Prepared in cooperation with the State of Washington Military Department Emergency Management Division

Population and Business Exposure to Twenty Scenario Earthquakes in the State of Washington

Open-File Report 2011-1016

U.S. Department of the Interior
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Contents

Figures

Tables

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Introduction

This report documents the results of an initial analysis of population and business exposure to scenario earthquakes in Washington. This analysis was conducted to support the U.S. Geological Survey (USGS) Pacific Northwest Multi-Hazards Demonstration Project (MHDP) and an ongoing collaboration between the State of Washington Emergency Management Division (WEMD) and the USGS on earthquake hazards and vulnerability topics. This report was developed to help WEMD meet internal planning needs. A subsequent report will provide analysis to the community level.

The objective of this project was to use scenario ground-motion hazard maps to estimate population and business exposure to twenty Washington earthquakes. In consultation with the USGS Earthquake Hazards Program and the Washington Division of Geology and Natural Resources, the twenty scenario earthquakes were selected by WEMD (fig. 1). Hazard maps were then produced by the USGS and placed in the USGS ShakeMap archive (U.S. Geological Survey, 2010). The scenario earthquakes and their moment magnitudes for this study are:

- Boulder Creek Fault *M* 6.8;
- Canyon River-Price Lake Fault *M* 7.4;
- Cascadia subduction zone megathrust *M* 9.0;
- Cascadia subduction zone megathrust (northern section) *M* 8.3;
- Chelan Fault *M* 7.2;
- Cle Elum-Wallula deformed zone *M* 6.8;
- Devils Mountain Fault *M* 7.1;
- Devils Mountain Fault (western section) *M* 7.4;
- Hite Fault *M* 6.8;
- Little River Fault (Lake Creek) *M* 6.8;
- Toppenish Ridge Fault (Mill Creek) *M* 7.1;
- Mount Saint Helens deformed zone *M* 7.0;
- Nisqually intraslab zone *M* 7.2;
- Saddle Mountain Fault *M* 7.35;
- Sea-Tac intraslab zone *M* 7.2;
- Seattle Fault *M* 7.2;
- Spokane blind fault *M* 5.5;
- Southern Whidbey Island Fault (SWIF) zone *M* 7.4;
- Southern Whidbey Island Fault (SWIF) zone (southeastern section) *M* 7.2; and
- Tacoma Fault *M* 7.1.

