Supplementary Material

Application of Scenario Earthquakes for Analysis of Seismically Triggered Landslide Hazard: A Case Study in Costa Rica

Aplicación de escenarios de terremotos para el análisis de la amenaza de deslizamientos disparados por sismos: un estudio de caso en Costa Rica

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Caption: This document contains supplementary figures and tables that provide useful information to readers interested in obtaining additional information about the results presented in this article.

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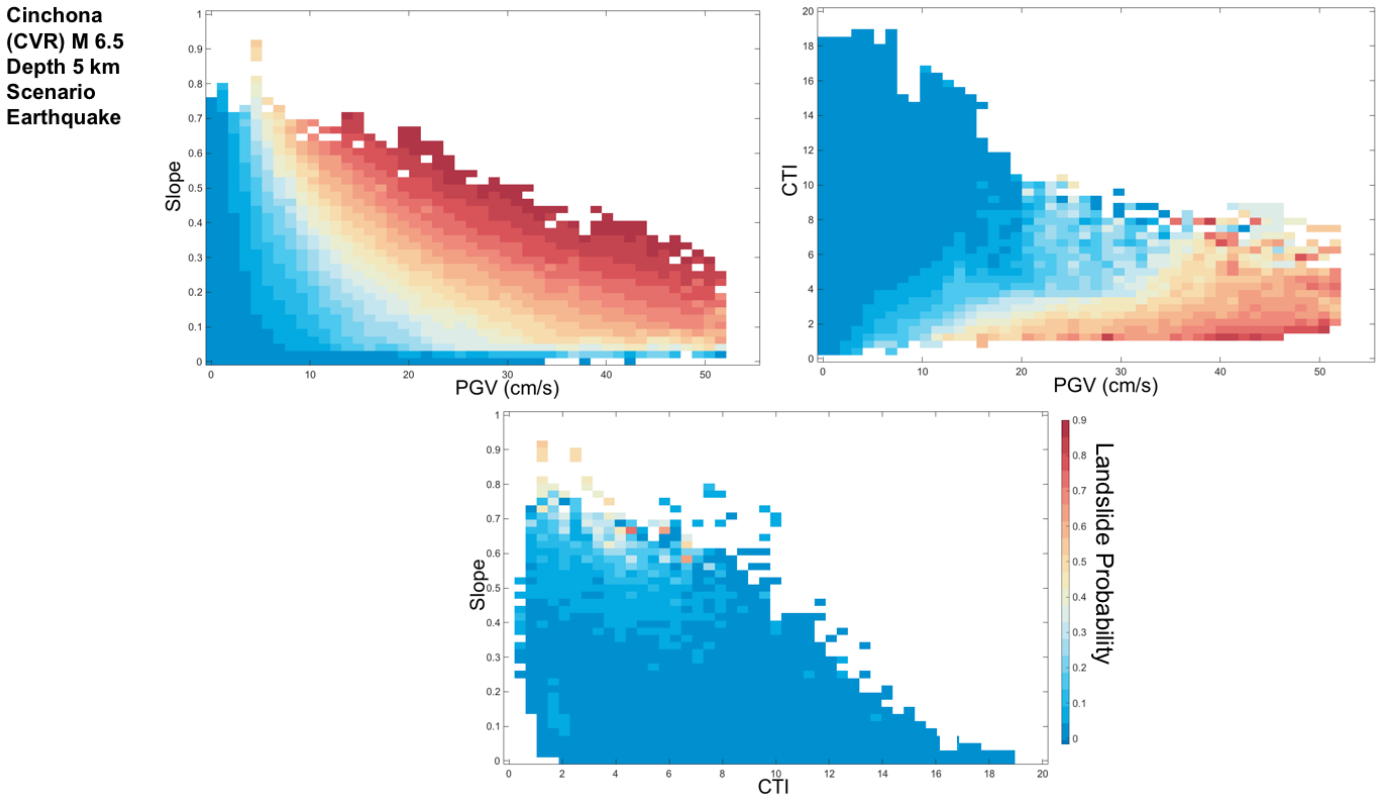

Fig. S1: Relationship of slope, peak ground velocity (PGV), and compound topographic index (CTI) with predicted landslide probability for an M 6.5 scenario event at the epicenter of the 2009 Cinchona earthquake, in the Central Volcanic Range (CVR) of Costa Rica.

