A Dream Come True? Analyzing the Geography of Opportunities for Public Housing Residents in Santiago de Chile

Sara McTarnaghan
University of Texas at Austin
Community and Regional Planning & Latin American Studies

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EXECUTIVE SUMMARY

This project is a critical analysis of the effectiveness of public housing to improve quality of life for beneficiaries of the program by analyzing the geography of opportunities of public housing residents in Santiago de Chile. The research focuses specifically on basic housing projects (fondo solidario de vivienda) that were contracted and built after 2006, when the government reform the housing policy to prioritize better localization.

I will assess residents’ access to a variety of public and private services, including: education, health, safety and public services, transportation, commerce, recreation, as well as vulnerability to risk sites. The results of the spatial analysis, complemented by interview data from residents and NGO representatives, will be analyzed to assess opportunities and vulnerabilities of residents. This multi-variable analysis contributes to current literature on housing segregation in Santiago, which focuses primarily on health, education and safety.
INTRODUCTION

Across Latin America, market forces have historically been unable (or unwilling) to provide housing to all sectors of society, leaving low-income communities without formal housing options in many cities. With accelerated urbanization over the past 50 years, the region saw the rapid growth of informal settlements or self-built environments in response to the lack of formal housing options. Recently, the Inter-American Development Bank estimated a housing deficit of 59 million units in Latin America; meaning roughly 1 in 3 people in the region have inadequate shelter (Bouillon, 2012). State governments have responded to urban poverty through many strategies, one of the most prominent interventions being the provision and financing of government subsidized public housing, filling the gap in the private housing market.

A Brief History of Public Housing in Chile

The history of public housing in Chile dates back to 1906, yet the reforms that largely shape current policy and the switch to a demand side system with the participation of the private sector occurred during the military rule, part of the wide range of neoliberal free-market reforms. The housing policy starting in 1978 changed the role of the government to that of a subsidiary agent, leaving construction and other transaction related responsibilities to non-state entities. Under this policy, the State, through the Ministerio de Vivienda y Urbanismo (MINVU) set regulations on basic quality and construction standards while the municipalities were responsible for legal and urban standards. The technical assistance, construction, and mediation between various actors were led by other entities, public and private, who were recipients of the subsidy. In practice, this eliminated all planning controls of over the land market to reduce cost of acquiring land (Gilbert, 2002, 310).

This policy began widespread implementation in the mid-1980s and was fully consolidated during the 1990s. Social housing during this period was understood by the MINVU as a “finished unit that would solve the housing deficit problem” to be accessed through the joint work of family savings and state support (Jiron, 2010, 2). It was largely focused on providing housing alternatives or the “sueño de la casa propia” to those that lived in campamentos or as “allegados” in overcrowded houses, and served to reduce greatly the number of informal settlements in the country. The modernizing role of the state was understood to facilitate this transition in the words of the MINVU:

“en nombre de todos los ciudadanos de Chile, el estado ayuda en dinero para la compra de su casa y la solución de su techo. Así ganará usted la dignidad humana que tanto merece por su honradez y su trabajo. Esto no es paternalism. Es justicia social” (Aravena et al, 2006, 27).

Beyond the stated goals of “justicia social”, many scholars have noted that the government was acutely interested in riding informal settlements from municipalities such as Providencia, Santiago or Las Condes as their presence created distortions in the cost of land in neighborhoods with “high development potential” (Ibid, 30).
Since the return to democracy in 1990, the government has focused largely on the eradication of slums in the country, seeking to reduce risks associated with the highly precarious living situation and improve quality of life for Chilean citizens, and has, by and large, successfully closed the housing deficit. The core principles and design of the housing policy have remained relatively consistent from that implemented in the 1970s and 80s, however, the Housing Reform of 2000 and the introduction of the Debt Free Dynamic Social Housing in 2002 adjusted the policy to improve coverage to the most vulnerable populations.

Growing Concerns about the Housing Policy

Since the early 2000s, academics and the NGO sector began to speak out and challenge the discourse of success regarding the housing policy; raising concerns about the peripheral location, substandard building quality and overcrowding that was occurring in these projects. An interdisciplinary team of scholars published the book Los Con Techo: un Desafío para la Política de Vivienda Social in 2005 revealing the discontent among residents and arguing that the housing problem in Chile had transitioned from those without housing to those living in these projects. Survey results revealed that 64.5 percent of public housing residents in projects built from 1980-2000 wanted leave their homes and 90 percent felt fear or shame of where they lived (Rodriquez & Sugranyes, 2005, 71).

The peripheral location of these housing interventions meant that many residents arrived at their new home only to find out that the "city" was missing, waiting up to 10 years for basic urban infrastructure [B. Baranda, Interview, 06/2013]. While basic public infrastructure eventually arrived, the public and private sector, he argues, has yet to invest in urban amenities in such areas. In 2009, the research institute CIPER published a large scale research project entitled "Vivir y Morir en una Zona Ocupada de Santiago", revealing that more than 650,000 people in Santiago live in zones where the State is absent, ruled by the “ley del mas fuerte”. These zones are areas in which basic infrastructure is missing and environmental hazard abundant, places where the police calls go unanswered and violence is high. To a large degree these ghettos grew out of earlier iterations of the housing policy, as it created isolated, homogenous zones of poverty across the city.

Housing Policy Today

In part to correct this legacy, since 2006, the Ministry of Housing and Urban Development (MINVU) and the Chilean government has increased regulations on the type of location of housing projects, increasing subsidies for localization. The government added new regulations on funding that was distributed to the private sector, such as limiting the number of units per project and matching construction sites near community of origin (MINVU). The localization subsidy was one of 6 strategies to improve social integration of housing projects.

