Spatial Analysis of SEII and Emergency Planning for Selected Environmental Hazards within the Portland Area

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GEOG 492/592
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Introduction

- 2-Part analysis of:
  - Predicted 6.8 magnitude earthquake along the Portland Hills faultline.
  - Possible flood event based on the FEMA 100yr flood plain.
- Type of analysis conducted:
  - WLC to develop Socio-Economic Impact Index (SEII) for block groups for both scenarios.
  - Network analysis to identify nearest evacuation shelters from critically affected areas.

Data Used

- Common Data:
  - RLIS: block groups; tax lots; zoning; streets; river fill; Northwest Oregon hillshade.
- Earthquake analysis:
  - DOGAMI IMS 15 predicted 6.8 magnitude earthquake study area.
- Flood analysis:
  - FEMA 100yr flood plain

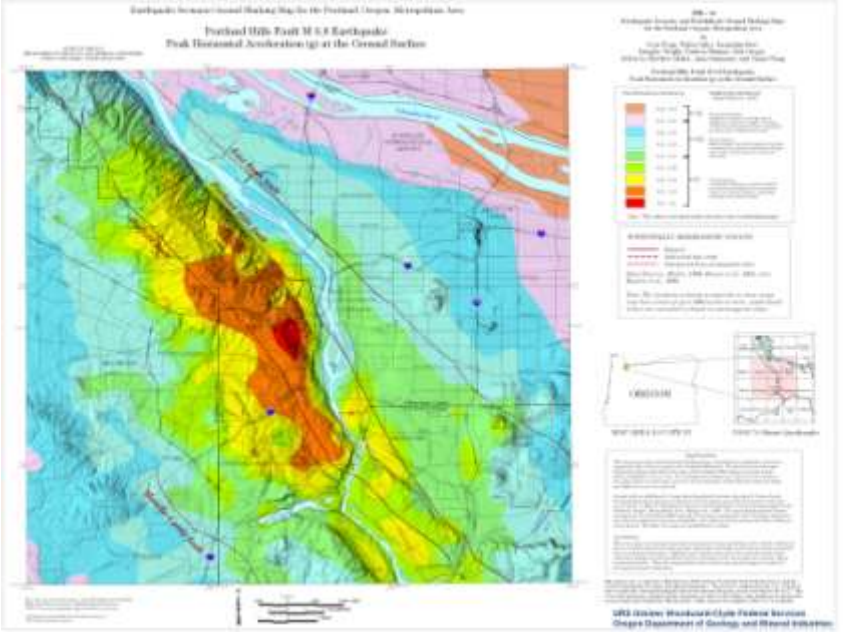
What is SEII?

(ess-ee-eye-eye)

- Socio-Economic Impact Index
- Comprised of key indicators for each event
- Earthquake indicators:
  - Block group population 2008; residential zoning; building value; building square footage; Modified Mercalli Intensity.
- Flood indicators:
  - Proportion of block group population 2008 by area affected; proportion of building value & land value affected.
- Data was normalized on a common scale to facilitate WLC.

Earthquake Scenario

- Why an EQ?
  - Oregon located along Cascadia Subduction Zone (CSZ).
  - Northwest Oregon has had 3 major events within the past 150yrs:
    - 1877 (M 5.3), 1962 (M 5.5), and 1993 (M 5.5).
  - Portland (study area) located along the Portland Hills fault line.
  - Oregon Department of Geology and Mineral Industries (DOGAMI) release of 6.8 magnitude scenario along Portland Hills fault.
  - Recent events have garnered significant attention and inquiry (e.g. Japan, Haiti, Indonesia).