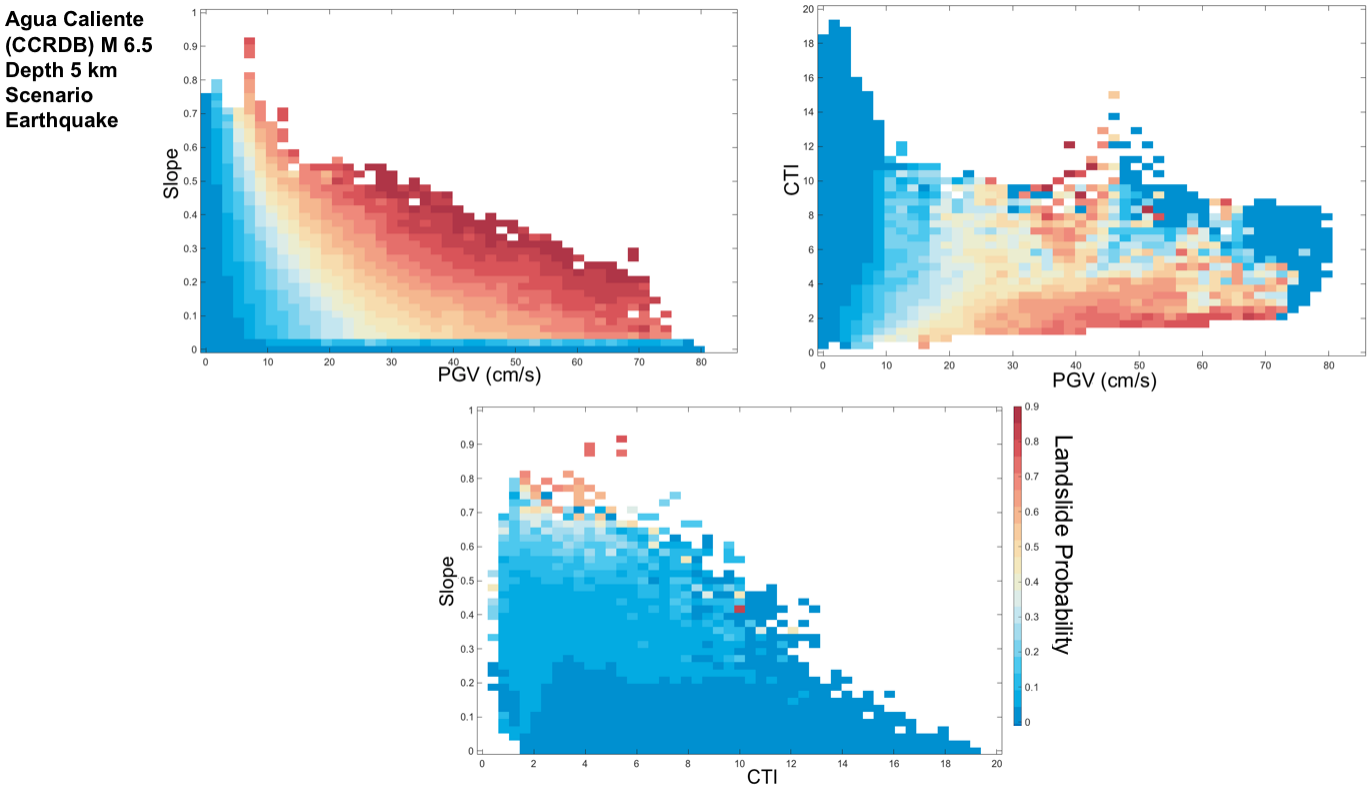

Fig. S2: Relationship of slope, peak ground velocity (PGV), and compound topographic index (CTI) with predicted landslide probability for an M 6.5 scenario event at the epicenter of the 1910 Cartago earthquake, on the Agua Caliente Fault of the Central Costa Rica Deformed Belt (CCRDB).

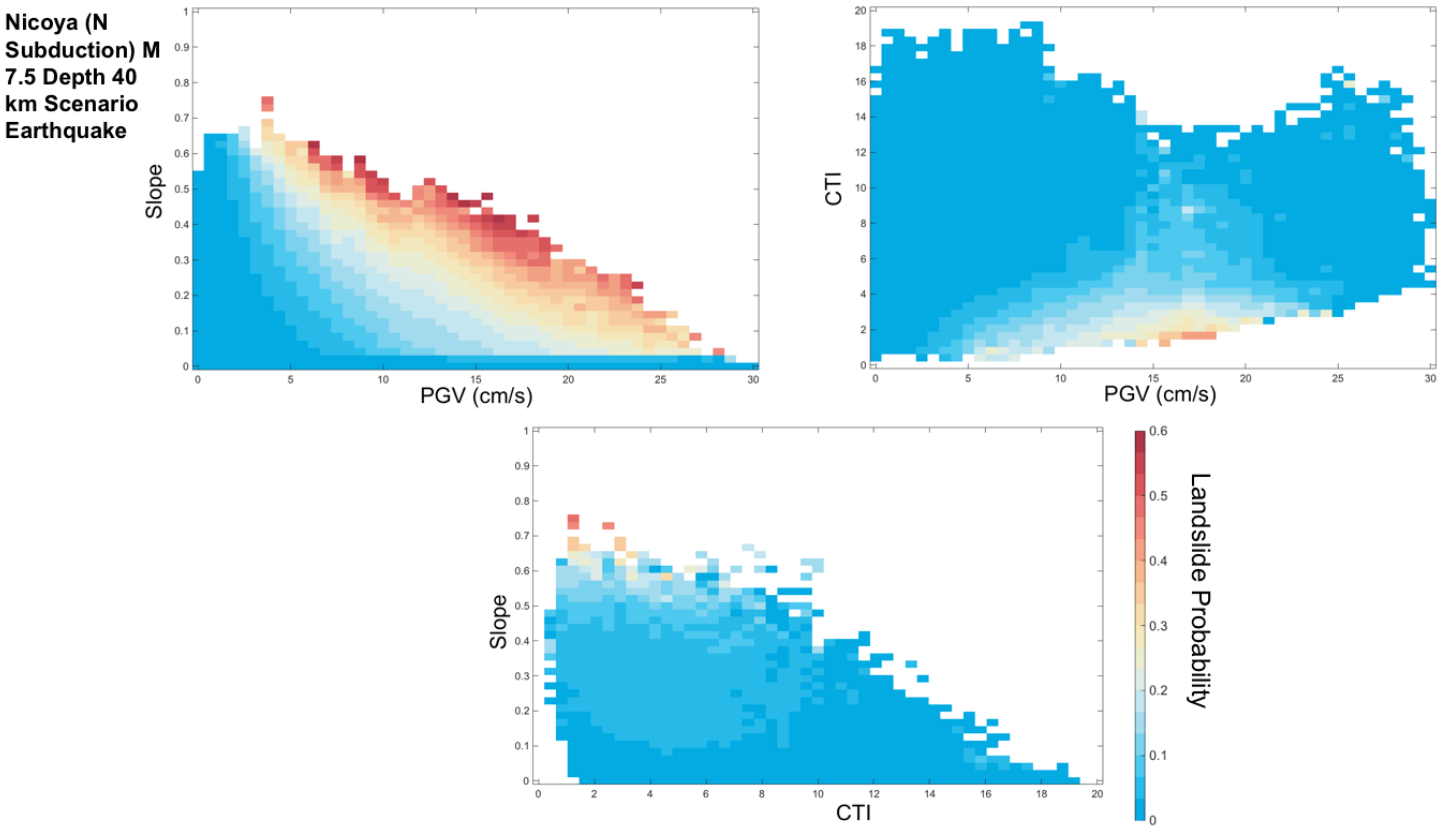

Fig. S3: Relationship of slope, peak ground velocity (PGV), and compound topographic index (CTI) with predicted landslide probability for an M 7.5 scenario subduction interplate earthquake at 40 km depth beneath the northern Nicoya peninsula of Costa Rica.

