



## Strategic Environmental Assessment in Latin America: A methodological proposal for urban planning in the Metropolitan Area of Concepción (Chile)

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### ABSTRACT

This work describes a methodology for Strategic Environmental Assessment of urban areas in Latin America based on the recently approved European Planning Directive, and applies it to the Metropolitan Area of Concepción (Chile). The method is based on the Land Suitability Index (LSI), a cartographic GIS-based index originally developed for the region of Barcelona (Spain) and aimed at determining the suitability of each point in a region for urban development, considering three sub-indexes: (i) Naturalness, (ii) Ecological Connectivity and (iii) Natural Risk. Using the LSI we evaluated the already approved urban plans of the municipalities in the region, considering two scenarios: the initial land use or baseline scenario (S0) and the designated land use or planned scenario (S1). The results show that overall the planned scenario will result in a loss of around 16% of naturalness, with particularly negative effects on brushwood and wetland areas. Connectivity will decrease by around 17%, and urban areas exposed to many types of natural risks will increase considerably, from approximately 49% to 92% of the total urban surface. Finally the LSI shows that around 252 ha are suitable for new urbanization in the extension area. This corresponds to around 0.7% of the total extension area (37.381 ha), which represents 12% of the region (271.398 ha). We propose this methodology can be a valuable contribution to the design of Strategic Environmental Assessment applications and indicators for land planning in Latin America.

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### Introduction

Strategic Environmental Assessment (SEA) has been a mandatory land planning procedure in Europe since the approval of the Directive 2001/42/EC, on the assessment of the effects of plans and programs on the environment. SEA is the process by which environmental considerations are required to be integrated into the preparation and adoption of these plans and programs in order to promote environmentally sustainable development (Jiricka and Pröbstl, 2008). In consequence, SEA will contribute to the reduction (or avoidance) of the environmental, social and economic costs often associated to excessive or chaotic urban growth (Portal and Béjar, 2005; Botequilha-Leitão and Ahern, 2002).

SEA is inspired by two objectives: (1) to overcome the insufficiencies of Environmental Impact Assessment (EIA) by evaluating projects earlier in the decision making process and (2) to emphasize the importance of a territory's limitations and opportunities by defining the options of sustainable development. While being a

more general procedure than project-specific assessment instruments such as EIA, it poses significant challenges for decision making (Unalan and Cowell, 2009). A particular challenge of SEA is how to adequately integrate all the dimensions of sustainable development so that it becomes an achievable, practical objective, which can thereby incorporate the environment into policies, plans, and programs (Oñate et al., 2002).

A particular focus of application for SEA is urban plans for metropolitan areas. Currently, more than 3 billion people are living in urban areas worldwide, and this figure will have increased to 6.4 billion by 2050 (United Nations, 2009). A critical feature of this projection is that the largest population growth expected in urban areas will be concentrated in the cities and towns of developing regions (United Nations, 2009), such as Latin America. However, these overpopulated metropolitan regions still house important natural areas featuring considerable ecological diversity, and providing ecological services to the population. There is, therefore, an urgent need to rethink the appraisal of urban plans and projects to consider metropolitan areas as a mosaic for natural systems and population. It is paramount to combine traditional urban planning that emphasizes quality of life, with conservationist planning that focuses on the conservation of ecosystems and biodiversity (Forman, 2004).

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In Latin America, a number of countries are progressively incorporating a SEA rationale via EIA, environmental frameworks and environmental mainstreaming in policies and plans (Sánchez-Triana and Quintero, 2003). In the case of Chile, the Environmental Impact Evaluation System (SEIA), detailed by the Environmental Law (1994), states that land planning instruments have to incorporate environmental impact studies in their approval process. Additionally, EIA regulations state that environmental assessment must be present from the project's beginning and the predicted scenario must be monitored to see if the environmental changes have been effectively minimized or avoided. However, these evaluations are frequently performed considering the impacts produced by each project or initiative and not with respect to the overall territorial model as required by SEA (Suazo et al., 2009).

In consequence, the EIA process in Chile does not sufficiently ensure the conservation of natural systems in metropolitan areas that are subjected to strong urbanizing pressures (83% of the population lives in urban areas; MINVU, 2008). In southern Chile, urban regulating plans for the coastal cities of Tomé, Penco and Coronel approved by the SEIA promote urban development in areas with a high risk of flooding or landslide (Suazo et al., 2009). Thus, the current urban growth regulation poses serious environmental and security challenges in metropolitan areas of Chile, because the norms are focused towards specific projects, while SEA embraces a wider view trying to protect and enhance the natural environment, integrating social and economic factors alongside environmental qualities (Wallington et al., 2007). Thus, we consider SEA is a more adequate assessment tool that favors the integration of impact assessment and sustainable urban growth in metropolitan areas of Chile.

