1356	0.0000	0.00
	Bridges	3.2004	0.0002	0.01
	Tunnels	0.0000	0.0000	0.00
	Facilities	31.9560	7.0558	22.08
	Subtotal	990.2920	7.0560	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Bus	Facilities	5.3628	0.5800	10.82
	Subtotal	5.3628	0.5800	
Ferry	Facilities	9.3170	0.6662	7.15
	Subtotal	9.3170	0.6662	
Port	Facilities	171.7420	23.2643	13.55
	Subtotal	171.7420	23.2643	
Airport	Facilities	138.4630	19.8702	14.35
	Runways	721.3160	0.0000	0.00
	Subtotal	859.7790	19.8702	
Total		19,198.64	60.33	

Table 13: Utility System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	1060.6872	137.4352	12.96
	Distribution Lines	1246.6915	4.7301	0.38
	Subtotal	2307.3787	142.1653	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	114.8484	13.2418	11.53
	Distribution Lines	748.0149	2.3760	0.32
	Subtotal	862.8633	15.6178	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	498.6766	0.8140	0.16
	Subtotal	498.6766	0.8140	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	14.3008	1.5743	11.01
	Subtotal	14.3008	1.5743	
Electrical Power	Facilities	3370.2350	18.4736	0.55
	Subtotal	3370.2350	18.4736	
Communication	Facilities	37.9660	4.4163	11.63
	Subtotal	37.9660	4.4163	
	Total	7,091.42	183.06	



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Appendix A: County Listing for the Region

- Berkeley,SC
- Charleston,SC
- Clarendon,SC
- Colleton,SC
- Dorchester,SC
- Georgetown,SC
- Orangeburg,SC
- Williamsburg,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Berkeley	177,843	14,648	2,561	17,210
	Charleston	350,209	37,719	11,002	48,722
	Clarendon	34,971	2,346	461	2,807
	Colleton	38,892	2,889	889	3,778
	Dorchester	136,555	12,315	2,003	14,319
	Georgetown	60,158	6,258	1,695	7,954
	Orangeburg	92,501	6,143	2,296	8,440
	Williamsburg	34,423	1,967	559	2,527
Total Region		925,552	84,285	21,466	105,757