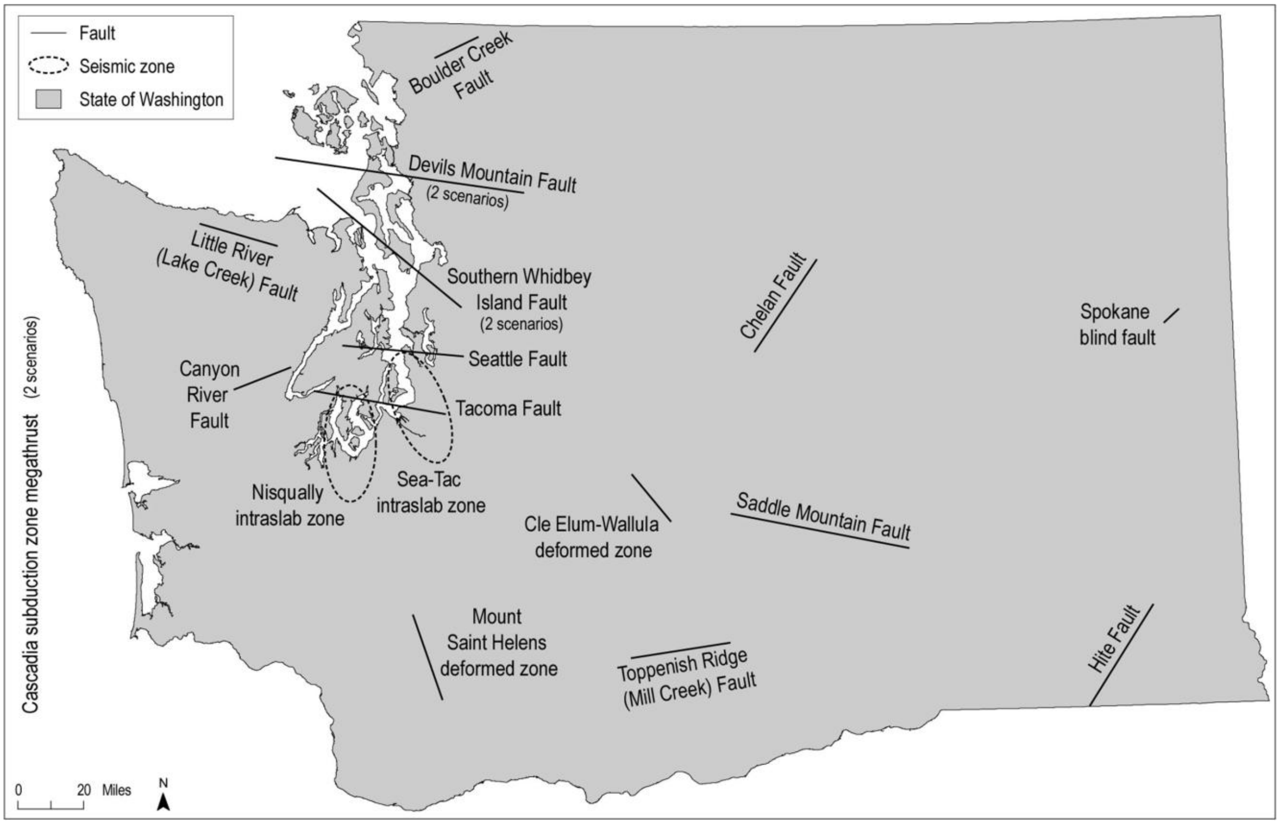

Figure 1. Study area map of scenario earthquakes in Washington (fault locations and extents generalized from U.S. Geological Survey, 2010, and Washington State Department of Natural Resources, 2010).

Methods

To describe population and business exposure to scenario earthquakes, geographic-information-system (GIS) tools were used to integrate publicly available hazard and socioeconomic data. Earthquake-hazard zones were delineated using GIS polygons that represent peak-ground-acceleration (PGA) values from the USGS ShakeMap archive (U.S. Geological Survey, 2010). PGA values were translated and represented by Modified Mercalli Intensity (MMI) classes. MMI describes the severity of an earthquake in terms of its effect on humans and structures. We used MMI classes instead of PGA values at WEMD's request because MMI classes are more easily understood by emergency managers than PGA values. Table 1 summarizes the relation between PGA values and MMI classes, as well as providing a description of societal impacts at each MMI level.

Table 1. Modified Mercalli Intensity (MMI) classes, including relations to peak-ground-acceleration values (Wald and others, 1999) and impact descriptions (abridged from U.S. Geological Survey, 1989).

Modified Mercalli Intensity	Peak Ground Acceleration (PGA)	Description of Societal Impact
I	< 0.0017 *g*	Not felt except by a very few under especially favorable conditions
II	0.0017 – 0.014 *g*	Felt only by a few persons at rest, especially on upper floors of buildings
III	0.0017 – 0.014 *g*	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	0.014 – 0.039 *g*	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably
V	0.039 – 0.092 *g*	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop
VI	0.092 – 0.18 *g*	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight
VII	0.18 – 0.34 *g*	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	0.34 – 0.65 *g*	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned
IX	0.65 – 1.24 *g*	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations
X	> 1.24 *g*	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Societal-asset calculations focus on the number of residents and businesses in the various earthquake-hazard zones. These assets are determined because U.S. jurisdictions are encouraged to collect similar data as they develop State and local mitigation plans (Federal Emergency Management Agency, 2001), a requirement to qualify for funds under the U.S. Hazard Mitigation Grant Program in accordance with the Disaster Mitigation Act of 2000, Public Law 106-390. Data used in this analysis include:

- Population—based on block-level population counts (GIS polygons) compiled for the 1990 and 2000 U.S. Census (U.S. Census Bureau, 2009) that identifies total residents and occupied housing units; and
- Business—based on the 2010 infoUSA Employer Database, a proprietary business database (GIS point file) that identifies location of businesses, number of employees, total sales volume, and the North American Industry Classification System (NAICS) code (infoUSA, 2010).

Before analysis, geospatial data were transformed to share the same datum (North American Datum of 1983, High Accuracy Reference Network, State Plane, Washington, South, FIPS 4602 Feet) and projection (Lambert Conformal Conic), thereby conforming to existing GIS data from the State of Washington's GIS database. Spatial analysis of vector data (for example, population polygons and business points) focused on determining whether or not points and polygons are inside earthquake-hazard zones. Slivers of population polygons that overlap earthquake-hazard zones were taken into account during analysis, and final values were adjusted proportionately.

In the tables and stacked bar-graphs, we have chosen to summarize resident, employee, housing unit, and business counts only for MMI V and above. In discussion with WEMD staff, we agreed that peak-ground-acceleration values at MMI V represent the beginning of significant earthquake-related impacts and damages. Calculations at lower MMI levels are likely to be less useful to emergency managers and therefore were not performed.

The results summarized in this report should be considered first approximations of population and business exposure and not exhaustive inventories. The ShakeMap geospatial layers we received had explicit spatial boundaries. Therefore, certain MMI zones, especially lower classes (MMI V for many scenarios, as well as MMI VI for the SWIF southeastern scenario), were clipped at study-area boundaries and do not represent the entire area likely to experience a certain level of ground shaking. Finally, this assessment of population and business exposure to earthquake hazards is based on scenario earthquakes and ground-shaking models. The results are not definitive loss estimates and are designed solely to help local and State emergency managers in their earthquake preparedness and planning efforts.

Results

Data presented in this initial report were generated to provide information for the WEMD staff. A subsequent report will build on this initial analysis with results tailored to individual communities and counties that could be impacted by the various scenario earthquakes. Preliminary results are presented in both tables and graphs to satisfy various needs of emergency managers. Results reported here include the number of residents, occupied housing units, businesses, and employees in the areas affected by the various MMI classes related to the twenty earthquake scenarios. We also calculate the change in residential exposure to earthquake hazards between 1990 and 2000.

