



Climate Adaptation Santiago (CAS)

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1. Project's General Framework

Time frame:

12/2009 – 11/2012 (36 months)

Partners:

- Universidad de Chile - Centro Internacional para el Desarrollo Urbano Sustentable (IDUS)
- Pontificia Universidad Católica de Chile - Instituto de Estudios Urbanos y Territoriales (IEU+T)
- Economic Commission for Latin America (ECLAC)
- Karlsruhe Institute of Technology (KIT) - Institute for Technology Assessment and System Analysis (ITAS)
- Helmholtz Centre for Environmental Research – UFZ (Institution responsible for the project coordination)

In cooperation with Chilean entities:

- Ministry of the Environment (SEREMI MMA)
- Gobierno Regional (GORE)

Contracting entity:

- Ministry of Environment, Ecology and Nuclear Safety (BMU) of the German Federal Government, International Climate Initiative

Project coordination:

Head: Bernd Hansjürgens, UFZ

Coordination: Kerstin Krellenberg, Katrin Barth



2. Project summary

In the future, climate change will be increasingly influencing the development of the Metropolitan Region of Santiago de Chile, and specially requires the introduction of adaptation measures, given the extreme concentration of economic power and functional systems in the region, as well as the high demand for resources.

The project's objective is to develop climate change adaptation measures for the Metropolitan Region of Santiago de Chile in the key sectors energy, water and land use. Activities include the estimation of the fundamental climate changes with a special focus on the urban-regional level, as well as the estimation of their consequences and impacts/vulnerabilities by the elaboration of explorative scenarios. As part of a participatory process (this includes a series of 10 Round Table Meetings), representatives of relevant authorities at regional and national level will develop, evaluate, and prioritize climate change adaptation measures and plan their implementation. With the integration of scientists and local authorities of other Latin American megacities the activities will be incorporated into a Regional Learning Network.

The project tries to contribute to the development of competences and capacities of local actors, especially the participants of the Round Table Meetings and the Regional Learning Network. At the same time it aims at raising awareness among the population about climate and resource protection, and to contribute to a reduction of climate change-associated risks, particularly for vulnerable groups.

3. Starting point of the project

The Metropolitan Region of Santiago de Chile is an agglomeration of more than six million inhabitants. Like other megacities in Latin America, Santiago is the political, administrative and economic center of the country. Due to the high concentration of economic power and functional systems in the region, the demand for resources is already high today and will continue increasing in the future.

Santiago de Chile is located in the subtropical central zone of Chile, in a valley between two Andean cordilleras. The climate in Santiago is dry in general. The annual average temperature is of 14 ° C, the average annual precipitation of 312.5 mm. The warmest months are December to February with an average temperature of 18.9 to 20.0°C and the coldest months are June to August with average values of 8.1 to 9.1°C. The highest precipitation rates are between May and August with an average of 57-85mm, the lowest rates occur from November to April with an average up to 14 mm monthly (average values of WMO from 1960 to 1991).

Estimated data of possible future consequences of climate change on the region exist from different sources at different spatial resolutions. General findings can be extracted from the reports of the Intergovernmental Panel on Climate Change (IPCC) for the Central Zone of Chile that includes the Metropolitan Region of Santiago. Since this global information is based on a low spatial resolution, their informative value for the local level is limited. For instance, the intense difference of the relief between the Andes in the East and the Pacific in the West as well as specific regional climate characteristics cannot be captured adequately.

In addition, model calculations are available from the University of Chile published in 2006 by CONAMA in a report on climate variability in Chile for the XXI century. Based on long-term measurements (1960-1991) of e.g. average temperature and precipitation a) the current climate was modeled and b) two alternative scenarios (A2 and B2 according to the IPCC) were calculated for 2071-2100 with the regional model PRECIS (Providing Regional Climates for Impact Studies), developed by the Hadley Centre dependent on United Kingdom Meteorological Office (Met Office). The spatial resolution of this model is 25 km and it covers



