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Climate Change Adaptive Capacity in Santiago de Chile: Creating a Governance Regime for Sustainability Planning

JONATHAN R. BARTON

Abstract

For most urban areas, the challenges of adaptation are as urgent as those of mitigation. This is particularly the case where adaptive capacity is weak, particularly in low- and middle-income countries, and the benefits of global mitigation in the short term will be experienced beyond 2050. A focus on adaptive capacity-building in these vulnerable settings is imperative. Much of the emphasis in climate change since the early 1990s has been on basic science and how public policy should respond to it; less attention has been paid to the governance implications and connections with wider development processes. This article explores the governance challenges of adaptation in the Santiago Metropolitan Region. It points to weaknesses in the water and energy sectors, which have highly sectoral, horizontally unintegrated institutional structures and instruments that pose significant challenges for adaptation. Such cases point to the need to engage with both the wider planning concerns of existing development strategies and the basic elements of transdisciplinarity, finance and human capital-building, in order to forge a more integrated adaptation response. Without an engagement with the governance issue and wider debates around metropolitan planning and socioeconomic development, it is unlikely the response will move beyond a limited physical infrastructure investment programme.

The governance imperative in climate change adaptation

Based on the currently available science on climate change, there is a clear imperative to move towards action-oriented strategies designed to reduce risk and maximize new opportunities over the coming decades. These strategies will emerge from new adaptation governance frameworks at national and subnational levels. They will involve a wide range of actors, from public sector institutions to civil society, incorporating private sector actors and research institutions. In the case of Chile and the Región Metropolitana de Santiago (RMS — Santiago Metropolitan Region), there has been an evident lack of engagement with such issues, where capacity issues relating to transdisciplinarity (the ability to focus on problem-solving at the interstices of diverse disciplines), finance and human capital-building remain implicit rather than explicit. It is such issues that underpin the creation of a governance regime (an institutional system for decision making and interventions by governmental and nongovernmental actors) that is able to integrate the adaptation agenda with broader development challenges and existing instruments in the search for virtuous synergies.

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The engagement with these issues and the imperative of linking any climate change adaptation with wider development concerns and existing social risk profiles, can be regarded as the basis for an effective governance regime underlying an adaptation agenda. Given the proximity between this agenda and the wider development agenda in urban and regional contexts, there is also clearly a strong overlap with sustainability planning that seeks to integrate diverse challenges within more integrated responses from diverse actors. Given the tentative pre-existence of the latter, there would appear to be a window of opportunity for synergies with an adaptation agenda.

The article begins with an overview of the Chilean institutional response to the climate change challenge, initiated by the publication of the National Action Plan in 2008, working from the 2006 National Strategy. The weak connection to city-region development is noted, as also to vulnerability and adaptation generally. The current situation in terms of water and energy management in the RMS is then presented since it reveals some of the structural problems that have to be addressed in order to move towards a more integrated, transdisciplinary response to climate change, together with the challenges of developing new instruments and investments and also human capital capacities. The last two sections return to the need for strategic planning and the linking of climate adaptation to existing instruments rather than to a plan that runs in parallel, which is also the basic platform of effective governance. Without a communicative planning approach to climate change adaptation, within an appropriate governance framework, there is a risk that a superficial, purely infrastructural response to climate change will take the place of a more socially based one, embedded in public, private and civil society awareness and changing behaviour. The framing of the debate and the subsequent responses is a governance issue, not merely a technical one, and it is here that considerable work remains in the Chilean context, in particular in the RMS, which is home to approximately 40% of the national population.

The material presented here is based on documentary analysis and participant observation of three processes during the period 2005 to 2010. The processes cover the fields of climate change, environmental governance and planning. The first of these relates to the emergence of the debate on climate change in Chile following the publication of the National Climate Change Strategy in 2006 (Gobierno de Chile, 2006) through to the launching of the National Climate Change Action Plan in 2008 and its aftermath. This first process is closely linked to the second. From the publication of the OECD environmental report on Chile in 2005 and consensus among presidential candidates during the 2006 campaign, there was a commitment to a reform of the environmental institutionality of the country. This led to the creation of a Minister for the Environment in 2007 (Law 20.173), and the replacement of the National Environment Commission (CONAMA) with a Ministry of the Environment, a Superintendency of the Environment, a National Environmental Evaluation Service and Environmental Tribunals (Law 20.417, 2010). This law gave overall responsibility for climate change affairs to the Environment Ministry, managed by an Office for Climate Change. As far as adaptation and planning are concerned, the shift of spatial planning responsibilities from the Ministry of Planning to the regional government administrations in 2007 also marks an important watershed. The means of adaptation capacity and planning converge around these three recent processes.

Towards adaptation governance and sustainability planning

The science documented in the Intergovernmental Panel on Climate Change (IPCC) reports (1990; 1995; 2001; 2007) is precise and clear regarding the changes expected, within different margins of certainty, at the global level (including an economic valuation — see the 2007 Stern Report). At national and subnational levels, however, uncertainty increases due to modelling limitations, local conditions and socioeconomic vulnerabilities and capacities (IDB, 2000; CEPAL, 2009a; 2009b). It is at these levels that adaptation must take place to respond to climate change (see UNDP, 2007).

The emergence of research and practice on adaptation is a more recent phenomenon dating from the Conference of the Parties (COP) meeting in Marrakech at which it was made explicit. There are several reasons for this. One is that most IPCC-related scientists are experienced in research on natural processes in areas such as atmospheric chemistry, climatology and meteorology. The role of social scientists has been secondary, although it has been growing with each assessment. However, adaptive capacity relates to a wide range of disciplines in the sciences and humanities. It is a truly transdisciplinary challenge since the adaptation agenda relates to core issues within contemporary development. These development challenges arise out of the traditional basic needs approach, as can be seen in the Millennium Development Goals, but also belong within the challenges of Agenda 21, the blueprint for sustainable development during the twenty-first century (WCED, 1987; UN Commission on Sustainable Development, 1992).

