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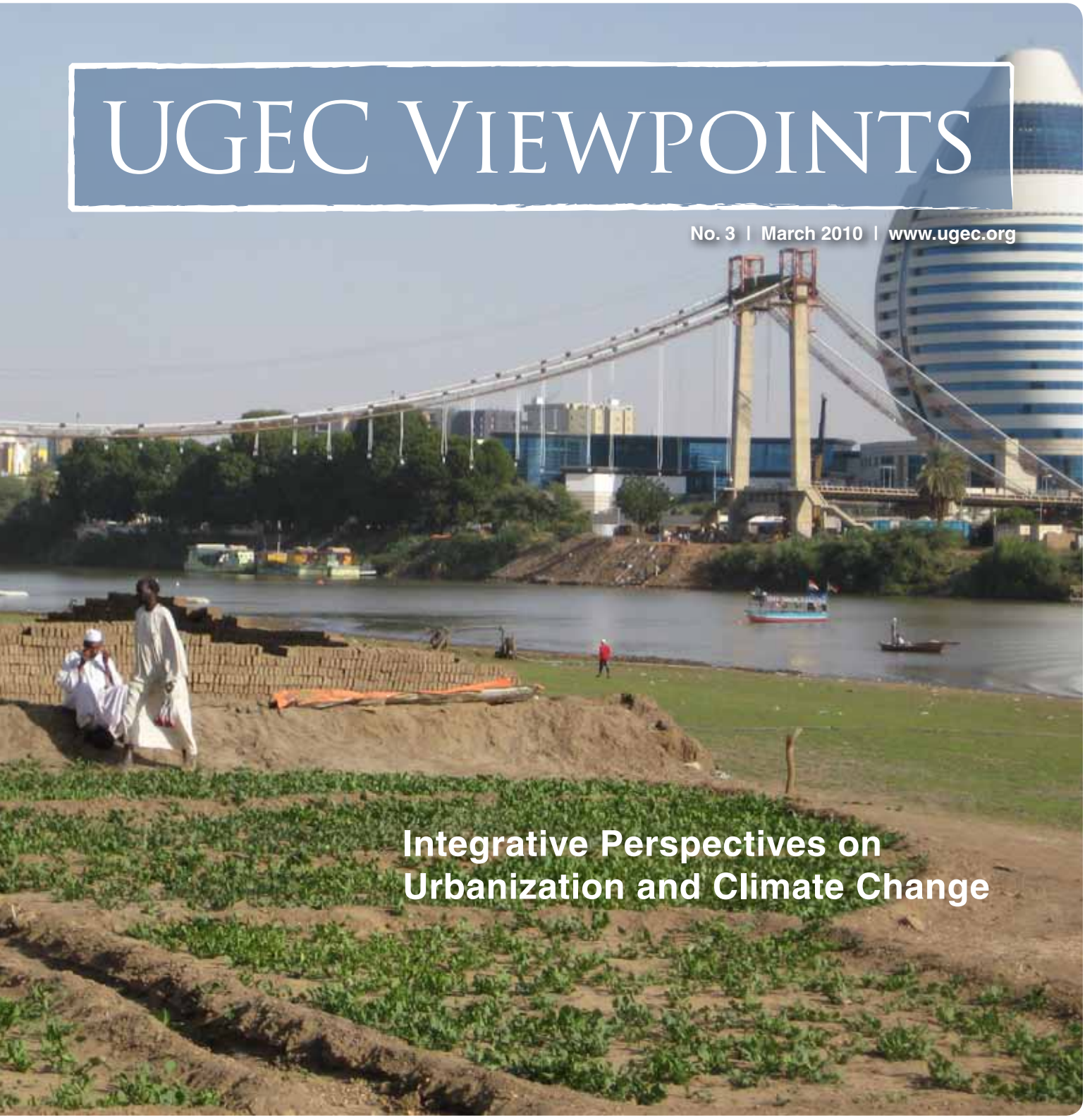

Integrative Perspectives on Urbanization and Climate Change

IHDP International Human Dimensions Programme on Global Environmental Change

ASU Global Institute of Sustainability

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Editorial

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Dear friends of the UGEC project,

This third issue of *UGEC Viewpoints* includes contributions from the wide spectrum of important thematic and regional foci in the UGEC field. We have put together a great issue and I would like to highlight a few of our contributions: the review of the Tyndall's Urban Integrated Assessment Facility, written by Richard Dawson and colleagues, which focuses on the case study of London; the discussion of climate change adaptation strategies within urban areas of Latin America that includes the case study of Santiago de Chile by Kerstin Krellenberg, Dirk Heinrichs and Jonathan Barton; and J. Marshall Shepherd's analysis of the role that urbanization plays on hydroclimate extremes and changes in the water cycle, highlighting the city of Atlanta.