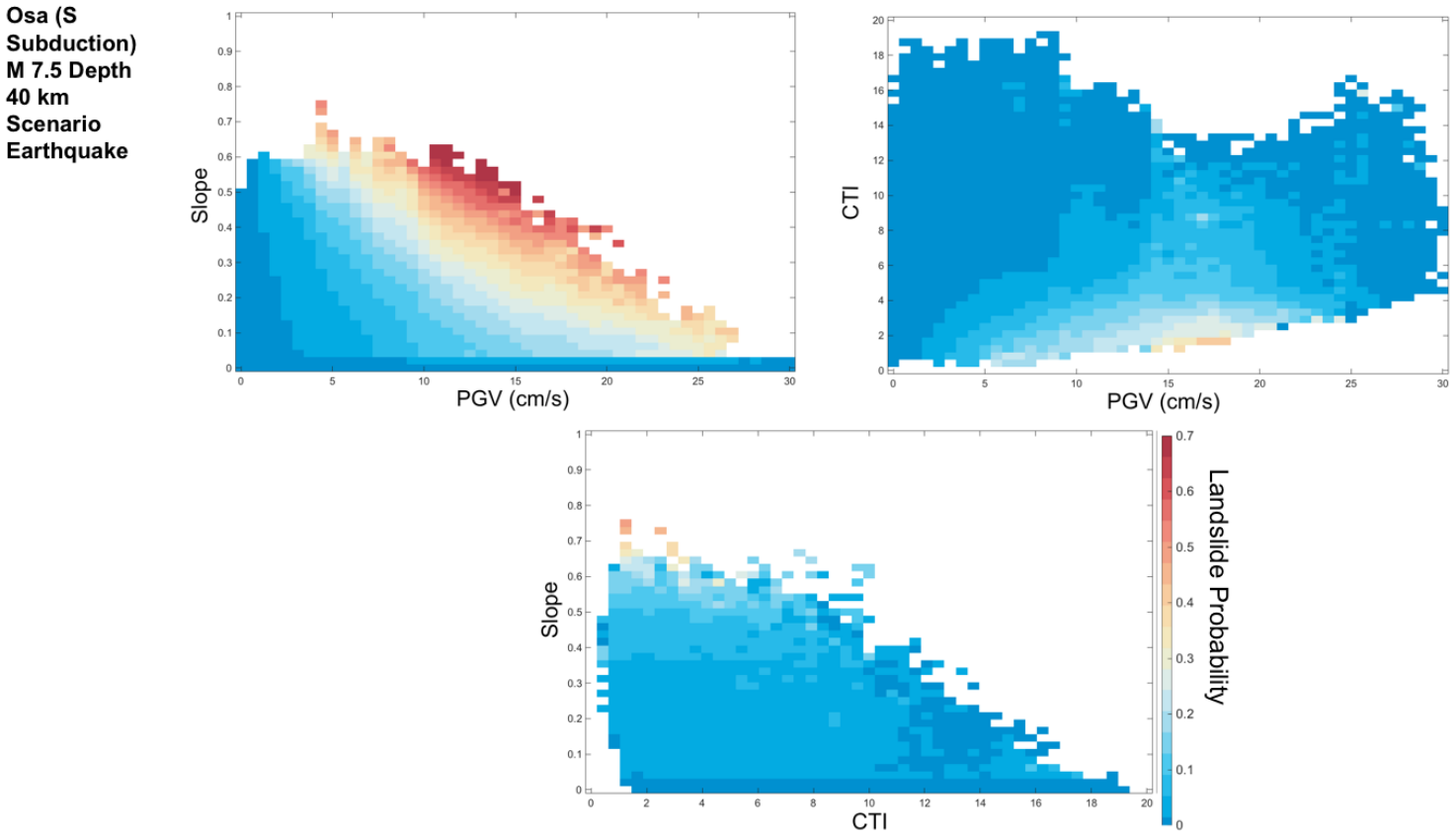

Fig. S4: Relationship of slope, peak ground velocity (PGV), and compound topographic index (CTI) with predicted landslide probability for an M 7.5 scenario subduction interplate earthquake at 40 km depth beneath the southern Osa peninsula of Costa Rica.