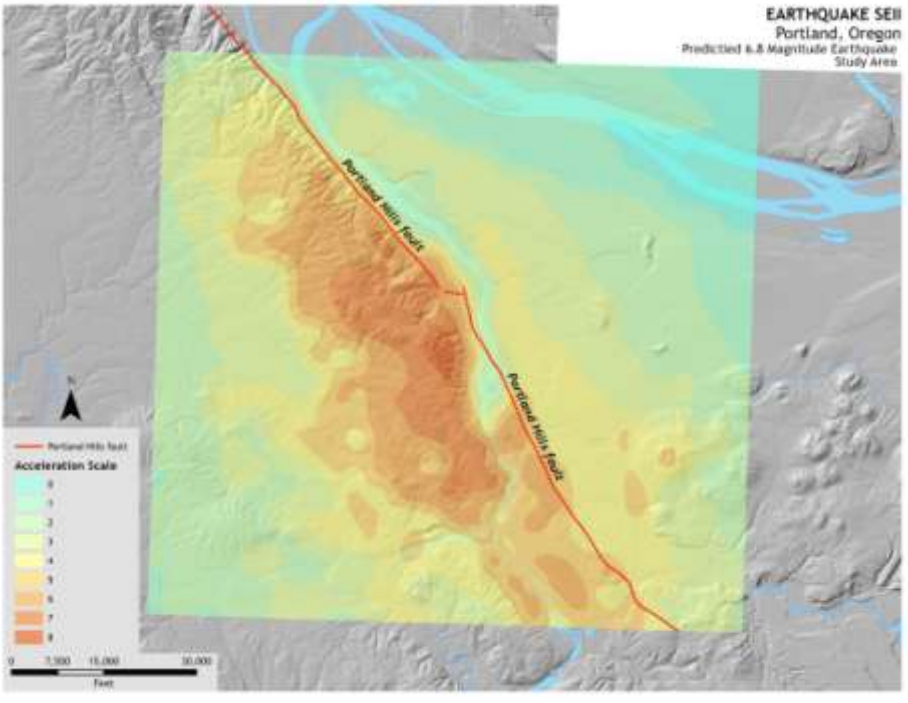


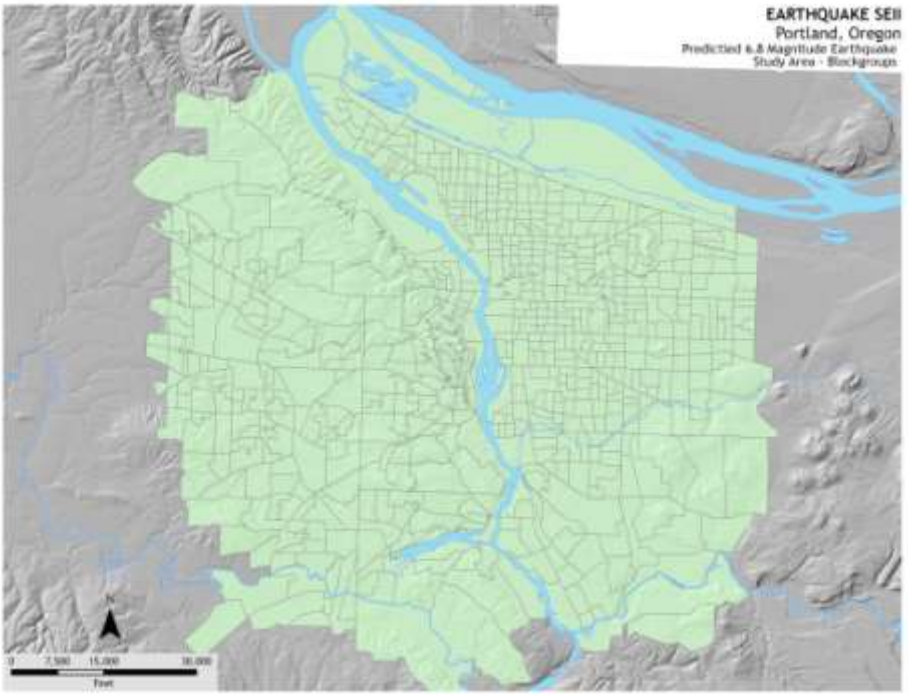
Modified Mercalli Intensity

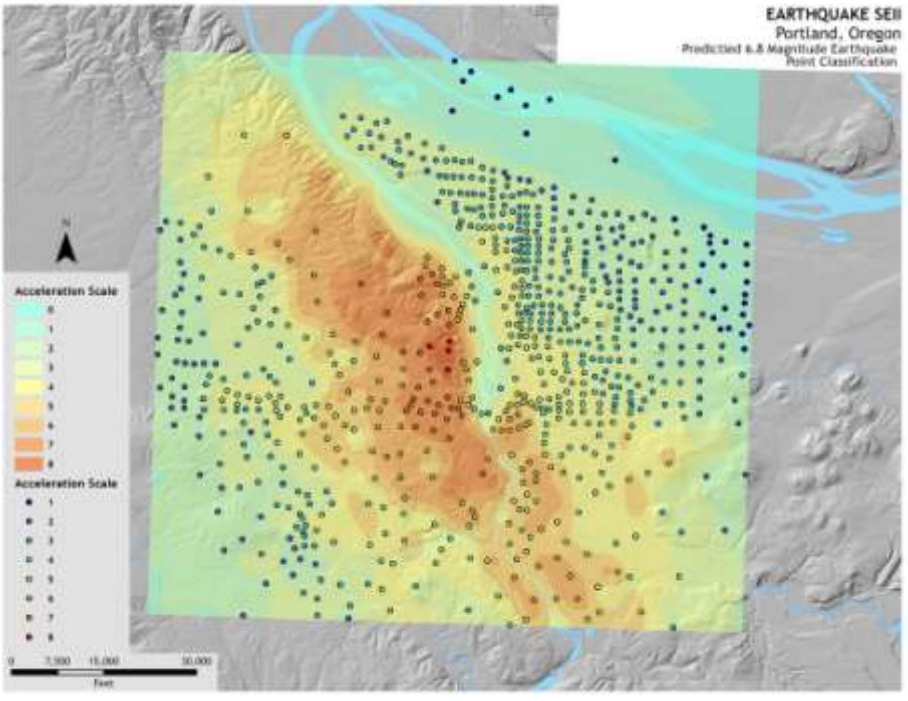
- Also known as MMI, it is a scale that measures the overall shaking severity of a seismic event.

- Ranges from a scale of 1 – 12, however values 11 and 12 are not considered in this study because:
  1. No incidence of these intensities have ever been recorded.
  2. Associated with apocalyptic scenarios (e.g. 2012).

- The study area of Portland falls within the range of 7 – 9.




EARTHQUAKE SEII
Portland, Oregon
Predicted 6.8 Magnitude Earthquake
Study Area - Blockgroups
N
0 7,500 15,000 30,000
Feet


