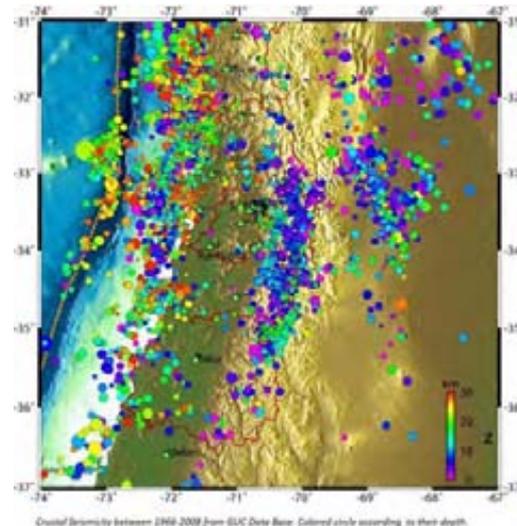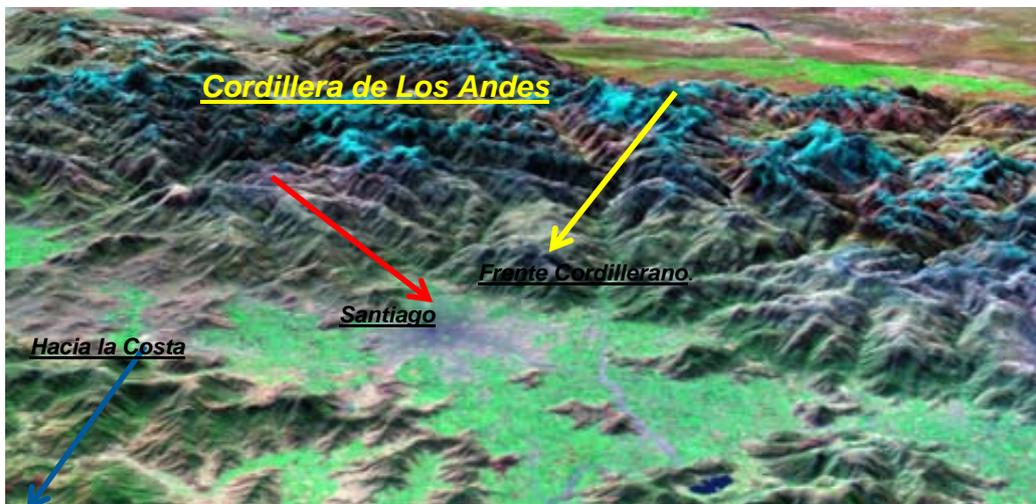HELMHOLTZ | ASSOCIATION

SEISMIC HAZARD IN THE METROPOLITAN REGION: NEW PERSPECTIVES IN THE ANDEAN TECTONIC CONTEXT CASE SANTIAGO DE CHILE

1. CONTEXTUALIZATION

The large cities will always face natural hazards, due to tectonic setting there have been many major earthquakes, some of them associated with different seismigenic zones, accompanied at times by major tsunamis and damage to the population. This has impacted negatively on the growth and development of the country and imposed significant challenges in the field of earthquake engineering. However, the less well know part remains the characterization and quantification of seismic hazard in the context of Andean tectonics.

Understanding the crustal seismicity in central Chile below the Andes is an open problem and crucial in determining the seismic hazard in an area where there are major reservoirs of water for the city of Santiago, such as hydroelectric Alfalfal, Maitenes, Puntilla, Queltehues; pipeline that crosses the ridge; mine exploitation such as El Teniente, El Volcan, Los Bronces; and most importantly a population in the city of Santiago, about 6,000,000 people. For all these reasons it is more than necessary to conduct studies to gather more information than presently available and so improve the quantification the seismic hazard in this region.

Crustal Seismicity between 1966-2008 from SUC Data Base. Colored circle according to their depth.

2. OBJETIVE AND RESEARCH QUESTIONS

Cordillera de Los Andes
Frente Cordillerano.
Santiago
Hacia la Costa

- The convergent plate margin between Nazca and South American Plates causes the uplift of the Andean orogeny and produces deformation patterns which recurrently fail in large to very large earthquakes. This situation also applies for the Central Region of Chile, locating the capital city of Santiago de Chile.
- The tectonic situation in this region is complex as deformation manifests itself in the deeper subduction zone but also in crustal fault systems parallel to the plate margin and the Andean mountain belt. Both tectonic settings substantially influence the seismic hazard in Santiago de Chile.
- The estimation of the rates of crustal deformation plays an important role in the understanding of the physical processes that take place in this tectonic enviroment.

The main objetive is characterize the seismic hazard in the metropolitan region.
- The specific objetives are:
a) The characterization of the crustal seismic activity.
b) Cuantification of the crustal deformation.
c) The contextualization between crustal seismicity and crustal deformation in an geology and tectonic environment.
- In this work, we propose to:
- Study the crustal seismicity in the Central Chile and characterization.
- Study from Crustal fault environment and related seismic activity.
- Interactions between subduction tectonic settings, crustal seismicity and crustal fault sistems and their meaning for seismic hazard in Santiago de Chile.
- Specification of these interactions and their influence on crustal faults going through Santiago de Chile.
- Use GPS techniques to determine the rate of crustal deformation

3. METHODOLOGY

A detailed database of crustal seismicity will be develop as a first step, from which all information of events of significant magnitude that can provide information about the stress regime in the zone will be selected.

A detailed analysis of the seismo-tectonics of the area will be made in order to have greater clarity about the evolution over time and the process of creating the current subduction environment and associated structures such as the Andes Mountains, the seismicity associated with this process, and the associated rate of crustal deformation.

Contact

Name: Adriana Perez F.

Institution: Universidad de Chile

Mail: aperez@dgf.uchile.cl

Supervisors: Jaime Campos, Stefano Parolai, Monika Sobiesiak

4. REFERENCES

- Barrientos, S., E. Vera, P. Alvarado, T. Monfret. 2004, Crustal seismicity in central Chile Journal of South American Earth Sciences 16 (2004) 759–768
- Cahill, T.; Isacks, B., 1992. Seismicity and shape of the subducted Nazca plate, *J. Geophys,. Res.*, **97**, 17503-17529.
- DeMets, C.; Gordon, R.; Argus, D.; Stein, S., 1994. Effect of recent revisions to the geomagnetic reversal time scale on estimate of current plate motions, *Geophys. Res. Lett.*, **21**, 2191-2194.
- Kelleher, J. A., 1972. Rupture zones of large South American earthquakes and some predictions, *J. Geophys. Res.*, **77**, 2087-2103.
- Pardo, M., D. Comte and T. Monfret (2002a), Seismotectonic and stress distribution in the central Chile subduction zone, J. S. Am. Earth Sci., 15, 11-22
- Pardo, M., D. Comte, T. Monfret, R. Boroschek and M. Astroza (2002b), The October 15, 1997 Punitaqui Earthquake (Mw=7.1): a destructive event within the subducting Nazca plate in central Chile, Tectonophysics, 345, 199-210.
- Ruegg, J.C., Campos, J., Madariaga., R., Kausel, E., De Chabalier, J.B., Armijo, R., Dimitrov, D., Georgiev, I., Barrientos, S. Interseismic strain accumulation in south central Chile from GPS measurements 1996-1999. 2002, *Geophys. Res. Lett.*, **29**.

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ

GFZ POTSDAM

Spatial Proximity and Social Integration
About social integration's dimensions in it's application to urban space

1.   Contextualization

In urban studies, the concept "social integration" has been used by many authors, but referring to different meanings, or without clarifying what are they understanding as integration. In residential segregation research, this is especially clear in the descriptions and explanations of the effects produced by socio spatial homogeneity, concentration, or frontiers between different social groups. This lead to the coexistence of different interpretations of de same phenomena, which could be seen in the Santiago's recent socio spatial changes debate.

This became a problem not only in the academic field, but also in the discussion (recently started in Chile) about urban policies oriented to promote social integration in the cities.

The aim of this research is to contribute to the social integration debate and to the urban policies related to it, through discussion and clarification of the term "social integration" in it's application to urban studies, and the empirical exploration of the effects generated by spatial proximity between different income groups.

2.   Objective and research questions

Research Questions

¿How could be understood the relationship between spatial proximity and social integration in cases of closeness between low income groups and high income groups?

¿How to conceptualize social integration in a way useful to urban phenomena, understanding it's spatial, material and even aesthetic dimensions?

¿Which are the effects of spatial proximity between high income groups and low income groups over the social integration process of the latest?

Objective

To explore the effects of spatial proximity between different income groups over it's social integration situation, differentiating those effects by dimensions of social integration, and by collective effects (neighborhood groups or associations level), and individual effects (households and individuals level).

4.   Linkages to other FoA/CCCs

Linkage with socio spatial differentiation work package 2 (spatial patterns of segregation and the role of land markets): The study will describe Santiago's residential segregation situation, and it will discuss it's subjacent factors.

