CHALMERS

A REVIEW OF SUSTAINABLE DEVELOPMENT INDICATORS FOR LAND USE PLANNING IN CHILE

Master of Science Thesis

MAURICIO E. GONZÁLEZ N.

Environmental Systems Analysis
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden 2006
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ABSTRACT

For many developing countries there is a need for monitoring governmental decisions on the use of natural resources in order to optimize their use. Sustainable development indicators are important tools, to evaluate, describe, and monitor environmental, economical and social processes regarding governmental initiatives, private actions and natural impacts.

One of the most important resources for humankind is land, basically for the large number of activities depending on that. To optimize land use, it is needed to plan the occupation process, and regulate the activities that can be developed with the use of the land. Government takes and important role to control the occupation process of the land. To do so, monitoring is an important aspect, and therefore to develop indicators for the sustainable development on the land use and its planning.

Land use planning in Chile is regulated by several factors, which include ministerial policies and laws, specific national, regional, or local governmental initiatives, and private investors. However, The Chilean government and its institutions still have not developed a formal monitoring process for land use planning from a sustainable development point of view. That means, integrating economical, environmental and social aspects. But, there are important approaches in setting environmental indicators of land use.

The DPSIR framework is presented as a clear and useful methodology to set up sustainable development indicators on land use planning in Chile, specially referred to a Territorial Planning Instrument, which regulates and sets norms on the occupation and use of the land at local level.

Keywords: Land-use, sustainable development indicators, land planning, sustainability, territorial planning instruments, monitoring.

RESUMEN

Para muchos países en vías de desarrollo existe una necesidad de monitorear las decisiones gubernamentales entorno al uso de los recursos naturales, para de esta manera optimizar el uso que se les da a ellos. Los indicadores de desarrollo sustentables son importantes herramientas para evaluar, describir y monitorear los procesos naturales, económicos y sociales que puedan verse afectados por iniciativas de gobierno, inversionistas privados e impactos naturales.

Uno de los más importantes recursos que cuenta la humanidad es el suelo, básicamente por la gran cantidad de actividades que depende de él. Para optimizar su uso, es necesario planificar sus procesos de ocupación, como también regular las actividades que puedan desarrollarse con su uso. Aquí, el gobierno toma un importante rol, como ente controlador del proceso de ocupación del territorio. Para esto, el monitoreo continuo del uso del territorio y su planificación es un aspecto fundamental, como así también el desarrollo de indicadores de sustentabilidad.

La planificación del uso del territorio en Chile es regulada por diversos factores, los cuales incluyen políticas y leyes ministeriales, iniciativas gubernamentales específicas a escala nacional, regional o local, e inversiones privadas. Sin embargo, el gobierno de Chile y sus instituciones aún no desarrollan un proceso de monitoreo formal para la planificación territorial desde un punto de vista del desarrollo sustentable. Esto significa integrando los aspectos económicos, ambientales y sociales. Sin embargo, existen importantes avances sobre el establecimiento de indicadores ambientales sobre el uso de suelo.

El marco DPSIR se presenta como una metodología clara y útil para establecer indicadores de desarrollo sustentable para la planificación del territorio en Chile, referido especialmente a un los Instrumento de Planificación Territorial, como los PRCs los cuales regulan y establecen las normas de ocupación y el uso de suelo a nivel local

Conceptos claves: Uso de suelo, indicadores de desarrollo sustentable, planificación territorial, sustentabilidad, instrumentos de planificación territorial, monitoreo.

ACKNOWLEDGEMENTS

This report was not only the result of my work. It was constructed by contributions of many people in different ways. From the first day I left Chile, until my last day in Sweden.

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To my brown-eyed girl, who gave me the strength to believe that everything can be done with love, and for supporting me in everything I ever wanted.

I also want to thank all the people from Chile, in CONAMA, MINVU, MINAGRI, SAG and CEPAL. Thank for the time that you have given to me.

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CHAPTER 1 – INTRODUCTION

"Sustainability is really the study of the interconnectedness of all things".

Barbara Lither.

1.1 THE PROBLEM

Sustainability has become an important issue for research and development (Lopez-ridaura *et al*., 2005), if we consider the natural resources, the way in which we use them it also becomes an important paradigm for resources managements.

Land use is one of the most important resources for human development, due to the number of productive activities, which are basically dependent on land, such as agriculture, mining, housing, and forestry within others (Schröeder *et al.,* 2002). That situation causes conflict on land use, due to the demand of that resource. Sometimes the occupation pattern given on land can bring serious environmental and social problems, or unsustainable land use, including expansion of agriculture into marginal land, unplanned urbanization, and land degradation (Shrestha, 2004).