Reference Maps:

Following this section is a series of reference maps included to orient the reader to Santiago de Chile - geographically, politically and demographically. First, a political boundaries map situates Santiago and highlights the municipal [comuna] boundaries within the metropolitan area. Secondly, demographic maps use Instituto Nacional de Estadística (INE) census results to reveal spatial trends of metropolitan segregation - endemic in Santiago. Density mapping
of socio-economic groups (GSE) using census categories (ABC1, C2, C3, D, E) is illustrative of this segregated pattern of urban growth. Lastly, a third map reveals localization trends of low-income housing in Santiago, including historic localization of public housing under the demand based policy (1980-2004), post reform basic housing projects, remaining informal settlements\(^1\), and areas identified as high risk "ghettos"\(^2\).

\(^1\) Estimates of informal settlements (campamentos) vary between official government reports and NGO or advocacy channels. Most recently, TECHO (a local non-profit) published a report revealing that the numbers

\(^2\) In 2010, ATISBA conducted a nationwide study to identify "guetos", areas characterized by majority of GSE groups D & E, high incidence of violence and low access to basic services.
A Dream Come True? Access and Opportunity in Santiago de Chile

CHILE

REGION METROPOLITANA Provincias

SANTIAGO Comunas

Comunas
Rio Mapocho
Provincias
Highways
Avenues

AUTHOR: Sara McTarnaghan | 12.11.2013
DATUM: WGS 1984 UTM Zone 19S
SOURCE: OC-UC, CIT-UAI, CIS-TECHO

CHILE REGION METROPOLITANA SANTIAGO

POLITICAL BOUNDARIES

0 105 Km

0 10050 Km

PROVINCIAS

Provincias

0 5 10 Km
DEMOGRAPHICS

A Dream Come True?
Access and Opportunity in Santiago de Chile

Distribution of Socio Economic Groups

Higher Education Attainment

Socioeconomic Group  Higher Edu Attainment
- 1 Dot = 25
- ABC1
- C2
- C3
- D
- E

INE 2002, By District

0-15%
15-30%
30-45%
45-75%

Rio Mapocho
Highways
Santiago
PUBLIC HOUSING
A Dream Come True?
Access and Opportunity in Santiago de Chile

Informal Settlements & Ghettos

Post-Reform Projects
Pre-Reform Projects
Informal Sett. (Techo)
Informal Sett. (Official)
Ghetto
Rio Mapocho
Highways
Avenues
Santiago

AUTHOR: Sara McTarnaghan | 12.11.2013
DATUM: WGS 1984 UTM Zone 19S
SOURCE: OC-UC, CIT-UAI, CIS-TECHO
PROBLEM STATEMENT

Historically, the Chilean housing policy has (re)produced segregation in Santiago through construction of public housing units on the urban fringe, isolating residents from basic public services and amenities. While the house itself often represents a major improvement in the “material” quality of life (better infrastructure, less vulnerability to hazards, etc.), the peripheral location raises series concerns about the right to the city for public housing residents. To correct this legacy, since 2006, the Ministry of Housing and Urban Development (MINVU) and the Chilean government have increased regulations on the type and location of housing projects, increasing subsidies for localization.

My overall hypothesis is that the housing projects have improved localization from former iterations of the housing policy due in part to a more conscious attention to locality in project design, but also a result of parallel processes of the expansion of the “city” to traditionally peripheral zones. However, I anticipate that the majority of housing projects will still face deficient access to many of the thematic areas analyzed. I expect this to be more acute in regards to recreation and commercial amenities rather than state-led public services.

RESEARCH QUESTION

To what degree have public housing projects in Santiago de Chile, contracted and built after the 2006 policy reform, been successful in meeting new policy goals which called for improved localization, based on access to crucial urban services (health, education, safety and public services, recreation, commerce, transportation, and cultural and public spaces)?

METHODOLOGY

Data Collection

To answer this research question and conduct a multi-variable analysis, I needed to collect a relatively large body of data for Santiago, Chile. This included spatial data on public and private amenities, public housing, key urban and environmental infrastructure, political and administrative boundaries, socio-environmental risks and hazards, as well as census data from the INE (equivalent of US census bureau). When possible, I sought to collect data that had some evaluation or qualitative analysis to allow for a more nuanced spatial analysis. For example, standardized testing scores (SIMCE) were available for all high schools in Santiago, which allowed me to disaggregate high, average and under-scoring schools.

All data was collected during fieldwork for my Masters thesis throughout the summer of 2013 from several universities and agencies in Santiago, Chile. This research would not have been possible if not for the generosity of the Centro de Inteligencia Territorial at Universidad Aldolfo Ibanez, Centro de Investigación Social at TECHO, and the Obersvatorio de Ciudades at Univerisdad Catolica de Chile in kindly sharing shapefiles and data with me.
A special thank you to Juan Correa and Pablo Beytía at the Centro Investigación Social at TECH and Javiera Cespedes and Daniela Paz Fuentes at the Centro de Ineligencia Territorial at UAI for their time and interest in the project. Additionally, I want to express my gratitude to the Lozano Long Institute of Latin American Studies and the School of Architecture at the University of Texas at Austin for providing scholarships to make the fieldwork possible.

**Data Preparation**

To begin, all data was cleaned and prepared for analysis. All of the geographic data in this study was defined and projected to have the following metadata:

- Datum: WGS 1984
- Projection: UTM Zone 19S

Additionally, all data was restricted to the study area – the Santiago metropolitan area – by clipping the files to the shapefile “Santiago.shp”. All files were renamed after clipping with the ending _clip.shp for organization.

