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Hazus: Earthquake Global Risk Report

Region Name: EQPlan_Aiken

Earthquake Scenario: M6.0-SCEMD Aiken Regional Scenario v1

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 6 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 4,490.82 square miles and contains 144 census tracts. There are over 228 thousand households in the region which has a total population of 584,472 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 257 thousand buildings in the region with a total building replacement value (excluding contents) of 61,045 (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 9,635 and 4,091 (millions of dollars) , respectively.



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Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 257 thousand buildings in the region which have an aggregate total replacement value of 61,045 (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 64% 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 8 hospitals in the region with a total bed capacity of 1,007 beds. There are 205 schools, 73 fire stations, 32 police stations and 6 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 2,150 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 13,726.00 (millions of dollars). This inventory includes over 1,095.48 miles of highways, 1,119 bridges, 56,165.72 miles of pipes.

Table 1: Transportation System Lifeline Inventory

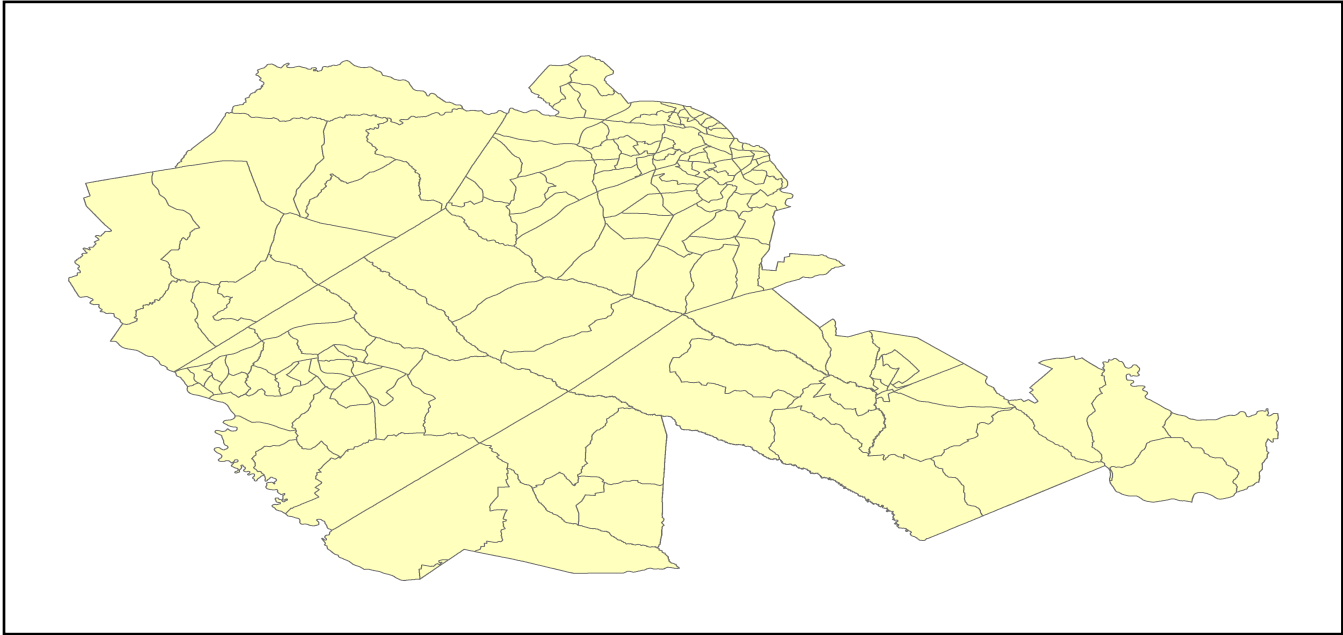
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	1,119	833.2292
	Segments	377	7869.2905
	Tunnels	0	0.0000
	Subtotal		8702.5197
Railways	Bridges	2	5.9482
	Facilities	2	5.3260
	Segments	211	518.9040
	Tunnels	0	0.0000
	Subtotal		530.1782
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		0.0000
Bus	Facilities	9	8.0442
	Subtotal		8.0442
Ferry	Facilities	0	0.0000
	Subtotal		0.0000
Port	Facilities	0	0.0000
	Subtotal		0.0000
Airport	Facilities	5	53.2550
	Runways	9	341.6760
	Subtotal		394.9310
		Total	9,635.70

