CHANGE IN POPULATION DENSITY & DISTRIBUTION IN BEND, OREGON

Dasymetric Mapping, 1990-2000

Bend, Oregon

- Largest city in Oregon east of the Cascade Mountains
- Seventh largest city in Oregon
- Population jump between 1990 & 2000: 20,469 to 52,800 (some of this due to growth, some to expansion of UGB)
- 2009 estimated population: 82,280
- Bend proper covers approximately 32 square miles
- Many jobs tied to real estate and construction since the population boom that took shape in the 1990s – much of which has now dried up
- (Source: City of Bend Website)

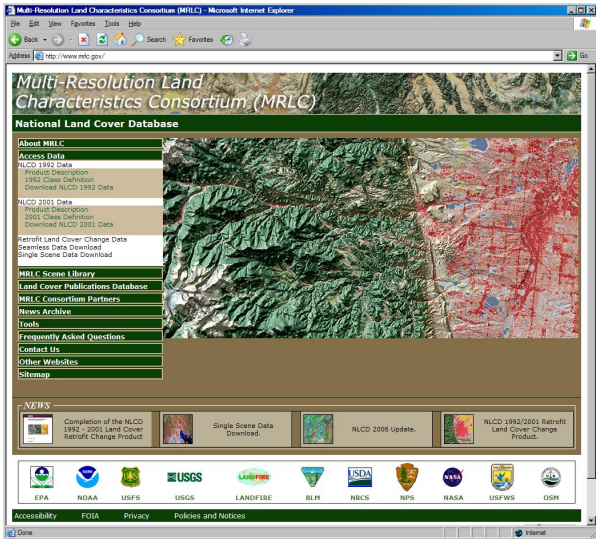
Dasymetric Mapping Review

- A method for disaggregating aggregate data
- Not 100% reliable, but provides a general idea of population concentrations within polygons that show aggregate data
- Uses land cover information to open possibilities of how population is structured within polygons
- Uses mapping units (raster pixels) to represent data in enumeration units (polygons)
- (Source: Readings, lectures)

Dasymetric Mapping of Bend Population Density Change, 1990-2000

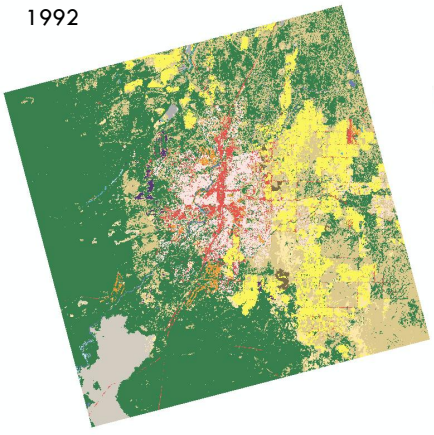
- Data collection
  - Land Cover Data
    - Multi-Resolution Land Characteristics Consortium (MRLC), part of USGS
    - Same land cover data used in Lab 4
  - Census Data
    - Oregon Geospatial Data Library
    - Whole feature classes for 2000
    - Whole feature classes for 1990, via 1995 shapefiles

Land Cover Data

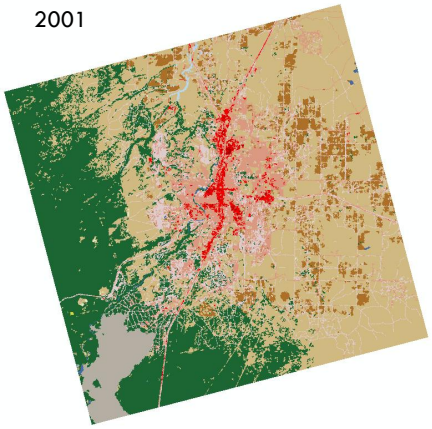


Landcover Rasters from MRLC

1992



2001



What do you notice right away?

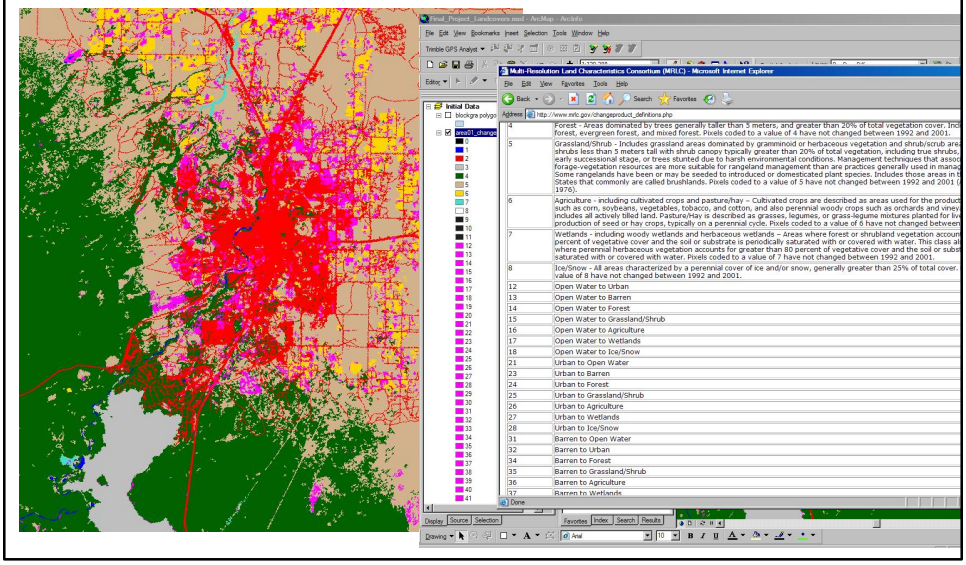
Raster Differences

- **Should I directly compare land cover from NLCD 92 with land cover from NLCD 2001?**