**GIS Methodology**

I used spatial analyst tools built into ArcGIS 10.1 to conduct a suitability analysis of public housing sites based on access to a series of public services and urban amenities and distance from hazardous sites. This allowed me to rank the public housing projects built after 2006 across themes and in a composite ranking based on their access to services (using distance as a proxy).

1. **Reference Maps: Setting the Stage**

Before starting my analysis I created a series of reference maps to orient the reader to Santiago de Chile - geographically, politically and demographically.

   a. **Political Boundaries**
   Series of maps to transition from the country-scale to regional and then city-scale. Provinces and Municipalities are labeled on the regional and city maps.

   b. **Demographics**
   1) **Socio-Economic Groups**
   Dot density map using classifications of Socioeconomic Groups and overall population counts from the 2002\(^3\) INE Chilean Census. Map shows areas of dense population and areas of homogeneity of socio-economic groups, both high and low-income.
   Symbolized using Dot Density tool; each dot = 25 people of a given socio-economic group (ABC1, C2, C3, D, E) per census block.

   2) **Higher Education Attainment**

\(^3\) A 2013 census was also carried out in Chile however there have been concerns raised over its accuracy. Currently, there is an internal review process occurring, so I opted to use data from the prior census.
To further illustrate trends of socio-economic segregation in Santiago, I included a map to illustrate higher education attainment in Santiago with 2002 INE Education Census Data. I joined the census data table with the census block (manzana) shapefile and symbolized by quantity of higher education attained in 4 classes. This data was spatially joined with the census districts shapefile to show trends across the city instead of block-by-block variation.

c) Housing

First map visualizes the post-reform public housing projects (unit of analysis for this study) compared to the location of the housing projects in the 1980-2004 period. A second map illustrates the localization of informal settlements and areas classified as ghettos.

2. Visualizing Amenities

To begin analysis, I created amenity maps in vector format across the seven themes identified (listed in the table below). This allows readers to get a sense of the patterns of localization of these amenities across the metropolitan area in relation to the housing projects. These layers were symbolized by type when possible to show the detailed breakdown of the amenity types.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Amenities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Public (Municipal) Preschools, High Schools (ranked by 2012 total SIMCE scores and classified High, Average, and Low Scoring), Higher Education</td>
</tr>
<tr>
<td>Health</td>
<td>Hospitals, Consultorios, Emergency Rooms, Medical Centers, Clinics</td>
</tr>
<tr>
<td>Safety and Public Services</td>
<td>Fire Station, Police Station, Investigations (PDI), Post Office, Lower Court, Ministry, Municipality, Civil Registry</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>Metro System, Transantiago Bus Routes, Feeder Bus Routes, Bus Terminals</td>
</tr>
<tr>
<td>Commerce</td>
<td>Malls, Commercial Centers, Grocery Stores, Open Air Markets</td>
</tr>
<tr>
<td>Recreation</td>
<td>Green Space, Public Spaces, Athletic Facilities</td>
</tr>
<tr>
<td>Hazardous Sites</td>
<td>Illegal Dumps, Landfills, Abandoned Lots</td>
</tr>
</tbody>
</table>

3. Thematic Suitability Analysis

For each of the seven thematic areas I used the vector amenity map created in the previous step to conduct a suitability analysis using the Spatial Analyst Toolset. First, I used the Euclidean Distance Tool to measure proximity to amenities (listed in the table above). A uniform classification system [Classes = 10 / Equal Intervals] was used. For cases where proximity was desirable the classes were reversed so that 1 would symbolize highest access.

4 Distance from (instead of proximity to) hazardous sites was calculated in the evaluation of the housing projects.
and 10 lowest. For cases where distance from site was desirable the new classes were not reversed so that 1 is most distance (desirable) and 10 is highest proximity (risk).

For each theme, amenities were assigned a “weight” or significance in the suitability equation using the raster calculator tool. Weights were determined by prioritizing the most important services and amenities. The equations used in this analysis can be found in the appendix of this document.

The weights raster data was reclassified for each theme (Classes = 10 / Equal Intervals / Inverse New Classes). This was converted back to vector format and spatially joined with the housing projects to rank the projects by access. The housing projects were then symbolized by quantity [GRIDCODE]; projects scoring 1 were defined as High Access, 2 – Medium Access and 3-10 - Low Access. This was consistent across all thematic access categories except for proximity to hazardous sites. For hazardous sites, most distance from sites was considered to be lowest risk. As such, the housing projects were ranked based on GRIDCODE score as follows: 1 – Low Risk, 2 – Medium Risk, 3+ - High Risk. The ranking of housing projects was symbolized by color and is displayed on each of the seven thematic maps.

4. Combined Accessibility Ranking

Using the suitability analysis from each of the seven thematic categories, I created a final Combined Accessibility Ranking to evaluate the housing projects. Using the Raster Calculator Tool in the Spatial Analyst Toolset, I combined the seven thematic raster files in one. The combined access raster was then reclassified (Classes = 10 / Equal Intervals / Inverse New Classes). Next, the reclassified file was converted back to vector format and spatially joined with the housing projects to rank the projects by access. The housing projects where then symbolized by quantity [GRIDCODE] and projects scoring 1 were defined as High Accessibility, 2 – Medium and 3-10 - Low Accessibility.

