

HURRICANE MARIA

Initial Hazus Run, 27 November 2017

ARA wind field

Hazus: Estimated Damage and Economic Losses

Puerto Rico, United States

Initial Hazus Wind Loss Estimates for Hurricane Maria using the ARA wind field.

Note: Model results produced by Shane Hubbard, PhD, University of Wisconsin-Madison and FEMA's HAZUS program, utilizing the FEMA Hazus 4.0 model. Level 1 data for PR was converted to the 2010 census geometries.

Disclaimer: 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 Hurricane.

Quick Assessment Report

November 27, 2017

Study Region : PR_Maria
 Scenario : Maria_18
 Scenario Description : User Defined
 Peak Gust Wind Speed (mph) : 147

Regional Statistics

Area (Square Miles) 3,452
 Number of Census Tracts 904
 Number of People in the Region 3,725,789

General Building Stock

Occupancy	Building Count	Dollar Exposure (\$ M)
Residential	1,390,338	230,498
Commercial	4,900	2,667
Other	1,381	909
Total	1,396,619	234,074

Scenario Results

Number of Buildings Damaged

Damage State	Residential	Commercial	Other	Total
Minor	300,000	700	200	300,000
Moderate	270,000	1,400	400	270,000
Severe	160,000	1,200	400	160,000
Destruction	19,000	20	20	19,000
Total	750,000	3,300	1,000	750,000

Shelter Requirements

Displaced Households (# Households) 130,000
 Short Term Shelter (# People) 49,000

Economic Loss (\$ Millions)

Capital Stock	26,565
Residential Property	25,744
Commercial Property	587
Other Property	234
Business Interruption (Income)	4,927
Total Direct Economic Loss	31,492

Totals only reflect data for those census tracts/block included in the user's study region.

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Hurricane Maria - Peak Wind Gusts (mph) by Census Tract

Observed ARA Wind Field Initial Run



Storm Positions

- Tropical Depression
- 🌀 Tropical Storm (39-73 mph)
- 🌀 Hurricane Category 1 (74-95 mph)
- 🌀 Hurricane Category 2 (96-110 mph)
- 🌀 Hurricane Category 3 (111-129 mph)
- 🌀 Hurricane Category 4 (130-156 mph)
- 🌀 Hurricane Category 5 (157+ mph)

— Hurricane Track

□ Counties

Peak Gusts (mph)

- 0 - 38
- 39 - 73
- 74 - 95
- 96 - 110
- 111 - 129
- 130 - 156
- 157 +

** Indicates peak wind gusts measured in miles per hour based on the NWS advisory.

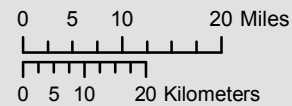
9/20/2017 9 PM
109 mph

9/20/2017 6 PM
115 mph

9/20/2017 3 PM
138 mph

9/20/2017 12 PM
150 mph

9/20/2017 9 AM
155 mph



Produced By: FEMA & Shane Hubbard
Product Created: 11/27/2017
Source Data: ESRI, NOAA, HAZUS, ASOS/NIST, ARA
Projection: Mercator Datum WGS84

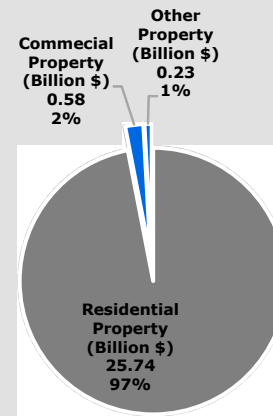
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Hurricane Maria - Direct Economic Losses for Buildings

Observed ARA Wind Field Initial Run



\$31.5 Billion
Total Capital Economic Loss



Storm Positions

- Tropical Depression
- Tropical Storm (39-73 mph)
- Hurricane Category 1 (74-95 mph)
- Hurricane Category 2 (96-110 mph)
- Hurricane Category 3 (111-129 mph)
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- Hurricane Category 5 (157+ mph)

