Hazus-MH: Earthquake Event Report

Region Name: Historic_1886quake

Earthquake Scenario: Historic 1886 7.3M

Print Date: July 07, 2016

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 is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop earthquake 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 earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 46 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 30,836.68 square miles and contains 1,098 census tracts. There are over 1,801 thousand households in the region which has a total population of 4,625,364 people (2010 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 1,976 thousand buildings in the region with a total building replacement value (excluding contents) of 488,950 (millions of dollars). Approximately 93.00 % of the buildings (and 79.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 77,549 and 38,286 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 1,976 thousand buildings in the region which have an aggregate total replacement value of 488,950 (millions of dollars) . Appendix B provides a general distribution of the building value by State 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 108 hospitals in the region with a total bed capacity of 14,840 beds. There are 1,550 schools, 482 fire stations, 205 police stations and 47 emergency operation facilities. With respect to high potential loss facilities (HPL), there are 0 dams identified within the region. Of these, 0 of the dams are classified as 'high hazard'. The inventory also includes 18,593 hazardous material sites, 0 military installations and 4 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 115,835.00 (millions of dollars). This inventory includes over 13,119 kilometers of highways, 9,957 bridges, 46,252 kilometers of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	9,957	8,425.30
	Segments	3,093	61,050.60
	Tunnels	0	0.00
		Subtotal	**69,475.90**
Railways	Bridges	23	109.40
	Facilities	40	106.50
	Segments	1,922	4,045.00
	Tunnels	0	0.00
		Subtotal	**4,260.90**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	44	39.30
		Subtotal	**39.30**
Ferry	Facilities	14	18.60
		Subtotal	**18.60**
Port	Facilities	88	175.70
		Subtotal	**175.70**
Airport	Facilities	58	617.80
	Runways	78	2,961.20
		Subtotal	**3,579.00**
		Total	**77,549.40**

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3,698.00
	Facilities	1,798	6,503.30
	Pipelines	69,676	7,864.10
		Subtotal	**18,065.40**
Waste Water	Distribution Lines	NA	2,218.80
	Facilities	2,577	410.10
	Pipelines	70,839	8,009.90
		Subtotal	**10,638.80**
Natural Gas	Distribution Lines	NA	1,479.20
	Facilities	1	893.80
	Pipelines	325	1,258.30
		Subtotal	**3,631.30**
Oil Systems	Facilities	35	62.60
	Pipelines	22	231.60
		Subtotal	**294.20**
Electrical Power	Facilities	433	12,873.80
		Subtotal	**12,873.80**
Communication	Facilities	202	178.90
		Subtotal	**178.90**
		Total	**45,682.40**

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	Historic 1886 7.3M
Type of Earthquake	Historical
Fault Name	NA
Historical Epicenter ID #	4694
Probabilistic Return Period	NA
Longitude of Epicenter	-80.00
Latitude of Epicenter	32.90
Earthquake Magnitude	7.30
Depth (Km)	10.00
Rupture Length (Km)	NA
Rupture Orientation (degrees)	NA
Attenuation Function	Central & East US (CEUS 2008)

Building Damage

Hazus estimates that about 289,259 buildings will be at least moderately damaged. This is over 15.00 % of the buildings in the region. There are an estimated 83,960 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.

Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	3,927	0.26	684	0.34	478	0.34	238	0.36	392	0.47
Commercial	61,722	4.15	9,464	4.72	7,484	5.36	3,692	5.63	9,559	11.39
Education	2,419	0.16	364	0.18	293	0.21	139	0.21	399	0.48
Government	2,234	0.15	372	0.19	318	0.23	129	0.20	296	0.35
Industrial	18,193	1.22	2,489	1.24	2,157	1.54	1,054	1.61	2,676	3.19
Other Residential	279,237	18.78	59,472	29.67	58,190	41.64	23,993	36.60	26,707	31.81
Religion	8,960	0.60	1,186	0.59	826	0.59	382	0.58	753	0.90
Single Family	1,110,325	74.67	126,392	63.06	69,992	50.09	35,935	54.81	43,179	51.43
Total	**1,487,016**		**200,423**		**139,737**		**65,561**		**83,961**	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	1,085,454	73.00	120461	60.10	64,931	46.47	34,322	52.35	37,080	44.16
Steel	42,520	2.86	6426	3.21	6,234	4.46	2,862	4.37	7,323	8.72
Concrete	7,699	0.52	1141	0.57	1,104	0.79	437	0.67	1,427	1.70
Precast	3,053	0.21	387	0.19	429	0.31	211	0.32	501	0.60
RM	12,465	0.84	1100	0.55	1,099	0.79	611	0.93	2,036	2.43
URM	103,844	6.98	17443	8.70	12,142	8.69	5,889	8.98	15,377	18.31
MH	231,981	15.60	53465	26.68	53,798	38.50	21,230	32.38	20,217	24.08
Total	**1,487,016**		**200,423**		**139,737**		**65,561**		**83,961**	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 14,840 hospital beds available for use. On the day of the earthquake, the model estimates that only 8,490 hospital beds (57.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 72.00% of the beds will be back in service. By 30 days, 83.00% 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	108	14	13	78
Schools	1,550	200	170	1,120
EOCs	47	3	2	33
PoliceStations	205	17	13	165
FireStations	482	54	30	347

Transportation and Utility Lifeline Damage

Table 6 provides damage estimates for the transportation system.