5. Case Studies

From the combined access ranking analysis, I selected one high ranking and one low ranking project for further analysis. By “zooming in” on these sites, the reader can get a sense of what is immediately available to the residents within a 1km radius of the housing project. Details of the two cases are in the table below:

<table>
<thead>
<tr>
<th>Case 1: High Accessibility Ranking</th>
<th>Case 1: Low Accessibility Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMATI Housing Project</strong></td>
<td><strong>Sueño Por Cumplir Housing Project</strong></td>
</tr>
<tr>
<td>Municipality: Estación Central</td>
<td>Municipality: Los Espejo</td>
</tr>
<tr>
<td>Inauguration: 2011</td>
<td>Inauguration: 2007</td>
</tr>
<tr>
<td>Families: 140</td>
<td>Families: 30</td>
</tr>
</tbody>
</table>
FINDINGS

In this section, readers will find 10 maps, organized as follows:

*Analysis: Access and Amenities by Theme*
1 | Proximity to Education Facilities
2 | Proximity to Health Facilities
3 | Proximity to Safety and Public Services
4 | Proximity to Transportation Infrastructure
5 | Proximity to Commerce
6 | Proximity to Recreation Sites
7 | Distance from Hazardous Sites

*Results*
8 | Combined Accessibility Score
9 | Case 1: High Access
10 | Case 2: Low Access
EDUCATION
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Ranking of Access to Education Facilities
Housing projects are ranked on an access scale based on proximity to municipal preschools, mid and high scoring K-12 schools, higher education, and distance from under achieving schools.

Distribution of Educational Facilities
- Preschool [Municipal]
- Higher Education
- K-12 Schools
  - Combined Simce Score 2012 [4 Basic]
- Underscoring
- Average
- High Achieving

Accessibility Score
- High
- Medium
- Low

Distribution of Educational Facilities
- Public Housing
- 1 Km Buffer
- Rio Mapocho
- Highways
- Avenues
- Santiago

Authors: Sara Mctarnaghan | 11.18.2013
Source: UC, CIT-UAI, CIS-TECHO
HEALTH
A Dream Come True?
Access and Opportunity in Santiago de Chile

Ranking of Access to Health Facilities
Housing projects are ranked on an access scale based on proximity to hospitals, consultorios, emergency services, medical centers, and clinics.

Distribution of Safety and Public Services
- Hospitals
- Consultorios
- Emergency Services
- Medical Centers
- Clinic

Accessibility Score
- High
- Medium
- Low

AUTHOR: Sara McTarnaghan | 11.18.2013
DATUM: WGS 1984 UTM Zone 19S
SOURCE: OC-UC, CIT-UAI, CIS-TECHO
Access and Opportunity in Santiago de Chile

A Dream Come True?

Public Services

Ranking of Access to Public Service Facilities

Housing projects are ranked on an access scale based on proximity to police stations, fire stations and other basic public services (listed below).

Distribution of Safety and Public Services

- Post Office
- Lower Court
- Ministry
- Municipality
- Civil Registry

Safety
- Fire Station
- Police Station
- Investigation

Accessibility Score
- High
- Medium
- Low

Author: Sara McTarnaghan | 12.11.2013
Source: OC-UC, CIT-UAI, CIS-TECHO

Datum: WGS 1984 UTM Zone 19S

0 5 10 Kilometers
Ranking of Access to Public Transportation

Housing projects are ranked on an access scale based on proximity to the metro, bus terminals, Transantiago routes, and feeder buses.
A Dream Come True?
Access and Opportunity in Santiago de Chile

Ranking of Access to Commercial Facilities
Housing projects are ranked on an access scale based on proximity to grocery stores, malls, commercial centers, and markets.

Distribution of Commercial Facilities
- Malls
- Commercial Centers
- Grocery Stores
- Markets
- Public Housing
- 1 Km Buffer
- Rio Mapocho
- Highways
- Avenues
- Santiago

Accessibility Score
- High
- Medium
- Low

AUTHOR: Sara McTarnaghan | 12.11.2013
DATUM: WGS 1984 UTM Zone 19S
SOURCE: OC-UC, CIT-UAI, CIS-TECHO
**RECREATION**

A Dream Come True?
Access and Opportunity in Santiago de Chile

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**Ranking of Access to Recreation Facilities**

Housing projects are ranked on an access scale based on the proximity to green space, public space, and athletic facilities as well as distance from open space in bad condition.

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**Distribution of Educational Facilities**

- Green Space
  - Good Condition
  - Bad Condition
- Public Housing
- 1 Km Buffer
- Rio Mapocho
- Highways
- Avenues
- Santiago
- Public Spaces
- Athletic Facilities

---

**Accessibility Score**

- High
- Medium
- Low
Ranking of Exposure to Hazardous Sites

Housing projects are ranked based on distance from sites that pose hazard or environmental risk. Exposure to risk was assessed based on proximity to illegal dumps, landfills and abandoned lots.