The translation of the adaptation agenda into household livelihoods, through perspectives such as coping strategies and resilience building, reveals this engagement with contemporary development in its broadest conception. So do planning and the central role of communication and participation in planning processes (Healey, 1996). In this sense, therefore, climate change adaptation is mainstreamed, and the overlaps with ongoing strategies, plans and programmes are evident (LCCP, 2005; Tompkins and Adger, 2005). In the context of urban settlements, the emphasis on ecological security (Hodson and Marvin, 2009) would appear to connect with traditional concerns relating to urban development over time, dating back to the hygienist emphasis in urban planning and encapsulating many of the elements of chapter 7 of Agenda 21 (rather than a new paradigm per se: for secure urbanism and resilient infrastructure read Programme Area D, and for equitable distribution of infrastructure, chapter 3). It is the governance capacity to provide this ecological security that is still weak in the Chilean context. Betsill and Bulkeley (2007: 448) point to three critical factors that play a role in this situation in other urban contexts: 'the multi-level nature of climate governance; the role of knowledge in local climate policy; and the stubborn gap between the rhetoric and reality of local climate policy.' All of these themes have to be borne in mind in the design of an appropriate adaptation governance framework.

What binds individuals, institutions and disciplines together as far as adaptation is concerned is the need to plan: planning to reduce social risk (the precautionary principle), for agricultural change, for water and energy resource management, for urban development, etc. Rather than a new field of action, climate change adaptation is a complement to existing strategies and public policies that are already fraught with complexity. Since it includes both gradual and episodic impacts, and connects with existing concerns regarding hazards such as flooding, landslides, extreme temperatures, the urban heat island, etc., and risks that are built into existing social formations due to their financial, physical, social, human and natural assets, there are many overlaps with existing programmes, plans and actions. However, for the most part these connections are not made.

Following this same argument, there are evident interrelations with existing development agendas, since adaptive capacity has much to do with broad-based development vulnerabilities and capacities. These vulnerabilities and capacities can be understood through assets-based approaches, coping mechanisms or through a livelihoods perspective with a view to understanding development transitions and transformations (Ellis, 1999; Huq and Reid, 2009; Pelling, 2011). In urban adaptations to climate change strategies already in place, as in Cape Town and Mexico City, this high level of agenda integration is apparent (City of Cape Town, 2006; Romero, 2007; Barton, 2009).

Adaptive capacity understood from a climate change perspective is remarkably similar to conventional understandings of development planning in which knowledge of risks of various kinds is communicated, internalized and responded to with a view to increasing resilience and providing more development alternatives into the future. In this

sense, knowledge of climate change issues reinforces the need to address multiple vulnerabilities. Its principal benefit is that it provides information about changes into the future, thus revealing a need to move beyond traditional approaches to, and understandings of, certain themes, for example resource management. Mark Pelling (2011: 163) phrases this requirement in the most synthetic and effective way: 'adapting *with* climate change'. Nevertheless, attempting to change approaches to development planning and basic assumptions about risks, vulnerabilities and resilience is not a straightforward or short-term challenge.

There are various explanations for a relative lack of adaptive planning and action with respect to the science that is currently available. These include a lack of awareness and knowledge of the science involved, hence scepticism or ignorance, and the NIMTO response — Not In My Term of Office — in which long-term considerations are postponed due to their complexity and potential resource implications. Two other factors are finance and human capital-building. The financial implications of effective adaptation are considerable, though it is also evident that these costs rise rather than diminish over time, an observation made very clearly in the Stern Report (Stern, 2007). Early investment planning will reduce public costs as well as private costs in increased insurance and individual protective measures. In a similar way that the true costs of Agenda 21 were engaged with only in Rio+5 in New York (Osborn and Bigg, 1998) and later at the Monterrey Summit on financing for sustainable development (2002), clarity regarding climate change adaptation costs will be necessary to understand how these fit with conventional development expenditure or the extent to which they involve fresh capital outlay.

Human capital with expertise in adaptation also remains limited. Since climate change awareness building has not been on the public agenda in most urban and regional settings in developing countries, given the longer-term rather than short-term construction of climate change issues, the focus on the mitigation, education and training associated with climate change issues remains partial (effectively sidelining many locations with low greenhouse gas emissions). This situation clearly feeds into institutional responses. Without awareness building among decision-makers and technical staff within territorial and sectoral institutions and agencies, it is unlikely that the wider population will mobilize around these issues.

Outlining a governance regime: the Chilean institutional response

At the COP meeting in Poznan, Poland in late 2008, the Chilean government finally revealed its climate change action plan. This action plan is based on decisions following several years of consideration of climate change impacts within the context of the National Strategy. The Strategy was the first organized response to climate change, driven by the Foreign Affairs Ministry as part of its obligations within the COP process. Since Chile's Environment Ministry only came into existence in October 2010, the Foreign Affairs Ministry represented the country in international environmental fora before then, supported by the National Environment Commission (CONAMA). However, the multisectoral approach to climate change within the National Strategy brought together a wide range of government departments and agencies under Foreign Affairs Ministry coordination. From its earliest formulations, the emphasis was clearly on the physical aspects of climate change impacts, as well as on mitigation in order not only to be able to contribute to total global emissions reductions (voluntarily since Chile is a non-Annex I country), but also to take advantage of the economic opportunities created by the Clean Development Mechanism (CDM). The National Designated Authority for CDM was formed in 2003 and had approved 17 projects by 2006, with a further 48 approved by 2008 (CNACG, 2006).

The creation of a National Climate Change Committee in 1996 gave rise to the first report on national climate change impacts. An inventory of emissions was established

and an analysis of vulnerability, with the country meeting 7 of the 9 vulnerability conditions of Article 4.8 of the Framework Convention (CONAMA, 2008). Much of the focus on vulnerability was directed at productive sectors and the potential impacts on the economy, agriculture in particular. It is for this reason that the only ministry represented directly on the Committee was Agriculture. Other services invited to participate were those relating to energy, marine affairs, meteorology and research. It was only during the second phase of development, 1998–2001, that other ministries were included (Economy, Transport and Telecommunications), as were mining and public energy interests (CNACG, 2006; CONAMA, 2008).