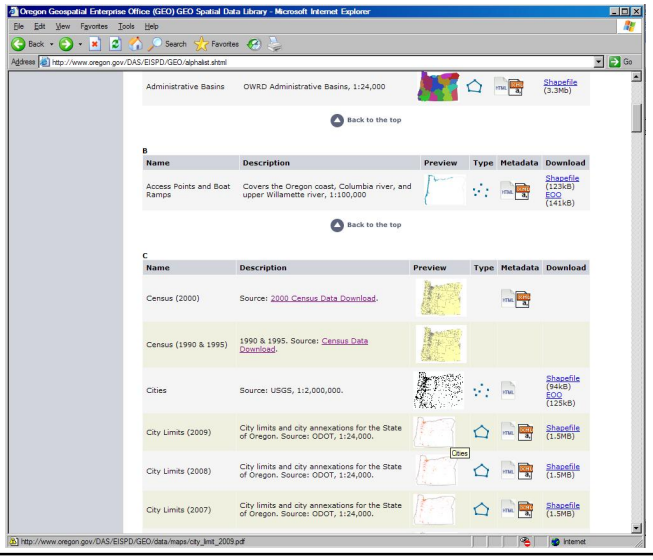
  Direct comparison is not recommended. Each dataset was mapped with different methods and slightly different classes. While the two NLCD products are designed to be similar, the slight differences in classification, combined with the final accuracy of the mapping (from 70-80%), result in two distinct products. The typical result of direct comparison will result in a change map showing differences between mapping methods rather than real change on the ground. The NLCD mapping team has completed a product that highlights areas of potential change between the two eras of land cover using the original TM imagery. This product is available for download at the MRLC web site. Access the Retrofit Land Cover Change Data product.