EARTHQUAKE SEII
Portland, Oregon
Predicted 6.8 Magnitude Earthquake
Point Classification
N
Acceleration Scale
6
7
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Acceleration Scale
1
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3
4
5
6
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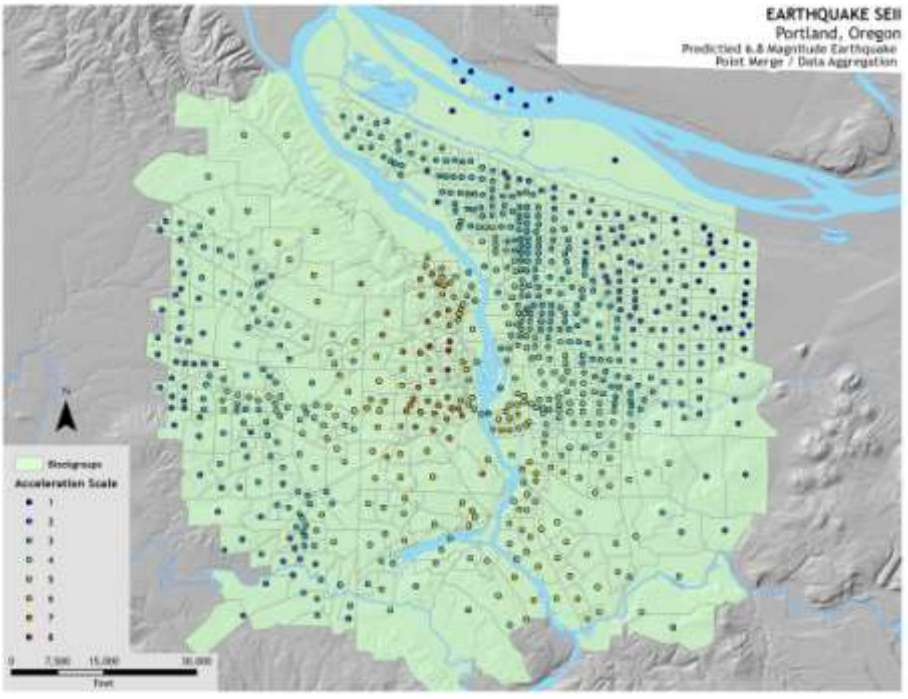
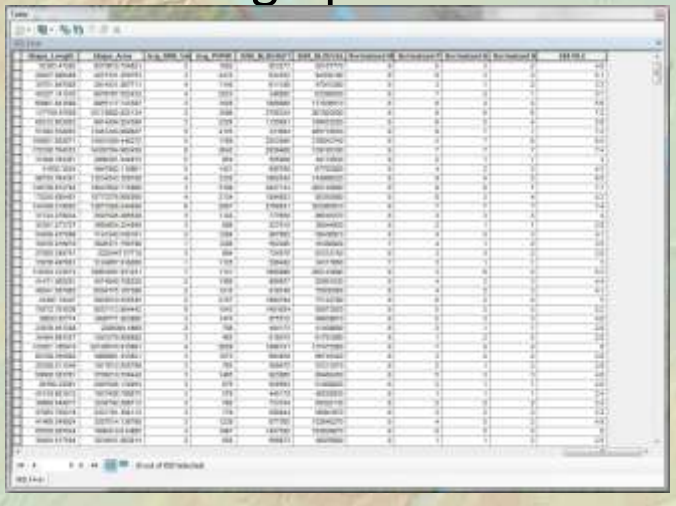
0 7,500 15,000 30,000
Feet



Setting up the WLC



The values of indicators used were normalized on a scale of 10 in order to accurately construct the WLC for the earthquake SEII. The MMI values assigned based on the acceleration values (1 – 8), and were given values from 7 – 9 since the MMI is already in a measurable range of 10.

Calculating the Final WLC Values

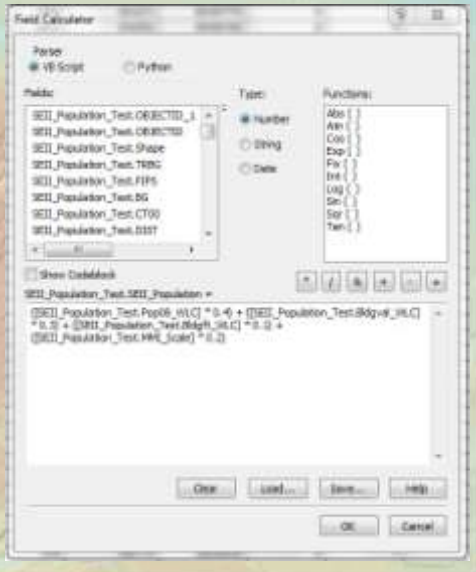
- The final WLC expression for our analysis (shown left) incorporated the normalized values multiplied by applied weights.

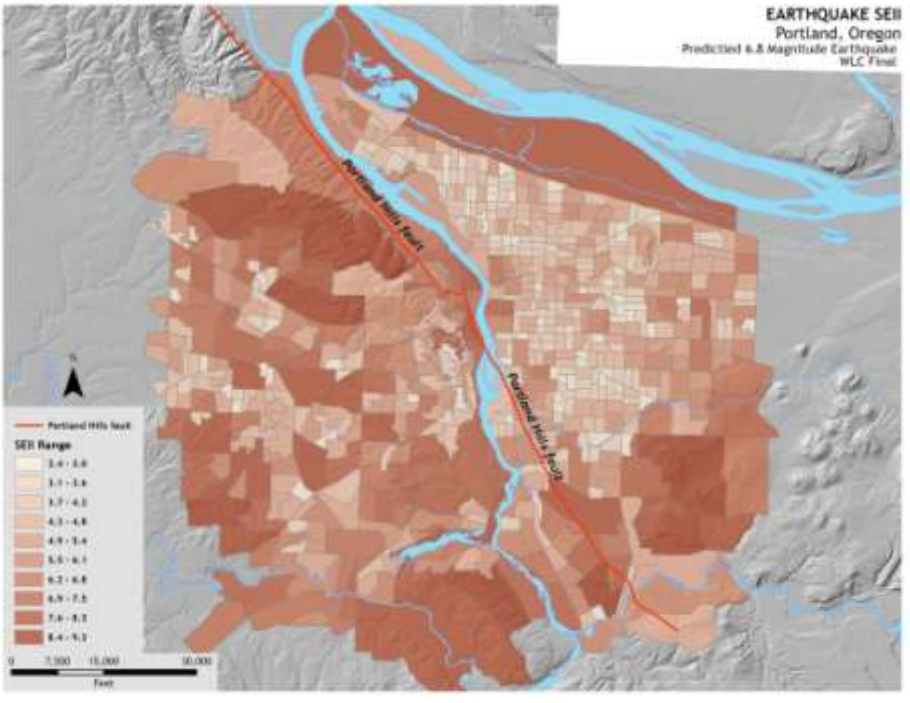
- The weights were chosen arbitrarily based on our own inference on each indicators importance.

