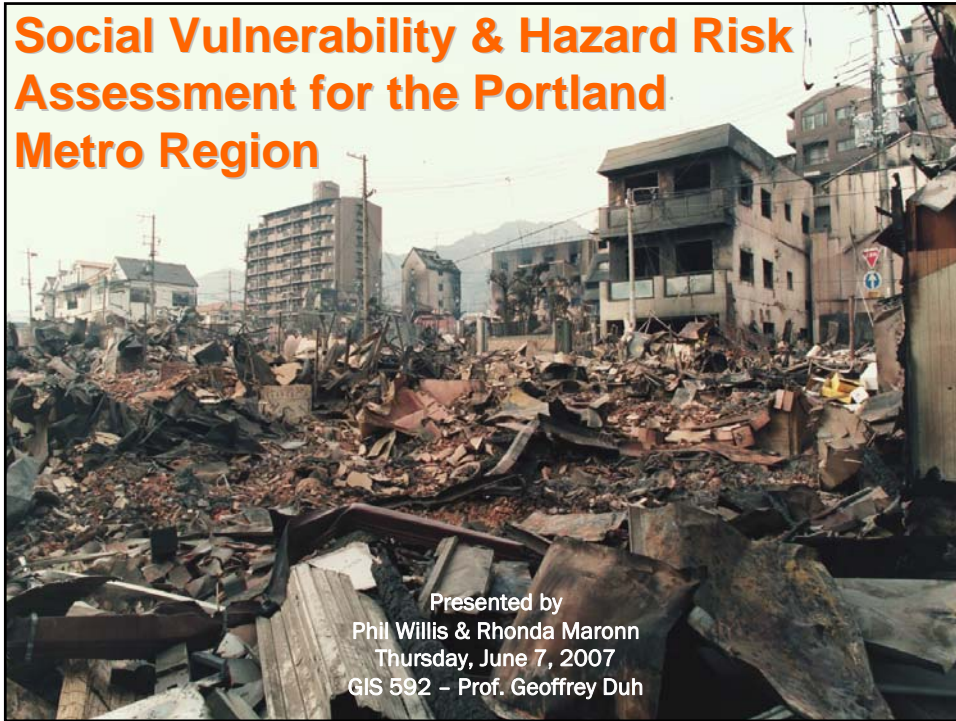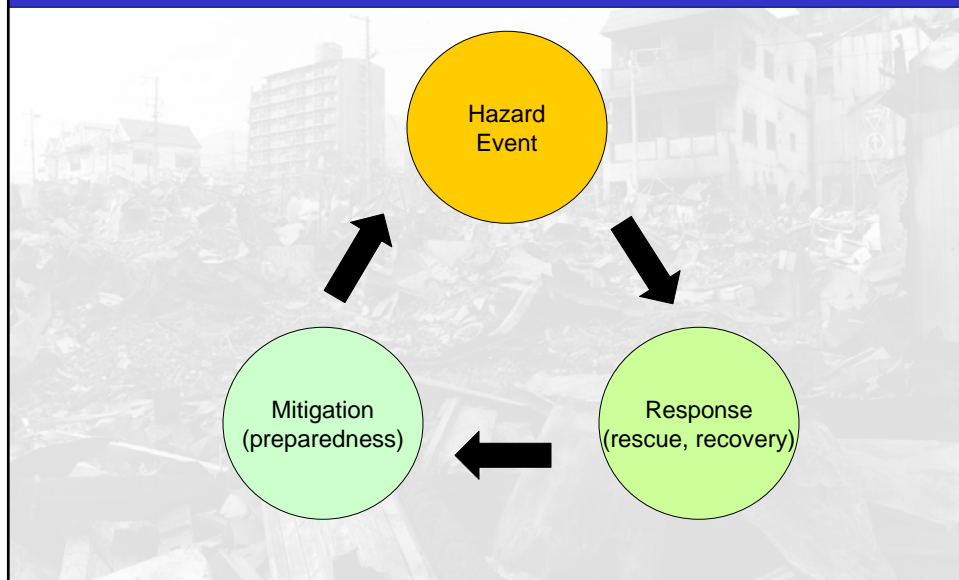# Social Vulnerability & Hazard Risk Assessment for the Portland Metro Region
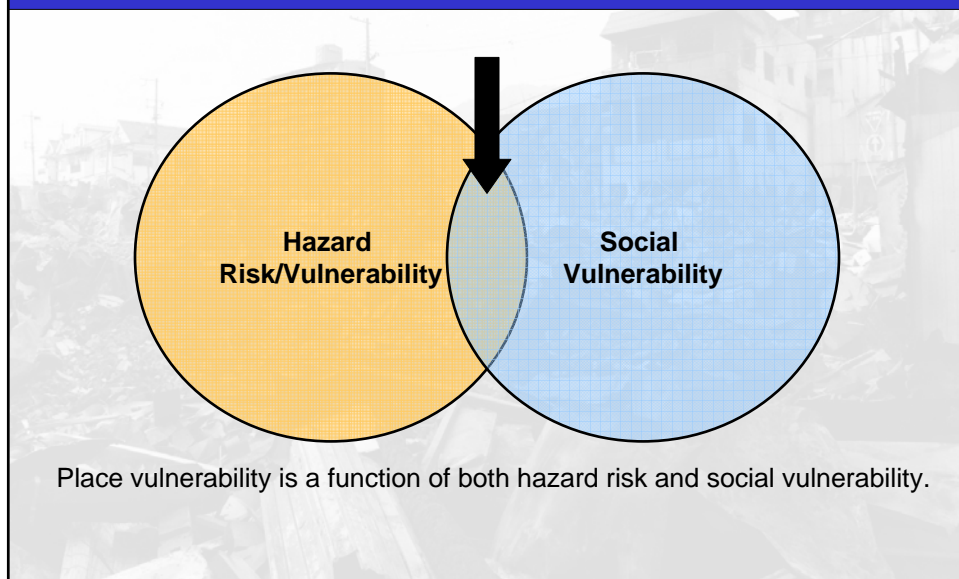
Presented by
Phil Willis & Rhonda Maronn
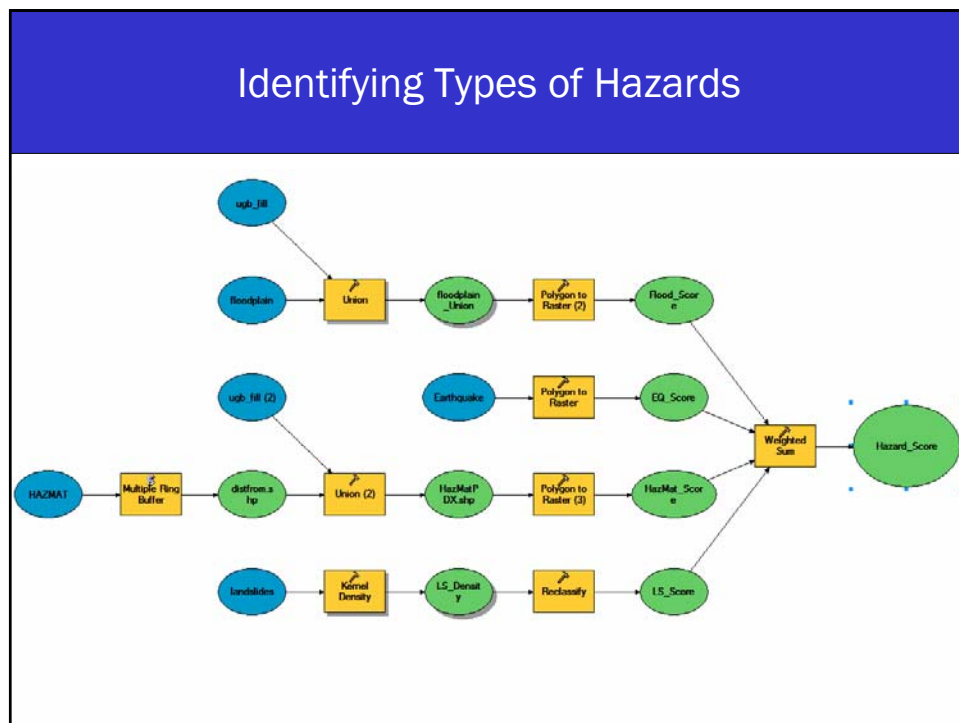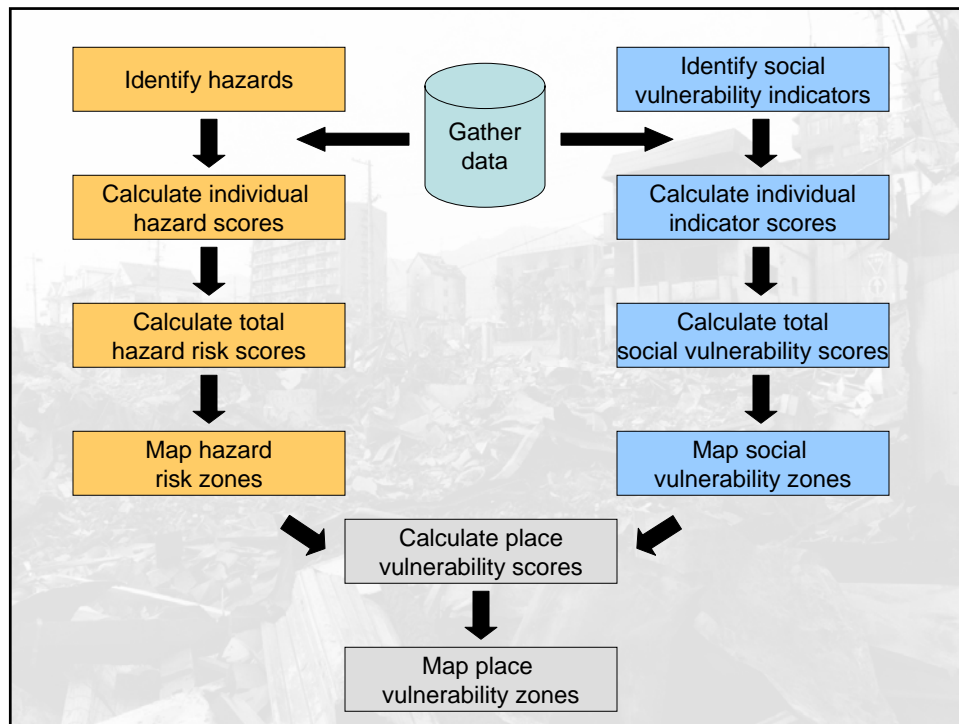Thursday, June 7, 2007
GIS 592 – Prof. Geoffrey Duh