Linkage with socio spatial differentiation work package 4 (Housing policies and socio spatial differentiation) and with governance work package 4 (public – private interplay and city – building on the urban fringe): The research will review the processes and actors behind the actual segregation pattern in Santiago, and it will discuss the alternatives on social integration urban policies in the Santiago actual context and having the international experience on social integration policies as a base.
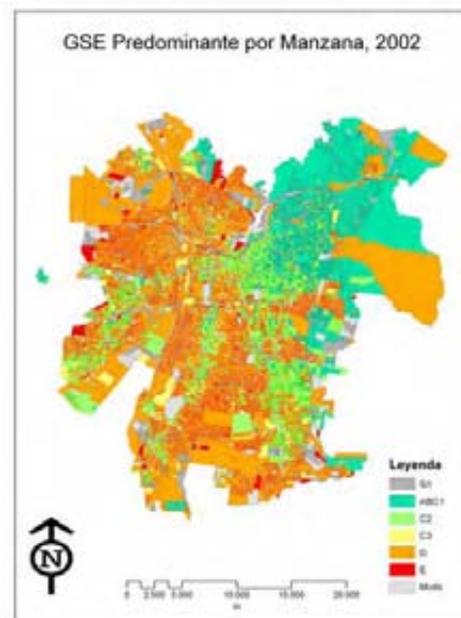
Predominant socioeconomic group by block, 2002

Project: Successful and critical neighborhoods
produced by chilean housing policy

3.   Methodology

1. First, a critical bibliographic review of the social integration notion and it's spatial applications, as about the effects of socio spatial homogeneity and spatial proximity between different income groups. As a product, is expected a social integration concept useful to urban studies, capable of discriminate the effects of different income groups localization patterns.

2. Second, a Santiago's residential segregation description, both as a general context of the research, and as a way to select cases of different income groups spatial proximity. This description will be based on secondary data of 2002 census (and primary data if it's required), and it will use the standard residential segregation measures.

3. Third, a number between one and three cases of spatial proximity between different income groups will be selected to it's qualitative study, as a way to understand how this proximity has affected the low income group's social integration situation. To accomplish that, is expected to build and apply qualitative instruments reflecting the social integration created earlier, oriented to understand the bonds between the different kinds of neighbors, the influence of one group over another, and the opinion of each group about the other, always looking for discriminate by different social integration dimensions.

Alejandra Rasse Figueroa

Pontificia Universidad Católica de Chile

arasse@uc.cl

Supervisor: Francisco Sabatini

SYSTEMATIZED INFORMATION (SI) FOR DECISION MAKING IN
URBAN PLANNING AND MANAGEMENT
IN THE SANTIAGO METROPOLITAN REGION (MRS).
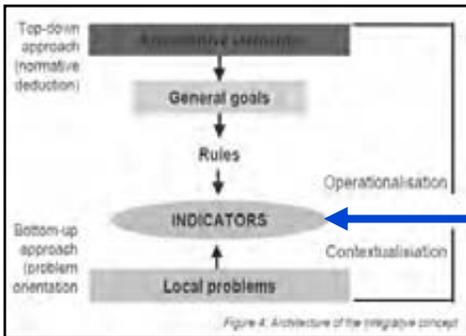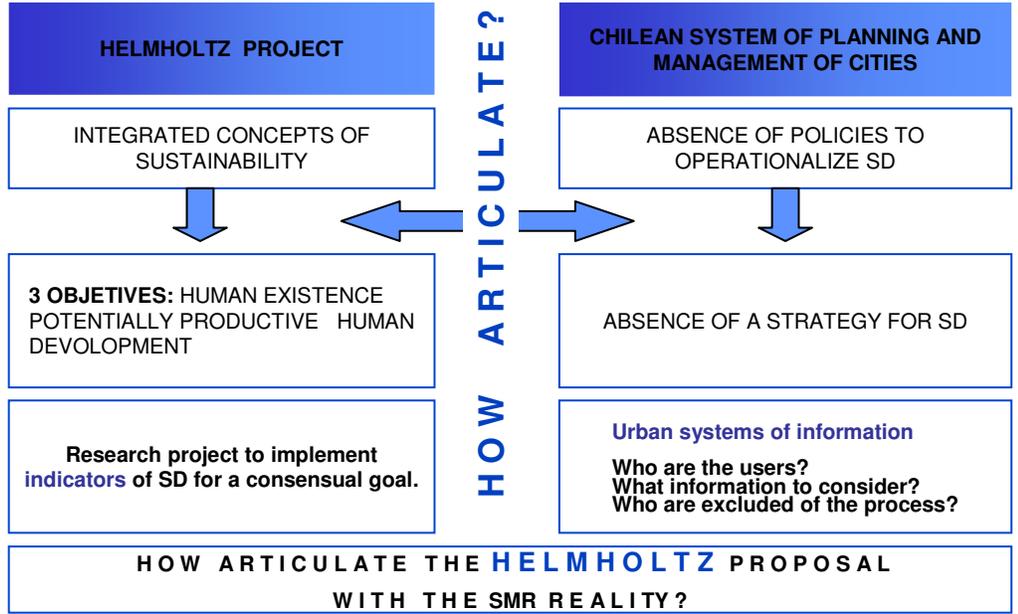## CHALLENGES IN TERMS OF SUSTAINABILITY AND GOVERNANCE

1/ LINK WITH FoA/ CCC
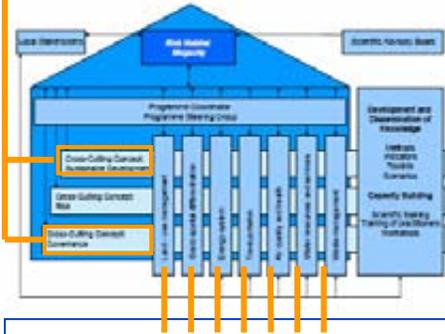
THE FIELDS OF APPLICATION ARE INCLUDED IN THE RESEARCH, FROM THE PERSPECTIVE OF URBAN PLANNING AND MANAGEMENTOF SMR WITH A VIEW TO THE SUSTAINABLE DEVELOPMENT OF THIS HUMAN SETTLEMENT.

2/ CONTEXTUALIZATION

1º core question/ How can the integrative Helmholtz concept be adjusted to local conditions
2º core question/ How to evaluate sustainability of the city and his hinterland?
3º core question/ Are there indicators in line with requeriments of sustainable development?

TO RESPOND, IT'S NECESARY TO KNOW BEFORE

HOW ARTICULATE?

HELMHOLTZ PROJECT

INTEGRATED CONCEPTS OF SUSTAINABILITY

3 OBJETIVES: HUMAN EXISTENCE POTENTIALLY PRODUCTIVE HUMAN DEVOLOPMENT

Research project to implement **indicators** of SD for a consensual goal.

CHILEAN SYSTEM OF PLANNING AND MANAGEMENT OF CITIES

ABSENCE OF POLICIES TO OPERATIONALIZE SD

ABSENCE OF A STRATEGY FOR SD

Urban systems of information

Who are the users?
What information to consider?
Who are excluded of the process?

HOW ARTICULATE THE HELMHOLTZ PROPOSAL WITH THE SMR REALITY?

3/ OBJETIVE AND RESEARCH QUESTION

DEFINE THE CIRCLE OF ACTORS INVOLVED IN URBAN PLANNING AND MANAGEMENT IN RELATION TO USE INFORMATION FOR DECISION MAKING.

BETWEN OPERACIONALIZATION AND CONTEXTUALIZATION, THE INDICATORS ARE ESSENTIAL TO ASSESSMENT AND DECISION MAKING.

Figure 4: Architecture of the integrative concept

5/ REFERENCES

ARGUELLO, Jorge (1994). Sistema de información para la gestión urbana en la ciudad de Córdoba. CEPAL- CNUAH, División de Medio Ambiente y Asentamientos Humanos.

BORJA, Jordi & CASTELLS, Manuel (2004). Local y Global. La gestión de las ciudades en la era de la información. Taurus, España.

GROSS, Patricio (2002). Sustentabilidad ¿un desafío imposible?. Ediciones Surambiente. Santiago de Chile.

HÄGERSTRAND Torsten & KUKLINSKI Antoni ed. (1969). Seminar Information Systems for Regional Development. Lund, Sweden The Royal University of Lund 1971.

HELMHOLTZ ASSOCIATION (2007). Risk Habitat Megacity ¿Sostenibilidad en Riesgo? Research Plan, January 2007A.

HEINRICHS, Dirck (SF). Why research on mega-urban regions matters!

4/ METHODOLOGY

Bibliographies review/ Construction of a theoretical framework/
Information+ sustentability+ planning and urban management

Identification of institution involved in decision making in planning and urban management (public/ private/ civil)

Who make decisions in urban planning and management?

Field work:

Interviews/
Questionary/

What are the sources of information used to make decisions?

Diagnosing use of sustainability indicators (SI) in public institutions, privates and / or civil, in decision making in urban planning and management.

Analysis of information sources/ Analysis of the organizational structure of actors

How are administered the sources and coordinate the actors?

According to diagnosis

What are de challenges in terms of sustainability?

How sistematize the urban reality by elaborating indicator categories?

Name: ALEJANDRA SALAS / **Institution**: P. UNIVERSIDAD CATÓLICA/ **Mail**: absalas@ uc.cl/ **Supervisor**: JONATHAN BARTON

Activity based demand modeling for the evaluation of transport policies in Santiago
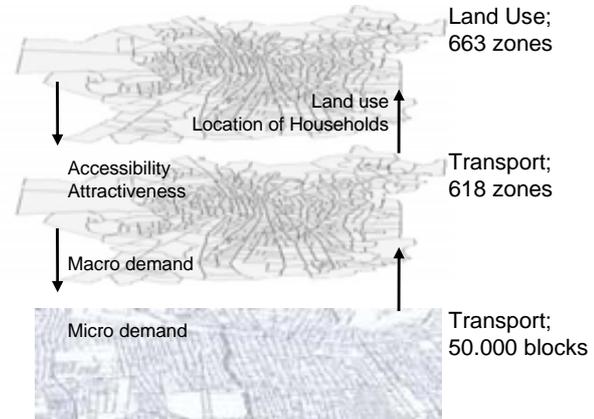
Contextualization

The PhD is embedded in the work of the Field of Application *'TRANSPORTATION'.*

Context: Activity-based approaches derive the daily transportation demand from the activities which the individual realizes. Models based on this approach offer broader options for the evaluation of transport policies. This is due to the reproduction of complete and coherent daily activity sequences which include number, type and durations of activities, total daily travel times as well as chosen transport modes. In advantage to traditional models, individuals living in a household context are modeled explicitly.