A tool for mitigating those impacts is to plan land use, and to monitor land by means of indicators for sustainable development, which have become important tools, when an assessment of the evolution of the use of this resource is required (Shrestha, 2004), but there are complexities in how to set up these indicators, and how they can be analyzed. Different interpretations can appear, since there are different views of sustainable development. For developing countries monitoring represent a new challenge, due to the lack of knowledge about indicators, economical deficiencies in the collection of information, and the lack of clarity in the institutional roles (Jolly & Boyle, 1993).

Therefore, to ensure the proper use of the land resource in developing countries, a development of a methodology to set up indicators for monitoring land use is needed. And it must deal with problems proper to these countries such as limited financial resources, infrastructure, trained personnel, expertise, and in many cases a weak institutional framework (Young, 1998).

1.2 GENERAL ASPECTS

The following chapter is related with three basic concepts and personal opinions about sustainability, land use and indicators. What is looked for here is a theoretical introduction of the general aspects of the thesis, giving ideas about the challenges and conceptual problems generated with the three key concepts, in a personal perspective.

1.2.1 Sustainability Concept

The term sustainability, nowadays has reached great importance, but what it really means, in the most basic level is "to preserve a system in time and space". For human societies, sustainability is the combination of production with conservation, but what appears here as an unavoidable question: Are human societies able to understand the complexity of the natural systems in order to use and preserve their resources to future generations? And are they prepared to manage their own currents needs and ensure a better quality of life for the future generations? It seems to be an important challenge for scientists, policy makers, economists, and the whole human kind.

Going deeper in the meaning of sustainability, *to sustain* means "to maintain; keep in existence; prolong" (Sutton, 2001). Then, sustainability can be reached only when human societies are able to maintain themselves, so they can keep their own internal organization that allows them to preserve their identities in time and space. Here will be introduced this term, as "the organization of the social system connotes the configuration of relations between the components that define identity of a system as a totality or singular entity" (Maturana, 2002); then, if the organization is preserved, the social system will go on as it is known, "sustain". Therefore, sustainability is related with the conservation of certain features in the relations of the system components, which allows us to recognize the systems as the same. But, it does not mean that social systems have to be maintained in the same state, because they change, evolve, and have the ability to adapt in order to fit to the different conditions their environment. Thus, human societies can be seen as complex systems that are embedded in another complex system, the nature (Bossel, 1999).

Taking into account the relational character between the societies and the nature, a way to obtain sustainable processes is by considering both complex systems, as interdependent systems; they co-evolve in mutual interaction permanently. Complex systems can modify their structure in order to be adapted to the different circumstances of their medium, so the structure refers to the components and the relation between them that realize a system as a

particular class (Maturana, 2002). In order to preserve their organization, systems have structural **changes** that allow them to always be adapted to the circumstances. If the organization changes, it disintegrates and something else appears in its place. Thus, societies as structured systems suffer changes in their structures as a result of their internal dynamics and their interactions. And, the same applies to the nature or environment, as a structured and complex system.

Thus, sustainability can be understood as a matter of how we preserve the conditions of the two systems, society and nature, in order to maintain their internal organizations, making sure they will be able to modify their structures together in time and space, according to their adaptation to their own relations and external interactions. Human actions can be made in both systems interfering and changing certain conditions, but always having in mind that they must not be harmful enough to endanger the ability of the systems of keep their structural changes in order to be adapted, what is called *ecological resilience*, and it can be defined as a measure of the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures (Peterson, Allen & Holling, 1998).

1.2.2 Sustainable Development

This concept carries the care of many people for a better quality of life, for their own as a single individual, for the others, and for the future human population. That includes preserving ecosystems, cultural identities, economies and resources. In fact, sustainable development, at the beginning was taken from an ecological point of view. But now, sustainable development includes all the components that take part in human societies. According to Brundtland (1987) "sustainable development is the development that meets the needs of the present generations without compromising the ability of future generations to meet their own needs".

Then, sustainable development is a paradigm of economic growth, which suggests that actions are in harmony with the global environment and social equity. In general, it means production with conservation. Then, sustainable development implies that the natural resources are rationally used without harm to the ecosystems. It conceives development as a process where economic growth, exploitation of resources, social equity, technological change and institutional decisions must be in concordance with the needs of the present and future generations (Brundtland, 1987).

Within of sustainable development there are three fundamental principles: economical growth, social equity, and protection of the environment, but for many developing countries governability is a very important aspect

which have to be taken into account when State policies are being assessed, that is the reason it is included in the next figure (**1.1**).