- From: http://www.mrlc.gov/faq.php

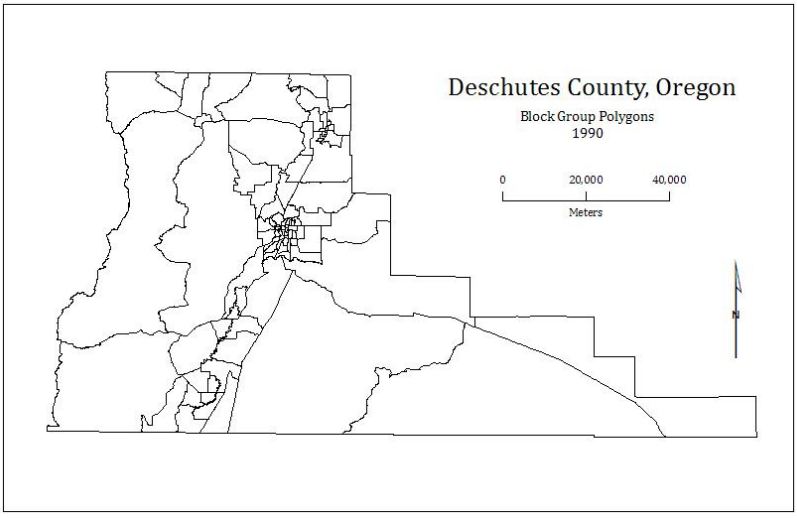
Retrofit Land Cover Change Data product



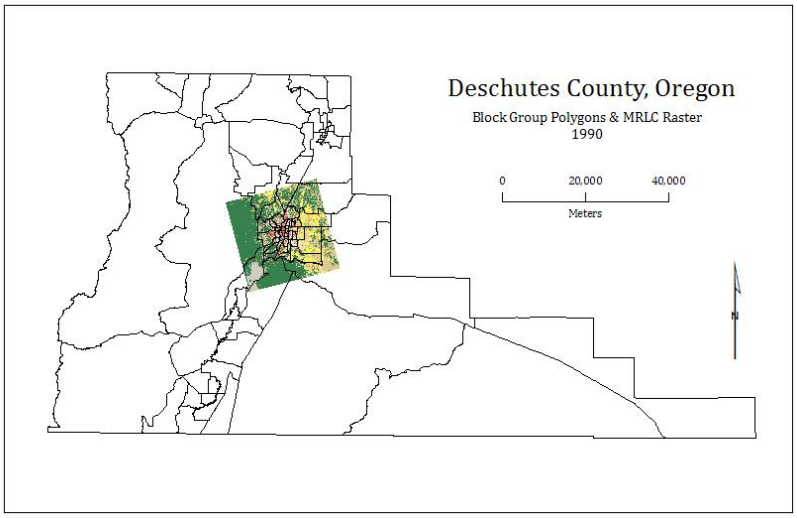
Census Data



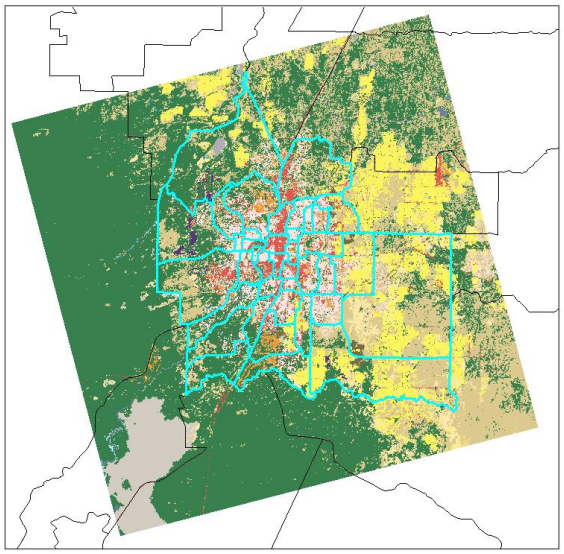
Deschutes County Block Groups, 1990



Choosing Block Groups for Study

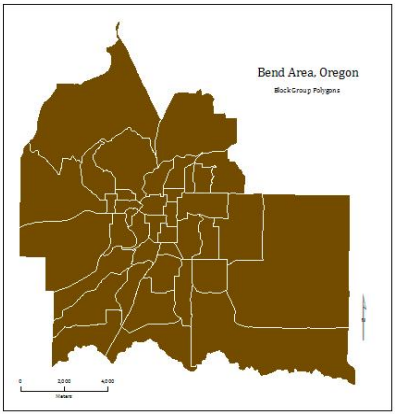


Choosing Block Groups for Study

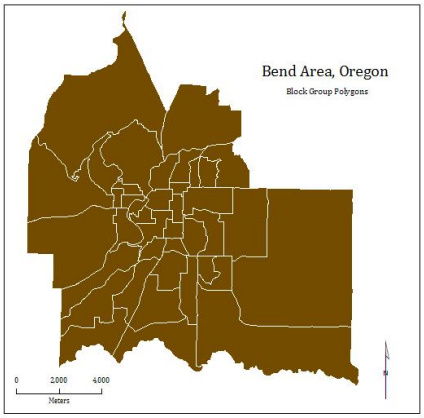


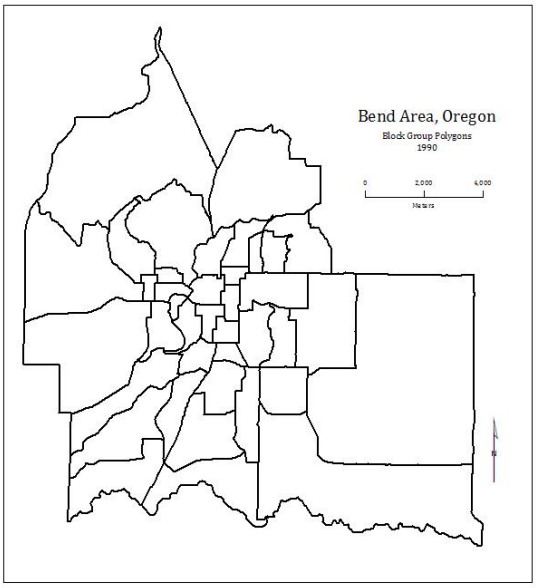
Creating a new layer for the Bend area

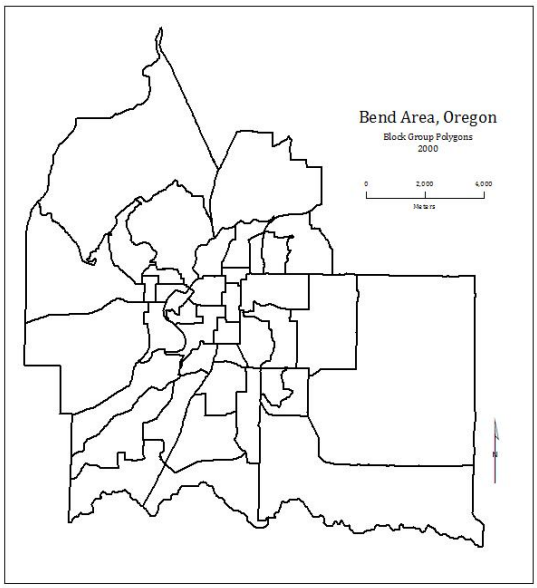
1990



2000

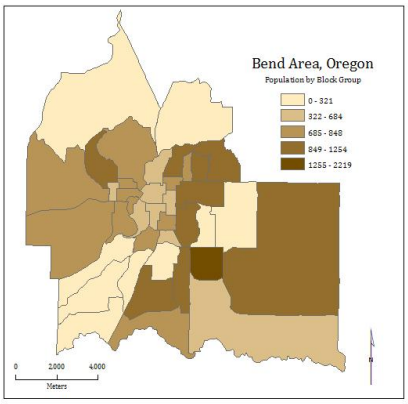




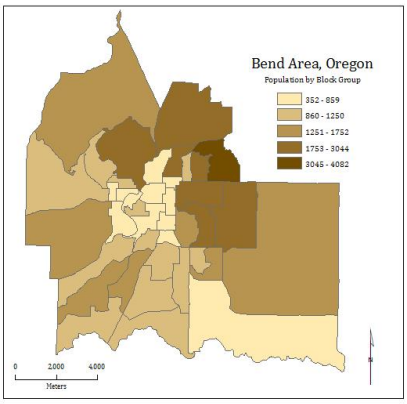


Population (Choropleth by Block Group)

1990

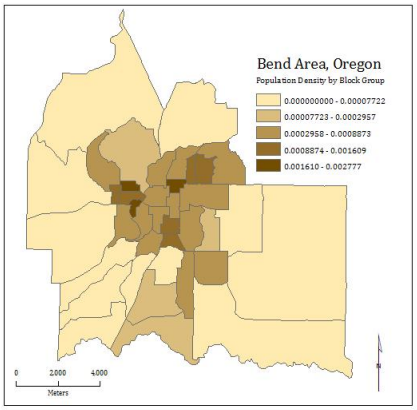


2000

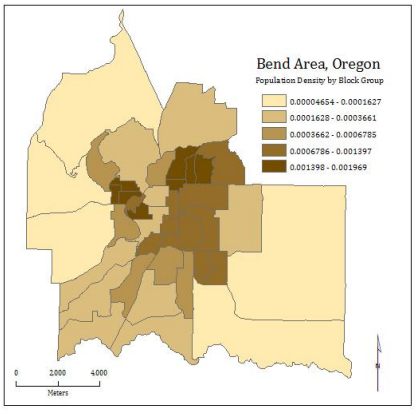


Population Density (Choropleth by Block Group)