completely the Chilean territory, divided into five zones. Interpolation for any points in the model network is possible, that enables to draw conclusions about both the current climate and the two scenario alternatives (A2 and B2). Existing uncertainties and inaccuracies (specifically in the area of the Andes) must be differently considered. The database for the regional modeling with PRECIS comes from the global model HadAM3 (also from the Hadley Centre), which in turn results from the coupled ocean-atmosphere model HadCM3. 'Intermediate' calculations for the years 2011-2030 and 2046-2065 have also been carried out with the model HadAM3. Based on the calculations of the regional models, different transects have been analyzed in detail, among others a swath of 50 km centered at 33.5 degrees south latitude which reflects approximately the Metropolitan Region of Santiago de Chile. Given the A2 scenario an increase in medium temperature of 3-4 ° C (in some areas up to 5 ° C) is expected in all months in this area between the years 2071 and 2100 (with respect to the current climate that has been modeled based on long-term measurements between 1960 and 1991). Thus, medium temperatures between 24 and 26°C are projected for the summer months (December to February). By contrast, precipitation is expected to decrease in the same period by up to 40%. So far, Santiago was subject to significant rainfalls between March and May with highest rates between June and August. Former are expected to decrease by 40% -60%, the latter even by 70% -80%. The already low precipitation rates between September and November (1-5mm) are likely to diminish by 50-70% leading to prolongation of the dry period. These projections are likewise reflected in the more moderate B2 scenario although to a lesser extent.

Despite the fact that Santiago de Chile is not directly located at the coast, expected sea level rise can't be neglected while considering climate changes in Santiago de Chile. Calculations and estimations have likewise been done with the global model HadCM3. Up to now, no final conclusions can be made regarding the related impacts. This requires further analysis of the relationship between sea level rise, its effects on the watersheds and the related reduction in the retention of melt water.

Strong interrelation exists between expected changes in medium temperatures and the amount and intensity of rainfall on the one hand, and changing land covers and uses on the other hand, with a direct relationship to the water supply of the Metropolitan Region of Santiago (MRS). As increasing temperatures will favor the melting of the glaciers and the decrease of precipitation will prolong the dry period and increase water demand, the entire water supply of the urban population is at considerable risk because the whole water supply for the urban area and for agricultural irrigation in the rural areas of the MRS highly depends on water from the Andes. This water, in turn, comes almost year-round from snowfields and glaciers that are extremely threatened by climate change both in terms of spatial expansion and persistence over time. A decrease in snowfields and glaciers in the Andes could consequently endanger both the supply of drinking and industrial water and the food supply of the urban population (due to bottlenecks in water supply for agriculture). Additionally, bottlenecks in energy supply that are already occurring in some years are expected to occur more frequently because nearly 50% of the energy supply is generated by hydroelectric power plants. An updated risk analysis of the hydroelectric sector (Vargas 2009) assumes that the runoff of the most important river in the Andean region (Rio Maipo) will decrease between 50 and 70% by the year 2070.

The spatial distribution of the risks and, therefore, the effects on different population groups are not foreseeable yet. Since in Santiago de Chile a high socio-spatial differentiation exists, the variation of climate change effects will also be high. Furthermore, no conclusions can be drawn regarding the impacts of climate change on the primary energy consumption. Possibly, the increased energy consumption for cooling will correspond to a decrease in energy consumption for heating in winter.



4. Objectives of the project

The main objective of the project is to develop climate change adaptation measures for the Metropolitan Region of Santiago de Chile. Mainly two areas of responsible public action will be strengthened through a close connection between scientific research and policy implementation: (1) to overcome sectoral barriers and (2) to orientate policies to cope with climate change to the long-term. The close collaboration with major local decision makers is an important part of the project.

The Chilean National Action Plan of Chile (PAN) provides the basis for it. In accordance with the PAN, the project intends to study in detail the complexity of interactions in the urban space, especially for sectors that are mostly affected by climate change in Santiago: energy, water and land use including socio-spatial effects of climate change. To fulfill this aim, it is fundamental to assess carefully the impacts of climate change, the resulting need for adaptation measures, the spatial distribution of risks and the corresponding effects on different population groups (social vulnerability).