Distribution of Hazardous Sites
- Illegal Dumps
- Landfills
- Abandoned Lots
- Public Housing
- 1 Km Buffer

Ranking
- High Risk
- Medium Risk
- Low Risk

A Dream Come True?
Access and Opportunity in Santiago de Chile
Housing projects are ranked on an access scale based on proximity to education, health, safety and public services, commerce, recreation, public transportation, and distance from hazardous sites.
CASE 1: HIGH ACCESS
A Dream Come True?
Access and Opportunity in Santiago de Chile

EMATI Housing Project | Estacion Central | 2011

Source: Chile Cumple via Flickr

Amenity
- Preschools [Municipal]
- K-12 Education
- Higher Education
- Health facilities
- Safety
- Grocery Stores
- Malls
- Markets
- Bus Terminals
- Metro Lines
- Transantiago Bus Routes
- Greenspace

EMATI Housing Project
1 Km Buffer
Streets
Highways

Risks
- Abandoned Lots

Source: Chile Cumple via Flickr

Author: Sara McTarnaghan | 12.11.2013
Datum: WGS 1984 UTM Zone 19S
Source: OC-UC, CIT-UAI, CIS-TECHO
CASE 2: LOW ACCESS

A Dream Come True?
Access and Opportunity in Santiago de Chile

Sueño Por Cumplir | Lo Espejo | 2007

Source: INV FAU Universidad de Chile

Amenity
- Preschool (Municipal)
- K-12 Education
- Safety Services
- Health Facilities
- Transantiago Bus Routes
- Open Air Market

Risk or Hazard
- Underscoring School
- Illegal Dumps
- Abandoned Lots
- Sueño Por Cumplir
- 1 Km Buffer
- Highways
- Streets

Source: INVI FAU Universidad de Chile

0 0.25 0.5 Kilometers
ANALYSIS

As shown on the chart below, there was great variation in the distribution of accessibility scores across the themes analyzed. For example, low scores in recreation and commerce countered high accessibility scores in health and public services. Alarmingly, the vast majority of housing projects face significant risk due to their proximity to hazardous sites. Overall, the majority of the housing ranked medium access (64%), and a smaller portion ranked high or low access, 23% and 12%, respectively.

The following section provides a theme-by-theme analysis of the results:

EDUCATION

Summary of Accessibility Ranking

| High:      | 18 Housing Projects |
| Medium:    | 19 Housing Projects |
| Low:       | 10 Housing Projects |

The map of educational facilities in Santiago reveals wide coverage of preschool and k-12 schools across the city, while institutions of higher education are largely concentrated in the historic core of the city, distant from public housing facilities. Although the location of k-12 schools is well dispersed, analysis on the performance of the schools shows concentrations of high achieving schools in the northeastern cone of the city with underscoring schools creating a peripheral belt around the city with the exception of the NE cone. School performance was evaluated using 2012 standardized test scores (SIMCE 4 Basicol). In many cases these low-performing schools were the closest school to the housing projects (within the 1km buffer).

HEALTH

Summary of Accessibility Ranking

| High:      | 34 Housing Projects |
| Medium:    | 12 Housing Projects |
| Low:       | 1 Housing Projects |

Overall the housing projects ranked highly on accessibility to health facilities, suggesting that the network of public health facilities (Hospitals, Clinics, Medical Centers, Emergency Services, and Consultorios) has wide coverage across Santiago.
SAFETY AND PUBLIC SERVICES

<table>
<thead>
<tr>
<th>Summary of Accessibility Ranking</th>
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</thead>
<tbody>
<tr>
<td>High: 28 Housing Projects</td>
</tr>
<tr>
<td>Medium: 15 Housing Projects</td>
</tr>
<tr>
<td>Low: 4 Housing Projects</td>
</tr>
</tbody>
</table>

Similar to health facilities, housing projects all ranked relatively high for access to safety and public services. The clear exception to this is a group of housing projects in the municipalities of Quilicura and Renca, located in NW Santiago.

TRANSPORTATION

<table>
<thead>
<tr>
<th>Summary of Accessibility Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>High: 23 Housing Projects</td>
</tr>
<tr>
<td>Medium: 21 Housing Projects</td>
</tr>
<tr>
<td>Low: 3 Housing Projects</td>
</tr>
</tbody>
</table>

The majority of housing projects ranked high or medium for accessibility to transportation infrastructure. Noticeably the housing projects located in central Santiago had better ranking due to network connectivity. As visible on the map Transantiago buses have quite thorough coverage across the city, however long trips and wait times and overcrowding can lessen the quality of service at these more distant sites.

COMMERCE

<table>
<thead>
<tr>
<th>Summary of Accessibility Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>High: 10 Housing Projects</td>
</tr>
<tr>
<td>Medium: 24 Housing Projects</td>
</tr>
<tr>
<td>Low: 13 Housing Projects</td>
</tr>
</tbody>
</table>

The commerce maps show interesting trends of commercial activity in Santiago, with formal commercial sites (Malls, Commercial Centers and Grocery Stores) more densely concentrated in the central and NE cone of the city and informal markets very prevalent in the rest of the city. Unlike some of the public services analyzed, many of the housing projects ranked Medium or Low on access to commercial facilities. Additionally, while clusters of better and worse access are visible, there is not one clear area to focus additional attention.

RECREATION

<table>
<thead>
<tr>
<th>Summary of Accessibility Ranking</th>
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</thead>
<tbody>
<tr>
<td>High: 7 Housing Projects</td>
</tr>
<tr>
<td>Medium: 18 Housing Projects</td>
</tr>
<tr>
<td>Low: 22 Housing Projects</td>
</tr>
</tbody>
</table>

Much like the analysis of commerce facilities, the housing projects mostly ranked Low or Medium for access to recreational facilities. The green space layer was separated into well-maintained and poorly maintained spaces (per information provided in the shape file) and most of the poorly maintained spaces were located near housing projects. For the analysis these poorly maintained spaces where calculated as a dis-amenity (distance from instead of proximity to) as they can become sites for unsafe activity.
HAZARDOUS SITES

<table>
<thead>
<tr>
<th>Summary of Risk Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low: 6 Housing Projects</td>
</tr>
<tr>
<td>Medium: 11 Housing Projects</td>
</tr>
<tr>
<td>High: 30 Housing Projects</td>
</tr>
</tbody>
</table>

This map, which shows proximity to hazardous sites, is perhaps the most telling and startling results of the analysis. Nearly 64 percent of the housing projects analyzed ranked high risk due to their proximity to hazardous sites (illegal dumps, landfill and abandoned lots). The co-location of public housing projects and these hazardous sites is clearly visible on the map; while the wealthier parts of the city show a complete lack of such locally unwanted land uses (LULUs).