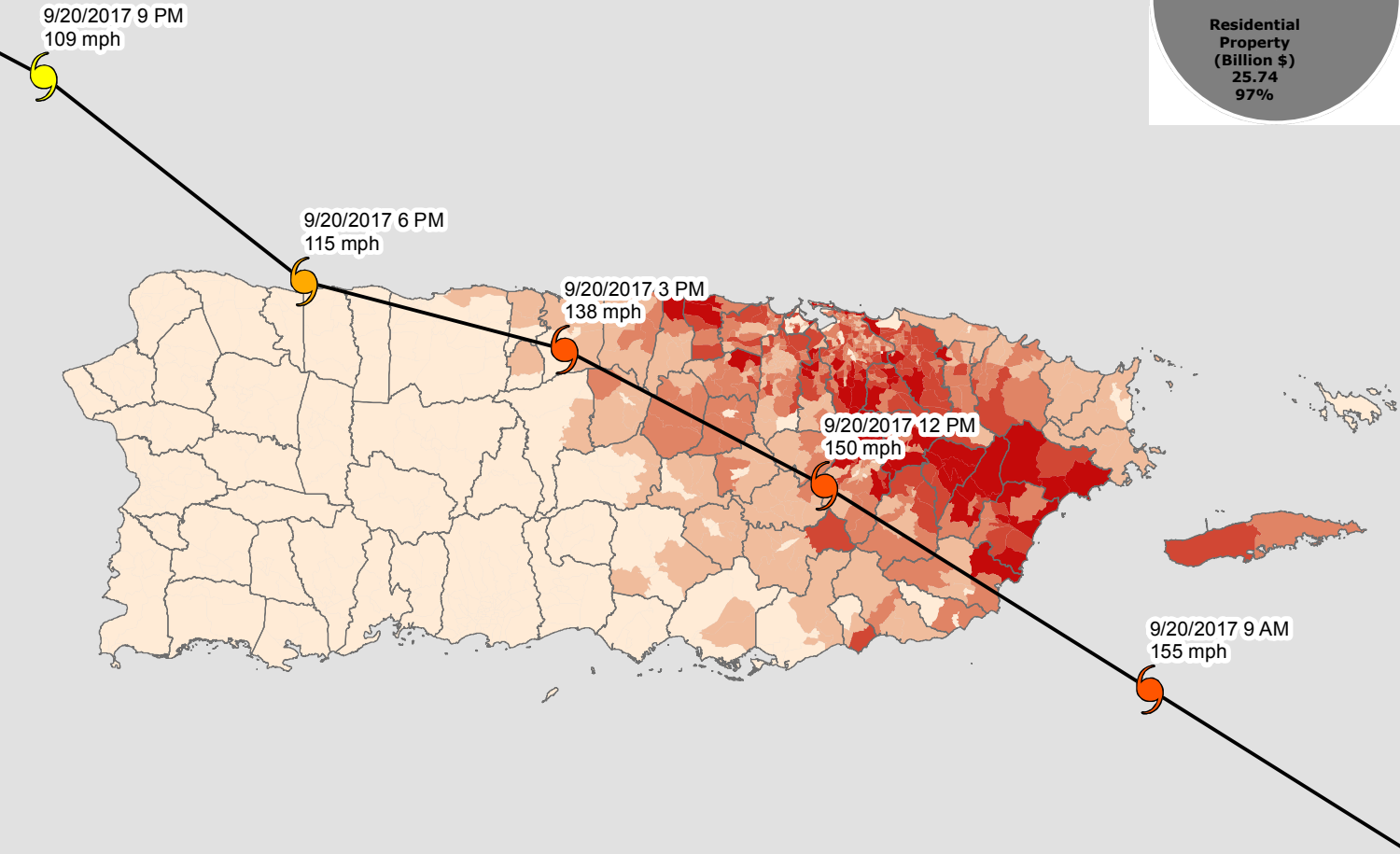
— Hurricane Track

□ Counties

Direct Economic Loss (\$k)

- \$0.00 - \$15,849.02
- \$15,849.03 - \$39,077.28
- \$39,077.29 - \$64,787.17
- \$64,787.18 - \$108,766.10
- \$108,766.11 - \$306,453.25

** Indicates losses related to building repair and replacement costs, damage to contents, losses of building inventory, relocation expense, capital-related.