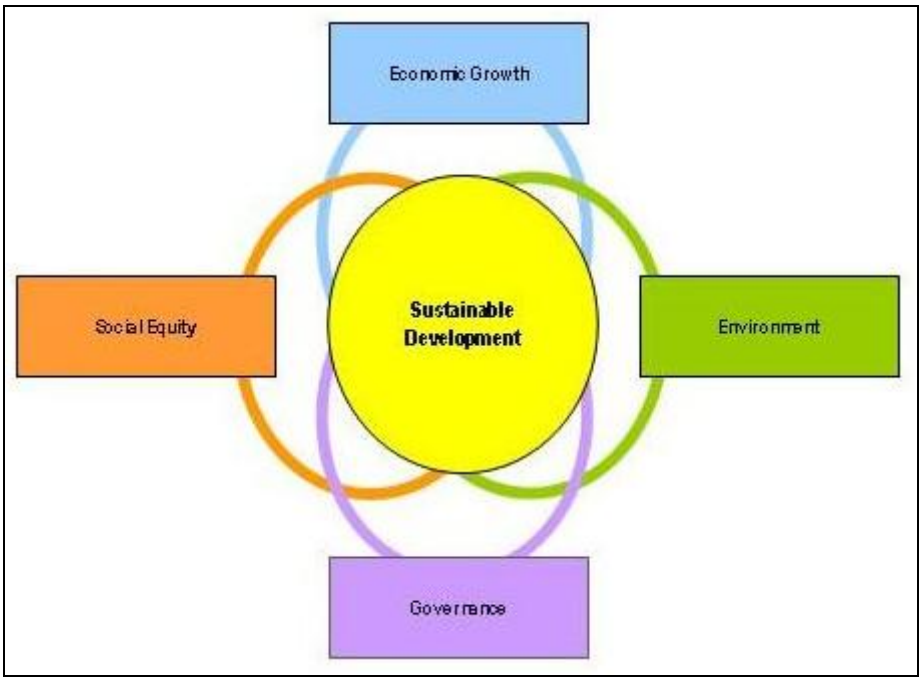

Figure 1. 1 Main aspects of sustainable development.

Social sustainability means development for all community members and it has direct relation with the population density, health, education and housing budgets, food distribution and quality, promoting social interaction, cultural enrichment, and the fight against criminality, marginality and poverty. Social sustainability is also related to more basic needs of happiness, safety, freedom, dignity and affection (Interface sustainability, 2004).

Environmental sustainability refers to the proper use, conservation, no-pollution, and efficiency in the management of land, flora, fauna, water, air and energy. According to CIDA (1992) the main objectives for environmental sustainability is to recognize the productive potential and ecosystems limits to development in given areas; to recognize environmental values in economic decision-making; and to consider the interrelationships of poverty, population and natural resources. At State level is assure that the policies care much for environmental issues, setting up laws and programs to preserve the natural goods, and develop strategies for the optimal use of natural resources.

Economical sustainability is specifically referred to a viable productivity and compatible with the environment and community needs. In the last decades, economic growth has been based in the intensive extraction of natural resources, many of them non-renewable such as oil. Economies highly dependent on fossil fuel consumption seems to have large difficulties in finding alternatives alternative energy sources due to the inertia of the current energy system. A key aspect could be moderation in the extraction and optimization of

the natural resources. Thus, the new paradigm for economic growth should be "sufficient is better" instead of "more is better" (Gross, 2005).

Governance refers to the capacity of a social system to recognize and face its challenges; this capacity becomes a reality within the institutional system quality to generate a positive collective action in this regard. In this sense, it is referred to the institutional capacities (public, social or private) like leadership, social participation, coordination and cooperation, conflicts prevention and management, access to information and to useful knowledge (Alcozeba, Queralt & Rodó, 2002).

Thus, these three main aspects of the traditional vision of sustainable development, more a clear and strong government with efficient institutions, societies can lead their steps to encouraging all members to construct a better society for all. The importance of that fourth aspect falls in that it has an integrator character, which has the responsibility of coordinating the governmental initiatives regarding those three aspects, and regulates the intervention processes, in a holistic point of view.

Nowadays, in many developing countries economic growth has been prioritized over social development and they have left environmental care in the last place. This situation has caused social problems such as poverty, criminality, scarcity and unequal distribution of resources, social injustices, among others. Environmental problems such as extinguished species and lack of biodiversity, deforestation, erosion, air, soil and water pollution, natural resources depletion are also occurring.

It is important to notice that some of these problems earlier mentioned can have their origins in governmental policies that prioritize economic growth instead of seeking a balance among social, environmental and economic development which sometimes leads an increasing social discontent that provokes politic instability, frequent leader alternation, weakening and mistrust in the State institutions. That can give origin to a vicious cycle, which impedes societies from reaching a sustainable development.

1.2.3 Sustainable Land Use

Natural factors such as hydro-geological, biological, ecological, climatological processes and human intervention create different landscapes with cultural, economical and ecological values (Haberl, Wackernagel & Wrbka, 2004). Humankind have developed its activities in the land, at the beginning as subsistence and over years the pressure on this resource has increased, due to the development of many different activities such as housing, food production, forestry, city establishment, among other. Thus, anthropogenic intervention of

the land has caused soil loss, erosion, land degradation and impoverished ecosystems during many decades.