On the basis of the 2000 Census, there are millions of Washington residents living in areas prone to significant ground shaking (table 2; fig. 2). The earthquake scenario with the highest number of residents in earthquake-hazard zones (MMI V and greater) is a Cascadia subduction zone (CSZ) megathrust earthquake. More than 5 million people are living in zones prone to MMI V and above ground shaking for earthquakes along the entire CSZ (*M* 9.0) and also for just the northern section of the CSZ (*M* 8.0).

Although CSZ earthquakes represent the highest overall residential exposure in Washington, a *M* 7.4 earthquake within the Southern Whidbey Island Fault (SWIF) zone could expose the highest number of residents (more than 137,000) to the greatest ground shaking (MMI IX) projected for the State. A *M* 7.1 earthquake on the Tacoma Fault could also expose a significant number of residents (approximately 62,000) to MMI IX ground shaking. Earthquake scenarios for the CSZ are not projected to expose any populations in the State of Washington to MMI IX ground shaking.

Table 2. Residential population exposure to scenario earthquakes in Washington.

Earthquake scenario	Exposed residential population in 2000, organized by MMI class					
	V	VI	VII	VIII	IX	TOTALS
Boulder Creek *M* 6.8	528,183	136,908	13,857	3,463	321	682,732
Canyon River *M* 7.4	2,901,320	791,490	39,459	2,861	116	3,735,245
Cascadia *M* 9.0	780,400	989,190	3,482,525	109,738	0	5,361,853
Cascadia (northern section) *M* 8.3	3,415,432	1,674,719	207,926	8,901	0	5,306,978
Chelan *M* 7.2	124,342	49,019	71,190	10,078	167	254,796
Cle Elum *M* 6.8	1,575,609	149,362	38,234	401	17	1,763,623
Devils Mountain *M* 7.1	2,394,711	397,411	107,617	45,873	2,164	2,947,777
Devils Mountain (western section) *M* 7.4	2,161,370	572,988	118,136	98,997	720	2,952,211
Hite *M* 6.8	139,232	3,235	23,537	29,266	0	195,269
Lake Creek *M* 6.8	3,682,057	16,370	18,110	32,770	1,726	3,751,033
Mill Creek *M* 7.1	322,549	157,650	69,938	3,147	20	553,304
Mt St Helens Zone *M* 7.0	1,284,015	100,031	5,532	1,203	0	1,390,781
Nisqually *M* 7.2	47,061	1,448,439	2,262,156	0	0	3,757,656
Saddle Mountain *M* 7.35	197,958	426,628	47,245	13,363	255	685,449
SeaTac *M* 7.2	52,207	445,927	3,305,549	0	0	3,803,683
Seattle *M* 7.2	355,105	1,441,297	1,103,800	1,035,911	0	3,936,113
Spokane *M* 5.5	126,124	136,667	181,365	0	0	444,156
SWIF *M* 7.4	1,270,495	1,221,859	1,070,349	403,838	137,848	4,104,389
SWIF (southeastern section) *M* 7.2	1,203,827	1,576,691	906,266	249,304	0	3,936,088
Tacoma *M* 7.1	799,104	1,477,240	1,097,000	406,773	61,915	3,842,031

