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Hazus: Earthquake Global Risk Report

Region Name: AZ_EQ_Scenario5

Earthquake Scenario: M7.2-Big Chino-Little Chino fault v3

Print Date: February 07, 2022

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.

Table of Contents

Section	Page #
General Description of the Region	3
Building and Lifeline Inventory	4
Building Inventory	
Critical Facility Inventory	
Transportation and Utility Lifeline Inventory	
Earthquake Scenario Parameters	7
Direct Earthquake Damage	8
Buildings Damage	
Essential Facilities Damage	
Transportation and Utility Lifeline Damage	
Induced Earthquake Damage	14
Fire Following Earthquake	
Debris Generation	
Social Impact	15
Shelter Requirements	
Casualties	
Economic Loss	17
Building Related Losses	
Transportation and Utility Lifeline Losses	
Appendix A: County Listing for the Region	
Appendix B: Regional Population and Building Value 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):

Arizona

Note:

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

The geographical size of the region is 61,160.66 square miles and contains 441 census tracts. There are over 724 thousand households in the region which has a total population of 1,853,000 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 780 thousand buildings in the region with a total building replacement value (excluding contents) of 170,674 (millions of dollars). Approximately 95.00 % of the buildings (and 84.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 47,347 and 37,201 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 780 thousand buildings in the region which have an aggregate total replacement value of 170,674 (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 47% 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 53 hospitals in the region with a total bed capacity of 4,840 beds. There are 966 schools, 266 fire stations, 92 police stations and 7 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 181 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 84,548.00 (millions of dollars). This inventory includes over 3,647.45 miles of highways, 3,396 bridges, 188,310.83 miles of pipes.

Table 1: Transportation System Lifeline Inventory

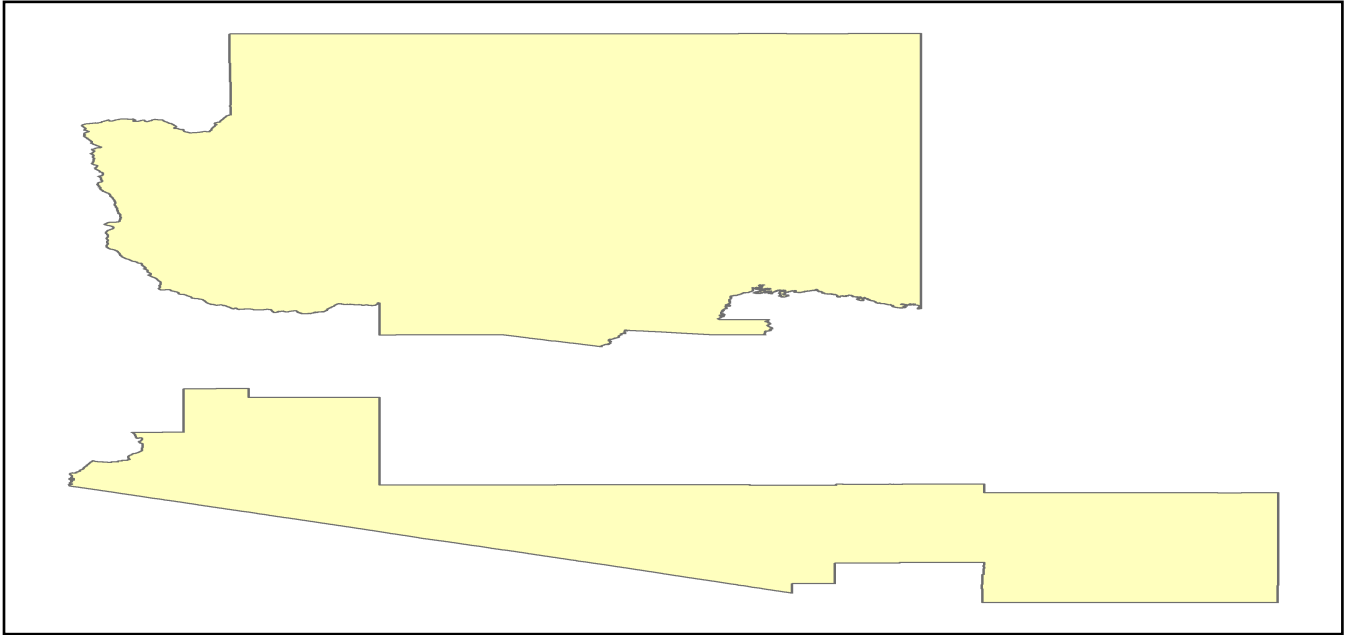
System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	3,396	5039.7869
	Segments	845	33587.0100
	Tunnels	1	22.5778
	Subtotal		38649.3747
Railways	Bridges	561	2451.5700
	Facilities	10	26.6300
	Segments	818	2817.3965
	Tunnels	0	0.0000
	Subtotal		5295.5965
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
	Subtotal		0.0000
Bus	Facilities	38	53.1392
	Subtotal		53.1392
Ferry	Facilities	1	1.3310
	Subtotal		1.3310
Port	Facilities	0	0.0000
	Subtotal		0.0000
Airport	Facilities	38	337.2365
	Runways	57	3011.2708
	Subtotal		3348.5073
		Total	47,347.90

Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	3747.1691
	Facilities	7	221.4450
	Pipelines	0	0.0000
	Subtotal		3968.6141
Waste Water	Distribution Lines	NA	2248.3015
	Facilities	110	13748.0200
	Pipelines	0	0.0000
	Subtotal		15996.3215
Natural Gas	Distribution Lines	NA	1498.8677
	Facilities	14	21.4130
	Pipelines	118	1960.2009
	Subtotal		3480.4816
Oil Systems	Facilities	1	0.0950
	Pipelines	0	0.0000
	Subtotal		0.0950
Electrical Power	Facilities	38	13743.6500
	Subtotal		13743.6500
Communication	Facilities	133	12.6350
	Subtotal		12.6350
	Total		37,201.80

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	M7.2-Big Chino-Little Chino fault v3
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	7.18
Depth (km)	0.00
Rupture Length (Km)	0.00
Rupture Orientation (degrees)	0.00
Attenuation Function	

Direct Earthquake Damage

Building Damage

Hazus estimates that about 20,348 buildings will be at least moderately damaged. This is over 3.00 % of the buildings in the region. There are an estimated 2,460 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

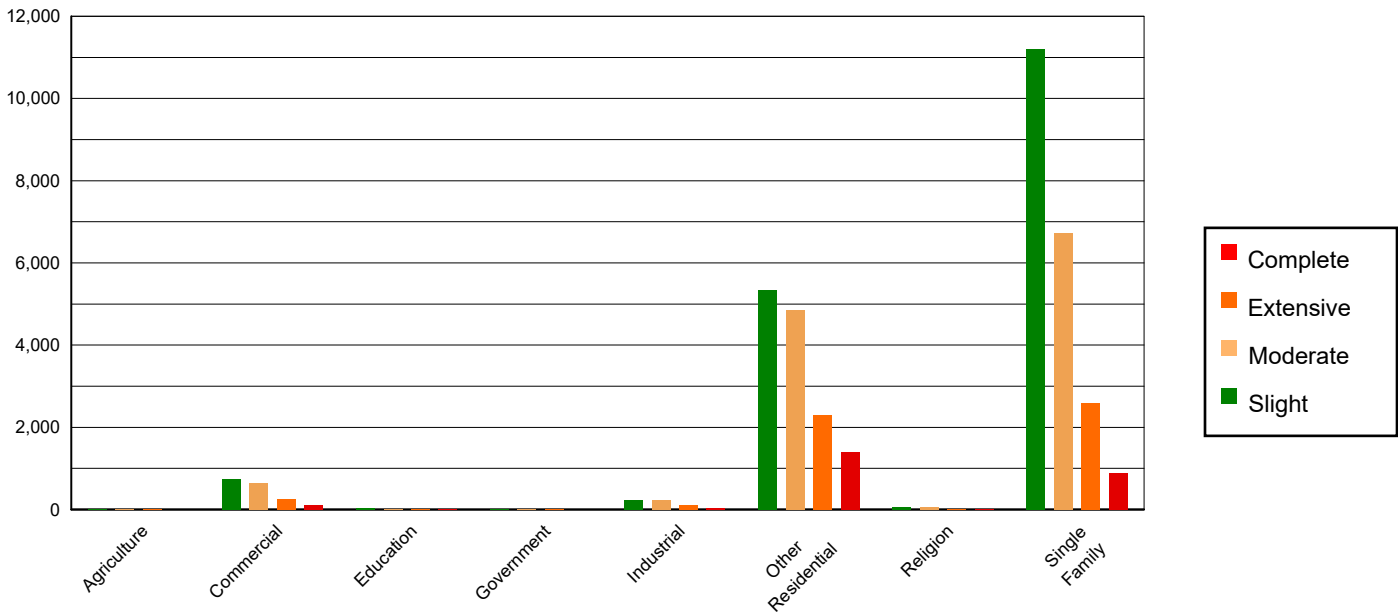


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	1257.39	0.17	28.27	0.16	23.58	0.19	10.97	0.21	4.79	0.19
Commercial	25300.97	3.41	738.42	4.18	640.19	5.09	267.86	5.05	108.56	4.41
Education	1125.02	0.15	29.55	0.17	25.07	0.20	10.97	0.21	5.39	0.22
Government	767.98	0.10	23.33	0.13	19.56	0.16	7.19	0.14	1.95	0.08
Industrial	6521.33	0.88	227.84	1.29	228.05	1.81	109.68	2.07	51.10	2.08