Land use is the pattern of occupation of a determined surface in function to its productive capacity. Thus, its development potential, mainly is grouped in accordance its location - rural or urban. Land use also represents a fundamental element for the economical development of a city and its inhabitants, since it shapes the urban structure and therefore its functionality (PAOT, 2003).

Land use planning covers activities from the formulation, implementation, monitoring of progress, and revision of plans related to the strategy of community development. Planning is important, since it defines the criteria for the development in the region, this process must tend to seek for "a mechanism" that allows to maintain the organization of the land away from disorder or just by good luck. It does not mean to make stricter patters of occupation, but it is to establish criteria with open alternatives to change. In that sense, the planning is a general process capable to propend sustainability of the use of the land from the change (Lavanderos & Malpartida, 2001).

Sustainable land use planning in rural areas deals with activities in large and small scale, such as cropping, farming, animal grazing, and forestry among others. Since these economical activities are strongly dependent on the land resources, they sometimes can constitute a menace for the environment. Direct environmental impacts from these activities are: degradation and soil salinization, biodiversity loss by introducing exotic species and removal of native vegetation (Hamblin 2001), groundwater depletion and water pollution, high phosphate loads to surface waters via over fertilized soils or erosion, among others ((Schröder *et al*., 2002).

These activities can cause changes in the balance and fluxes of the pre-existing ecosystems, thereby limiting self-regulatory ecosystem functions. For instance, the intensive agriculture of the past with its strong intervention of landscape structures and vast interference of energy and matter cycles has caused stress and degradation of the production basis; sometimes this perturbation has also been exerted on neighbouring ecosystems. (Schröder *et al*., 2002).

To overcome the economic, social and political inadequacies leading to ecological degradation, the demands for sustainable rural land use planning needs to be transposed into knowledge-based practical instructions and political regulations on a regional scale by developing complementary activities on rural areas, that allow a harmonic development of these areas with the use of natural resources, avoiding the conflicts that might appear about land use and allowing to supply rural areas with goods and services, such as roads, health

centers, schools, and infrastructure needed for the integral development of these areas.

At last, but not less important, the development of economical activities and the complementary activities earlier mentioned must be executed in a way that ensure the environmental protection through sustainable agriculture and forestry, protection of wild areas, control and decontamination of hydrological systems, species preservation. That is to say by planning the territory.

In the urban area land use planning refers to the ability of construct cities, to define policies, urban planning at different scales and monitoring the urban processes. Related to this, the term "sustainable cities" began to enter into the discussion of urbanization and regional planning (Mendes, 2005). To get sustainability in a city, an assessment of the environmental, social and economical characteristics of the region is required, and also its pattern, function, and flows. This is, to evaluate soil, water, vegetation features, building types, transport systems, social organization, economical activities and spatial distribution of the services.

On a global level, sustainable land use planning is the way, which this resource is used to provide the different needs for the society. Here the previous model of sustainable development enters the game. So, sustainable land use has to deal with the economical, social and environmental aspects of a society, described previously. And also a clear and strong government, with efficient institutions, and community support must manage the planning of the land (**Figure 1.2**). Although not all the processes regarding land use can be controlled by governmental policies or actions, it is needed to emphasize the importance of that entity in this matter, in the development of monitoring tools, such indicators, and implement laws to regulate the use of the resource.

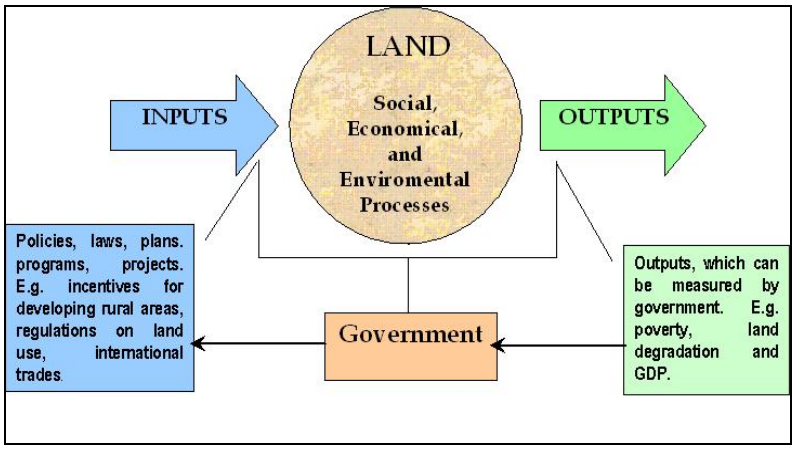

Figure 1. 2 The role of the Government in land use planning

It is known that many economical, social and environmental processes are closely related to land and its use. Economical activities, such as agriculture,

mining, and forestry depend their developments on land use planning and governmental policies, amongst other factors. Some aspects of human systems can evolve in different ways depending of the features of the territory and also in the occupation pattern of the land. As well as, the natural part of the territory, such as forest, fauna and national parks could be affected by decisions regarding land planning within a region.