The joint focus on urbanization and global environmental change now appears more important than ever. A clear message of the recent COP15 United Nations Climate Change Conference in Copenhagen in December 2009 is that humanity's response to climate change – through mitigation and adaptation actions and institutional change – will have to occur concurrently at multiple scales, including but not solely relying on, action from national governments. In particular, the centrality of urban areas in finding solutions to the combined demographic, economic and environmental challenges we will face due to climate change in this century is now undeniable. Thus, we find that our UGEC 2010 Conference, "Opportunities and Challenges for Sustainability in an Urbanizing World" could not be held at a more appropriate time. Scientists, practitioners, policymakers and stakeholders are all invited to participate in a forum for reflection, exchange of knowledge, experiences, lessons, ideas and information on the multifaceted interactions between urban areas and global environmental change. Preparations for the conference are well under way and a call for abstracts is out – which you can find on the last page of this issue. We ask you to please circulate widely the conference website (http://www.ugec2010.org) or the pdf copy of this issue which can be found on the web at http://www.ugec.org.

We hope you will enjoy reading our current *UGEC Viewpoints*. Another issue will be published before next October, so you will be receiving additional information on the conference through that publication. Please do check out our conference website http://www.ugec2010.org for more regular updates. We hope you will seriously consider participating in the event and look forward to meeting as many of you as possible in person in October!

Best regards,

Michail Fragkias
UGEC Executive Officer

Table of Contents

Busy traffic in Santiago, Chile with the Andes in the background

Climate Change and Adaptation Strategies in Latin American City-Regions: The Case of Santiago de Chile

Kerstin Krellenberg, Dirk Heinrichs, Jonathan Barton

Induced by a growing consensus that climate change is inevitable and plausible scenarios of impacts, city administrations worldwide are planning their responses. Although cities are key sources of greenhouse gas emissions and are highly vulnerable to the consequences of changes, they are also initiating actions to both reduce greenhouse gas emissions and to confront the anticipated effects. The Latin American/Caribbean region is no exception to this, as if follows North America (the most urbanized region worldwide), with approximately 80% of the population living in urban areas (United Nations 2008). Megacities like Mexico City or Sao Paulo (Prefeitura da Cidade de São Paulo, 2009) have very recently launched climate action plans to confront local problems related to land use and water management, transportation and disaster risk reduction. Other cities, such as Santiago de Chile, are still awaiting similar action steps, which will be developed from the national action plan established in December 2008.

Climate Change Scenarios for Latin America

In Latin America, anticipated climate changes and their predicted impacts are already experienced and traceable. According to the Intergovernmental Panel on Climate Change (IPCC), median annual temperatures rose by 1˚C between 1961 – 1990, accompanied by glacial melting and a rising sea level of 2-3mm. At the same time, precipitation variability and an increase in extreme events that often correlate with the El Niño-Southern Oscillation (ENSO) phenomena have been observed. Related consequences are floods, land slides, and water and energy scarcity.

Following the IPCC (2007) and its global models, these consequences will become increasingly severe in Latin America, considering the predicted median annual temperature rise between 1.4 and 2.6˚C exceeds historic trends. The expected consequences are complex, and on the whole negative. Rising temperatures and precipitation variability are expected to aggravate glacial melting along the Andean range, as these countries are already suffering seasonal shortages in water for irrigation, drinking water and hydropower supply. Other predicted impacts are salinization and desertification in arid

regions, which will consequently affect the food industry. Together with the sea level rise, an increase in coastal flooding events seems unavoidable. These are only some of the expected multiple impacts on ecosystems, resources and population.

Deducing local consequences of climate change impacts for city-regions is complicated and afflicted with a high level of uncertainty due to the problem of downscaling global climate models and the complexity of synergetic urban and regional processes. Nevertheless, based on different types of information available for the metropolitan area of Santiago de Chile, this article attempts to explore the challenges facing Latin American city-regions in the context of climate change.

