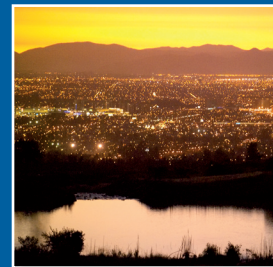
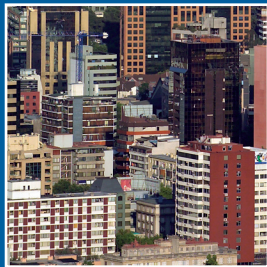


# Risk Habitat Megacity

A Helmholtz Research Initiative 2007 – 2013

Research Plan (Summary) | March 2008



German Aerospace Center | Forschungszentrum Karlsruhe | GeoForschungsZentrum Potsdam |  
Helmholtz Centre for Infection Research | Helmholtz Centre for Environmental Research – UFZ  
Universidad de Chile | Pontificia Universidad Católica de Chile | Pontificia Universidad Católica  
de Valparaíso | Economic Commission for Latin America and the Caribbean of the United Nations  
(ECLAC/CEPAL) | Universidad Alberto Hurtado

# Table of contents

- 1. The *Risk Habitat Megacity* research initiative:  
Facing the challenge of the ‘urban millennium’..... 3
- 2. Partners ..... 4
- 3. General objectives and key research questions ..... 5
- 4. Focus on Latin America ..... 5
- 5. Santiago de Chile: pilot case and platform for research ..... 5
- 6. Research approach and topics ..... 6
  - Sustainable Development..... 6
  - Risk ..... 7
  - Governance ..... 7
  - Land use management ..... 8
  - Socio-spatial differentiation ..... 8
  - Energy system ..... 9
  - Transportation ..... 9
  - Air quality and health ..... 10
  - Water resources and services ..... 11
  - Waste management ..... 11
- 7. Results of the research ..... 11
- 8. Timeframe and Work plan (2007 – 2010) ..... 12
- 9. Expansion of the initiative to other Megacities in Latin America (2010 – 2013) ... 13
- References ..... 14



## 1. The *Risk Habitat Megacity* research initiative: Facing the challenge of the ‘urban millennium’

Urbanization is one of the most dramatic processes of global change. Particularly in megacities, it anticipates trends with both regional and global consequences that are not yet well understood. Mega-urbanization involves not only unprecedented growth, high population density, and a concentration of economic and political power, but also a complex variety of simultaneous and interacting processes.

As human activities shift to cities, the future of the world community depends more and more on urban sustainability (McGranahan et al. 2001). The scale, the speed of change, the growing mobilization of people, information, goods and capital, and the global connectedness of megacities all combine to create new physical, economic and social dynamics, a new complexity, and new dimensions of risk. This places cities at the centre of the challenges for global sustainable development.

Megacities are laboratories of change, representing both a space of opportunity and a space of risk. On the one hand, they are the engines of global economic growth. They generate a huge share of the gross domestic product of their respective countries and provide extensive opportunities for employment and investment (World Bank 2000). On the other hand, the development of mega-agglomerations causes a number of risks and dangers for the inhabitants and for protected goods. „Urbanization affects disasters just as profoundly as disasters can affect urbanization“ (Pelling 2003, 7).

Levels of sustainability and potential risks depend greatly on urban governance, i.e., how decisions on publicly relevant affairs are made in and between the spheres of the state, the civil society and the private sector. Extreme air and water pollution, deterioration of infrastructures, the spread of violence and crime, transport gridlocks, and social and spatial polarization make well-designed governance strategies indispensable to resolving and overcoming these problems and their attendant risks (UN Habitat/ DFID 2002). On the other hand, there is evidence that poor governance performance can amplify or even produce risks to and negative impacts on human security (Hardoy et al. 2001).