Here, the government takes an important role, regulating the processes of occupation and use of the land, in based on policies, which are the general framework for land use, laws to permit and forbid activities in certain areas, or norms. To do so, governments must co-ordinate their activities through local units. To shape policies in a local way it will be necessary to divide the region in manageable territorial areas and to decentralise some responsibilities to the local actors and initiatives. At the same time it is important to ensure and to organise solidarity between all urban territorial areas and the rural surroundings and the central government. It is a question of efficiency in the administration and also of political strategies that involves reorganising the political authorities and administration responsibilities between the central and the local authorities (Kötter, 2004) So, the fundamental input from the State regarding land use is based in policies, laws, plans, programs and projects in land use planning.

1.2.4 Indicators

Indicators are present almost everywhere; when, monitoring complex systems we use them. They are a necessary part of the stream of information used to understand the world, make decisions, and plan actions. Indicators can be tools of change, learning and propaganda. Their presence, absence, or prominence affects behaviour (Meadows, 1998).

Indicators are both important and dangerous because they sit at the center of the decision-making process. In a system, indicators give information about the state of a component, or process of the system, for example for a marine ecosystem the number of a fish species can be used to assess the state of that component, an for that, the amount of caught fish can be used as an indicator to estimate the quantity of that remaining specie in the sea. It is important to know that indicators sometimes cannot measure accurately the actual system state, but some proxy or associated state (Meadows, 1998). If an indicator of the state of the system is poorly chosen, inaccurately measured, delayed, noisy, decisions based on it cannot be effective. Misleading indicators might cause wrong reactions.

The following scheme represent a system where indicators are situated in the output flow, because they give information about the changes of certain

components or processes of the system, and with that information the state of the system can be estimated (perceived state), if there is a discrepancy between the perceived state and the goals, actions should be taken to adjust that. That is called "*feedback*" (**Figure 1.3**), which can be used as a learning tool for system management, so with this new information it is possible to make changes in the input flow or in the processes of the system, in order to rectify it. All this can be understood as a sub-system of information. For the government these rectifications can be understood as changes or actualization of policies or laws.

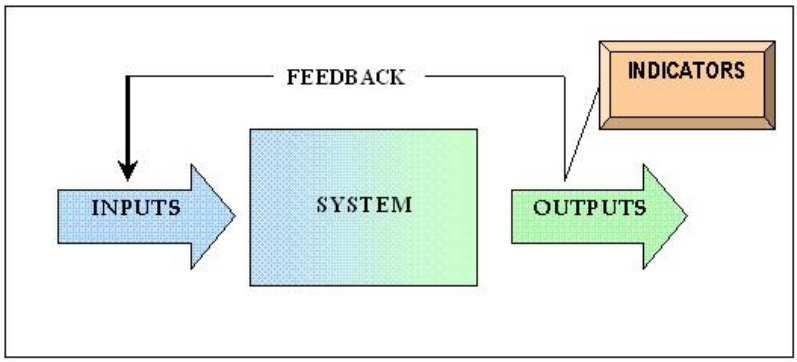

Figure 1. 3 System and its sub-system of information

It is important to notice, that complex systems can be divided into sub-systems, which can regulate the internal processes of it (nestedness), so indicators can measure also output fluxes from sub-systems within a system. Thus, the internal processes of a system can be monitored.

However it is necessary to clarify that indicators are not the system; they are abstractions from the system. Furthermore, they are abstractions from a model of the real system. And, models are assumptions about how the world works based on the personality, culture, language, training and experience. So, models can be enormously varied. "The objective reality independent of the observer" does not exist, it is important to recognize the observer as a constitutive component of what is observed. Thus, from a unanimous objective reality we have to pass to different worlds constructed by each and every observer (Maturana & Varela, 1984). So, here arises an important problem how do we set up common indicators from a model, if models depend on every observer of the system?

It is known that models are simplified mental schemes from complex systems, we are not capable to represent accurately all interactions, and information fluxes in a complex system. That is the reason why our limited models suffer from failures, accidents, surprises, and not always the predicted information is coherent with the real results. For instance imprecision in the weather forecast. Then, models are incomplete. And therefore, indicators developed on models cannot provide all information needed to assess complex systems.