The ministries and departments most closely associated with spatial planning — the Ministry of Housing and Urbanism (MINVU), the Under-Secretariat for Regional Development (SUBDERE), the Ministry of Planning (MIDEPLAN) and the regional governments (GORE) themselves — only started to be involved in the discussions very recently and as a result of the orientation of the Action Plan (November 2008) and their need to incorporate climate change planning into their instruments. As the administrators of territorial planning instruments, which are designed to bring together socioeconomic and socioecological dimensions of spatial change in the short (investment plans and projects), medium (policies and programmes) and long (strategies) term, their incorporation is vital in order to complement the existing emphasis on specific 'built' interventions.

In this sense, Chile is currently at a juncture. This juncture is defined by the broadening of the climate change agenda to include adaptation more fully and recognizing that this, in essence, requires the incorporation of public institutions and other actors, including NGOs and the private sector, within a more complex governance regime that is transversal and merges with more generalized development concerns, including issues of social vulnerability, water and energy markets and pricing, transport modes, coastal zone settlement, and housing and land use allocation, among others.

A review of the climate change strategy and the Action Plan provides evidence of the lack of consideration of the deeper implications of adaptation to climate change. The fact that the Action Plan identifies areas which will require further development to create specific strategies and programmes is emblematic in this sense. There is no clear financing associated with the Plan, nor is there any identification of human capital weaknesses. The emphasis on physical infrastructure suggests that the engineering response to adaptation — a 'hard' option — overrides any consideration of softer options. In many ways this reflects the difficulties of establishing transdisciplinary approaches to climate change adaptation where particular ministries and agencies take a lead role in view of the dominant social construction of the problem and the possible responses. While climate change adaptation is presented as a risk reduction strategy, the 'solution' of 'climate-proofing' communities with new physical infrastructure provides a common response, despite the clear financial burdens of such an approach.

Although there is growing awareness and the documentation at the national level is beginning to reflect adaptation concerns, this process has been slow. A further consideration is that urban adaptation is hardly considered, despite the fact that over 80% of Chileans live in urban settlements, many in coastal areas. The Action Plan emphasizes the opportunities for incorporating adaptation considerations into regulatory plans. However, this had to be grounded in practice, principally in instruments and procedures, by 2012. In 2013 much of this work remains to be done (PNUD–Ministerio de Medio Ambiente, 2011).

The challenges for the Santiago Metropolitan Region

The National Plan announced to coincide with the Poznan meeting still retains a strong emphasis on the early strategy agenda of mitigation and on impacts in productive sectors. Consequently, the plan is organized in terms of sectors, with a particular

focus on agriculture, forestry, mining, fisheries, energy, biodiversity, health and water resources. This last field is relevant not only for industrial and residential use, but also for irrigation and hydroelectric power (which accounts for 10.7% of national energy supply) (CEPAL, 2008). Notable by its relative absence is the field of urban development.

The most obvious overlaps are in the areas of health, energy, infrastructure and water resources. A particular area of concern is infrastructure development in coastal zone settlements. This brings together the designated partners of the Ministry of Public Works (MOP), the Directorate General of Marine Areas and the Under-Secretariat for the Navy. However, MINVU and local and regional governments are not considered the lead partners. To some extent this reveals the technical, infrastructural focus of the adaptation agenda for settlements. Nevertheless, the Plan also makes reference to two fields of action that are highly relevant for urban development. The first of these is the incorporation of impact studies in regulatory plans in order to avoid urban expansion and localization of activities and housing in areas of increased risk. The second is an improvement in the articulation between urban planning instruments and information generated by other services in relation to coastal areas and river basins (CONAMA, 2008).

The instruments that are relevant to spatial planning are the following: regional development strategies, metropolitan regulatory plans, municipal regulatory plans, municipal development plans and coastal zone plans. Alongside these statutory planning instruments, there is a raft of other planning mechanisms that revolve around sectoral interventions associated with short- and medium-term public investment. One of these, for instance, is the infrastructure programming of the Ministry of Public Works: 'Infrastructure Chile 2020'. Another is the 'Cities Agenda 2006–2010' of MINVU. The interface between individual ministries and their related services and agencies, and the territorial administrations in charge of planning instruments, is a complex one in the Chilean context. The power dynamic in the presidentialist system favours particular ministries that are most closely aligned with a traditional developmentalist agenda, such as production, transport and infrastructure, agriculture, and housing. It tends to override the regional and local planning organizations associated with regional and local governments. In the case of regional governments, it should also be borne in mind that the principal authority (in each of the 15 regions) — the *Intendente* — is hand-picked by the president, not elected. Thus, the ministries operate in each region through SEREMIs (Regional Ministerial Secretariats), in unison with the *Intendente*. The strong centralization of decision-making at the national level through these political figures reflects this particular power dynamic, as does the proportion of public investment generated from national ministries compared with regional and local financing channels.

In the case of the Metropolitan Region, with its large share of the national population and national GDP, the influence of national-level authorities in local and regional affairs is further enhanced, leading to a high degree of overlap between the responsibilities, policies, programmes and projects of public organizations. The idea of a single metropolitan mayor, with the power of integrated planning, over and above the other 52 local mayors in the region (or at least the 34 in the Metropolitan Area), has been discussed often but has received little political support to date (Chuaqui and Valdivieso, 2004). The existing structure, with the *Intendente* coordinating with the regional government apparatus, with technical teams in areas of planning and socioeconomic issues, and with a regional council of elected councillors (selected by the municipal councillors), is considered to be weak in terms of democratic accountability and regional and metropolitan autonomy. This situation is currently undergoing change, however, via new legislation from the end of 2009 (Law 20.390) which creates direct elections (by the electorate) to the Regional Council; the president of this council will thus become a democratically elected figure to rival the one directly preferred by the president, the *Intendente*.