Research Question

Which residential areas in the Portland Metro region are more likely to be adversely affected by hazard events?
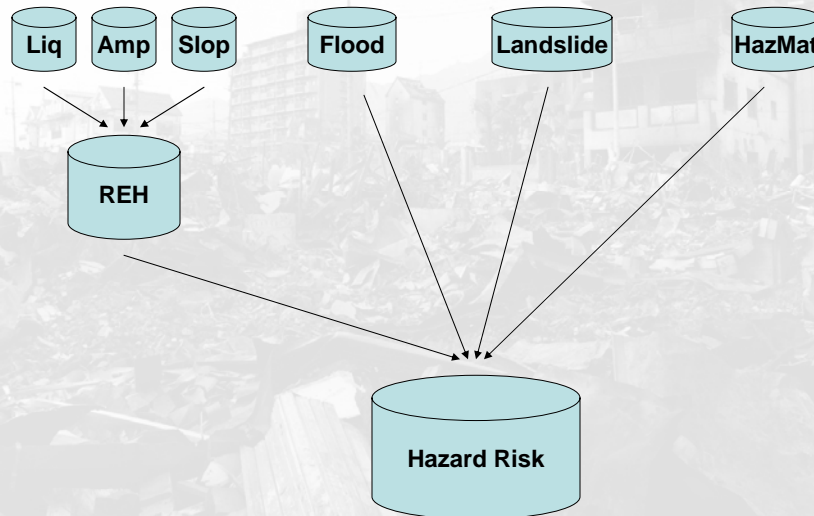
Emergency Management

Hazard Event → Response (rescue, recovery) → Mitigation (preparedness) → (cycle back to Hazard Event)

Place Vulnerability

Hazard Risk/Vulnerability — Social Vulnerability

Place vulnerability is a function of both hazard risk and social vulnerability.

