Estimating tsunami risk

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Park H, DT Cox, AR Barbosa (2018) "Probabilistic Tsunami Hazard Assessment (PTHA) for Resilience Assessment of a Coastal Community," *Natural Hazards*, https://doi.org/10.1007/s11069-018-3460-3.

Flow Depth

AEP = 0.001 (1,000yr) AEP = 0.0004 (2,500yr) AEP = 0.0001 (10,000yr)



Park H, DT Cox, AR Barbosa (2018) "Probabilistic Tsunami Hazard Assessment (PTHA) for Resilience Assessment of a Coastal Community," *Natural Hazards*, https://doi.org/10.1007/s11069-018-3460-3.

Flow Speed



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Momentum Flux

AEP = 0.001 (1,000yr) AEP = 0.0004 (2,500yr) AEP = 0.0001 (10,000yr)



Park H, DT Cox, AR Barbosa (2018) "Probabilistic Tsunami Hazard Assessment (PTHA) for Resilience Assessment of a Coastal Community," *Natural Hazards*, https://doi.org/10.1007/s11069-018-3460-3.

Arrival Time

AEP = 0.001 (1,000yr) AEP = 0.0004 (2,500yr) AEP = 0.0001 (10,000yr)



Park H, DT Cox, AR Barbosa (2018) "Probabilistic Tsunami Hazard Assessment (PTHA) for Resilience Assessment of a Coastal Community," Natural Hazards, https://doi.org/10.1007/s11069-018-3460-3.

Duration of Flooding

Joint Distributions of IMs

Correlation or relationship among h_{max} and other IMs



Joint Distributions of IMs

- Correlation or relationship among \mathbf{h}_{\max} and other IMs



PTHA Comparison for Newport, Oregon



Figure 7: Comparison of maximum extent of tsunami inundation in Newport, Oregon, for (a) present study with AEP = 0.0004, (b) ASCE Tsunami Design Geodatabase (TDG) for AEP = 0.0004, and (c) DOGAMI TIM, 'M' scenario (b and c are courtesy of ASCE TDG and Oregon Department of Geology and Mineral Industries).

Park H, DT Cox, AR Barbosa (2018) "Probabilistic Tsunami Hazard Assessment (PTHA) for Resilience Assessment of a Coastal Community," Natural Hazards, https://doi.org/10.1007/s11069-018-3460-3.