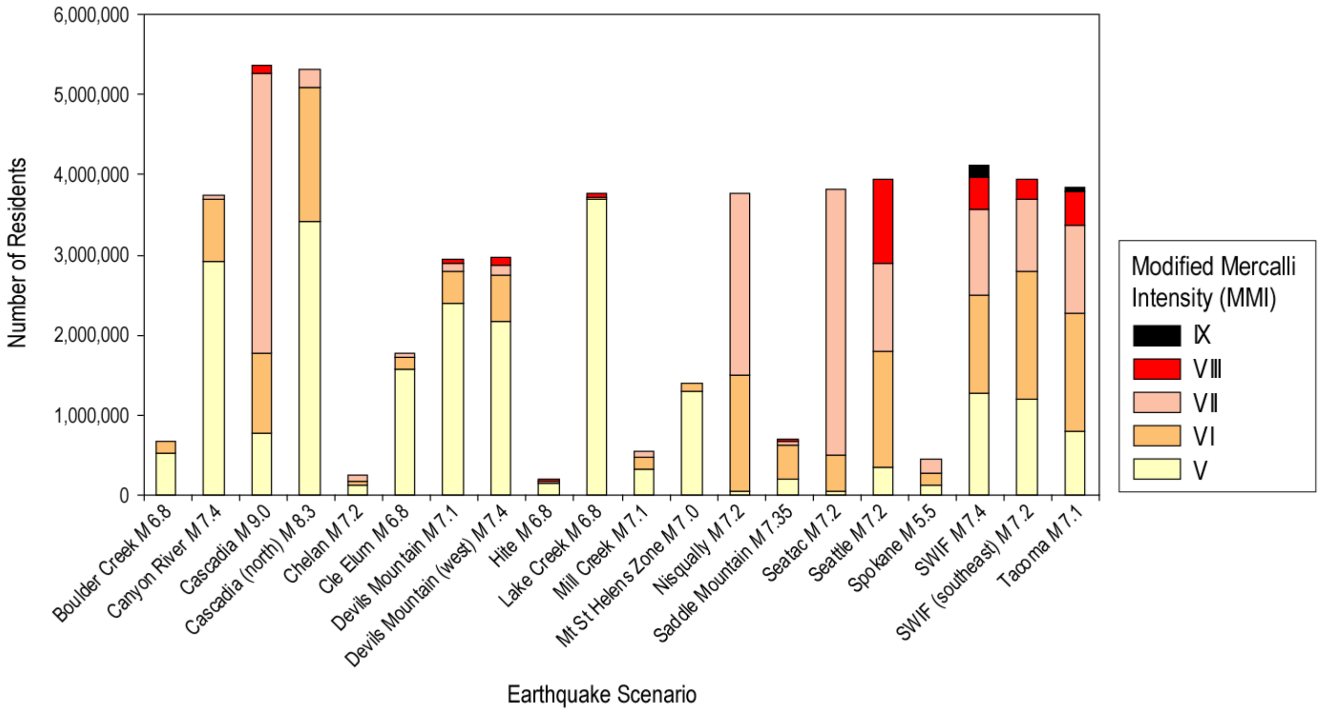

Figure 2. Residential population exposure to scenario earthquakes in Washington.

The exposure of occupied housing units, not surprisingly, follows the trends in residential exposure (table 3; fig. 3). Exposure of occupied housing units to MMI V to IX ground-shaking classes ranges from approximately 68,000 for a *M* 6.8 Hite Fault earthquake to more than 2 million for a CSZ earthquake. Earthquakes related to the SWIF (*M* 7.4) and the Tacoma Fault (*M* 7.1) would expose the greatest number of occupied housing units to the greatest ground-shaking potential (more than 51,000 and 23,000 housing units, respectively, to MMI IX shaking).

Table 3. Exposure of occupied housing units to scenario earthquakes in Washington.

Earthquake scenario	Exposed occupied housing units in 2000, organized by MMI class					
	V	VI	VII	VIII	IX	TOTALS
Boulder Creek *M* 6.8	203,804	52,679	4,671	1,179	118	262,451
Canyon River *M* 7.4	1,135,578	318,863	14,552	1,357	58	1,470,408
Cascadia *M* 9.0	275,627	361,110	1,384,118	43,002	0	2,063,857
Cascadia (northern section) *M* 8.3	1,328,325	628,800	81,135	4,161	0	2,042,421
Chelan *M* 7.2	45,657	18,038	26,224	3,593	72	93,585
Cle Elum *M* 6.8	586,065	53,299	14,721	152	8	654,246
Devils Mountain *M* 7.1	965,101	151,125	39,312	16,634	829	1,173,001
Devils Mountain (western section) *M* 7.4	872,284	220,586	44,277	37,108	312	1,174,567
Hite *M* 6.8	47,909	1,063	9,022	10,202	0	68,195
Lake Creek *M* 6.8	1,447,013	7,254	8,365	13,965	661	1,477,258
Mill Creek *M* 7.1	114,445	56,711	19,425	796	5	191,383
Mt St Helens Zone *M* 7.0	478,782	37,980	2,184	493	0	519,439
Nisqually *M* 7.2	17,926	565,224	893,998	0	0	1,477,148
Saddle Mountain *M* 7.35	72,425	146,633	16,426	3,469	75	239,028
SeaTac *M* 7.2	21,147	170,133	1,301,711	0	0	1,492,991
Seattle *M* 7.2	138,222	542,087	432,342	431,866	0	1,544,516
Spokane *M* 5.5	44,778	52,120	76,451	0	0	173,349
SWIF *M* 7.4	479,709	479,095	448,132	151,450	51,672	1,610,059
SWIF (southeastern section) *M* 7.2	455,320	632,095	358,475	98,615	0	1,544,506
Tacoma *M* 7.1	305,286	592,176	432,761	154,974	23,696	1,508,892