Identifying Types of Hazards

Identifying Types of Hazards

Identifying Types of Hazards

Earthquakes

Landslides

Floods

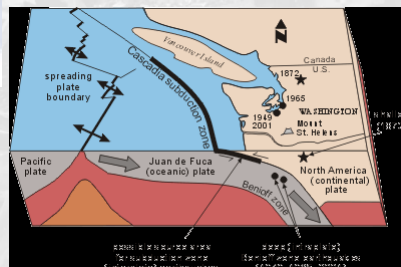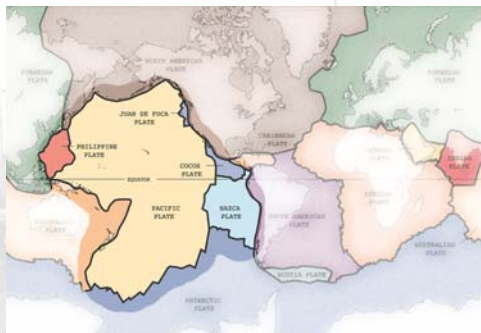Hazardous Materials

Identifying Types of Hazards

Earthquakes

Landslides

Floods

Hazardous Materials

Earthquakes and Plate Tectonics

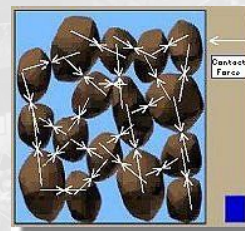# Relative Earthquake Hazard (REH)

Relative Liquefaction Hazard

Relative Amplification Hazard

Slope Instability Hazard

REH – What is Liquefaction

Before
-unconsolidated soils
-each particle is in contact with a
    number of neighbors
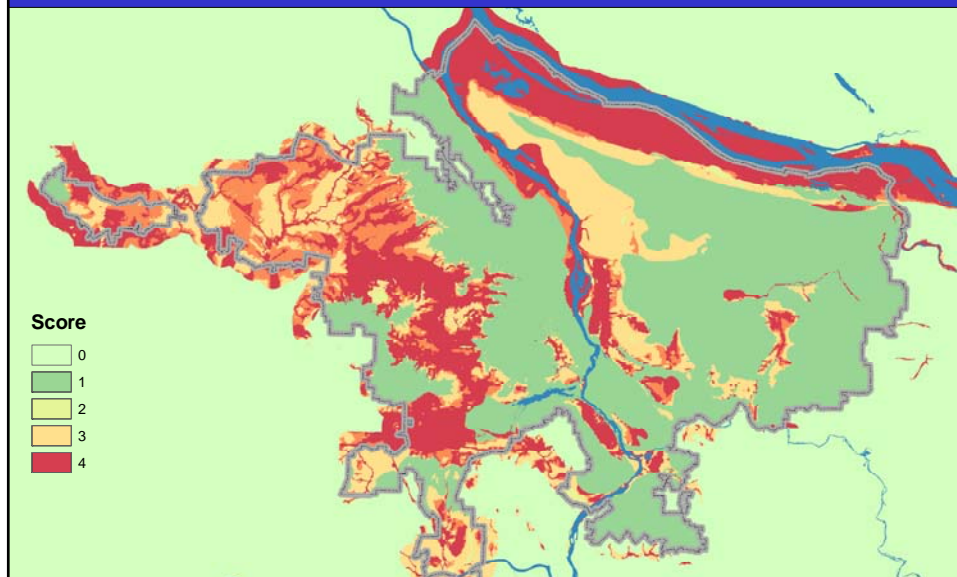-contact forces give the soil its strength

After
-breakdown of structure because water in
    soil cannot be squeeze out (trapped)
-increase in water pressure which reduces
    the contact forces
-weakens the soil deposits

REH – Relative Liquefaction Hazard

REH – Relative Liquefaction Hazard

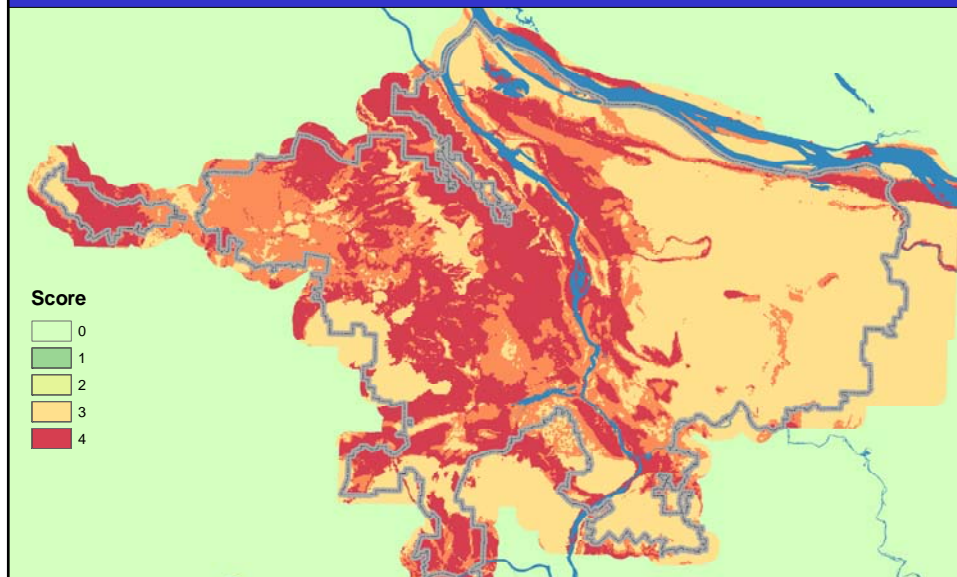
Score
- 0
- 1
- 2
- 3
- 4

REH – What is Amplification?