Three tools for building information at study area

1. Tax lot (Stat_Class, Year)



2. Pictures from Google map street view



3. Fields survey Rapid Visual Screening (RVS)

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FEMA BUILDING TYPE Basis Socre memory Vertical Impulsity, Vi, Moderney Vertical Impulsity, Vi, Mode	CoNet Know Van SLt≥ SMM: V artial ↓	21 09 06 07 03 05 00 04 07 05 00 04 07	Di Mojo Quini AASIC 019 0.05 0.07 0.03 1.9 0.5 0.5 0.2 0.2 0.4 0.7 0.7	SCO 40.4 520 520 520 520 54 54 54 54 54 54 54 54 54 54	RE, MO 31 0.5 0.3 0.3 0.3 0.3 0.3 0.3 0.3 0.3	H-b- DIFIEH 92 98 14 -0.7 -0.4 -0.5 -0.2 1.1 0.3 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	RS, AN 83 0.6 0.5 0.5 0.3 1.1 0.4 0.2 NA 0.5 ARDS s That Ti s Phat Ti Phat Ti S Phat Ti Phat T	Additional ND FIN 84 970 1.4 -0.7 -0.4 -0.4 -0.2 1.5 0.3 0.5	Al sketch AAL LI SS (URM BAP) 12 0.7 0.3 0.4 0.1 NA 0.2 0.5	es or com EVEL 1 0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.1 1.4 0.2 -0.1 0.3 2.0 ACTI Detaile	2 sments c SCO 5CO 12 -08 -04 -05 -02 -03 03 03 03 ON R	n separa RE, S ₂ (3) 0.9 0.9 0.9 0.3 0.0 0.0 0.1 0.0 0.1 0.3 EQUIR tural Eva	te page ct PC1 (TU) -0.7 -0.4 -0.5 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4 -0.2 -0.4	PC2 1.0 -0.7 -0.4 -0.4 -0.4 -0.4 -0.1 -0.1 -0.2 -0.1 -0.2 -0.4 -0.4 -0.4 -0.4 -0.4 -0.7 -0.4 -0.7 -0.4 -0.4 -0.7 -0.4 -0.4 -0.4 -0.1 -0.2 -0.4 -0.5 -0	RM1 ptp -0.7 -0.4 -0.4 -0.2 -0.2 -0.2 -0.2 -0.3 -0.2 -0.3 -0.2 -0.2 -0.3 -0.2 -0.2 -0.3 -0.2 -0.3 -0.4 -0.4 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7	RM2 (40) 1.1 -0.7 -0.4 -0.2 1.6 0.3 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	URM 0.9 -0.6 -0.3 -0.3 -0.3 -0.0 NA 0.0 0.0 0.0 0.2	
FEMA BUILDING TYPE Basic Score Sowen Vericoli Imputatity, Vi, Modrate Vericol Imputatity, Vi, Modrate Vericol Imputatity, Vi, Pac-Ode Facility (1) Statistics Sol Type (1) Statistics Sol Type (1) Statistics Sol Type (1) Statistics Sol Type (1) Statistics FINAL LEVEL 1 SCORE, EXTENT OF REVIEW Exterline: Pinterior: Pinterior Extender: Pinterior Extender: Pinterior Statistics Y	Do Net Know Via Str≥ Swev: V artial ↓ A es ↓ V	21 09 06 07 03 19 05 00 00 0,4 0,7 0,4 0,7	Di Mojo Quere ASIC ⁰ W1A 19 -0.5 -0.7 -0.3 19 0.5 -0.7 -0.3 19 0.5 -0.7 -0.3 19 0.5 -0.7 -0.3 19 0.5 -0.7 -0.3 19 0.5 -0.5 -0.7 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	SCO 820 1.8 -0.9 -0.5 -0.6 -0.3 2.0 0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.	