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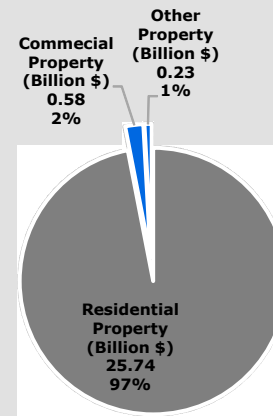
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Hurricane Maria - Direct Economic Losses for Buildings

Observed ARA Wind Field Initial Run



\$31.5 Billion
Total Capital Economic Loss



Storm Positions

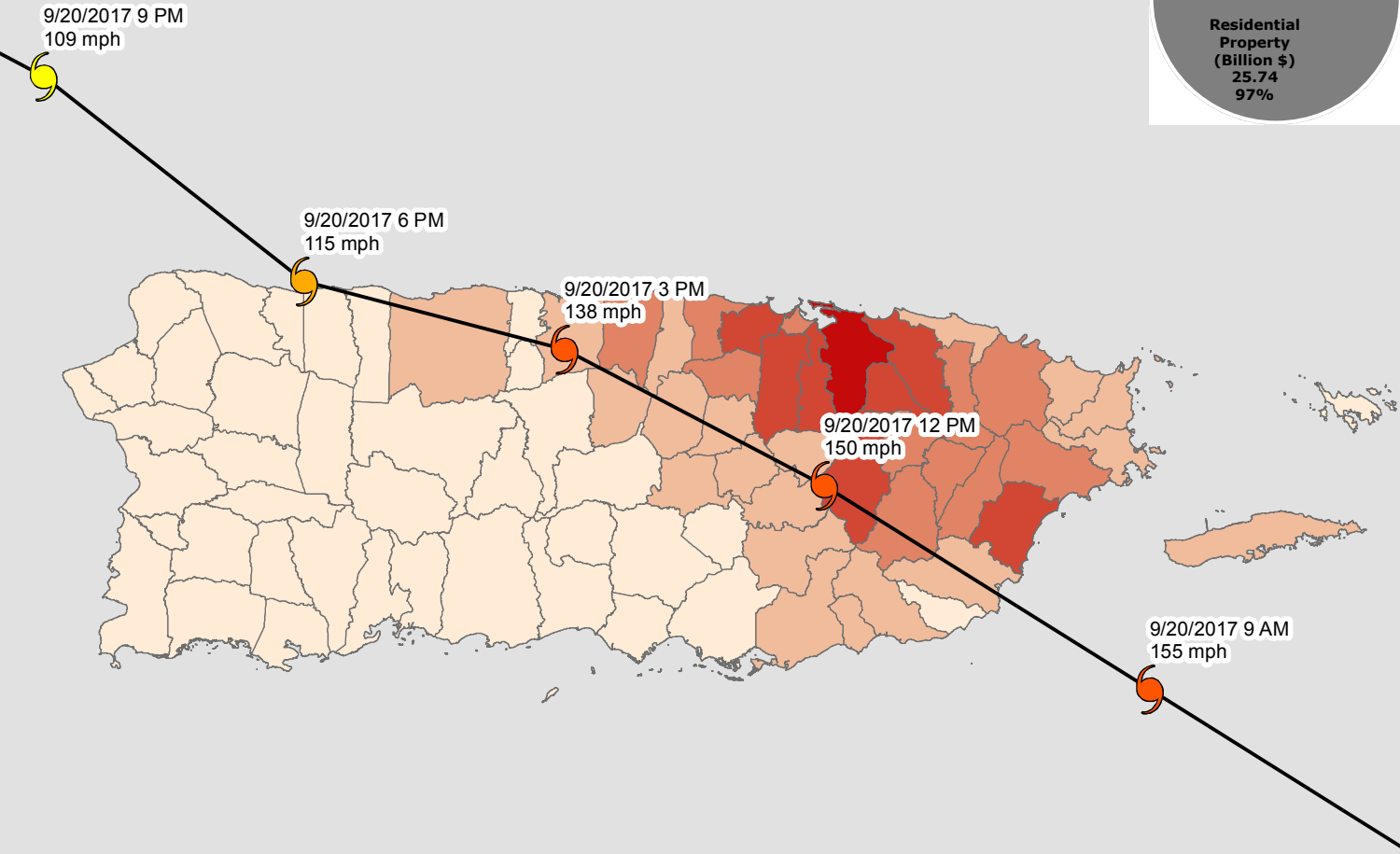
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- Hurricane Category 5 (157+ mph)