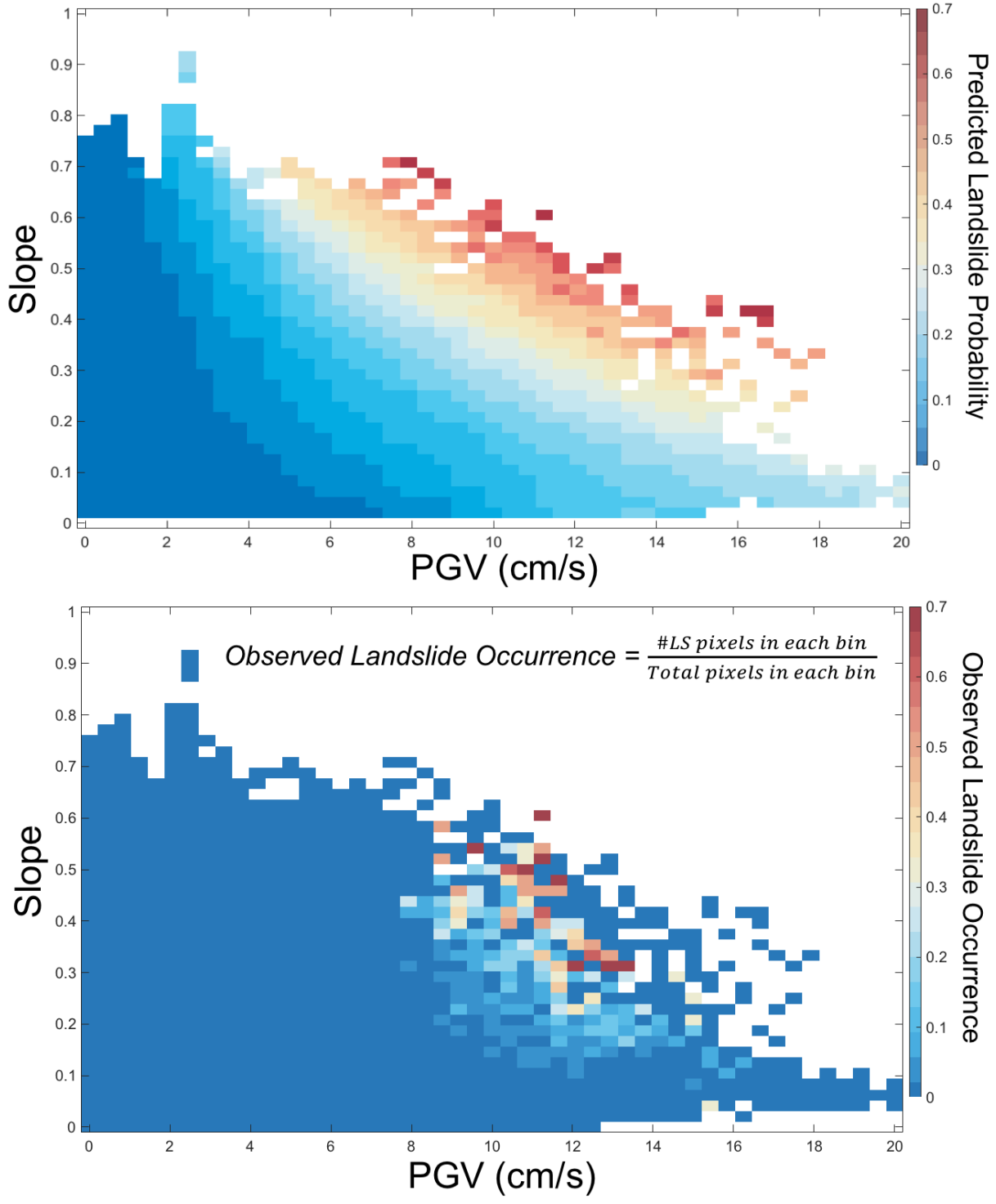

Fig. S5: Relationship of slope and peak ground velocity (PGV) with predicted (top) landslide probabilities and observed (bottom) landslide occurrence (Ruiz et al. 2019) for the 2009 Cinchona M 6.1 earthquake.

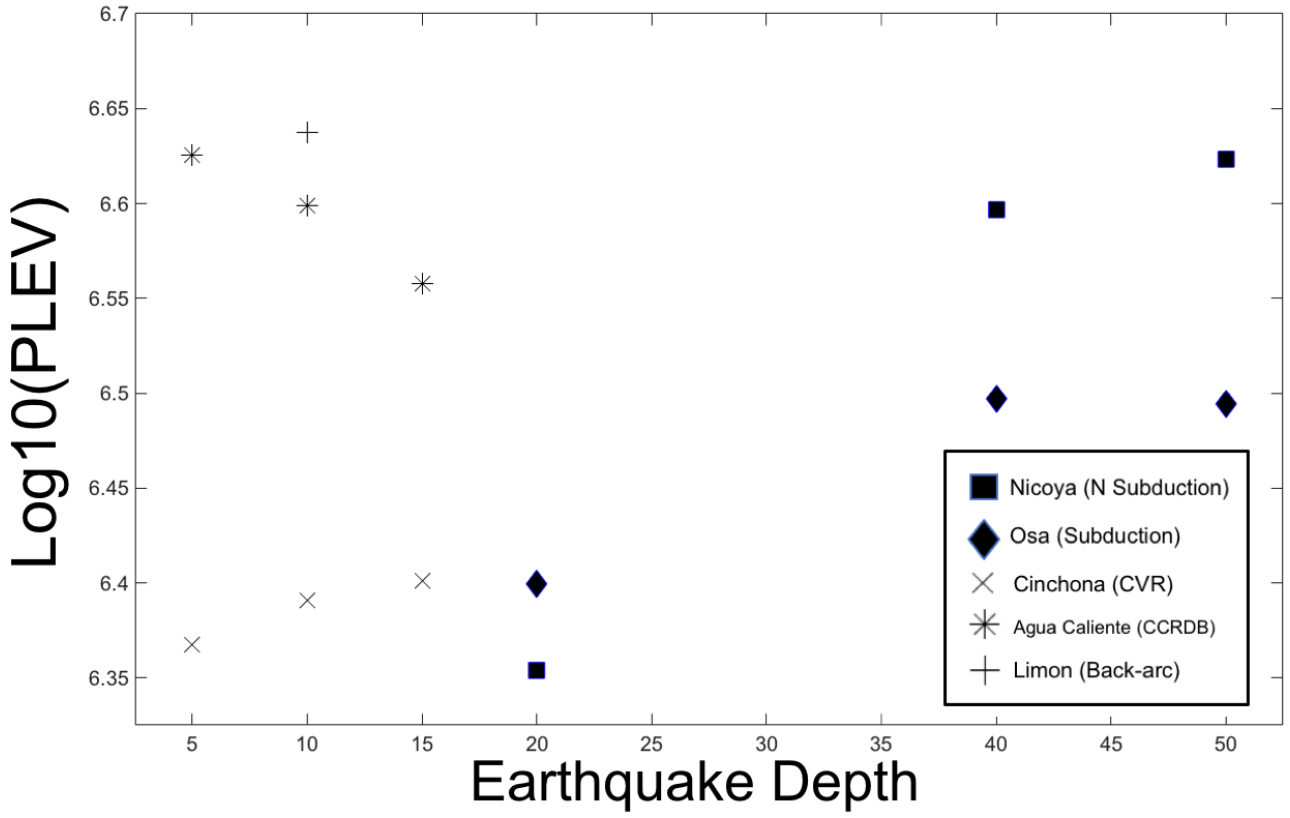

Fig. S6: Scatter plot showing the relationship of earthquake depth on the predicted landslide exposure value (PLEV) for each tectonic environment of Costa Rica included in this study. Subduction interplate earthquakes are denoted with a square (Nicoya) and X (Osa), and intraplate earthquakes are denoted as a diamond (Cinchona), * (Agua Caliente), and + (Limon).