The challenges of metropolitan governability, and the strong degree of centralization, can be seen in different initiatives. The case of the Transantiago public transport system, introduced in February 2007 as an integrated bus–metro system in the metropolitan area, is a good example. Consecutive ministers of transport have dedicated themselves to this project since 2005, operating mainly at national level to generate the political will and technical coordination required. The role of the regional and local governments has been negligible. The institutional structure of the Metropolitan Region is relevant to the possibilities of generating a coordinated, transversal adaptation plan in place of a sectorally motivated set of plans created by various ministries, services and agencies, with little or no coordination between them. As regards spatial planning, the most appropriate public organization — in terms of its administrative objectives and territorial (integrated) focus — is the regional government. However, the regional government is particularly weak compared with other ministries, due to the public budgets that they are able to mobilize.

In order to create a more transversal approach to urban strategy and investment, an Inter-Ministerial Committee on Cities and Territory (COMICYT) was created in 2000, bringing together MINVU, the Ministry of Public Works, Transport and Telecommunications and the Ministry of National Property (Bienes Nacionales) (Gobierno de Chile, 2007). The need for an integrated approach to public investment programming is at the heart of this initiative; however, its strategic role suggests that its potential influence in shaping climate change adaptation in urban areas is highly significant, perhaps in collaboration with regional governments in each metropolitan context. Since 2010 this committee has operated as the Inter-Ministerial Committee on Infrastructure, Cities and Territory.

The centralization of Chilean public decision-making within the key sectoral ministries of finance, economy, public works, transport, agriculture, health and education typifies a situation that has strong historical roots. Despite the wealth of Chile being created in the mining regions to the north and the agriculture, forestry and fishing regions to the south (Ramírez and Silva, 2008), Santiago has fed off this production since independence and created a national hub for public and private institutions in administration and finance. Despite attempts to decentralize decision-making, or at least deconcentrate it, since the 1960s, a national development logic generated in and then disseminated from the RMS has characterized Chilean contemporary history (Arenas and Cáceres, 2001; Boisier, 2004). Since it is the sectoral ministries that are responsible for this development logic, constructed around a powerful presidential system (with Congress based in Valparaiso 120 km away), the regional and local territorial authorities within the RMS suffer the same fate as those in other regions. Given the concentration of population and GDP generation in the RMS, this situation is arguably more challenging still since the president and the ministers (the executive) are very keen to have a direct involvement in local affairs and local investments. This is one of the reasons mooted for reticence in creating a single metropolitan city mayor (as opposed to 34 elected municipal mayors and one nominated *Intendente*). Perhaps one of the most emblematic examples of this presidential authority over the city was the direct intervention of President Lagos in 2005 to ensure the full cooperation of the metro (a quango) in the Transantiago system after initial opposition due to the fare structuring.

This situation is perhaps most notable in terms of the public sector budgets operated in each region by the ministerial regional secretariats as opposed to the regional government and municipal governments. Effectively, there is strong central control over local capacity, and a limitation of the latter through diverse financial and institutional mechanisms. Climate change adaptation, given its close links to the wider development agenda, inevitably suffers from these same limitations. It is precisely for these reasons that the issue of governance has to be addressed urgently in this regard in order for climate change planning, in adaptation and mitigation, to be effective.

Water and energy governance in the Santiago Metropolitan Region

The catchment area of the Mapocho–Maipo river systems provides the spatial context for the current Metropolitan Region of Santiago (52 municipalities), within which the principal concentration of population is to be found in the Metropolitan Area (34 municipalities). The catchment area is also characterized by its semi-arid conditions, and the concentration of precipitation during a short period from April to August (principally June–July). Rather than the physical nature of the setting and its features, the principal development challenges are associated with the population concentration in the basin. The last census data (2002) reveals that the Metropolitan Region houses just over 6 million people (96.9% urban), 39% of the national population. This concentration also contributes significantly to the fact that Chile is one of the most urbanized countries in Latin America, in the most urbanized continent of the world (UN-HABITAT, 2006). As such, the destiny of the vast majority of Chileans lies in urban areas (MINVU, 2006), and in the medium and longer terms the ability to 'climate-proof' these settlements in the most effective way possible is vital.

Building adaptive capacity through effective governance regimes is a sine qua non of this climate-proofing process, and the current tension between national agenda-setting and local authority capacities for adaptation are evident. Within the context of urban ecological security, it is precisely this scalar mapping of commitments, goals, responsibilities, financing, human capital formation and other related issues that defines climate change adaptation within national contexts. Of particular importance is the role of local government in managing key resources that have been identified as being increasingly 'stressed' by climate change, within national contexts whereby control over these resources is concentrated within national bodies operating with national-level (neoliberal, market-based) logics and models of generation and distribution. In many ways, resistance to this centralization of resource administration and its short-termism, and demands for more local responses to specific climate change impacts that are highly variable across the country, underpins the adaptation argument. Urban ecological security also therefore invokes a call for the decentralization of decision-making over key resources and their local specificities, or at the very least a negotiation over the levels at which certain decisions should be taken to ensure the most effective resource management systems in the short and long terms. The current challenges in two of the most critical sectors, energy and water, are addressed in the following section.

Water management

Beyond the institutional challenges mentioned previously, the themes that will take precedence in a potential Santiago adaptation plan will be those relating to water management and energy use. Water management remains central to any adaptation plan due to the expected intensity of rain events (episodic) and also the gradual decline in water availability in the Maipo river basin.

With regard to the first point, a major initiative in the field of stormwater drainage was generated during the period 2000 to 2006 as part of the Regional Development Strategy. This involved debates over the financing of stormwater drainage systems in the city. The failure to agree on who should absorb these costs has resulted in this project becoming 'frozen' in Congress. Expansion of the existing system takes place in the meantime, with costs transferred to users directly through their water bills. Other potential financiers of the Master Plan include municipalities and new housing development companies. The large sums involved in the effective retrofitting of the city with large drainage pipe networks have been justified in terms of the problems of localized flooding during heavy rainfall events.