— Hurricane Track

Direct Economic Loss (\$k)

- \$1,447.34 - \$112,442.27
- \$112,442.28 - \$375,276.86
- \$375,276.87 - \$844,086.45
- \$844,086.46 - \$2,782,740.21
- \$2,782,740.22 - \$7,262,750.80
- Counties

** Indicates losses related to building repair and replacement costs, damage to contents, losses of building inventory, relocation expense, capital-related.



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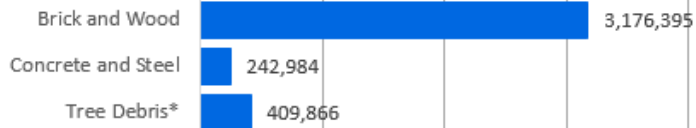
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Hurricane Maria - Debris Generated by Tract (Hazus)

Observed ARA Wind Field Initial Run



Wind Debris (Tons) by Type



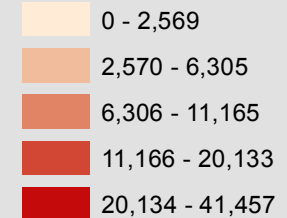
Storm Positions

- Tropical Depression
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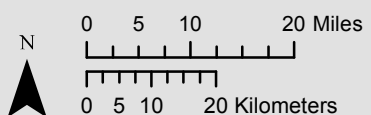
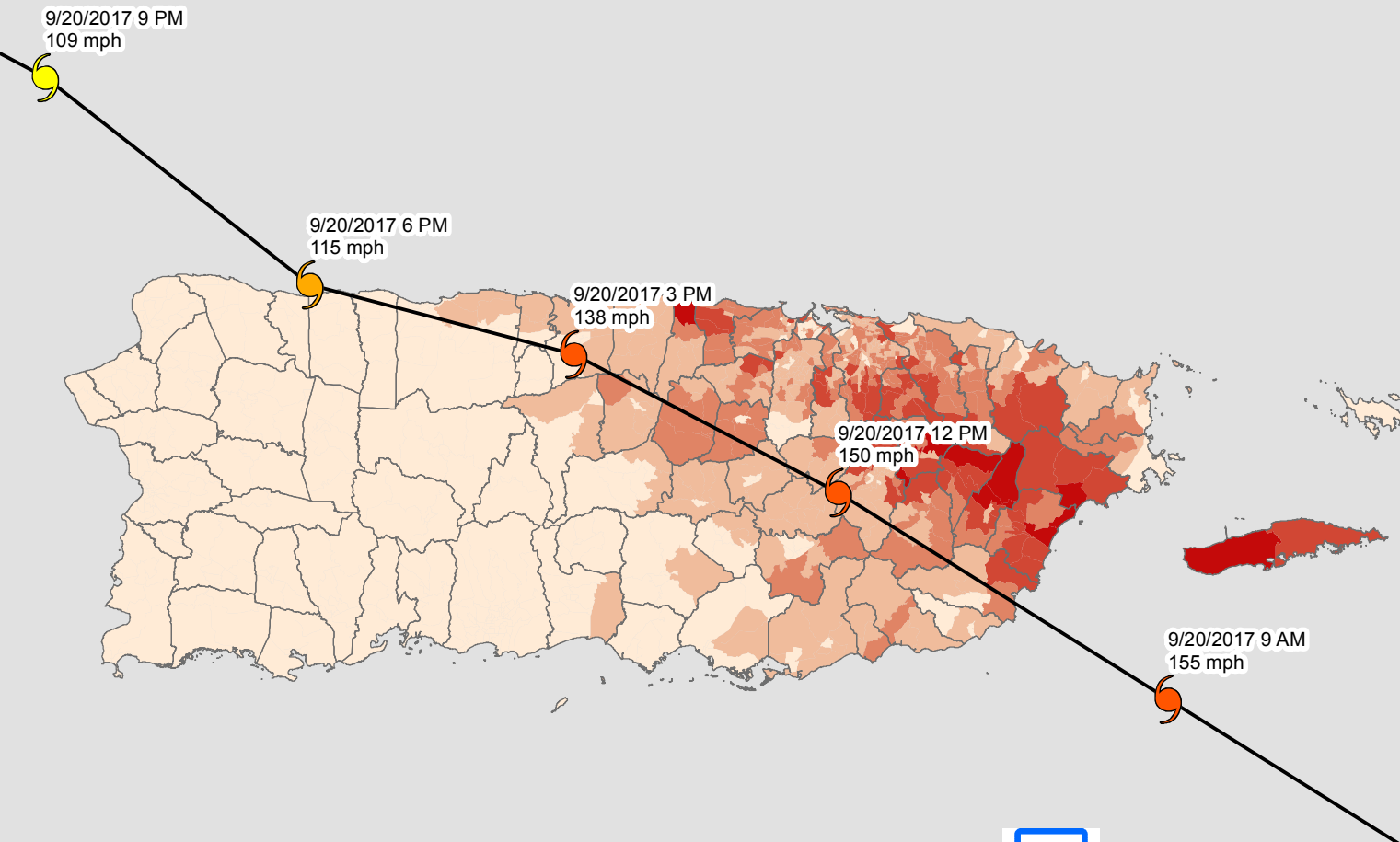
— Hurricane Track