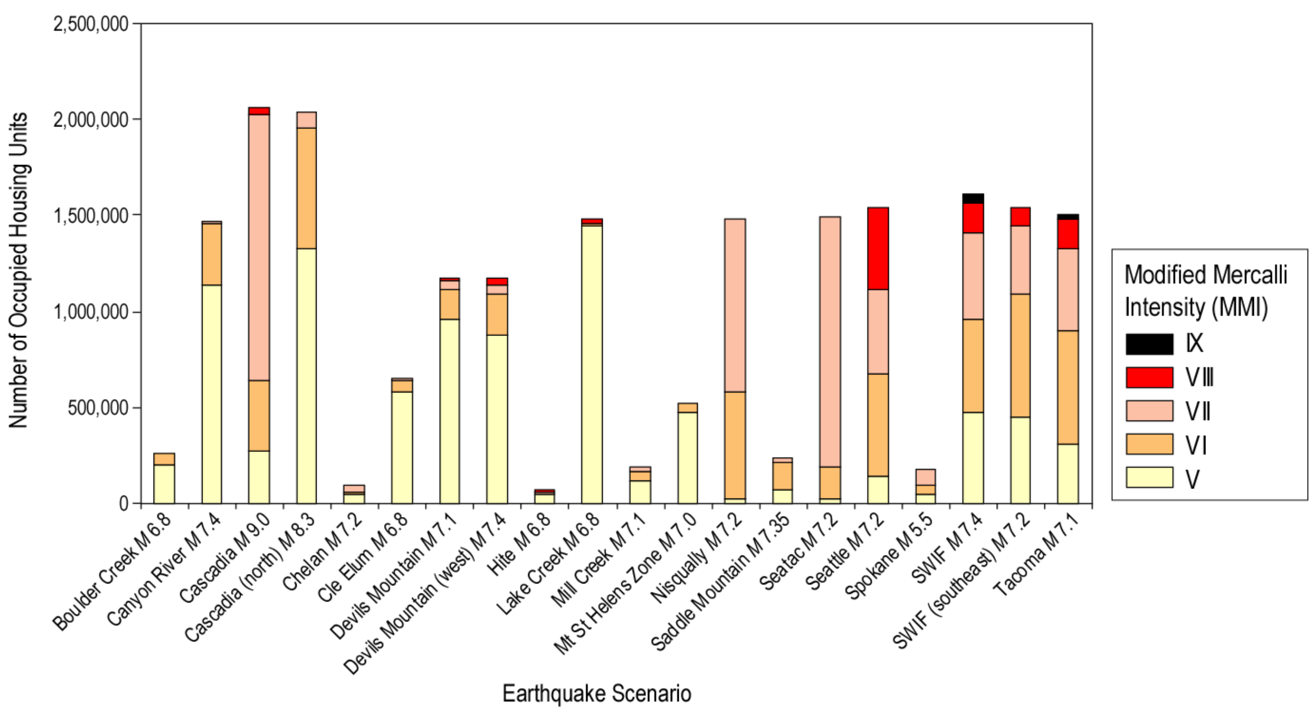

Figure 3. Exposure of occupied housing units to scenario earthquakes in Washington.

Between 1990 and 2000, the exposure of residential populations has increased across the State of Washington (table 4; fig. 4). The greatest increases were related to CSZ earthquakes. Although residential exposure has increased between 1990 and 2000, a comparison of figures 2 and 4 suggests that increases in residential exposure are not unique to any one earthquake scenario and that population across the State of Washington increased fairly uniformly.

Table 4. Increase in residential population exposure to earthquakes, 1990 to 2000, in Washington.

Earthquake scenario	Increase in residential exposure to earthquakes, 1990 to 2000, by MMI class					
	V	VI	VII	VIII	IX	TOTALS
Boulder Creek *M* 6.8	119,702	31,139	2,071	2,243	119	155,274
Canyon River *M* 7.4	458,958	124,235	8,319	595	65	592,173
Cascadia *M* 9.0	145,145	272,080	528,423	9,021	0	954,668
Cascadia (northern section) *M* 8.3	576,409	348,586	21,282	1,352	0	947,629
Chelan *M* 7.2	25,259	10,951	14,056	1,679	36	51,981
Cle Elum *M* 6.8	301,478	23,447	6,989	35	4	331,953
Devils Mountain *M* 7.1	357,674	95,674	24,896	11,774	638	490,657
Devils Mountain (western section) *M* 7.4	295,434	146,687	30,720	16,981	56	489,878
Hite *M* 6.8	25,220	1,031	2,481	2,580	0	31,311
Lake Creek *M* 6.8	596,939	4,032	3,943	2,721	512	608,147
Mill Creek *M* 7.1	72,297	24,200	10,103	318	12	106,929
Mt St Helens Zone *M* 7.0	265,128	15,290	640	78	0	281,136
Nisqually *M* 7.2	6,443	243,153	349,527	0	0	599,123
Saddle Mountain *M* 7.35	34,798	80,269	9,688	5,342	74	130,172
SeaTac *M* 7.2	4,166	99,380	519,388	0	0	622,934
Seattle *M* 7.2	59,233	293,715	163,643	130,761	0	647,351
Spokane *M* 5.5	27,416	26,080	10,072	0	0	63,568
SWIF *M* 7.4	237,609	183,914	151,993	76,315	40,101	689,933
SWIF (southeastern section) *M* 7.2	204,025	243,189	144,804	55,332	0	647,350
Tacoma *M* 7.1	173,728	217,415	149,156	75,034	8,795	624,128