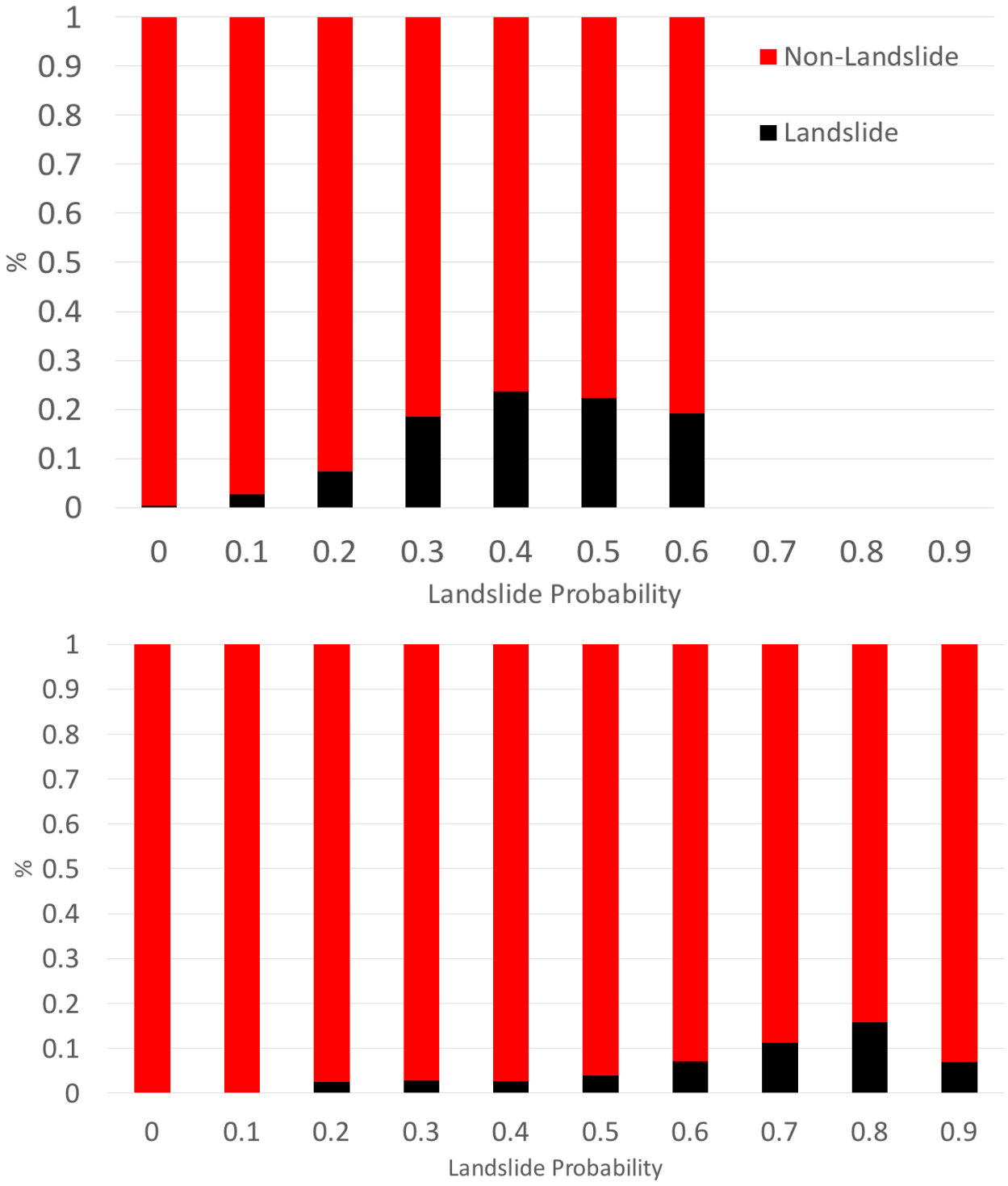

Fig. S7: Histograms of the percentage of observed non-landslide and landslide pixels for the and 2009 Cinchona (top; Ruiz et al., 2019) and 1991 Limon (bottom; Hernandez et al., 1992) landslide inventories at each predicted landslide probability bin.