While the scale, the velocity of change, the global connectedness and complexity of mega-urbanization pose fresh challenges for research, megacities are rarely explicitly, let alone systematically, taken up as a distinct category or focus of empirical research. These challenges require research involving a comprehensive rather than a sectoral approach and an integrative perspective as a basis for modelling and scenario techniques. Research needs to embrace a problem perspective, linking the generation of orientation knowledge with action-oriented knowledge and the implementation of solutions. This involves the transfer of results into both academic and professional education, and to local stakeholders.

The research initiative *Risk Habitat Megacity* faces the research challenges outlined above with a comprehensive and interdisciplinary approach. By investigating the processes and associated risks of mega-urbanization and developing implementation solutions for sustainable urban development, it presents new knowledge for orientation and application. It widens the skills required to analyse the complex urban habitat and the knowledge to propose and monitor adequate policies. While research of this international initiative has its focus on megacities in Latin America in general, Santiago de Chile is the first study case and platform for knowledge transfer and network-



ing. The research plan adopts an *integrative research approach* that combines basic theoretical and conceptual considerations with empirical and application-oriented analysis. It makes use of several integration tools such as common conceptual-analytical concepts, the application of jointly elaborated scenarios and indicators, involvement of a wide spectrum of disciplines and cooperation with the relevant local stakeholders, in particular local authorities.

## 2. Partners

The *Risk Habitat Megacity* research initiative reflects the joint work of a network of about fifty natural and social scientists and engineers from more than ten Universities and research centres from Latin American countries and the Helmholtz Association in Germany.

At the *Universidad de Chile*, the *Facultad de Ciencias Físicas y Matemáticas* conducts research on transport, air quality, land use, energy, water quality, environmental economics, and policy analysis and instrument choice. At the *Pontificia Universidad Católica de Chile*, the *Instituto de Estudios Urbanos y Territoriales* of the *Facultad de Arquitectura, Diseño y Estudios Urbanos* has research experience in urban governance, urban sustainability, socio-spatial segregation, sub-urbanization, sprawl and land use planning. Further partners with respect to the case study of Santiago de Chile are the *Universidad Alberto Hurtado* and the *Pontificia Universidad Católica de Valparaíso*.

The *Economic Commission for Latin America and the Caribbean of the United Nations (ECLAC/CEPAL)* plays an important role for the initiative with respect to stakeholder involvement and the regional perspective. ECLAC/CEPAL is one of five regional Economic Commissions established by the United Nations. Its mandate is to conduct regional analysis, elaborate proposals and provide technical cooperation to the governments of Latin America and the Caribbean in the interests of promoting economic, social and sustainable development. ECLAC is represented by the *División de Desarrollo Sostenible y Asentamientos Humanos (DDSAH)*. This division is the technical secretariat for several regional bodies, such as the *Forum of Ministries of Housing and Urban Development (MINURVI)* and the *Latin America and the Caribbean Organization of Intermediate Governments (OLAGI)*.

The German Helmholtz Association is a community of 15 national centres which engage in scientific-technical and biological-medical research. As the largest research organization in Germany, its mission is to contribute significantly to solving grand challenges which face science, society and industry. Helmholtz fulfils its mission by concentrating its resources in six research fields: Energy, Earth and Environment, Health, Key Technologies, Structure of Matter, Transport and Space. Five research centres participate in the *Risk Habitat Megacity* research initiative: the *German Aerospace Centre (DLR)*, the *Forschungszentrum Karlsruhe (FZK)*, the *Helmholtz Centre for Infection Research (HZI)*, the *GeoForschungsZentrum Potsdam (GFZ)*, and the *Helmholtz Centre for Environmental Research (UFZ)*. At the UFZ, the *Risk Habitat Megacity* research initiative is coordinated.