Other Residential	161650.00	21.77	5351.97	30.30	4862.86	38.65	2294.58	43.22	1399.59	56.89
Religion	2281.97	0.31	65.05	0.37	55.49	0.44	22.59	0.43	7.90	0.32
Single Family	543588.96	73.21	11200.04	63.40	6725.54	53.46	2584.71	48.69	880.75	35.80
Total	742,494		17,664		12,580		5,309		2,460	

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

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	353373.98	47.59	8029.91	45.46	2772.21	22.04	478.07	9.01	70.27	2.86
Steel	8248.11	1.11	225.59	1.28	251.12	2.00	107.48	2.02	52.37	2.13
Concrete	7881.78	1.06	238.60	1.35	207.48	1.65	80.99	1.53	30.49	1.24
Precast	6562.76	0.88	174.22	0.99	218.61	1.74	124.64	2.35	45.65	1.86
RM	210006.35	28.28	3552.83	20.11	4051.62	32.21	2100.38	39.57	755.10	30.69
URM	16794.01	2.26	585.73	3.32	442.83	3.52	186.43	3.51	117.60	4.78
MH	139626.62	18.81	4857.59	27.50	4636.47	36.85	2230.54	42.02	1388.54	56.44
Total	742,494		17,664		12,580		5,309		2,460	

*Note:

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

Essential Facility Damage

Before the earthquake, the region had 4,840 hospital beds available for use. On the day of the earthquake, the model estimates that only 4,521 hospital beds (93.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 97.00% of the beds will be back in service. By 30 days, 99.00% 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	53	0	0	52
Schools	966	9	0	929
EOCs	7	0	0	7
PoliceStations	92	1	0	88
FireStations	266	3	0	257