An increase in strength of shaking

Soft soils overlying hard bedrock tend to amplify the ground motions

Sediments & thick soils tend to amplify seismic waves

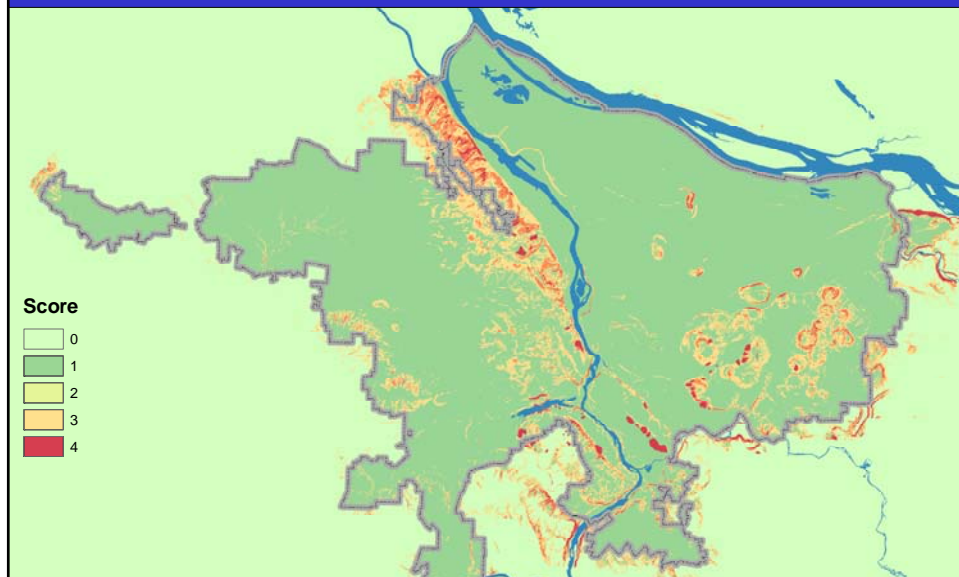## REH – Relative Amplification Hazard

Score
- 0
- 1
- 2
- 3
- 4

REH – Slope

Slopes between 15 percent & 30 percent

Slopes between 30 percent & 45 percent

Slopes greater than 45 percent

REH – Slope

Score
- 0
- 1
- 2
- 3
- 4

REH – Final Scores
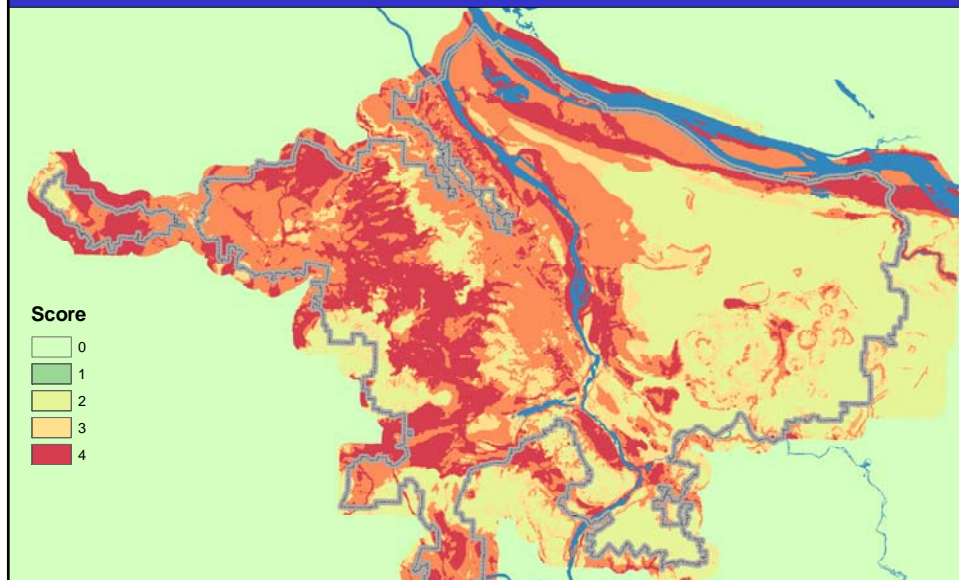
Score
0
1
2
3
4

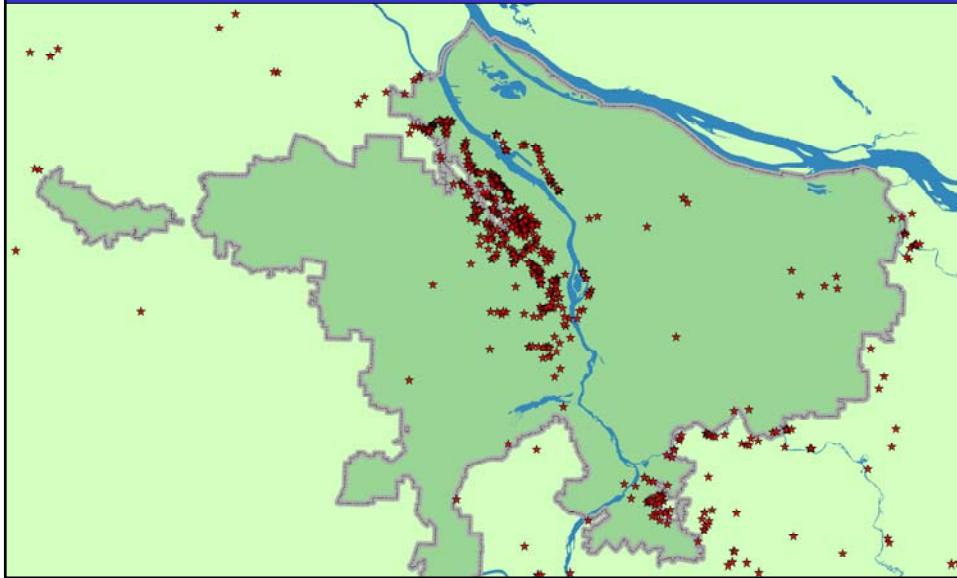**Identifying Types of Hazards**
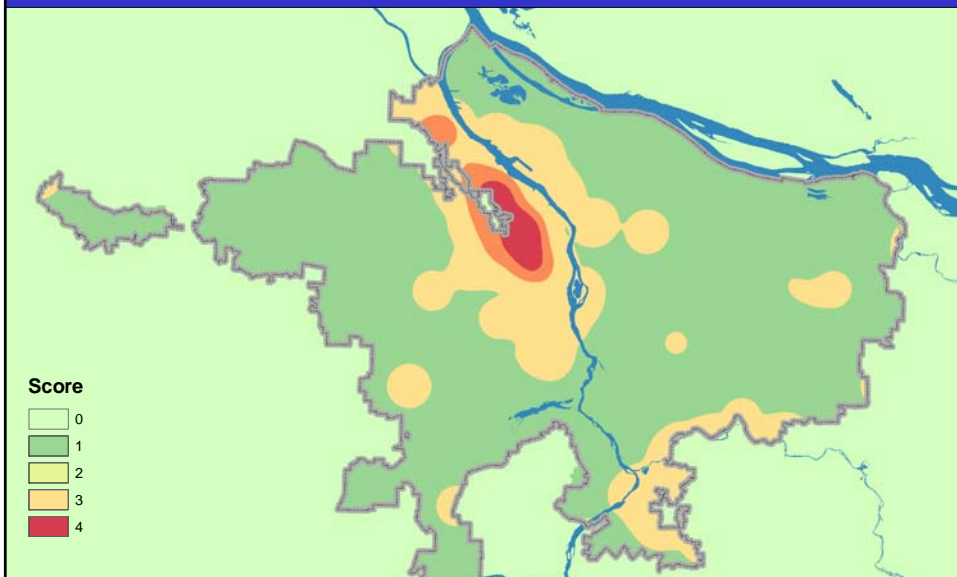
Earthquakes