### 3. General objectives and key research questions

The overall objective of the research initiative is to deepen the understanding of the complex urban processes, interactions and feedback mechanisms that turn megacities and large agglomerations into a habitat of risk and opportunity. It intends to evaluate urban risks under sustainability criteria, to develop analytical tools and instruments for action-oriented knowledge to tackle the risks of mega-urbanization, and to derive paths for a more sustainable development. It seeks answers to several core questions:

- » What risks, or indeed opportunities, are associated with mega-urbanization?
- » How can the transformation of the complex *Risk Habitat Megacity* be predicted and described?
- » What specific strategies and policies can steer the urban system towards a more sustainable development?
- » What institutional and organizational preconditions are required for their effective implementation?

### 4. Focus on Latin America

The geographic focus of the research initiative is on Latin America. Two salient features characterize the region: it is by far the most urbanized developing region in the world, and has the distinction of being the most inequitable one (ECLAC/CEPAL 2005). The region's overall urbanization coefficient of 76 % compares with that of Europe (75.5 %), and substantially exceeds that of other world regions, such as South-East Asia (36 %) and Sub-Saharan Africa (35 %). In some Latin American countries, the urban population has reached 90 % and beyond (ECLAC/CEPAL 2000). At the same time, the region's population is concentrated in its principal cities rather than elsewhere, which explains the significant number of vast agglomerations and megacities.

Urbanization in Latin America has reached a turning point. The predominantly rural-urban migratory flows have given way to migration from one urban area to an-

other, intra-metropolitan, and international migration. Urban growth and conversion of rural land for urban expansion is taking place at an unprecedented rate (UNEP 2004). Urban sprawl has accentuated a range of typical trends, such as socio-spatial fragmentation and segregation (Coy/ Pöhler 2002; Sabatini et al. 2001; De Matos 2002). Unequal distribution of resources or political power coupled with weak institutional controls goes hand in hand with extremely high rates of urban violence and insecurity (UN Habitat 2006). Increasing transport problems and air pollution (ECLAC/CEPAL 2000; 2005), inadequate housing conditions (Gilbert 1996; 2005), deficits in the supply of water and sanitation, inefficient transformation and use of energy, and deficient disposal and treatment of a rising amount of solid waste all impact on environmental health (ECLAC/CEPAL 2005; Winchester 2005). The major cities in the region are likewise extremely vulnerable to natural disasters and the technological risks inherent in high-risk activities (ECLAC/CEPAL 2005). Faced with these challenges, the larger countries of the region have altered their political, administrative and fiscal structures with a transfer of power, resources and responsibilities to subnational units of government.

### 5. Santiago de Chile: as pilot case and research platform

Santiago de Chile is the 'anchor city' for the initiative where the partners aim to establish a "research and training platform" for megacities, which will connect *Risk Habitat Megacity* with the relevant programmes of the partners already in existence. The metropolitan region of Santiago de Chile is also the pilot case. The choice for Santiago de Chile rests on five arguments:

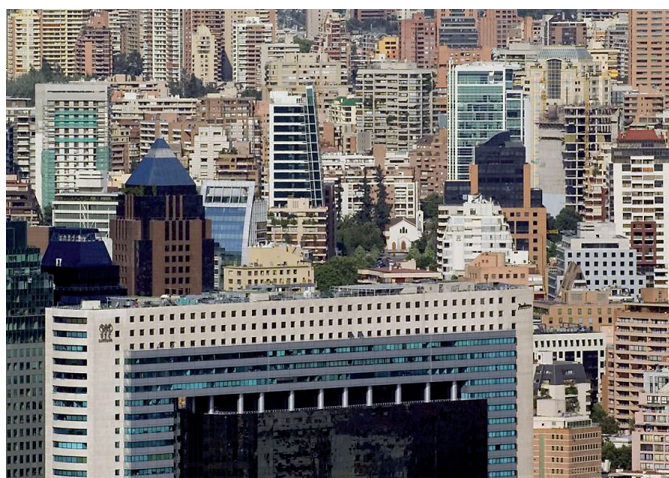
- (1) Santiago de Chile gives access to a wide range of representative problems associated with megacities, permitting the design of a conceptual framework and its transfer to other urban agglomerations in the region.
- (2) The advanced stage of urbanization in Santiago de Chile makes it possible to detect emerging problems and opportunities and to draw lessons from the strategies adopted in response to the challenges of urban development.