1990



2000

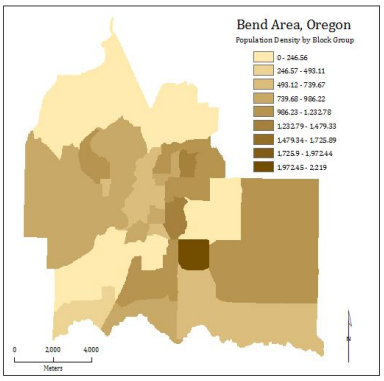


Calculation of Population per Landcover Raster Cell

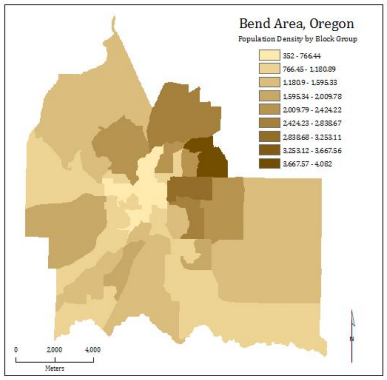
- Directly from Lab 4:
  - $P = \{[R_A*(P_A/P_A)]*N/E\}/A_T$
    - P = population of cell
    - R_A = relative density of the cell with landcover type A
    - P_A = proportion of cells of landcover type A in enumeration unit
    - N = actual population of enumeration unit
    - E = expected population of enumeration unit calculated using the relative densities
    - A_T = total number of cells in the enumeration unit

Raster Map of actual population of enumeration unit (N)

1990

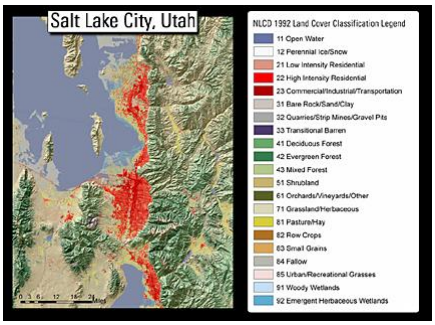


2000

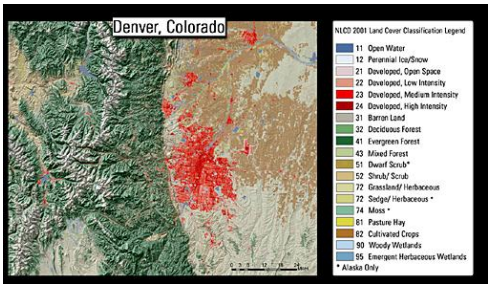


Reclassification of Landcover Rasters (R_A)

