Population change in Latin American and the Caribbean, 1990-2000, a spatial time series

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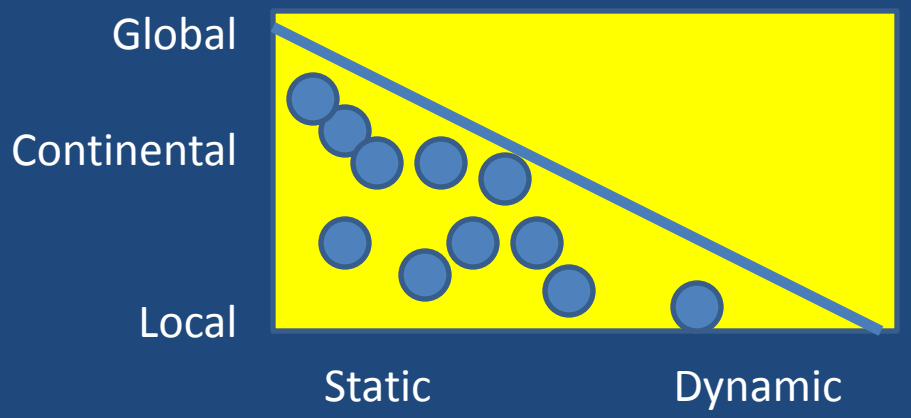
Characterizing spatial distribution of population dynamically is important

- Driver of global change processes
  - Land use
  - Climate change
  - Hydrology
  - Emerging infectious diseases
- Element of vulnerability to
  - Global change
  - Natural disasters
  - Epidemics
  - Political conflict

Fundamental building block of sustainability science

But it is hard to do on a large scale

- Georeferencing of census data is not standardized across countries
  - Process is ad hoc
  - Each country does it differently
- Boundaries change over time
  - Complicates dynamic analysis of spatial data
- As a result, spatial studies of population dynamics tend to be small-scale, local and regional
- Gap: continental-scale spatial analysis of population dynamics

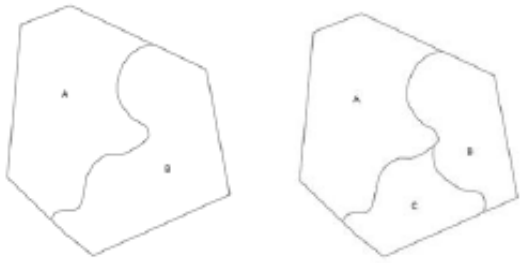


Our goals

- Characterize changing distribution of population in Latin America and Caribbean 1990-2000
  - Replicable methods
  - Spatial consistency
  - Comparable units
  - Spatial resolution suitable to global change analysis
- Integrate with comparable measures of land cover change (produced by collaborators) to explain interactions

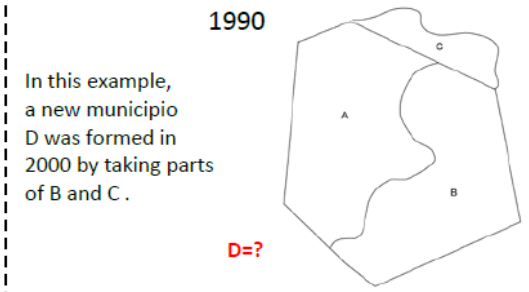
Dealing with changes in administrative boundaries

A. Contiguously Split Administrative Units



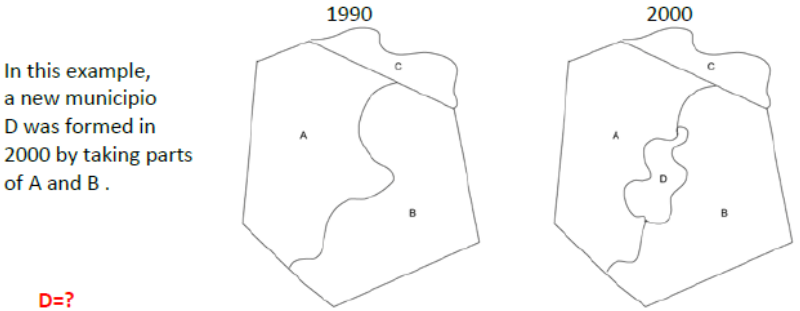
Problem: You don't have an official 1990 population estimate for municipio C.

B. Non-Contiguously Split Administrative Units



Problem: You don't have an official 1990 population estimate for municipio D, B* or C*.

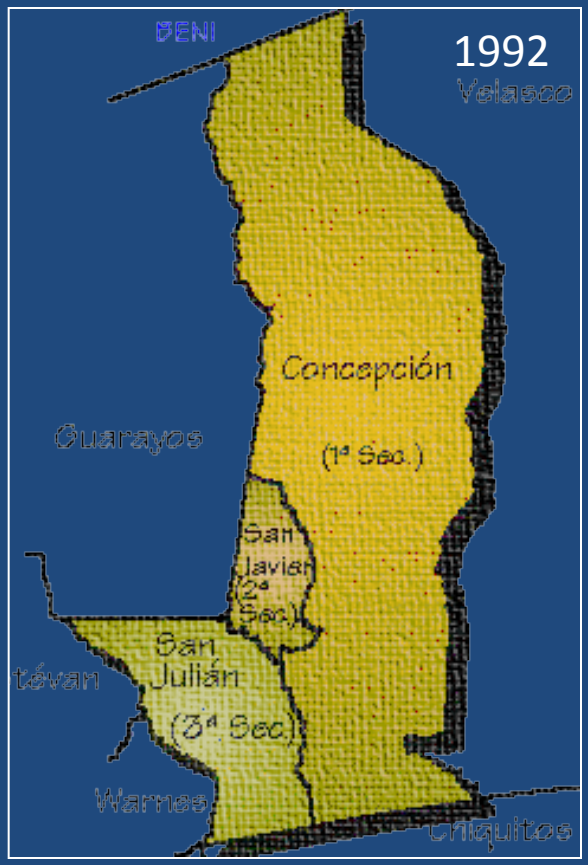
C. Newly Formed Units



Problem: You don't have an official 1990 population estimate for municipio D, A* or B*.

Changes due to subdivision of census enumeration units, but also to administrative changes

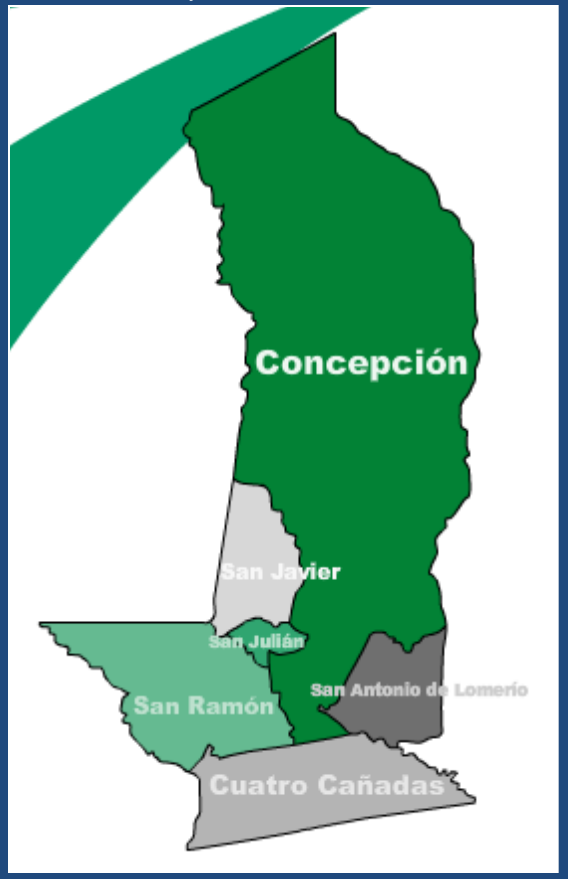
Source: María Muñíz, CIESIN, 2008



3 sections: Concepcion, San Javier, San Julian

5 sections: Concepcion, San Javier, San Julian, San Ramon, San Antonio de Lomerío