- (3) As the centre of regional networking, Santiago de Chile holds a strategic position. It is home to key international institutions, in particular the *Economic Commission for Latin America and the Caribbean* (ECLAC/CEPAL).
- (4) Santiago de Chile offers excellent research partners, infrastructure and data. The Helmholtz Association centres involved have established links with a range of research organizations in Chile, and the cooperation with the partners at the *Universidad de Chile* and the *Pontificia Universidad Católica de Chile* is particular strong.
- (5) Stakeholders, in particular the regional government (*Gobierno Regional*) have expressed their profound interest to collaborate with the initiative.

## 6. Research approach and topics

The research plan adopts an interdisciplinary and integrative research approach that combines basic theoretical and conceptual considerations with empirical and application-oriented analysis. To implement the research approach and to offer a common framework for orientation, the research initiative applies three well-established, theory-based analytical concepts:

- (1) The concept of *Sustainable Development* formulates the target dimension of the initiative. Based on an existing sustainability concept developed in the Helmholtz Association (Kopfmüller et al. 2001), it provides orientation towards basic *goals*



by defining specific sustainability criteria in close cooperation between the Chilean and German partners.

- (2) The *Risk* concept focuses on the extent of the *problems* and their severity. In addition, it helps to identify and analyse the conditions for and impacts of the emergence of risks that pose a potential threat to future sustainability. For this purpose an appropriate combination of natural, applied and social scientific risk research approaches will be applied to the perspectives of hazardous events and the vulnerability of the “System” Megacity
- (3) The *Governance* concept concentrates on the *actions* to be undertaken. This will be achieved by analysis of current efforts to enhance sustainability in megacities, and by the provision of knowledge and recommendations relevant to the appropriate solutions to specific problems and their potential for implementation. Local political and administrative authorities will be involved in the process of working out targets for sustainable urban development and of proposing appropriate ways to meet them.

The initiative applies these three research topics, the “cross-cutting concepts”, to several typical megacity issues, such as *Land use management, Socio-spatial differentiation, Energy system, Transportation, Air quality and health, Water resources and services, and Waste management*, which are the seven “fields of application” (see Figure 1).

### Sustainable Development

Megacities and metropolitan regions as key driving factors for regional, national and global economic, social and cultural development in an increasingly globalized world play a crucial role in the achievement of sustainable development. On the one hand, they “produce” problems that endanger sustainable development both in their own territory and at the global level. On the other hand, they provide opportunities for the reduction or solution of such problems. In Chile, as in many other Latin American countries, the national government has not formulated a sustainable development strategy as yet, albeit the process is currently in progress. Neither is there an official sustainable development plan for Santiago de Chile.