1992

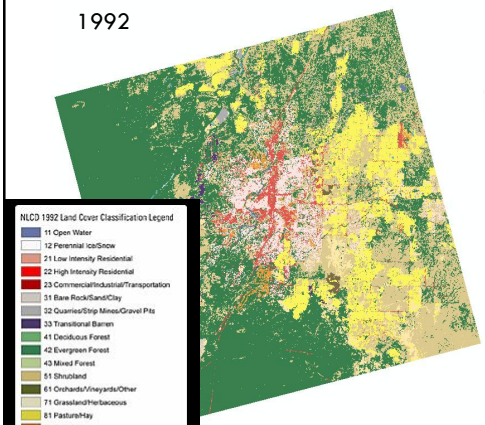


2001

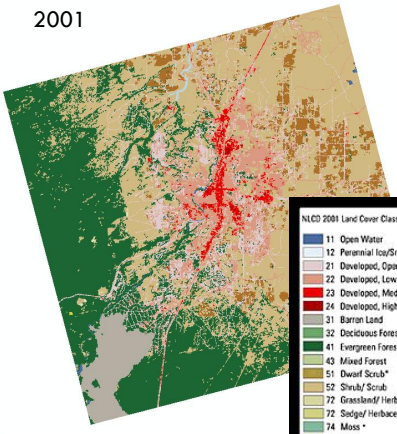


Landcover Rasters from MRLC

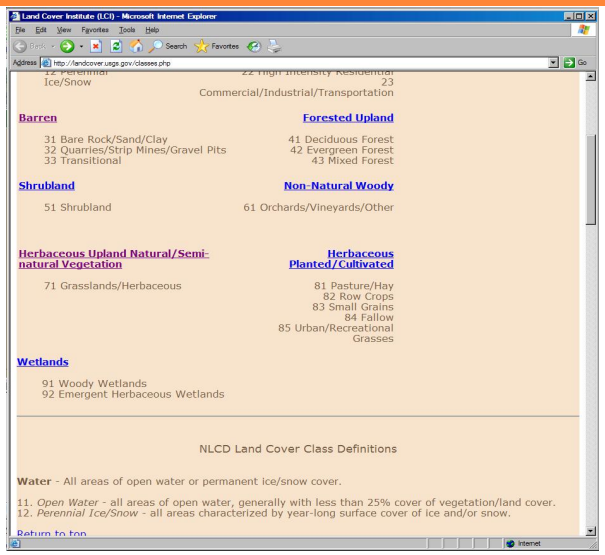
1992



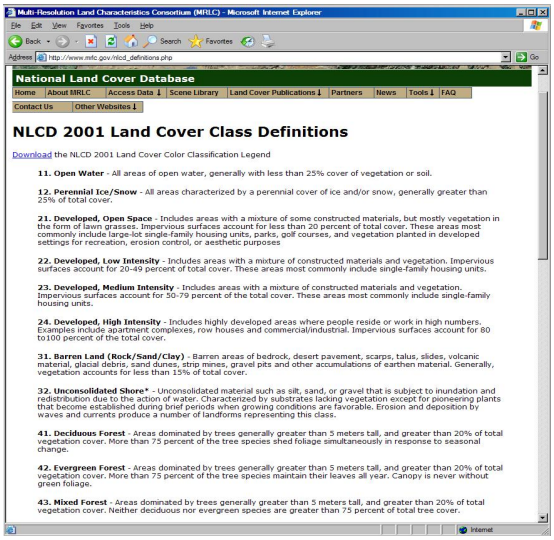
2001



Checking on definitions



Checking on definitions



Initial Reclassification of Landcover Rasters

- Landcover codes first reclassified into 5 classes for clarity and uniformity:
- **1 = Residential** (includes MRLC codes 21 & 22)
- **2 = Commercial/Industrial** (codes 23 & 24)
- **3 = Agricultural** (codes 61, 71, 81, 82, 83, 85)
- **4 = Natural** (codes 41, 42, 43, 51, 51, 72)
- **5 = Water & Other Uninhabited** (codes 11, 12, 31, 32, 33, 90, 91, 92, 95)

Calculating Relative Density (R_A)

Population Density = Population/Area

Total Density = ∑ Densities of all classes

Relative Density (R_A) = Population Density/Total Density

R_A Value for Classification = R_A * 100

1990					
	Residential	Comm./Ind.	Agricultural	Natural	
Population	848	546	846	321	
Area	454463	1035770	4699570	4237830	Total Den.
Density	0.001865938	0.000527144	0.000180016	7.57E-05	0.002649
Rel. Density	0.704434671	0.199008999	0.067960355	0.028596	
R_A Value	**70.44346705**	**19.90089994**	**6.796035545**	**2.859597**	100

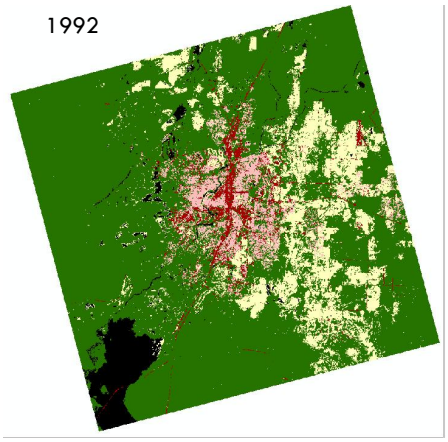
2000					
	Residential	Comm./Ind.	Agricultural	Natural	
Population	670	352	954	1452	
Area	426448	1051290	18072400	30552800	Total Den.
Density	0.001571118	0.000334827	5.27877E-05	4.75243E-05	0.002006
Rel. Density	0.783109128	0.166891299	0.02631153	0.023688042	
R_A Value	**78.31091283**	**16.68912993**	**2.631153043**	**2.368804202**	100