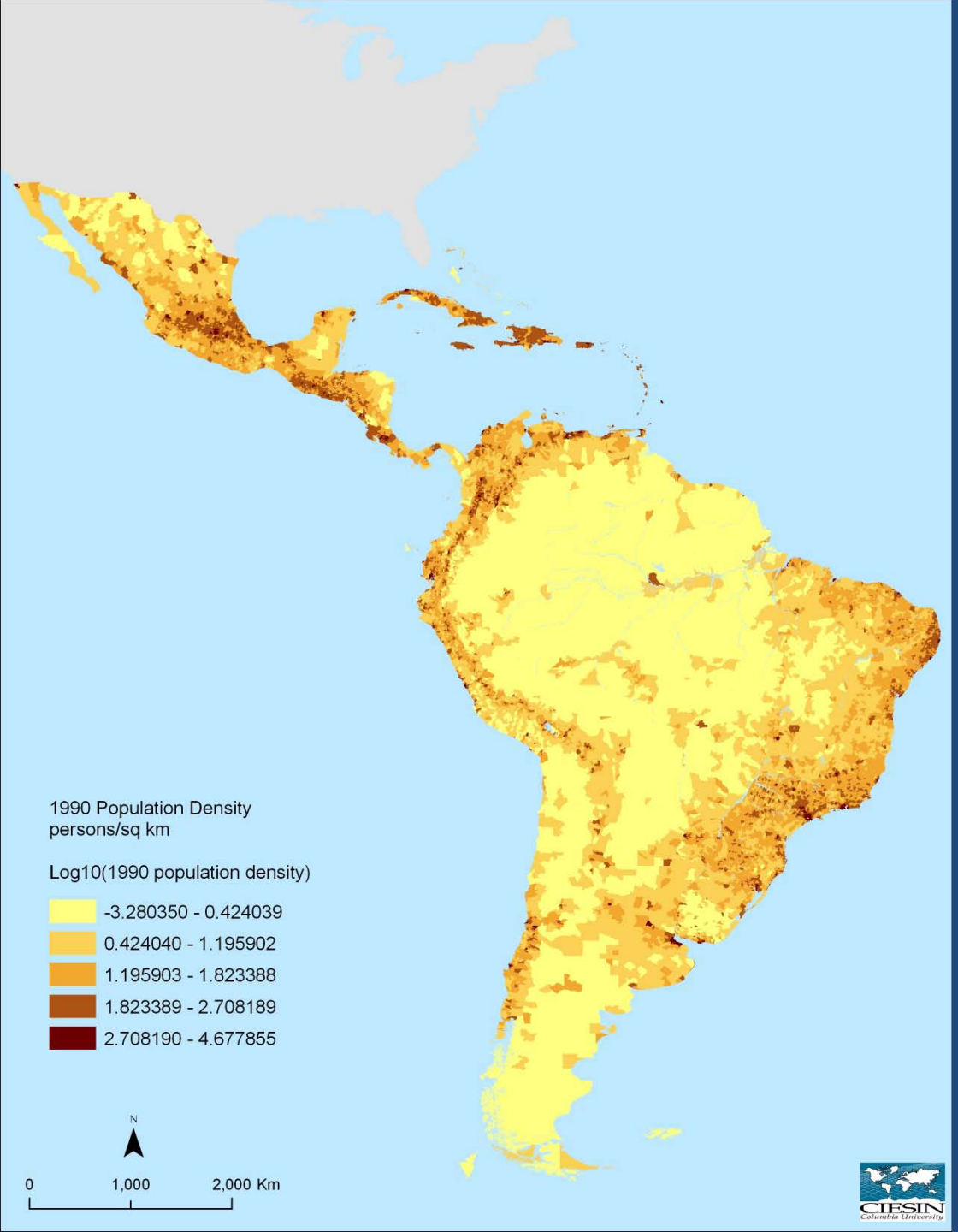
6 sections: Concepcion, San Javier, San Julian, San Ramon, San Antonio de Lomerío, Cuatro Cañadas



Ñuflo de Flores, Santa Cruz, Bolivia

- 45 Countries
- 16,080 administrative units
  - Primarily municipio

Population Density, 1990



Matching reference years

- Start with data from multiple census years
- Calculate annual growth rates

$$r = \frac{LN\left[\left(P_2 / P_1\right)\right]}{\left(t_2 - t_1\right)}$$

where, LN = the natural log, P_1 and P_2= population counts for the first and second reference years, t_1 and t_2 = time periods 1 and 2.

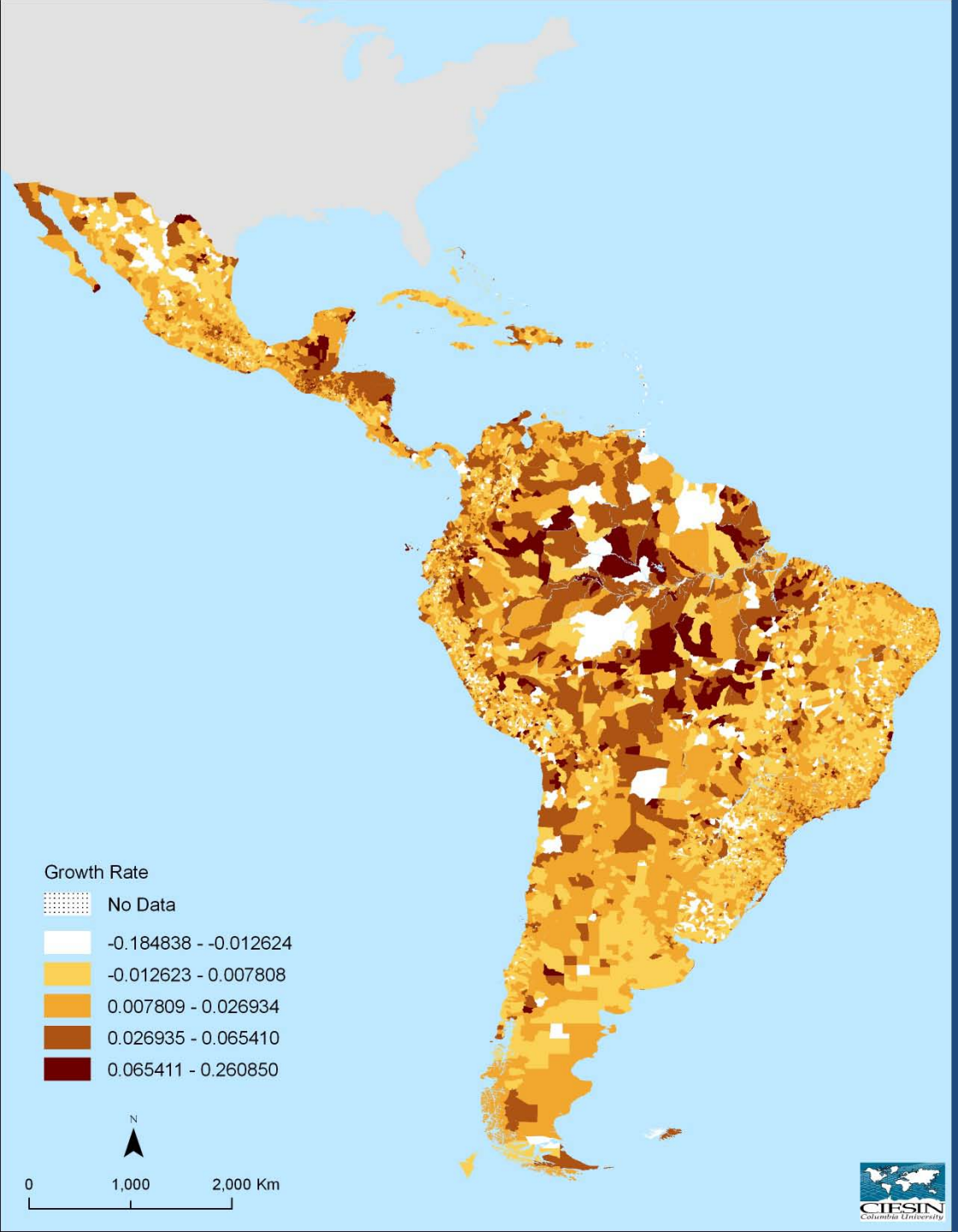
- Extrapolate and interpolate to generate estimates for 1990 and 2000