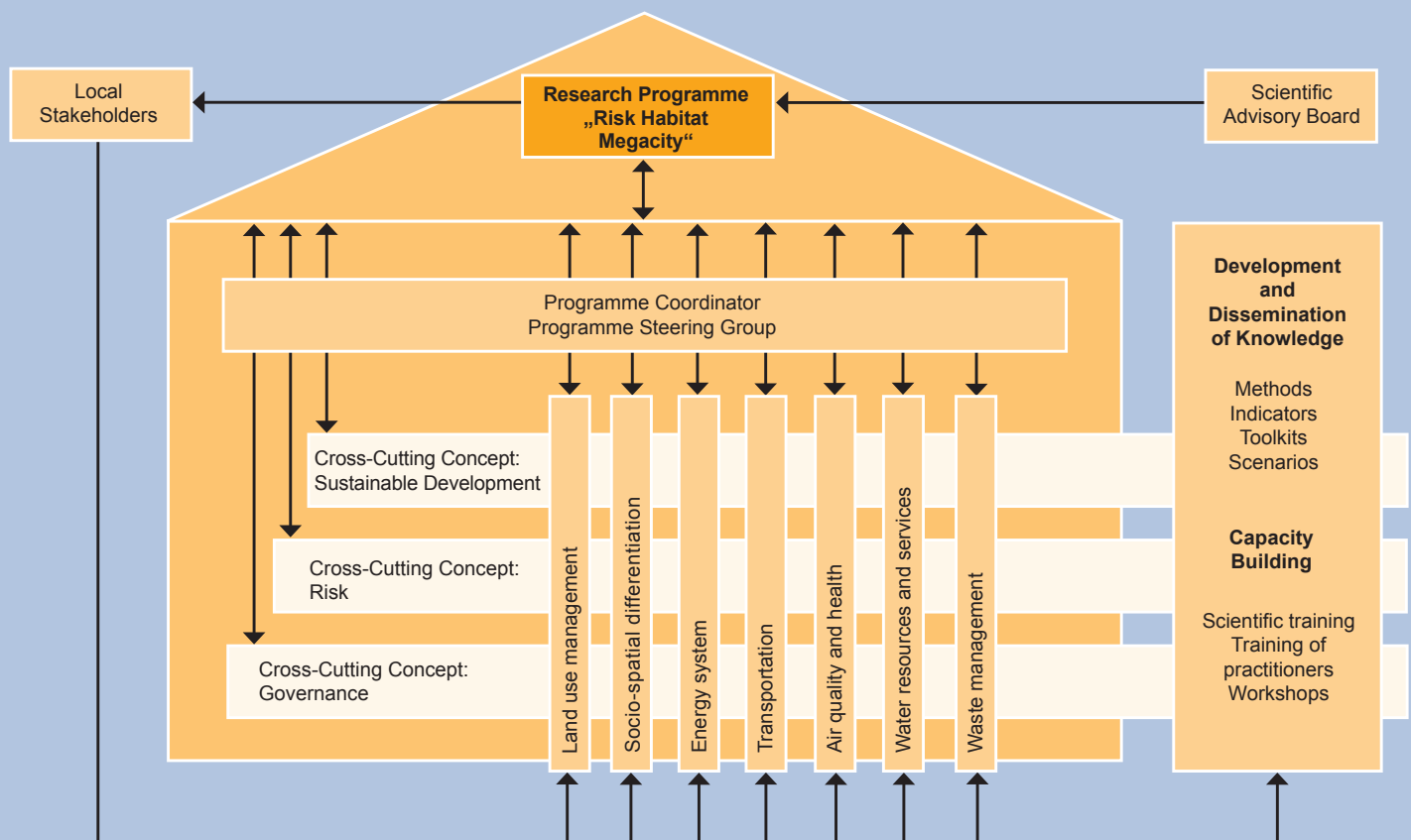


Figure 1: Programme architecture

Objectives of research:

- » Apply and contextualize the integrative sustainability concept of the Helmholtz Association (Kopfmüller et al. 2001) to Santiago de Chile and other Latin American megacities;
- » Analyse and assess the sustainability performance of Santiago and other Megacities and
- » Contribute to the ongoing development process of a sustainable urban development strategy in Santiago.

## Risk

Megacities sometimes face specific difficulties in coping with functional needs. Furthermore, their regular mode of operation simultaneously produces risks that endanger their own survival: “A megacity is a prime example of such a critical stage of development: an organism with more than ten million living cells gradually risks being suffocated by the problems it has itself created – like traffic, environmen-

tal damage and crime” (Munich Re Group 2004, 1).

Objectives of research:

- » Develop a heuristic for a qualitative risk assessment and
- » Generate a comprehensive and dense description of the mechanisms of risk production in Megacities in general and in particular for Santiago de Chile.