Landslides

Floods

Hazardous Materials

Landslide Hazards

Landslide Hazards Score

Score
0
1
2
3
4

Identifying Types of Hazards
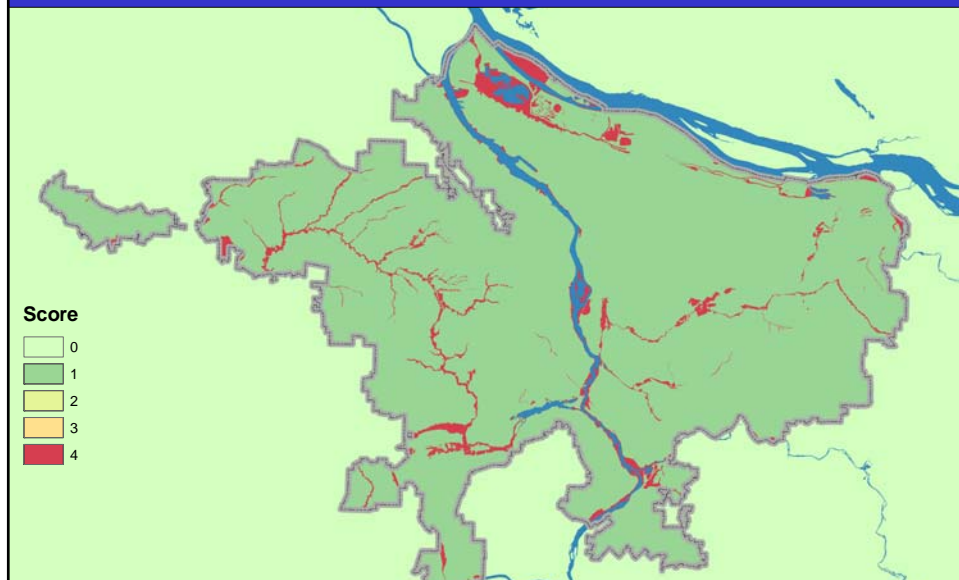
Earthquakes

Landslides

Floods

Hazardous Materials

Flood Hazards

100 year flood data from FEMA

Flood Hazards

Score
- 0
- 1
- 2
- 3
- 4

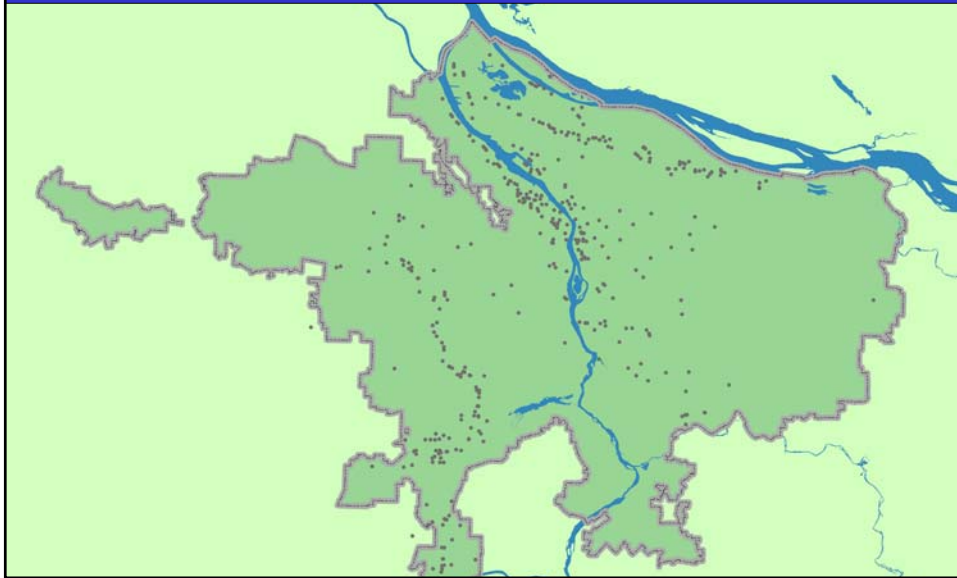## Identifying Types of Hazards

Earthquakes

Landslides

Floods

Hazardous Materials

Hazardous Materials

Hazardous Materials

Score
0
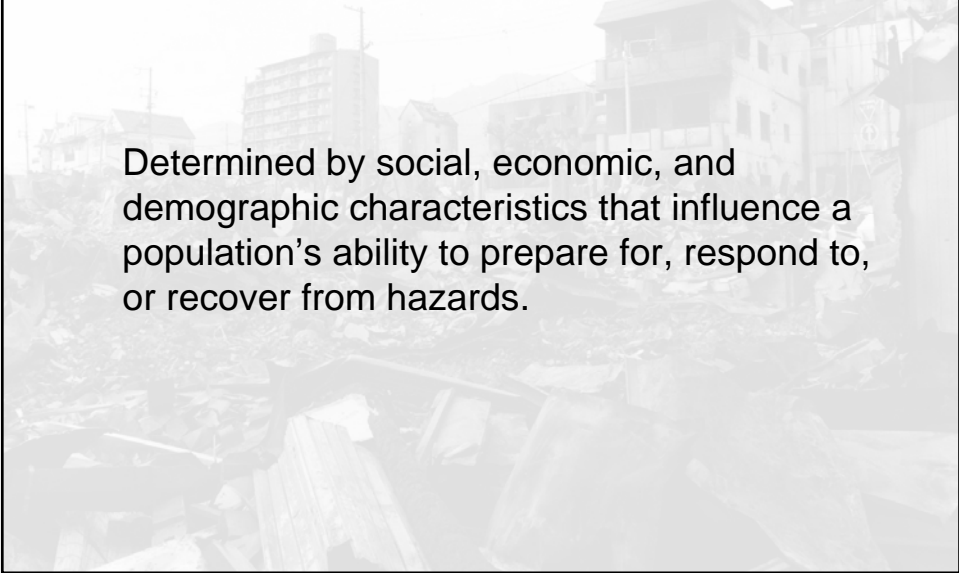1
2

Identifying Types of Hazards

Hazard Risk (Multi-Criteria Analysis)

Score
- 0
- 1
- 2
- 3
- 4

What is Social Vulnerability?