□ Counties

Total Debris (tons)



*Debris includes: brick/wood, concrete/steel and tree debris only in or near right of ways.



3.8M Tons
Total Wind Debris Generated

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Source Data: ESRI, NOAA, HAZUS, ASOS/NIST, ARA
Projection: Mercator Datum WGS84

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Direct Economic Losses For Buildings:

November 27, 2017

All values are in thousands of dollars

	Capital Stock Losses				Income Losses				Total Loss
	Cost Building Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	
Puerto Rico									
Adjuntas	7,058	818	1	0.65	604	3	5	184	8,673
Aguada	5,538	585	0	0.23	507	1	0	194	6,827
Aguadilla	12,471	1,065	0	0.32	946	1	0	369	14,852
Aguas Buenas	146,488	50,780	7	9.57	32,732	13	51	9,443	239,515
Aibonito	70,737	20,232	9	5.02	16,689	69	85	4,621	112,442
Añasco	4,167	404	0	0.24	390	0	0	132	5,094
Arecibo	141,613	35,416	88	2.31	26,311	178	320	7,285	211,211
Arroyo	92,666	30,757	5	7.67	20,417	39	58	6,062	150,003
Barceloneta	58,848	16,642	18	4.05	13,245	55	65	3,640	92,512
Barranquitas	90,293	27,107	2	5.76	21,017	7	28	5,866	144,320
Bayamón	1,547,107	547,399	2,479	11.89	295,861	3,608	5,038	96,371	2,497,862
Cabo Rojo	5,219	304	0	0.13	527	0	0	182	6,232
Caguas	1,003,820	357,804	329	10.98	197,996	940	1,298	60,264	1,622,452
Camuy	16,503	1,835	1	0.85	1,820	14	21	463	20,657
Canóvanas	418,353	155,614	86	14.11	84,093	181	311	24,331	682,968
Carolina	1,730,283	628,604	489	14.91	314,086	1,646	1,804	105,828	2,782,740
Cataño	309,245	119,403	243	18.60	51,955	685	886	18,135	500,552
Cayey	160,644	48,548	7	5.91	35,135	51	111	10,946	255,443