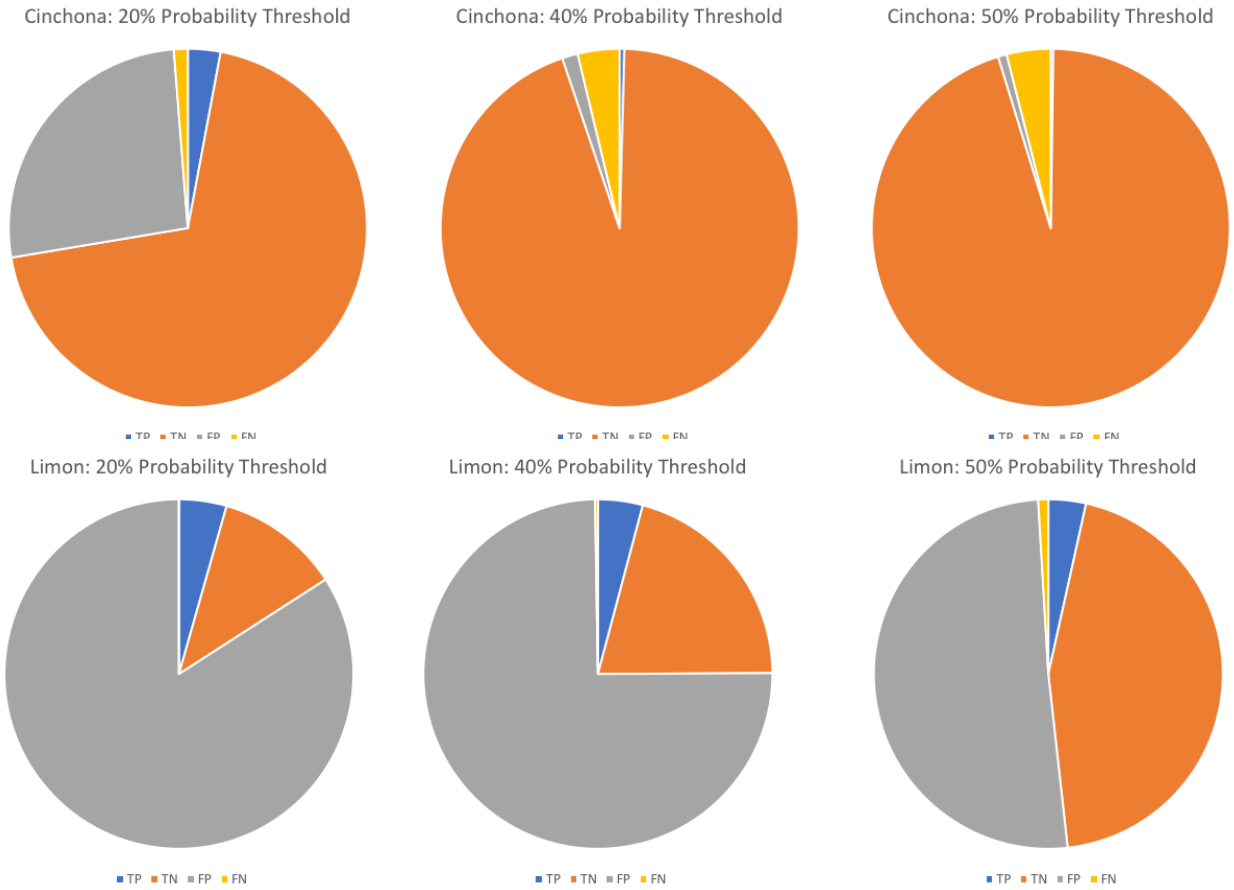

Fig. S8: Pie Charts of the observed percentage of true positive (TP), true negative (TN), false positive (FP), and false negative (FN) for the 2009 Cinchona (top; Ruiz et al., 2019) and 1991 Limon (bottom; Hernandez et al., 1992) landslide inventories, for a 20%, 40%, and 50% predicted landslide probability thresholds.

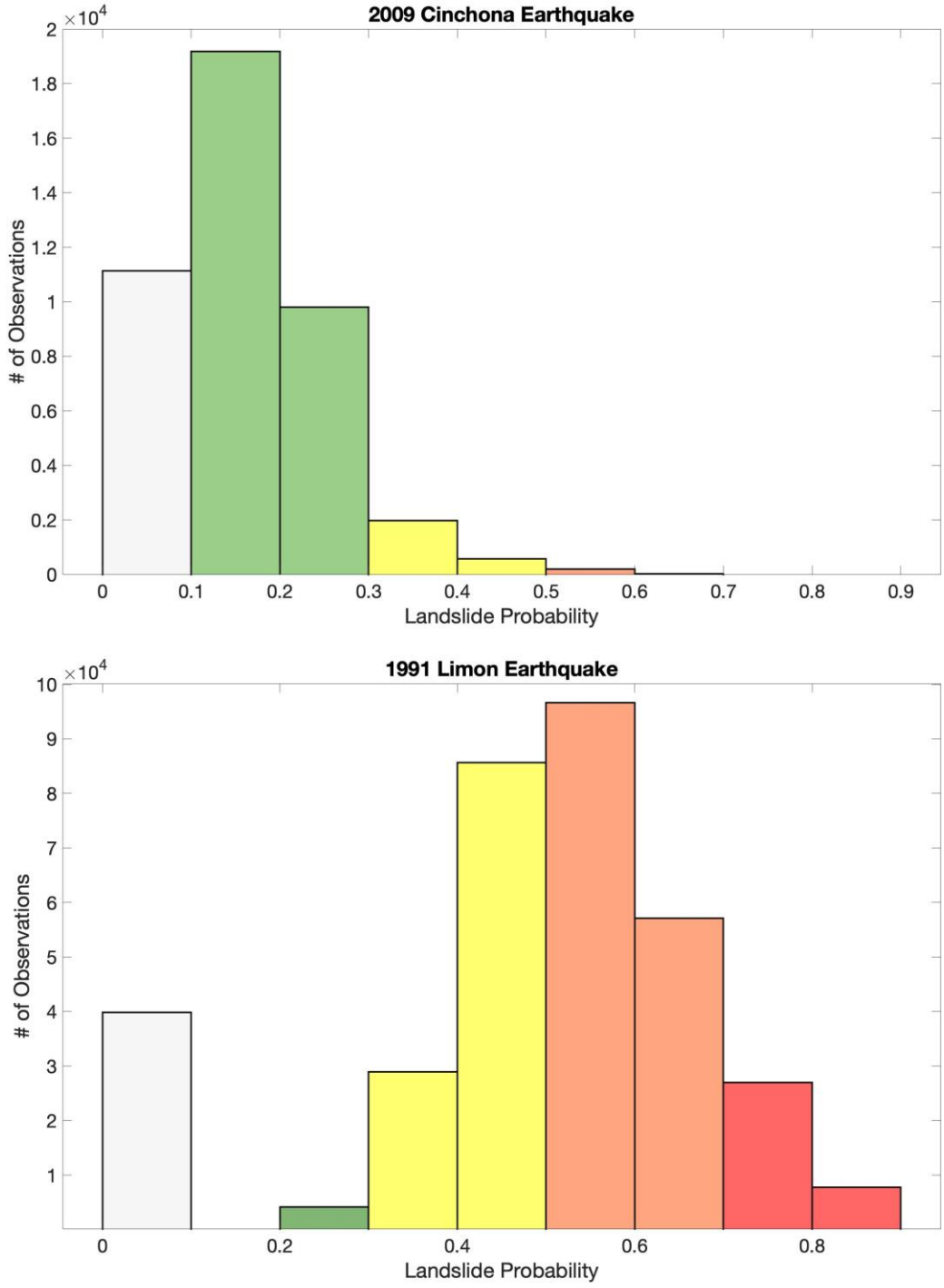

Fig. 9: Histogram of the number of observations per landslide probability bin within the bounds of the 1991 Limon (Hernandez et al., 1992) and 2009 Cinchona (Ruiz et al., 2019) landslide inventories. Landslide probability bins are color coded using the probability color scale shown in the maps of Figure 7.

