Fiverr order [redacted]:
Hypsographic demography report

Seller: Taylor Lange
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Request

- Investigate whether there has been a migration from higher to lower altitudes to contribute to a project on decreasing atmospheric oxygen.

Data & Methods

Data sources:

Elevation Data – Digital Elevation Models from `elevatr` R package (Hollister et al., 2020) using tiles from Amazon Web Services registry of open data[1]

2000, 2010 Census shape files & Census – accessed county shape files through `tigris` (Walker & Rudis, 2020) and census numbers through `tidycensus` (Walker et al., 2020)

NHGIS county Shape files & Historical Census (1960,1970,1980,1990) (Manson et al., 2020)

Process

Population

I drew decennial census data for 1960-2010 from the National Historic Geographic Information Systems (NHGIS) historic census, and from the census bureau. The NHGIS is a division of the University of Minnesota that is tasked with keeping records of census data on behalf of the government, in addition to housing and administering microdata for the census.

The US census bureau tabulates population characteristics at multiple geographic scales, though these scales have changed from year to year. The smallest scale that is consistent from 1960-2010 is the county level.

Elevation

There are currently available datasets that list the elevation of counties in the US, so I had to calculate it from scratch for every county for each year. Elevation data are stored in an image format called a raster, where each pixel indicates a different value, in this case the elevation of an area of land. Raster images are taken by satellites, planes, and other measurement devices, and they assign each pixel an elevation value according to its distance from sea level. Measurements are taken at evenly spaced points on the ground, and the area around each point is assumed to have the same elevation as the point the measurement was taken. Wikipedia explains these images, also called digital elevation models (DEMS), how they are produced, and how to read them: https://en.wikipedia.org/wiki/Digital_elevation_model#:~:text=A%20digital%20elevation%20model%20(DEM,)%2C%20moon%2C%20or%20asteroid.&text=DEMs%20are%20used%20often%20in,for%20digitally%20produced%20relief%20maps.

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[1] Data can be found at https://registry.opendata.aws/terrain-tiles/

To find the elevation of a county, I download the DEM of the area each county occupies, overlayed the raster with county boundaries, then calculate the mean and median of all of the values that fall within. Figure 1 Shows this process graphically.

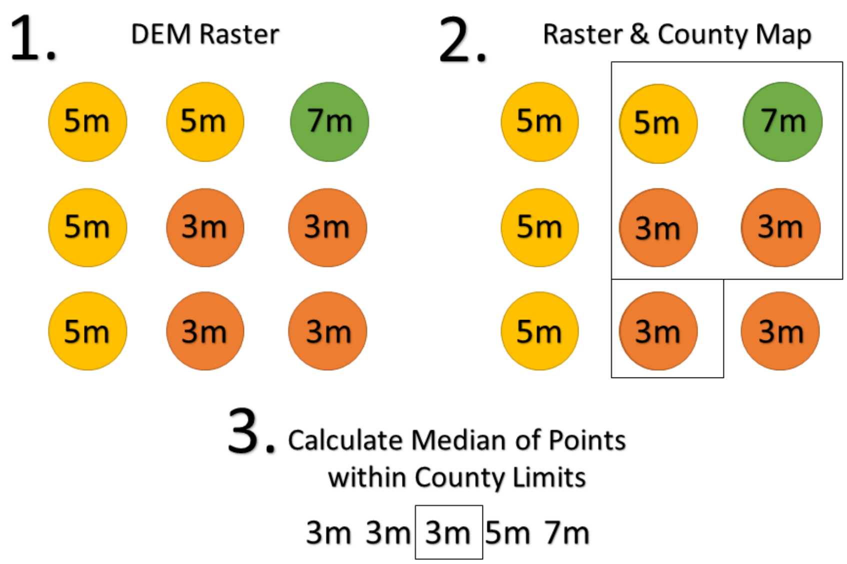


Figure 1 Process of calculating the elevation of a county.

I repeat this process for the county boundaries every year from 1960 – 2010 as the boundaries change from year to year. I then join these elevation estimates to county level population tabulations for the total population and counts for specific ages.

Elevation & Population Groupings

Some acute symptoms of high altitude illnesses, and physiological changes induced by altitude can be detected at altitudes as low as 1500 meters (Barry & Pollard, 2003). Additionally, many chronic altitude sicknesses tend to show up above 2500m (León-Velarde et al., 2005). As such, I divided the counties into 3 categories based on their median elevation:

1. Lower Altitude: Less than 1500 meters
2. Intermediate Altitude: between 1500 meters and 2500 meters
3. High Altitude: 2500 or higher.