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	903.9006
	Facilities	307	652.6675
	Pipelines	0	0.0000
	Subtotal		1556.5681
Waste Water	Distribution Lines	NA	542.3403
	Facilities	209	40.0904
	Pipelines	0	0.0000
	Subtotal		582.4307
Natural Gas	Distribution Lines	NA	361.5602
	Facilities	0	0.0000
	Pipelines	0	0.0000
	Subtotal		361.5602
Oil Systems	Facilities	5	8.9380
	Pipelines	0	0.0000
	Subtotal		8.9380
Electrical Power	Facilities	81	1561.8250
	Subtotal		1561.8250
Communication	Facilities	27	19.7620
	Subtotal		19.7620
	Total		4,091.10

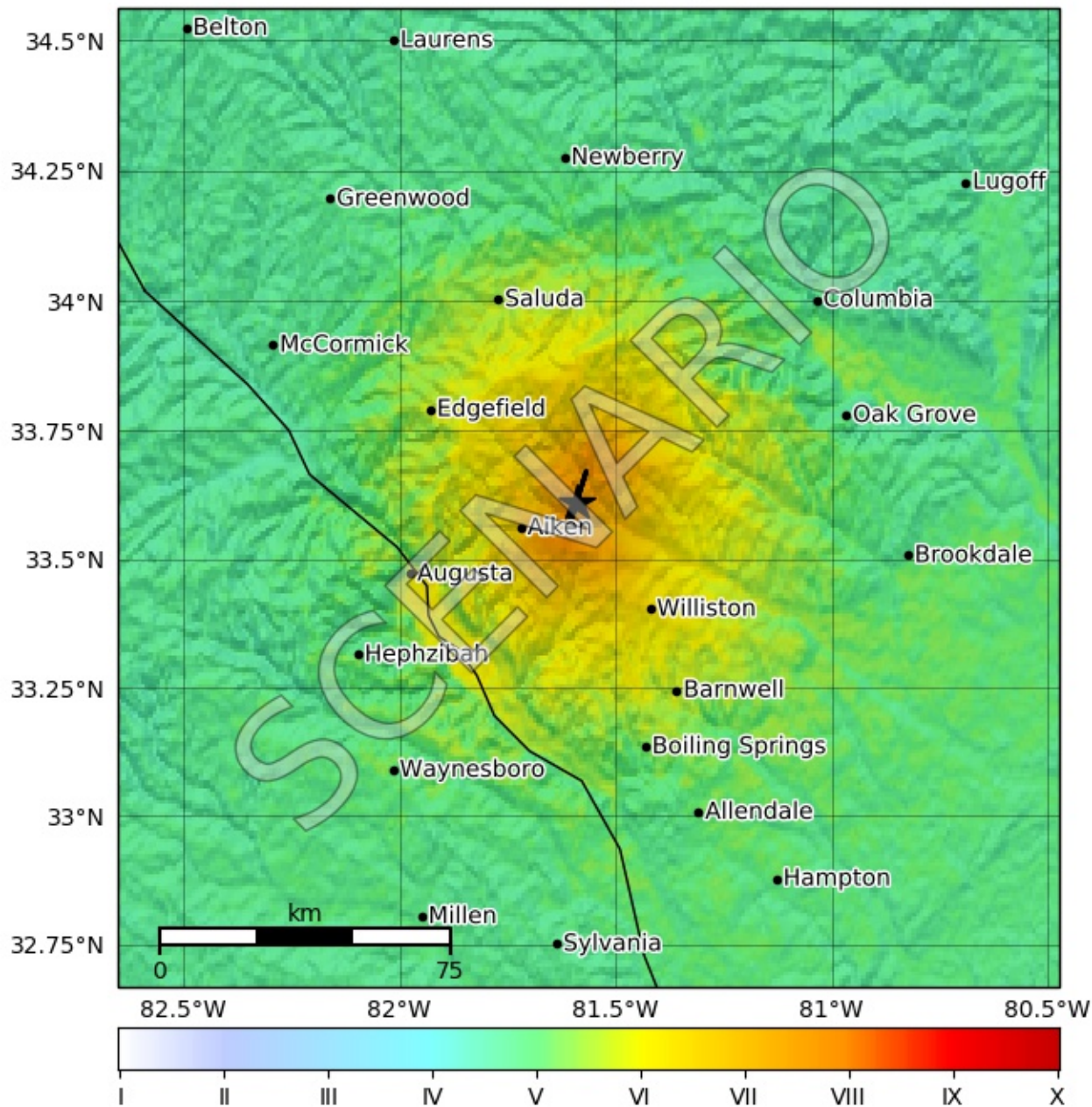
Earthquake Scenario

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 Aiken Regional Scenario v1
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 Aiken Regional Scenario
Aug 29, 2018 00:00:00 UTC M6.0 N33.61 W81.59 Depth: 5.5km
ID:scemd2018_aiken_se



Direct Earthquake Damage

Building Damage

Hazus estimates that about 14,912 buildings will be at least moderately damaged. This is over 6.00 % of the buildings in the region. There are an estimated 342 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