CONCLUSIONS

The two cases, the EMATI Housing Project in Estación Central and Sueño Por Cumplir in Lo Espejo were selected for high and low accessibility score rankings, respectively, and both sites reveal wildly different geographies of opportunity and access. This suggests that the housing policy has had mixed success in prioritizing location in newly funded and built projects.

The case of EMATI shows a resource rich neighborhood with preschool through higher educational facilities, police and fire departments, a diversity of commercial offerings and several parks and plazas. The housing project is connected to the rest of Santiago through major transit (bus and metro) as well as important avenues. There are a few small pockets of abandoned lots, however no other environmental hazards are present.

This case clearly shows an example of what the housing policy should seek to accomplish, not only providing shelter and a permanent housing solution to low-income families, but also connecting them (or maintaining existing connections) to a diverse network of basic services and amenities.

On the other hand, the second case study is representative of a housing policy that has been unable to change course. The site is located at the edge of the city in the municipality of Lo Espejo. While basic public services are available within a 1km radius, the nearest k-12 school is underscoring and there is a complete absence of recreational or commercial facilities. Furthermore, the concentration of hazardous sites suggests that residents here carry an unfair burden of LULUs and likely face undue environmental risk.

In conclusion, the results reveal uneven progress on improving opportunity to basic services and amenities, suggesting that the lived experience at each of the 47 sites analyzed would vary greatly for families. This research confirms the importance of broadening the traditional list of public services to include a more holistic list of services, amenities and dis-amenities that families interact with in their day-to-day lives. Additionally, clear trends of co-location of housing projects and hazardous sites raises concerns about spatial justice in Santiago and merits further study. The same methodology used in this report to facilitate the post-occupancy evaluation of housing projects based on localization could be utilized at the
municipal or city level to identify suitable (amenity rich) locations for siting of future housing projects.

**ADDITIONAL RESEARCH**

This research builds upon studies of access and vulnerability in Santiago and sets the stage for future research. Most immediately, the analysis could be extended to include a wider spectrum of commercial and recreation facilities as well as hazardous sites that were not included due to data limitations. Additionally, the research could be complemented through on-site evaluation of several of the housing projects analyzed. This would allow the spatial data to be triangulated with information and experiences directly from residents through cognitive mapping and/or interviews. The addition of qualitative analysis would make up for one of the inherent limitations of GIS – its inability to include non-physical barriers to access and opportunity.
REFERENCES


Baranda, B. [2013, June 18]. Personal Interview.


TECHO. [2013] Reporte Mapas de Vulnerabilidad Territorial. Available at: http://www.techo.org/mapas-de-vulnerabilidad-territorial/
APPENDIX
Data Sources

All data was collected during field research during summer of 2013 from several universities and agencies in Santiago, Chile. This research would not have been possible if not for the generosity of the Centro de Inteligencia Territorial at Universidad Aldolfo Ibáñez, Centro de Investigación Social at the NGO TECHO, and the Observatorio de Ciudades at Universidad Catolica de Chile in kindly sharing shapefiles and data with me. Contact information available upon request.

Centro de Inteligencia Territorial [CIT] [Computer Files] [2013]. Santiago, Chile: Universidad Adolfo Ibáñez.

Centro de Investigación Social [Computer Files] [2013]. Santiago, Chile: Techo.

Observatorio de Ciudades [Computer Files] [2013]. Santiago, Chile: Universidad Catolica de Chile.

Detailed Data Processing Steps

1. Data Preparation
   a) Project
      All shapefiles and census data collected were compiled into a Data log and organized by theme. All shapefiles that were not already defined and projected to WGS_1984_UTM_Zone_19S were re-projected. This process of data preparation is documented in the Data log.

   b) Clip
      The study area was restricted to the urban limits of the Santiago Metropolitan Area using the shapefile “santiago.shp”. All files needed for the analysis were clipped to the study area.

   c) Join Census Data to “manzanas_Project_clip.shp”
      In order to represent data spatially, all census data from the INE 2002 census was joined with the “manzanas_project_clip.shp” file and new shapefiles were saved.

         “GSE_censo2002.dbf” → “GSE_censo2002_join.shp”
         “Poblacion_censo2002.dbf” → “poblacion_censo2002_join.shp”
         “Vivienda_censo2002.dbf” → “vivienda_censo2002_join.shp”

2. Maps

2a. Develop Base Map
   • Add Layers: “santiago.shp”, “RMfinal_Project_clip.shp”, “hidrol_clip.shp”, “barrios_clip.shp”
• Show Rio Mapocho for wayfinding: Select by attribute “hidrol_clip.shp”, select “Rio Mapocho”, Create new layer from selection “Rio_Mapocho.shp”
• Buffer Housing Projects: Buffer “barrios_clip.shp”, set buffer 1km
• Chile Reference Map:
  o Add Layers: Chile.shp, Santiago.shp

2b. Reference & Demographic Maps

1. Political Boundaries
   a) Chile
      • Add layers: chile.shp, lin_admin_13.shp, Santiago.shp
   b) Region Metropolitana
      • Add layers: lin_admin_13.shp, Santiago.shp
      • Dissolve lin_admin_13.shp by Provincias, label provincias
   c) Santiago
      • Use base map
      • Add layer comunas.shp, label