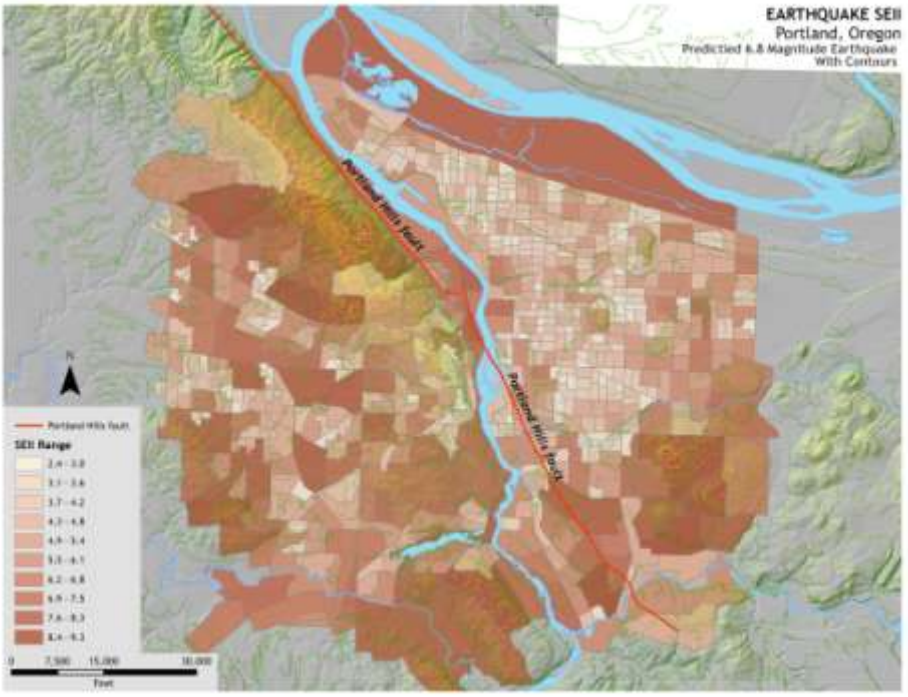
Indicator	Pop 08	BldgVal	BldgSqFt	MMI Scale
Weight	0.4	0.3	0.1	0.2

- A simplified version of the expression is as follows:

(Pop 08 * 0.4) + (BldgVal * 0.3) + (BldgSqFt * 0.1) + (MMI Scale * 0.2)







Considerations for EQ Analysis

- The study area may depict the block groups affected, however:
  - The effects of the earthquake extend well beyond that of the study area, thus absolute figures on the amount of property damage and people affected would be innaccurate.
  - The study is severely limited by the instance of a 6.8 magnitude earthquake.
  - A small shift in magnitude exponentially increases the effect of the event, which in turn would make this a poor model for estimating the effect of magnitudes around 6.8.

Flooding in the Portland Area

Willamette Valley Flood of 1996

- January to February in 1996

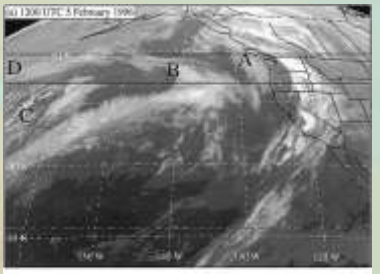
- 8 deaths in Oregon

- Over $500 million in Property Damage throughout the Pacific Northwest

-30,000 residents displaced from their homes

Flooding in the Portland Area

Combination of heavy rain, saturated ground, frozen snow pack at low elevations, warm jet stream with additional rain led to overflowing streams and tributaries – flooded into the region's major rivers.



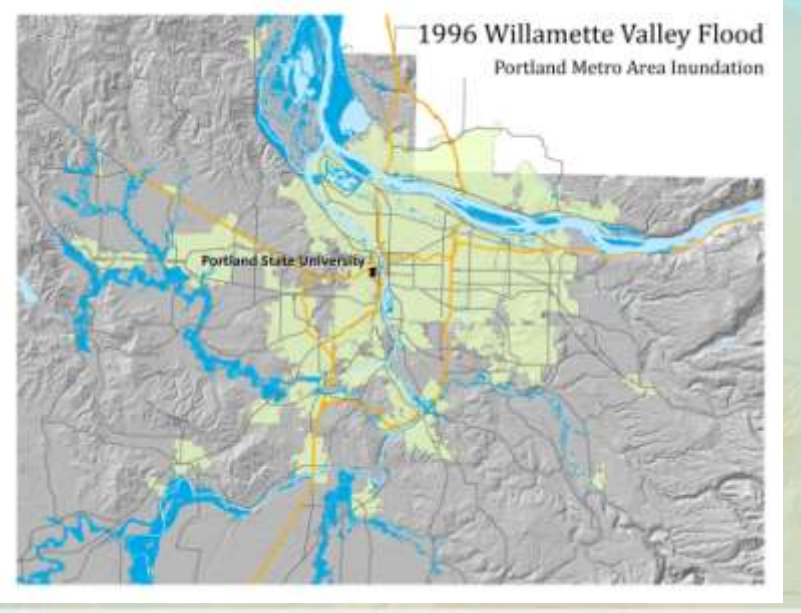
Factors Contributing to Flood Frequency and Intensity

- Rainfall intensity and duration
- Ground moisture conditions
- Watershed condition, including steepness of terrain, soil types, amount and type of vegetation, density of development
- Existence of flood control features (levees and flood control channels)
- Velocity of flow

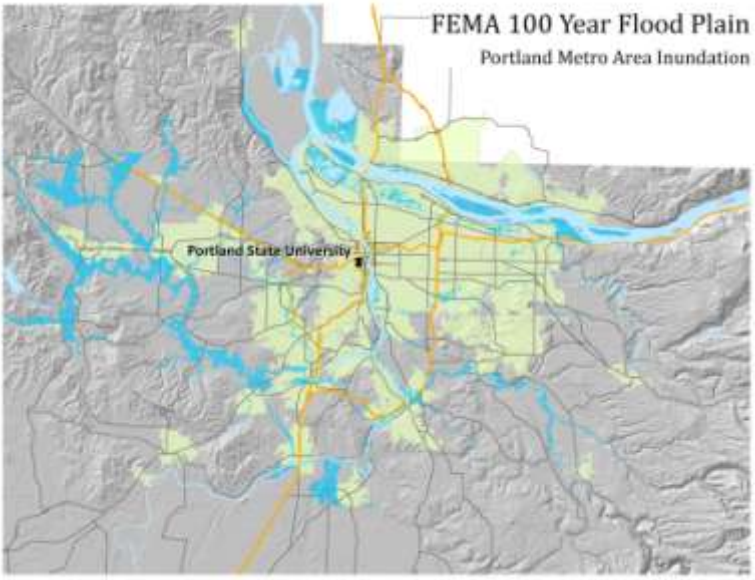
Impacts

- Structure flood inundation – water damage to structural element and contents
- Erosion or scouring of land – roadway embankments, stream banks, building foundations
- Damage to structures, roads, bridges, culverts
- Hazardous or toxic materials release as wastewater treatment plants or sewage lagoons inundated; storage tanks and pipelines damaged