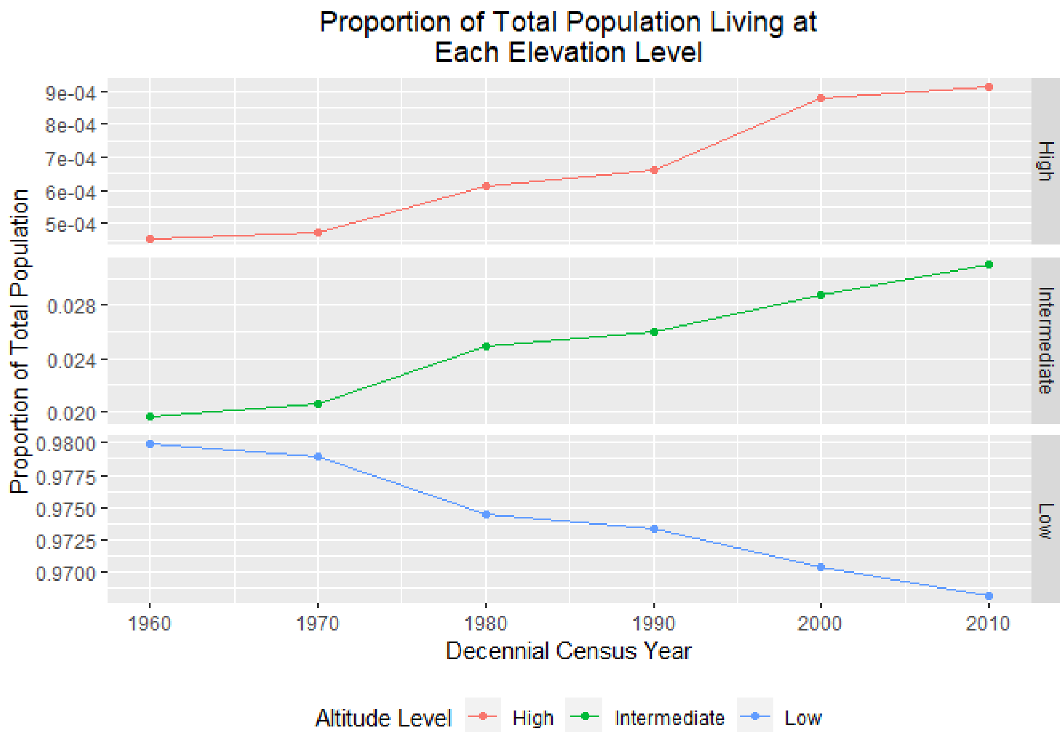
Since we are concerned with the elderly at these populations, I also took some sub counts of the population based upon their age:

1. Total Population – All people in the county
2. 45 years or older – Divide People in the county into 2 groups, those above and below 45 years
3. 65 years or older - Divide People in the county into 2 groups, those above and below 65 years

Results

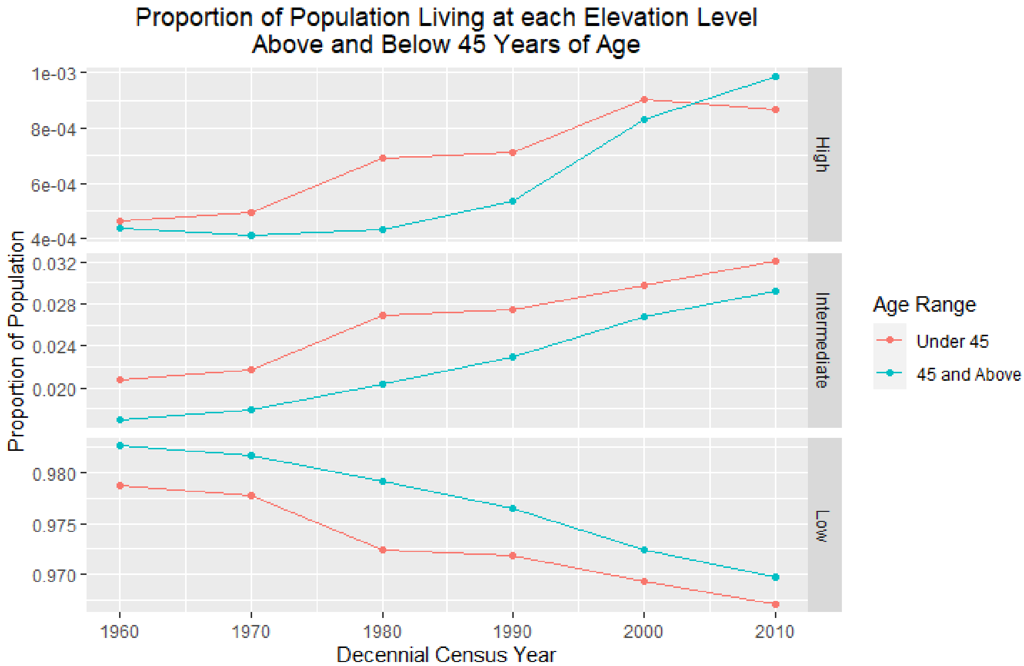
I divide the population up across all 3 altitude levels and calculate the proportion of the population that lives at each elevation level across time and report these results. Proportions are better, as looking at raw numbers could be misleading. Total population growth causes unformal growth across all altitudes, so looking at the raw population could mask actual migration. Proportions would indicate if there are differences in these growth rates at higher elevations due to increased death from altitude related complications or migration.