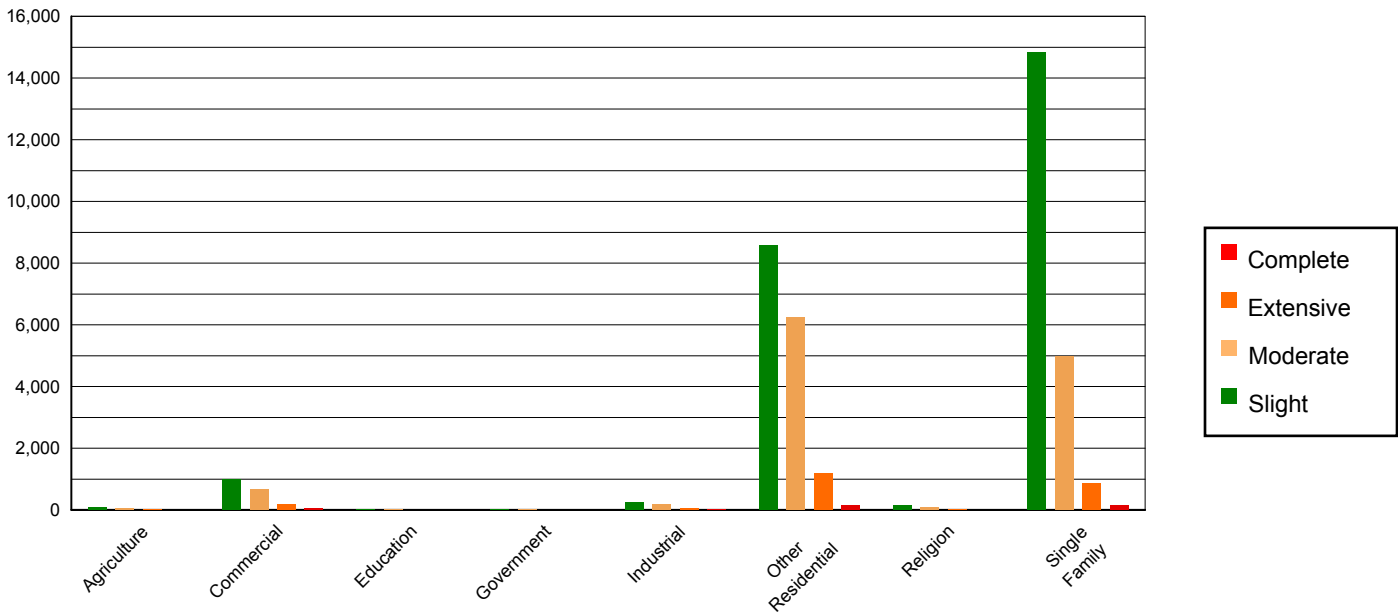


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	690.01	0.32	80.53	0.32	44.32	0.36	11.94	0.51	2.19	0.64
Commercial	9831.24	4.52	1000.67	4.01	649.30	5.31	191.27	8.18	38.52	11.25
Education	357.51	0.16	31.38	0.13	20.09	0.16	5.75	0.25	1.27	0.37
Government	343.63	0.16	33.17	0.13	22.53	0.18	6.43	0.27	1.25	0.36
Industrial	2766.65	1.27	250.63	1.01	172.04	1.41	51.63	2.21	10.04	2.93
Other Residential	51983.10	23.91	8570.83	34.37	6254.10	51.13	1187.86	50.80	144.12	42.11
Religion	1302.30	0.60	153.89	0.62	90.89	0.74	27.10	1.16	5.83	1.70
Single Family	150172.57	69.06	14816.39	59.41	4978.53	40.70	856.44	36.62	139.07	40.63
Total	217,447		24,937		12,232		2,338		342	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	145597.54	66.96	13747.64	55.13	4074.14	33.31	517.82	22.14	36.85	10.77
Steel	6995.67	3.22	561.43	2.25	412.17	3.37	118.47	5.07	20.73	6.06
Concrete	1132.58	0.52	96.51	0.39	75.35	0.62	19.29	0.82	3.17	0.93
Precast	436.70	0.20	45.80	0.18	47.61	0.39	20.25	0.87	2.22	0.65
RM	1621.63	0.75	121.02	0.49	115.41	0.94	43.76	1.87	2.72	0.79
URM	14226.00	6.54	2230.69	8.95	1479.72	12.10	492.11	21.04	145.02	42.37