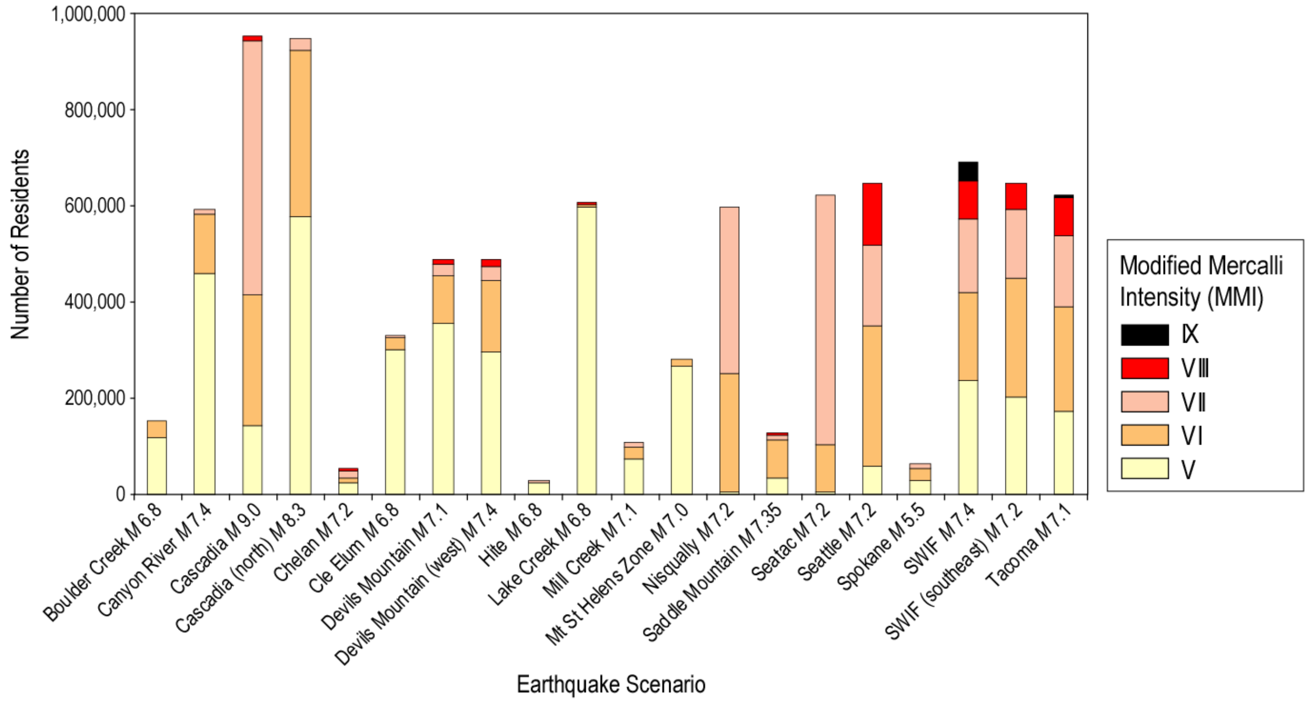

Figure 4. Increase in residential population exposure to earthquakes, 1990 to 2000, in Washington.

The exposure of businesses to MMI V to IX ground-shaking classes ranges from approximately 6,500 for a *M* 6.8 Hite Fault earthquake to more than 200,000 for a CSZ earthquake (table 5; fig. 5). This analysis of business exposure does not differentiate between small businesses with only a few employees and large corporations with thousands of employees. A subsequent analysis of employee exposure accounts for variations in business size.

An earthquake related to the Seattle Fault (*M* 7.2) would likely have the greatest impact to business communities, as it could expose more than 55,000 businesses to MMI VIII ground shaking. Earthquake scenarios for the SWIF (*M* 7.4) and Tacoma Fault (*M* 7.1) would expose several thousands of businesses to MMI IX ground shaking (3,827 and 1,486, respectively) but would have significantly lower numbers of businesses in MMI VIII classes (14,339 and 14,950 businesses, respectively) than a Seattle *M* 7.2 earthquake scenario. In general, scenario earthquakes associated with the Seattle, SWIF, and Tacoma faults likely represent the greatest threats to businesses of the twenty scenarios in this study.

Table 5. Business exposure to scenario earthquakes in Washington.

Earthquake scenario	Exposed businesses in 2010, organized by MMI class					
	V	VI	VII	VIII	IX	TOTALS
Boulder Creek *M* 6.8	20,529	6,507	341	50	8	27,435
Canyon River *M* 7.4	105,931	44,614	1,275	47	1	151,868
Cascadia *M* 9.0	26,841	33,629	146,947	3,467	0	210,884
Cascadia (northern section) *M* 8.3	142,043	59,683	7,587	199	0	209,512
Chelan *M* 7.2	4,529	1,692	3,077	168	1	9,467
Cle Elum *M* 6.8	57,498	5,633	1,776	14	0	64,921
Devils Mountain *M* 7.1	104,685	15,583	3,624	2,321	49	126,262
Devils Mountain (western section) *M* 7.4	95,457	22,350	4,264	4,226	27	126,324
Hite *M* 6.8	4,268	70	779	1,450	0	6,567
Lake Creek *M* 6.8	152,171	1,130	1,100	1,759	30	156,190
Mill Creek *M* 7.1	11,531	6,199	1,414	43	0	19,187
Mt St Helens Zone *M* 7.0	44,323	4,129	99	8	0	48,559
Nisqually *M* 7.2	880	51,918	98,587	0	0	151,385
Saddle Mountain *M* 7.35	6,948	15,710	1,830	223	5	24,716
SeaTac *M* 7.2	1,631	15,657	136,628	0	0	153,916
Seattle *M* 7.2	12,531	51,830	39,569	55,907	0	159,837
Spokane *M* 5.5	3,620	5,137	9,516	0	0	18,273
SWIF *M* 7.4	43,698	53,917	52,249	14,339	3,827	168,030
SWIF (southeastern section) *M* 7.2	42,863	73,945	34,264	8,765	0	159,837
Tacoma *M* 7.1	26,797	61,129	50,819	14,950	1,486	155,181

