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Urbano Sustentable

ACCESSIBILITY AND EQUITY
THE CASE OF SANTIAGO, CHILE

Ignacio Tiznado

Ricardo Hurtubia

Juan Carlos Muñoz

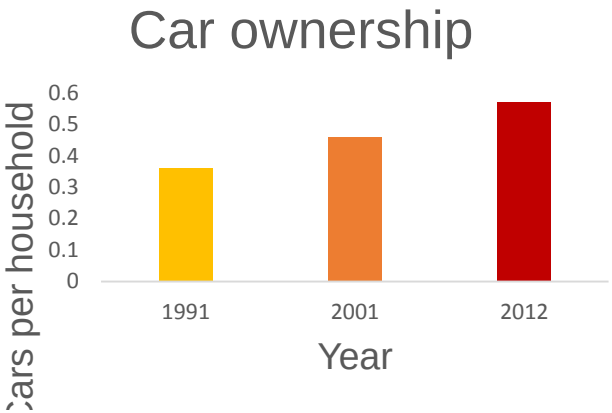
Outline

- **Santiago, Chile**
  - Urban segregation and income inequality
  - Accessibility to opportunities: evolution of activity center
- **Employment accessibility**
- **New accessibility measures**
  - Incorporating quality of service
- **Application and case study**
- **Conclusions and future work**

Santiago, Chile

Santiago, Chile

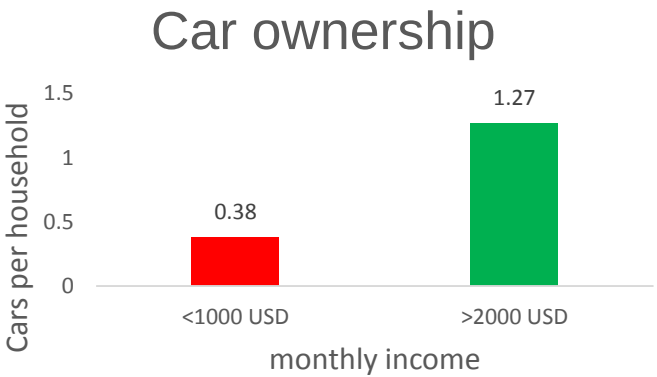
- Gini coefficient: 0.503 (MDS, 2013)
  - High, compared with developed countries. Worst within OECD countries (2014)
- 9.2% of population live in poverty situation
  - Only 6.19% of them are located on east zone
- Increased car ownership



Source: O-D Survey from 1991, 2001 and 2012

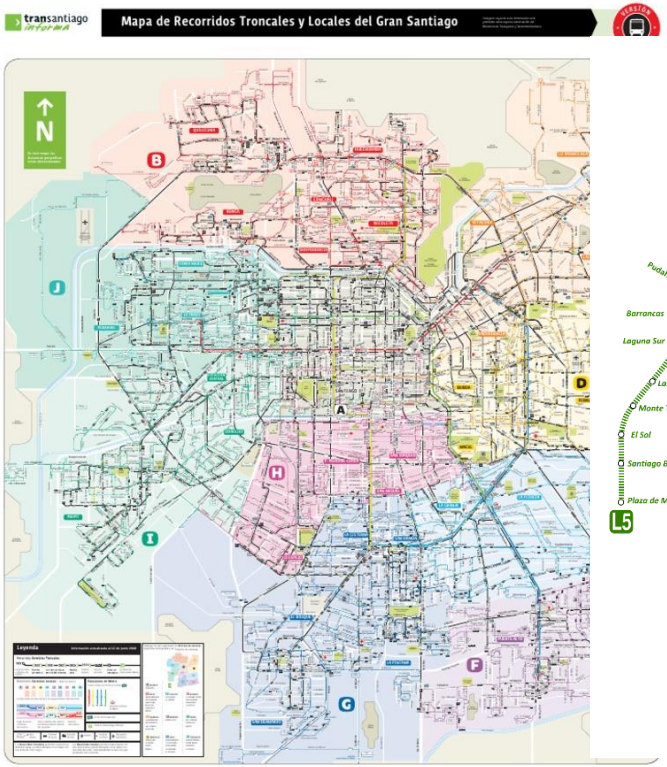
Santiago, Chile

But 59% of households does not have access to car (captive public transport users)