Therefore, here the task in setting indicators on complex system is to at least reduce uncertainties. For this, indicators must be objective to avoid personal interpretation of the results, what is measured, and the data collected. Objective indicators are sensed by instruments and can be verified by other observers, they measured principally quantity.

Whereas, when we have to measure quality, subjective indicators are needed, and they are sensed by the observer through means not easily explained, but they must be constructed in agreement with possible observers. Also, for both kinds of indicators, it is needed prepared observers, educated in its terms and units of measurements, and able to analyze the information received by the indicator its limits and scopes, considering the system evaluated (Meadows, 1998).

For even more complex systems, such as societies or ecosystems, one indicator is not sufficient to give all the information needed to assess the system's evolution, even indexes, which are the emergent from the relational information generated by a set of indicators, are not able to accurately and objectively give an account of the state of the system. For instance, according to Meadows (1998), we will probably never settle on a single global index of sustainable development - Too many people work on different problems and need different kinds of information. Therefore, to evaluate if the evolution of a complex system is coherent with the settled goals an Information System is needed.

An information system implies different indicators, a hierarchical structure amongst them, and different indexes which can contribute to understand the evolution of certain aspects of a system. The main reason why this is needed is because they must cover the different worldviews and mental models created by people over complex systems. Worldviews define what is important, what questions have to be asked, what goals are wanted and possible to achieve, and what can and should be measured.

1.2.4.1 Sustainable Development Indicators (SDIs)

Sustainable Development Indicators (SDIs) are designed to monitor fundamental aspects of the society-nature system in order to generate information needed to document the current state and the history leading up to it (Haberl, Wackernagel & Wrbka, 2004), they must bring information needed to assess if the social, environmental, and economical variables are in accord with the settled goals on sustainable development. Indicators must communicate the problems, achievements, and progresses related with sustainability to the community.

Design and implementation of sustainability indicators begun in the late 80's in Canada and in some European countries, adopting fundamentally an

researching character and a partial vision. They just used to assess systems on a productive point of view, or just evaluated a reduced number of dimensions. In the next decade the issue became important due to the Conference of United Nations about Environment and Development (Rio de Janeiro, 1992), where the Commission of Sustainable Development was created to monitoring sustainable development progress, and to evaluate the advances of the 21 Agenda. To accomplish that, it was necessary adopt measurement tool for sustainable development (Gross & Arrué, 2005).

At the beginning, sustainability indicators referred mainly to environmental sustainability, which did not incorporate inter-relations amongst the system components, for instance CO_2 emissions just gives information about the environmental aspect of sustainable development. Later, indicators of sustainable development were built. They considered the economical, environmental, social, and institutional variables. Nevertheless, in many cases they did not put together two or more of these variables. The next step is to develop indicators able to link these variables, describing synergic processes, adopting different system attributes and dimension of sustainable development (Gross & Arrué, 2005).

1.2.4.2 Indicators of Sustainable Land Use

Monitoring sustainable land use relies on land quality and quantity indicators to identify problems and measure trends. Indicators types of sustainable land use can vary greatly, amongst deserts, mountains, agricultural lands and tropical forests, because they involve different ecosystems with different land conditions where different productive activities might be developed. For these reasons it is necessary to develop specific indicators of sustainable land use that allow to evaluate and measure the development of the region, which involves many times developing suitable types of indicators for the specific area to be assessed.

Indicators must to provide information needed for land managers, that information involves technologies for instance, methods used per type of cropping, policies or regulation on land use, and activities such as, housing, agriculture, forestry etc. aimed at integrating socioeconomic principles with environmental concerns, by developing certain activities simultaneously such as:

- maintaining and enhancing production
- reducing the level of production risk, and enhancing soil capacity to buffer against degradation processes
- protecting the potential of natural resources and preventing degradation of soil and water quality

- developing economically viable and socially acceptable economic activities
- assuring access to the benefits from improved land management
- sharing responsibilities for sustainability land management between the productive sector and involving the governments to undertake and active role in the development of policies, laws, plans and programs (**Figure 1.4**). In this example indicators provide the information to the governmental part in order to monitoring its actions regarding land use, and the consequences on the environment, population and economy. But indicators can be used by all kind of stakeholder of the matter, such as farmers or private investors.