Study Region : PR_Maria
Scenario : Maria_18

Direct Economic Losses For Buildings:

November 27, 2017

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	Cost Building Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	
Puerto Rico									
Ceiba	77,849	24,593	1	7.61	17,174	8	19	5,191	124,836
Ciales	34,731	10,934	38	3.32	6,873	26	40	1,855	54,497
Cidra	190,637	64,819	12	8.05	39,074	138	258	12,250	307,188
Coamo	73,086	18,536	9	3.15	16,117	20	30	4,314	112,112
Comerio	85,090	27,707	3	7.97	19,915	0	2	5,633	138,350
Corozal	166,938	60,030	21	8.76	37,275	32	79	10,520	274,896
Culebra	2,926	368	0	1.30	426	0	0	115	3,835
Dorado	371,781	142,805	341	13.39	67,572	736	939	21,107	605,281
Fajardo	115,064	30,370	29	4.27	24,522	18	23	7,356	177,381
Florida	19,277	5,397	3	2.83	3,891	11	13	1,034	29,627
Guánica	2,741	13	0	0.21	292	0	0	102	3,148
Guayama	117,621	30,692	16	4.15	26,374	26	28	7,435	182,192
Guayanilla	4,659	525	0	0.40	339	0	0	109	5,632
Guaynabo	872,640	307,964	495	12.87	139,096	1,786	2,040	50,778	1,374,798
Gurabo	519,196	200,662	64	18.02	95,875	84	110	28,096	844,086
Hatillo	35,492	6,369	0	1.53	5,954	1	1	1,536	49,353
Hormigueros	1,762	8	0	0.16	129	0	0	45	1,944
Humacao	798,114	309,517	63	20.42	150,219	793	1,204	46,619	1,306,529

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November 27, 2017

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	Capital Stock Losses				Income Losses				Total Loss
	Cost Building Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	
Puerto Rico									
Isabela	17,217	1,582	0	0.60	1,791	3	5	498	21,096
Jayuya	12,564	2,202	6	1.40	1,793	4	7	484	17,060
Juana Díaz	30,516	4,345	5	1.12	4,017	6	11	997	39,897
Juncos	469,395	184,057	100	19.68	91,225	185	284	27,128	772,374
Lajas	2,795	7	0	0.17	268	0	0	88	3,158
Lares	11,097	2,265	0	0.65	830	2	1	260	14,454
Las Marías	2,261	603	0	0.42	131	0	0	43	3,038
Las Piedras	411,597	160,907	8	18.81	83,661	26	53	24,366	680,618
Loíza	181,565	62,905	10	10.09	39,456	16	39	11,451	295,442
Luquillo	80,136	22,536	3	5.22	16,639	67	182	5,227	124,790
Manatí	117,851	32,862	13	4.47	26,373	58	69	7,476	184,702
Maricao	1,266	61	0	0.35	92	0	0	28	1,447
Maunabo	42,621	13,604	9	5.75	9,804	26	34	2,737	68,835
Mayagüez	10,663	706	0	0.19	1,042	0	1	432	12,845
Moca	7,301	539	0	0.32	551	0	0	180	8,571
Morovis	102,559	35,424	7	6.09	22,589	24	30	6,228	166,861
Naguabo	298,353	117,770	43	18.72	59,941	266	329	17,944	494,646
Naranjito	132,544	46,662	6	8.78	30,113	16	29	8,418	217,788

Study Region : PR_Maria
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Direct Economic Losses For Buildings:

November 27, 2017

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	Cost Building Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	
Puerto Rico									
Orocovis	58,488	19,071	2	4.72	12,852	2	6	3,510	93,932
Patillas	78,202	26,626	111	6.23	17,499	51	105	4,921	127,514
Peñuelas	6,733	1,519	0	0.55	575	0	0	169	8,995
Ponce	60,206	4,830	3	0.59	5,739	45	33	2,240	73,097
Quebradillas	12,449	2,485	1	0.88	1,200	4	6	337	16,481
Rincón	1,935	30	0	0.16	222	0	0	85	2,272
Río Grande	301,119	98,875	13	8.30	63,705	186	183	18,665	482,747
Sabana Grande	3,917	23	0	0.26	350	1	0	123	4,414
Salinas	60,013	14,996	14	2.97	12,965	27	67	3,474	91,556
San Germán	4,919	831	0	0.22	413	0	0	151	6,314
San Juan	4,470,811	1,684,579	11,087	14.71	702,502	49,246	56,025	288,500	7,262,751
San Lorenzo	312,536	115,666	78	12.74	67,518	164	239	19,329	515,530
San Sebastián	13,957	4,294	0	0.56	838	1	0	269	19,360
Santa Isabel	23,063	4,385	2	1.70	4,148	10	15	1,053	32,676
Toa Alta	485,680	172,869	44	11.29	94,654	155	230	27,926	781,557
Toa Baja	786,191	294,997	180	14.72	150,985	1,409	1,358	48,138	1,283,259
Trujillo Alto	793,046	295,120	71	16.70	131,242	103	153	45,200	1,264,935
Utuado	19,980	3,645	0	1.06	2,288	3	4	614	26,534

Study Region : PR_Maria
Scenario : Maria_18

Direct Economic Losses For Buildings:

November 27, 2017

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	Capital Stock Losses				Income Losses				Total Loss
	Cost Building Damage	Cost Contents Damage	Inventory Loss	Loss Ratio %	Relocation Loss	Capital Related Loss	Wages Losses	Rental Income Loss	
Puerto Rico									
Vega Alta	231,098	81,390	3	10.25	47,946	20	42	14,777	375,277
Vega Baja	277,407	96,254	36	7.67	60,370	194	198	17,163	451,622
Vieques	82,059	29,503	11	11.19	18,091	10	20	5,111	134,805
Villalba	24,994	4,832	0	1.90	4,566	3	6	1,186	35,587
Yabucoa	191,799	65,867	72	8.85	43,319	124	170	12,138	313,488
Yauco	8,163	248	1	0.32	659	3	1	232	9,307
Total	19,551,724	6,996,593	16,796	8.35	3,600,410	63,632	74,803	1,187,711	31,491,670
Study Region Total	19,551,724	6,996,593	16,796	8.35	3,600,410	63,632	74,803	1,187,711	31,491,670

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.

Study Region : PR_Maria
Scenario : Maria_18

Debris Summary Report:

November 27, 2017

All values are in tons.

	Brick, Wood and Other	Reinf. Concrete and Steel	Eligible Tree Debris	Other Tree Debris	Total
Puerto Rico					
Adjuntas	944	6	2,338	29,779	33,067
Aguada	542	0	1,725	3,468	5,735
Aguadilla	1,406	3	1,680	3,832	6,921
Aguas Buenas	25,227	1,949	7,668	32,705	67,549
Aibonito	11,979	765	2,161	13,346	28,251
Añasco	350	0	1,016	7,489	8,855
Arecibo	22,395	956	11,930	63,872	99,153
Arroyo	15,651	1,174	3,139	4,604	24,568
Barceloneta	9,834	611	1,547	6,057	18,049
Barranquitas	15,214	1,008	7,582	11,406	35,210
Bayamón	252,496	18,992	4,841	7,412	283,741
Cabo Rojo	432	0	2,324	3,597	6,353
Caguas	160,443	12,484	21,823	58,375	253,125
Camuy	2,438	37	2,119	13,885	18,479
Canóvanas	70,622	6,500	6,673	12,230	96,025
Carolina	289,130	23,419	13,952	25,374	351,875
Cataño	50,977	4,446	1,727	2,363	59,513
Cayey	27,283	1,591	9,623	28,952	67,449
Ceiba	13,197	884	4,021	6,034	24,136
Ciales	5,215	236	5,026	73,341	83,818
Cidra	30,457	2,048	9,721	33,678	75,904
Coamo	12,204	671	1,081	13,753	27,709
Comerío	14,801	1,127	1,583	12,526	30,037
Corozal	27,445	2,080	12,299	57,412	99,236
Culebra	487	9	0	0	496
Dorado	57,629	5,005	4,571	18,686	85,891
Fajardo	19,023	911	8,236	11,304	39,474
Florida	2,996	128	1,660	11,487	16,271
Guánica	278	0	138	1,335	1,751
Guayama	19,398	1,034	8,536	28,017	56,985
Guayanilla	483	1	1,464	13,586	15,534
Guaynabo	128,717	8,829	11,545	17,889	166,980