The reasons for this flooding lie in previous planning deficiencies that led to the urbanization of previous river channels and overflow zones (dry during the greater part

of the year) and the failure to incorporate natural infiltration areas into the urban fabric. The urgency of the issue and the response also has much to do with the fact that the flooding takes places not only in the poorer settlements of the city, such as a spontaneous settlement along the Mapocho river banks in the municipality of Lo Barnechea, but also in higher-income areas. In 2005 the municipality of La Reina, which sits in the piedmont zone on the eastern flanks of the city, experienced heavy flooding, and new infrastructure to mitigate these impacts was initiated, particularly an increase in the capacity of the San Ramon artificial channel that runs through the municipality.

In the area of water availability, the likelihood of rising conflicts is high. Currently water rights are purchased within the context of the 1980 Water Code. However, the markets are now saturated and there are few transactions since rights are not offered for sale and no new rights are being issued for surface water. In the Metropolitan Region, the principal demands are for use in the residential areas and also in agricultural irrigation. With respect to the latter, the Action Plan states the intention to increase irrigation by 50% (mainly by increasing storage capacity). In the context of the RMS, the means of satisfying this increased demand is unclear. With the population increases in the region forecast to date (approximately 6 million currently, rising to 8 million by 2030, according to the National Statistical Institute), demand will continue to rise. If increased agricultural demand is added to this, the hydrological system in the basin will be compromised. The satisfaction of this expected demand, under the limitations of physical availability and current rights distribution, will require external sourcing (from other river basins). As a consequence, the limits of the current system and its redistribution mechanisms are already evident.

Of particular concern is the gradual decline in glacier capacity. The principal glaciers that feed the Mapocho–Maipu system, El Plomo for instance, are likely to contract according to scenario expectations of temperature changes and precipitation. Since these are the means by which water is stored in the system and released throughout the year, any decline in capacity will have to be met from other sources. Since this phenomenon is also happening in other basins along the Andes chain, availability for transfer to the region is also likely to be limited, or will result in changing land use in the areas from which it is drawn. Although demand could potentially be controlled through pricing mechanisms, there are obvious areas where initiatives could be generated. An example of this is an increase in water storage facilities for the months of heavy rainfall. Another is a change in consumption behaviour relating to domestic gardens and watering regimes; this is particularly relevant in terms of the planting of exotic water-thirsty species and grassed areas (in domestic gardens, also in public spaces), as opposed to endemic species. This would also contribute to conservation in this global hotspot for Mediterranean biodiversity (PNUMA–IEUT, 2004; Millennium Ecosystem Assessment Program, 2005; Parés *et al*., 2013).

As far as the approach to water management is concerned, it should be recognized that the 1980 Water Code (despite the revisions of 2005) is basically a neoliberal instrument that commodifies the resource according to market mechanisms. Issues such as ecological services remain weakly defined (although supposedly guaranteed through a minimum flow requirement), and there is no strategic planning of the resource beyond the control of new rights. With the current block on new surface water rights allocations, and concerns regarding underground rights (new provisions being subject to new hydrological evidence that may potentially overturn these allocations), this reductionist neoliberal perspective has led to a situation in which different new demands are unlikely to be met.

Against this background one has to factor in the longer-term perspective whereby there is likely to be a 40% decline in water availability (due to temperature rises, reduced precipitation and glacier loss) by 2070 (Universidad de Chile, 2006). The limitations of a disciplinary view of commodified water, as opposed to a socioecological perspective, would appear to be evident. There is also a lack of clarity over who should fund future hydrological stress. Currently, the state subsidizes the poorest social groups to cover their

water bills, but this situation is likely to become more contentious over subsequent decades as population numbers rise, the resource becomes less available, and new infrastructure provision, i.e. channelling water between river basins and desalination plants, proves costly. As for human capital-building in this field, the emphasis on market mechanisms is clearly limited in terms of how absolute shortages have to be managed to deliver basic services and ensure human rights. Although the Dublin Principles (1992) emphasize the role of the market in effective distribution (Principle 4), there is also the principle that regards water as a basic human right since it is both a finite, vulnerable resource and necessary to sustain life, the environment and development (Principle 1).

Energy management

With regard to energy use and the overall thermal conditions within the urban area compared with its surroundings, there are different considerations to bear in mind. The first of these is the total energy demand in the region and the energy mix that meets this demand. This is very much related to the mitigation agenda since Chile has few fossil energy reserves of its own and therefore relies on imports of energy and domestic hydroelectricity generation from regions further south (mega projects rather than micro-hydro) (see Barton *et al*., 2007). Currently, hydropower generation is one of the most heated environmental issues on the public agenda. The planned construction of several new installations in the Magallanes region (the furthest south), connected to the areas of highest demand via a long power distribution system, has generated considerable NGO opposition. The projects (by the firm HidroAysen) are on hold as a consequence of multiple observations made by public agencies within the environmental impact assessment (EIA) process (2008). Bringing power generation closer to demand has also resulted in conflicts, the case in point being the 2009 approval (by the Metropolitan Regional Council) of a hydro project in the Alto Maipo valley (531 MW, planned to enter production in 2013). Although this local project responds to the criticisms of many environmentalists who question the logic of transferring power along half the length of Chile from the southern to the central regions (HydroAysén), it has met with opposition principally due to its large scale (reservoir system) as opposed to micro alternatives (normally less than 100 MW) that do not involving damming.

The preponderance of Santiago in total national demand is significant, although the energy demand in the mining sector in other regions is particularly onerous. Nevertheless, the changing energy demand and mix in the supply system reveal the role of the city in national energy strategies. This is above and beyond the conventional mitigation agenda relating to fossil fuel use in industry and transport: the latter rises in line with the increase in the vehicle fleet, from 500,000 to 800,000 between 1992 and 2002, and the rising proportion of journeys made in private vehicles compared with other modes of transport (SECTRA 2006).