Transportation Lifeline Damage

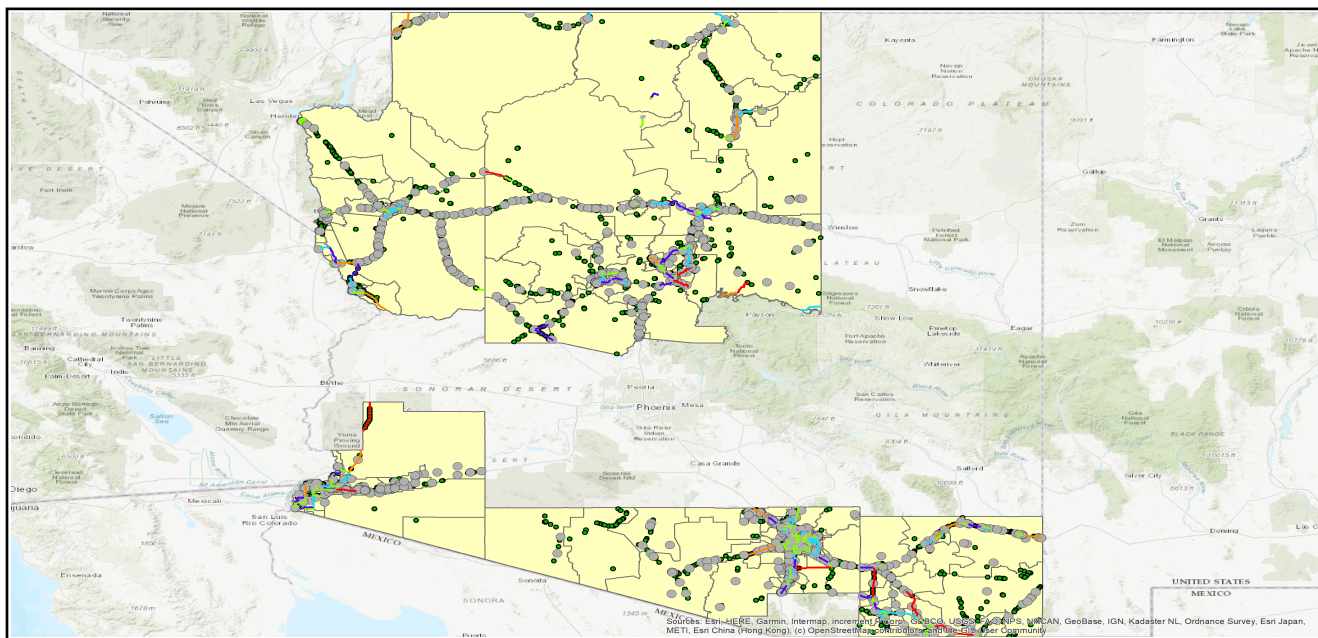


Table 6: Expected Damage to the Transportation Systems

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	845	0	0	845	845
	Bridges	3,396	3	1	3,393	3,395
	Tunnels	1	0	0	0	0
Railways	Segments	818	0	0	818	818
	Bridges	561	0	0	561	561
	Tunnels	0	0	0	0	0
	Facilities	10	0	0	10	10
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	38	0	0	38	38
Ferry	Facilities	1	0	0	1	1
Port	Facilities	0	0	0	0	0
Airport	Facilities	38	0	0	38	38
	Runways	57	0	0	57	57

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	7	0	0	7	7
Waste Water	110	0	0	110	110
Natural Gas	14	0	0	14	14
Oil Systems	1	0	0	1	1
Electrical Power	38	1	0	38	38
Communication	133	1	0	133	133

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

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	116,419	2030	508
Waste Water	69,851	1020	255
Natural Gas	2,040	20	5
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	724,445	1,249	862	324	0	0
Electric Power		2,157	1,263	476	85	3