Goal: The PhD focus on the development of an activity-based model and hence the evaluation of impacts of concrete policies (e.g. pricing schemes) and societal developments en general (e.g. population, income). Thus, the work focus on the provision of a supportive planning tool for decision-making in the transportation sector.

Research Issue: Multi-level modeling

Land Use; 663 zones

Land use
Location of Households

Accessibility
Attractiveness

Transport; 618 zones

Macro demand

Micro demand

Transport; 50.000 blocks

Research Questions

How is the *individuals demand for traveling* reproduced using different techniques of traditional and activity-based demand modeling?

What kind of *restrictions appear if we implement an activity-based perspective* in a large agglomeration like Santiago?

How can we *combine established methods with practices 'activity-based' that focus on the individuals behavior*?

Methodology

➡ *Literature Review* on techniques of travel demand modeling

➡ *Conceptual Framework* for the activity-based approach in Santiago

➡ *Data Preparation,* e.g. of Activity Plans using the Mobility Survey 'EOD' (Cluster analysis) and Households/Persons using CENSO

➡ *Calculation of Probabilities* using EOD-survey and ESTRAUS model

➡ *Running models* MUSSA/ESTRAUS to "feed" the new activity-based approach

➡ *Selection of measures* by empirical findings and literature review

Linkages to other FoA/CCCs

➡ Air Quality and Health > provision of traffic flows for emission modeling
➡ Socio-Spatial Differentiation > accessibility standards by transport modes

➡ Governance > effects and feasibility of transport policies

Preliminary Results

➡ Advanced and agreed formulation of the activity-based approach

➡ Generation of the activity sequences using the EOD-survey

➡ Identification of relevant transport policies by interviews expert

Contact

Name:　　　　Andreas Justen

Institution:　German Aerospace Center (DLR) –
　　　　　　　Institute of Transport Research (IVF)

Mail:　　　　andreas.justen@dlr.de

Supervisors:　Barbara Lenz (DLR), Francisco Martínez (UCH),
　　　　　　　Cristián Cortés (UCH)

Flood risk assessment in Santiago de Chile

1.   Contextualization

Santiago de Chile is a city that is characterized by different types of horizontal and vertical urban growth during the last decades. The process of urban expansion implies land use and land cover (LULC) changes, most noticeable in the newly developing areas in the outskirts of the city, where former agriculturally used or natural areas are converted into impervious urban spaces (Figure 1, Hansjürgens et al. 2007, Romero et al. 2008).

The quantification and qualitative assessment of these land use/land cover changes and their impact on the environment with a special focus on flood hazard and flood risk form the framework of this research.

Figure 1:
Urban growth of Santiago de Chile between 1989 and 2004.

Source: Romero et al. 2008
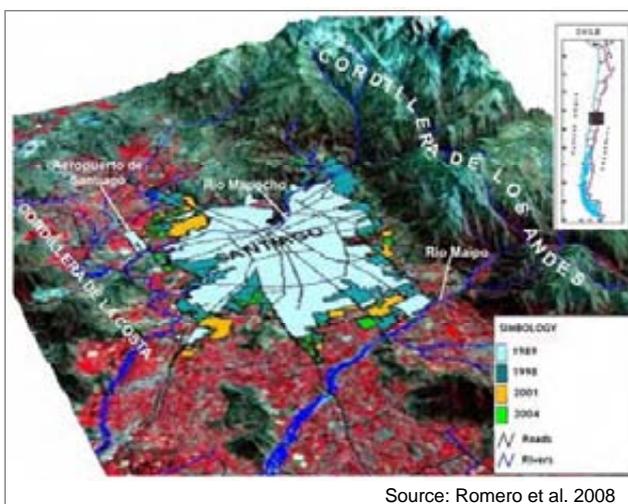
2.   Objective and research questions

Objective:

The goal of this research is to investigate ways of sustainable urban development and land use management against the background of flood risk reduction. Therefore, the interaction between flood risk and specific land use types that amplify or minimize the risk will be investigated.

Research questions:

Where and why do floods occur in Santiago?

Where and how does the flood hazard become a risk?

How do people cope with/react on floods and which official disaster management instruments exist?

What measures in land use adaptations can be taken to decrease the flood risk? How is it incorporated in urban planning? Which projects are planned or already existing to address the problem?

3.   Methodology

Figure 2: Methodology for the study.

4.   Preliminary Results

➤ Selection of a risk concept suitable for the specified research goals

➤ Development of a set of indicators to describe flood hazard, physical and social vulnerability and the elements at risk

➤ Pre-processing of newly acquired satellite data

5.   Linkages to other FoA/CCCs

This study is linked to the Fields of Application *Socio-Spatial Differentiation* and *Water Resources and Services*, as well as to the Cross-cutting Concepts *Risk* and *Sustainable Development*.

6.   References

Hansjürgens, B., Heinrichs, D., Kopfmüller, J., Lehn, H. & Nuissl, H., Eds. (2007) Risk Habitat Megacity ¿Sostenibilidad en Riesgo? A Helmholtz Research Initiative 2007-2013. Research Plan. Leipzig.

Romero, H., A. E. Vásquez, M. Molina & P. Smith (2008) Socio-environmental effects of land use and land cover changes caused by urban sprawl of the Chilean Metropolitan area. Urban issues under a context of free market economy in developing nations. Presentation held at Helmholtz Centre for Environmental Research, 04/04/2008. Leipzig.
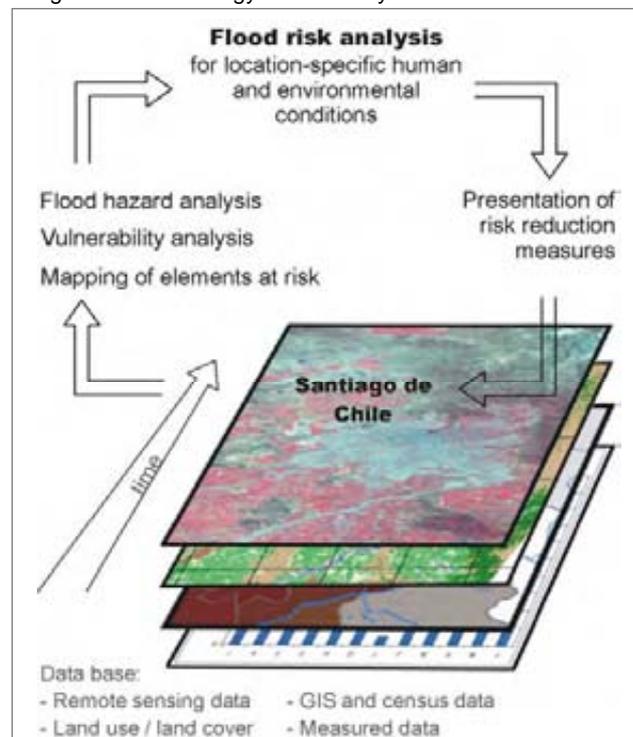
Contact

Name: Annemarie Ebert

Institution: Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

Mail: annemarie.ebert@ufz.de

Supervisors: Prof. Dr. Ulrike Weiland (UFZ), PD Dr. Frido Reinstorf (HS Magdeburg Stendal)

HELMHOLTZ
CENTRE FOR
ENVIRONMENTAL
RESEARCH – UFZ

Public transport governance in the light of decentralization
The cases of Santiago de Chile and Bogotá

1.   Contextualization

Currently different stakeholders are reorganizing the public transport systems in Santiago de Chile (*Transantiago*) and in Bogotá (*Transmilenio*). The main aim is to make the service more attractive and thereby reduce the individual motorization. But in particular the implementation in Santiago causes serious problems. One explanation (out of many) for these problems points out to the institutional and governmental strategy of *Transantiago* (Figueroa & Orellana 2007).

The doctoral thesis will examine the governance pattern of *Transantiago* and compare it with the governance situation of *Transmilenio* by using the term 'governance' as an analytical expression. For this pattern the processes, i.e. the current state, of decentralization play an important role wherefore the research focuses on the impact of decentralization on public transport modernization projects.

The doctoral thesis is part of work package 3 of the cross cutting concept "governance". It focuses on governance pattern in the light of decentralization processes.

Concept development, integration of research and results (WP1)			
Scenario analysis (WP 2)			
Decentrali-zation (WP3)	Public-private interplay (WP 4)	Privatization (WP 5)	Informality (WP 6)

2.   Objective and research questions

The objective of this doctoral thesis is

- to comprehend processes of governance and decentralization in an integrated manner,
- to understand the public transport governance in Santiago and Bogotá and
- to provide recommendations for *Transantiago*, *Transmilenio* as well as for the implementation of large reorganization projects in general.