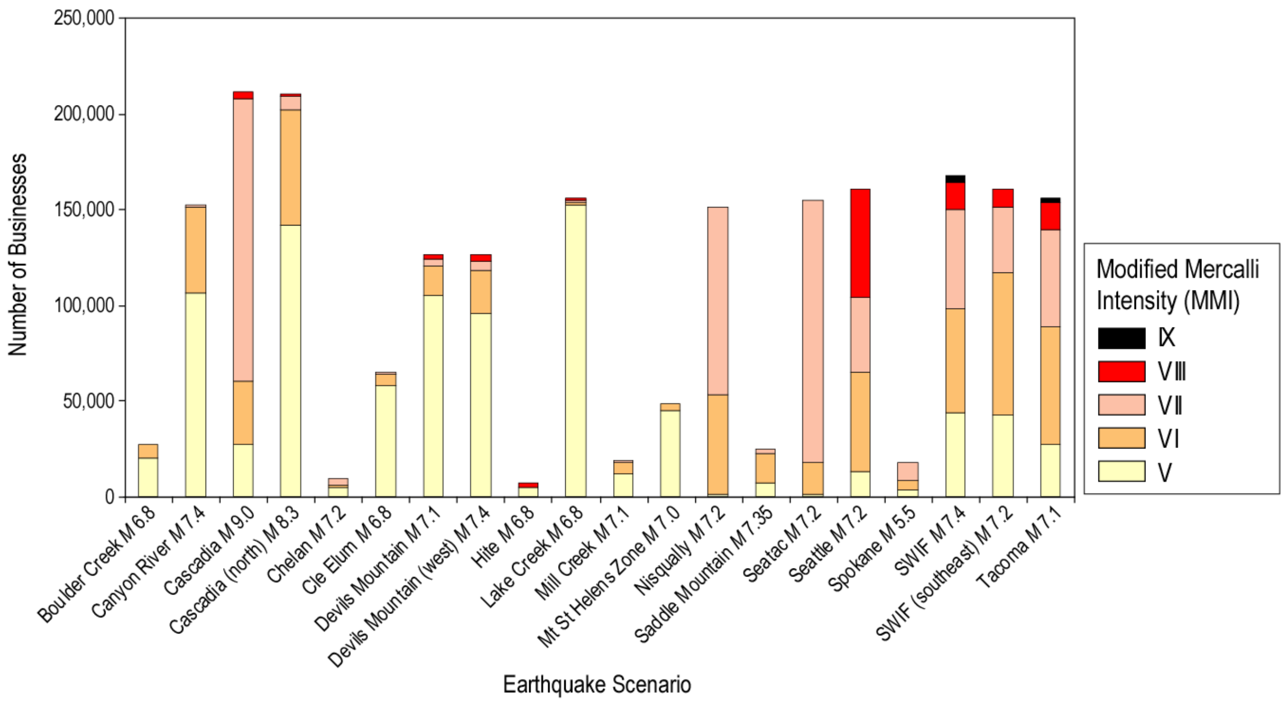

Figure 5. Business exposure to scenario earthquakes in Washington.

The exposure of employees to MMI V to IX ground-shaking classes ranges from approximately 68,000 for a *M* 6.8 Hite Fault earthquake to more than 2.2 million for a CSZ earthquake (table 6; fig. 6). An earthquake related to the Seattle Fault (*M* 7.2) would likely have the greatest impact to business communities, as it could expose more than 678,000 employees to MMI VIII ground shaking. Again, earthquake scenarios for the SWIF (M 7.4) and Tacoma Fault (*M* 7.1) would expose significant numbers of employees to MMI IX ground shaking (42,737 and 9,567, respectively) but would have significantly lower numbers than a Seattle scenario in MMI VIII classes (both approximately one-third of Seattle Fault estimates).

Table 6. Employee exposure to scenario earthquakes in Washington.

Earthquake scenario	Number of Employees (2010), organized by MMI class					
	V	VI	VII	VIII	IX	TOTALS
Boulder Creek *M* 6.8	188,657	66,923	2,564	202	18	258,364
Canyon River *M* 7.4	1,112,577	575,656	9,616	253	30	1,698,132
Cascadia *M* 9.0	291,546	297,972	1,662,116	27,755	0	2,279,389
Cascadia (northern section) *M* 8.3	1,549,172	651,810	68,419	789	0	2,270,190
Chelan *M* 7.2	46,788	13,648	33,358	1,674	1	95,469
Cle Elum *M* 6.8	657,580	62,266	11,567	52	0	731,465
Devils Mountain *M* 7.1	1,161,231	153,138	34,050	22,547	233	1,371,199
Devils Mountain (western section) *M* 7.4	1,077,903	221,021	36,928	36,942	70	1,372,864
Hite *M* 6.8	46,683	2,386	5,314	13,839	0	68,222
Lake Creek *M* 6.8	1,717,686	6,729	6,018	15,114	136	1,745,683
Mill Creek *M* 7.1	134,814	66,648	18,388	659	0	220,509
Mt St Helens Zone *M* 7.0	460,550	38,141	512	73	0	499,276
Nisqually *M* 7.2	4,369	531,130	1,155,059	0	0	1,690,558
Saddle Mountain *M* 7.35	64,699	195,056	15,340	2,499	47	277,641
SeaTac *M* 7.2	14,375	132,619	1,562,848	0	0	1,709,842
Seattle *M* 7.2	101,488	564,679	417,017	678,087	0	1,761,271
Spokane *M* 5.5	35,044	50,967	124,568	0	0	210,579
SWIF *M* 7.4	448,337	628,400	574,810	143,361	42,737	1,837,645
SWIF (southeastern section) *M* 7.2	464,566	877,856	333,159	85,690	0	1,761,271
Tacoma *M* 7.1	245,299	655,844	618,869	191,380	9,567	1,720,959