Relative Density Values (R_A)

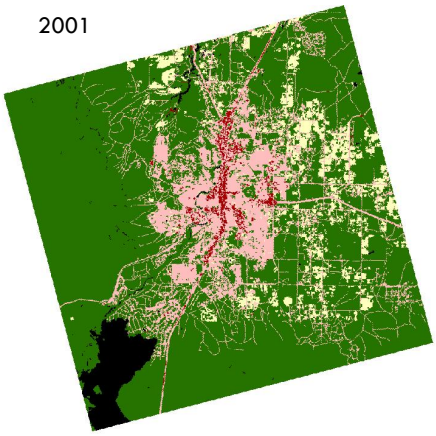
- 1990
  - 1= Residential = 70
  - 2 = Commercial/Industrial = 20
  - 3 = Agricultural = 7
  - 4 = Natural = 3
  - 5 = Water & Other Uninhabited = 0
- 2000
  - 1= Residential = 78
  - 2 = Commercial/Industrial = 17
  - 3 = Agricultural = 3
  - 4 = Natural = 2
  - 5 = Water & Other Uninhabited = 0

Relative Density Output Rasters (R_A)

1992

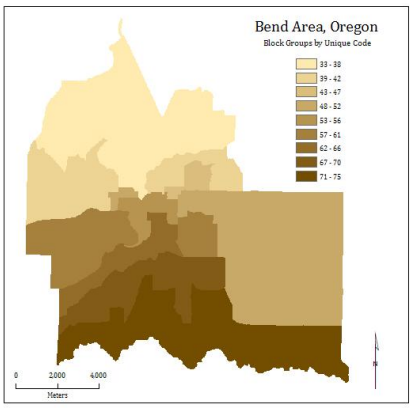


2001

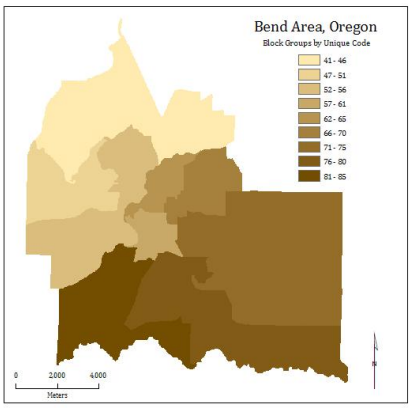


Block Group Raster by Unique Code

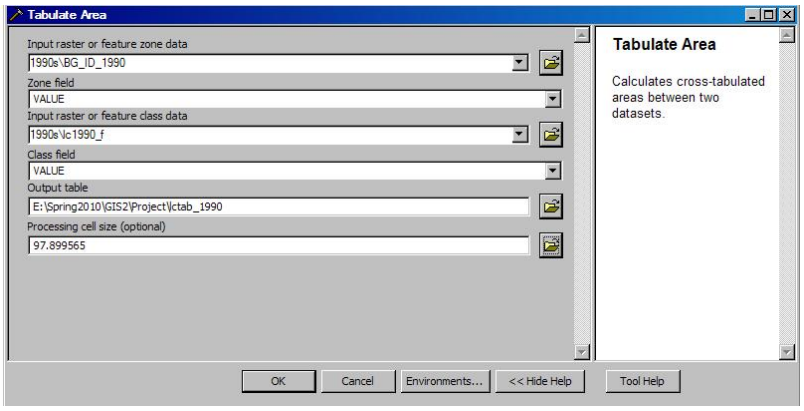
1990



2000

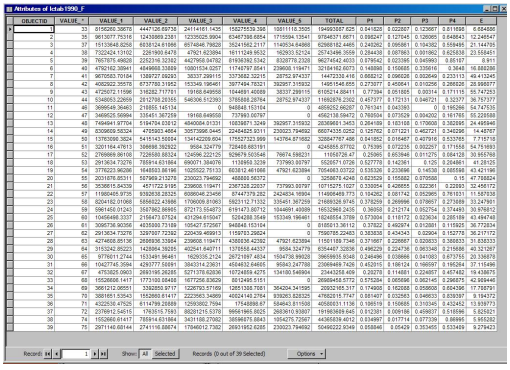


Tabulating Area with Zonal Toolset



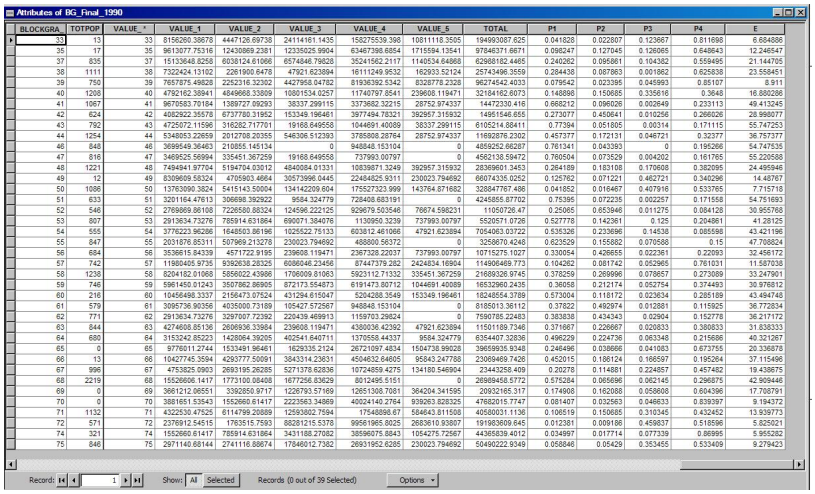
Adding Proportional Data (Using Field Calculator)