ordelad 4 RE, MO 3 045 -0.3 0.3 -0.3 0.3 -0.3 0.3 -0.3 0.3 -0.3 0.4 -0.5 0.3 -0.3 0.4 -0.5 0.5 -0.3 0.6 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.3 0.5 -0.5 0.6 -0.5 0.7 -0.8 0.8 -0.7 0.9 -0.0 0.9 -0.0	H-b = DIFIEI 92 98 14 -0.7 -0.4 -0.5 -0.2 1.1 0.3 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	RS, AN 83 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	Additions ND FIN S4 pro- p	All sketch AAL LI SS (URM MA) 12 0.7 0.3 0.4 0.1 0.4 0.1 0.5	ρc es or con es or con 10 10 11 10 11 10 114 02 0.1 114 0.2 0.1 114 0.2 0.3 2.0 ACTI Petailo Ye	2 aments of SCO (22) (12) -0.8 -0.2 -0.2 -0.3 -0.2 -0.3 0.3 ON R ¹ d Struct	n separa (080) 0.9 0.9 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	te page cr PC1 (T/) -0.7 -0.4 -0.5 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	PC2 1.0 -0.7 -0.4 -0.4 -0.4 -0.4 -0.1 -0.1 -0.2 -0.1 -0.2 -0.1 -0.2 -0.4 -0.4 -0.4 -0.7 -0.4 -0.4 -0.7 -0.4 -0.4 -0.7 -0.4 -0.4 -0.1 -0.7 -0.4 -0.1 -0.2 -0.4 -0.1 -0.4 -0.1 -0.4 -0.1 -0.4 -0.1 -0.4 -0.4 -0.1 -0.4 -0.1 -0.4 -0.1 -0.4 -0.1 -0.4 -0.1 -0	RM1 (F0) 1.1 -0.7 -0.4 -0.4 -0.2 1.5 0.3 -0.2 -0.2 -0.2 0.3 .0 0 -0.7 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.2 -0.2 -0.2 -0.3 .0 -0.4 -0.2 -0.2 -0.3 -0.2 -0.2 -0.3 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3	RM2 (40) 1.1 -0.7 -0.4 -0.4 -0.2 1.6 0.3 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	URM 0.9 -0.5 -0.3 0.0 NA 0.1 0.0 0.0 0.0 0.2	
FEMA BUILDING TYPE Basic Score Sowen Verical Imputing, Vi, Modraney Verical Imputing, V, Pac-Ode Pacabenchans Soli Type E (> 3 stories) Soli Type E (> 3 stories) Soli Type E (> 3 stories) FINAL LEVEL 1 SCORE, EXTENT OF REVIEW FINAL LEVEL 1 SCORE; EXTENT OF REVIEW Comparing Reviewed: Y Soli Type Source: Geologic Hazards Scurce:	Do Not Know Do Not Know V SL1≥ Sumx V artial One V ass	21 0.9 0.6 0.7 0.3 0.5 0.0 0.4 0.7 0.3 0.5 0.0 0.4 0.7	Dimon ASIC WIA 19 -0.9 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7	SCO 820 18 -0.9 -0.5 -0.6 -0.5 -0.6 -0.3 2.0 0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.	Control 1	H-b = DIFIEI 98 98 14 -0.7 -0.4 -0.5 -0.2 1.1 0.3 -0.2 -0.2 1.1 0.3 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.3 -0.5 Structure -0.3 -0.5 Structure -0.5 -0.2 -0.2 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.2 -0.3 -0.5 -0.5 -0.2 -0.3 -0.5 -0.5 -0.2 -0.3 -0.5 -0.5 -0.5 -0.5 -0.5 -0.2 -0.3 -0.5 -0.	RS, AN 83 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5	Additions ND FIN 900 900 900 900 900 900 900 900 900 90	All skeetch WAL LI WAL LI WAN WAN WAN WAN WAN WAN WAN WAN WAN WAN	ρ ρ ρ ρ ρ σ	2 aments of SCO (22 (12) -0.8 -0.2 -0.2 -0.3 -0.2 -0.3 0.3 ON R d Struct s, unkno s, score s, other	n separa (0,84) 0.9 0.9 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	tr page PC1 (74) 1.1 -0.7 -0.4 -0.5 -0.2 1.5 -0.2 1.5 -0.2 NA -0.2 U RED sluation A building	PC2 1.0 -0.7 -0.4 -0.4 -0.1 1.7 0.2 -0.1 -0.1 -0.2 Sec, 2 Require ig type o	RM1 (FD) 1.1 -0.7 -0.4 -0.4 -0.2 1.5 0.3 -0.2 -0.2 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.4 -0.4 -0.4 -0.4 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.4 -0.4 -0.2 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	RM2 (40) 1.1 -0.7 -0.4 -0.2 1.6 0.3 -0.2 -0.2 -0.2 -0.2 0.3 -0.2 0.3 -0.2 0.3 -0.2 0.3 -0.2 0.3 -0.2 0.3 -0.2 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.7 -0.4 -0.4 -0.7 -0.4 -0.4 -0.2 -0.4 -0.4 -0.2 -0.4 -0.4 -0.2 -0.4 -0.4 -0.2 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4	URM 0.5 -0.3 -0.3 0.0 NA 0.1 0.0 0.0 0.2	