While the mitigation issues of total energy demand and composition can be understood in national terms, the immediate local impacts in terms of the heat island effect should be managed within an adaptation plan. With expected temperature rises, there is a need to reduce the overall thermal effects, effectively offsetting rising atmospheric temperatures via a cooling of the city. This is necessary to avoid, primarily, a resort to the air conditioning of buildings and the positive feedback that this will generate for new energy demand (if from non-renewable resources or traditional — mega-hydro — as opposed to non-traditional, renewable sources). A rise in air conditioning merely places an increasing burden on the energy grid and creates new mitigation challenges if the energy is principally fossil-fuel-sourced. To date, air conditioning is not widespread in the metropolitan area, despite average temperatures between 25–32ºC for most months of the year; given the semi-arid setting of the city, this heat is dry rather than humid, which reduces the overall heat sensation.

The ways in which the heat island effect can be mitigated through adaptation are in the fields of spatial planning and in building design. In 2008, as part of a larger package of economic measures, the Treasury Minister announced subsidies for the incorporation of non-traditional renewable energy in the national grid, and also in new housing for localized supply provision. These benefits will increase the proportion of solar energy generation in existing and new buildings, particularly large apartment blocks where beneficial returns (economies of scale) may be higher. Nevertheless, conventional housing and apartment block design remains relatively inefficient in energy terms. Materials selection, building design and building performance are all areas where major efficiencies can be generated, reducing the heat island effect (principally the radiation of excess heat from buildings and infrastructure such as pavements and roads), and increasing building eco-efficiency in the process. More attention to building eco-efficiency standards, e.g. LEED in the US, or BREEAM in the UK, adapted to the regional conditions, would be a form of incentivizing and supporting innovative design and materials selection that would lead to reductions in total demand energy and reduced energy loss to the environment.

A new Construction and Urbanization Law was considered in Congress during the mid-2000s, but it did not include measures in this area (and was not finally approved). Nevertheless, a housing efficiency programme with subsidies as incentives could be managed directly by MINVU, e.g. for the construction of social housing. An eco-efficiency programme launched in 2007 by the Ministry of the Economy in response to gas supply shortages from Argentina focused on the household, aiming at reductions in the use of lighting and attention to product purchase and use (e.g. the promotion of efficiency coding for refrigerators). The emphasis, therefore, was placed on intra-household behavioural changes, whereas an alternative focus to complement this would include a concerted programme that would change architectural and construction design logics. The *Programa País de Eficiencia Energética* (now the *Agencia Chilena de Eficiencia Energética*) linked up with several municipalities in the RMS to reduce public lighting costs with more efficient technologies.

Since energy is managed centrally through the National Energy Commission and, more recently, the Ministry of Energy (created in 2009), the regional issues relating to energy demand and supply have been hidden within a nationally organized market-based system that operates in accordance with a neoliberal logic whereby the cheapest unit of electricity is taken into the interconnected system at any particular moment (regardless of its ecological merits). Both the energy market and the water market are products of the neoliberal instruments introduced by decrees implemented by the Pinochet dictatorship (1973–90) (Collins and Lear, 1995; Bauer, 1998). Since each is dominated by a neoliberal market logic, the generation of alternative financing arrangements, for strategic supply purposes for example, adequate training of personnel in socioecological perspectives on resource management, and a more transdisciplinary overview of these resources in their local and regional contexts and in terms of their ecological functions have been largely neglected.

For the RMS, the hazards of rising temperatures and a large water deficit in the medium to long term pose key adaptation challenges. Metropolitan energy issues will have an important role to play also, particularly in terms of ecological footprints on other regions, as well as the city's own heat island effect. Beyond the policies, programmes and projects that may be generated, the key factor will be a governance regime capable of bringing these initiatives together in an integrated rather than sectoral structure. A sustainable development orientation would seem to be more favourable than a resource efficiency logic, also a consideration of the potential lead role of the regional government (as opposed to the Environment Ministry). This would facilitate an integrated strategy that dovetails with existing planning within a framework of sustainable development. Such a governance regime would tie in with existing structures and adapt them, rather than constructing a parallel system.

Adaptation through sustainability planning

The challenges of climate change adaptation overlap with the challenges of daily planning and interventions in the metropolitan region. They also fall within the realm of strategic planning (Barton, 2006; Barton *et al*., 2007). If issues such as water and energy planning and the reduction of vulnerability and subsequent risk are understood as development issues, exacerbated by climate change scenarios for gradual and episodic impacts, they can be fully integrated into existing governance structures. In this way, climate change adaptation should be understood as being part and parcel of current planning frameworks and not as a specific, sectoral need that can be managed by a single agency or via a specific instrument such as a unitary action plan. Any instrument that is generated must be clearly linked to existing mechanisms, which include strategies, plans, programmes and projects. In this sense, there is considerable scope for strategic environmental assessment as a tool in this design process. It is important here to distinguish between these types of 'embedded climate proofing' initiatives, including spatial planning instruments, and 'complementary climate proofing' initiatives (Barton, 2012). While the former build on existing mechanisms and instruments, effectively mainstreaming climate change adaptation in the process, the latter introduce climate change as a new area of urban and regional planning, creating a new set of instruments. A focus on the latter over the former may well generate subsequent difficulties in ensuring complementarity, coordination and coherence in public policy and planning (Lerda *et al*., 2005).