Determined by social, economic, and demographic characteristics that influence a population's ability to prepare for, respond to, or recover from hazards.

Social Vulnerability Indicators

- Age
- Household Income
- Disability
- Language Barrier
- Population
- Population Density

Calculating
social vulnerability

Social Vulnerability Score

$$SV_{BG} = \frac{\left[\dfrac{X_{BG}}{X_{BG\ total}} \right]}{Max\ X_{BG}}$$

X ➔ Value of the socioeconomic indicator
SV ➔ Social vulnerability score

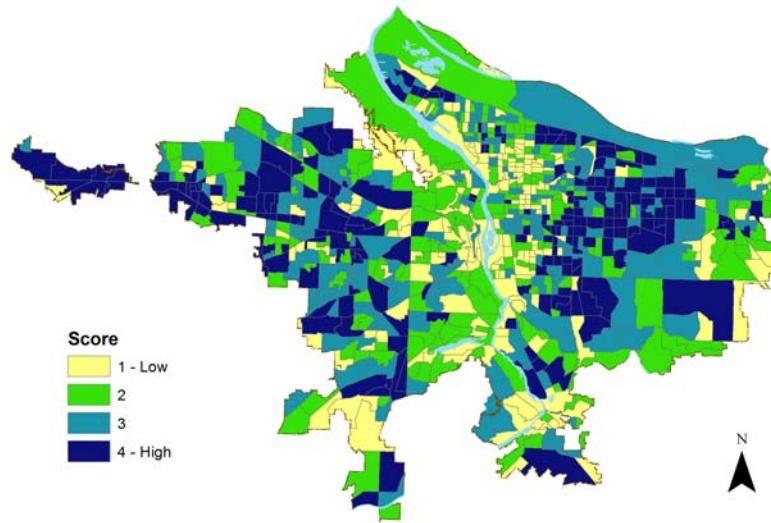## Total Social Vulnerability

$$SV_{Total} = SV_1 + SV_2 + SV_3 + \ldots + SV_X$$

$SV_{1 \text{ to } X}$ are the social vulnerability scores for each social or economic indicator
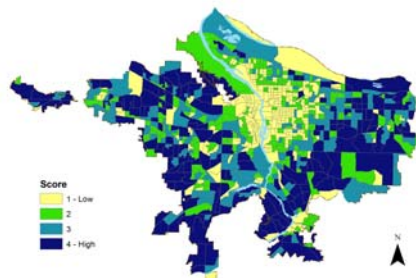
i.e., SV value for age, income, disability, language barrier, population and population density
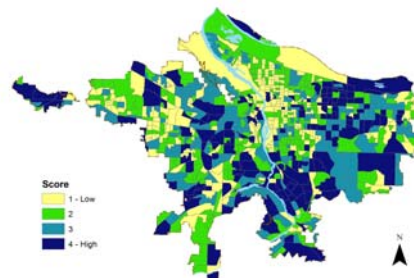
Mapping
social vulnerability

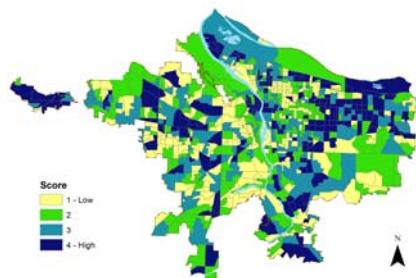Distribution of No or Low Ability to Speak English
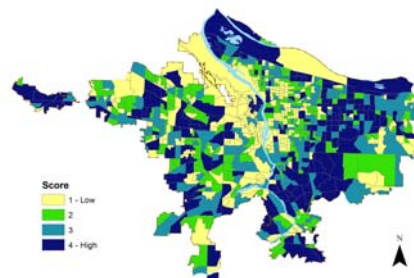

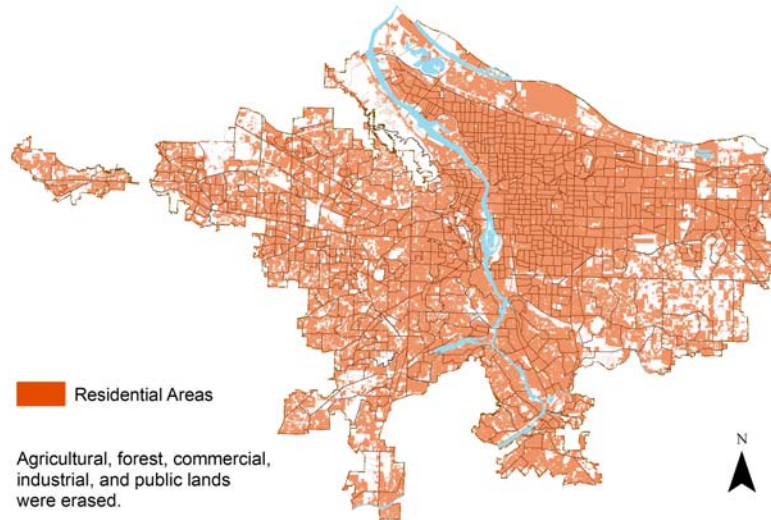Distribution of Young (0-17 years)

Distribution of Old (65+ years)
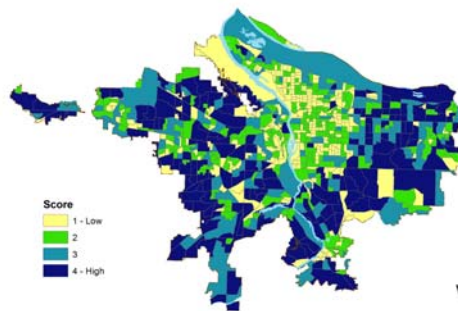
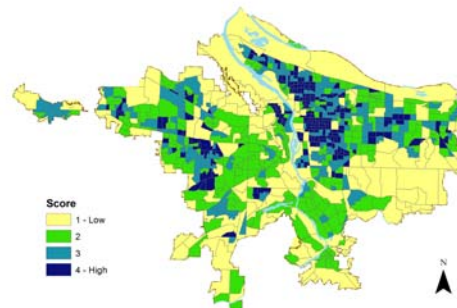Distribution of Household Incomes below Poverty Level