- VALUE_1, VALUE_2, etc. = #of cells in each class (VALUE_5 not counted)
- TOTAL = VALUE_1 + VALUE_2 + VALUE_1+ VALUE_2
- P1 = VALUE_1/TOTAL, etc. (proportion of VALUE_1 to total number of cells)
- E = P_1*70 + P_2*20 + P_3*7 + P_4*3 (example is 1990; proportions established by relative density calculation)



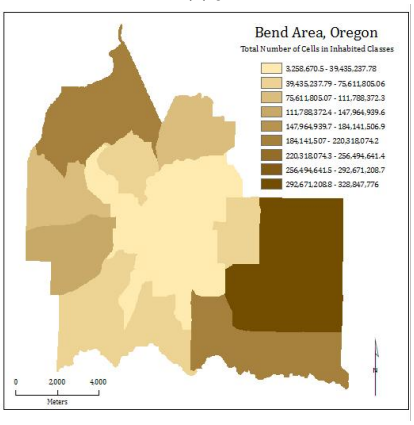
Joining Proportional Data to Population Data

- Simple table join (made not so simple by a simple problem)

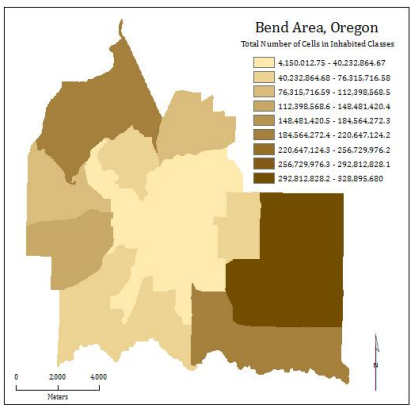


TOTAL Raster Maps

1990

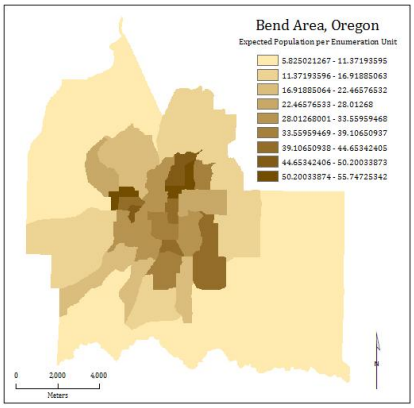


2000

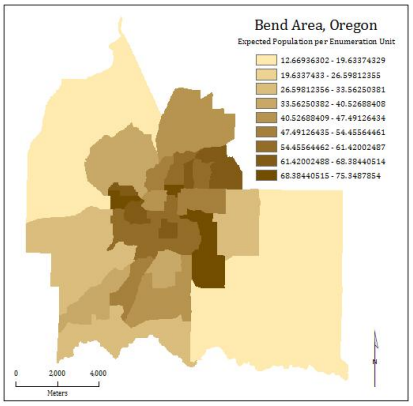


E Raster Maps

1990



2000

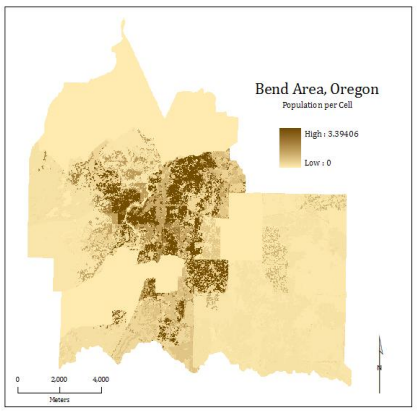


Calculating Population per Cell

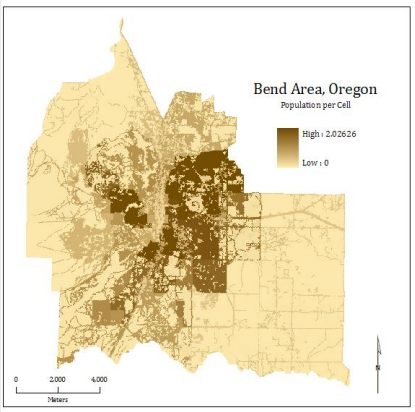
- Using Raster Calculator in Spatial Analyst
- ([Density Raster 1990] * [Population Raster 1990] * CellSize * CellSize) / ([E Raster 1990] * [TOTAL Raster 1990])
- ([Density Raster 2000] * [Population Raster 2000] * CellSize * CellSize) / ([E Raster 2000] * [TOTAL Raster 2000])
- Cell Size = 97.8995648

Final Dasymetric Maps

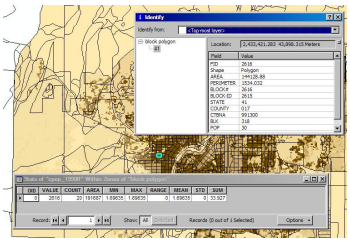
1990

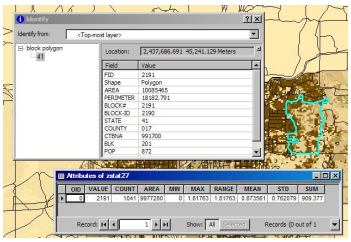


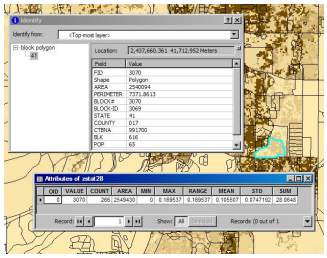
2000



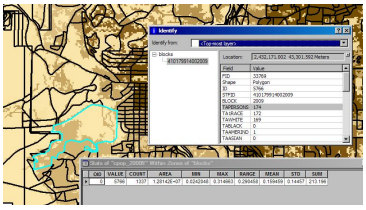
Checking Results, 1990

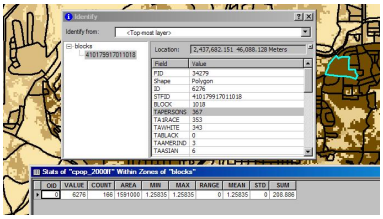


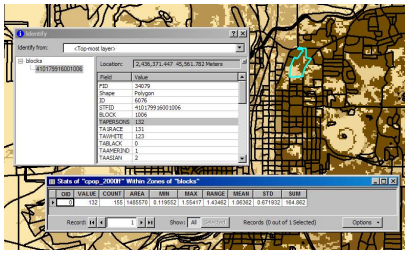




Checking Results, 2000







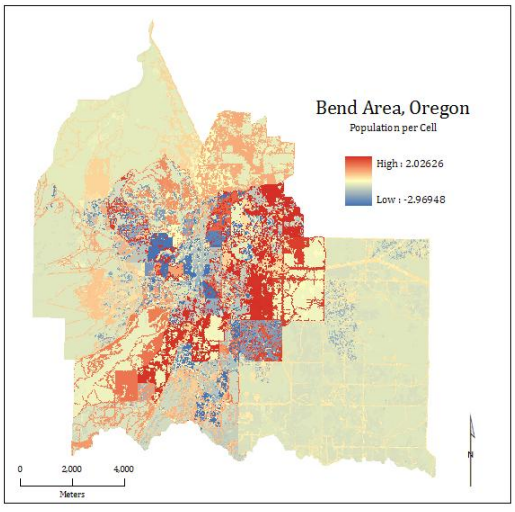
Difference in Population Density

2000 Population Density Raster

Minus

1990 Population Density Raster

Equals:



Conclusions

- Population Changes
  - Density appears to have increased the most in the Northeast and Southwest portions of Bend, though there are increases elsewhere.
  - Neither raster matched terribly well with census block population data, but 1990 was *slightly* better.
- Questions
  - Counterintuitive: Why was density higher in 1990 populated areas?
  - Could reclassification have been done differently to get a better outcome?
  - Why is 1990 more accurate than 2000 when checked?
  - Drop in Relative Density in agricultural and natural areas: is this relative to the increase in density in the city, or has population density dropped there as well?
  - What role does growth vs. expansion of UGB play?

Conclusions

- Shortcomings of Dasymetric Mapping
  - Not to be used for definitive data
  - Only a very general idea of the *possible* distribution and density of population
  - Different densities during different time periods
- Problematic Landcover Rasters
  - Not intended for comparisons
  - Issues with reclassification
  - Disparities in population change raster
  - With comparable rasters, results would give an even better idea of population density and distribution

Conclusions

- Possibility of a better study
  - Rasters with identical classification systems
  - Rasters with consistent land cover classification and from same time of year
  - Using census blocks instead of block groups
  - User gaining experience

Sources

- Websites
  - City of Bend Website: http://www.ci.bend.or.us/
  - GEOG 492/592 Course Website: http://web.pdx.edu/~jduh/courses/geog492s10/index.htm
  - Multi-resolution Landuse Characteristics Consortium Website: http://www.mrlc.gov/
  - Oregon Geospatial Data Library: http://www.oregon.gov/DAS/EISPD/GEO/alphalist.shtml
- People
  - Duh, Geoffrey: GEOG 592 Professor
  - Jones, Nadia: GEOG 592 Lab Instructor

Sources

- Course Materials
  - Course Lecture 4a (April 20, 2010)
  - GEOG 592 Lab 4 instructions
  - Holloway, S. R., Schumacher, J., and Redmond, R. L. 1997. "Dasymetric Mapping Using Arc/Info." *Cartographic Design Using ArcView and ARC/INFO*. High Mountain Press, NM