The following formula is then applied to the official population estimates, to extrapolate the data:

$$e^{rt} \times P_1$$

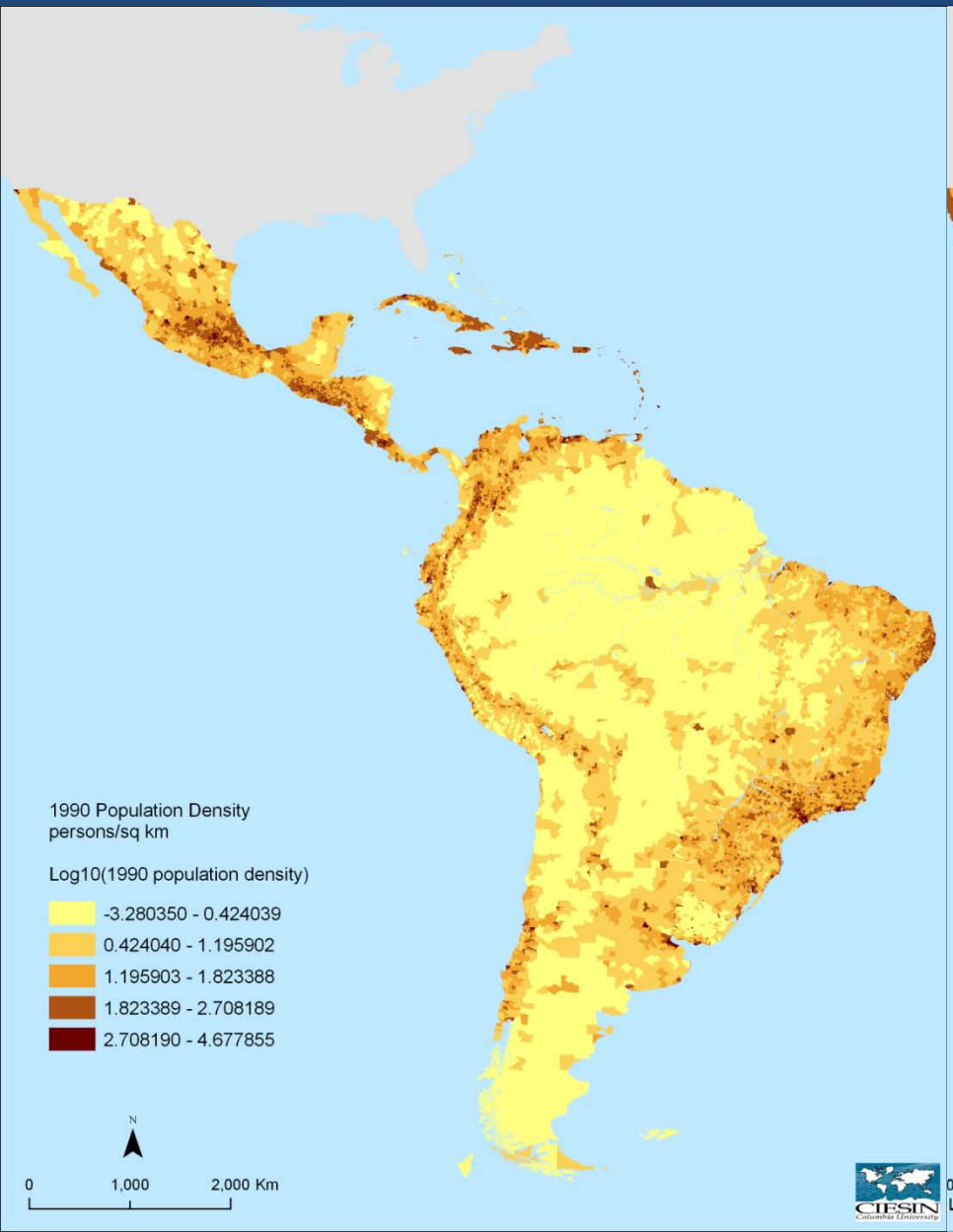
where, r= the geometric growth rate (as defined above), t= the number of years the initial estimate will be projected forward/backward, P1= population counts for the first reference year

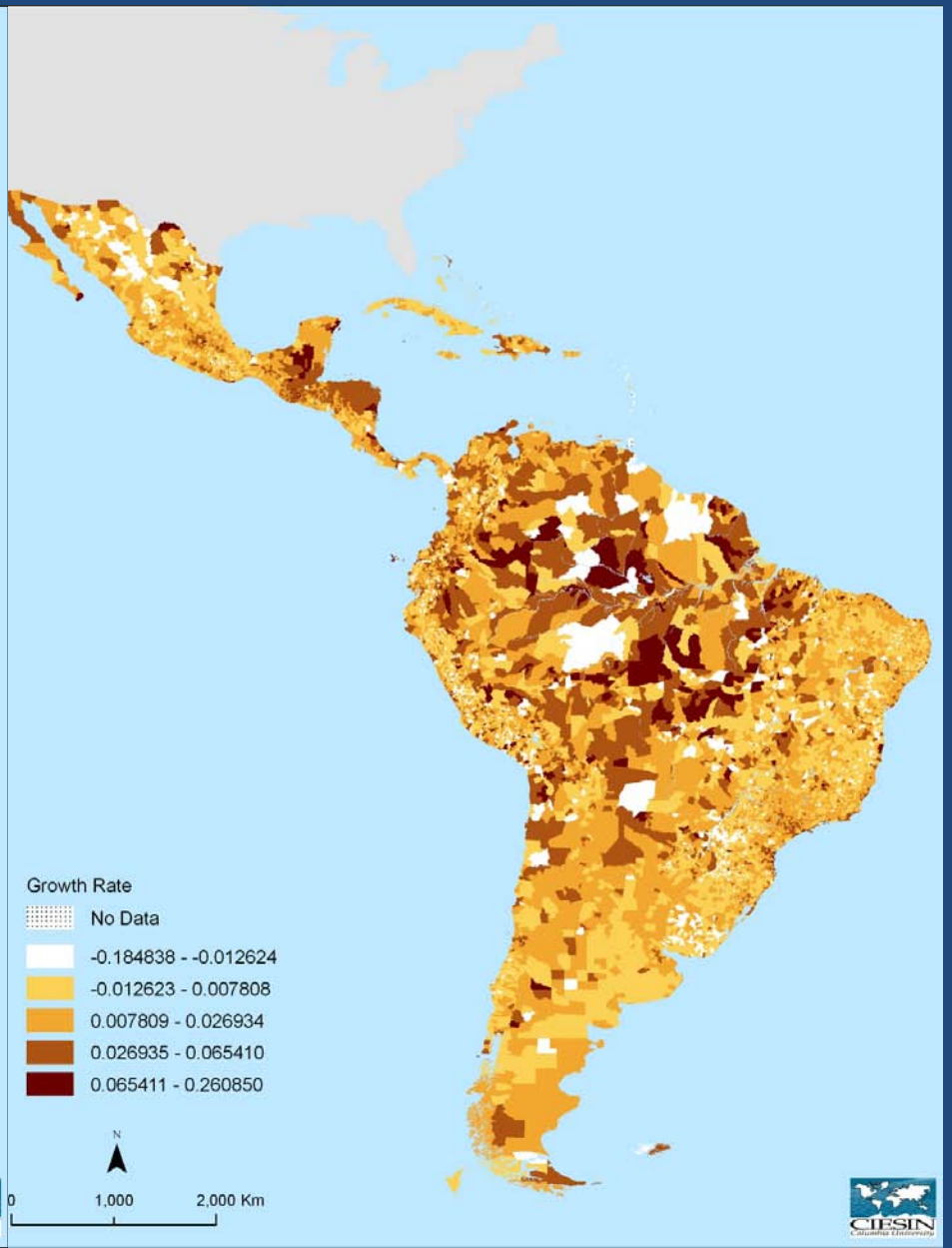
Growth Rate, 1990-2000



Density

Growth Rate





Descriptives

1990 Density (people/sq km)

- Mean 228
- Min 0
- Max 47,627
- Std. Dev. 1450

1990-2000 Growth Rate (%)