MH	47436.87	21.82	8134.39	32.62	6027.41	49.28	1126.73	48.18	131.59	38.44
Total	217,447		24,937		12,232		2,338		342	

*Note:

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

Essential Facility Damage

Before the earthquake, the region had 1,007 hospital beds available for use. On the day of the earthquake, the model estimates that only 804 hospital beds (80.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 91.00% of the beds will be back in service. By 30 days, 98.00% 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	8	0	0	8
Schools	205	14	0	175
EOCs	6	0	0	5
PoliceStations	32	0	0	20
FireStations	73	4	0	61

Transportation Lifeline Damage

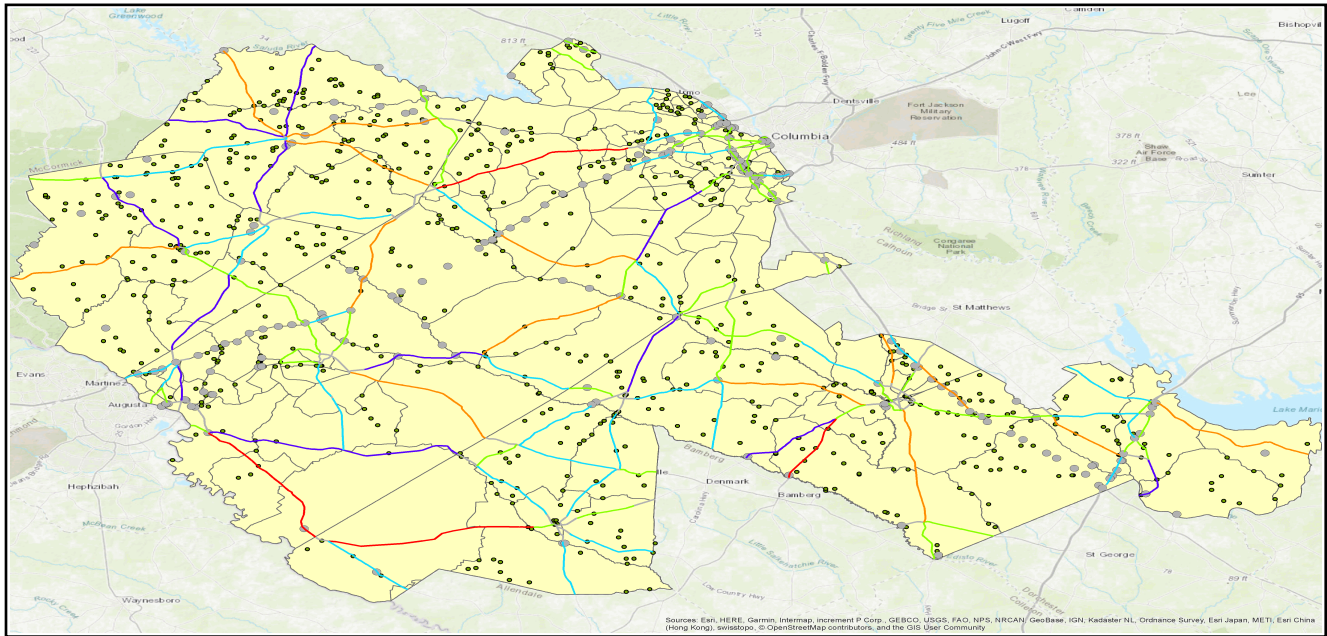


Table 6: Expected Damage to the Transportation Systems

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	377	0	0	377	377
	Bridges	1,119	3	0	1,115	1,119
	Tunnels	0	0	0	0	0
Railways	Segments	211	0	0	211	211
	Bridges	2	0	0	2	2
	Tunnels	0	0	0	0	0
	Facilities	2	0	0	2	2
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	9	3	0	8	8
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	5	1	0	4	5
	Runways	9	0	0	9	9