FEMA BUILDING TYPE Basic Score Sowen Vertical Imputativy, V _L , Moderane Vertical Imputativy, V _L , Pro-Code Soil Type A (2) S	Do Net Know VLs SLt≥ Swew: V artial ↓ Nes V	2.1 -0.9 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.7 -0.9 -0.7 -0.7 -0.9 -0.7 -0.7 -0.9 -0.7 -0.7 -0.7 -0.7 -0.7 -0.9 -0.7 -	Dimon ASIC WIA 19 -0.5 -0.7 -0.3 19 0.5 -0.2 -0.7 -0.2 -0.4 -0.7 -0.2 -0.4 -0.7 -0.2 -0.4 -0.7 -0.2 -0.4 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	SCO W2 1.8 -0.5 -0.6 -0.3 2.0 0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.	RE, MO 34 -0.8 -0.8 -0.3 -0.5	Hub - DIFIEF S2 (iii) 14 -0.7 1.1 0.3 0.2 0.3 0.5 R HAZ, ding pole H, 3 know g hazard	RS, AN 83 0.4 0.5 0.5 0.5 0.5 0.5 1.1 0.4 0.2 NA 0.5 8 Teraluz s That Ti de s That	2017 4 Additionum ND FIN 900 900 900 900 900 900 900 900 900 90	Ar A Steelen Ar	PC es or com es or com evel 1 1 1 0 7 0 4 0 1 0 7 0 0 1 1 0 1 1	2 scool 1.2 -0.3 -0.4 -0.5 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.	n separa RE, S ₂ (384) 0.9 0.9 0.3 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	te page 17 PC1 (70) 1.1 -0.7 -0.4 -0.5 -0.2 1.5 -0.2 1.5 -0.2 NA -0.2 U RED sluation A building reset Evaluation	PC2 1.0 -0.7 -0.4 -0.4 -0.1 1.7 0.2 -0.1 -0.1 -0.2 Sec, 2 Require ig type o	RM1 prop 1.1 -0.7 -0.4 -0.4 -0.2 1.6 0.3 -0.2 -0.2 -0.2 -0.2 -0.3 .0 -0.4 -0.7	RM2 (40) 1.1 -0.7 -0.4 -0.4 -0.2 -0.2 -0.2 -0.2 0.2 0.2 0.2	URM 0.5 -0.3 -0.3 0.0 NA 0.1 0.0 0.0 0.2	
FEMA BUILDING TYPE Basic Score Scorem Vericial Insputinty, Vr, Modreno Verical Insputinty, Vr, Pro-Code Para-Denchmark Soil Type (2 / 3 acrise) Soil Type (2 / 3 acrise) Soil Type (2 / 3 acrise) FINAL LEVEL 1 SCORE, EXTENT OF REVIEW EXtricis: EXTENT OF REVIEW EXtricis: Drawings Reviewed: Y Soil Type Source: Constant Source: Constant Paraone EVEL 2 SCOREEMIN	C PEPEC	21 -09 -07 -03 19 05 00 -0.7 -0.3 19 0.5 0.0 0.0 -0.7 -0.7 -0.3 19 0.5 0.0 0.0 0.0 -0.7 -0.7 -0.9 -0.7 -0.7 -0.9 -0.7 -0.9 -0.7	Di Moji Asic ASIC UIA 19 0.5 -0.7 -0.3 19 0.5 -0.2 -0.4 0.7 -0.3 -0.2 -0.4 -0.7 -0.3 -0.2 -0.4 -0.7 -0.2 -0.4 -0.5 -0.2 -0.4 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	(0) 4 9 200 9 200 9 20 9 20 9 20 9 20 9 20 9	RE, MO RE, MO 04 03 03 03 03 03 03 03 03 03 03	444 H-D DIFIEF 52 (987) 1.4 -0.7 -0.4 -0.5 -0.2 -0.2 -0.2 -0.2 -0.3 -0.5 R HAZ R	RS, AN 18 -0.5	Additional ND FIN St St St St St St St St St St St St St	at sketch val. LLI statut val. LLI statut val. val. statut	