- Mean 15.8
- Min -84.3
- Max 1,262
- Std. Dev. 36.1

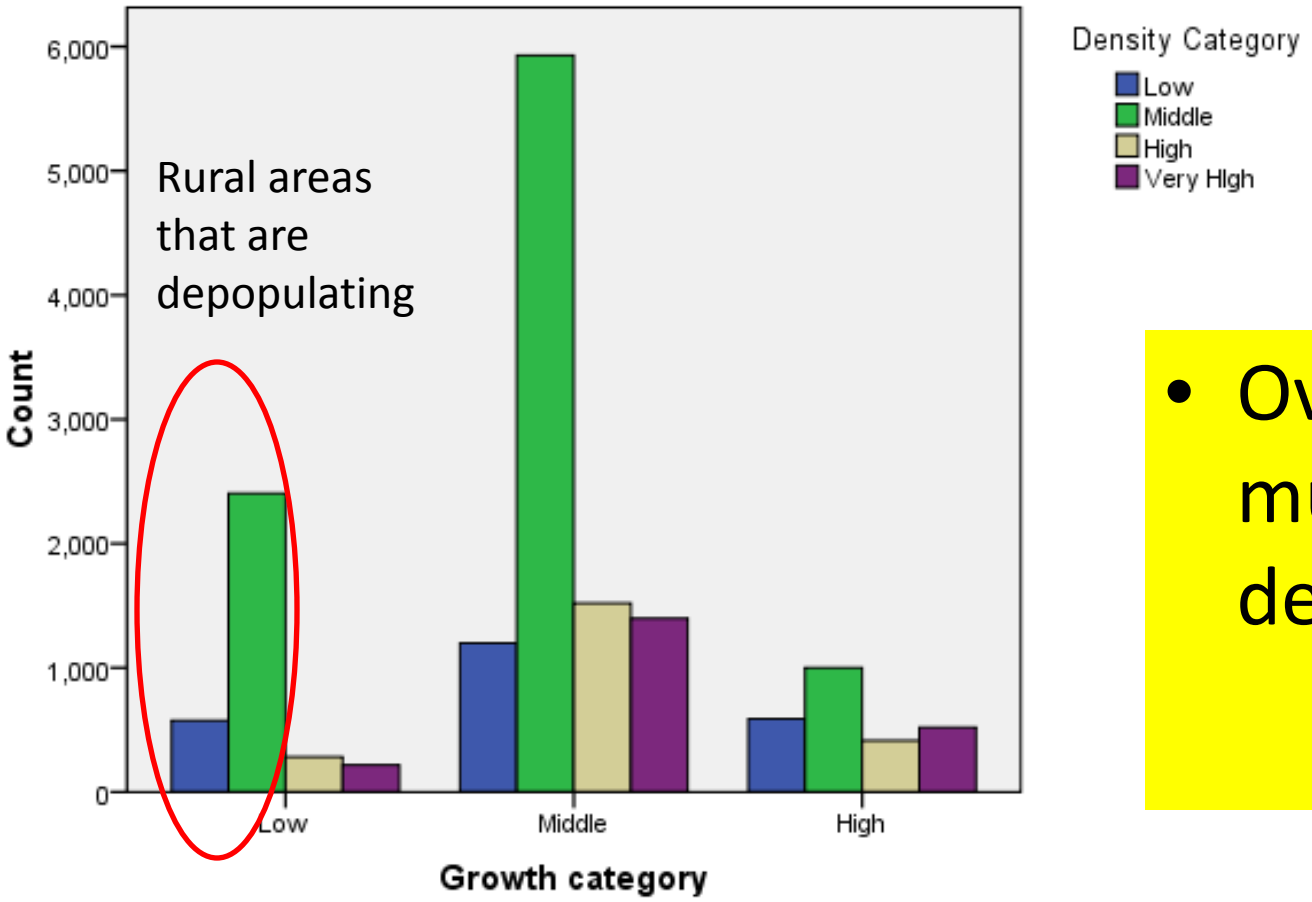
Grouping the municipios

- Density (persons/sq km)
  - Low 0 - 5.7 (n=2397)
  - Middle 5.7 - 72 (n=9333)
  - High 72 - 162 (n=-2215)
  - Very high 162 - 47,627 (n=2135)
- Growth Rate (%)
  - Low -84 - -2.2 (n=3477)
  - Middle -2.2 - 34 (n=10,048)
  - High 34 - 1,262 (n=2521)

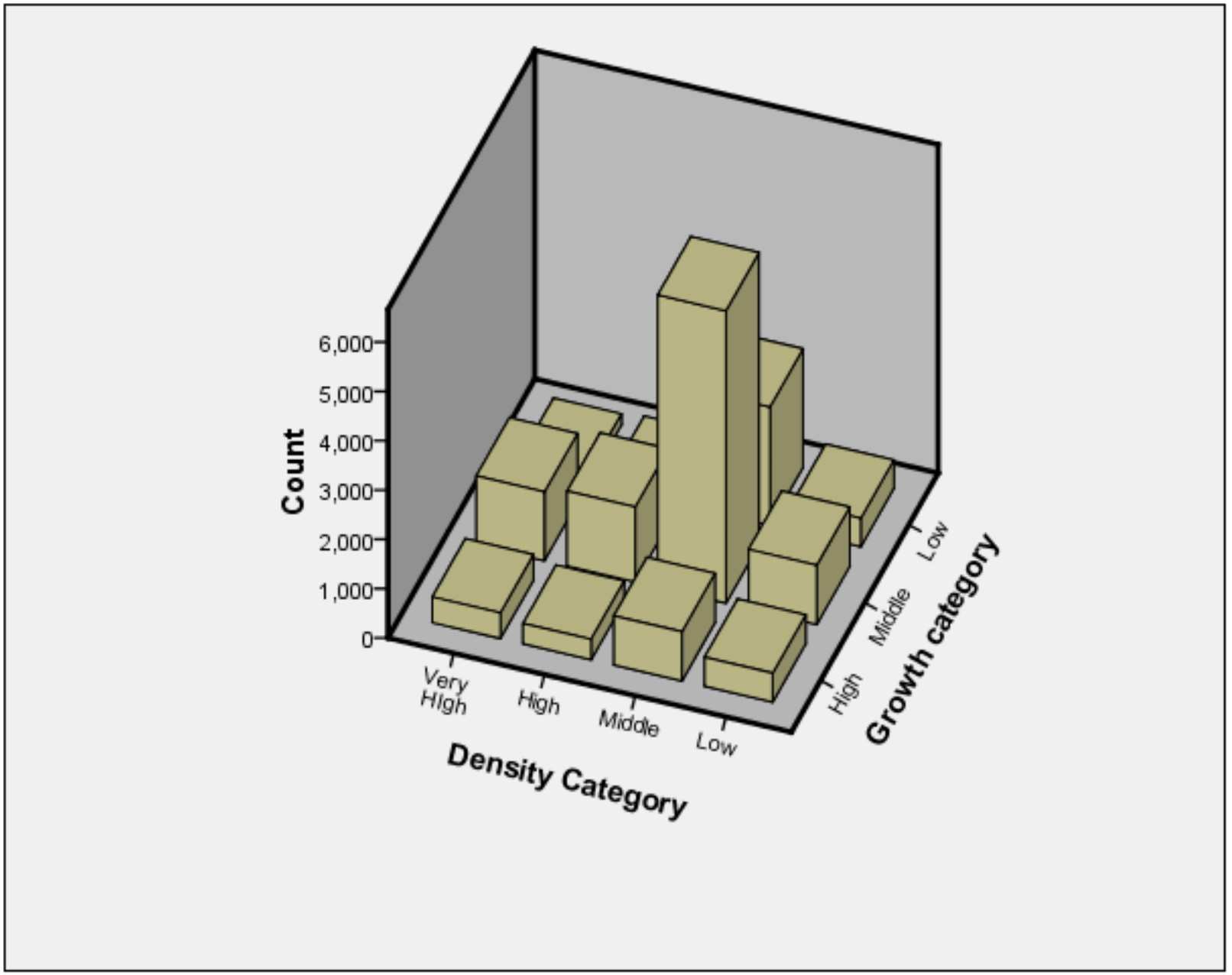
Growth category * Density Category Crosstabulation

