Earthquake Risks and Mitigation in Oregon

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I. Introduction

A. Oregon and earthquakes
1. all parts of state have potential for earthquakes
2. Oregon lies at juncture of Cascadia Subduction Zone
a. Juan de Fuca plate subducts beneath N. America

B. Earthquake types
1. Intraplate quakes - within the Juan de Fuca plate
2. Crustal quakes - within the over-riding N. American plate
3. Subduction-Zone quakes - at interface between subducting and over-riding slabs
4. Volcanic-related quakes
a. Cascade volcanic arc

C. Seismic Records
1. limited historic seismicity
2. surface traces of active faults limited

D. Moral of Story:
1. moderate level of historic record for quakes but...
2. significant risk in Oregon

II. Earthquake Sources in Pacific Northwest
A. Convergent Plate Tectonic Setting
1. Cascadia subduction

2. Paleoseismic record
a. last major subduction zone quake ~300 yrs ago
b. several large magnitude quakes in past several 1000 yrs

3. maximum magnitude quakes expected: 8.5-9.0 (wow!!)

B. Quake Types
1. Deep Intraplate
a. depth 40-60 km, within interior of Juan de Fuca plate
b. max magnitude ~7.5
c. micro-earthquakes common
2. Shallow Crustal quakes
a. depth 10-25 km, in N. American crust
(1) e.g. Klamath Falls 1993 (M5.9-6.3)
3. Volcanic Quakes
a. max Magnitude ~5.5
b. e.g. Mt. St. Helens 1980

III. Seismic Risk in Oregon

A. Historic seismicity is low frequency
1. problem - complacency
2. Explanations for low seismic frequency in Cascadia Subduction Zone
a. convergence rate = 0
(1) known: convergence rate = 3-4 cm/yr
b. converging slip accommodated aseismically
c. PNW is in major seismic gap, with major locked plate segments
(1) "the big one is coming"

B. Factors for Oregon
1. Population increase, > population density
2. low public awareness

C. History of Seismic Work in Oregon
1. Trojan Nuclear Plant Siting
2. Bonneville Power Administration

D. Current Seismic Data Set
1. prehistoric earthquake record
a. Native American legends
(1) Tsunamis
(2) landslides
b. Japanese historic documents
2. Instrument-recorded data
a. GPS ground motion measurements
b. seismic analysis
3. Geologic Records
a. quake-induced landslides
b. buried forests / marsh soils resulting from coseismic subsidence
(1) recurrence interval estimates for great quakes: 400-800 yrs
c. tsunamic sand deposits in back bay aeras
d. liquefaction features
e. turbidites
f. offshore submarine landslides

IV. Hazards Mitigation and Risk Analysis
A. Terms Defined
1. hazard - probability of ground shaking (or any event)
2. risk - potential for death / destruction associated with hazard
B. Earthquake Hazards Mapping Program

V. Hazards Maps
A. Hazards Associations
1. Liquefaction potential
a. unstable saturated soils, during shaking
2. Amplification of Shaking
a. unconsolidated, fine-grained soils
3. Landsliding

B. Key Data / Spatial Associations
   1. Bedrock Geology
   2. Topographic Slope
   3. Surficial Geology
      a. Soils Distribution
      b. Alluvial Sediments
   4. Groundwater Conditions
      a. Depth to Water
      b. Unconsolidated Aquifers

C. Map Products
   1. Liquefaction Susceptibility
      a. high susceptibility: loos, saturated sands / silt below water table
      b. low susceptibility: consolidated bedrock, compacted gravels
      c. Result of Liquefaction - structural failures
      d. e.g. Scale
         (1) 0 - no suscept. = bedrock
         (2) 1 - < 6ft of liq. material
         (3) 5 - > 25 ft of liq. material

   2. Amplification Susceptibility
      a. defined - materials intensification of groundshaking energy
         (1) "ground motion amplification"
      b. most susceptible: thick deposits soft, low density unconsolidated soils
         (1) low shear wave velocity = high damage

      c. e.g. Scale
         (1) 0 - no suscept. / bedrock
         (2) 5 - low density soils/ unconsolidated

   3. Landslide Susceptibility

      a. earthquake induced shaking / landslides
      b. Factors
         (1) slope / gradient
         (2) groundwater saturation
         (3) vegetative cover
         (4) colluvial thickness / easily weathered rocks
         (5) bedrock structure
            (a) bedding planes
            (b) joints
      c. e.g. scale - slope angle
         (1) 1 - low susceptibility (slopes < 6 degrees)
         (2) 4 - high susc (slopes > 22 degrees)

4. Relative Earthquake Hazard: based on above 3 criteria

a. Primary Analytical Tools
(1) Surface Mapping / Public Record
(a) Bedrock Geologic Maps
(b) Surficial Geology Maps
(c) Soils Survey Maps
(2) Geographic Information Systems
(a) Computer - Based Spatial Analysis
i) Maps + Database

Category of Quake Hazard	Liquefaction	Amplification	Landsliding
0 (low)	0	1	0
1	1	1	1
2	1	2	1
3	2	2	2
4	3	3	3
5(high)	3	3	3

(0 = low, 3 = highest)