Induced Earthquake Damage

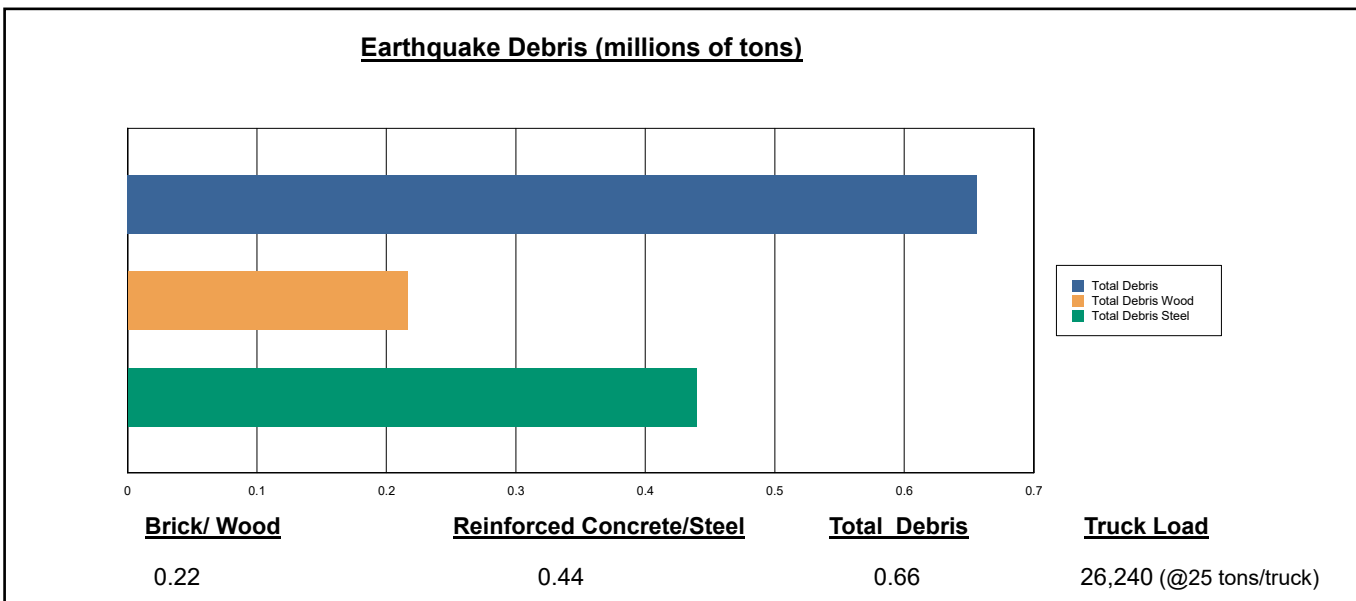
Fire Following Earthquake

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.