ρc es or con es or con es or con evel 1.0 0.7 0.4 0.4 0.4 0.4 0.4 0.1 0.3 2.0 ACTI Detailo Ve Ve	2 sments c (2 (500) (2 (500) (1 -0.3 -0.4 -0.5 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.3 -0.3 -0.3 -0.3 -0.3 -0.3 -0.3	n separa RE, S ₁ (09) 0.9 0.6 0.3 0.0 0.0 0.1 0.1 0.3 EQUIR tural Eva wm FEM less har hazards tructural	the page f PCt (T/b) 1.1 -0.7 -0.4 -0.5 -0.2 1.5 -0.2 1.5 -0.2 NA -0.2 U U U	PC2 1.0 -0.7 -0.4 -0.1 -0.1 -0.2 -0.1 -0.1 -0.2 -0.1 -0.2 -0.1 -0.2 -0.5 -0.7 -0.4 -0.4 -0.7 -0.4 -0.4 -0.4 -0.4 -0.4 -0.1 -0.2 -0.5 -0.4 -0.1 -0.2 -0.5 -0.4 -0.1 -0.2 -0.5 -0	RM1 PO 1.1 -0.7 -0.4 -0.2 1.5 0.3 -0.2 -0.2 -0.3 .0 ommeno metric	RM2 (40) 1.1 -0.7 -0.4 -0.2 1.6 0.3 -0.2 -0.2 -0.2 0.2 0.2 0.2 0.2 0.2	URM 0.5 -0.3 -0.3 0.0 0.0 0.0 0.0 0.0 0.0 0.2 0.2	
FEMA BUILDING TYPE Basis Score Score Vertical Insplatry, VJ, Modrane Vertical Insplatry, VJ, Modrane Vertical Insplatry, VJ, Pac-Odd, Pack-Benchmas Soil Type E (-) 3 stories) FINAL LEVEL 1 SCORE, EXTENT OF REVIEW FINAL LEVEL 1 SCORE, EXTENT OF REVIEW FINAL LEVEL 1 SCORE, Contact Person: LEVEL 2 SCREENIN Vmc. Final C 2 Score	Co Net Know	211 0.9 0.6 0.7 0.3 1.9 0.5 0.0 0.4 0.7 0.3 1.9 0.5 0.0 0.4 0.7 0.5 0.0 0.0 0.0 0.0 0.0 0.0 0.0	D3 More Cases	K0.44 SCO W2 1.8 -0.9 -0.5 -0.6 -0.3 -0.2 0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.7 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.6 -0.5 -0.5 -0.6 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5 -0.5	codial 4 codial 4 Codia	Hub S2 (987) 14 1-0-7 0.7 0.4 0.5 0.2 0.2 0.3 0.5 R HAZ R HAZ R hazard g hazad ng ng ng nctanl	RS, AN 83 0.M 1.6 -0.5 -0	Additional ND FIM St St St St St St St St St St St St St	A sketch VAL LLI VAL LLI SS WAN 12 0.7 0.3 0.4 0.1 0.4 0.1 0.5 Coent F n to	PC es or con es or con es or con evel 1 10 0.7 -0.4 -0.4 -0.4 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 -0.4 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.4 0.7 0.	2 ments c 1 SCO C2 C2 C3 0.3 0.2 0.3 0.3 0.3 0.3 0.0 R d Struct s, unknow s, score s, score s, nonstru	an separa RE, S ₁ (JSW) 0.9 0.5 0.3 0.3 0.3 0.0 0.1 0.1 0.1 0.3 EQUIR tural Eva wwn FEMan heaznd's turactural ha	Evaluation Evalua	PC2 1.0 -0.7 -0.4 -0.4 -0.4 -0.1 0.2 -0.1 -0.2 Sec, 2 Require g type o tion Rec dentified sist that	RM1 (FD) 1.1 -0.7 -0.4 -0.4 -0.2 -0.2 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.2 -0.3 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.7 -0.4 -0.2 -0.7 -0.4 -0.4 -0.2 -0.5 -0.4 -0.4 -0.4 -0.2 -0.4 -0.4 -0.2 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4 -0.4	R3M2 (PD) 1.1 -0.7 -0.4 -0.4 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2 -0.2	URM 0.5 -0.3 -0.3 0.0 0.0 0.0 0.0 0.0 0.0 0.2 eck cnej siluated stion, but	
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Building Classification