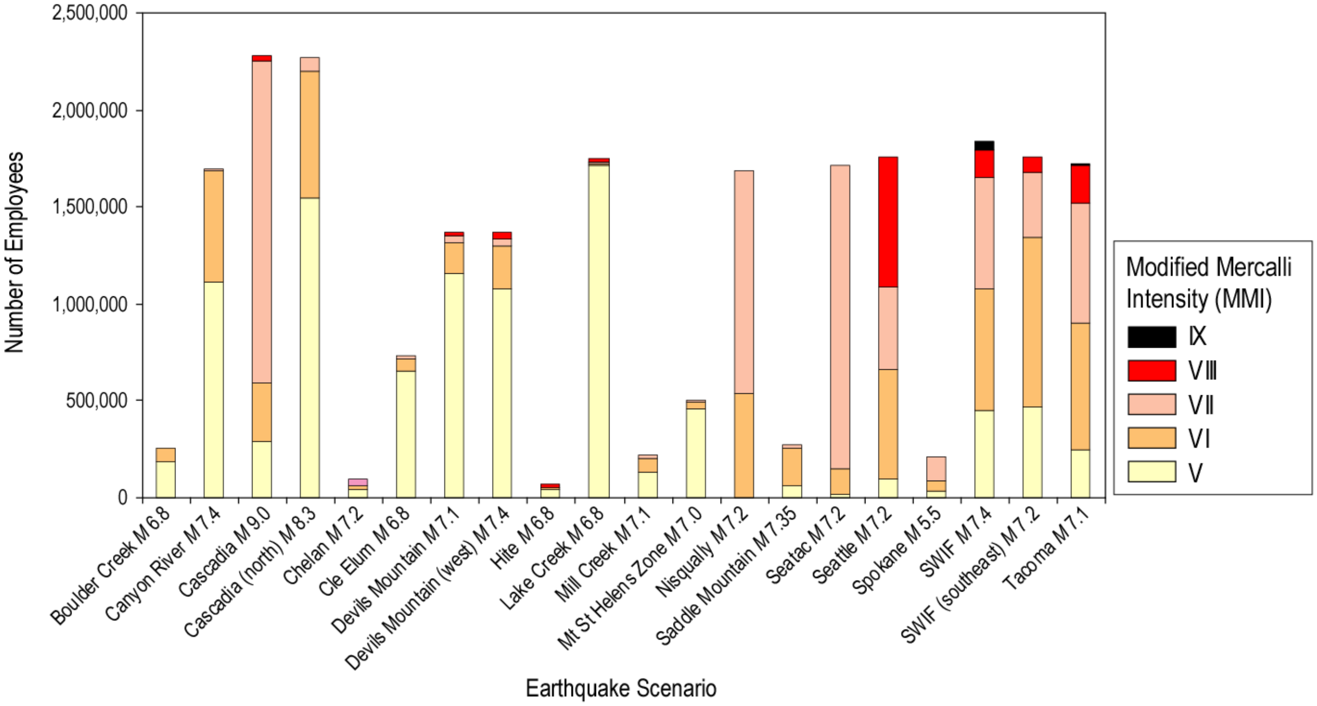

Figure 6. Employee exposure to scenario earthquakes in Washington.

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References Cited

Federal Emergency Management Agency, 2001, State and local mitigation planning how-to guide No. 2—Understanding your risks: Federal Emergency Management Agency no. 386-2, last accessed August 21, 2007, at http://www.fema.gov/library/viewRecord.do?id=1880.

InfoUSA, 2010, Employer database: online dataset, last accessed December 14, 2010, at http://www.infousagov.com/employer.asp.

U.S. Census Bureau, 2009, Census 2000: Census 2000 Gateway, last accessed December 14, 2010, at http://www.census.gov/main/www/cen2000.html.

U.S. Geological Survey, 1989, The severity of an earthquake: U.S. Geological Survey General Interest Publication, 15 p.

U.S. Geological Survey, 2010, ShakeMap Archive: last accessed December 14, 2010, at http://earthquake.usgs.gov/earthquakes/shakemap/list.php?x=1&n=global.

Wald, D., Quitoriano, V., Heaton, T., and Kanamori, H., 1999, Relationships between peak ground acceleration, peak ground velocity, and Modified Mercalli Intensity in California: Earthquake Spectra, v. 15 no. 3, p. 557–564.

Washington State Department of Natural Resources, 2010, Seismogenic features, Washington State Department of Natural Resources, Division of Geology and Earth Resources, last accessed January 21, 2011, at http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx.