

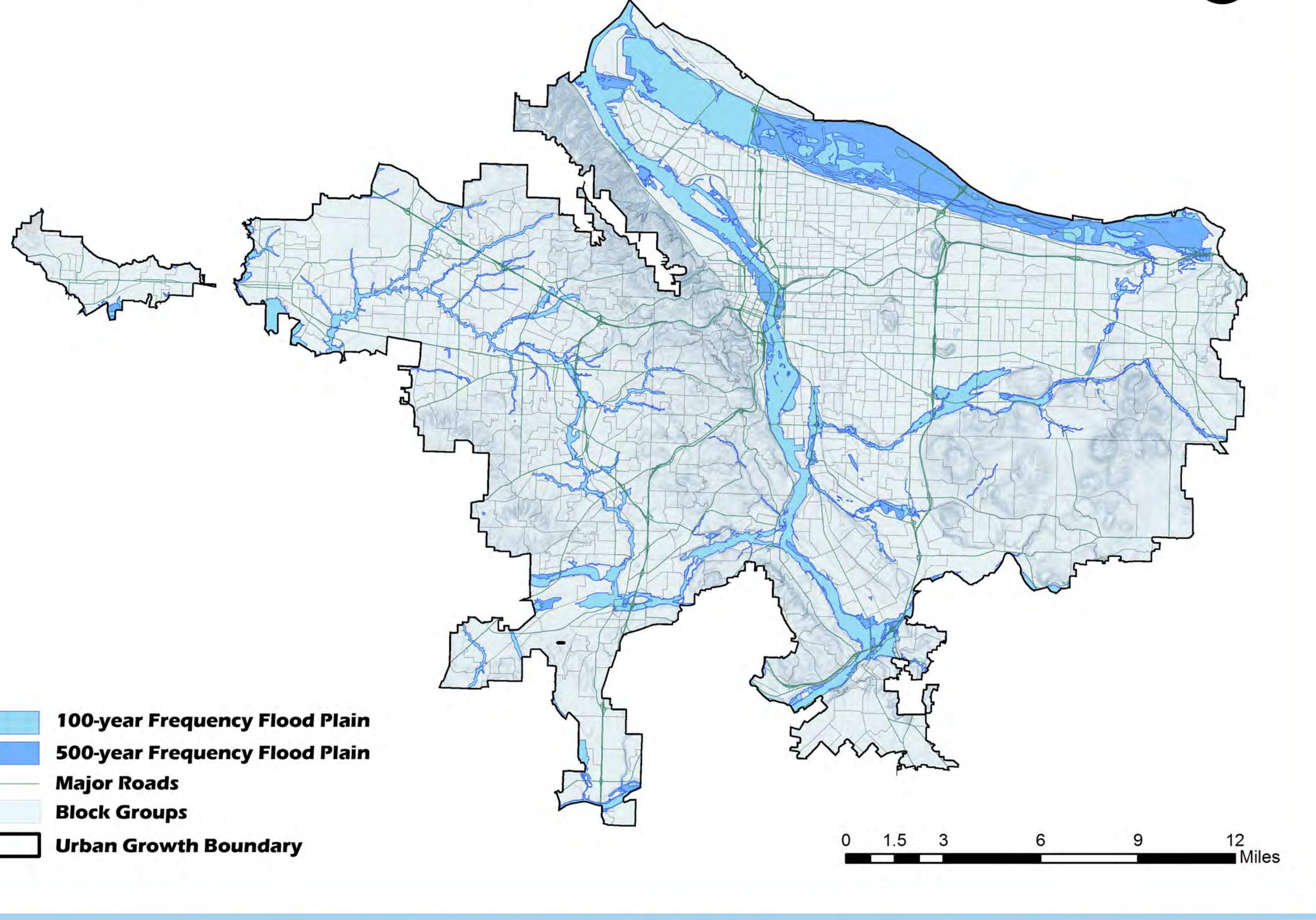
GIS SPATIAL ANALYSIS

CLIMATE CHANGE VULNERABILITY

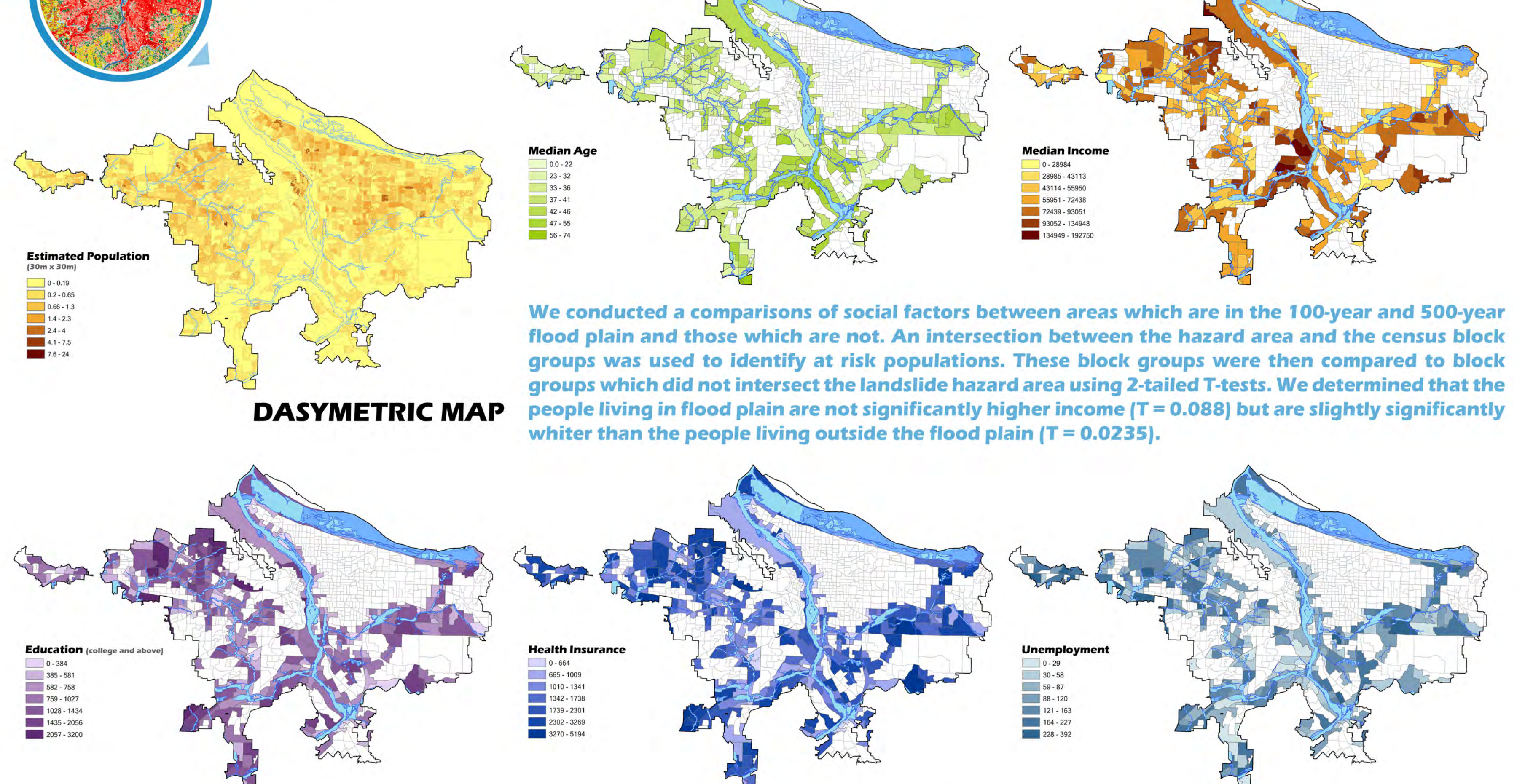
Natural disasters such as floods and landslides are expected to occur more often and with greater severity as a result of climate change. These events are unevenly geographically distributed, landslides primarily on steep slopes and floods near water bodies. This distribution may result in more vulnerability for some segments of society. Urban vulnerability in the context of climate change is critical because certain populations may have less capacity to prepare for, respond to, and recover from disasters. Under the assumption that such populations may be disproportionately affected by climate change, this research focuses on analyzing the relationship between geographic location of hazard areas and various social determinants of vulnerability such as income, age, race, education, employment, and health insurance coverage.

FLOOD

The Portland Metropolitan Area



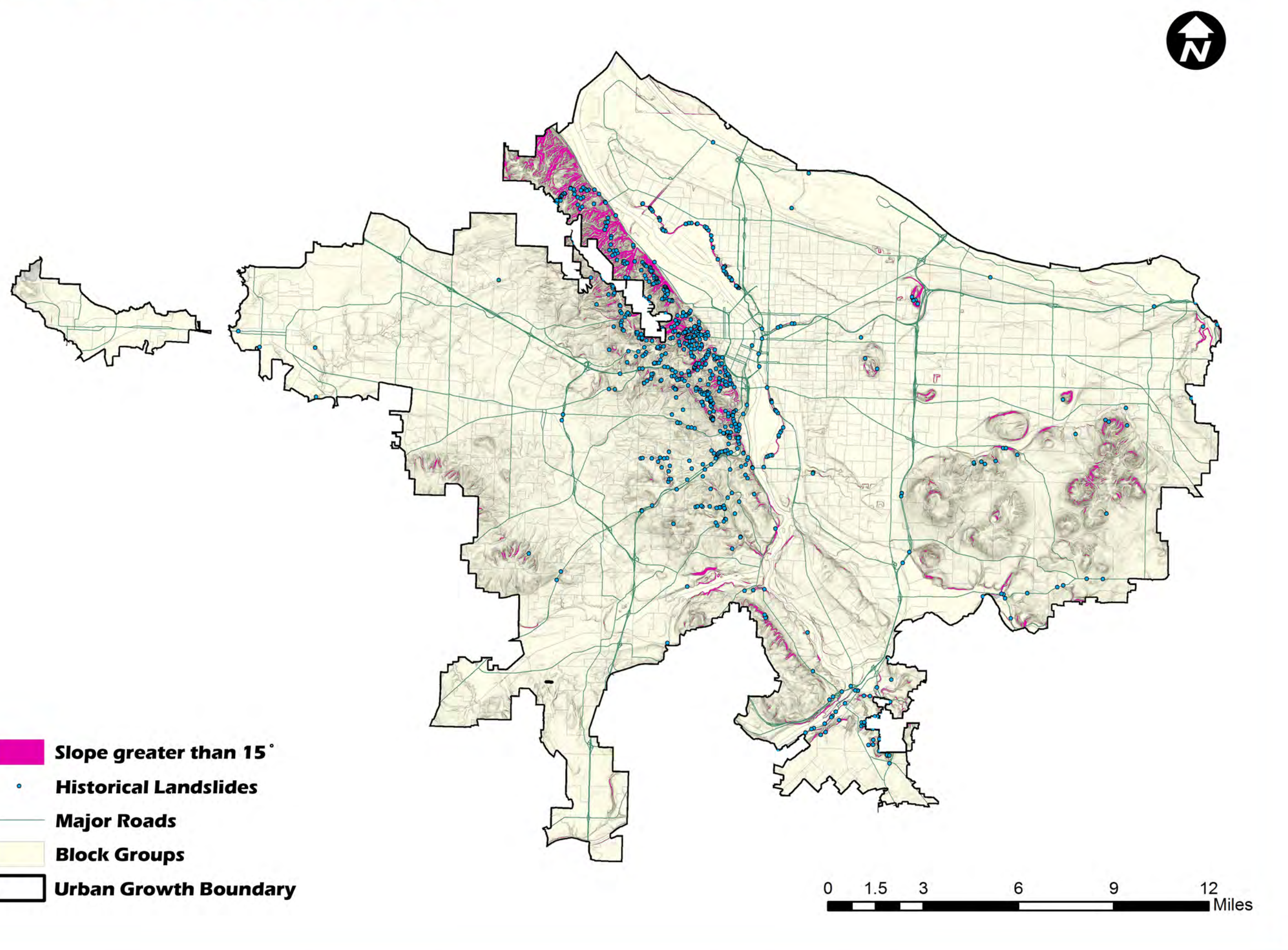
LAND USE



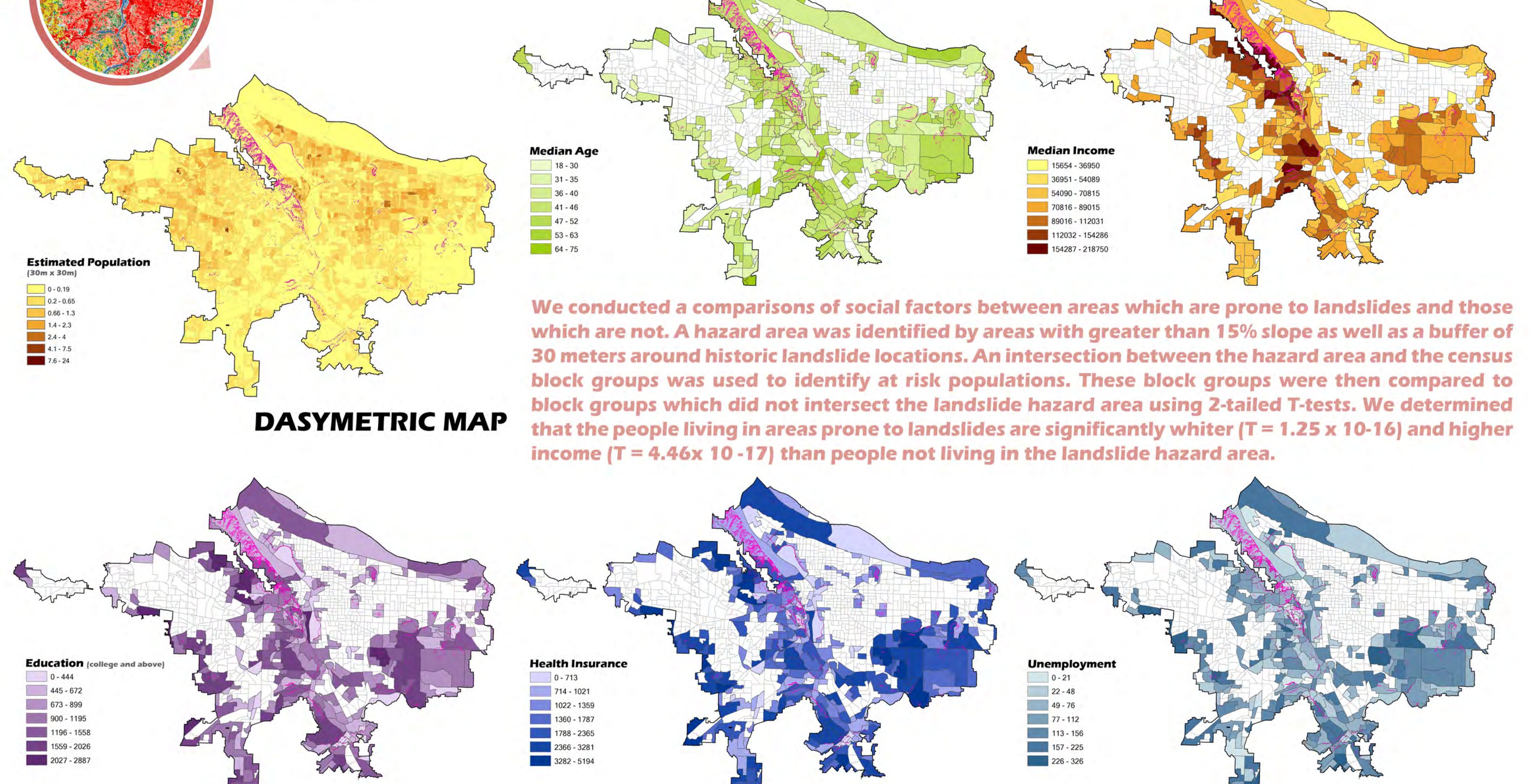
We conducted a comparisons of social factors between areas which are in the 100-year and 500-year flood plain and those which are not. An intersection between the hazard area and the census block groups was used to identify at risk populations. These block groups were then compared to block groups which did not intersect the landslide hazard area using 2-tailed T-tests. We determined that the people living in flood plain are not significantly higher income ($T = 0.088$) but are slightly significantly whiter than the people living outside the flood plain ($T = 0.0235$).

The target area of this research is the Portland Metropolitan region; highly urbanized areas near the Willamette River, and its tributaries. 100-year and 500-year frequency flood plain (the area that could experience a flood having a 1% and 0.2% probability of occurring in any given year) data is used in this research because there can always be unusual climate change circumstances that may occur to cause localized flooding of any property even though the probability of such occurrences is generally low. The global surface temperatures have risen by almost a degree in the last century, and the rainfall discharge also has rapidly increased due to global climate change. These recent abnormal weather events are rapidly changing urban environment and such natural disasters not only degrade the quality of urban life, but also threaten human lives in some extreme cases.

LANDSLIDE



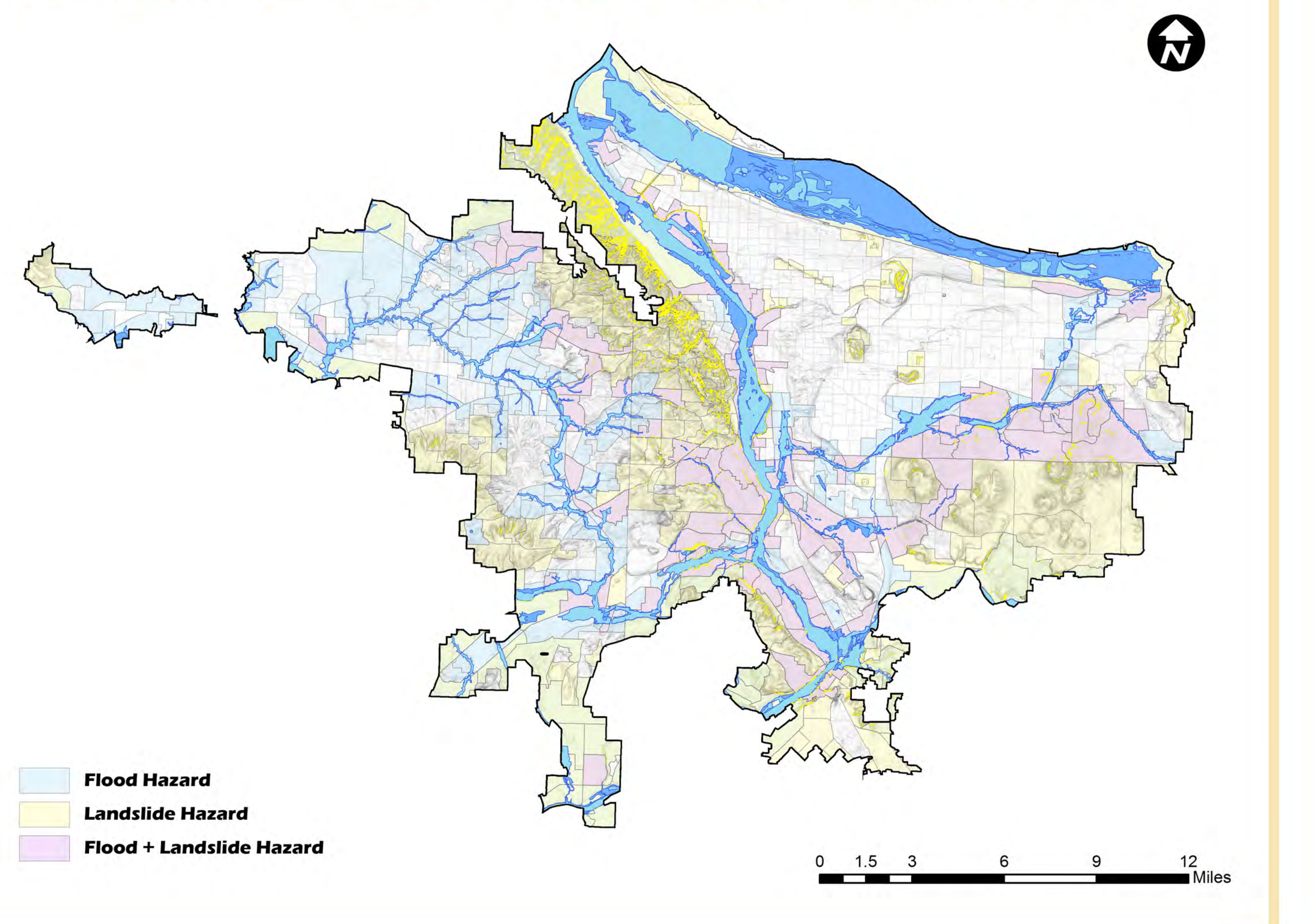
LAND USE



We conducted a comparisons of social factors between areas which are prone to landslides and those which are not. A hazard area was identified by areas with greater than 15% slope as well as a buffer of 30 meters around historic landslide locations. An intersection between the hazard area and the census block groups was used to identify at risk populations. These block groups were then compared to block groups which did not intersect the landslide hazard area using 2-tailed T-tests. We determined that the people living in areas prone to landslides are significantly whiter ($T = 1.25 \times 10^{-16}$) and higher income ($T = 4.46 \times 10^{-17}$) than people not living in the landslide hazard area.