Fragility curves (Suppasri et al., 2013) for collapse damage



Fragility curves (Suppasri et al., 2013) for collapse damage





Photo taken by Hyoungsu Park, at Seaside Field trip (July, 14, 2015)









Park, H, MS Alam, DT Cox, AR Barbosa, JW van de Lindt (2019) "Probabilistic seismic and tsunami damage analysis (PSTDA) for the Cascadia Subduction Zone applied to Seaside, Oregon," *International Journal of Disaster Risk Reduction*, 35, 101076, https://doi.org/10.1016/j.ijdrr.2019.101076.







Higher probability Lower consequences

Highest

Risk

Lower probability Higher consequences

Annualized Risk for Building Damages in Seaside



Critical (lifeline) infrastructure networks



Buildings Transportation 500 500 В Α 400 400 300 300 200 200 100 100

Annualized Risk for Building Damages in Seaside

Sanderson D, S Kameshwar, N Rosenheim, DT Cox (2021) "Deaggregation of multi-hazard damages, losses, risks, and connectivity: An application to the joint seismic-tsunami hazard at Seaside, Oregon," Natural Hazards, https://doi.org/10.1007/s11069-021-04900-9.





Sanderson D, DT Cox (2023) "Comparison of national and local building inventories for damage and loss modeling of seismic and tsunami hazards: From parcel-to-city-scale" *International Journal of Disaster Risk Reduction*, https://doi.org/10.1016/j.ijdrr.2023.103755



Sanderson D, DT Cox (2023) "Comparison of national and local building inventories for damage and loss modeling of seismic and tsunami hazards: From parcel-to-city-scale" *International Journal of Disaster Risk Reduction*, https://doi.org/10.1016/j.ijdrr.2023.103755



1,000 yr event Block Level

Tax Assessor









Distribution of expected debris volume (m³) per unit area (hectare) for 1000 year event without advection. (a) Volume of total debris from EQ+TSU, (b) Volume of buoyant debris only from EQ+TSU.

Advection of buoyant debris from PSTDA at AEP = 0.0004 (2,500 yr)

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Thresholds:



Park H, DT Cox (2019) "Effects of advection on forecasting construction debris for vulnerability assessment under multi-hazard earthquake and tsunami," *Coastal Engineering* https://doi.org/10.1016/j.coastaleng.2019.103541

Post-event Community Connectivity and Access to Critical Facilities



Table 1

Likelihood of accessing hospitals and the high school immediately after tsunami events.

	(a)	Connectiv	ity to hospi	ital					
Return period	AA #2	AA #5	AA #6	AA #7	AA #8				
250	0.84	1.00	1.00	1.00	0.99				
500	0.67	1.00	1.00	1.00	0.82				
1000	0.00	0.00	0.00	0.00	0.00				
2500	0.00	0.00	1.00	0.00	0.00				
5000	0.00	0.00	0.00	0.00	0.00				
10000	0.00	0.00	0.00	0.00	0.00				
(b) Connectivity to high school									
	(b) (Connectivit	y to high so	hool					
Return period	(b) (AA #2	AA #5	y to high so AA #6	hool AA #7	AA #8				
Return period 250	(b) (AA #2 0.83	AA #5 0.99	y to high so AA #6 0.99	hool AA #7 0.99	AA #8 1.00				
Return period 250 500	(b) (AA #2 0.83 0.63	AA #5 0.99 0.95	y to high so AA #6 0.99 0.95	hool AA #7 0.99 0.95	AA #8 1.00 0.86				
Return period 250 500 1000	(b) (AA #2 0.83 0.63 0.10	AA #5 0.99 0.95 0.00	y to high so AA #6 0.99 0.95 0.34	hool AA #7 0.99 0.95 0.02	AA #8 1.00 0.86 0.32				
Return period 250 500 1000 2500	(b) (AA #2 0.83 0.63 0.10 0.01	AA #5 0.99 0.95 0.00 0.00	y to high so AA #6 0.99 0.95 0.34 0.05	hool AA #7 0.99 0.95 0.02 0.00	AA #8 1.00 0.86 0.32 0.04				
Return period 250 500 1000 2500 5000	(b) (AA #2 0.83 0.63 0.10 0.01 0.00	Connectivit AA #5 0.99 0.95 0.00 0.00 0.00	y to high so AA #6 0.99 0.95 0.34 0.05 0.00	hool AA #7 0.99 0.95 0.02 0.00 0.00	AA #8 1.00 0.86 0.32 0.04 0.04				

Kameshwar S, H Park, DT Cox, AR Barbosa (2021) "Effect of disaster debris, flood duration, and bridge damage on immediate post-tsunami connectivity," *Int. J. Disaster Risk Reduction*, https://doi.org/10.1016/j.ijdrr.2021.102119.

Life Safety Modeling

- Effect of earthquake damage on the tsunami casualty:
 - EQ damage increases building evacuation time.
 - EQ debris increases pedestrian evacuation time.
- Work in progress:
 - Risk-based modeling for EQ + Tsu
 - Inclusion of **tourist** in life safety and risk
 - Impact of **structural retrofit** on building egress and road debris







Amini M, DR Sanderson, DT Cox, AR Barbosa (2023) "Evaluating structural retrofit and land use policy options for multi-hazard earthquake and tsunami risk reduction for life safety and damage in a coastal city," *Natural Hazards*, https://doi.org/10.1007/s11069-023-05937-8

Thank you!

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