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	307	60	0	221	303
Waste Water	209	27	0	160	200
Natural Gas	0	0	0	0	0
Oil Systems	5	0	0	5	5
Electrical Power	81	18	0	51	69
Communication	27	3	0	24	27

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	28,083	559	140
Waste Water	16,850	281	70
Natural Gas	11,233	96	24
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	228,586	64	0	0	0	0
Electric Power		54,295	39,136	22,003	6,330	220

Induced Earthquake Damage

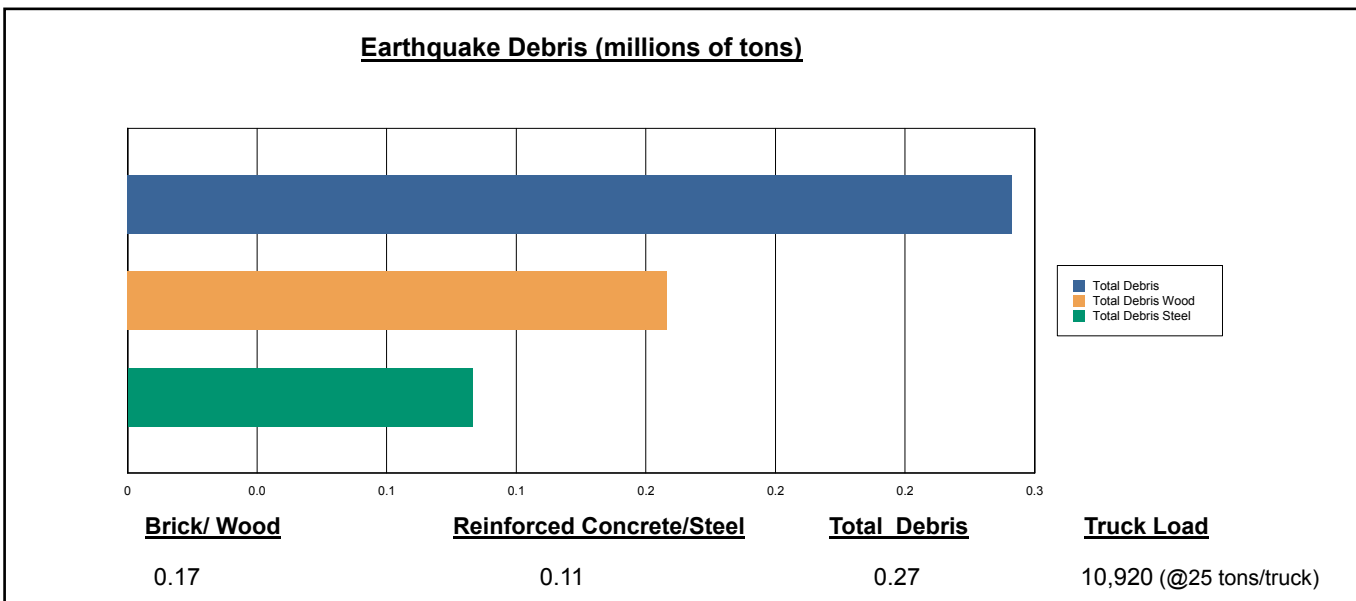
Fire Following Earthquake

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.