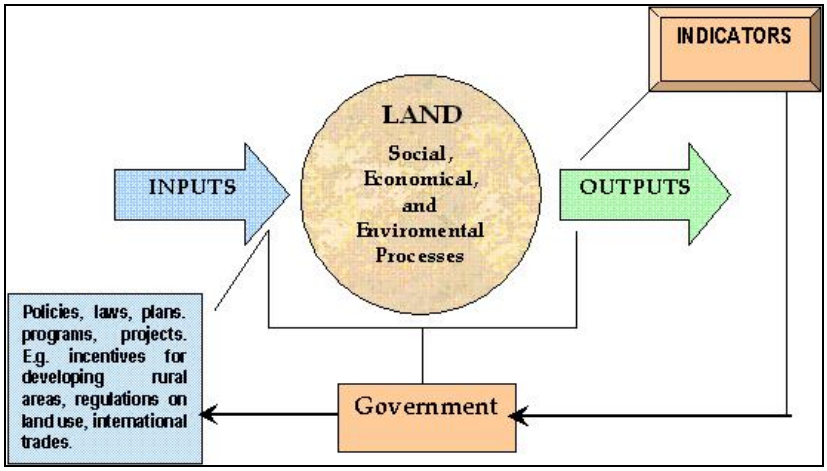

Figure 1. 4 Land use planning system from the governmental point of view.

Generally, in developing countries, it is essential that scarce resources devoted to land management can be used more cost-efficiently and that policy-makers have at least basic indicators of whether environmental conditions and land quality are getting better or worse. Sustainable land management requires a long-term commitment on maintaining the quality of the land resource. Unfortunately, short-term economics often promote technologies that exploit and degrade the land (SRDIS, nd).

Indicators of sustainable land use, such as nutrient balance, loss of organic matter, land use intensity and diversity, and land cover are useful for land managers and decision makers to monitor and improve the performance of projects with respect to their socio-economic and environmental impacts, and to assess the trend towards or away from land use sustainability. Indicators of sustainable land use are also required to evaluate the environmental impacts. The quantitative assessment of physical impacts, such as depletion of soil nutrients, loss of organic matter, soil erosion, water contamination, etc. may appear to be costly and cumbersome during project implementation, but the long-term negative impact of reduced land quality, such as decreased efficiency of fertilizers, increased erosion, increased fuel consumption, increased pest infestation like nematodes, often result in rehabilitation costs that are much

higher than the incomes. Thus, it is possible and sometimes cheaper long-term land use planning, strategically, with monitoring and indicator system of land use, in order to reduced the negative impacts that can be caused by the short-term income from a degradative land use.

The development of indicators of sustainable land use should follow a logical framework, by providing information not only on the state of the resources, but also the underlying causes as well as the response of the society to the state and the pressure exerted on the land resources (Pieri, C., *et al*, 1995). These indicators can be short or long term and to involve different spatial scales.

For short term to manage ecosystems like agriculture and forestry, indicators should measure nutrient balance, yield trends and yield gaps, land use intensity, land use diversity, land cover, among others. For long terms indicators of sustainable land use should deal with soil quality, land cover, nutrient balance, and agro-biodiversity. Sustainable land use indicators that involve large spatial scales could also include indicators related to water quality, forest land quality, rangeland quality, land pollution, etc, because they might be useful in evaluations and plans and projects developments. For these reason, they must still be complemented with indicators of the other pillars of sustainable land management, economic viability, system resilience, and social equity and acceptability.

1.3 AIMS OF THE WORK

The purpose of this work falls in the current need for indicators of sustainability in developing countries, which deal with the use of the land. Specifying the importance of these tools to monitor governmental actions and private influences on the use of that resource. In this case, a special reference is given to the current situation of Chile regarding territorial planning.

For this, first an institutional description was made, indicating the State institutions involved, the administrative structure of the Chilean territory, and the main territorial planning instruments used, remarking the problems and deficiencies of that framework. Secondly a review of the indicators used in Chile by the State institutions to assess the different actions on land planning, regarding the social, environmental and economical dimensions.

Finally, the thesis aims to develop a methodology to set up indicators of sustainability, which can be applicable in Chile for monitoring the current territorial planning instruments in at regional and local scales. This part is based mainly on the international experiences about the matter.

CHAPTER 2 – LAND USE PLANNING IN CHILE

"In developing countries, awareness by Governments of the critical role played by land resources are poor, and institutions inadequately funded".

Anthony Young.

The Republic of Chile is a country in South America occupying a long coastal strip between the Andes Mountains and the Pacific Ocean. It shares borders with Argentina to the east, Bolivia to the northeast and Peru to the north. Chile extends nearly 4,300 Km. in a north-south direction, with an average width of only 177 Km. This makes Chile the longest and narrowest country in the world (Government of Chile, 2005)

The country may be divided into three distinct regions. The north, which has one of the driest deserts in the world, also contains the country's largest mining and fisheries investments. The Central Valley, which has most of the population, is where the country's main industrial and agricultural interests are situated. The south, which is largely characterized by fiords and glaciers, ends in the world's most southerly city, Punta Arenas, across the Strait of Magallanes.