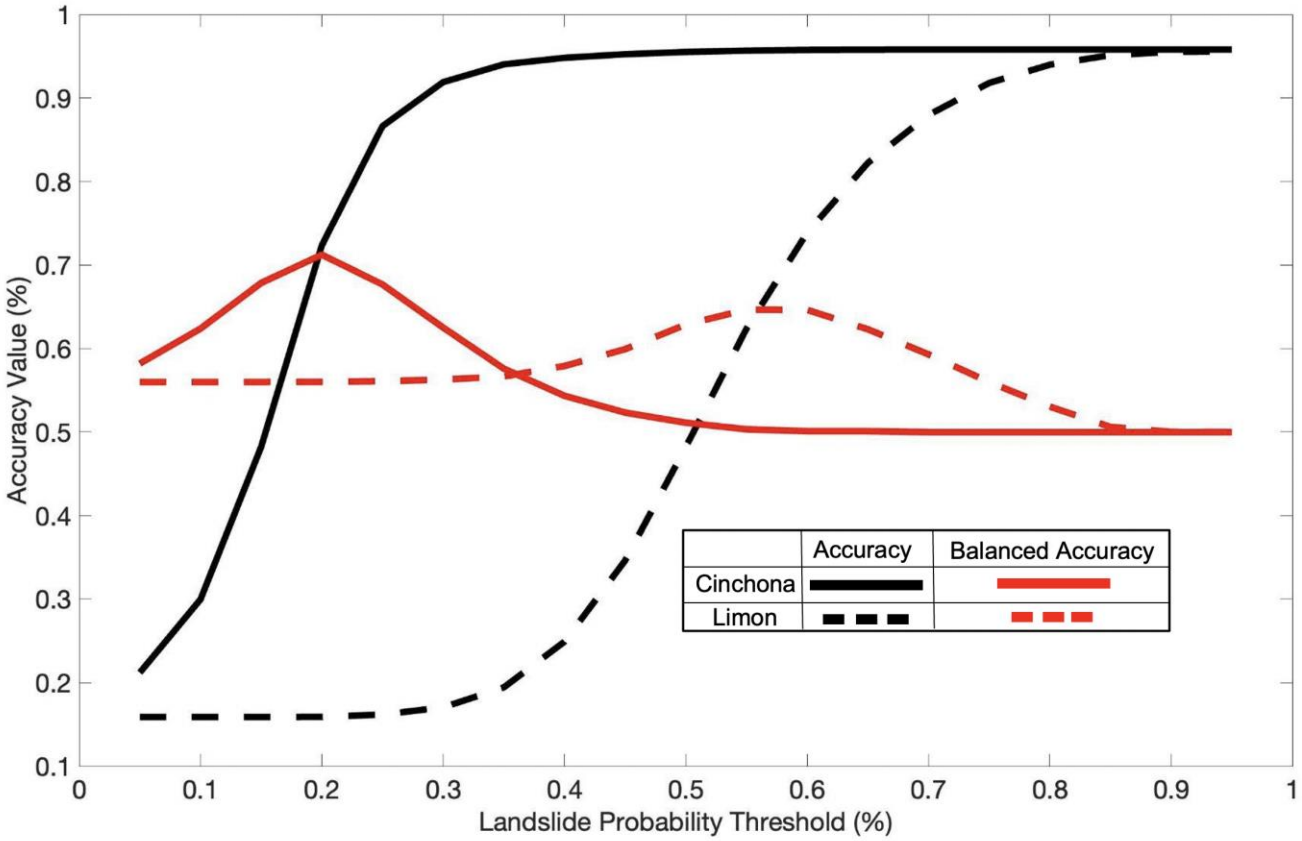

Fig. S10: Accuracy (black) and balanced accuracy (red) values for the 2009 Cinchona (solid) and 1991 Limon (dashed) earthquakes at each landslide probability threshold value, calculated using equation 3. We observe both maximum accuracy and balanced accuracy to occur at much lower landslide probability thresholds for the Cinchona earthquake relative to Limon.

Table S1: Summary table of probabilistic landslide exposure value (PLEV), landslide hazard index (LHI), and maximum landslide probability for each scenario earthquake.

Scenario	PLEV	LHI	Maximum Landslide Probability
N M7 D20	5.93E+05	2.15 E+03	0.666
N M75 D20	2.26E+06	4.60E+03	0.892
N M8 D20	6.04E+06	8.64E+03	0.939
N M75 D40	3.95E+06	6.29E+03	0.786
N M75 D50	4.20E+06	6.40E+03	0.787
O M7 D20	6.39E+05	2.18E+03	0.779
O M75 D20	2.51E+06	4.70E+03	0.863
O M8 D20	8.81E+06	9.15E+03	0.922
O M75 D40	3.14E+06	6.30E+03	0.783
O M75 D50	3.12E+06	6.43E+03	0.719
AC M5 D5	3.60E+05	391.35	0.217
AC M55 D5	1.43E+06	409.99	0.564
AC M6 D5	4.22E+06	1.00E+03	0.831
AC M65 D5	9.64E+06	3.09E+03	0.956
AC M6 D10	3.97E+06	1.11E+03	0.732
AC M6 D15	3.61E+06	1.27E+03	0.732
CC M5 D5	1.41E+05	395.33	0.308
CC M55 D5	6.66E+05	413.89	0.697
CC M6 D5	2.33E+06	1.01E+03	0.947
CC M65 D5	6.71E+06	3.10E+03	0.979
CC M6 D10	2.46E+06	1.12E+03	0.906
CC M6 D15	2.52E+06	1.27E+03	0.857
LM M7.6 D10	4.34E+06	2.16E+03	0.674

Each scenario location is abbreviated as follows: N: Nicoya, O: Osa, AC: Agua Caliente, CC: Cinchona, LM: Limon. Scenario location abbreviations are followed by M: earthquake magnitude, and D: earthquake depth (km).

