11.953
Comparative Land Use and Transportation Planning
Assignment II: Measuring the Built Environment in Santiago de Chile
Due Session 12

In this assignment, you are to work in teams of two persons. We will establish the team pairs in Session 10.

All of the files for this assignment are on the MIT server. Your use of these files is subject to the strict confidentiality code you will sign in class. Once you are finished with this assignment, you agree to remove – by Session 14 – the raw data files used from any personal computers, shared computers, or other electronic file-space.

This assignment requires the use of GIS. No complex GIS manipulations are necessary; but some basic operations will be required. The TA will be available to answer questions and doubts in the computer lab (37-312) after Session 11, at a time to be determined in class.

There are six relevant information sources on the MIT server.
1. AssnII_FilesKey_Final.xls.
   - This is an excel spreadsheet that contains – within separate worksheets – the "data dictionary" for each of the files referred to below.
2. FullCens
   - This set of files contains demographic and basic housing information, aggregated to the Census block.
3. Curbcut
   - This set of files contains the road areas, extracted from the FullCens shapefile.
4. InUseBlks
   - This set of files contains land use information (types of land use activities) aggregated into the Census Blocks
5. TAZ_Built
   - This set of files contains the relevant land use information aggregated into the Traffic Analysis Zones (TAZs).
6. Cellresult
   - This file contains the relevant land use information aggregated into 250 meter by 250 meter grid cells. The land use information was put into the grid cells, when relevant by way of spatial averaging from the Census Blocks and the curb cut.

When indicated, please include the requested maps for each of the questions (1-4) below. The maps should be legible and easily decipherable. In addition, there are several questions (a, b, c, etc.) to answer within each numbered question. In most cases, you can answer these questions in two to three sentences, sometimes less; rarely will you need more. *Brevity is appreciated.*

Questions:

1. Measuring the "Built Environment" at the Metropolitan Level
   a) Use the data in the FullCens and Curbcut shapefiles to calculate a net and a gross city-wide density. Which do you think is more instructive – net or gross density?
   b) How much of Santiago is covered by streets?
   c) Compare Santiago's density to the densities given for other major world cities in Table 7 of the Kenworthy and Laube (1999) article (annexed at the end of this assignment) (be careful about whether to compare net or gross density). What does this tell you about Santiago?
   d) What hypothesis(es) would you make regarding the influence this indicator on travel behavior?
   e) What are the problems with this measure of urban structure?

2. Measuring the Built Environment by Census Blocks
   Use the census block data (InUseBlks and FullCens) to derive the following measures of the residential built environment with which you can describe each Census Block:
   - Average Population density
   - Average Household size
   - FAR (floor area ratio)
   - Dwelling unit density

   For each of the above measures:
   a) Create a map that displays your measure for the census blocks across the city.
   b) What can you learn from this measure? What are its shortcomings?
   c) What would you hypothesize about this measure's influence on travel behavior, as measured at the census block?

   Finally,
   d) Using the above measures, form a hypothesis about where the poorer and richer parts of the city are. Explain your reasoning (note, you do not necessarily need to use all of the above measures to answer this question).

3. Measuring the Built Environment by Traffic Analysis Zones
   The TAZ_Built shapefile contains more information than the census files about the built environment, including information about roadways. *Note that not all TAZs contain built environment information.* Using this file:
   a) Recalculate and *re-map* residential density using only the TAZ_Built shapefile (and the data it contains). How does this compare to your previous measures of residential density derived using census blocks?
   b) Calculate, for each TAZ, the average road width and display this in a map. What patterns, if any emerge?
   c) Create a single map – using only the information contained in the TAZ_Built file – that attempts to show street configurations. Why did you choose this measure how does it represent street configuration? What expectations would

you have about how street configuration might vary across the city? Does your map support these expectations?

d) Before proceeding to question (e) below, using only a single type of land use, what would be the appropriate variable to use to represent the Central Business District (CBD)? Map it. What does this tell you about Santiago?

e) Use the following land use diversity index[1] to represent the mix of land uses for each TAZ:

$$DI = 1 - \left[\frac{\left[\frac{r}{T} - \frac{1}{6}\right] + \left[\frac{c}{T} - \frac{1}{6}\right] + \left[\frac{h}{T} - \frac{1}{6}\right] + \left[\frac{o}{T} - \frac{1}{6}\right] + \left[\frac{p}{T} - \frac{1}{6}\right] + \left[\frac{s}{T} - \frac{1}{6}\right]}{\frac{5}{3}} \right]$$

Where:
DI = diversity index
r = residential floor space
c = commercial floor space
h = health/community service floor space
o = office floor space
p = public administration floor space
s = social services floor space
T = total of all of the above
(all in square meters)

The index aims to capture the mix of uses relative to a "perfect" distribution of uses. A value of 0 means that the land in the area has a single use, and a value of 1 indicates perfect mixing among the six uses. Using this index, map land use diversity, measured at the TAZ-level, across the city.

What patterns emerge?
What would you hypothesize about the effect of this variable on travel behavior?

f) Take a look at the TAZs that contain very little or no information on the built environment. What do these TAZs tend to have in common? Assume that these TAZs are not "empty" in real life. What implications does this have for our representation of the city? What about for transportation planning and related policies?

4. Measuring the Built Environment by Spatial Averages
    Using the Cellresult shapefile:

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[1] Rajamani, J.C. Bhat, S. Handy, G Knaap, Y. Song. Assessing Impact of Urban Form Measures on Nonwork Trip Mode Choice After Controlling for Demographic and Level-of-Service Effects. *Transportation Research Record 1831*, 2003, pp. 158-165.

a) Recalculate and re-map the 3 measures you derived in Question 2 above that you can also derive using the information in the Cellresult shapefile. Why is this spatial representation better/worse than the census block map?

b) Calculate, for each grid cell, a measure that attempts to reflect street configurations. Show your map. What patterns, if any emerge? How do these patterns compare to those derived for the TAZ, above? (note, you do not, necessarily, need to have calculated the same indicator as above to answer this question)

c) Before proceeding to question (d) below, using only a single type of land use, what would be the appropriate variable to use to represent the Central Business District (CBD)? Map it. How does your result compare to the measure derived for the TAZ, above?

d) Following 3(e), above, calculate for each grid cell, the Diversity Index. How do your results compare to the DI calculated for the TAZ, above?

e) Which spatial unit of analysis (grid cells, TAZs, census blocks) do you think provides the most accurate portrayal of (ignoring the empty TAZs):
   - Residential density;
   - The CBD (only for the relevant spatial units for which this was calculated);
   - Street configurations (only for the relevant spatial units for which this was calculated);
   - The diversity index (only for the relevant spatial units for which this was calculated)?

f) Comparing the TAZs and the grid cell (and, again, ignoring the empty TAZs), which of the comparable measurements changed the most depending upon the unit of analysis?

g) What are the strengths and weaknesses of the spatial averaging (grid cell) approach?

h) Finally, if you had your choice of approach for spatially measuring the built environment in Santiago, which approach would you use (*be brief*, but be creative)?

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