Research questions

- Which conditions of governance are necessary for the implementation of public transport projects of this "mega" scale?
- How does the process of decentralization impact on the reorganization of public transport?

Fig. 1: Public transport systems in Santiago de Chile and Bogotá

Source: own illustration   Source: www.transantiagoinforma.cl   Source: www.transmilenio.gov.co   Source: www.transmilenio.gov.co

3.   Methodology

The doctoral thesis will employ a qualitative approach to the empirical analysis of governance patterns: Guided expert interviews will be the main source of data which will be interpreted by means of a qualitative content analysis.

The interviewed persons will be selected out of two groups:

- **Key persons** who are not directly involved in the planning process but who can discus the situation in a broader context.
- **Actors** who are directly involved in the planning process and who have knowledge of the internal structure and processes.

4.   Preliminary Results

For analyzing patterns of governance in the field of spatial planning Nuissl & Heinrichs (2006) propose a framework with three core elements:

governance		
actors	institutions	decision making

The doctoral thesis uses this framework as a conceptual basis and will develop it further by applying it to the cases under scrutiny.

5.   Linkages to other FoA/CCCs

FoA Transportation: **public transport in the context of urban transport system**
FoA Air quality and health: role of public transport for improved air quality
FoA Socio-spatial differentiation: inclusion/exclusion of public transport supply
CCC Sustainable development: balance of power and ability to coordinate and regulate

6.   References

FIGUEROA, O.; ORELLANA, A. (2007): "Transantiago: gobernabilidad e institucionalidad". In: Eure 33 (100), pp. 165-171.

NUISSL, H.; HEINRICHS, D. (2006): "Zwischen Paradigma und heißer Luft: Der Begriff der Governance als Anregung für die räumliche Planung". In: Altrock, Uwe (Ed.): "Schwacher Staat - sparsame Stadt". pp. 51-72.

Contact

Name: Dipl.-Ing. Carolin Schulz

Institution: Helmholtz Centre for Environmental Research – UFZ

Mail: carolin.schulz@ufz.de

Supervisors: PD Dr. Henning Nuissl, Prof. Dr. Barbara Lenz

Management and Regulation of Gravel Mining and Water use in Urban Areas
Conditions in the Maipo River

1. Contextualization

The growth of big cities (Megacities) leads to the expansion in the demand of many resources (e.g. energy and water) and basic services (transportation, waste disposal, etc). In this process the demand for construction of infrastructure also grows. This industry needs aggregates (gravel and sand) as a principal resource. In Chile most of this material comes from the extraction of sediment from rivers with high rates of sediment production/transport.

In rivers the flow of water and production/transport of sediment are physically linked, so i) the demand for water has a direct impact on the availability of sediments and ii) the demand for aggregates has a direct impact on the characteristics and behavior of the flow. Presently, the link between river flow and sediment transport is an active research field and we propose to use results of this research to develop tools to be able to quantify such interaction.

2. Hypothesis and Research Questions

Significant extractions of granular material from the streambed generate important modification to the river behavior.
Local impact have been studied by others scientists (e.g., Kondolf, 1997; Marston, 2003). The analyses have shown that those impacts are far from being local, affecting long distances upstream and downstream in the river.
In general, high extraction rates generate a reduced sediment transport that generates an excess of energy to be used to degrade other parts of the streambed and banks.
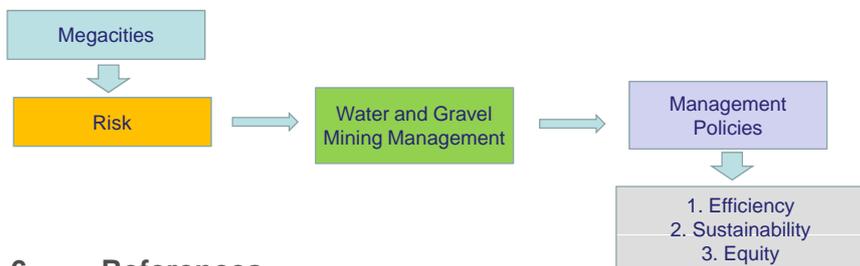Problems related to river behavior modification: 1.*Reduced sediment transport*, 2.*Decreased sediment replacement rates downstream from the extraction area*, 3.*Impact on civil works founded in the river bed* (bridges, pipes, etc), 4.*Impact on water catchment infrastructure* (lower riverbed), 5.*Water supply can be compromised*, 6.*Impact on environment and ecosystems*.

3. Methodology

The methodology considers:
1. *Identify the main gravel extraction industries in the Maipo river and their extraction rates.*
2. *Estimate the gravel and sediment production rates for different conditions of flow discharge in the Maipo River.*
3. *Create a model to predict the response of the river in terms of flow and morphology to different perturbations based in multiple scenarios.*
4. *Do some laboratory experiments for model calibration.*
5. *Link the river behavior and water/aggregate demands with a management model.*

5. Linkages to other FoA/CCCs

Megacities → Risk → Water and Gravel Mining Management → Management Policies → 1. Efficiency 2. Sustainability 3. Equity

6. References

1. *Hungry water: Effects of Dams and Gravel Mining on River Channels.* Kondolf, M.-1997
2. *Extracción mecanizada de áridos desde cauces naturales.* Dirección de Obras Hidráulicas, Ministerio de Obras Públicas – Gobierno de Chile.

Fig. 1: Building undercut by bank erosion (Oregon,1996)

Source: Hungry water: Effects of Dams and Gravel Mining on River Channels ; Kondolf-1997

Fig. 2: Gravel extraction in Maipo river (Santiago,2007)

Source: Photograph by the author, Santiago-2007

4. Research Advances

At this point of the research we are working in the development of a methodology to estimate sediment production rates in the Maipo river using a sediment transport simulation model and field data representative of current sediment and water use/extraction rates.

The model will be used to evaluate changes in sediment availability due to changes in gravel extraction rates and water use upstream of the urban area of Santiago.

Working in the first paper for: *The International Conference of Science and Information Technologies for Sustainable Management of Aquatic Ecosystems* (Heic 2009, Concepción, Chile)

Contact

Name: Cristián Godoy Barbieri
Institution: Universidad de Chile
Mail: cgodoy@ing.uchile.cl
Supervisors: James McPhee and Yarko Niño

Development of a modeling chain for the description of the air quality within the greater area of Santiago de Chile

1. Context

- A detailed understanding of the distribution and behavior of pollutants in the air is a prerequisite for studies on the health impact of contaminated air.

- Air quality data from monitoring stations is usually not representative for the concentration of contaminants within a larger (three-dimensional) area.

- Common air quality models operate on a broad scale, with distances measured in kilometers. While this approach works very well for regional (meso-scale) air pollution modeling, it is not suitable to estimate levels of contaminants within the urban system (micro-scale).

- As traffic emissions account for an immense share of contaminants, their dispersion in the air is the most relevant of processes on the micro-scale to be considered when modeling urban air quality.
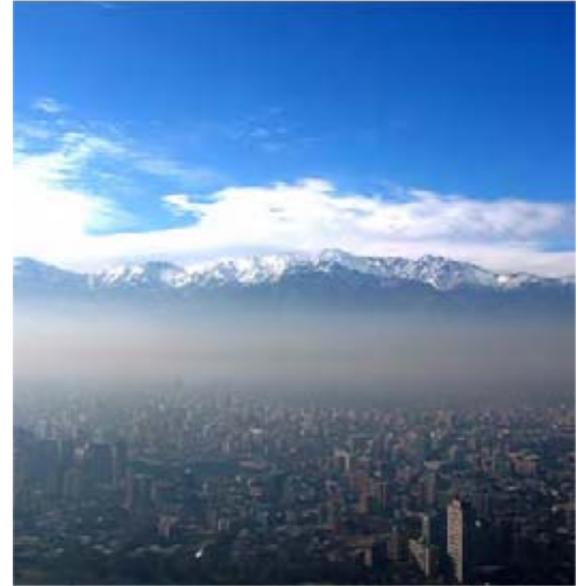

Source: Mickey Ashmore

2. Objective and research questions

- The objective is to develop a modeling chain, starting with the simulation of the dispersion of traffic emissions within a street canyon and reaching up to modeling meteorology and air chemistry for grid cells of 3km by 3km.

- How can I integrate models across scales? More specifically, how do chemical processes occurring on the micro-scale relate to those taken into account on the meso-scale?

3. Methodology

- Linking GRAL and WRF/Chem will allow for locally observed meteorological input to be replaced with WRF/Chem output. This way, background pollutant concentrations due to sources outside the area modeled on the micro-scale are no longer neglected.

- A chemistry module will be integrated in GRAL: WRF/Chem benefits from refined emission input.
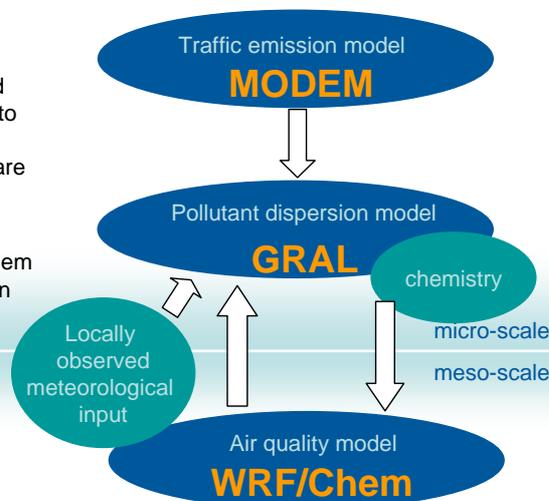
4. Preliminary Results

- The work has recently started. Results at this point reduce to first simulations with GRAL based on meteorological input from WRF/Chem as well as clarifying methodology and tasks.