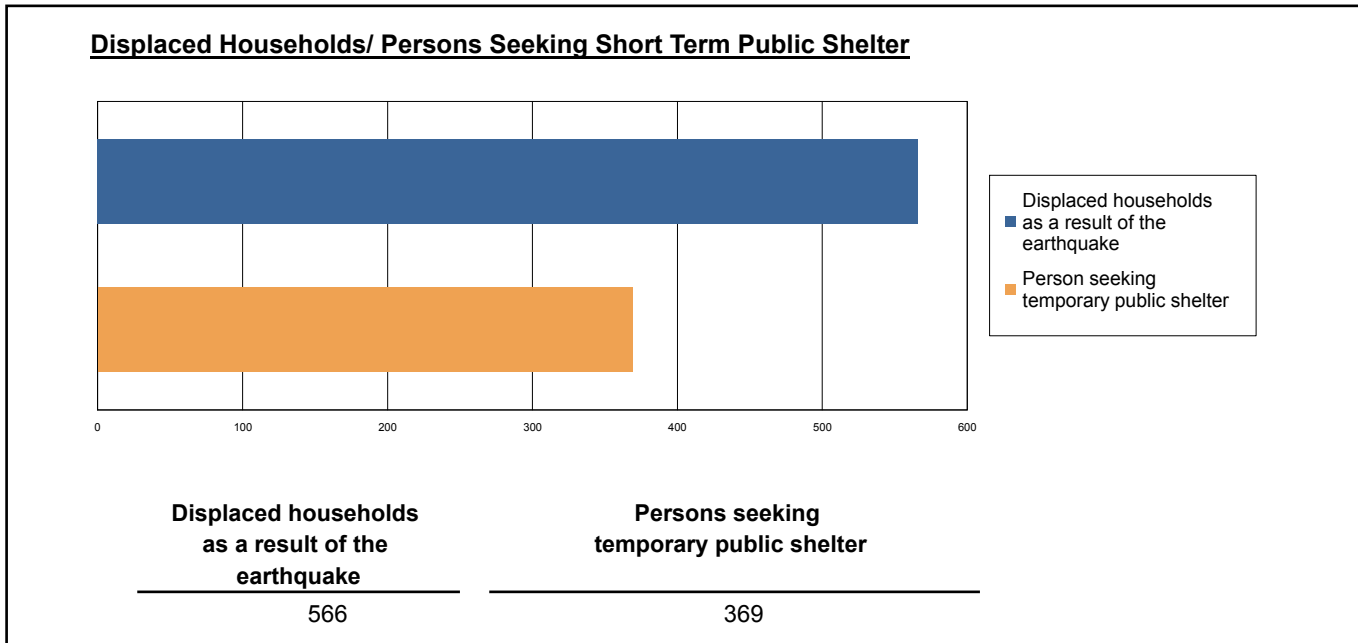
The model estimates that a total of 273,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 61.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 10,920 truckloads (@25 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 566 households to be displaced due to the earthquake. Of these, 369 people (out of a total population of 584,472) 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	2.41	0.49	0.06	0.12
	Commuting	0.01	0.01	0.02	0.00
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	4.14	0.84	0.10	0.20
	Other-Residential	92.63	13.96	0.91	1.68
	Single Family	118.59	19.70	2.07	4.01
	Total	218	35	3	6
2 PM	Commercial	148.21	30.52	3.84	7.45
	Commuting	0.09	0.10	0.19	0.04
	Educational	69.35	14.94	1.99	3.85
	Hotels	0.00	0.00	0.00	0.00
	Industrial	30.62	6.22	0.77	1.49
	Other-Residential	21.13	3.27	0.23	0.42
	Single Family	28.93	5.01	0.56	1.03
	Total	298	60	8	14
5 PM	Commercial	106.78	22.15	2.82	5.40
	Commuting	1.44	1.69	3.12	0.59
	Educational	5.24	1.09	0.14	0.28
	Hotels	0.00	0.00	0.00	0.00
	Industrial	19.14	3.89	0.48	0.93
	Other-Residential	33.87	5.21	0.37	0.66
	Single Family	46.68	8.05	0.90	1.66
	Total	213	42	8	10



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Economic Loss

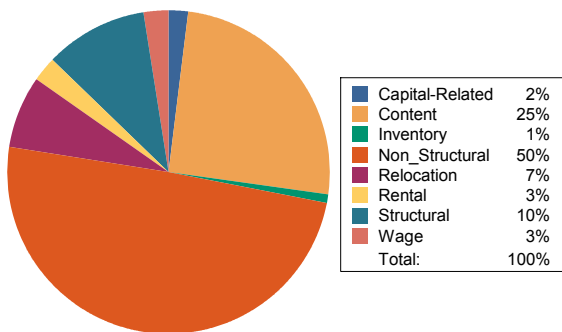
The total economic loss estimated for the earthquake is 1,590.02 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

