Dasymetric Mapping Using Arc/Info. Cartographic Design Using ArcView and ARC/INFO.
High Mountain Press, NM.

Data Enumeration Units & Mapping Units

• Aggregate data vs individual data
  – Census population / public use microdata sample (PUMS)
  – Traffic volume / speed

• Enumeration and mapping units
  – EU: the spatial extent in which the data were collected/recorded
  – MU: the spatial extent that shares the same map symbol
Aggregated Data

• Enumeration Units

Mapping Aggregated Data

• Choropleth maps
  – Each spatial unit (polygon) is filled with a uniform color or pattern
  – Enumeration unit of data is the same as mapping unit

• Dasymetric maps
  – Each spatial unit (polygon or grid cell) is filled with a uniform color or pattern
  – Mapping unit is based on sharp changes in the statistical surface of data
  – A technique to spatially disaggregate aggregated data
Mapping Aggregated Data (cont.)

• Isopleth maps
  – No pre-defined mapping unit
  – Data are associated with point locations
  – Represented by lines of equal attribute value (e.g., contours)

Example: Kernel Density Estimate (KDE)

Mapping Aggregated Data (cont.)

• Pycnophylactic Smoothing Technique (Tobler 1979)
  – Pycnophylactic property: summing the variable values for all the mapping units within any enumeration unit produces the same variable figure as that originally assigned to that enumeration unit.
Applications of Dasymetric Mapping

- Changing mapping unit (areal interpolation)

- Disaggregating aggregated information
  - Areal interpolation where mapping unit is a subset of enumeration unit
  - Areal interpolation where ancillary information is used (aka intelligent dasymetric mapping)

Area Interpolation

- Estimate the value of a mapping unit based on the values of associated enumeration units.

Example:
Total population: 100
Total area of enumeration unit: 10
Area of A: 7 (Proportion: 0.7)
Area of B: 3 (Proportion: 0.3)
What are the est. popu. in A and B?

Popu. A = Total Popu x Area Proportion of A
Popu. B = Total Popu x Area Proportion of B
Dasymetric Mapping (pro rata)

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
</table>

Enumeration Units:
A: Total popu: 300
B: Total popu: 100
Proportion of mapping unit in A: 0.3
Proportion of mapping unit in B: 0.3

What's the population in the mapping unit?

300 x 0.3 + 100 x 0.3 = 120

Population and Population Density

- Popu. Density = Popu. / Area
- Popu. = Popu. Density x Area
Dasymetric Mapping with Ancillary Info

Example:
Total population $N$: 100
Total area of enumeration unit: 10 (unit$^2$)
Area of $A_A$: 7 (unit$^2$)
Area of $B_A$: 3 (unit$^2$)
$B$’s population is twice as dense as $A$’s
(i.e., relative density $A : B = 1 : 2$)

Actual density of $A$ and $B$: $1 \times K, 2 \times K$  
(K is a constant)
Actual population of $A$ and $B$: $1K \times 7, 2K \times 3$
Total population $100 = 1K \times 7 + 2K \times 3$
$K = 100 / 13$
Population of $A = 1K \times 7 = 100 / 13 \times 7 = 53.85$
Population of $B = 2K \times 3 = 2 \times 100 / 13 \times 3 = 46.15$

$K = N / (R_A \times A_A + R_B \times A_B)$
$P_A = R_A \times A_A \times K, \quad P_B = R_B \times A_B \times K$
$P_{mu} = (R_A \times A_A) \times N / E$
$E = R_A \times A_A + R_B \times A_B$

Dasymetric Mapping (cont.)

$P_{mu} = (R_A \times A_A) \times N / E$
**ArcToolBox**
Analysis Tool toolset -> Statistics -> Summary Statistics

**Dasymetric mapping**

**Input table**

<table>
<thead>
<tr>
<th>OBD</th>
<th>E_ID</th>
<th>AXIDB</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>4.2</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>2.6</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>16.2</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>10.6</td>
</tr>
</tbody>
</table>

**Output table**

WHERE

\[ P = \frac{R_m \cdot A_m \cdot E}{N} \]

- **R** = Relative Density of Mapping Unit Population
- **E** = Expected Population of Enumeration Unit
- **A** = Area of Mapping Unit
- **N** = Actual Population of Enumeration Unit
Choropleth vs Dasymetric Maps

Grid-based Dasymetric Mapping (Lab 4)

\[ P_{\text{mu}} = (R_A \times P_A) \times N / E \]
\[ P_{\text{cell}} = (R_A \times P_A / P_A) \times (N / A_T) / E \]
\[ = (R_A \times N / A_T) / E \]

Where,
- \( P_{\text{cell}} \) is the population of a cell,
- \( R_A \) is the relative density of a cell with land-cover type A,
- \( P_A \) is the proportion of cells of land-cover type A in the enumeration unit.
- \( N \) is the actual population of enumeration unit (i.e., census block group).
- \( E \) is the expected population of enumeration unit calculated using the relative densities.
- \( A_T \) is the total number of cells in the enumeration unit.

\( P_A / P_A \) cancels \( P_A \) out of the equation, i.e., not used in the cell-based method.