Count

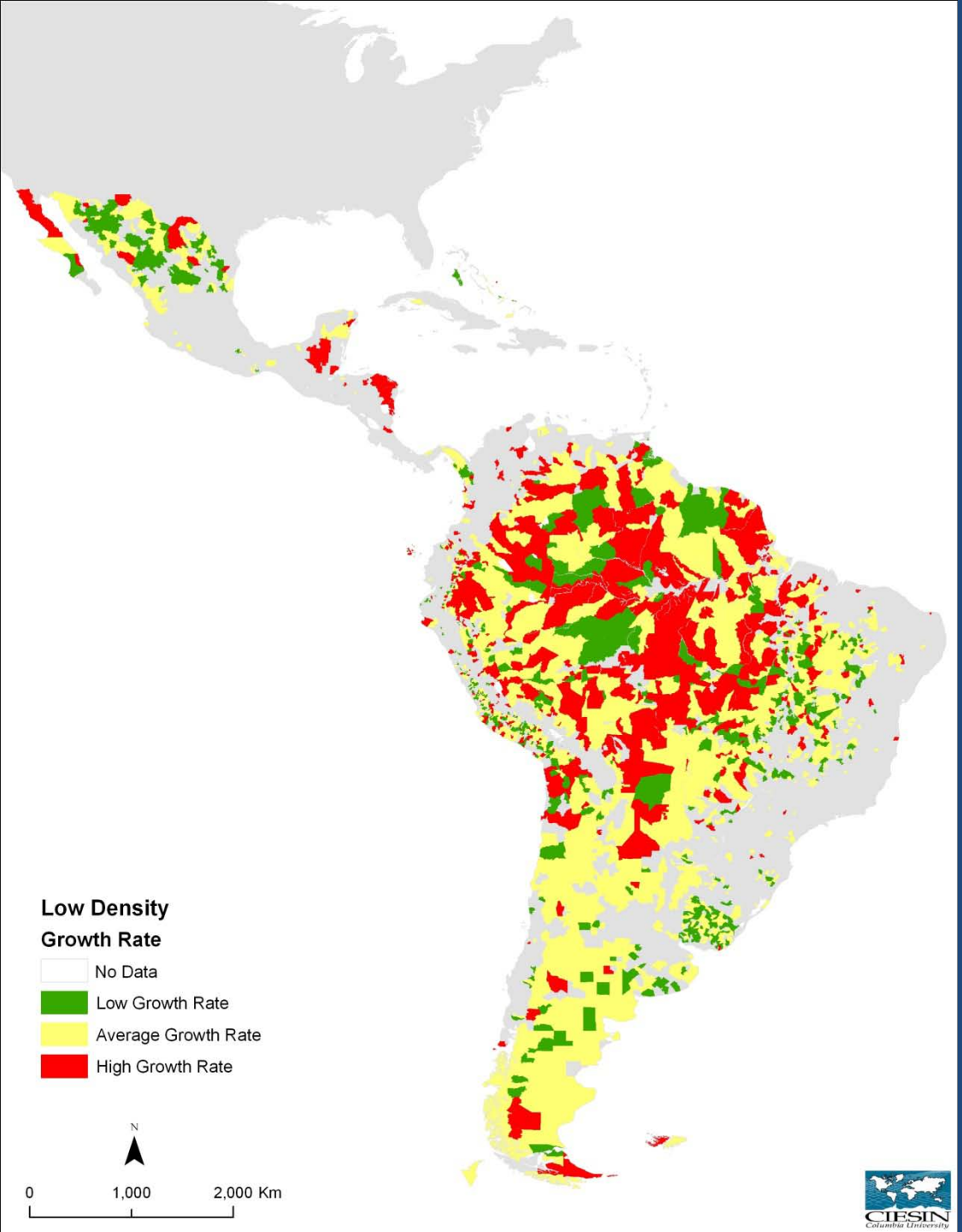
		Density Category				
		Low	Middle	High	Very HIgh	Total
Growth category	Low	575	2403	281	218	3477
	Middle	1199	5931	1520	1398	10048
	High	589	999	414	519	2521
Total		2363	9333	2215	2135	16046