Santiago de Chile: A Case of Rapid Urbanization and Pressures on Natural Resources

The metropolitan region of Santiago de Chile, with its population of six million, is the economic centre of Chile, contributing 42.7% to the national GDP (GORE 2009). The expected population by 2030 will exceed eight million people (MINVU 2008). In comparison with other Latin American city-regions, population density in Santiago de Chile is relatively high with approximately 90 persons per hectare, however, the central area possesses comparatively lower density than other areas due to a process of population loss to more peripheral urban municipalities (according to the national census, 1992-2002); this has generated a process of suburban sprawl during recent decades (Figure 1).

Figure 1 | The "sprawling" city of Santiago de Chile

Source: A. Künzelmann, UFZ

These urbanization processes have led to land use changes in principally agricultural areas and in the Andean piedmont where much of the region's remaining conservation zones are concentrated. With increasing urban land use, there is also increased risk due to the loss of environmental services, e.g. water infiltration, heat mitigation, and biodiversity conservation. Accordingly, a more fragmented city-region has evolved in functional and spatial terms, associated with important socio-ecological ramifications. Urban and regional form and their uses accompany the pressures of population growth and economic productivity that generate different resource demands for land, water and energy. The combined effects of these pressures make the metropolitan region increasingly sensitive to climate change.

While the city of Santiago is a successful case in terms of water supply coverage with almost 100% of the population connected to the domestic water supply and sanitation systems, it registers the highest in aggregate per capita water consumption among all large agglomerations in Latin America. At 616 litres per person/day (INE 2006), the inhabitants of the metropolitan region and their productive activities consume three times the amount of water than those in Lima (SEDAPAL 2008). The figure exceeds that of Mexico City (Del Valle-Cardenas 2009) or Buenos Aires (PNUMA 2003a), which are both known for notoriously high levels of water demand. With roughly 230 litres of per capita domestic use, less than one third is dedicated to domestic uses (PNUMA 2003b). The larger share is reserved for agricultural production[1].

Local Climate Trends and Climate Change Scenarios for Santiago

Santiago de Chile is located in the Maipo river basin on the western flanks of the Andes and is subject to a subtropical dry climate, with median annual temperatures of 14°C and annual median precipitation rates of 312.5mm. The warmest months are December, January and February with an average of 18.9 – 20.0° C; the coldest period is between June and August with an average of 8.1 - 9.1° C. Most of the precipitation occurs between May and August (57 - 85 mm). The driest period is November through April with an average of 2 - 14 mm monthly (median values from the World Meteorological Organization between 1960 - 1991).

Projected data for possible future impacts of climate change on the metropolitan region of Santiago are currently generated from different sources at different spatial resolutions.

1 Note, a comparison between different city-regions is difficult because of different administrative units, survey dates, etc., but nevertheless, the given figures allow a general comparison.

Cable car in San Cristobal hill, overlooking a panoramic view of Santiago de Chile

The principal reference point for downscaled climate change scenarios is that of the CONAMA (2006) study conducted by the University of Chile. Based on long-term measurements (1960-1991), the current climate and two alternatives for 2071-2100 (A2 and B2, according to the IPCC) were modelled with the PRECIS-model (Providing Regional Climates for Impact Studies), developed by the Hadley Centre of the UK Meteorological Met Office. The spatial resolution of cells of 25km^2 generates large uncertainties and inaccuracies, however, the modelling processes also provide relevant ranges in which public policy must be formulated; one of the 50km wide transects of the model represents an approximation to the metropolitan region of Santiago de Chile.

In terms of the more "pessimistic" (A2) scenario, an increase in the median temperature of around 3-4°C (in parts to 5°C) is expected for the period 2071-2100. In terms of precipitation (scenarios A2 and B2), the reductions are in the order of 40% in lower lying areas, less so as the Andean topography bears an increasing influence moving up into the Cordillera (mountain belt) (CONAMA 2006). Together with rising temperature, this is clearly relevant in terms of glacier dynamics, with their subsequent influence on year-long water availability in the basin's two river systems. The consequence will be higher winter discharges of water, gradually reducing over time as the glacial capacities diminish. The effects will be most evident in the drier months (the first four months of the year, in particular) when glacial thaw provides an important water flow through the system.

The Challenge Ahead: Water and Climate Change Governance within Spatial Planning

The combination of recent urbanization patterns, increasing demand for water in the metropolitan region and expected climate change will provide challenges, particularly with respect to equitable distribution of different resources. It is likely that new conflicts will emerge, e.g. over water availability, leading to demands for climate change governance in relation to spatial planning. To date, national and local government has only partially addressed these concerns. The Chilean national action plan creates a framework for action, but the issues are yet to be incorporated into regional and municipal government instruments and investments. It is also unclear how much of the projected 1.1% of GDP loss (to 2100) will be related to urban management issues, compared with productive sectors, e.g. mining and agriculture (CEPAL 2009).