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 1,428.07 (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 67 % 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)

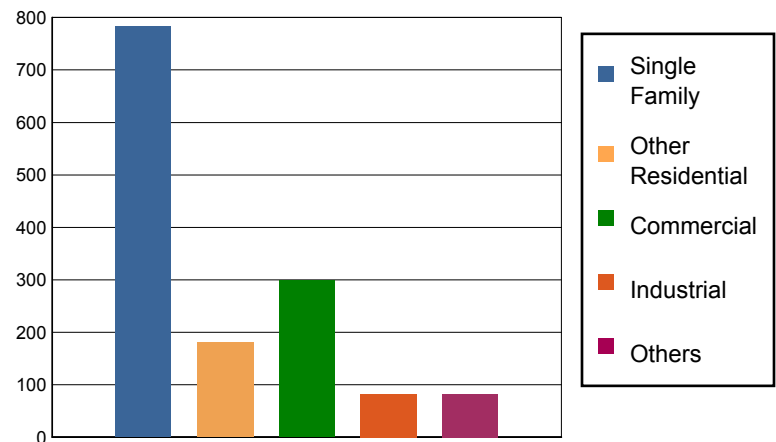


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	3.2910	29.2308	1.3382	2.9047	36.7647
	Capital-Related	0.0000	1.3983	24.3730	0.8149	0.5814	27.1676
	Rental	13.4632	7.6303	15.3734	0.5030	1.2340	38.2039
	Relocation	47.4483	17.0214	24.1609	2.6567	9.5158	100.8031
	Subtotal	60.9115	29.3410	93.1381	5.3128	14.2359	202.9393
Capital Stock Losses							
	Structural	75.9370	23.9151	28.3815	6.9955	9.3540	144.5831
	Non_Structural	437.8705	97.9738	102.6902	36.1217	34.2912	708.9474
	Content	208.2374	29.2174	73.0550	28.4619	24.4777	363.4494
	Inventory	0.0000	0.0000	2.0871	5.7525	0.3128	8.1524
	Subtotal	722.0449	151.1063	206.2138	77.3316	68.4357	1225.1323
	Total	782.96	180.45	299.35	82.64	82.67	1428.07

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	7869.2905	0.0000	0.00
	Bridges	833.2292	3.9908	0.48
	Tunnels	0.0000	0.0000	0.00
	Subtotal	8702.5197	3.9908	
Railways	Segments	518.9040	0.0000	0.00
	Bridges	5.9482	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	5.3260	0.3354	6.30
	Subtotal	530.1782	0.3354	
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	8.0442	1.8438	22.92
	Subtotal	8.0442	1.8438	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Airport	Facilities	53.2550	9.7612	18.33
	Runways	341.6760	0.0000	0.00
	Subtotal	394.9310	9.7612	
Total		9,635.67	15.93	

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	652.6675	60.2387	9.23
	Distribution Lines	903.9006	2.5137	0.28
	Subtotal	1556.5681	62.7524	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	40.0904	3.2415	8.09
	Distribution Lines	542.3403	1.2627	0.23
	Subtotal	582.4307	4.5042	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	361.5602	0.4326	0.12
	Subtotal	361.5602	0.4326	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	8.9380	0.3931	4.40
	Subtotal	8.9380	0.3931	
Electrical Power	Facilities	1561.8250	75.2676	4.82
	Subtotal	1561.8250	75.2676	
Communication	Facilities	19.7620	2.6665	13.49
	Subtotal	19.7620	2.6665	
	Total	4,091.08	146.02	



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Appendix A: County Listing for the Region

Aiken,SC

Barnwell,SC

Edgefield,SC

Lexington,SC

Orangeburg,SC

Saluda,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina	Aiken	160,099	13,569	3,084	16,654
	Barnwell	22,621	1,487	523	2,010
	Edgefield	26,985	2,043	558	2,601
	Lexington	262,391	23,838	5,680	29,518
	Orangeburg	92,501	6,143	2,296	8,440
	Saluda	19,875	1,522	297	1,820
Total Region		584,472	48,602	12,438	61,043