5. Linkages to other FoA/CCCs

- A joint effort with the FOA Transportation producing data on dynamic driving behavior will provide a basis to improve traffic emission modeling by complementing MODEM with modules from alternative models (NEMO, IVE).

- As socio-spatial differences correspond to local discrepancies in the fleet composition (which is essential when estimating traffic emissions), insights in the FOA socio-spatial differences are likely to advance the traffic emission inventory.

- Modeling results can be translated into air pollution risk maps, which are essential for health impact studies: a link to the CCC Risk.

Contact

Name: Friederike Greb

Institution: Institute for Meteorology and Climate Research

               Atmospheric Environmental Research Division (IMK-IFU)

               Forschungszentrum Karlsruhe GmbH

Mail: friederike.greb@imk.fzk.de

Supervisor: Dr. Peter Suppan

Coordination as a mechanism of risk observation

1. Contextualization

This research tries to describe and analyze the coordination process of the Chilean State, giving account on how the risk concept is integrated in new strategies of construction of public policies.

Coordination is understood, on one hand, as a way of communication between functional systems, and on the other hand, as a way of relation between formal and informal spheres of decisions-making.

Risk is understood as a possibility of exclusion. Risk is not possible to be controlled, but it is a possible result of a decision, therefore, it is understood as a probability.

Every political decision is a decision about risk and for that it is necessary to develop efficient strategies of construction of public policies that involve this concept and its relation with the possibilities of inclusion/exclusion.

2. Research questions

How the observation of risk can be a strategy in the construction of public policies?

How the observation of risk allows to distinguish between probabilities of inclusion/exclusion?

Which are the principal strategies of coordination between the state and informal agents, in the construction and implementation of public policies?

3. Methodology

Stage 1	Theoretical definition of concepts: such as coordination, risk, inclusion/ exclusion, state, informal networks.
Stage 2	Selection and analysis of construction and implementation processes of public policies in different fields of application.
Stage 3	Bibliographical and documentary revision of public policies, social programs and strategies of coordination.
Stage 4	Interviews to key informants of the state and other informal agents.
Stage 5	Description of forms of coordination between the state and informal agents in the context of application fields.
Stage 6	Construction of risk of exclusion indicators.
Stage 7	Development of the final doctoral thesis, contrast of hypothesis, elaboration of conclusions.

4. Linkages to other FoA/CCCs

About the Sustainable Development concept:

Sustainable Development implies the evaluation of risks related to possible environmental damages. At the same time, it implies the elaboration of strategies of inclusion increase.

This research is oriented, on one hand, to the development of an observation methodology of risk, such as decisions about environmental damages, and on the other hand, to the construction of public policies that incorporate this kind of risk as a possibility of acute exclusion.

About the Governance concept:

Risk may be described from different spheres of decision-making, and these spheres refer to systems and actors. To observer all the risks of every decision, we must see them from all positions.

The coordination between different spheres of decision-making may be a strategy of observation of risk, as well as a strategy of governance.

Contact

Name:	Gabriela Azócar de la Cruz
Institution:	Universidad Alberto Hurtado
Mail:	gabriela.azocar@gmail.com
Supervisors:	Aldo Mascareño Lara

Modelling Energy Systems in Megacities with a Focus on Sustainable Development

1.   Context

The scientific evidence on the need for urgent action on the problem of climate change, which requires reduction in emission of greenhouse gases, has now became stronger and convincing. The urgency of controlling local pollution from combustion of different fuels emerges, as well as the need to ensure future energy security.

In Chile, there are two electrical systems, the North and the Central. The North system has approximately 3700 [MW] of installed power capacity and 99% of it is from Thermal energy (basically from coal, fuel, diesel and gas). The Central system, which serves more than 90% of the population, has approximately 8000 [MW] of installed power capacity and 38% of it is from Thermal energy. For the year, 2050 this percentages cannot be the same. With the increase of population, this percentages of Thermal energy (produced by coal, fuel, diesel and gas) are not acceptable, so new technologies expect to emerge and Renewable energy would be an important agent of the energy field.

2.   Hypothesis and research questions

Hypothesis:
It is possible to develop a model of energy consumption and use it in modern Megacities.

Research question:
Which are the concepts and mechanisms underlying the development pathway of the energy demand at a city level from a technical, environmental, economic and social perspective?
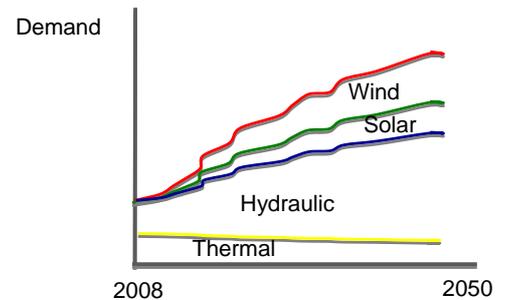

fig.1: Example of a energy scenario

3.   Methodology

The investigation starts with the identification of the components of the energy demand at a city level. Then, it formulates a proper modelling of the interactions of those components in order to represent its driving forces and the consequent evolution in time. The study focuses on the understanding of modelling approaches for the energy consumption and use among the different sectors inside a city (residential, commercial and industrial).

Future demand of energy in red (fig.1) has to be cover with different types of generation. In this scenario, Renewable and Hydraulic energy increases through the years and Thermal energy decreases or remains constant. In this example, the energy field could have a large impact in the amount of CO_2 tons produced, but in the end this scenarios will depend on political decisions.

To estimate demand, the idea is to develop three important models: (1) Households, (2) Transport, (3) Industry and Service.
The first global approach is to divide the world in three areas that have different needs (in terms of cooling, heating, transportation, etc.) and try to model dynamic consumption. A more specific approach is to determine for Santiago de Chile different types of houses and the evolution of transportation taking for example an income division. The model of Industry and service is an open area of research, which is not totally covered by previous studies, so is the principal objective of this thesis.

5.   Linkages to other FoA/CCCs

Transport (new technologies)   Land use (Households)

Contact

Name: Gonzalo Paredes Martinez

Institution: Universidad de Chile

Mail: goparede@ing.uchile.cl

Supervisors: Sonja Simon (DLR) – Luis Vargas (UCH)

URBAN POVERTY AND ACCESS TO DRINKING WATER SERVICE IN SANTIAGO DE CHILE (1981 – 2008)

Adaptation strategies as a response to the exclusion from a basic utility service that is offered almost universally

2. Hypothesis and Research questions

Hypothesis

...The **"new urban poverty"** that takes place in the modern cities, has **new spatial patterns**, **new ways to exert power**, and most of all, **new adaptation strategies as a response to the multiple exclusion ways** imposed by the late capitalism from the beginning of the twenty first century

Main Question

What kind of **adaptation strategies** have, those who are **excluded** from water service provision in Santiago de Chile developed, since the **privatization** of this utility service, from 1981 to 2008?

Secondary Questions

How has the access to the drinking **water** service in Santiago, evolved, **from 1981 to 2008**?

How has the **privatization** policies (methods) been developed, in the specific case of the water service in Santiago, from 1981 to 2008?

How has the **urban morphology** of Santiago influenced the access to water service process in its metropolitan area from 1981 to 2008?

5. Linkages to other FoA/CCCs

Cross-cutting concept: Sustainable Development

The **equity of distribution** regarding ecological resources, income, access to information, burdens arising from political measures, etc., and the relevance

Cross-cutting concept: Risk

The **inclusion of city inhabitants** in different functional parts. This includes the opportunity of all inhabitants to have legal rights (as citizens), to do business, to work, to enjoy security of tenure, to vote and to participate in education

1. Contextualization
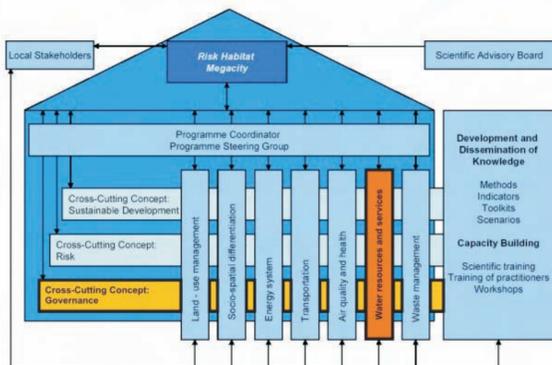
- **RHM Cross Cutting Concept: Governance**

| Concept development, integration of research and results (WP1)			
Scenario analysis (WP 2)			
Megacity governance in the light of decentralization (WP3)	Public-private interplay and "city-building" on the urban fringe (WP 4)	Privatization – quality and governability of infrastructural services (WP 5)	Government and informality in LA megacity governance (WP 6)

3. Methodology

Water Market (Design)	Before 1981 Monopoly of the Government				1981 – 1989 New Water Cod				1990 – 2008 Privatization of the service				Scale
Collection	W	G	M	P	W	G	M	P	W	G	M	P	REGION
Production	W	G	M	P	W	G	M	P	W	G	M	P	
Distribution	W	G	M	P	W	G	M	P	W	G	M	P	CITY
Consumption	W	G	M	P	W	G	M	P	W	G	M	P	DISTRICT
Recollection	W	G	M	P	W	G	M	P	W	G	M	P	CITY
Treatment	W	G	M	P	W	G	M	P	W	G	M	P	REGION
Environmental Restitution	W	G	M	P	W	G	M	P	W	G	M	P	

W = Water   G = Governance   M = Morphology   P = Poverty

	Scale	Method	Source	Technical
Parte 1	Region	Quantitative	Secondary	Documenting Spatial Analysis
Parte 2	City	Quantitative and Qualitative	Primary and Secondary	Documenting Spatial Analysis Ethnography
Parte 3	District	Qualitative	Primary and Secondary	Documenting Spatial Analysis Ethnography
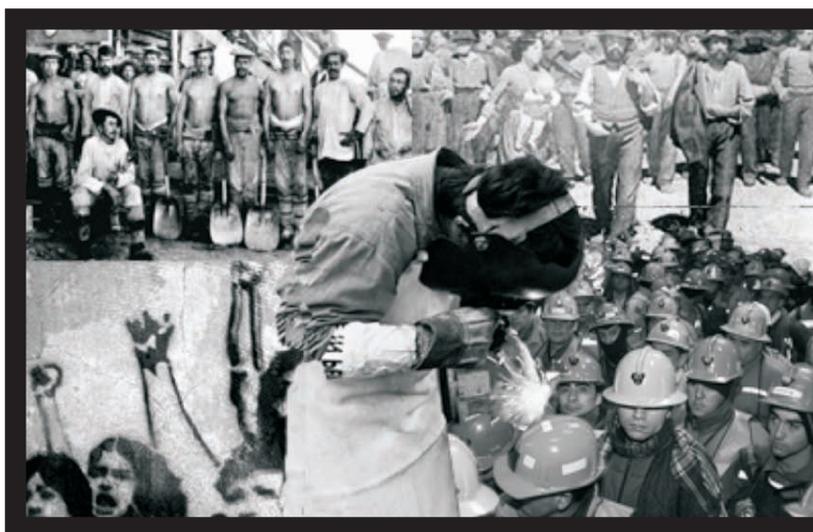
4. Preliminary Results and references

THEORETICAL FRAME .... → WATER MARKET

Lewis Culture of poverty 1960

Castells Structural poverty 1970

De Mattos Unit urban society with regard to capital

Monguin Urbanism that privatizes and fragments

Davis Power of work of a thousand millions of persons had been expulsed from the world system

Bourdieu Social field

Wacquant "Urban Parias"

Bourgois Resistance

de Certeau Practiced placed

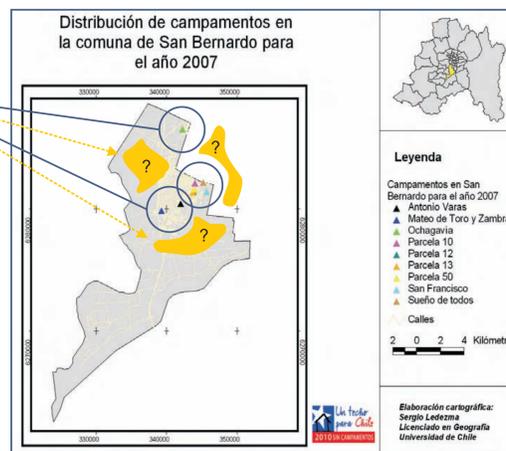Collection

Production

Distribution

Wilson "NEW URBAN POVERTY" (unemployment) → consumption

Recollection

Treatment

Environmental Restitution

Distribución de campamentos en la comuna de San Bernardo para el año 2007

Leyenda
Campamentos en San Bernardo para el año 2007
▲ Antonio Varas
▲ Mateo de Toro y Zambrano
▲ Ochagavia
▲ Parcela 10
▲ Parcela 12
▲ Parcela 13
▲ Parcela 50
▲ San Francisco
▲ Sueño de todos
Calles

0 2 4 Kilómetros

Elaboración cartográfica: Sergio Ledezma Licenciado en Geografía Universidad de Chile

To explore the transition to the **new urban poverty**

To identify **new spatial patterns** of poverty

To record the emergence of a **new urban-political figure** (adaptation strategies)

To demostrate the **new relationship** between **government policy and market forces** in the planning process of major cities (Privatization – Funding)

Contact

Name: Gustavo A. Durán Saavedra
Institution: Pontificia Universidad Católica de Chile
Mail: gudusa@uc.cl
Supervisors: Claudia Rodríguez Seeger, Ph D.

Applied General Equilibrium and Sustainability Indicators for Santiago

1.   Contextualization

Computable General Equilibrium models (CGE) are a powerful tool to quantify and analyze systematically the impacts of policies and shocks on the different agents in an economy and the environment. Direct, indirect and induced effects can be evaluated on economic variables such as regional product and sector production, social variables such as poverty and income distribution and environmental variables such as emissions to air including local and global pollutants, or discharges to water and soil.

The central context: Urban sustainable development as considered by UFZ

Protection of human health indicators will be achieved. Indicators for rule sustainable use of the environment as a sink for waste and emissions will also be obtained.

2.   Research questions

What is the effect of expected economic growth of the Metropolitan Region on key sustainable indicators? For example, the impact on poverty alleviation, income distribution, emissions, energy use.

What are the tradeoffs associated with different development paths?

What sectors will develop more/less and how will the development of specific sectors affect compliance of sustainable goals and rules?

Sustainable Development

Source: www.teachernet.gov.uk

3.   Methodology

The proposed PhD dissertation considers to develop a revised Computable General Equilibrium (CGE) model for the Metropolitan Region of Santiago that would allow evaluating the economic, social and environmental impacts of different development paths for Santiago. These impacts should be related to specific sustainability indicators. To develop such a model, a necessary step is to build a Social Accounting Matrix (SAM) for the Metropolitan Region. This would allow differentiating the local effect of local policies from national level effects. In this way, it would be possible to simulate the evolution of these indicators in a business as usual scenario, and examine their evolution under alternative scenarios, in particular scenarios with a specific concern relating to sustainable development.

 An interesting extension would be to analyze the environmental impacts of the development of the different sectors through the use of satellite accounts. For example, the SEEA (*System of Integrated Environmental and Economic Accounts*) methodology developed by the United Nations to be applied to the national accounting framework based on input output matrices.

5.   Linkages to other FoA/CCCs

Cross-cutting themes

        -Sustainable Development: Economic, Environmental and Social Indicators
Also:
        - Risks: Health impacts

        -Governance: Public Policy Guidance

6.   References

John Beghin, Sébastien Dessus, David Roland-Holst and Dominique van der Mensbrugghe, "General Equilibrium Modelling of Trade and the Environment" OECD Development Centre, 1996.
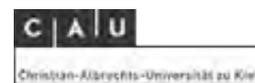
Contact

Name: Jacques Clerc

Institution: Universidad de Chile

Mail: jaclerc@ing.uchile.cl

Supervisor: Raúl O'Ryan

Universidad de Chile
Facultad de Ciencias Físicas y Matemáticas
Departamento de Ingeniería Industrial

Ambivalent segregation patterns considering spatial and temporal dimensions of social integration: the case of Santiago de Chile

1. Contextualization

Ongoing processes of spatial marginalization and social exclusion are accompanied by the search of possible ways for more social integration in present-day Latin America. Thus, the emergence of new gated communities for different social groups including both higher and middle income groups, has a new unimaginable impact on the urban landscape and the social mixing of otherwise poor areas. This tendency does not only play an important role in changing socio-economic residential segregation patterns (figure 1), but also for new opportunities of socio-spatial integration processes as well.

The debate about opportunities following potentially social integration processes by spatial proximity in Santiago de Chile has inspired this thesis. In this context, the thesis aims at analyzing new gated communities for well-off inhabitants in peripheral areas, which were populated until recently by economically disadvantaged groups, leading to more spatial proximity between different social groups. Beyond the spatial dimension, it further focuses on the temporal dimension of socio-spatial integration underlining its dynamic process character. This is an issue that has not been sufficiently dealt with so far.

This research proposal is part of the Field of Application 'Socio-spatial differentiation' within the framework of RHM. Its very focus is on the interplay of spatial proximity and social integration, which constitutes the work package 3.
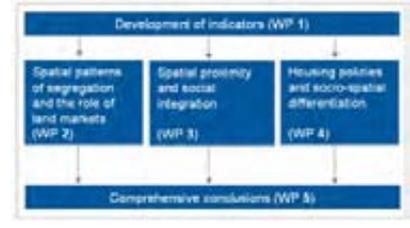

Fig. 1: *Development of concentration of economically disadvantaged groups (minorities) in Santiago de Chile between 1992 and 2002*
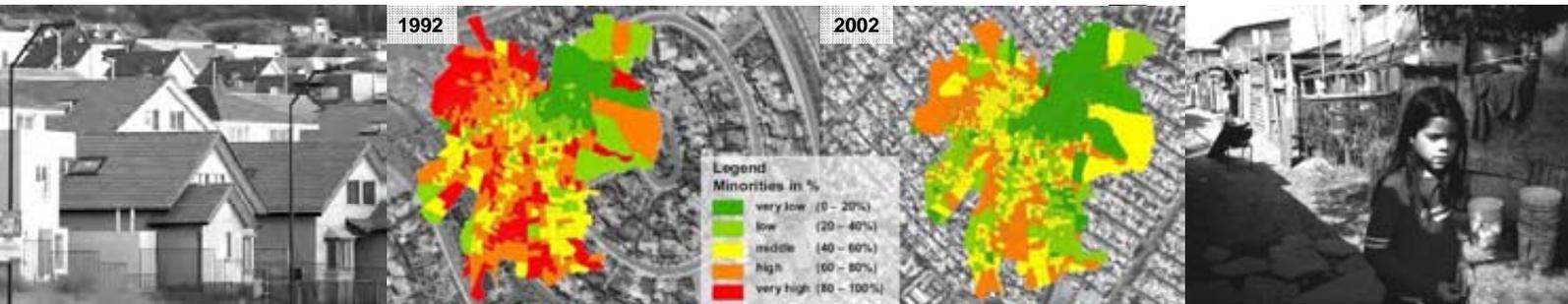

1992   **2002**

Legend
Minorities in %
- very low (0 – 20%)
- low (20 – 40%)
- middle (40 – 60%)
- high (60 – 80%)
- very high (80 – 100%)

Photo: Künzelmann (UFZ)   Source: Sabatini, Wormald, Sierralta, Peters (2007)   Photo: Christian Demarco

2. Objective and research questions

This doctoral thesis focuses on the correlation of spatial proximity and mechanisms of social integration. The research questions are as follows:

- Can spatial proximity lead to social integration between different social groups?
- Which determinants influence the opportunities of social integration?
- Does time affect the level of social integration?

3. Methodology

Quantitative approach
- Analysis of segregation patterns by way of census data 1992 and 2002
- Surveys in 6 neighbourhoods of different social strata

Qualitative approach
- Interviews with key persons
- Discussion within focus groups
- Applying mental maps

4. Preliminary Results

According to Salcedo and Sabatini (2007), the physical and spatial transformation of the not so well-off periphery has favoured important identity changes in the residents: from 'class identity' to 'territory identity'. This means, residents of new gated communities are seen by their not so well-off neighbours not just as the 'others', but also as people with whom they share a common identity: belonging to a given neighbourhood. It was shown that the 'otherness' of well-off gated community residents was reduced by way of mutual relation within their neighbourhood.

5. Linkages

CCC Sustainable Development:	social and cultural resources and equal opportunities
CCC Risk:	social vulnerabilities, inclusion versus exclusion
CCC Governance:	recommendations for urban policies
FoA Land-use management:	changing land use patterns causing new social networks
FoA Waste management:	impacts on informal sector

6. References

- Sabatini, F.; Wormald, G.; Sierralta, C. and Peters, P. (2007): Segregación residencial en Santiago: tendencias 1992 – 2002 y efectos vinculados con su escala geográfica. *Documentos de Trabajo N°37*, PUC/IEU+T, Santiago de Chile.
- Salcedo, R. and Sabatini, F. (2007): Gated Communities and the Poor in Santiago, Chile: Functional and symbolic integration in a context of aggressive capitalist colonization of lower-class areas. *Housing Policy Debate*, Vol. 18, Issue 3, pp. 577 – 606.

Contact
Name: Dipl.-Geogr. Juliane Welz
Institutions: Helmholtz Centre for Environmental Research – UFZ
                University of Hamburg
Mail: juliane.welz@ufz.de
Supervisors: PD Dr. Sigrun Kabisch, Prof. Dr. Christof Parnreiter

HELMHOLTZ
CENTRE FOR
ENVIRONMENTAL
RESEARCH – UFZ

Site effect characterization by means of seismic noise and earthquake analysis in large urban areas of Santiago de Chile

1.   Contextualization

Similar to other metropolitan areas, Santiago is undergoing a rapid process of urbanisation with changes in land use and urban morphology. Due to the tectonic situation, large earthquakes are a frequent phenomenon. The amplification of ground motion over sedimentary basin can increase their damage potential. The enhanced land use analysis will contribute to hazard zoning and disaster damage mapping.

2.   Objective and research questions

Wald et al. suggested that slope of topography is related to seismic wave velocity and therefore allows a first order classification of site depended seismic hazards.
Research questions are:
• Can single parameters (e. g. slope of topography) provide an estimation of the seismic velocity below a site?
• Is v_s^{30} (average seismic velocity in the uppermost thirty meters) a reliable parameter for the estimation of site effects?
• Is the approach of *Wald* also valid on other resolution scales?

3.   Methodology

To evaluate site response of some characteristic sites inside the city we have installed a network composed of eight seismic stations for recording earthquake activities (Figure 1). These data allow to analyse the variability of site response with respect to topography and geology and to compare observed with numerical site responses.
Additionally, measurements of seismic noise at ~ 150 sites have been / will be carried out allowing the fundamental frequency of the sites to be determined by H / V seismic noise (Nakamura approach, Figures 1 and 2). With the help of an inversion procedure, calculations of the velocity profile of the seismic S-wave can be carried out under the constraint of the thickness of the sediments.
Empirical relationships between v_s and slope will be calculated and compared with the results of *Wald*. The suitability of v_s as a proxy estimate for site amplification will be checked versus observed amplification factors.

4.   Preliminary Results

H / V spectral ratio results of different sites in Santiago are shown in Figure 3. These results will be combined with topography related parameters and building characteristics for a first order microzonation.
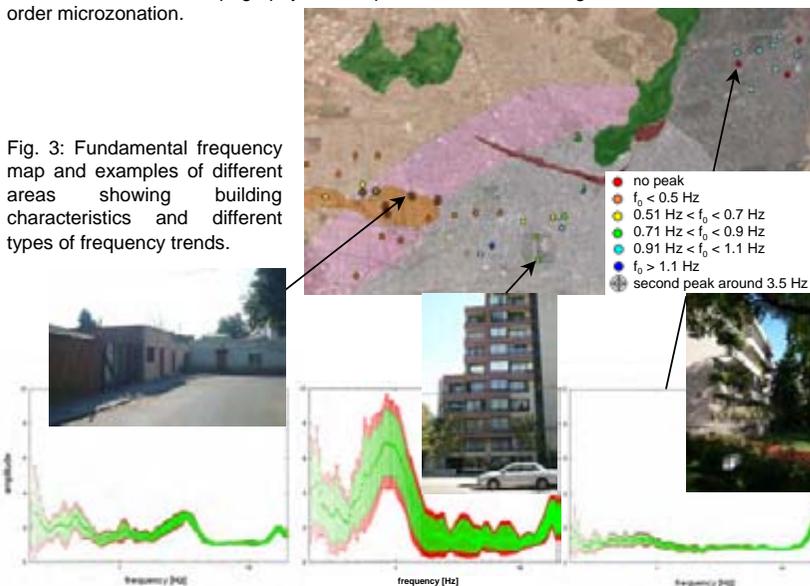

Fig. 3: Fundamental frequency map and examples of different areas showing building characteristics and different types of frequency trends.

Legend:
- no peak
- $f_0 < 0.5$ Hz
- 0.51 Hz $< f_0 < 0.7$ Hz
- 0.71 Hz $< f_0 < 0.9$ Hz
- 0.91 Hz $< f_0 < 1.1$ Hz
- $f_0 > 1.1$ Hz
- second peak around 3.5 Hz

Contact

Name:	Marco Pilz
Institution:	GeoForschungsZentrum Potsdam
Mail:	pilz@gfz-potsdam.de
Supervisors:	Stefano Parolai, Jochen Zschau

Fig. 1: Geological map showing the area of investigation. Points illustrate the sites where measurements have already been performed.

Legend:
- igneous rock
- stiff pumice
- fine-grained soil
- transition zone
- Santiago gravel
- Mapocho gravel
- artificial fill
- ○ seismic stations
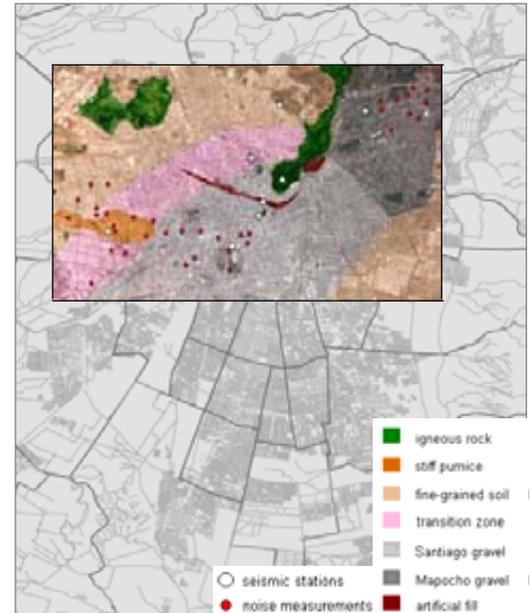- ● noise measurements

Fig. 2: Seismometer for measurements of seismic noise and earthquake recordings.

5.   Linkages to other FoA/CCCs

Our pursued objective in the frame of the research initiative is to evaluate the performance of different tools for reliable ground motion scenarios, especially with regard to the high development dynamics of the megacity. By identifying areas prone to large amplification of ground motion in case of an earthquake, we can provide information on specific sites relevant to managing an urban area (e.g., lifelines, critical facilities, expansion areas). This data can serve as an input for the *socio-spatial differentiation* and *transportation* fields of application.
On the other hand, the *land use management* field of application needs information on the urban structure and its change, the concentration of commercial / industrial sites, major shopping centres, and residential areas, and furthermore on its direction of development

6.   References

G. Valenzuela, Suelo de fundacion del Gran Santiago, Instituto de investigaciones geologicas, Santiago, 1978

D. J. Wald, T. I. Allen: "Topographic slope as a proxy for seismic site conditions and amplification", *Bull. Seis. Soc. of America* **97**, 1379-1395 (2007)

The Role of Public Participation in Privatized Planning.
Governance Innovations on the Urban Fringe in Santiago de Chile*

1. Contextualization

In Santiago de Chile large urban projects in form of super modern highways, shopping malls and huge gated communities on the urban fringes are changing the physical and socio-spatial geography of the city-region in important ways (Borsdorf and Hidalgo 2005).

Furthermore, these projects and the modes of governance by which they are implemented represent a new way of city-building that is primarily based on the initiative, interests and capital of private actors (Zunino 2006). In lack of metropolitan authorities and the face of political fragmentation the question arises how to guarantee a minimum degree of public participation and the consideration of public interest in future city building.
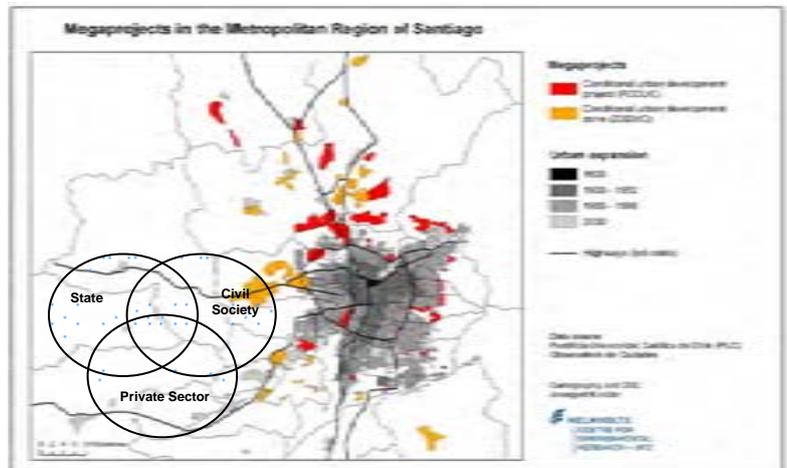
2. Research Objectives and Questions

• To identify main actors, institutions and their logics in large urban projects on the urban fringe in Santiago
• To identify mechanisms of inclusion in and exclusion of decision-making processes on the urban fringe in Santiago regarding different groups of actors
• To help identify mechanisms for a more sustainable (and thus inclusive and participatory) governance of city expansion

- On what kind of governance mechanisms the large residential projects in the periphery of Santiago are based?
- Which forms of public participation are involved in the governance of large urban projects?
- How, by whom and based on which concepts should be decided on the future role of public participation in city building in Santiago?

3. Methodology

1. Literature Review: Public participation in city building

   Context1: Assess the evolution of public participation in Santiago (history of formal and informal institutions, actors, culture)

   Context2: Describe and contextualize the emergence of large residential projects on the urban fringe in Santiago (choose case studies)

2. Empirical work: Investigate governance and participation mechanisms in selected cases (e.g. Pudahuel, Colina).

   Heuristic Framework: History, Actors, Institutions, Scale

3. Generate theory and action oriented knowledge

Method-Mix:
- problem centered interviews
- part. Observation
- analysis of statistics and documents

4. Preliminary Results

✓ Historical contextualization of new planning instruments (commented time line)

✓ Identification and description of assets of megaprojects on the urban fringe (chart)

✓ Identification of involved actors on the regional scale (first actor overview list)

✓ Identification of interview partners and guiding questions

5. Linkages to other FoA/CCCs

The work is linked to the FoA 'Socio-Spatial Differentiation' in so far as I am assessing the role of private actors in transforming socio-spatial patterns on the urban fringe and will discuss the role of land markets.

6.References

Borsdorf, A. and Hidalgo, R. (2005): Städtebauliche Megaprojekte im Umland lateinamerikanischer Metropolen - eine Antithese zur Stadt? Das Beispiel Santiago de Chile. *Geographische Rundschau* 57(10): 30-38.

Zunino, H. M. (2006). Power relations in urban decision-making: Neo-liberalism, techno-politicians; and authoritarian redevelopment in Santiago, Chile. *Urban Studies* 43(10): 1825 - 1846.

Contact
Name: Michael Lukas
Institution: Helmholtz-Centre for Environmental
              Research - UFZ
Mail: michael.lukas@ufz.de
Supervisors: PD Dr. Henning Nuissl
              Prof. Dr. Rainer Wehrhahn

Analysis of Different Waste Management Systems for Santiago de Chile, Impacts on Informal Sector

1.   Contextualization

Large cities are big waste producers. When waste is not properly managed it poses a health risk for the population and negative impacts in the local and global environment. Different waste management options have to be analyzed and compared to find out those that make possible to achieve a sustainable development in Santiago considering institutional, social and environmental aspects. These options will consider the integration of the informal sector or *cartoneros* because of social and cultural reasons and moreover, because they play an important role in the recycling of valuable materials in the country.

2.   Objectives and Research Question

2.1   Description of current waste management system
2.2   Description of current situation of the informal sector
2.3   Evaluation of different waste management scenarios, under a sustainable concept
2.4   Integration of the informal sector into proposed waste management systems

Research Question: How to take advantage, in a sustainable way, of the municipal solid waste in Santiago de Chile, achieving at the same time the integration of the informal collectors?

3.   Methodology

3.1   Waste data collection
3.2   Analysis and evaluation of the data
    3.2.1   Estimation of data quality
    3.2.2   Estimation of missing data
    3.2.3   Elaboration of mass / energy balances of current systems
3.3   Analysis and selection of technical systems of waste management
    3.3.1   Elaboration of mass / energy balances
    3.3.2   Estimation of missing data
3.4   Research of Informal sector characteristics
    3.4.1 Integration of the informal sector into proposed waste management systems

4.   Linkages to other FoA/CCCs

waste deposited in landfills produces leachate, which should be treated properly in order to maintain rivers and underground water free of pollution

Water

Air/ Energy

if biogas from waste is just released to the atmosphere, it contributes to the green house effect, but it may be recovered and used for energy production

Social Inclusion

with the integration of the informal sector an important social aspect is being considered

5.   Preliminary Results
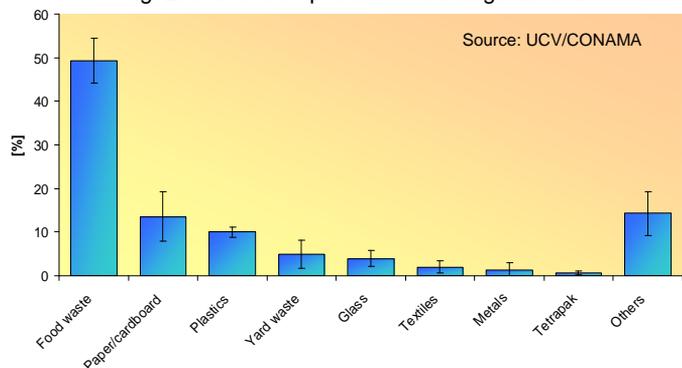
Waste Management Situation in Santiago

➢ **Service coverage**: 99 – 100 %. Formal and informal collection.

➢ **Service level of waste collection**: frequency of three to six times per week depending on the municipality.
An important part of the collection is done by the informal sector, it has been estimated that there are about 10.000 people working on this in Santiago, carrying about 100 kg/person.day [4]

➢ **Waste production** [1]   **Total:**   2,7 Million Mg/a
Specific: 1,09 kg/person.day;
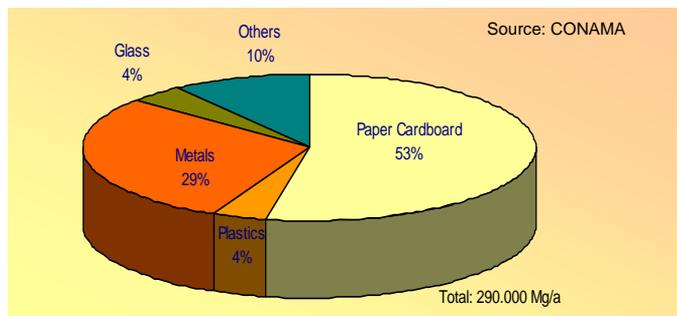
Fig. 1. Waste Management System in Santiago de Chile

By two transfer stations
LANDFILLS
Loma Los Colorados: 60%
Santa Marta: 26%
Santiago Poniente: 14%

Final Disposal: 90%

Production Plants

Middle men

Total Recycling: 10%

Source: Seremi Salud

Fig. 2. Waste Composition in Santiago de Chile

Source: UCV/CONAMA

[%]

Food waste, Paper/cardboard, Plastics, Yard waste, Glass, Textiles, Metals, Tetrapak, Others

Fig. 3. Recycled Materials in Santiago de Chile

Source: CONAMA

Glass 4%
Others 10%
Paper Cardboard 53%
Metals 29%
Plastics 4%
Total: 290.000 Mg/a

Contact
Name: Dipl.-Ing. Tahnee González Martínez
Institution: Research Centre Karlsruhe
Mail: tahnee.gonzalez@itc-tab.fzk.de
Supervisors: Dipl.-Phys. Rainer Bräutigam; Prof. Dr.-Ing. Helmut Seifert

6.   References

[1] Caracterización de Residuos Sólidos Domiciliarios en la Región Metropolitana. PUCV, CONAMA. 2006

[2] Estrategia de Reciclaje de Residuos Sólidos Domiciliarios en la Región Metropolitana, CONAMA, R.M. 2005

[3] Seremi de Salud, RM

[4] Casa de La Paz