2. Demographics
   • Use Base Map
   • Add layers: GSE_censo2002_join.shp
   • Symbolize by dot density for each GSE class [ABC1, B1, C1, D, E], 1 dot = 25 people

3. Public Housing
   • Use Base Map
   • Add layers: barriodefinitiva.shp, campamentos.shp, campamentos_OCUC.shp, guetos.shp

2c. Thematic Maps

1. Proximity to Education Facilities
   • Use Base Map
   • Add Layers: “jardines_infantiles_Project_clip.shp”, “colegios_Project_clip.shp”, “educacion_superior_Project_clip.shp”
   • Set processing extent to Santiago.shp
   • Symbolize “colegios_Project_clip.shp” by Combined 2012 4 Basico SIMCE Score in three classes (Underscoring = 468-680 Average = 68-887 High Achieving = 888-1027)
   • Select low achieving schools and save as new shapefile \rightarrow cLow.shp
   • Select average achieving schools and save as new shapefile \rightarrow cMed.shp
   • Select high achieving schools and save as new shapefile \rightarrow cHigh.shp
   • Preschool: Euclidean distance “jardines_infantiles_Project_clip.shp” \rightarrow jard_dist.shp
     // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes \rightarrow jard_dist_Re.shp
   • K-12 Average: Euclidean distance cMED.shp \rightarrow cMED_dist.shp
     // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes \rightarrow cMED_dist_re.shp
   • K-12 High Scoring: Euclidean distance cHigh.shp \rightarrow cHigh_dist.shp
     // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes \rightarrow cHIGH_dist_re.shp
   • K-12 Underachieving: Euclidean distance cLow.shp \rightarrow cLOW_dist.shp
     // Reclassify distance: Method = Equal interval, Classes = 10 \rightarrow cLow_dist_re.shp
• **Higher Education:** Euclidean distance "educacion_superior_Project_clip.shp" → HiEd_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → HiEd_dist_re.shp


• Convert Raster to Polygon: Input = edu_wei_re.shp → edu_wei_re_poly.shp

• Spatial join barrios_clip.shp by location with edu_wei_re_poly.shp → edu_rank.shp

• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

2. Proximity to Health Facilities

• Use Base Map

• Add Layers: "salud_project_clip"

• Set processing extent to Santiago.shp

• Symbolize by Tipo

• Select hospital and save as new shapefile → hospitals.shp

• Select consultorios and save as new shapefile → consultorios.shp

• Select servicio de urgencia and save as new shapefile → emerg.shp

• Select centros medicas and save as new shapefile → medcen.shp

• Select clinicas and save as new shapefile → clinicas.shp

• **Hospitals:** Euclidean distance "hospitals.shp" → hosp_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → hosp_dist_re.shp

• **Consultorios:** Euclidean distance consul.shp → consul_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → consul_dist_re.shp

• **Emergency Services:** Euclidean distance emerg.shp → emerg_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → emerg_dist_re.shp

• **Medical Centers:** Euclidean distance "cenmed.shp" → cenmed_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → cenmed_dist_re.shp

• **Clinicas:** Euclidean distance "clinic.shp" → clinic_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → clinic_dist_re.shp


• Convert Raster to Polygon: Input = health_wei_re.shp → health_wei_re_poly.shp

• Spatial join barrios_clip.shp by location with health_wei_re_poly.shp → healthrank.shp

• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

3. Proximity to Safety and Public Services

• Use Base Map

• Add Layers: seguridad_Project_clip.shp, servicios_publicos_Project_clip.shp

• Set processing extent to Santiago.shp
• Symbolize by “seguridad_Project_clip.shp” by Tipo: Bomberos, Carabineros, Investigaciones
• Symbolize “servicios_publicos_Project_clip.shp” by type: Correos de Chile, Juzgados y Fiscalias, Ministerio, Municipalidad, Registro Civil
• Safety: Euclidean distance seguridad_Project_clip.shp → safe_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → safe_dist_Re.shp
• Public Services: Euclidean distance servicios_publicos_Project_clip.shp → PS_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → PS_dist_re.shp
• Convert Raster to Polygon: Input = safety_wei_re.shp → safety_wei_re_poly.shp
• Spatial join barrios_clip.shp by location with safety_wei_re_poly.shp
• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

4. Proximity to Transportation Infrastructure
• Use Base Map
• Add Layers: terminales_buses_Project_clip.shp, metro.shp, troncales.shp, bus.shp
• Set processing extent to Santiago.shp
• Metro: Euclidean distance metro.shp → metro_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → metro_dist_Re.shp
• Bus Terminals: Euclidean distance terminals_buses.shp → term_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → term_dist_re.shp
• Transantiago: Euclidean distance troncales_clip.shp → tron_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → tron_dist_Re.shp
• Feeder Buses: Euclidean distance bus.shp → bus_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → busdist_re.shp
• Convert Raster to Polygon: Input = trans_wei_re.shp → trans_wei_re_poly.shp
• Spatial join barrios_clip.shp by location with trans_wei_re_poly.shp
• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

5. Proximity to Commerce
• Use Base Map
• Add Layers: malls_clip.shp, centroscomerciales_clip.shp, feriaslibres_clip.shp, supermercados.shp
• Set processing extent to Santiago.shp
6. Proximity to Recreation Sites