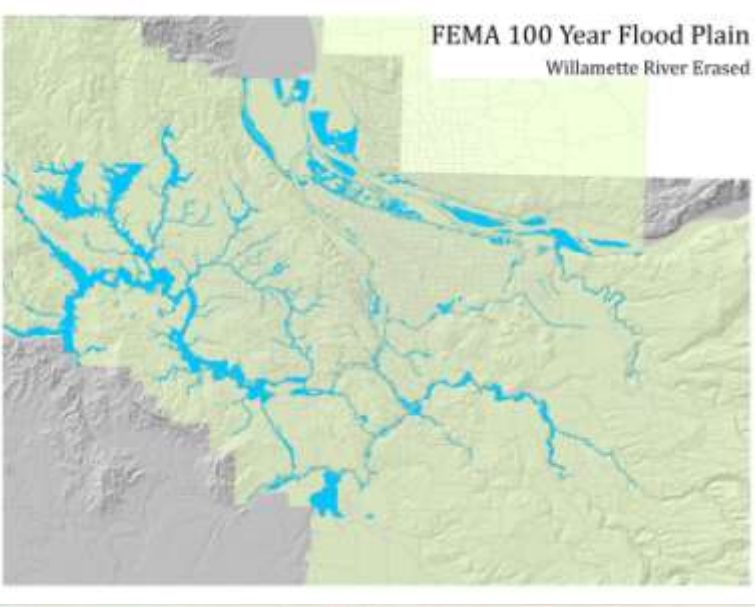
Flooding in the Portland Area



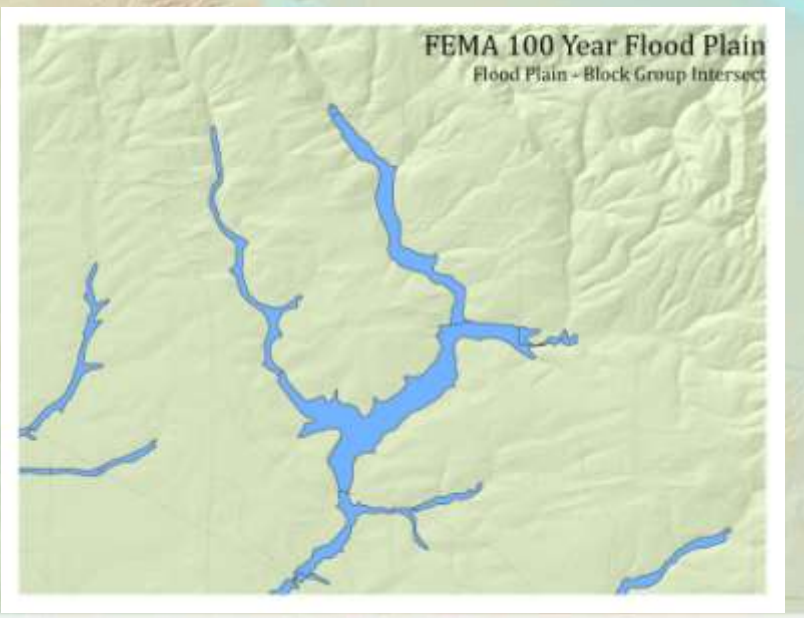
FEMA 100 Year Flood Plain



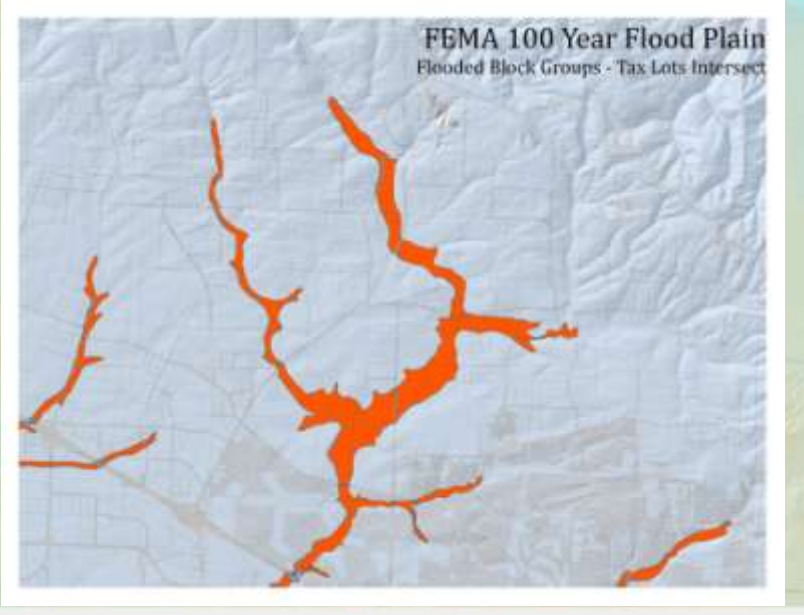
River Fill Erased from Flood Plain



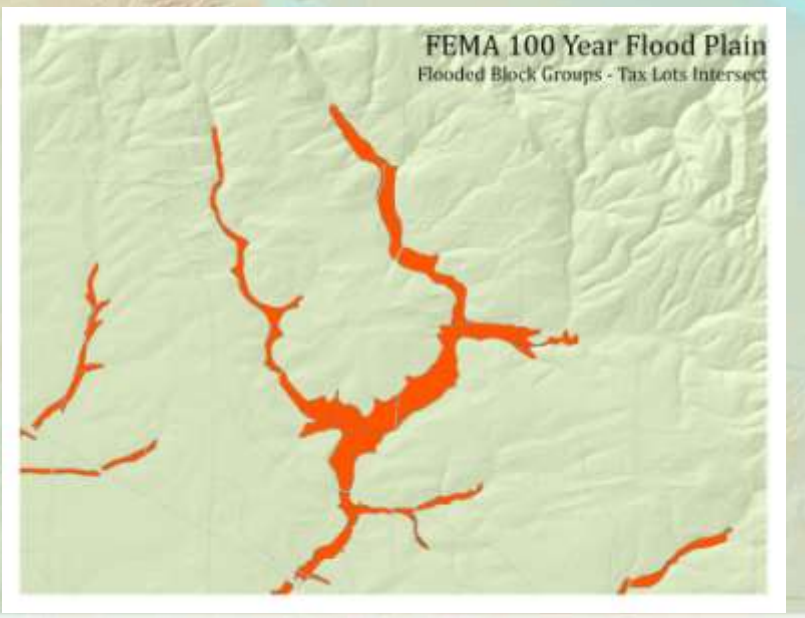
Flooded Area Intersected with Block Groups