The essential element, in terms of embedded climate proofing, is the way in which traditional approaches to development planning through sectoral and spatial mechanisms are changed in order to build in perspectives based on the medium and longer terms, for *anticipatory* rather than reactionary adaptation (Huq and Reid, 2009). This type of intergenerational perspective is precisely the space where climate change adaptation intersects, and effectively merges with, sustainable development planning. Governance regimes that facilitate this shift in perspective are essential for this to take place and for adaptive capacity to be constructed. These governance regimes are not necessarily new (although the national Office of Climate Change is an example of a new government institution), but rather adaptations themselves, whereby the challenges posed by climate change are linked to existing development concerns (managed by sectoral institutions, regional governments or local governments, in association with the private sector, civil society and academia), and confronted with more transversal concepts and methods.

Urban and regional planning is embedded in the Santiago metropolitan management system. The instruments (see Table 1) that exist are various and they seek to structure all public policies and related investments. The most important of these is the intermunicipal regulatory plan that defines land use across an enlarged metropolitan area (although not for the whole region). This plan, approved in 1994, has been instrumental in defining the growth of the city. In 1997 the city limits were extended by incorporating the province of Chacabuco to the north of the metropolitan area, through a modification of the 1994 plan; other areas to the southwest were incorporated in 2006.

A recent proposal (Modificación 100), developed since 2008, to modify the intermunicipal regulatory plan (rejected by the national audit office in 2011 for irregularities, but reformulated and resubmitted to the Regional Government in 2012) failed to mention climate change mitigation or adaptation issues, despite the fact that it claimed to be preparing the city for more sustainable development to the year 2030, and an expected population of 8 million (MINVU, 2008). If land uses and urban expansion do not incorporate metropolitan climate change adaptation, the connections with mobility, energy and water use, green space generation and distribution, vulnerability and social risk will remain weak and a more sectoral approach can only be generated as an 'add-on'.

A new instrument that is currently being developed nationally for use by regional governments is the Regional Spatial Plan (PROT) to plan non-urban space within the

Table 1 Principal spatial planning instruments in the Santiago Metropolitan Region[a]

Instrument	Authority	Mandatory or Indicative
Inter-municipal (Metropolitan) Regulatory Plan	Ministry of Housing and Urbanism	Mandatory
Local Regulatory Plans	Municipalities	Mandatory
Local Development Plans	Municipalities	Mandatory
Sectional Plans (micro-scale regulatory plan modifications)	Municipalities	Mandatory
Regional Development Strategy[b]	Regional Government	Indicative
Regional Urban Development Plan	Ministry of Housing and Urbanism	Indicative
Regional Spatial Plan[c]	Regional Government	Indicative

[a]As sectoral instruments — although transversal in nature — the National Climate Change Strategy and subsequent Plan should dovetail with existing instruments.
[b]The latest of these strategies (2006–10) was effectively superseded by the Agenda 10 plan introduced by the administration of President Bachelet in 2006–10 to orient regional investments in ten thematic fields.
[c]Not developed as yet for the Santiago Metropolitan Region.

region. To date this has very little regulation or zoning apart from protected area designations and environmental impact assessments of new projects, but it has the potential to incorporate a wide range of adaptation considerations. In the only example of a PROT in the country, however, in the Aysén Region, there is no evidence of the incorporation of climate change mitigation or adaptation issues (SERPLAC Región de Aysén, 2005).

With lower average per capita green spaces in the city than the WHO norm ($9m^2$/cap), average surface temperatures remain high for most of the year. However, there are marked differences across the city. In the eastern municipalities, where higher-income groups reside, the piedmont landscape, accompanied by larger gardens and larger public spaces, leads to lower temperatures compared with those in lower-income areas where private gardens and public green spaces are limited in total area and in maintenance (e.g. limited vegetation cover due to the watering costs for such municipalities with housing, education, health and security expenditure priorities) (Romero and Molina, n.d.).

Increasing the total urban surface area devoted to green space, thus effectively increasing the city's own environmental services, can be valued in terms of potential infiltration areas for intense rainfall events (flooding impact reduction), carbon sequestration (depending on vegetation cover), particulate matter capture (a serious problem in the metropolitan area where a Plan for Prevention and Atmospheric Decontamination — PPDA — has been in operation since 1998) and temperature reductions. To this should be added the recreational benefits of such areas. In a MINVU–INE (2008) qualitative study of urban quality of life, the lack of green spaces is ranked highest of 12 municipal themes (including lighting, infestations, noise, smog, congestion, transport, waste, etc.); therefore the potential benefits of working in this field are considerable.

Within the National Action Plan, the emphasis on engaging with climate change through regulatory planning is evident, although there is a clear bias toward coastal settlements rather than the major inland cities. Despite this, it is imperative that climate change planning is seen as part of the process of regulatory planning, or a complement to it. Currently, the incorporation of risk into regulatory plans — both intermunicipal and municipal — is an obligation according to the Law on Urbanism and Construction. However, the precise nature of risks from change, such as climate-change-related risks or even those associated with Ulrich Beck's (1992) risk society of reflexive modernization,

remains unclear. The legal requirements for regulatory plans make explicit the need to incorporate risks (Article 2.1.17, Ordenanza General) where they constitute hazards for settlements. These include zoning of areas of building restriction for hazards such as flooding, avalanches, landslides, volcanic lava and volcanic faults, and potentially dangerous infrastructure. These are clearly related to manifestations of climate change and reveal that adaptation themes have already been incorporated into planning instruments. However, the changes expected over time are not built into these same planning instruments in their design and approval phases.

Other significant planning instruments — the Regional Urban Development Plan, the Regional Development Strategy, and municipal-level instruments such as the municipal regulatory plan and development plan — also share some of the weaknesses and possibilities of the metropolitan regulatory plan. Of the existing instruments, the Regional Urban Development Plan, which indicates the urban development of the region, its socioeconomic profile and connectivity, and which should underpin the current modification of the Metropolitan Regulatory Plan, does not consider climate change, although it also offers a development trajectory to 2030 (SEREMI RM Vivienda y Urbanismo, 2005). As for the Regional Development Strategy that was in place during the period 2006 to 2010, it contained no reference to climate change either, although considerations of flooding and green spaces were apparent, as with the previous Strategy (2000–06; SERPLAC Región Metropolitana, 2000). Climate change is however considered in the new strategy, approved late in 2012. The lack of climate change planning prior to 2012 could also be seen in specific government programming and investment strategies for the region, such as Agenda 10 (2007–10; Gobierno Regional Metropolitano de Santiago, 2007). An earlier initiative for regional planning, supported by the German development agency GTZ (1996–2005; Gobierno Regional Metropolitano de Santiago, 2005), was also not explicit about potential climate change issues in the region's spatial planning (although it did develop important maps to support decision-making in the areas of flooding, green spaces, etc.).