## Governance

Almost all Latin American countries have embarked on a process of profound democratization in the last twenty years. Re-organization and transformation of public decision-making procedures, including the re-formulation of the relationship between the state, civil society and the private sector, have been at the heart of this process. However, governance structures still seem inadequate to meet the significant challenges the continent’s large agglomerations are facing (De Mattos

et al. 2005). There are at least four major issues and challenges of urban governance in Latin America that deserve particular attention: decentralization, privatization, participation and informality.

Objectives of research:

- » Facilitate the implementation of strategies for sustainable urban development by clarifying the framework conditions set by existing governance structures;
- » Assess in how far existing governance structures enhance certain risks and impede the attainment of sustainability goals, and to use the findings of Risk Habitat Megacity in order to support the improvement of governance performance;
- » Generate theoretical insights into how current trends in terms of decentralization, participation, privatization as well as the matter of informality can either obstruct or facilitate the governance of megacities and
- » Provide general recommendations on the modification of governance structures in the study region.

## Land use management

Similar to other metropolitan areas, Santiago is undergoing a rapid process of urbanization with changes in land use and urban morphology. Planned and informal expansion reduces valuable open space and soils, and increases impervious surfaces. Large cities always face natural hazards, which only become risks or disasters when lives and livelihood are endangered. So risks are often the result of inadequate social or human practices associated with the complex natural setting and cause accumulated social and physical vulnerability (Brauch 2005; Winchester 2005). Due to the tectonic situation, large earthquakes are a frequent phenomenon. The urban environment is also vulnerable to flooding and landslide risks. Building activities on the peri-urban piedmont and the clearing of avalanche forests in mountain regions has begun to affect a growing number of people.

Objectives of research:

- » Assess how land use and land use change modify metropolitan areas;
- » Distinguish urban structure types and assess the relation between their characteristics and the respective level of vulnerability or resilience to natural risks;
- » Identify risk-prone areas in the context of the pre-

dominant risks (earthquakes, flooding and landslides);

- » Identify appropriate assessment and monitoring methods for single and multiple risks and
- » Assess adequacy of existing land use planning and risk management approaches to the relevant governance.

## Socio-spatial differentiation

Intensive socio-spatial differences are a characteristic trait of Latin American societies and have a powerful impact on land use patterns. While large-scale residential segregation has long dominated cities all over Latin America (Sabatini 2003), it is now approaching a new dimension (Borsdorf 2006). In the last decade Santiago de Chile has witnessed an emergence of vast real estate projects in previously disadvantaged areas. As a result, upper and lower income groups now live closer to one another than was the case in the past. While spatial dimension of social differentiation has decreased, social separation has increased and is now far more pronounced than ever (Sabatini et al. 2001). Social housing programmes for poor households likewise have a considerable impact on socio-spatial differentiation.

Objectives of research:

- » Conceptualize the interaction between the urban land market and residential segregation patterns;
- » Assess opportunities and risks of new patterns of segregation, in particular whether spatial proximity promotes social integration and
- » Assess of the role of housing policies in processes of socio-spatial differentiation.







## Energy system

Energy consumption in Santiago de Chile is rising fast. Apart from the problem of resource exploitation, this energy use also leads to the production of pollutants that contribute to a worsening of the air quality in the city (Arenas et al. 2000). In addition, more and more industries in the hinterland of the city consume energy resources such as oil and natural gas. A core strategic question is how the rapidly growing energy demand can be managed and how air pollution can at the same time be controlled. Severe disruptions are known to have occurred in the delivery of natural gas from Argentina to Chile in recent years. This forced industries and residential consumers to switch to other fuels, which in turn led to higher costs and frequently to a further deterioration of the air quality in Santiago de Chile (EIA 2006).

Objectives of research:

- » Identify structures and characteristics of the energy system with respect to the city and their relation to the environment, and evaluation of current situation;
- » Develop most suitable and most effective political and societal strategies to mitigate or avoid current or future problems and risks concerning the energy supply;

- » Develop highly stable and sustainable energy system and
- » Develop a model for future energy system development under varying frameworks, leading to an “image” of a more sustainable energy system for a megacity.