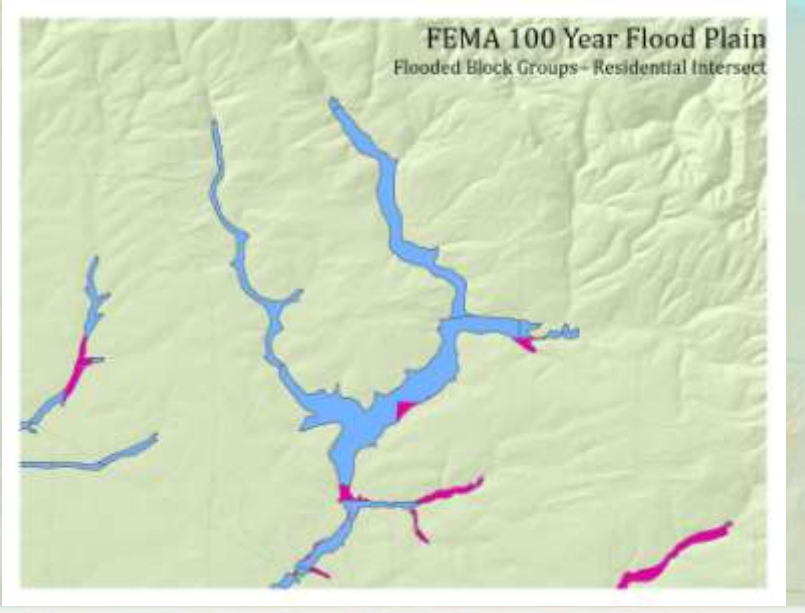
Flooded Block Groups Intersected with Taxlots



Flooded Block Groups Intersected with Taxlots



Flooded Block Groups Intersected with Dissolved Residential Zones

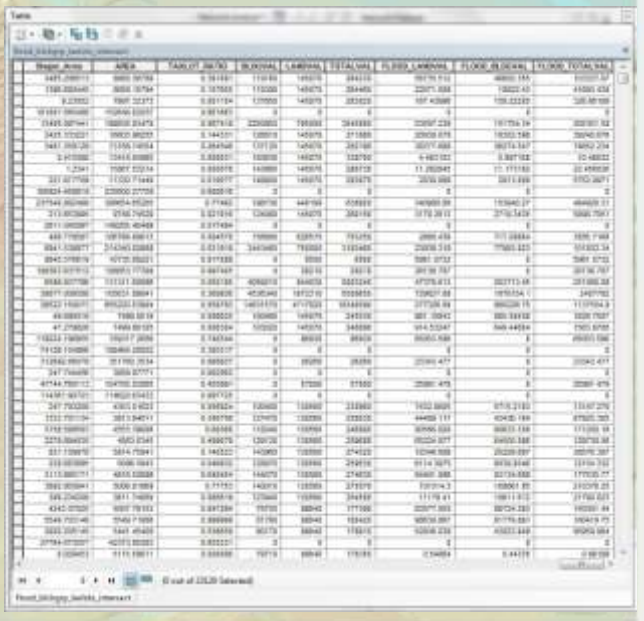


Calculating Indicators for Flooded Area in each Block Group

Needed to calculate the tax lot values that are covered by the flooded area.

- Calculated a % of area of each taxlot that is covered by the flood plain

- Multiplied BLDGVAL, LANDVAL, and TOTALVAL by the % to find the estimated value of the tax lot that is covered by the flood plain

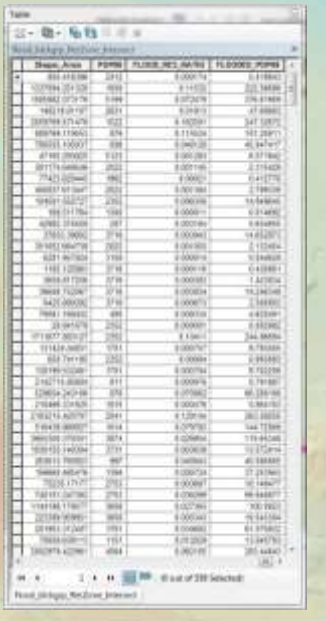


Calculating Indicators for Flooded Area in each Block Group

Needed to calculate the area of residential zones that are covered by the flood plain

- Calculated a % of area that is Residential inside the Flood Plain

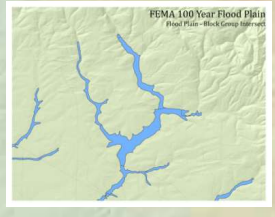
- Multiplied the POP08 for each block group by the area % to find that average population affected by the flooded area in each block group.