What the experience of these regional planning instruments reveals is that the spatial instruments, where one might find a closer connection with the diversity of climate change issues, are currently underutilized in terms of adaptation potential. A greater attention to risk in these instruments would contribute a great deal in this regard, creating the basis for long-term strategic planning; currently they are the only instruments that project long term (beyond 5 years). Since climate change adaptation incorporates gradual processes and episodic events, the need for strategic planning not only into the medium term (2030) but also the long term becomes more apparent. It is precisely these longer-term perspectives that will be needed to determine visions and policies regarding water and energy use, productive diversity, housing and infrastructure capacity, etc. In the Chilean case, with fewer climate change impacts towards the south of the country (less significant temperature and precipitation changes), for instance, there may be a case for reflecting on national development strategies that promote settlement and productive activity localization in these areas.

A distinction should also be made between indicative instruments, such as the regional development strategy (which are strategic and not legally binding), normative instruments such as the regulatory plans (which fix land uses, densities, etc., and are binding), and investment programming by public bodies (ministries, services, agencies) that determine a range of interventions through more local plans, programmes and projects.

Building adaptation governance on core capacities and resources

Urban governance issues are complex, both in terms of the issues involved and the multilevel political frameworks for addressing them. The Santiago Metropolitan Area is a case in point, with 34 mayors, one *Intendente* and a multitude of government

ministries, services and agencies, not to mention non-governmental actors. Adaptation to climate change is yet another of the governance challenges that has to be faced. Rather than a focus principally on the 'what' of climate change adaptation, e.g. investments in defensive infrastructure, increasing green spaces or water storage capacity, it is imperative that the 'who' of adaptation should be engaged with as directly.

Given that this issue is transversal for sectoral and territorial authorities, private firms and civil society, there should be clarity about responsibilities, needs, strategy and finances. A piecemeal approach to flooding, heat stress, water scarcity and education should be discouraged, with a view to understanding expected patterns of climate phenomena, wider vulnerability issues and potential synergies between organizations and measures. The potential efficacy of adaptation responses depends as much on this governance framework as it does on the measures themselves. Without this framework, financing may well be sporadic, wider consciousness may remain low and climate proofing may be fragmented geographically and by socioeconomic groups. It is only once this governance framework imperative has been established that associated elements can be addressed appropriately and transdisciplinarity, financing, human capital-building and integration with other strategies and instruments such as transport policies and regulatory plans can be achieved.

As far as the challenge of transdisciplinarity is concerned, the integration of climate change adaptation issues within regional and urban planning instruments will ensure that they are dealt with in a transdisciplinary way. By drawing climate change debates away from climate change science based on global modelling of temperatures and towards local development and the potential impacts of expected trends, the complementarity with social sciences can be emphasized. In terms of finance, it is evident that gradual and episodic climate change impacts, for which adaptation is required, will be unlikely to lever in large new financial resources. It is only through consideration of climate change adaptation within existing development actions that effective strategies will be financially viable under conditions of limited public resources. As for the human-capital-building exercises of improved education and capacity building through training programmes and public awareness campaigns, there is no evident incorporation of these issues. The national policy of education for sustainable development, approved in 2008, is certainly a supportive mechanism in this regard. It too, however, is not explicit as regards climate change.

It is evident that adaptation governance is still in a nascent phase in Chile and in the RMS. Issues such as transdisciplinarity, financing and human capital-building are yet to be addressed in order to begin to establish an appropriate governance regime that is able to link climate change responses to existing development imperatives. By 2013, this governance regime should be in place if a sectoral, partial approach to engaging with gradual and episodic challenges in climate change adaptation is to be avoided. It will also have to be part and parcel of the current institutional framework, in order to maximize synergies with existing institutions, budgetary allocations and legitimacy within governmental prioritizations and those of civil society. Bulkeley (2010) emphasizes the different governance dynamics in play. There is a need for 'vertical autonomy', whereby there are multi-level governance links but also spaces for local decision making and action at the city level — also 'network governance' where horizontal linkages (e.g. international support, university links, civil society coordination) have an influence on local processes. Both governance dynamics should be capitalized upon.

By establishing these links effectively, the climate change adaptation agenda and an adaptation plan will form a necessary and relevant part of the jigsaw of regional sustainability planning through which Agenda 21 principles and actions can be grounded through praxis. The experiences of resource management, involving energy and water for instance, point to the gaps that currently exist and the difficulties to be faced in consolidating development not only in terms of current challenges based on past projections and experiences, but also current and future challenges in terms of the threats to opportunities posed by climate change.

An adaptation plan would be the most appropriate way of recognizing synergies and maximizing returns in terms of climate proofing. An adaptation plan for the city-region that incorporated changes in building design and performance (also for infrastructure), improved and increased green spaces, more efficient water use in residential, industrial and agricultural contexts, and an energy policy that incorporated efficiencies and changes in the composition of the energy mix (increased solar energy for instance) would represent a significant advance. Broad-based participation from community-based organizations, environmental NGOs, the private sector and educational institutions is also required, given the wide-ranging remit of an adaptation agenda and subsequent plan of action at the metropolitan level.

Jonathan R. Barton (jbarton@uc.cl), CEDEUS and Instituto de Estudios Urbanos y Territoriales, Pontificia Universidad Católica de Chile, El Comendador 1916, Providencia, Santiago de Chile, Chile.

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