Landslides encompass a wide range of ground movements ranging from slow moving slumps to sudden rock falls. Numerous factors can contribute to the occurrence of a landslide including: slope, rock or soil type, groundwater pressure, loss of stabilizing vegetation, erosion, and earthquakes. Especially groundwater pressure and vegetation loss may be exacerbated by climate change leading to more landslides in at risk areas. Although many variables can be used to predict landslide hazard areas, the primary risk factors are steep slopes and the previous occurrence of landslides.

CLIMATE CHANGE HAZARDS



STATISTICAL ANALYSIS

CENSUS (Block Groups)		Population: Non-white		Population: Non-white	
Portland Metropolitan:		Flood area average: 17.8%	Landslide prone area average: 16.3%	Flood area average: 17.8%	Landslide prone area average: 16.3%
White	1,233,977 (100%)	Non-flood area average: 19.9%	Non-landslide prone area average: 22.5%	Non-flood area average: 19.9%	Non-landslide prone area average: 22.5%
Non-white	316,488 (100%)	2-tail T-test: 0.0235 (2.35%)	2 tail T-test: 1.25×10^{-16}	2-tail T-test: 0.0235 (2.35%)	2 tail T-test: 1.25×10^{-16}
Flood:		Income		Income	
White	490,345 (39.74%)	Flood area average: \$60130	Landslide prone area average: \$76,477	Flood area average: \$60130	Landslide prone area average: \$76,477
Non-white	120,592 (38.10%)	Non-flood area average: \$63460	Non-landslide prone area average: \$57,656	Non-flood area average: \$63460	Non-landslide prone area average: \$57,656
Landslide:		2-tail T-test: 0.0883 (8.83%)	2 tail T-test: 4.46×10^{-17}	2-tail T-test: 0.0883 (8.83%)	2 tail T-test: 4.46×10^{-17}
White	435,878 (35.32%)	Health Insurance		Health Insurance	
Non-white	316,488 (26.79%)	Flood area average: 84.6%	Landslide prone area average: 88.7%	Flood area average: 84.6%	Landslide prone area average: 88.7%
DASYMETRIC MAPPING		Non-flood area average: 85.5%	Non-landslide prone area average: 84.1%	Non-flood area average: 85.5%	Non-landslide prone area average: 84.1%
Portland Metropolitan:		2-tail T-test: 0.222 (22.2%)	2 tail T-test: 1.976×10^{-13}	2-tail T-test: 0.222 (22.2%)	2 tail T-test: 1.976×10^{-13}
White	1,222,046 (100%)	Unemployment		Unemployment	
Non-white	315,435 (100%)	Flood area average: 10.6%	Landslide prone area average: 9.3%	Flood area average: 10.6%	Landslide prone area average: 9.3%
Flood:		Non-flood area average: 10.1%	Non-landslide prone area average: 10.4%	Non-flood area average: 10.1%	Non-landslide prone area average: 10.4%
White	53,245 (4.36%)	2-tail T-test: 0.391 (39.1%)	2 tail T-test: 2.00×10^{-8}	2-tail T-test: 0.391 (39.1%)	2 tail T-test: 2.00×10^{-8}
Non-white	13,118 (1.07%)				
Landslide:					
White	7,317 (0.06%)				
Non-white	1,237 (0.10%)				

SOURCE:
 Oregon Geospatial Data Library (www.oregon.gov/DAS/CIO/GEO)
 100-Frequency Flood Plain / 500-year Frequency Flood Plain
 Portland State University RLS
 Urban Growth Boundary / Rivers and Streams / Arterial roads / DEM
 NHGIS Data (www.nhgis.org)
 Block Group
 Census Data: Population / Median Age / Median Income / Education / Health Insurance / Unemployment (2009-2013)
 Multi-Resolution Land Characteristics Consortium MRLC (www.mrlc.gov)
 National Land Cover Database (2011)
 Statewide Landslide Information Database for Oregon SLIDO (www.oregongeology.org/sub/slido/data.htm)
 Historical Landslide Data