## Transportation

The unceasing spatial expansion of Latin American megacities such as Santiago de Chile is closely linked to a growing demand for transport, which in turn generates a permanent need for new infrastructure. As the extreme dynamics in the transportation sector jeopardize the sustainability of megacities and create specific risks, the need for qualified planning and management measures that gear transportation and travel behaviour towards sustainability goals seems urgent. Transportation planning in megacities requires tools that allow for the evaluation of policy measures with respect to their potential to achieve ecological, economical and social sustainability goals.

Objectives of research:

- » Identify most effective transport demand management measures in Santiago de Chile with regard to



a more sustainable transportation system now and in the future and assess their influence on transport demand or support modal shifts from private to public transport;

- » Assess data requirement and availability in Santiago de Chile or other Latin American megacities for the work with modelling instruments;
- » Investigate how expertise in micro- and macroscopic modelling can be brought together to enable the evaluation of transport demand management measures such as congestion charging, speed limits or changes in service of the public transport sector and
- » Assess to what extent the transportation sector contributes to air pollution throughout the city and how the analysis of the vehicle fleet structure can improve the forecast of emission distribution models?

## Air quality and health

Air pollution in megacities and densely populated areas has become a serious problem and is most pronounced in topographically structured areas (Molina/ Molina 2004; Gurjar/ Lelieveld 2005). Major contributors to air pollution are traffic emissions, domestic heating and industrial sources. In the face of the expected growth of urban populations, rise in standards of living, expansion of the economy and urban sprawl, air pollution will reach intolerable levels in the future. Air quality is a predominant factor for environment associated diseases. Emissions from different anthropogenic processes and topographi-

cal and meteorological conditions determine outdoor air quality. A detailed knowledge of the air quality situation is a basic requirement for the development of feasible strategies to improve air quality and the concomitant health status.

Objectives of research:

- » Assess how a suitable emission inventory for the production of reliable air quality assessment studies can be developed;
- » Assess to what extent traffic emissions and air quality in megacities and their surrounding regions depend on vehicle fleet composition and traffic flows;
- » Clarify how separate information platforms (satellite data, in situ measurements and modelling tools) can be linked as a preliminary to the development of an integrated approach to air quality assessment;
- » Determine the relation between the levels of outdoor air pollution by various airborne substances (gaseous and particles) and the incidence of selected environment-related diseases and
- » Assess the contribution of traffic emissions to health conditions and health risks associated with housing area/ housing type using the evaluation of different housing areas/ types.



## Water resources and services

Drinking water supplies and discharge of waste water are indispensable prerequisites for human life and well-being, and the prevention of infectious and chronic diseases. Furthermore, lack of access to basic services can lead to grave economic consequences. Santiago de Chile is known for its high level of coverage, efficiency and quality in water service provision, distinguishing it favourably from most other cities in Latin America (Jouravlev 2004). Investigations of the specific determinants and implications of this performance (regulatory framework, upstream and downstream linkages, and ecological, economic and social conditions) could provide a framework for comparison or application to other metropolitan areas in the region.

Objectives of research:

- » Develop a general implementation strategy for sustainable water supply and sewage treatment;
- » Assess water related risks (hygienic, economic, ecological, technical) for sustainable development and
- » Conduct a risk analysis of the water infrastructure.

## Waste management

Although health and environmental problems arising from inadequate solid waste management are well known, many parts of Latin America have not given this issue the necessary weight. Likewise, big cities are the

most active generators of municipal waste per capita. On the other hands, segregation and recovery of recyclable materials is not carried out on a large scale and technological development and research in municipal solid waste management is low. Waste that is not collected is either recycled informally or deposited in pseudo legal dumps, illegal garbage dumps, or simply dumped indiscriminately. Handling of domestic waste is regulated by several laws, remittals, regulations and enactments, and the authority to supervise compliance is divided between several public institutions.