- **Malls:** Euclidean distance malls.shp → malls_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → malls_dist_Re.shp
- **Grocery Stores:** Euclidean distance supermercados.shp → super_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → super_dist_re.shp
- **Commercial Centers:** Euclidean distance centroscomerciales_clip.shp → centro_dist.shp // Reclassify distance: Method = Equal interval, Classes = 10 // Inverse new classes → centro_dist_Re.shp
- **Markets:** Euclidean distance feriaslibres.shp → ferias_dist.shp // Reclassify distance: Method = Equal Interval, Classes = 10 // Inverse new classes → fer_dist_re.shp

**Composite Health Raster:** Raster Calculator = \[ \text{mall_dist_Re.shp} \times 0.20 + \text{super_dist_re.shp} \times 0.35 + \text{centro_dist_Re.shp} \times 0.20 + \text{fer_dist_re.shp} \times 0.25 \] → rec_dist.shp // Reclassify: Method = Equal interval, Classes = 10 // Inverse New classes → rec_dist_re.shp

Convert Raster to Polygon: Input = rec_dist_re.shp → rec_dist_re_poly.shp
Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

7. Distance from Hazardous Sites

- **Use Base Map**
- **Add Layers:** V_clandestinos_clip.shp, residuous_clip.shp, sitios_eriázos_project_clip.shp
- **Set processing extent to Santiago.shp**
• **Illegals Dumps**: Euclidean distance \( v_{clandestinos}.shp \rightarrow \text{vert\_dist.shp} \) // Reclassify distance: Method = Equal interval, Classes = 10 // \( \rightarrow \text{vert\_dist\_Re.shp} \)

• **Landfills**: Euclidean distance \( \text{residuous\_clip.shp} \rightarrow \text{res\_dist.shp} \) // Reclassify distance: Method = Equal interval, Classes = 10 // \( \rightarrow \text{res\_dist\_Re.shp} \)

• **Abandoned Lots**: Euclidean distance \( \text{sitios\_eriazos\_project\_clip.shp} \rightarrow \text{eriazos\_dist.shp} \) // Reclassify distance: Method = Equal interval, Classes = 10 // \( \rightarrow \text{eriazos\_dist\_Re.shp} \)

• Composite Hazardous Sites Raster: Raster Calculator = \[
\text{vert\_dist\_Re.shp} \times .40 + \text{res\_dist\_Re.shp} \times .30 + \text{eriazos\_dist\_Re.shp} \times .30
\] \( \rightarrow \text{env\_wei.shp} \) // Reclassify: Method = Equal interval, Classes = 10 // Inverse New classes \( \rightarrow \text{env\_wei\_re.shp} \)

• Convert Raster to Polygon: Input = \( \text{env\_wei\_re.shp} \rightarrow \text{env\_wei\_re\_poly.shp} \)

• Spatial join \( \text{barrios\_clip.shp} \) by location with \( \text{env\_wei\_re\_poly.shp} \)

• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High Risk, 2 = Medium Risk, 3+ = Low Risk)

8. Combined Accessibility Score

• Use Base Map

• Add: \( \text{edu\_wei\_re.shp}; \text{health\_wei\_re.shp}; \text{safety\_wei\_re.shp}; \text{trans\_wei\_re.shp}; \text{comm\_wei\_re.shp}; \text{rec\_wei\_re.shp}; \text{env\_wei\_re.shp} \)

• Composite Hazardous Sites Raster: Raster Calculator = \[
\text{edu\_wei\_re.shp} \times .16 + \text{health\_wei\_re.shp} \times .14 + \text{safety\_wei\_re.shp} \times .14 + \text{trans\_wei\_re.shp} \times .14 + \text{comm\_wei\_re.shp} \times .14 + \text{rec\_wei\_re.shp} \times .14 + \text{env\_wei\_re.shp} \times .14
\] \( \rightarrow \text{ALL\_wei.shp} \) // Reclassify: Method = Equal interval, Classes = 10 // Inverse New classes \( \rightarrow \text{ALL\_wei\_re.shp} \)

• Convert Raster to Polygon: Input = \( \text{ALL\_wei\_re.shp} \rightarrow \text{ALL\_wei\_re\_poly.shp} \)

• Spatial join \( \text{barrios\_clip.shp} \) by location \( \text{ALL\_wei\_re\_poly.shp} \rightarrow \text{allrank.shp} \)

• Classify housing projects by rank // Symbolize quantity by gridcode (1 = High, 2 = Medium, 3+ = Low)

9. Case 1: High Access

• Add base map

• Add layers: \( \text{allrank.shp}, \) all amenity layers used in analysis

• Select example of high ranking housing project [EMATI], create layer from selection \( \rightarrow \text{emati.shp} \)

• Cream 1km buffer from housing project – \( 1\text{kmEMATI\_buffer.shp} \)

• Delete all layers that do not have attributes in 1km buffer; clip all remaining layers to \( 1\text{kmEMATI\_buffer.shp} \)

10. Case 2: Low Access

• Add base map

• Add layers: \( \text{allrank.shp}, \) all amenity layers used in analysis

• Select example of low accessibility score housing project [Sueño Por Cumplir], create layer from selection \( \rightarrow \text{sueno.shp} \)

• Cream 1km buffer from housing project – \( 1\text{kmSUENO\_buffer.shp} \)

• Delete all layers that do not have attributes in 1km buffer; clip all remaining layers to \( 1\text{kmSUENO\_buffer.shp} \)
Summary of Metadata

All of the geographic data in this study was defined and projected to have the following metadata:

Datum: WGS 1984
Projection: UTM Zone 19S