One of the main difficulties of applying SEA is that many regional plans frequently fail to take environmental factors properly into account (Marull et al., 2007). Quantitative socio-environmental indices, already in use for aquatic systems (Paul, 2003), may be a good choice to assess the impact on land of diverse alternative plans (Lugeri et al., 2000). Indeed, a number of interesting applications have been developed on the interface between landscape ecology and urban planning principles (Botequilha-Leitão and Ahern, 2002; Opdam et al., 2002; Corry and Nassauer, 2005; Termorshuizen et al., 2007). However, such approaches have not provided significant advances in perhaps the most important constraint of these methods: the lack of standard methodologies. The recently developed Land Suitability Index (LSI) aims to overcome this challenge and has been used to evaluate the adequacy of land for urban development in the region of Barcelona (Spain) in the SEA context. It combines three main sub-indices concerning (i) the vulnerability of the biosphere, lithosphere, and hydrosphere to impacts arising from implementing the predevelopment proposals; (ii) the natural heritage value of the target area; and (iii) its contribution to terrestrial ecological connectivity (Marull et al., 2007).

The development of these methodologies and their application to SEA might be, however, affected by data quality and availability (Marull et al., 2007; Desmond, 2007). In particular, spatial and thematic accuracy of cartographic datasets might have non-negligible effects on the SEA results and their consequences on decision making. Therefore, it might be desirable to generate statistically valid estimates of the accuracy of these maps, e.g. describing their misclassification errors (Nusser and Klaas, 2003; Serra et al., 2003). However, the effects of data quality on uncertainty have been explored only recently within SEA context (João, 2007), together with other uncertainty sources affecting it (João, 2007). SEA is generally seen as a process dealing with highly diverse data sources and societal values, and supporting great flexibility in its expected outcomes (Partidário, 1996, 2007; OECD, 2006). Thus, it is assumed that data quality should not preclude the application of SEA but only modulate its expectative.

This paper aims at incorporating SEA principles into the assessment of the Plan for the Metropolitan Area of Concepción (Central Chile) based on the Land Suitability Index developed for the Metropolitan Area of Barcelona (Marull et al., 2007). The original methodology has been adapted to the general Latin-American scenario, characterized by low availability of reliable GIS data. We present the method developed and tested in the Metropolitan Area of Concepción (Chile), which focused on the evaluation of ecological functionality and natural risk for the population, and was based on a limited number of GIS layers. Using this methodology, we have determined (i) the expected changes in environmental dimensions (natural heritage, natural risk, and ecological function) under the plan application and (ii) the suitability for urban development of the planned areas, based on these dimensions.

## Materials and methods

### Study area

The Concepción Metropolitan Area (CMA thereafter) is located in south central Chile, between 36° 35' and 37° 00' south latitude and 72° 45' to 73° 15' west, comprising 2830.40 km<sup>2</sup>. It spreads over 60 km of coastline from the township of Tomé (the northern limit) to that of Lota (the southern limit), and also comprises the townships of Chiguayante, Concepción, Coronel, Hualqui, Lota, Penco, San Pedro de la Paz, Santa Juana, Talcahuano, and Tomé. The municipality of Concepción is the capital of the Bio Bio Region and corresponds to 7.6% of the Region. The population lives principally on the western branch of the coastal mountains, the tertiary marine platforms and the deltas emerging from the Andean Bio Bio tributaries. According to the Population and Housing Census (2002), 902,712 people live in the CMA. This corresponds to 48.49% of the total population of the Bio Bio Region, with a density of 318.9 inhabitants per km<sup>2</sup>. In the CMA, 97% of the population lives in urban areas, representing 57.31% of the urban population of Bio Bio Region (INE, 2002).

### The Metropolitan Urban Plan of Concepción

The Metropolitan Urban Plan of Concepción (MUPC thereafter) was approved in 2003 and its principal goals are (i) to regulate the physical development of the urban and rural areas of the inter-county system, (ii) to guarantee the integrity and continuity of different elements that structure neighboring counties, (iii) to provide a stable reference frame to evaluate and invest in projects that are of community interest, and (iv) to move towards sustainable development in the CMA. The counties included in the Plan are: Concepción, Chiguayante, Hualpén, Hualqui Talcahuano, Penco, San Pedro, Tomé, Coronel, Lota and Santa Juana. The plan also regulates the administrative structuring of this particularly dynamic area. For example, it was responsible for the creation of a new county Hualpen out of a previously existing one in March 2004.

The zoning map of MUPC is based on instrumental objectives that should strengthen the territory's physical potential and socioeconomic specialization by facilitating integral functioning and specifically differentiating between inhabitable and protected spaces. The habitable area is divided between urban and rural areas within the urban limits of the CMA. The urban area is subdivided into the consolidated urban area (22,504 ha; 8.47%) that receives population growth and the urban extension area (31,381 ha; 11.82%) for future growth which, in turn, is divided into areas of: (i) mixed housing, (ii) preferential housing, (iii) conditioned development, and (iv) extension in sloped terrain.

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