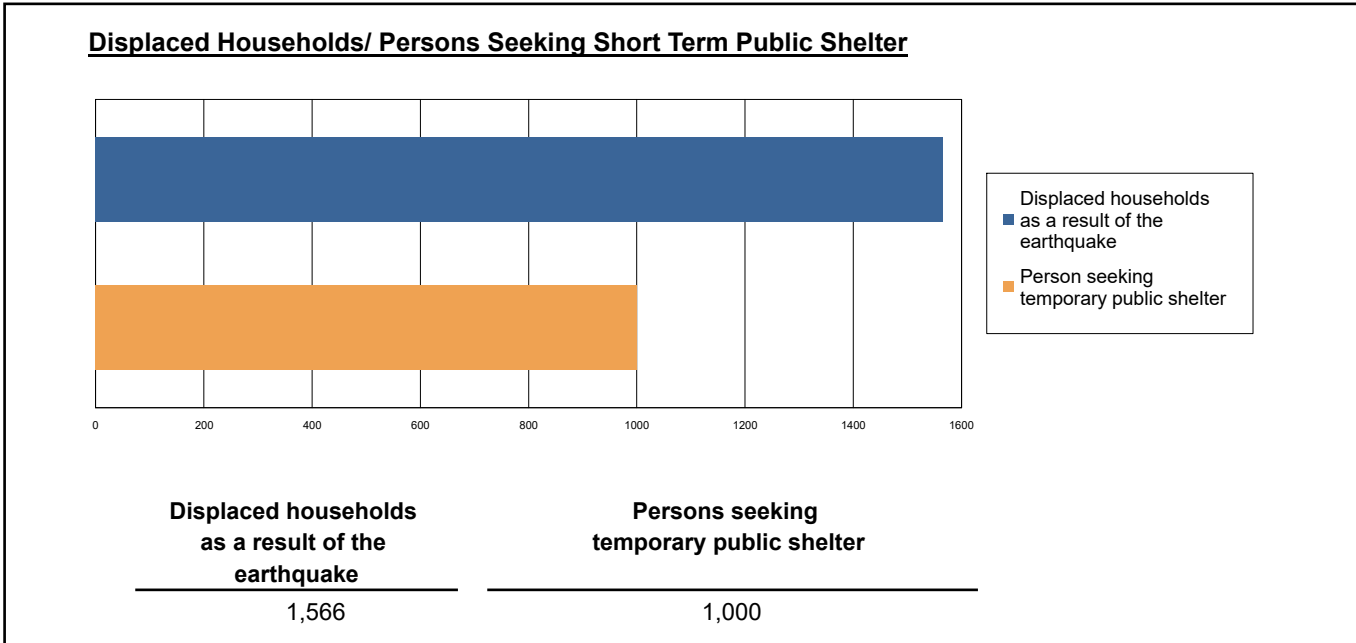
The model estimates that a total of 656,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 33.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 26,240 truckloads (@25 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 1,566 households to be displaced due to the earthquake. Of these, 1,000 people (out of a total population of 1,853,000) 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	6.10	1.70	0.28	0.55
	Commuting	0.02	0.02	0.04	0.01
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	7.75	2.11	0.32	0.63
	Other-Residential	214.95	45.51	2.80	4.64
	Single Family	305.10	81.44	13.13	25.94
	Total	534	131	17	32
2 PM	Commercial	390.62	109.51	17.89	35.13
	Commuting	0.18	0.22	0.39	0.08
	Educational	130.10	37.56	6.28	12.30
	Hotels	0.00	0.00	0.00	0.00
	Industrial	57.01	15.51	2.37	4.61
	Other-Residential	53.80	11.48	0.72	1.21
	Single Family	85.22	22.68	3.70	7.05
	Total	717	197	31	60
5 PM	Commercial	273.34	76.56	12.54	24.40
	Commuting	2.79	3.43	6.15	1.17
	Educational	8.61	2.22	0.35	0.68
	Hotels	0.00	0.00	0.00	0.00
	Industrial	35.63	9.70	1.48	2.88
	Other-Residential	76.70	16.23	1.01	1.70
	Single Family	118.44	31.22	5.06	9.66
	Total	516	139	27	41



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Economic Loss

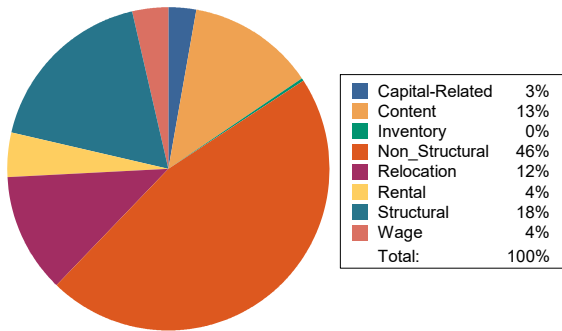
The total economic loss estimated for the earthquake is 1,403.45 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

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 1,286.93 (millions of dollars); 23 % 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)