Debris Summary Report:

November 27, 2017

All values are in tons.

	Brick, Wood and Other	Reinf. Concrete and Steel	Eligible Tree Debris	Other Tree Debris	Total
Puerto Rico					
Gurabo	86,252	8,555	6,709	15,122	116,638
Hatillo	5,758	200	505	3,684	10,147
Hormigueros	130	0	544	817	1,491
Humacao	146,200	14,684	7,868	16,629	185,381
Isabela	2,334	31	1,128	9,921	13,414
Jayuya	1,956	46	2,108	28,130	32,240
Juana Díaz	4,722	96	5,405	10,144	20,367
Juncos	84,352	8,505	5,106	15,574	113,537
Lajas	223	0	0	0	223
Lares	1,311	7	3,857	30,142	35,317
Las Marías	192	0	1,054	16,851	18,097
Las Piedras	76,174	7,666	7,298	32,855	123,993
Loíza	31,198	2,594	669	8,181	42,642
Luquillo	13,100	682	2,828	21,749	38,359
Manatí	19,441	1,058	5,972	22,899	49,370
Maricao	138	0	475	10,985	11,598
Maunabo	7,064	468	2,021	17,555	27,108
Mayagüez	1,181	1	1,767	8,004	10,953
Moca	734	2	2,262	7,824	10,822
Morovis	16,311	1,089	8,811	37,862	64,073
Naguabo	55,095	5,527	4,771	46,497	111,890
Naranjito	22,294	1,715	7,324	29,161	60,494
Orocovis	9,273	549	6,327	63,375	79,524
Patillas	12,696	828	5,134	52,142	70,800
Peñuelas	692	5	1,665	15,941	18,303
Ponce	8,539	57	3,318	26,537	38,451
Quebradillas	1,664	19	2,348	9,209	13,240
Rincón	226	0	0	0	226
Río Grande	49,343	3,666	13,038	28,086	94,133
Sabana Grande	425	0	0	0	425
Salinas	10,057	568	581	7,358	18,564
San Germán	409	0	1,699	12,566	14,674

Debris Summary Report:

November 27, 2017

All values are in tons.

	Brick, Wood and Other	Reinf. Concrete and Steel	Eligible Tree Debris	Other Tree Debris	Total
Puerto Rico					
San Juan	682,237	43,558	28,397	15,946	770,138
San Lorenzo	54,404	4,834	8,294	46,502	114,034
San Sebastián	1,311	5	4,213	32,216	37,745
Santa Isabel	3,720	154	240	2,304	6,418
Toa Alta	75,561	6,157	10,457	15,449	107,624
Toa Baja	133,330	11,473	8,687	10,519	164,009
Trujillo Alto	125,875	10,510	12,299	13,966	162,650
Utuado	2,864	43	5,059	73,360	81,326
Vega Alta	39,713	3,140	9,034	34,412	86,299
Vega Baja	45,136	3,402	12,436	50,433	111,407
Vieques	14,626	1,272	17,271	23,850	57,019
Villalba	4,061	151	3,098	16,147	23,457
Yabucoa	33,464	2,762	3,730	27,653	67,609
Yauco	916	1	311	3,339	4,567
Total	3,176,395	242,984	409,866	1,599,691	5,428,936
Study Region Total	3,176,395	242,984	409,866	1,599,691	5,428,936

Totals only reflect data for those census tracts/blocks included in the user's study region and will reflect the entire county/state only if all of the census blocks for that county/state were selected at the time of study region creation.