Distribution of Disabled

Residential Areas within Block Groups
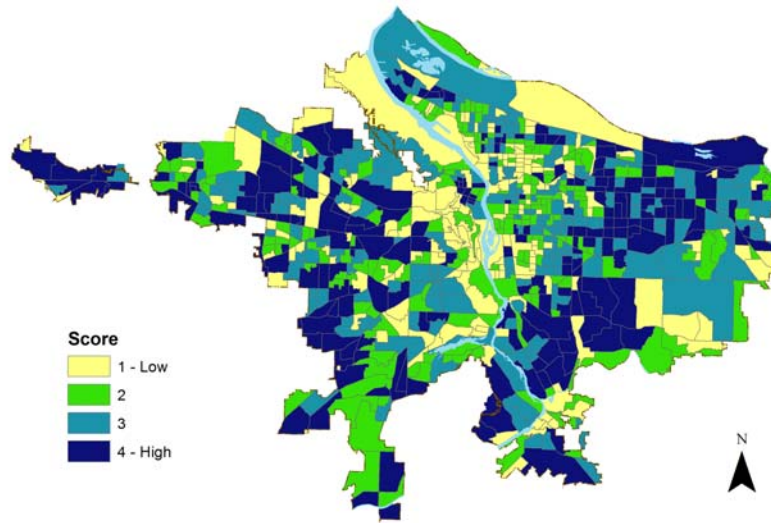

Distribution of Population among Census Block Groups

Distribution of Population Density within Residential Areas of Census Block Groups

Distribution of Total Social Vulnerability

Score
1 - Low
2
3
4 - High

Results

Place Vulnerability
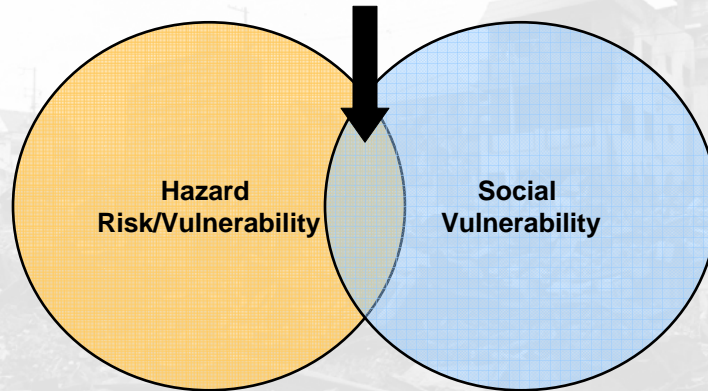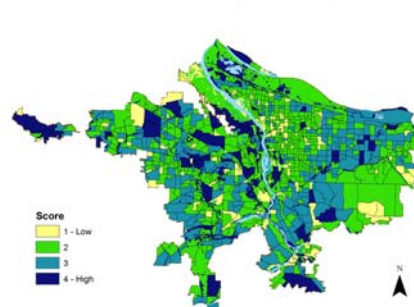
Hazard Risk/Vulnerability

Social Vulnerability

Place vulnerability is a function of both hazard risk and social vulnerability.

Hazard Risk Raster Map

Social Vulnerability Raster Map

Score
1 - Low
2
3
4 - High

Place Vulnerability Raster Map

Score
1 - Low
2
3
4 - High
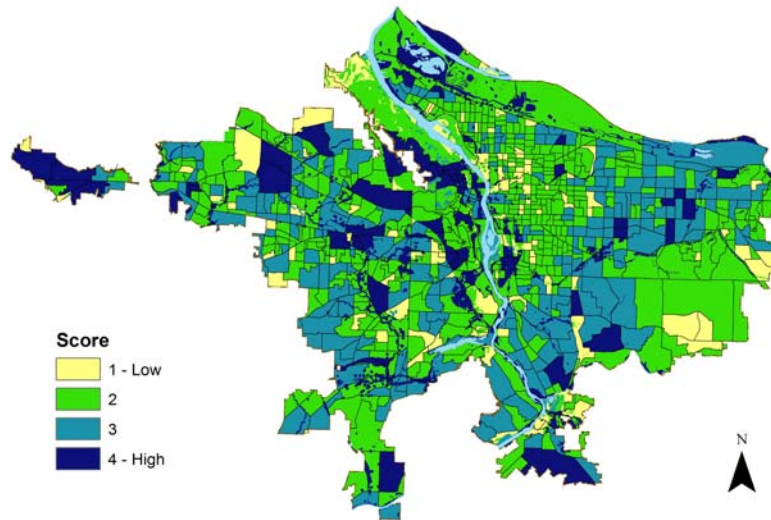
Results of Raster Calculation for Place Vulnerability in Portland Metro Region