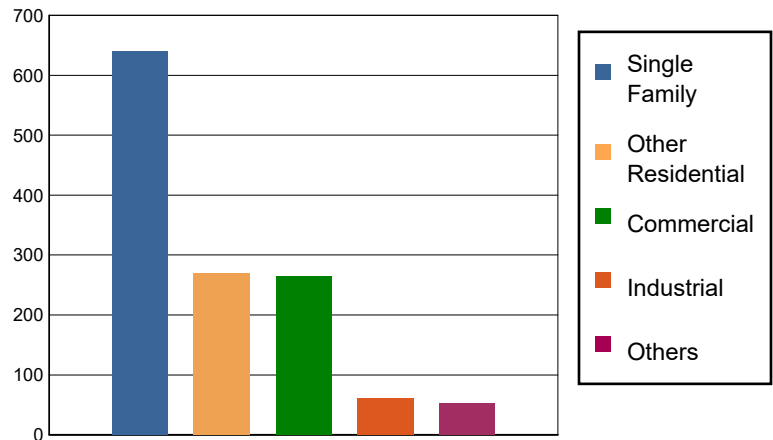


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	5.5517	36.7759	1.6468	2.1580	46.1324
	Capital-Related	0.0000	2.3666	31.9445	1.0270	0.5707	35.9088
	Rental	26.4085	11.8977	17.2946	0.5301	1.0816	57.2125
	Relocation	92.0878	23.5087	26.7045	3.2681	8.8604	154.4295
	Subtotal	118.4963	43.3247	112.7195	6.4720	12.6707	293.6832
Capital Stock Losses							
	Structural	123.2967	50.9389	35.6374	9.8645	9.1326	228.8701
	Non_Structural	320.7871	147.6515	80.7731	26.3624	21.6187	597.1928
	Content	77.0685	26.7171	35.1183	14.8541	9.4058	163.1638
	Inventory	0.0000	0.0000	1.0181	2.8780	0.1204	4.0165
	Subtotal	521.1523	225.3075	152.5469	53.9590	40.2775	993.2432
	Total	639.65	268.63	265.27	60.43	52.95	1286.93

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	33587.0100	0.0000	0.00
	Bridges	5039.7869	5.2419	0.10
	Tunnels	22.5778	0.0000	0.00
	Subtotal	38649.3747	5.2419	
Railways	Segments	2817.3965	0.0000	0.00
	Bridges	2451.5700	5.9451	0.24
	Tunnels	0.0000	0.0000	0.00
	Facilities	26.6300	0.1880	0.71
	Subtotal	5295.5965	6.1331	
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	53.1392	1.4303	2.69
	Subtotal	53.1392	1.4303	
Ferry	Facilities	1.3310	0.0012	0.09
	Subtotal	1.3310	0.0012	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	0.0000	0.0000	
Airport	Facilities	337.2365	2.4776	0.73
	Runways	3011.2708	0.0000	0.00
	Subtotal	3348.5073	2.4776	
Total		47,347.95	15.28	

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	221.4450	0.0008	0.00
	Distribution Lines	3747.1691	9.1353	0.24
	Subtotal	3968.6141	9.1361	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	13748.0200	42.5751	0.31
	Distribution Lines	2248.3015	4.5889	0.20
	Subtotal	15996.3215	47.1640	
Natural Gas	Pipelines	1960.2009	0.0000	0.00
	Facilities	21.4130	0.2126	0.99
	Distribution Lines	1498.8677	1.5721	0.10
	Subtotal	3480.4816	1.7847	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0950	0.0000	0.00
	Subtotal	0.0950	0.0000	
Electrical Power	Facilities	13743.6500	43.0900	0.31
	Subtotal	13743.6500	43.0900	
Communication	Facilities	12.6350	0.0675	0.53
	Subtotal	12.6350	0.0675	
	Total	37,201.80	101.24	



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Appendix A: County Listing for the Region

Cochise,AZ

Coconino,AZ

Mohave,AZ

Pima,AZ

Yavapai,AZ

Yuma,AZ

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Arizona	Cochise	131,346	9,498	1,736	11,235
	Coconino	134,421	11,458	2,685	14,144
	Mohave	200,186	14,812	2,582	17,394
	Pima	980,263	78,852	14,275	93,128
	Yavapai	211,033	17,028	3,556	20,585
	Yuma	195,751	11,954	2,231	14,186
Total Region		1,853,000	143,602	27,065	170,672