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	3,093	0	0	3,093	3,093
	Bridges	9,957	2,087	384	7,923	9,375
	Tunnels	0	0	0	0	0
Railways	Segments	1,922	0	0	1,922	1,922
	Bridges	23	0	0	23	23
	Tunnels	0	0	0	0	0
	Facilities	40	10	9	30	30
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	44	2	0	43	43
Ferry	Facilities	14	3	0	11	12
Port	Facilities	88	67	34	21	32
Airport	Facilities	58	4	1	56	57
	Runways	78	0	0	78	78

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	1,798	99	4	1,690	1,777
Waste Water	2,577	569	150	1,975	2,195
Natural Gas	1	0	0	1	1
Oil Systems	35	8	8	27	27
Electrical Power	433	31	7	292	293
Communication	202	28	10	175	184

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

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	26,033	6208	1552
Waste Water	17,464	632	158
Natural Gas	2,429	156	39
Oil	326	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	1,801,181	166,675	132,127	94,519	0	0
Electric Power		213,063	179,386	134,568	53,899	1,341

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 17.11 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 43.00% 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 684,440 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 93,990 households to be displaced due to the earthquake. Of these, 62,464 people (out of a total population of 4,625,364) 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	306	94	15	29
	Commuting	4	4	8	2
	Educational	0	0	0	0
	Hotels	0	0	0	0
	Industrial	380	117	19	37
	Other-Residential	9,006	2,524	322	616
	Single Family	9,967	2,572	272	508
	Total	**19,664**	**5,311**	**636**	**1,191**
2 PM	Commercial	17,509	5,371	843	1,650
	Commuting	34	40	75	14
	Educational	7,049	2,224	369	718
	Hotels	0	0	0	0
	Industrial	2,820	869	139	270
	Other-Residential	1,797	501	65	119
	Single Family	2,042	533	62	105
	Total	**31,250**	**9,537**	**1,553**	**2,877**
5 PM	Commercial	12,429	3,816	605	1,164
	Commuting	619	730	1,348	255
	Educational	917	293	49	96
	Hotels	0	0	0	0
	Industrial	1,762	543	87	169
	Other-Residential	3,465	982	132	241
	Single Family	4,016	1,052	124	209
	Total	**23,208**	**7,416**	**2,344**	**2,133**

Economic Loss

The total economic loss estimated for the earthquake is 60,285.79 (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 57,493.83 (millions of dollars); 15 % 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 61 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.

Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	231.19	1,438.92	55.37	92.39	1,817.87
	Capital-Related	0.00	98.00	1,261.22	33.61	22.31	1,415.15
	Rental	450.19	711.21	631.90	17.17	43.96	1,854.43
	Relocation	1,543.74	596.16	984.73	74.69	322.92	3,522.23
	Subtotal	**1,993.93**	**1,636.56**	**4,316.77**	**180.83**	**481.58**	**8,609.67**
Capital Stock Losses							
	Structural	3,923.14	1,521.53	1,935.29	408.86	402.48	8,191.30
	Non_Structural	14,038.32	7,138.46	6,433.23	1,684.79	1,317.49	30,612.29
	Content	3,469.88	1,499.60	3,111.96	1,058.24	631.55	9,771.22
	Inventory	0.00	0.00	87.88	213.18	8.28	309.35
	Subtotal	**21,431.34**	**10,159.59**	**11,568.36**	**3,365.06**	**2,359.80**	**48,884.15**
	Total	**23,425.27**	**11,796.15**	**15,885.13**	**3,545.90**	**2,841.38**	**57,493.83**

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.

Hazus estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 14 presents the results of the region for the given earthquake.

Table 12: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	61,050.57	$0.00	0.00
	Bridges	8,425.30	$1087.74	12.91
	Tunnels	0.00	$0.00	0.00
	Subtotal	**69475.90**	**1,087.70**	
Railways	Segments	4,044.96	$0.00	0.00
	Bridges	109.40	$0.79	0.72
	Tunnels	0.00	$0.00	0.00
	Facilities	106.52	$26.17	24.57
	Subtotal	**4260.90**	**27.00**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	39.33	$3.06	7.77
	Subtotal	**39.30**	**3.10**	
Ferry	Facilities	18.63	$4.55	24.42
	Subtotal	**18.60**	**4.60**	
Port	Facilities	175.74	$109.01	62.03
	Subtotal	**175.70**	**109.00**	
Airport	Facilities	617.76	$60.72	9.83
	Runways	2,961.19	$0.00	0.00
	Subtotal	**3579.00**	**60.70**	
	Total	**77549.40**	**1,292.00**	

Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	7,864.10	$16.76	0.21
	Facilities	6,503.30	$697.77	10.73
	Distribution Lines	3,698.00	$251.37	6.80
	Subtotal	**18,065.39**	**$965.90**	
Waste Water	Pipelines	8,009.90	$2.03	0.03
	Facilities	410.10	$64.45	15.71
	Distribution Lines	2,218.80	$180.15	8.12
	Subtotal	**10,638.83**	**$246.63**	
Natural Gas	Pipelines	1,258.30	$0.02	0.00
	Facilities	893.80	$4.46	0.50
	Distribution Lines	1,479.20	$51.67	3.49
	Subtotal	**3,631.31**	**$56.14**	
Oil Systems	Pipelines	231.60	$0.00	0.00
	Facilities	62.60	$12.23	19.54
	Subtotal	**294.18**	**$12.23**	
Electrical Power	Facilities	12,873.80	$201.83	1.57
	Subtotal	**12,873.76**	**$201.83**	
Communication	Facilities	178.90	$17.18	9.61
	Subtotal	**178.88**	**$17.18**	
	Total	**45,682.36**	**$1,499.92**	

Table 14. Indirect Economic Impact with outside aid

(Employment as # of people and Income in millions of $)

LOSS	Total	%

Appendix A: County Listing for the Region

Abbeville,SC

Aiken,SC

Allendale,SC

Anderson,SC

Bamberg,SC

Barnwell,SC

Beaufort,SC

Berkeley,SC

Calhoun,SC

Charleston,SC

Cherokee,SC

Chester,SC

Chesterfield,SC

Clarendon,SC

Colleton,SC

Darlington,SC

Dillon,SC

Dorchester,SC

Edgefield,SC

Fairfield,SC

Florence,SC

Georgetown,SC

Greenville,SC

Greenwood,SC

Hampton,SC

Horry,SC

Jasper,SC

Kershaw,SC

Lancaster,SC

Laurens,SC

Lee,SC

Lexington,SC

McCormick,SC

Marion,SC

Marlboro,SC

Newberry,SC

Oconee,SC

Orangeburg,SC

Pickens,SC

Richland,SC

Saluda,SC

Spartanburg,SC

Sumter,SC

Union,SC

Williamsburg,SC

York,SC

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
South Carolina					
	Abbeville	25,417	1,651	510	2,162
	Aiken	160,099	12,984	2,969	15,953
	Allendale	10,419	609	239	848
	Anderson	187,126	14,819	4,326	19,145
	Bamberg	15,987	1,229	288	1,518
	Barnwell	22,621	1,411	497	1,909
	Beaufort	162,233	20,179	3,038	23,218
	Berkeley	177,843	13,958	2,387	16,346
	Calhoun	15,175	1,012	196	1,209
	Charleston	350,209	36,073	10,497	46,571
	Cherokee	55,342	3,275	1,147	4,422
	Chester	33,140	2,054	657	2,712
	Chesterfield	46,734	2,764	842	3,607
	Clarendon	34,971	2,200	412	2,613
	Colleton	38,892	2,723	838	3,562
	Darlington	68,681	4,450	1,428	5,878
	Dillon	32,062	1,612	551	2,163
	Dorchester	136,555	11,641	1,870	13,511
	Edgefield	26,985	1,943	526	2,470
	Fairfield	23,956	1,723	360	2,083
	Florence	136,885	9,672	3,713	13,385
	Georgetown	60,158	6,001	1,594	7,596
	Greenville	451,225	38,889	11,726	50,615
	Greenwood	69,661	5,330	1,825	7,155
	Hampton	21,090	1,204	346	1,551
	Horry	269,291	29,302	5,393	34,695
	Jasper	24,777	1,455	411	1,866
	Kershaw	61,697	4,571	1,039	5,611
	Lancaster	76,652	5,646	1,251	6,898
	Laurens	66,537	4,441	1,299	5,740
	Lee	19,220	930	300	1,230
	Lexington	262,391	22,611	5,144	27,756
	McCormick	10,233	858	148	1,006
	Marion	33,062	1,966	722	2,688
	Marlboro	28,933	1,575	481	2,057
	Newberry	37,508	2,976	745	3,722
	Oconee	74,273	6,500	1,484	7,985
	Orangeburg	92,501	5,768	2,088	7,856
	Pickens	119,224	9,101	2,388	11,489
	Richland	384,504	35,817	9,706	45,524
	Saluda	19,875	1,457	261	1,718
	Spartanburg	284,307	22,494	8,026	30,520
	Sumter	107,456	7,470	2,281	9,752
	Union	28,961	1,969	591	2,560

	Williamsburg	34,423	1,874	498	2,372
	York	226,073	19,563	4,115	23,679
Total State		**4,625,364**	**387,750**	**101,153**	**488,926**
Total Region		**4,625,364**	**387,750**	**101,153**	**488,926**