Score
1 - Low
2
3
4 - High

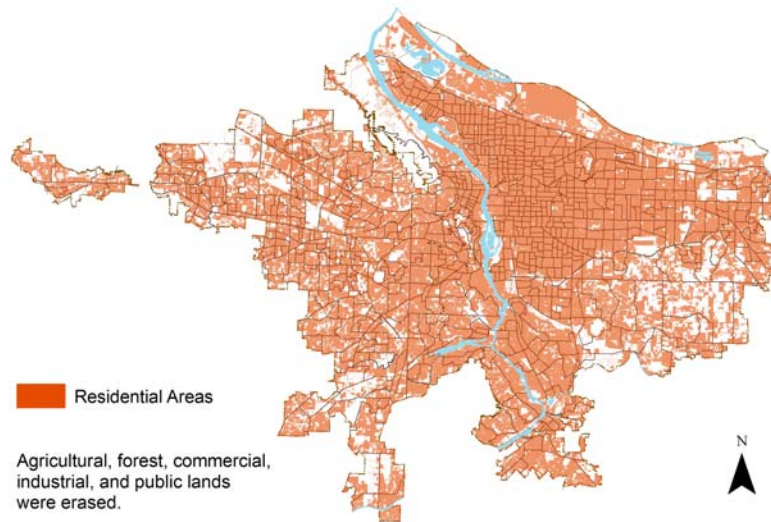The differential variability within block groups is due to the hazard risk distribution.
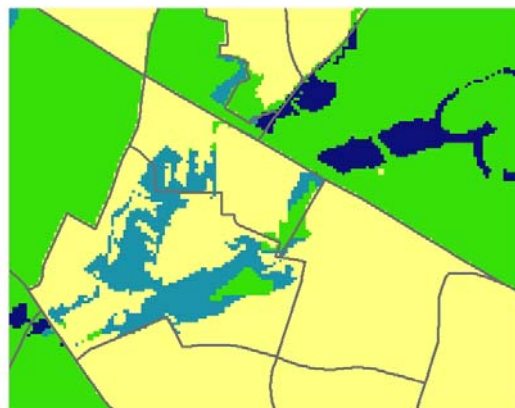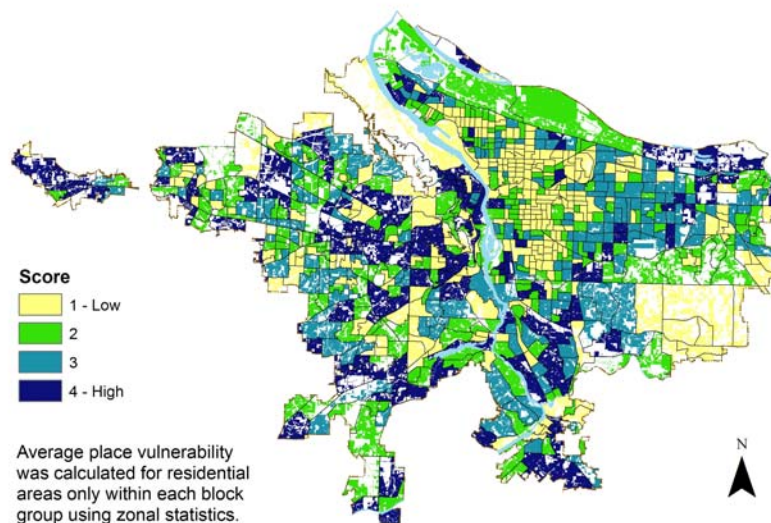
Place vulnerability = Total hazard risk x Social vulnerability score

Residential Areas within Block Groups

Residential Areas

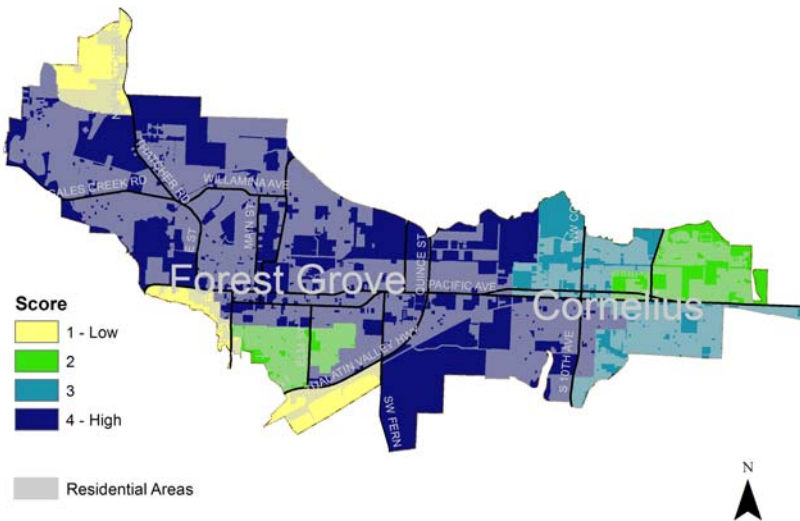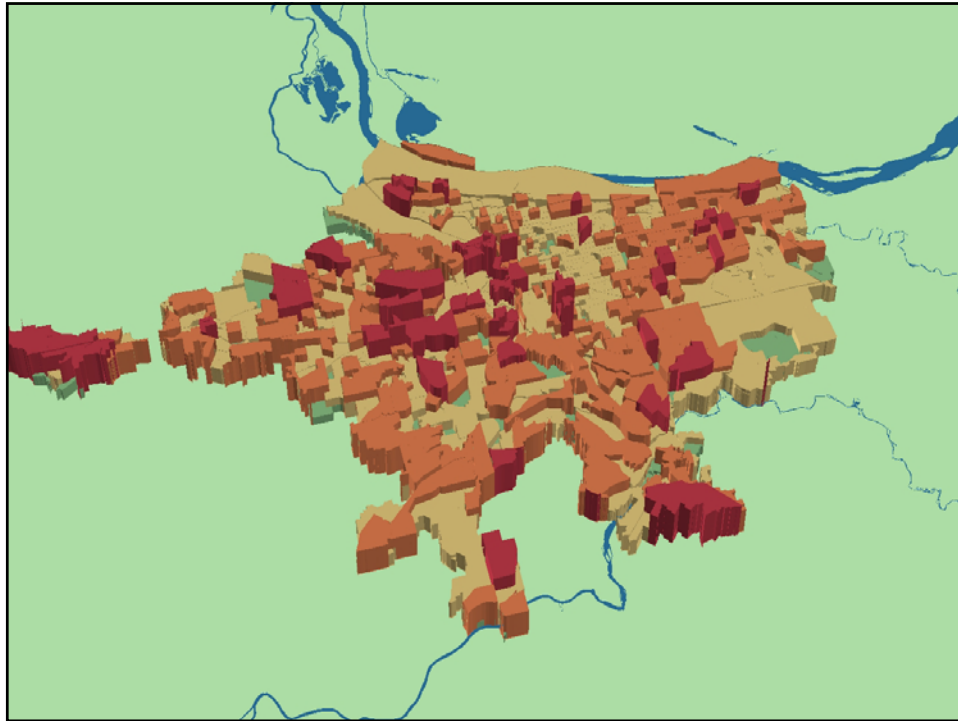Agricultural, forest, commercial, industrial, and public lands were erased.

Place Vulnerability in Residential Areas

Score
1 - Low
2
3
4 - High

Average place vulnerability was calculated for residential areas only within each block group using zonal statistics.

Place Vulnerability in Residential Areas within Block Groups

Score
1 - Low
2
3
4 - High

The average place vulnerability score was assigned to the entire block group using the maximum value tool in zonal statistics.

The non-residential areas had a value of zero, therefore the average value for the residential areas calculated in the previous step was assigned to the entire block group.

Place Vulnerability for Residential Areas in Forest Grove and Cornelius

Score
1 - Low
2
3
4 - High

Residential Areas

Data Sources

- 2000 U.S. census data
  - SF3 block group level
- RLIS layers
  - 2000 census block groups
  - UGB
  - tax lots
  - floodplain
- Metro Natural Hazards program
  - relative earthquake hazard
  - 1996 landslides
  - hazardous materials sites