Objectives of research:

- » Analyse the current waste management system in the metropolitan region of Santiago de Chile and
- » Analyse different scenarios for waste management and development of strategies to accomplish a more sustainable system of waste management.

## 7. Results of the research

The initiative will lead to a variety of results in the different topics, i.e., empirical findings, methods, models, tools and measures associated with the fields of application and problems under review. The topic-related results represent the essential products to be integrated and synthesized at the overall level of the initiative. The most important outcomes are:

- (1) Assessment of the sustainability performance of the case study together with a set of operable sustainability indicators for all topics;
- (2) Database for these indicators and other relevant issues;
- (3) Proposal for a consistent sustainable development strategy for Santiago de Chile;
- (4) Elaboration of alternative scenarios marked by different assumptions on the future direction and extent of their driving forces to strengthen the action orientation of research;
- (5) Documentation of risks across the fields of application and recommendations for the appropriate consideration of the most pressing current and future risks in urban management;
- (6) Refined analytical concept for transfer to other Latin American megacities;
- (7) Training of around 20 young researchers, who prepare their PhD thesis as part of the initiative; activities will comprise training and education by the Chilean and German research partners and
- (8) Transfer results and knowledge into academic and professional practice.

The dissemination of the major outcomes will take various forms and is geared to specific groups. The results will be shared with the scientific community through joint publications, using the intended annual conference as a forum for scientific exchange and discussion, and integrating the concept and its results into existing or specifically designed academic courses. Policy briefs addressing stakeholders, in particular policy-makers and local authorities are planned and will be distributed in Santiago de Chile and at the regional level through ECLAC/CEPAL.



## 8. Timeframe and Workplan (2007 – 2010)

In the course of an initial three-year phase (2007 – 2010), the involved partners are testing the applicability of the integrative concept and develop implementation solutions for the pilot case Santiago de Chile. The programme of work focuses on the following activities that are simultaneously carried out in all fields of application:

- » Development and adjustment of indicators;
- » Status analysis;
- » First evaluation, scenarios (models);
- » Measures, policy recommendations and
- » Final evaluation and conclusions.

On this basis the teams will synthesize the results to a consistent sustainability strategy and recommendations for improved integration of risk mitigation and risk management in urban governance in Santiago de Chile.

The implementation of the programme includes annual status conferences. They provide a science policy window for continuous dialogue on the results of the initiative and permit societal groups to participate and contribute to the debate from their respective points of view. From an early stage of implementation, the consortium will furthermore encourage the participation of research communities (including PhD candidates) and policy-makers from other megacities in the region. Thus, these conferences play a significant role in ena-





bling interested partners to join the process, to cooperate in developing the concept, and to identify the cases for investigation in phase two.

## 9. Expansion of the initiative to other Megacities in Latin America (2010 – 2013)

The initiative intends to transfer the interdisciplinary and integrative research framework to other Latin American megacities in a second phase (2010 – 2013). During the final year of the first phase (2007 – 2010), the analytical framework of *Risk Habitat Megacity* will therefore be examined with respect to its transferability to other Latin American megacities. This includes an assessment of the proposed strategies and measures with regard to their applicability outside Chile, i.e., in other contexts. It likewise includes the adjustment of the focus and research questions in the fields of application to the specific context of the case cities in the second phase.

To prepare the expansion, several activities will take place already at an early stage of the first phase (2007 – 2010). They involve a dialogue with interested potential partners, the clarification of the conditions for expansion, the selection of case studies and the thematic focus. Selection will be based on several considerations such as interest of scientists and institutions, access to information and data as well as international research undertaken in subjects related to the project at a metropolitan level. Furthermore, the case cities should have a population of at least five million.

While the partners will apply the overall framework to these cases, the focus of empirical investigation and the selected fields of application may well differ from case to case. At the end of the second phase, results from the individual case studies will be aggregated and generalized to a regional perspective. «

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