Table S2: Table of predicted fatality ranges for each scenario earthquake, using the UNHDI fatality regression of Nowicki Jessee et al. (2020).

Scenario Earthquake	**Predicted Fatality**	Lower-bound prediction of 95%	Upper-bound prediction of 95%	Lower-bound prediction of 68%	Upper-bound prediction of 68%
N M7 D20	**5**	< 1	4420	< 1	433
N M75 D20	**8**	< 1	8200	< 1	787
N M8 D20	**12**	< 1	13000	< 1	1230
N M75 D40	**10**	< 1	10700	< 1	1010
N M75 D50	**10**	< 1	11100	< 1	1040
O M7 D20	**5**	< 1	4570	< 1	447
O M75 D20	**8**	< 1	8610	< 1	825
O M8 D20	**14**	< 1	15600	< 1	1460
O M75 D40	**9**	< 1	9570	< 1	913
O M75 D50	**9**	< 1	9540	< 1	910
AC M5 D5	**4**	< 1	3520	< 1	347
AC M55 D5	**7**	< 1	6620	< 1	640
AC M6 D5	**10**	< 1	11000	< 1	1040
AC M65 D5	**15**	< 1	16300	< 1	1520
AC M6 D10	**10**	< 1	10700	< 1	1020
AC M6 D15	**10**	< 1	10200	< 1	972
CC M5 D5	**3**	< 1	2320	< 1	231

CC M55 D5	**5**	< 1	4660	< 1	456
CC M6 D5	**8**	< 1	8310	< 1	798
CC M65 D5	**13**	< 1	13700	< 1	1290
CC M6 D10	**8**	< 1	8530	< 1	817
CC M6 D15	**8**	< 1	8630	< 1	826
LM M7.6 D10	**11**	< 1	11100	< 1	1060

Each scenario location is abbreviated as follows: N: Nicoya, O: Osa, AC: Agua Caliente, CC: Cinchona, LM: Limon. Scenario location abbreviations are followed by M: earthquake magnitude, and D: earthquake depth (km).

Table S3: Table of predicted fatality ranges for each scenario earthquake, using the global average fatality regression of Nowicki Jessee et al. (2020).

Scenario Earthquake	**Predicted Fatality**	Lower-bound prediction of 95%	Upper-bound prediction of 95%	Lower-bound prediction of 68%	Upper-bound prediction of 68%
N M7 D20	**15**	< 1	10097	< 1	795
N M75 D20	**30**	< 1	21486	< 1	1662
N M8 D20	**51**	< 1	37778	< 1	2872
N M75 D40	**41**	< 1	29576	< 1	2266
N M75 D50	**42**	< 1	30638	< 1	2345
O M7 D20	**15**	< 1	10528	< 1	829
O M75 D20	**32**	< 1	22811	< 1	1761
O M8 D20	**62**	< 1	47019	< 1	3548
O M75 D40	**36**	< 1	25927	< 1	1994
O M75 D50	**36**	< 1	25832	< 1	1987
AC M5 D5	**11**	< 1	7648	< 1	606
AC M55 D5	**24**	< 1	16566	< 1	1290
AC M6 D5	**42**	< 1	30722	< 1	2351
AC M65 D5	**65**	< 1	49546	< 1	3732
AC M6 D10	**41**	< 1	29662	< 1	2272
AC M6 D15	**39**	< 1	28086	< 1	2155
CC M5 D5	**7**	< 1	4565	< 1	364
CC M55 D5	**16**	< 1	10774	< 1	848
CC M6 D5	**31**	< 1	21863	< 1	1690
CC M65 D5	**54**	< 1	40149	< 1	3046
CC M6 D10	**32**	< 1	22550	< 1	1742
CC M6 D15	**32**	< 1	22863	< 1	1765
LM M7.6 D10	**43**	< 1	31221	< 1	2388

Each scenario location is abbreviated as follows: N: Nicoya, O: Osa, AC: Agua Caliente, CC: Cinchona, LM: Limon. Scenario location abbreviations are followed by M: earthquake magnitude, and D: earthquake depth.

Table S4: Table of observed non-landslide (NONLS), landslide (LS), total, and percent landslide (%LS) pixels that fall within each predicted landslide probability bin, for the 2009 Cinchona and 1991 Limon earthquakes.

2009 Cinchona Earthquake (M 6.1)				
Predicted LS Probability	NONLS	LS	Total	% LS
0-0.1	11095	40	11135	0.36
0.1-0.2	18681	500	19181	2.61
0.2-0.3	9095	713	9808	7.27
0.3-0.4	1613	365	1978	18.45
0.4-0.5	435	135	570	23.68
0.5-0.6	149	43	192	22.40
0.6-0.7	21	5	26	19.23
0.7-0.8	0	0	0	0
0.8-0.9	0	0	0	0
0.9-1.0	0	0	0	0

1991 Limon Earthquake (M 7.6)				
Predicted LS Probability	NONLS	LS	Total	% LS
0-0.1	39844	0	39844	0
0.1-0.2	83	0	83	0
0.2-0.3	4062	104	4166	2.50
0.3-0.4	28144	798	28942	2.76
0.4-0.5	83330	2324	85654	2.71
0.5-0.6	92861	3745	96606	3.88
0.6-0.7	53030	4079	57109	7.14
0.7-0.8	23941	3020	26961	11.20
0.8-0.9	6569	1232	7801	15.79
0.9-1.0	244	18	262	6.87