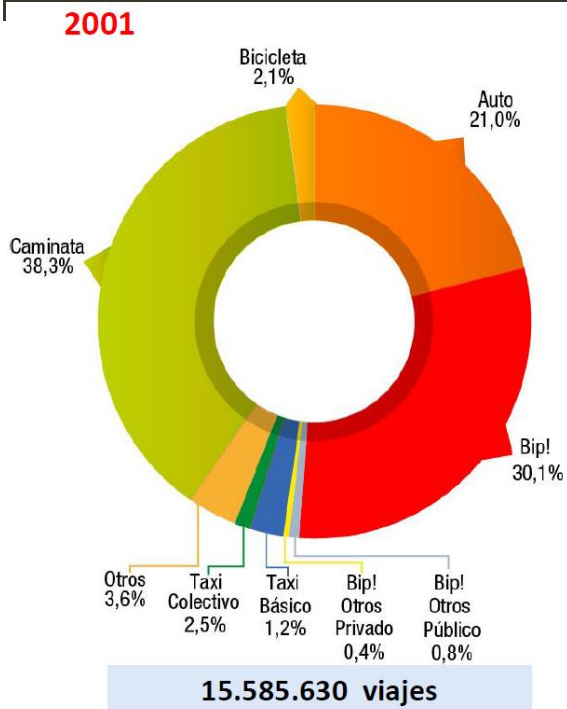


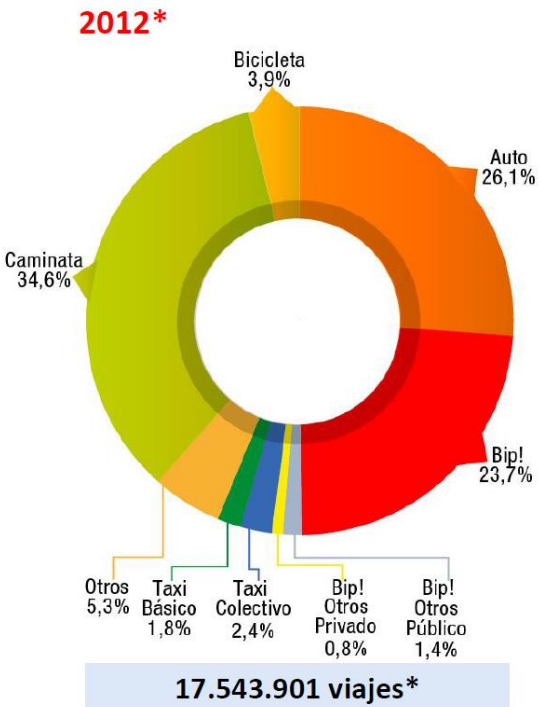
Source: O-D Survey from 2012

Transantiago



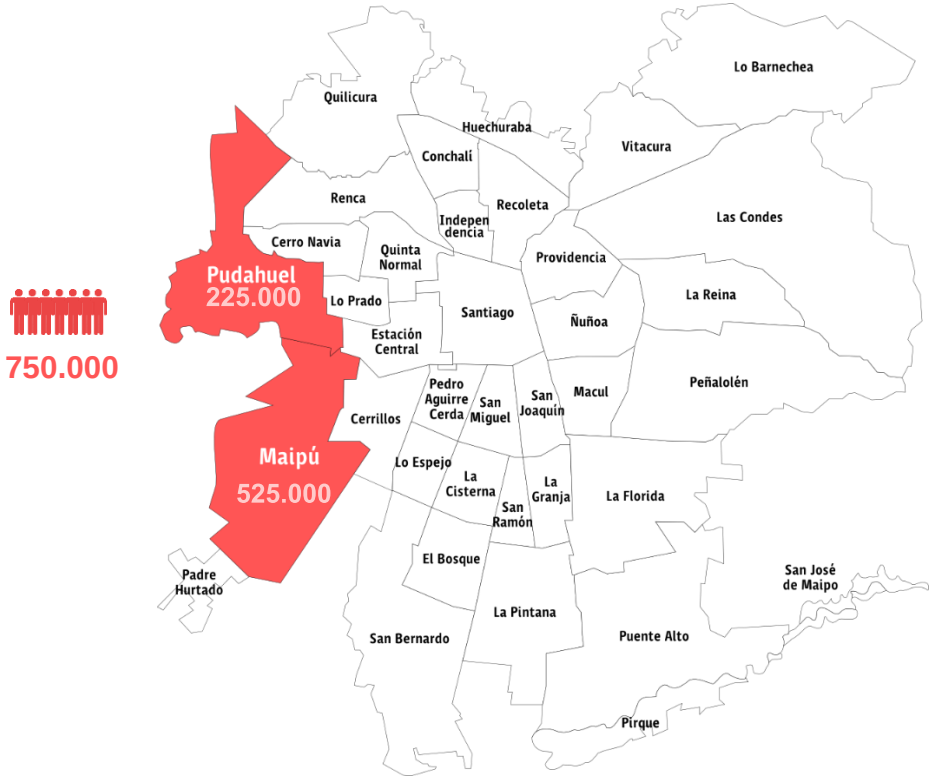
Modal split evolution





Source : “Encuesta Origen Destino de Santigo 2012”. Presentation, Ministerio de Transporte (20

Population distribution



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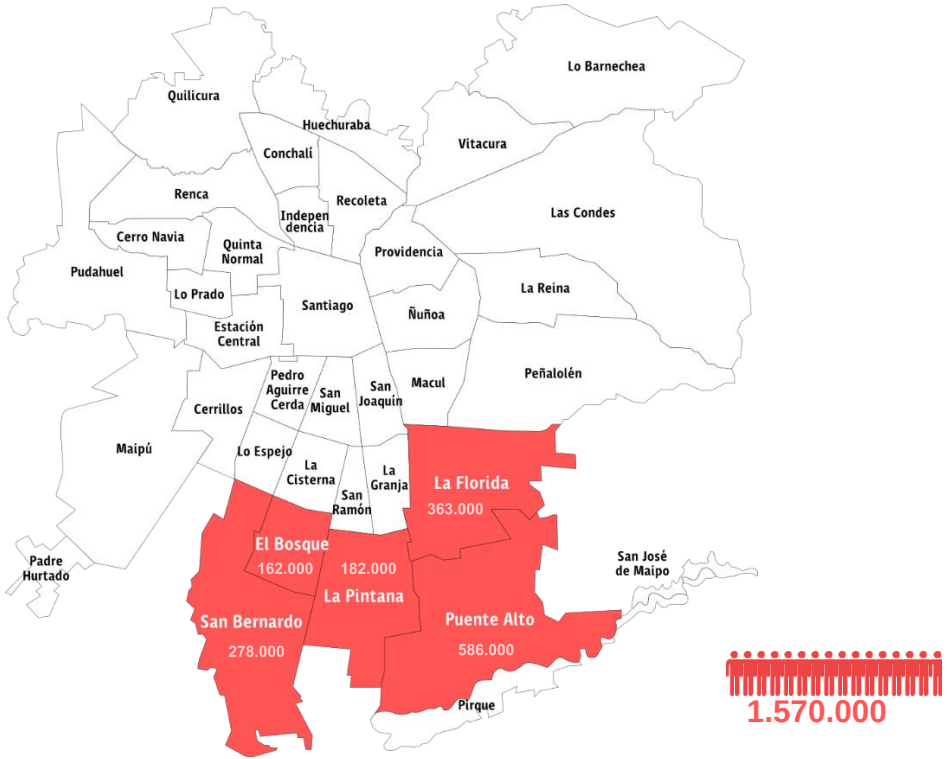

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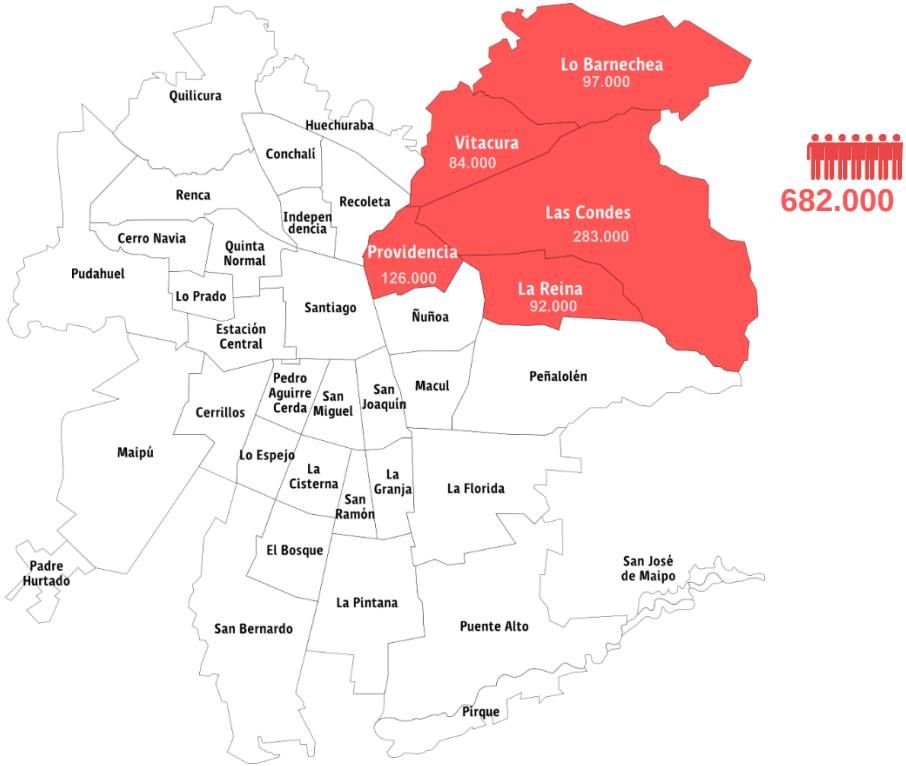
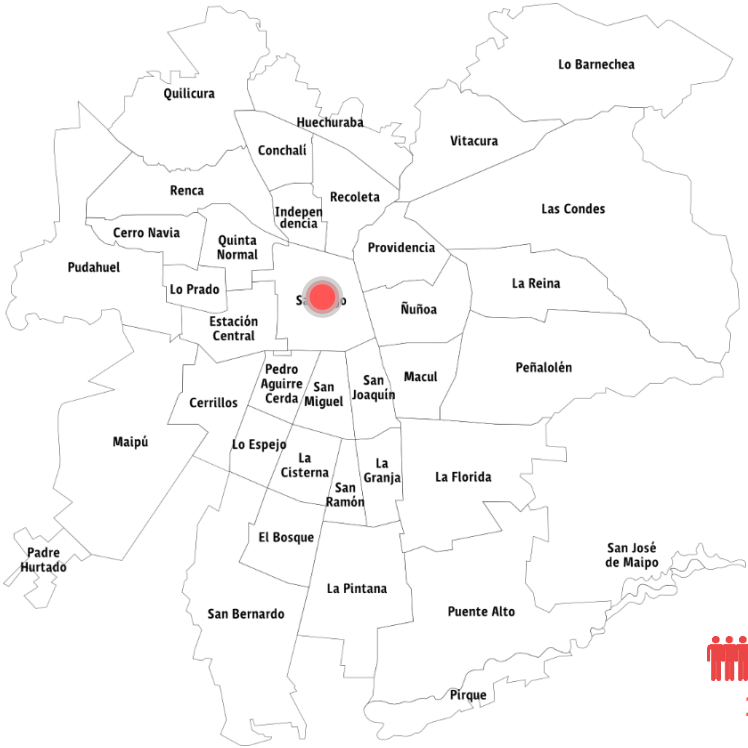


Activity center evolution

1970

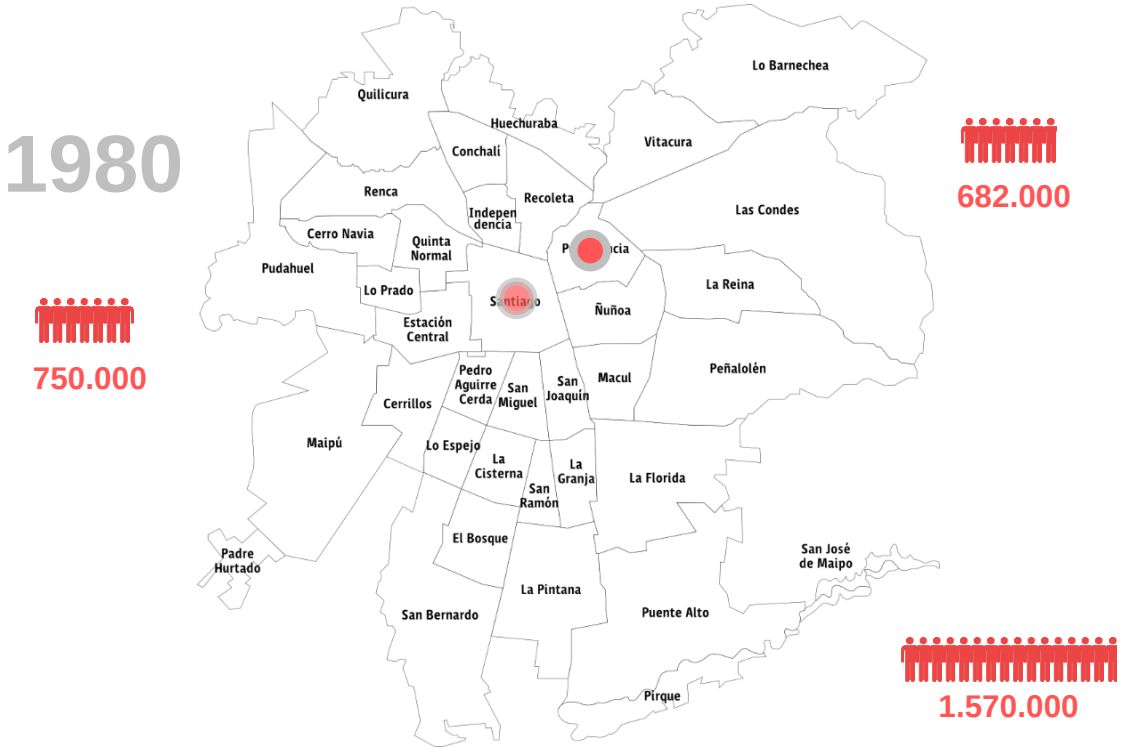
750.000



682.000

1.570.000

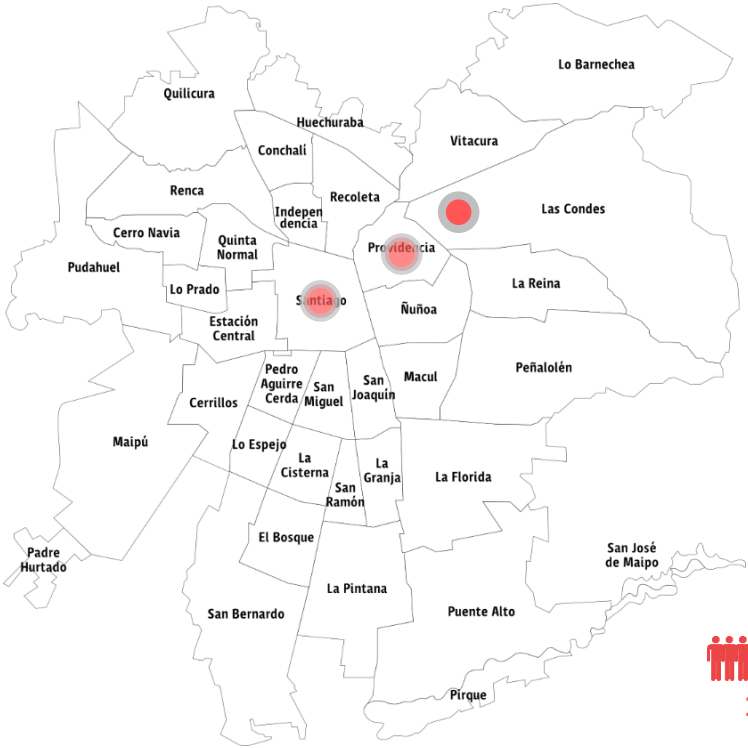
Activity center evolution



Activity center evolution

1990

750.000



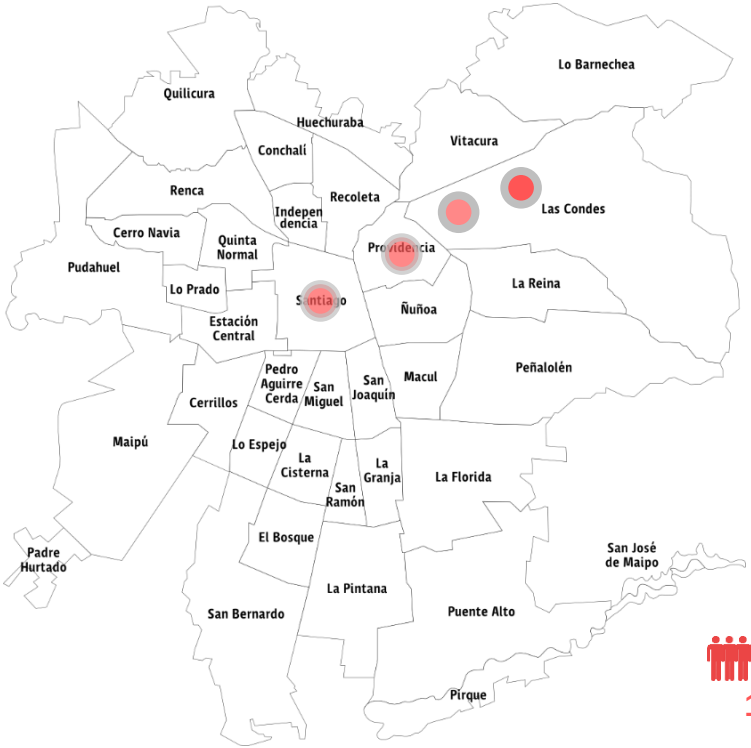
682.000

1.570.000

Activity center evolution

From 2000

750.000



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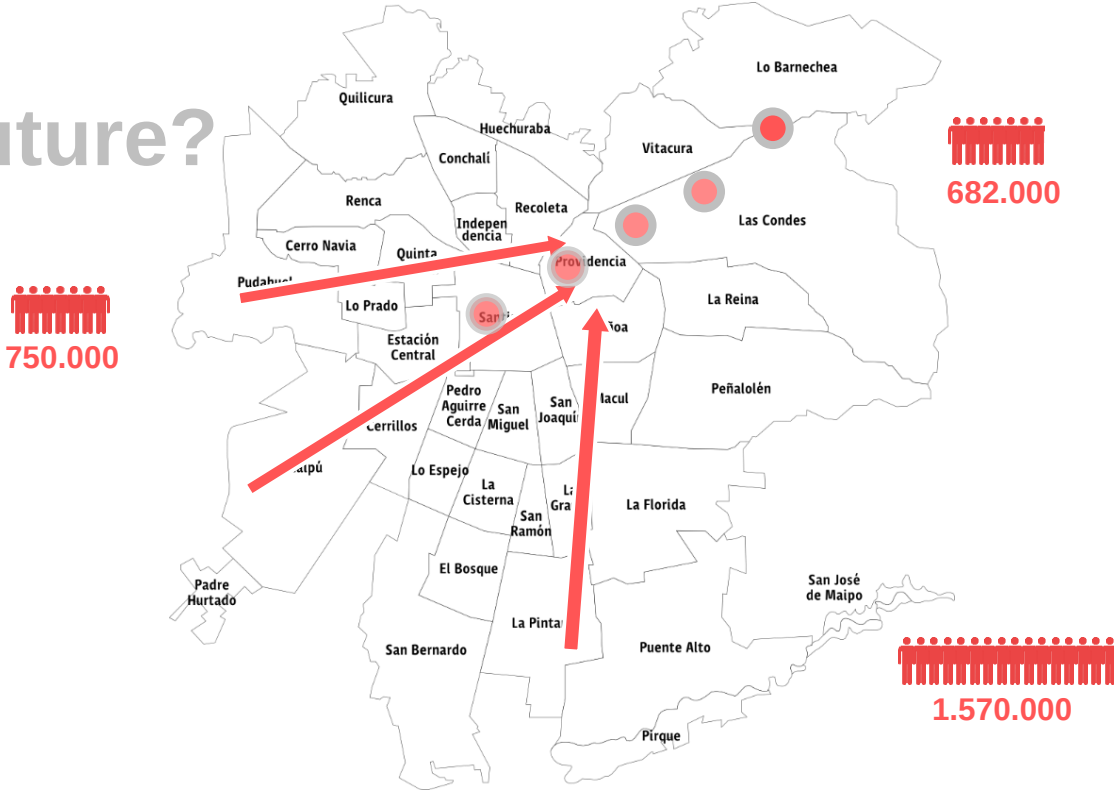
Activity center evolution

¿Future?



Causes

- Land use planning instruments are often weak
- Lack of integrated land use and transport planning
- 37 communes, each with their own mayor, budget and regulations (Lack of metropolitan authority)
- Loose requirements for new real estate developments
  - Conditioned Urban Development Zones
  - Social housing (conditions to benefit from subsidies)
    - Less than 500 meters from public transport

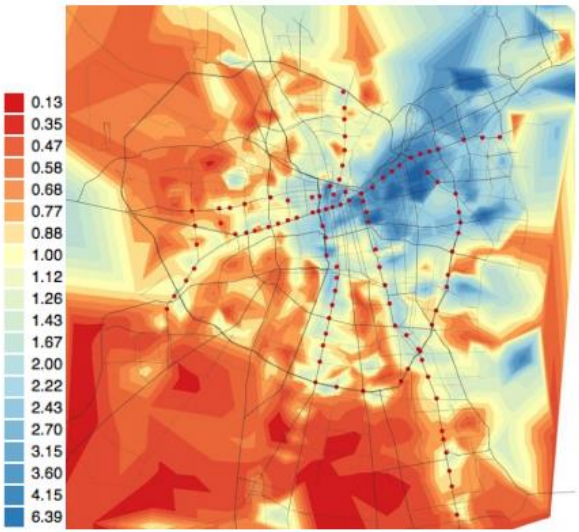
Consequences

- Low accessibility to activities and urban services
- Travel time increase in lower-income communes due to peripheral location (Sabatini et al., 2001; Rodriguez, 2008)
- Big impact in terms of equity and social exclusion (Hidalgo, 2007; Rivera, 2012)
- Hard to overcome through just improvement of the transport system

Transit accessibility to employment

- Based on strategic four step model (ESTRAUS)
  - E_j: number of opportunities in j
  - c_{ij} : generalized cost (fare, travel, walking and waiting time)

$$A_i = \sum_j E_j \cdot \exp(\beta \cdot c_{ij})$$



Source: Niehaus, Galilea & Hurtubia (2016)

- Similar to several accessibility measures found in the literature ((Handy & Niemeier (1997), Kwan (1998), van Wee et al. (2001), Geurs & van Wee (2004))

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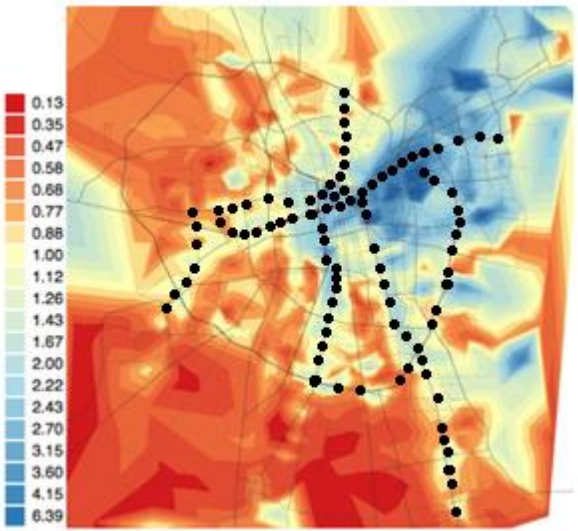

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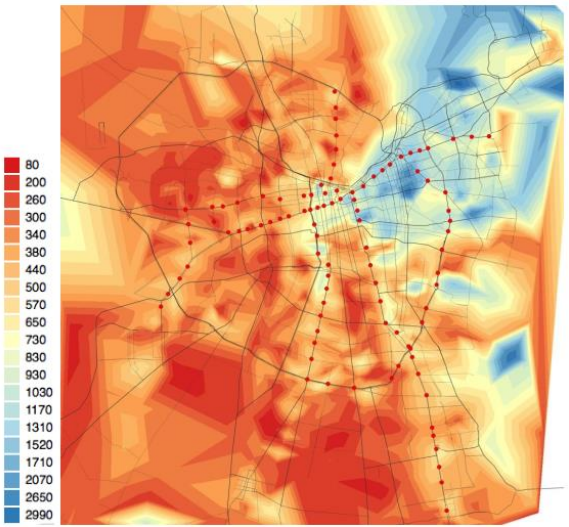


Average income per person, USD 2012
(Source: Niehaus, Galilea & Hurtubia (2016), based on O-D Survey (2012))

Public transport accessibility

- Few research on this topic (Martin et al., 2002)
- Most studies focus only on physical accessibility (Lei & Church , 2010)
- Quality of service is usually not taken into account

San Miguel

Las Condes

Quality of service

Transit stops

Santa Rosa

San Bernardo

Las Condes

Quality of service

Environment

La Pintana

Providencia

Quality of service

Environment

Peñaflor

Lo Barnechea

Quality of service

Comfort


517 J.J.PEREZ

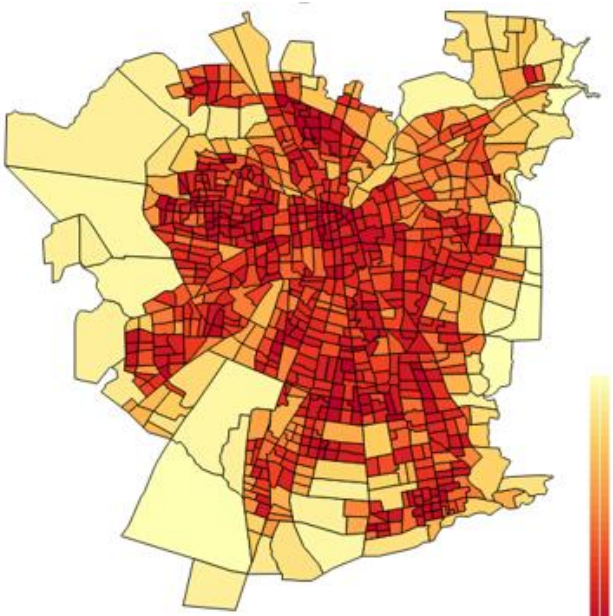
We want to include all these aspects in an expanded accessibility measure

Application

- Physical accessibility to 10 closer transit stops
  - Logistic function and speed of 3 km/hr
  - calibration based on observed trips (O-D survey, 2012)
  - Values: 0 to 1 for each transit stop (Max value: 10)

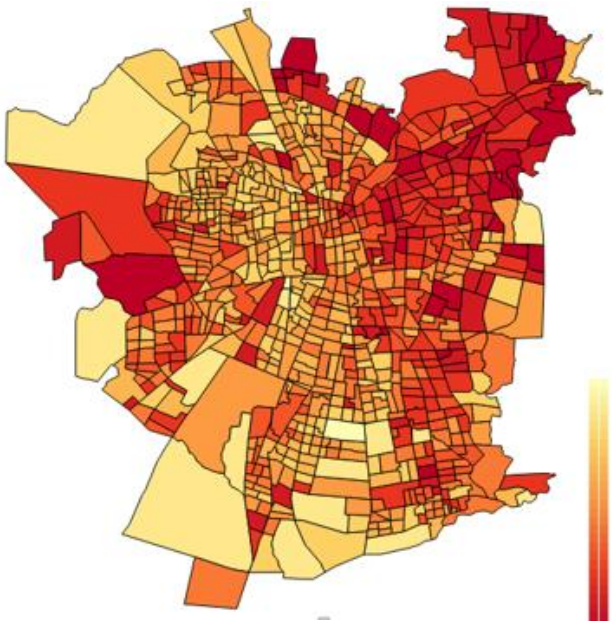
- Infrastructure and environmental quality index
  - Index based on “perceived” cleanness, security, streets/sidewalk’s quality, environment
  - All components are binary, except streets/sidewak’s quality
  - Values for index: 2 to 20

Physical accessibility and LOS



0

9,5

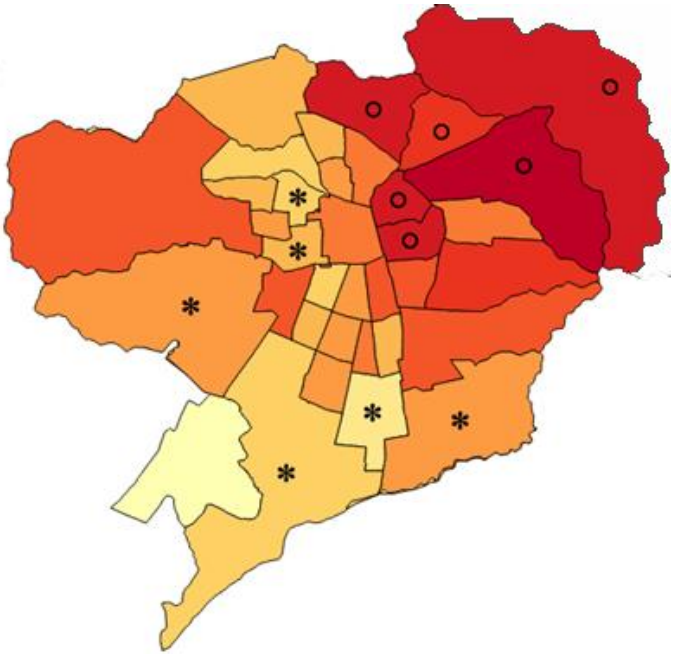


3,1

16,6

Equity?

Trips		Communes	Level of service
21,01%	○	Las Condes Huechuraba Providencia Ñuñoa Lo Barnechea Vitacura	13,07 / 20
21,01%	*	Puente Alto Maipú San Bernardo Estación Central La Pintana Quinta Normal	9,63 / 20



What about the quality of service of public transport?

Motivation

Component	Trip 1	Trip 2
On board time (mins)	17	12
Waiting time (mins)	3	5
Walking time (mins)	5	8
Transfers	0	1
Comfort (p/m^2)	3	5
Total (mins)	25	25

- C[illegible] provide equal levels of accessibility

Proposal

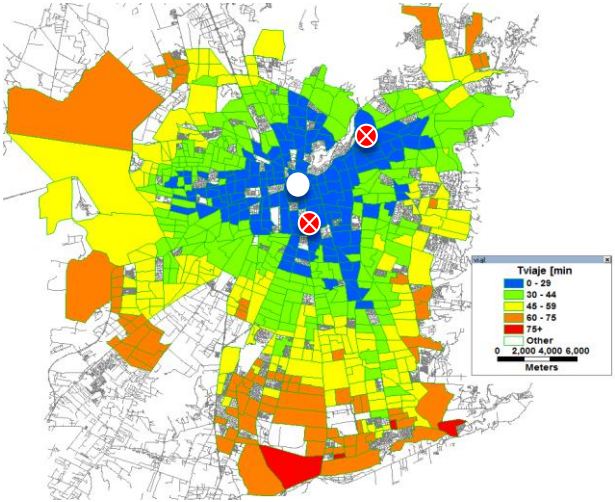
- Incorporate quality of service to accessibility measures
- Data coming from observed smartcard transactions
- Accounting for:
  - Disaggregate total travel time (waiting, walking, on board)
  - Penalty for bad quality of service (transfers, crowding, unreliability)

How to do it?

Travel time → Wardman (2001): Times and quality of service ratings are measured in units of 'in-vehicle time' (IVT)

Component	Equivalency	Source
Walking and waiting time	1.6 times (average in UK studies)	Wardman (2001)
Reliability	CoV and percentile for travel and waiting times	Marguier & Ceder, 1984; Chen et al., 2003
Transfers	Penalty: 2 to 22 minutes	Currie, 2005; Raveau et al., 2014
Comfort	Perceived time is 1 to 2.2 times IVT, depending on crowding level	Whelan & Crockett, 2009; Tirachini et al., 2013

Example



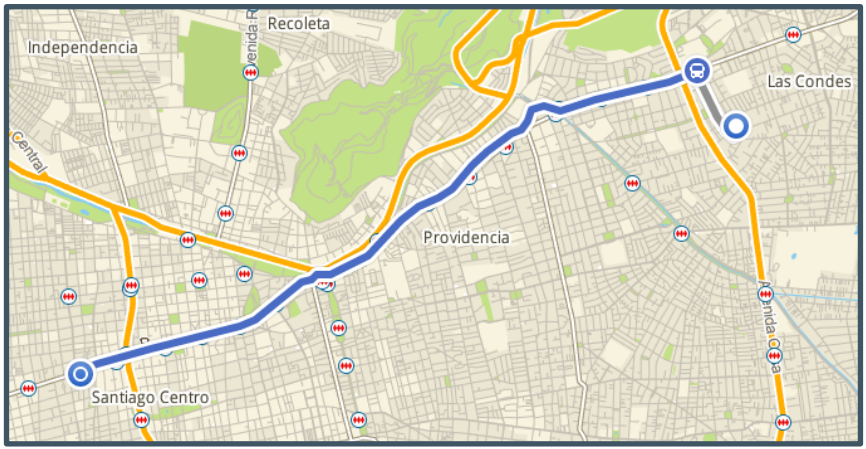
- Trip to Santiago Centro from San Miguel and Las Condes
- What is the difference in terms of quality of service between this two communes?

tal travel times (not include walking and waiting times) to Santiago Centro and Providencia. Morning peak, April 2013
(Source: DTPM (2013))

Case study: Metro

Source: 2gis.cl

Case study: Bus



Source: 2gis.cl

Case study

	Las Condes		San Miguel	
Quality of service	**Metro**	**Bus**	**Metro**	**Bus**
Distance	9,4 km	10 km	7,9 km	6,7 km
Total travel time	31 mins	47 mins	32 mins	35 mins
Waiting time	1,78 mins	5,1 mins	2,84 mins	7,3 mins
Walking time	15 mins	16,3 mins	23,3 mins	9,2 mins
Comfort	4-5 p/m^2	3-4 p/m^2	5-6 p/m^2	4-5 p/m^2
Reliability	0,59	0,907	0,58	0,765

Source: 2gis.cl and data from DTPM & Metro (2015)

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What this means?

- In terms of accessibility and equity, the level of service may have a big impact

	Las Condes (Metro)		San Miguel (Metro)	
Component	**Classic measure**	**Expanded measure**	**Classic measure**	**Expanded measure**
On board (mins)	14.22	14.22	5.86	5.86
Waiting time (mins)	1.78	2,85	2.84	4.54
Walking time (mins)	15	24	23.3	37.3
Comfort (multiplicator)	-	X1.2	-	X1.5
Total (IVT)	31	49.3	32	71.6

Conclusions

- Evident inequity in Santiago
  - Urgent need to address problems of land use and transport planning
  - Communal budgets are poorly distributed. Metropolitan government?
  - Need to invest in public transport quality

- Accounting for quality of service allows to observe real differences in terms of unequal access to opportunities.
  - Effect of environment and urban infrastructure
  - Effect of level of service

Recommendations

- If you are going to evaluate transportation projects, CBA may not be enough. Accessibility and equity indexes are needed.
- If you are going to measure accessibility for equity purposes, you should consider quality of service and users perception
- Land use planning should encourage new subcenters (but, how do we do this?)

Some questions

- Increased motorization rate is sustained over time. More and more people “leaves” public transport
  - Should we focus on benefiting captive public transport users or on discouraging car use?
  - Or should we allow people to “do whatever they want” and provide the required infrastructure
- What should we deal with first?
  - Waiting time? Comfort? Reliability?
  - Which changes would have the most impact and which are more feasible?
- Are we still in time to revert the poor land use policies from last 40 years?

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Application

- Accessibility to 10 closer transit stops
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$$A_i = \sum_{j \in \varphi} f(t_{ij})$$

$$f(t_{ij}) = \frac{1}{1+\alpha e^{-\beta t_{ij}}}$$