The changes in temperature and precipitation interact with changing land cover and land uses and are directly connected to water supply in the metropolitan region. As the anticipated temperature rise will increase glacial melting and likely reductions in precipitation will increase the length and intensity of dry periods, the water demands of a growing population will aggravate the entire water balance in the metropolitan region. The recession of the Andean glaciers as the principal source of water in Santiago will not only threaten domestic water consumption, but also the supply of agricultural production. Furthermore, bottlenecks in the energy supply are expected, as about 50% of national energy is generated from hydropower (a loss of 10-20% according to CEPAL 2009). The spatial distribution of associated risks and impacts on different socio-economic groups has not yet been predicted, as vulnerability assessments have not been generated. Likewise, the possible effects of climate change on primary energy demand are uncertain, e.g. a higher demand for summer cooling systems may be compensated by a reduction in energy demand for heating in winter.

Water supply bottlenecks are already evident. The water market is based on water rights that are purchased and transacted (Water Code 1981, modified 2005) based on a minimum stream flow condition and a total availability calculated by the national water authority (DGA: Dirección General de Aguas). Currently, there is an insufficient supply for new surface consumptive rights to be made available in the Maipo basin, while groundwater

rights are offered provisionally, subject to better information about the dynamics of the groundwater hydrology in the basin (DGA 2003). Meanwhile, there is pressure from more powerful interests to buy out smaller rights holders, such as small-scale irrigation associations. The market is also unable to respond to fluctuations in the hydrological cycle, e.g. the El Niño phenomenon, since rights are fixed (although subject to extraction volume modifications) and are awarded in perpetuity. In consequence, as water availability decreases, existing rights cannot continue to allow extraction according to initial volumes and no new uses will be catered to without the termination of old uses.

The limitations of the existing water market, its weaknesses in responding to the natural cycles in the water basin, and the anticipated scarcity due to climate change, present a major adaptation challenge. Conflicts over the equitable distribution of water will increase, particularly between the demands from the residential, agricultural, and mining sectors and environmental services. Assuming that the residential expansion of land will continue, the question remains as to how a potential 40% reduction in rain water availability (CONAMA 2006) will be met by a population in the metropolitan area that is 30% larger than at present. Due to the fact that the city's location is in a biodiversity hot spot with current levels of green space per habitant (3.2 m^2/cap, CONAMA 2002) well below the World Health Organization recommendation of 9m^2/cap, water use issues come in to play. These include maintaining the region's ecosystems and increasing public spaces to enhance urban quality of life and to reduce, for example, the heat island effect. This will require a significant shift in water management in many areas, e.g. reduced agricultural irrigation capacity, watering, and species selection in public spaces and domestic gardens, a storm water drainage system that seeks to shift water downstream of the city as swiftly as possible during peak events (rather than capture and storage), and broad-based demand reductions.

A further challenge related to the issue of water is climate change governance within spatial planning. The 2005 national climate change strategy concentrates on productive sectors, particularly mitigation and Clean Development Mechanism (CDM) opportunities, but fails to put much weight on adaptation issues (CONAMA 2005). It also fails to explicitly consider urban centres in spite of over 80% of Chileans living in urban areas, with over 40% of the national population living in the metropolitan region. This has changed slightly with the publication of the 2008 national action plan (CONAMA 2008). The plan focuses on seven fields for action, water being one of them. Although urban change, except coastal city risk, is not an explicit focus of the plan, all seven issues relate to urban transformations. Their incorporation into planning instruments will be a primary challenge for climate change adaptation. To date, the regional development strategy, metropolitan and local regulatory plans, and local development plans have not included climate change considerations explicitly, largely because of the sectoral approach to public management. It is yet unclear how this national and sector-oriented document can be translated into local action in the metropolitan region.

Climate change adaptation will demand a coordinated response from government agencies within the context of a regional adaptation plan. Although the DGA manages the water market, the water planning dimension must be brought within the administration of the territorial authority, the Regional Government, as part of a strategy enabling cohesion with the priorities of the national plan and engagement with the multiple public and private actors who are direct stakeholders - from rights holders (agriculturalists, mining firms and others), to the environment commission, the housing and urbanization ministry, the public works ministry, and municipal authorities. It is clear that at present, this natural resource market has serious limitations for facing the climate change challenge of this century.

The references for this article are available on our website: http://ugec.org/docs/ViewpointsIssue3References.pdf