Total Population



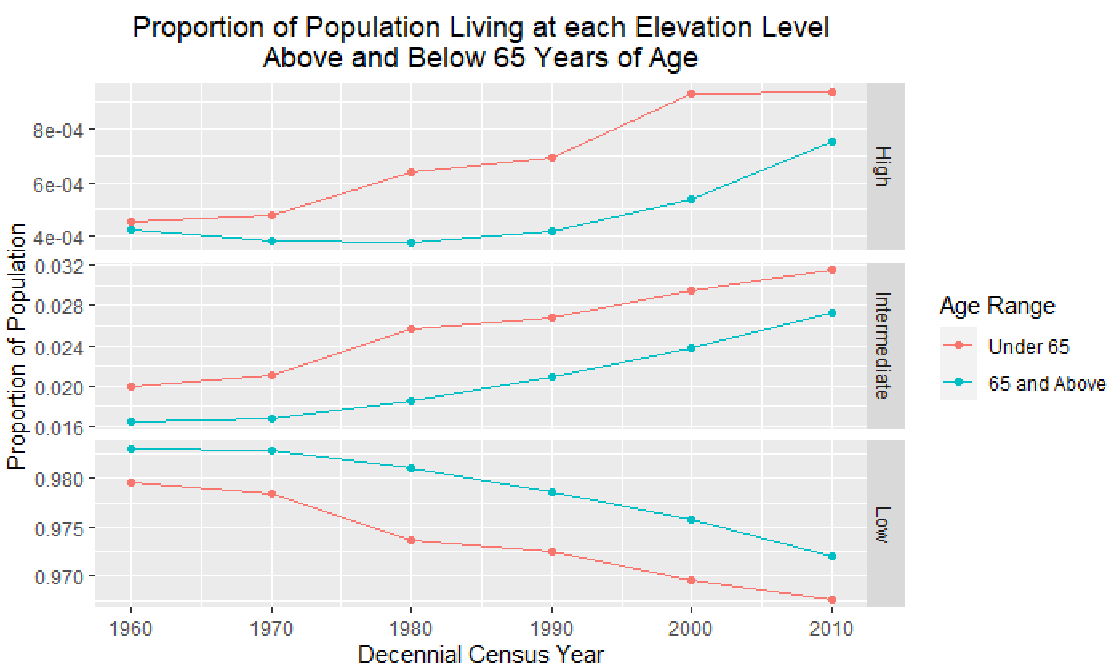
The proportion of the total population that lives at intermediate and higher elevations has actually increased since 1960, while the proportion that lives at lower elevations has been steadily decreasing.

Ages 45 and Above



The trend for those 45 and above is the same as that of the total population, though the population proportion grows slower at the highest altitudes. The proportion is also consistently less at intermediate elevations.

Age 65 and Above



Again, the trend for those 65 and above is the same as that of the total population, with more caveats. The population proportion of 65+ individuals falls between 1960 and 1980, before growing at the highest altitudes, and the proportion remains less through 2010.

What does this all mean? Though there are considerably less people living at high altitudes than at low, and this proportion is slowly growing. Furthermore, the proportion of older folks living at higher elevations has been growing, but less so than for younger populations.

References

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Hollister, J., Shah, T., Robitaille, A. L., Beck, M. W., & Johnson, M. (2020). *elevatr: Access Elevation Data from Various APIs* (0.3.1). https://CRAN.R-project.org/package=elevatr

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