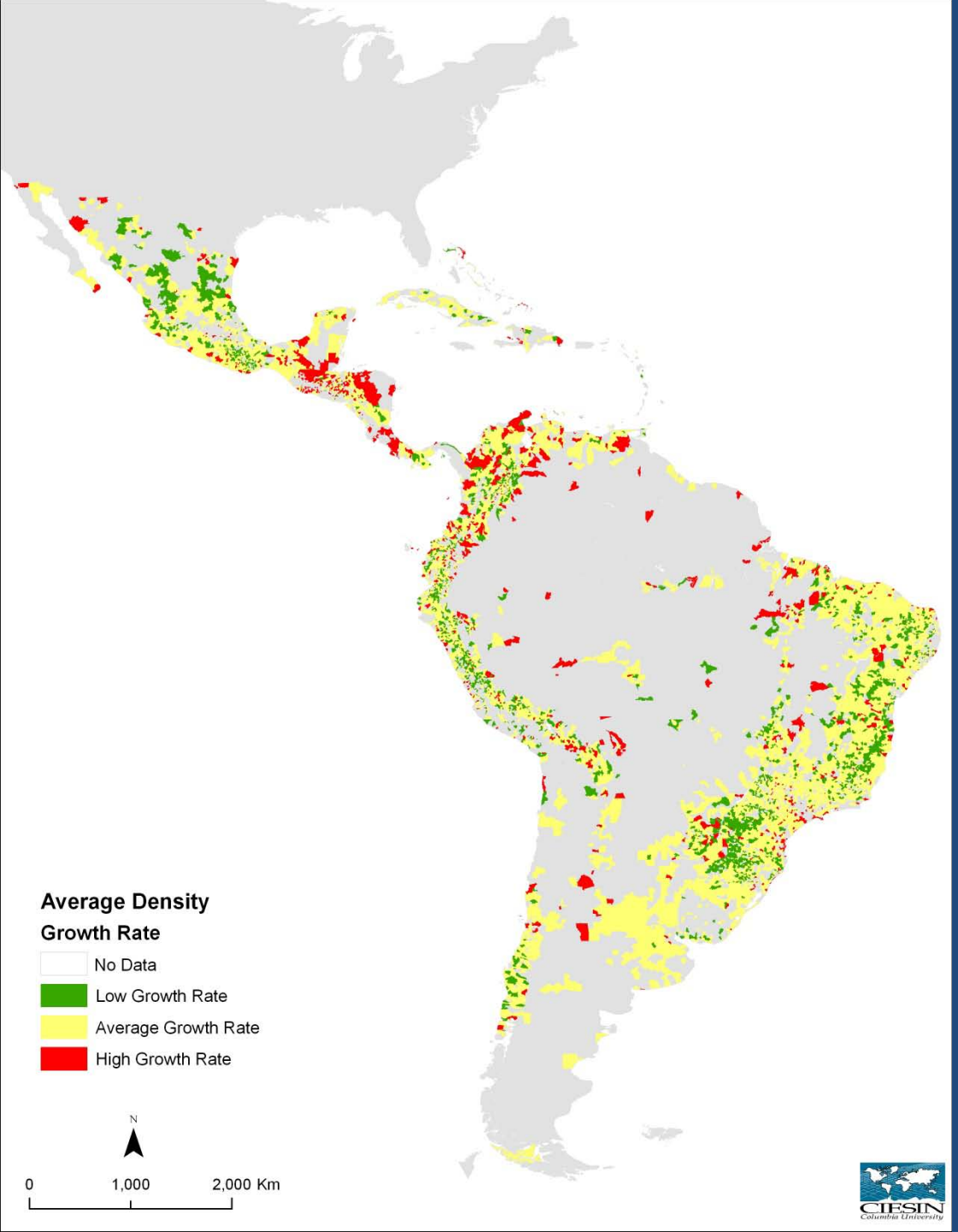


- Over 4,000 municipios are depopulating

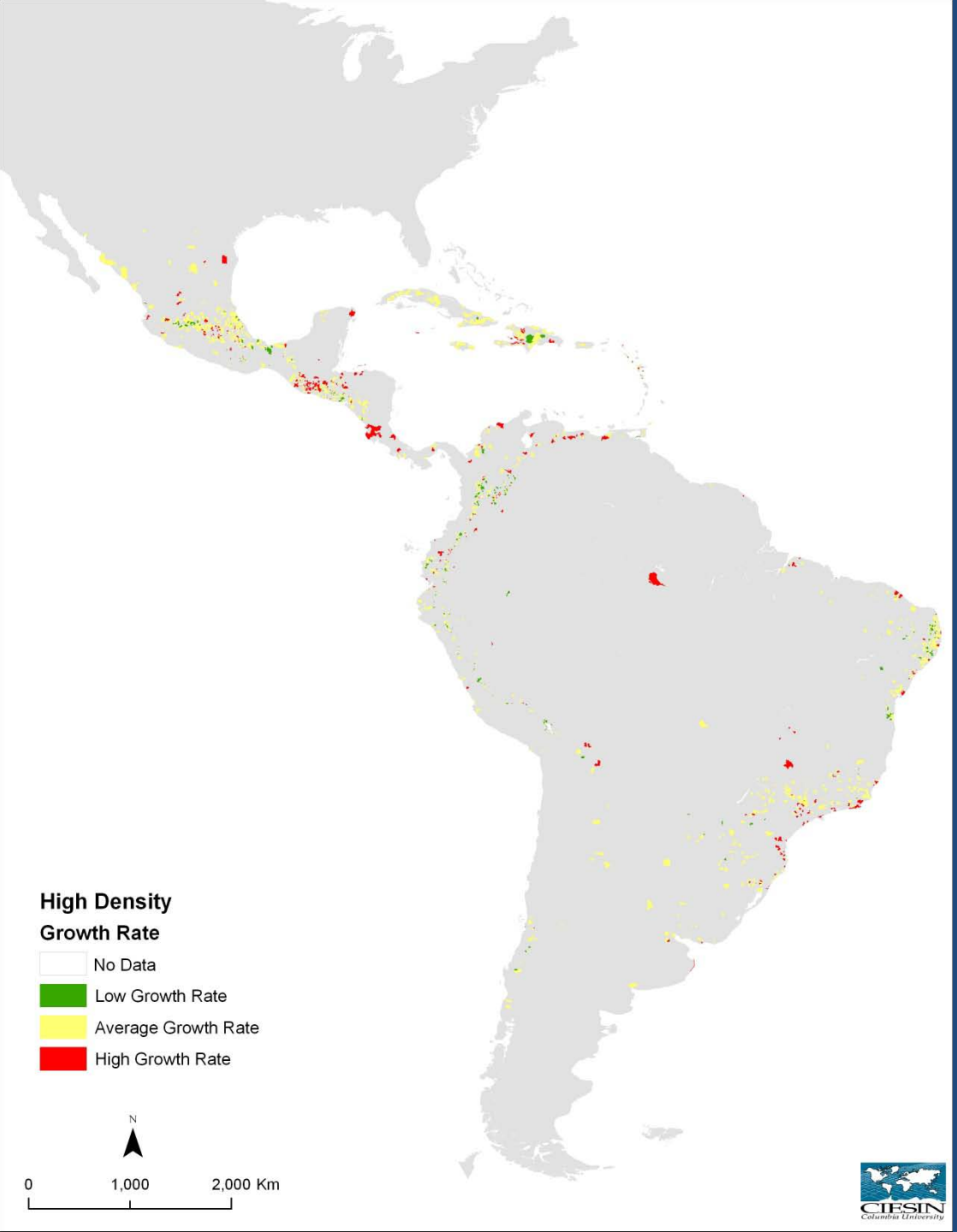

Count
6,000
5,000
4,000
3,000
2,000
1,000
0
Very High
High
Middle
Low
Density Category
High
Middle
Low
Growth category

Municipios with low 1990 population density

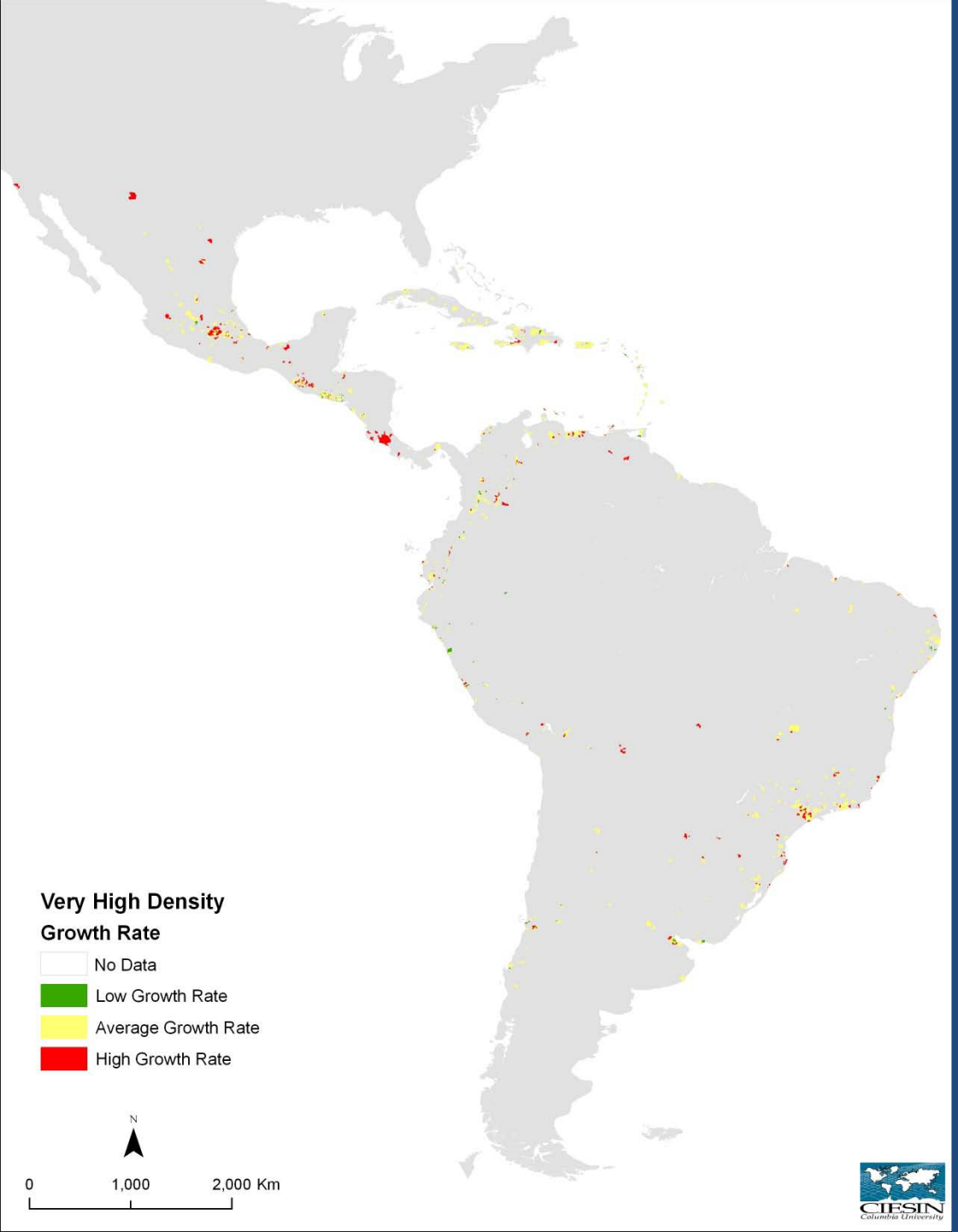




Municipios with average 1990 population density



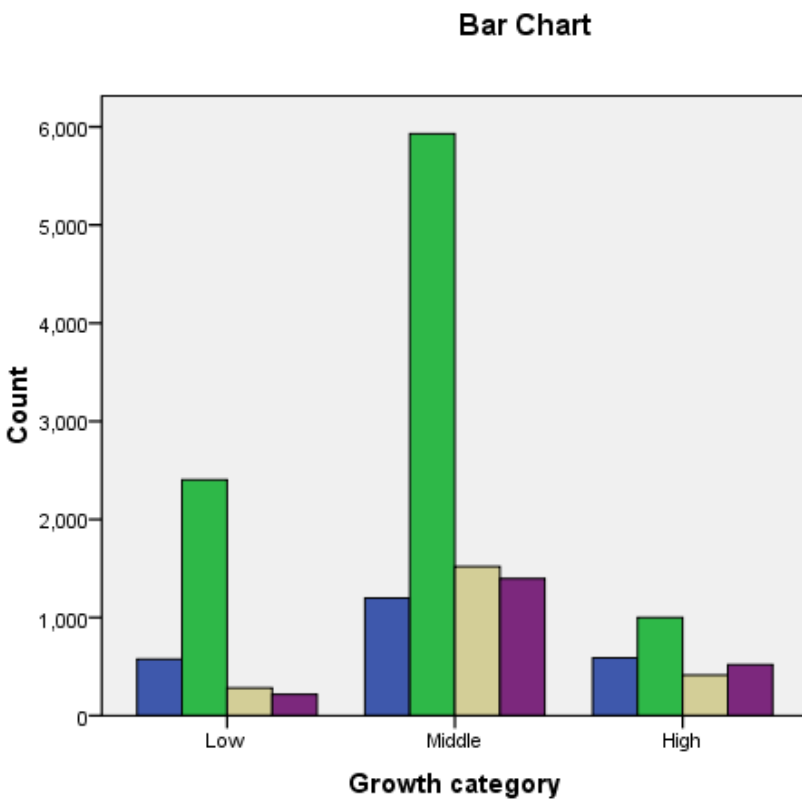
Municipios with high 1990 population density

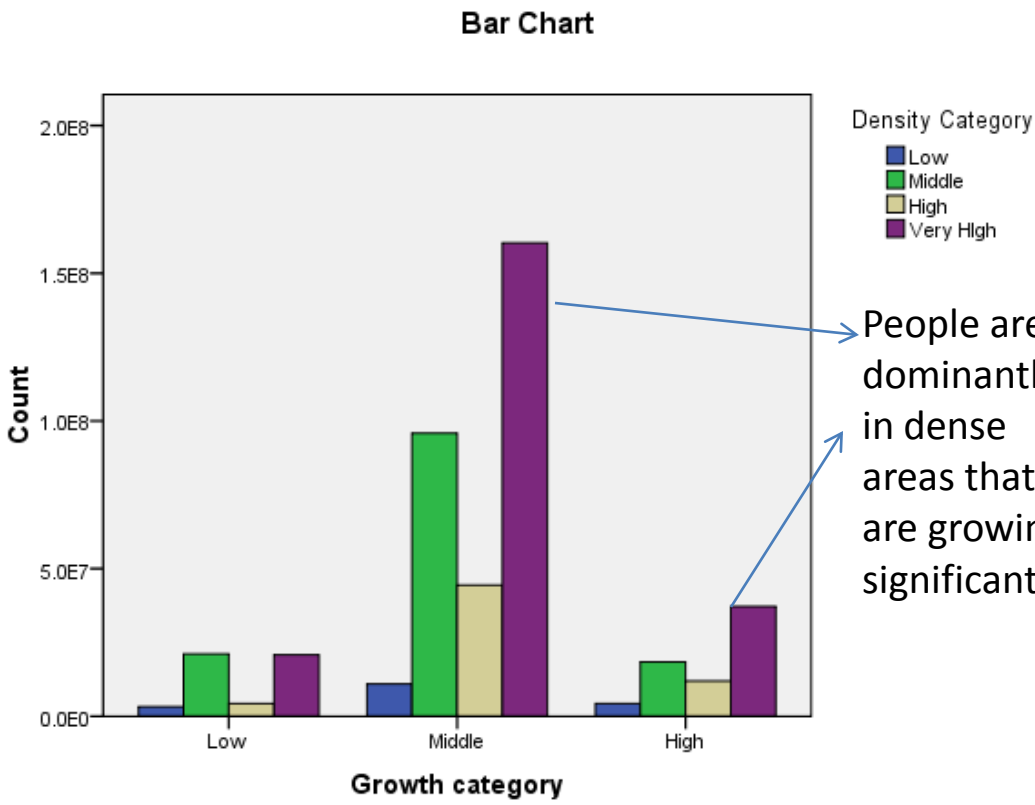


Municipios with very high 1990 population density

Unweighted

Pop-weighted

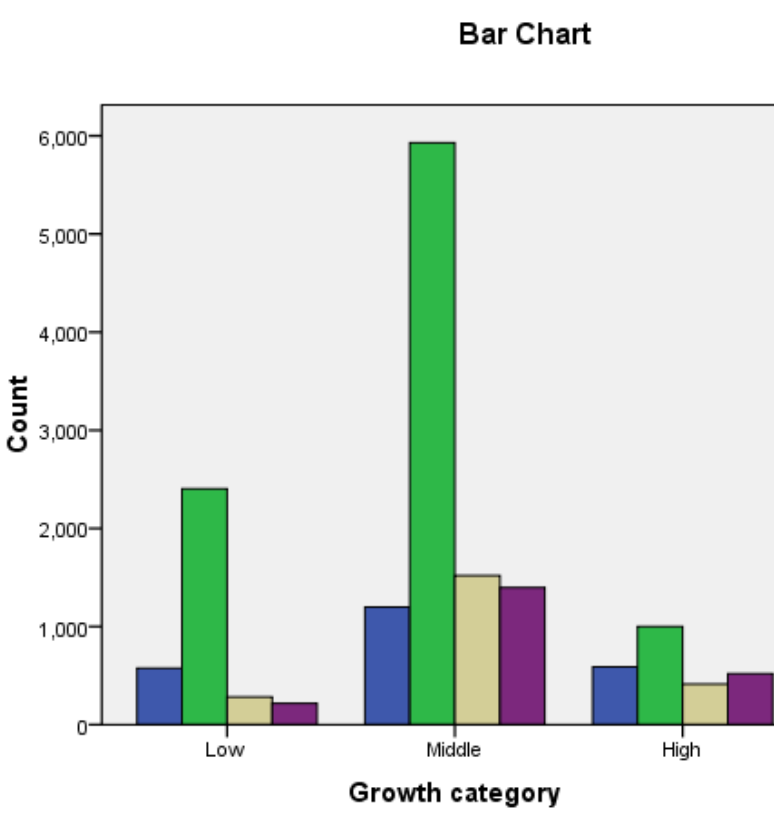


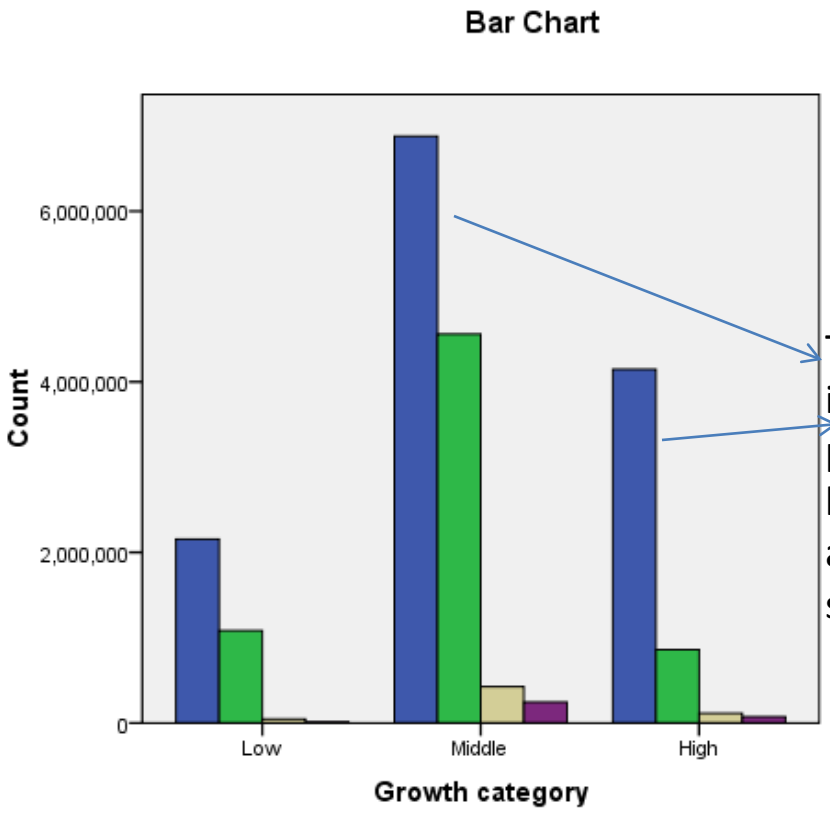


People are
dominantl
in dense
areas that
are growir
significant

Unweighted

Area-weighted

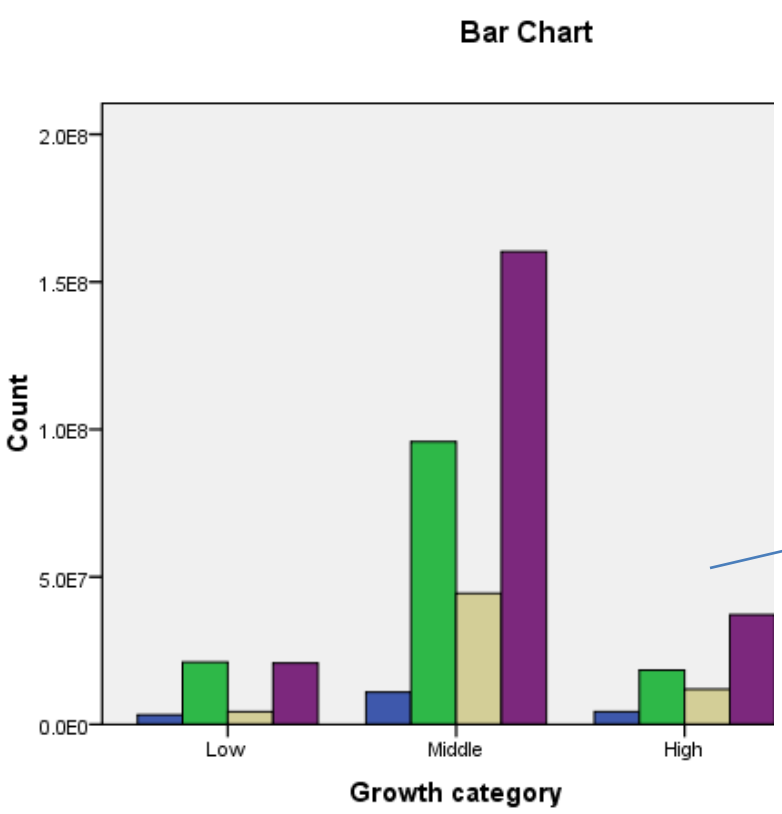


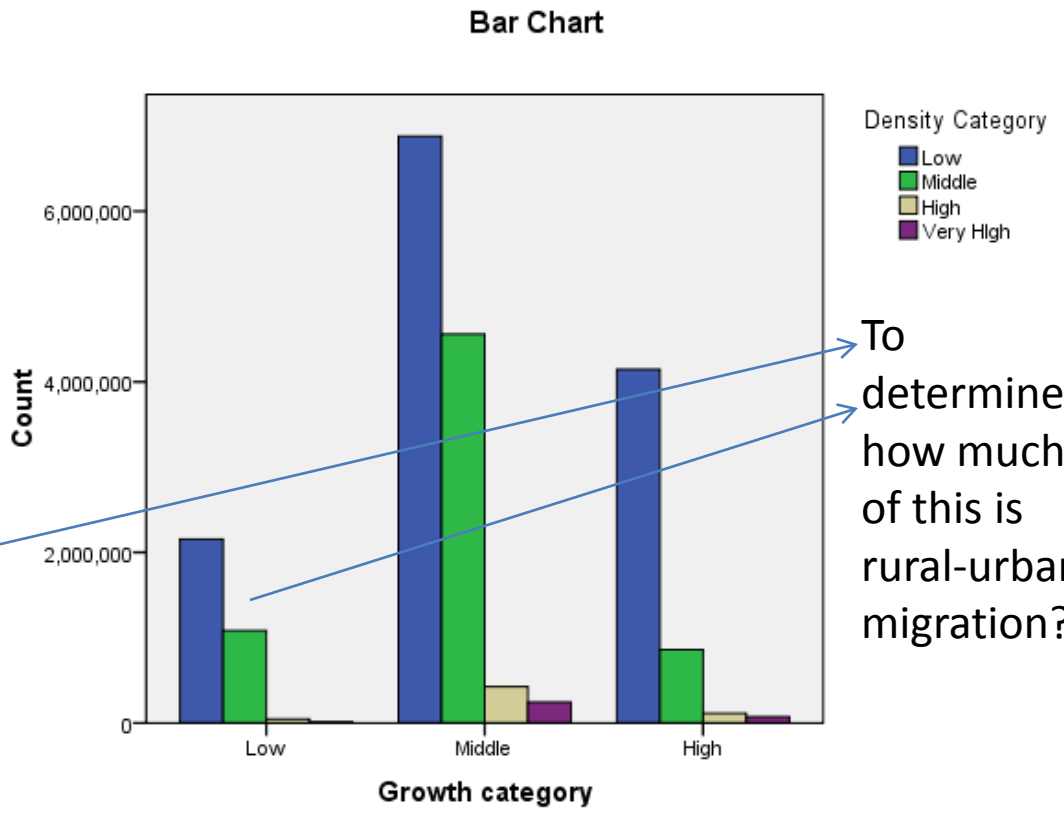


The land area is predominantly low-density and growing significantly

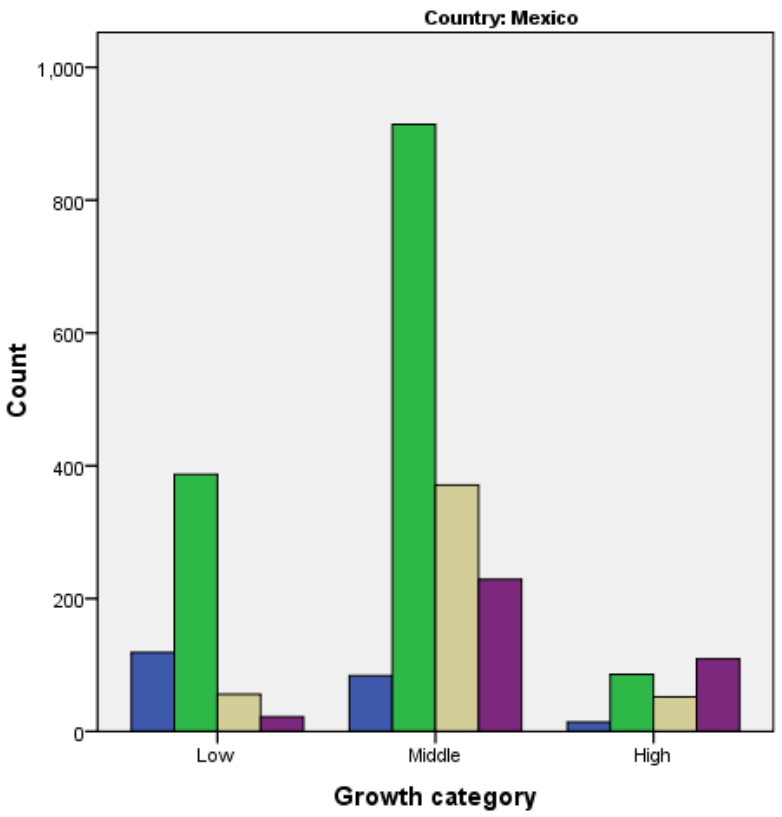