The implementation of the developed measures in the Metropolitan Region of Santiago is seen as an integral part of the overall objective. Relying on experiences that were obtained by the development of a sustainability strategy for Santiago de Chile, transferable adaptation measures to climate change throughout the region will be developed in cooperation with partners from other Latin American megacities (Regional Learning Network). In addition, the project's aim is to illustrate the "state of the art" related to urban adaptation to climate change in Latin American cities. Furthermore, the promotion of capabilities for decision makers in Latin America and the exchange of experiences are also sought.

The overall objectives of the project are:

- **Estimation of the major climate changes at the urban and regional level in Santiago de Chile**
Analyze existing data and research, and if required complement and/or validate them in order to get definite and precise conclusions with regard to the initial situation of climate change, on which the remaining targets will be based.
- **Estimation of the climate change effects on the sectors of water, energy, land use and social vulnerability**
In order to get definite conclusions about the interactions between climate change and the key sectors, a scenario framework will be used to analyze in detail the different areas and their interrelated functioning.
- **Strengthening capacities of stakeholders in the Metropolitan Region of Santiago de Chile**
This especially affects the Ministry of the Environment (MMA), but also the Regional Government. It is the MMA's responsibility to deal with climate change adaptation in Chile and, therefore, is the main organizations involved. The Regional Government, being the supervisory authority of the 52 communes of the Metropolitan Area, plays an equally decisive role in order to develop a strategy to climate change adaptation. In addition, the Regional Government signed its accession to the C40 in 2009. The collaboration with both entities offers a great opportunity to entrench the importance of climate change prevention. The project will make an important contribution to consolidate this process.
- **Promotion of information exchange between different sectoral ministries (Regional Ministerial Secretary, SEREMI) and administrations within the Metropolitan Region**
It is planned to overcome the restricted sector orientation of the several ministries, e. g. the Ministry of Energy or the Ministry of Public Works (responsible for public infrastructure, roads, water supply), leading them to a more integrative collaboration. Therefore, the project includes the organization of ten round table meetings and the coordination of a continuous process of cooperation with a group of local stakeholders.



- **Knowledge creation, transfer and spreading**

The results will be prepared and disseminated according to the needs of the recipients. The most important target groups are local stakeholders, decision makers and the administration of Santiago de Chile, citizens, decision makers in Latin America, international organizations, forums and networks (UN, World Bank, UGEC, etc.).

5. Work phases

Work Package 1: Assessment of the main climate changes and climate variability focusing on the urban-regional level in Santiago de Chile (UCH responsibility).

- Documentation of the state-of-the-art with regard to the IPCC scenarios and other global and especially regional models.
- Analysis of existing local data sets, and comparison with data from national and international institutions.
- Assessment of future climate-changes in the Metropolitan Region of Santiago with special focus on temperature and precipitation.

Work Package 2: Estimation of the effects and impacts of climate change on the key sectors energy, water and land cover using explorative scenarios (KIT and UFZ responsibility)

- Analysis of the complex interrelation between climate change and decline in water availability and supply.
- Analysis of the changes in energy demand as a result of temperature changes (cooling and heating) and assessment of the change in energy supply as a result of lower availability of water in the future (hydropower).
- Assessment of land use changes resulting from constant urbanization. Focusing on hazards caused by climate change and changes in land use and cover (heat and flood), to show, among others, the existing potential to reduce risks.
- Assessment of the distribution of the impacts on different population groups and their vulnerability (exposure analysis).

Work Package 3: Design / selection of measures in the frame of a participatory process with local stakeholders (PUC responsibility)

With this purpose, a series of Round Table Meetings on adaptation to climate change are organized; representatives from all relevant authorities at regional and national levels will get together regularly during the course of the project. The main objective of the round table meetings is to determine possible measures, to establish criteria for their evaluation, to prioritize and select appropriate measures and finally implement them. This includes the following:

- Collection of measures and initiatives that deal with the impacts of climate change in the key sectors energy, water, land use and land coverage, and socio-economic consequences (social vulnerability), focusing on those that interrelate the mentioned sectors;
- Development and selection of prioritization and choice criteria. The criteria will be fixed by agreement with local stakeholders. Possible criteria are: effectiveness, period of time until implementation, judicial and institutional conditions, synergy effects and obstacles to implementation, costs, consistency with existing sectoral activities, alignment with mitigation measures already in progress (especially CDM);
- Listing institutional requirements that are necessary for adaptation planning of prioritized measures, for example, regulations on energy efficiency of buildings or on alternative energy sources as prerequisites for changes in the energy sector:
- On one hand, analysis of current policies related to adaptation strategies; identification of responsible / participating organizations, existing cooperation mechanisms, and on the other obstacles to implementation, e.g. conflicts with existing strategies and development



objectives, lack of capacities for implementation, ambiguous division of competences, lack of acceptance of prioritized measures among the population, etc.;

- Evaluation of the measures based on the criteria and prioritization, preparation of specific (feasibility) studies to foster decision making (elaboration of expert reports);
- Determination of measures' selection.

Work Package 4: Implementation of the selected measures (PUC and MMA/GORE responsibility)

- Development of adaptive target values for the selected measures, implementation through guidelines / regulations, development of mechanisms to ensure the execution of guidelines and regulations, development of mechanisms for evaluation and conversion of the adaptive strategy into a long-term planning.
- Design and implementation of a cooperative and consulting process (in collaboration with the Regional Government and relevant ministries) that should make the authorities aware of the potential effects of climate change as well as to possible methods of prevention / reaction, to use that as a basis for developing an adaptation strategy and an implementation planning; development of (horizontal, vertical) cooperation mechanisms, for example, the set-up of an Office of Climate Change;
- Elaboration of information materials for the administrations and to raise public awareness.

Work Package 5: Regional Learning Network in Latin America (ECLAC responsibility)

- Integration of scientists and responsible decision-makers and administrations of other Latin American cities, to support and reproduce the Santiago strategy's process and to learn from existing experiences and knowledge.
- Furthermore, the integration of the measures into the process of climate change that is guided by the United Nations Commission for Latin America and the Caribbean is sought (through its function of secretarial work for national ministries' periodical consultations).

6. Project monitoring, evaluation of outcome and results

The evaluation and monitoring of outcomes are ensured by measurable and verifiable indicators. The project partners will regularly (quarterly) inform the applicant about the progress of work, either *in situ* or through video conferencing. The results will be documented in interim reports (protocols). The project partners will jointly write interim reports to be handed the Ministry (BMU).

Important interim results are:

- Completion of a final report on main climate changes in Santiago (State-of-the-Art): 6 months after project start;
- Organization of a series of Round Table Meetings with binding confirmations of about 15 to 20 representatives of key administrations (Santiago de Chile): 6 months after project start;
- Confirmation of organizations / representatives from 5-6 cities in Latin America to cooperate and join the regional learning network: 6 months after project start;
- Presentation of the estimated, scenario-based impacts that climate change will have on the sectors energy, water, land use and social vulnerability (interim reports): 12 months after the project start, final report 18 months after the project start;
- Listing of possible measures and binding setting of criteria for prioritization: 18 months after the project start;
- Feedback on possible measures from the Regional Learning Network: 18 months after the project start;
- Completion of a list of prioritized measures agreed upon with local stakeholders (report): 24 months after the project start;



- Submission of implementation arrangements for prioritized measures: 30 months after the project start;
- Materials / products (focused on defined target groups): 36 months after the project start.

The success of the project will be measured by the following ascertainable results:

- There is an extensive and comprehensive database as a result of the analysis of major climate changes, complemented by own empirical research;
- There is detailed information on the impacts that the climate change will have on different sectors, and it is used to develop measures;
- Five to ten prioritized adaptation measures were identified as a result from the participatory process based on and supported by the knowledge of the participants of the Round Table;
- There are agreements / implementation plans with cooperation mechanisms for identified / prioritized (intersectoral) measures in Santiago;
- There is a monitoring system, installed by the most relevant cooperation partners (GORE, MMA), that supervises the implementation of the adaptation program to climate change;
- A set of information on climate change, on adaptation requirements and measures is offered to the citizens of Santiago;
- There is documentation (manual) for the participating administrations;
- The exchange within the Regional Learning Network led to other activities in at least two participating cities (for example, the adoption of particular elements or of the overall process and implementation of measures)