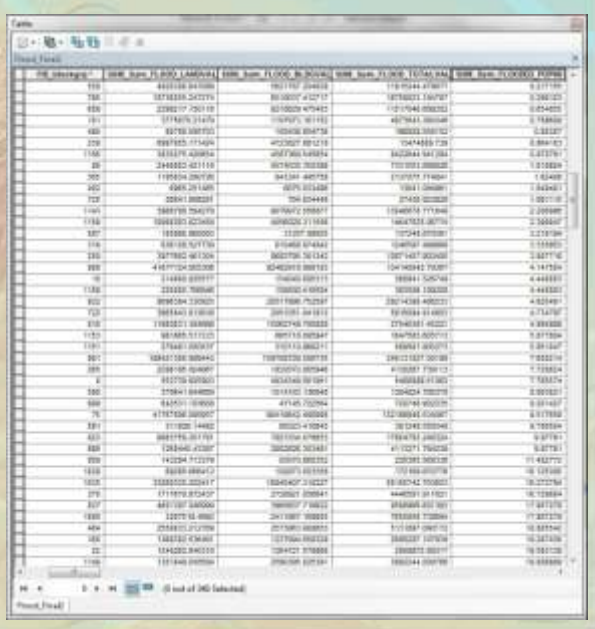


Calculating Indicators for Flooded Area in each Block Group

Spatial Join with SUM Attributes to the Intersected Flood Area Block Groups

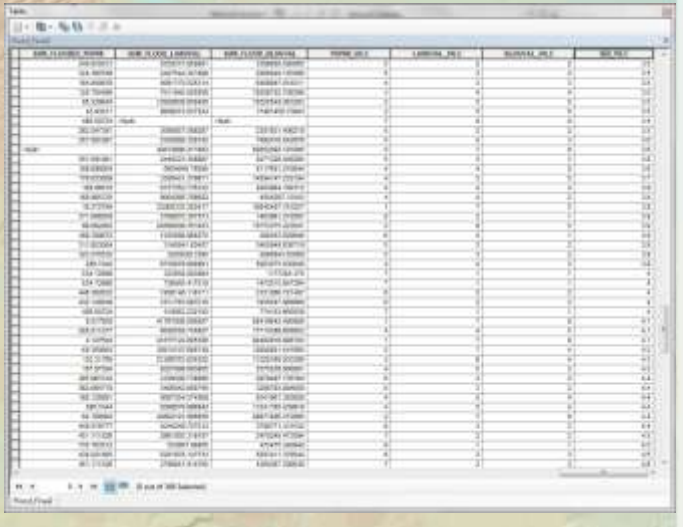
Needed all the indicators in one table to calculate our SEII scores.





Reclassifying Indicators into a Single Scale

Normalized our SEII indicators into 10 classes to calculate the Weighted Linear Combination.

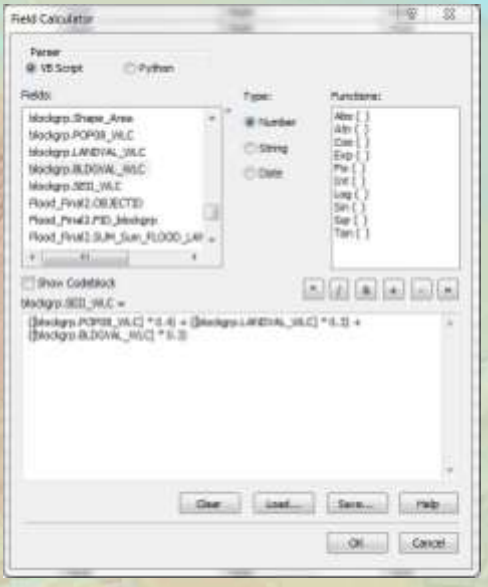


Calculating for the SEII

Calculated the WLC with Weights for our final Socio-Economic Impact Index

Could now symbolize the Flooded Block Group areas by the SEII

Joined back to Block Groups for symbolization

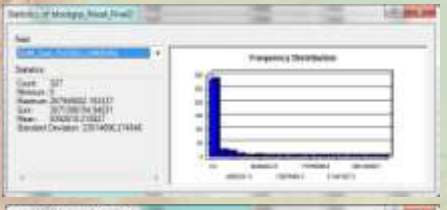


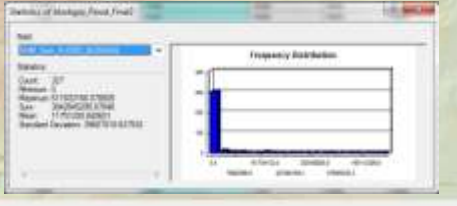
Total Potential Impacts on the Flooded Areas

Population : 86,901

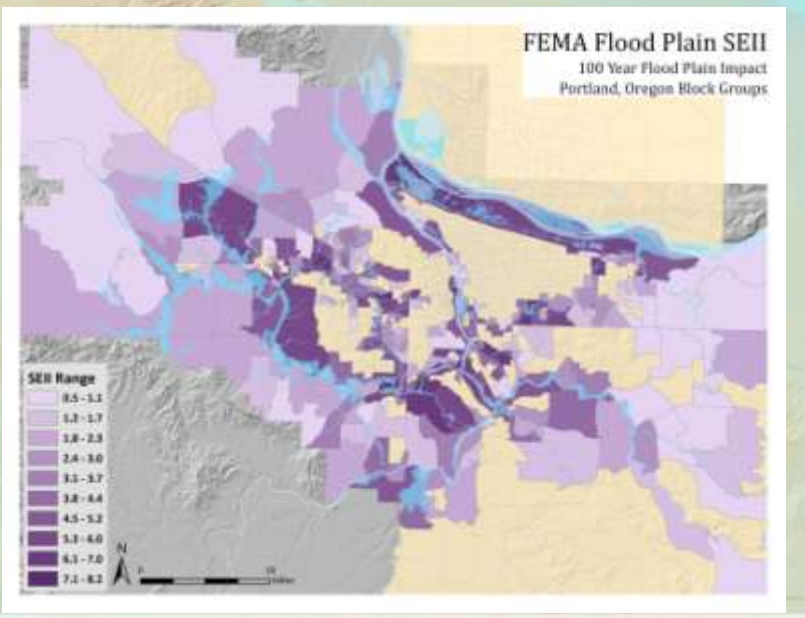
Land Value: 3,071,386,155

Building Value: 3,842,645,290





SEII: 10 Classes

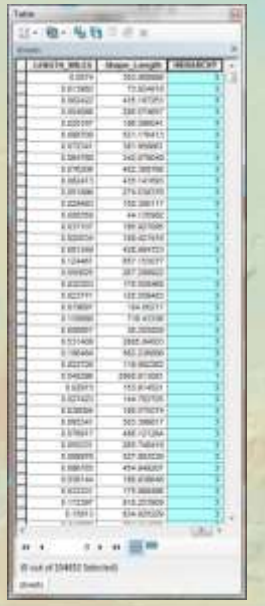


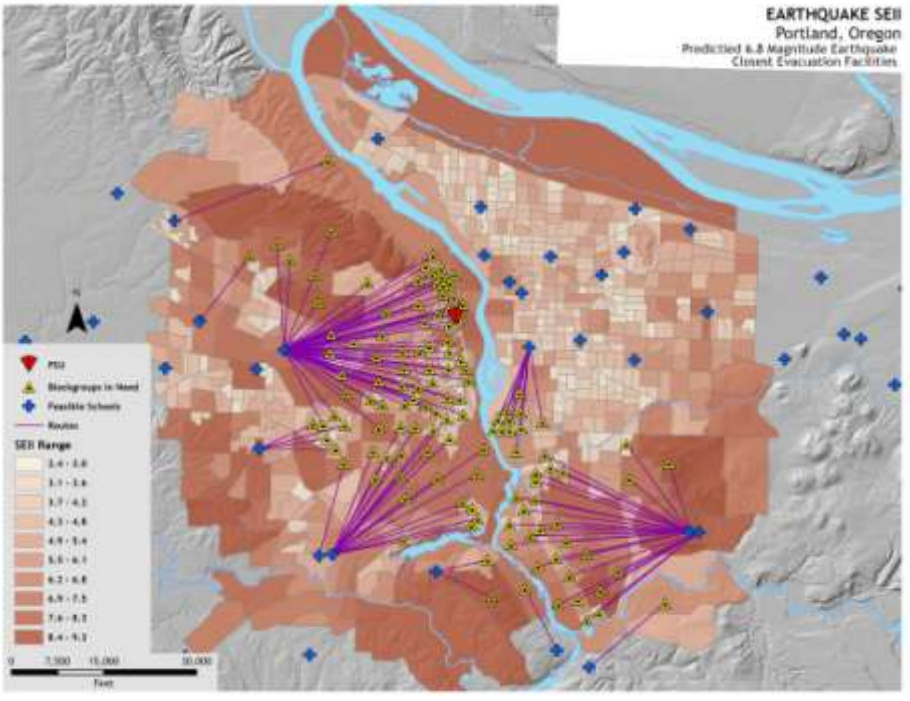
Flooding Event Analysis Considerations

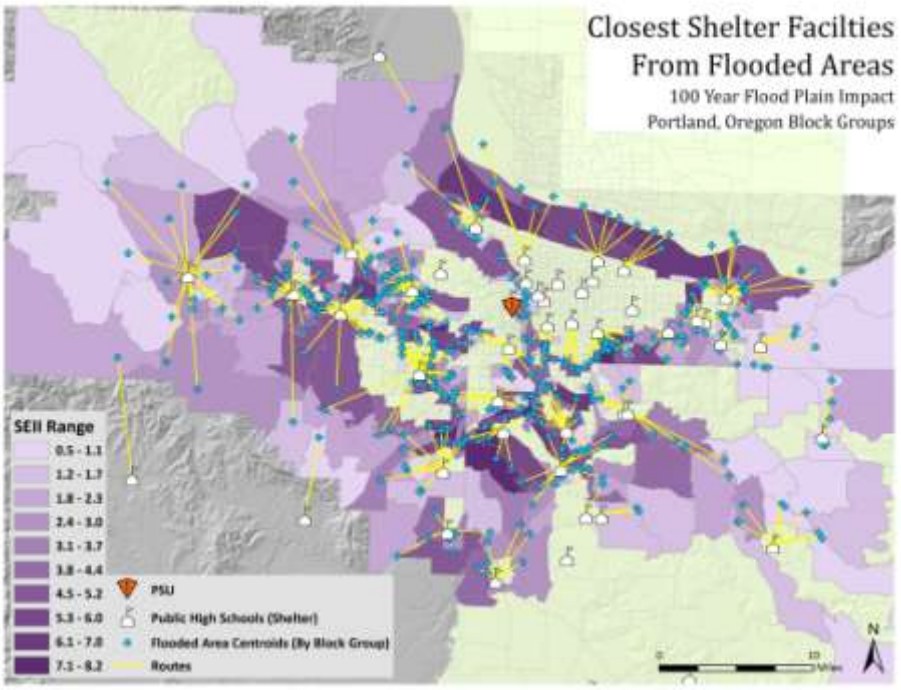
- The total values for affected population are estimated potential impacts; we cannot determine, for sure, the distribution of populations in each block group
- The affected population may be more than just the flood coverage area, anyone within a certain distance of the floods reach may also be impacted
- Taxlot Land and Building values are potential estimates; we don't know whether the whole taxlot will be affected when only a portion of it is covered by the flood plain (it likely would be)
- The Potential Impact Totals are for the value of the Land and Building affected, not the cost of repairs

Locating Possible Facilities for Displaced Populations

- Selected Public High Schools as possible shelter locations
- Located Centroids for Block Groups needing evacuation
- Calculated a distance in miles and hierarchy for the Portland streets data set
- Built a Network file using the streets file as the source
- Calculated the closest facilities (schools) for all indices (evacuated block groups)







Conclusions and Further Analysis

- Indicator values and coverage areas are estimates of potential hazard events.
- Socio-Economic Impact Index is subjective to the indicators used in the WLC and the weights that are applied.
- Expert knowledge would aid in determining other possible indicators to be included and their relative socio-economic impact.
- The natural hazard data is not completely representative of what will actually happen in an event since they are predictions.
- Would like to explore more indicators that could aid in refining the accuracy of the WLC.
- Examine the potential that our models could be applied to other areas besides Portland.

More Information on Portland Natural Hazards

- Visit the Portland Office of Emergency Planning for helpful info:
  - Portland-specific information on natural hazards including earthquakes, flooding, severe weather, landslides, erosion, wildland urban fire, volcanic activity, invasive plant species
  - Education on what to do in case of these possible events
  - Having an emergency plan and making an emergency kit
  - http://www.portlandonline.com/oem/

Sources

- RLIS February 2011 ESRI data
- URS Greiner Woodward-Clyde Federal Services in conjunction with the Oregon Department of Geology and Mineral Industries
- Portland Office of Emergency Planning, http://www.portlandonline.com/oem/