Pop weighted

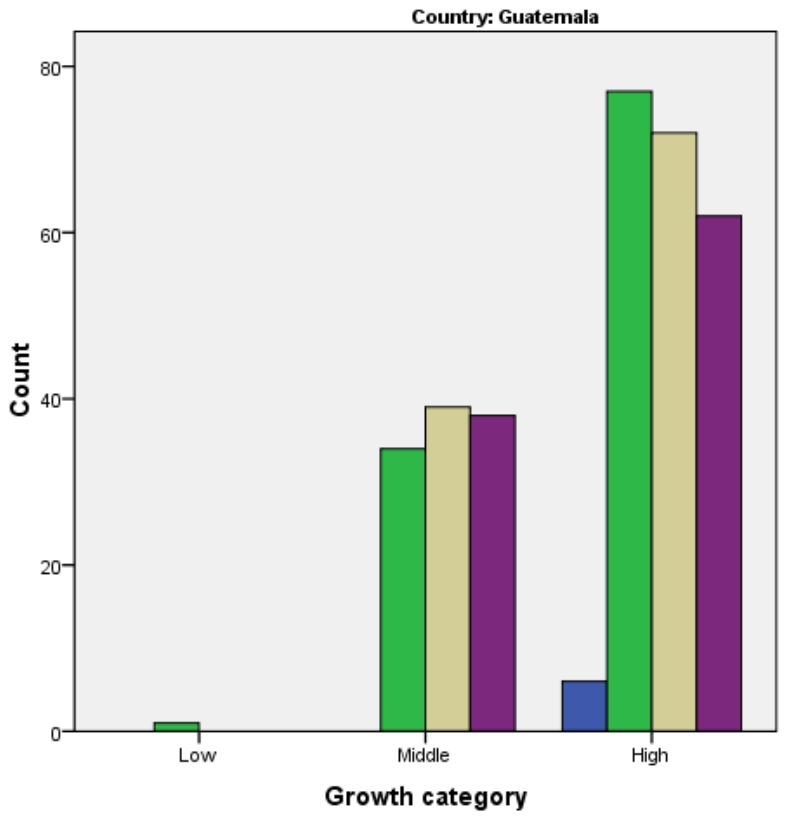
Area weighted





To determine how much of this is rural-urban migration?


Country: Mexico
1,000
800
600
400
200
0
Count
Low
Middle
High
Growth category


Country: Guatemala
80
60
40
20
0
Count
Low
Middle
High
Growth category
Density Category
Low
Middle
High
Very High

Next steps

- Integrated model to explain land cover, demographic change
- Describe shifting patterns of vulnerability to climate change