Chile is a relatively homogenous country. Unlike some of its South American neighbours, around 95% of Chileans descend from early Spanish colonists. According to the Statistics National Institute (Instituto Nacional de Estadísticas, INE, 2002), the current population in Chile is 15,116,435 inhabitants, less than 20 inhabitants per square Km. The population has increased at an annual average rate of 1.2% between 1992 and 2002, which is one of the lowest growth rates in Latin America. The Chilean population is highly urbanized, with 86.7% of the population living in urban areas. About 40% of the population live in the Metropolitan area of Santiago. The six largest cities are Santiago (4,655,800 inhabitants), Concepción (373,400 inhabitants), Viña del Mar (318,489 inhabitants), Antofagasta (293,800 inhabitants), Valparaíso (267,800 inhabitants) and Temuco (266,225 inhabitants).

The urbanization process in Chile is one of the most important phenomena in the last decades. Nowadays, about 80 % of the population in Chile is considered urban, surpassing the rate of urbanization in most other countries in South America and the world.

This urbanization process implies an important population growing in the majority of the cities, and has produced strong impacts in the environment. So, the production, interchange and consuming patterns operated in the country have had as a consequence transformations in the urban and ecological structures, by modifying the physical, spatial, functional and social relations, in local, regional, national and global levels (UCH, 2004).

The current scenario for land use planning includes many challenges and uncertainties. Challenges in terms of presenting possibilities of a greater approach to the comprehension of the urban systems, and uncertainties in terms of an increment in the complexity and dynamism of this phenomenon, in spite of cities are considered as fundamental entities where the growing and human development is occurring.

The following paragraphs are referred to the manner in which the Chilean government deals with the use of the land and the urbanization process, a description of the institutional mechanism which controls the territorial planning, and the use of the land are presented. It was based fundamentally in a research made between September until December of 2005 in the three most important entities involved in land use in Chile: The Agriculture Ministry (Ministerio de Agricultura, MINAGRI), The Environmental National Commission (Comisión Nacional del Medio Ambiente, CONAMA), and The Ministry of Housing and Urbanization (Ministerio de Vivienda y Urbanismo, MINVU), by using literature and interviews with people involve in the issue in that entities.

Consulted literature concerned official related publications and reports chosen from the above entities public libraries plus CEPAL, UNDP and OECD publications. Interviews were planned by introducing the public functionaries about the subject of this research before to interview them by using the following lead questions:

1. What is the role of your institution regarding land planning?
2. What kind of plans/programs/projects has your institution regarding land use planning?
3. Have the institution a methodology to monitoring that plans /projects/ programs?. If yes, what aspects of sustainable development do they monitor (economical, social, environmental)?
4. To do so, what types of indicators are being used to monitoring that plans/programs/project?

The interview details, such as institutions, department and public functionaries' name are described in the following table (**2.1**).

Table 2. 1 List of people interviewed

ENTITY	DEPARTMENT	NAME
MINAGRI	SAG	German Ruíz
MINAGRI	ODEPA	Patricio Grez
MINAGRI	SAG	Rodolfo Fredes
MINAGRI	Seremi	Galvarino Castillo
CONAMA	SINIA	Karin Mollt
CONAMA	Land Use	Ricardo Perez
MINVU	Seremi	Seremi´s assistant of MINVU metropolitano
MINVU	Observatorio urbano	Sergio León
CEPAL	Sustainable development and human settlements	Jose Javier Gomez

2.1 STATE ORGANIZATION AND LEGISLATION

The Chilean State has a unitary character, that is, in its whole territory the unity of juridical ordering is kept. Its main authority is the President of The Republic, who is elected by popular vote for a four-year term. To achieve the governmental objectives, the country is divided in thirteen minor territorial unities named Regions; the management of each one is in charge of the **Regional Commissioner** (Intendente Regional). Each Region is divided in **Provinces** (Provincias), which are in charge of a **Governor** (Gobernador Provincial). Commisioners and governors are appointed by the President. Finally each Province is divided into municipal districts called **Communes** (Comunas), whether they are located in rural or urban areas. Each commune is commanded by the **Mayor** (Alcalde), who is the main local authority, and he/she is elected by popular elections. The country is divided into 13 regions, which include the capital, Santiago; 51 provinces; and 335 communes (Government of Chile, 2005).

The National level is under the Executive Power of the State, that is the President and the Ministries, which are in charge of created policies and norms over the entire territory of the Country. From here emanate laws and policies related with territorial planning, and other aspects regarding land planning, or land use.

The legislative branch is represented by a bicameral National Congress, which is formed by the Senate and the Chamber of Deputies. It is composed of a Senate, which has 38 members elected by direct popular vote (two for each of the 19 senatorial circumscriptions). In addition, there are nine institutional members, which are appointed in accordance with a special procedure established in the Constitution. All of the above senators serve eight-year terms. The Senate is partially renewed every four years. The Chamber of Deputies has 120 members, all of whom are elected by popular vote and serve 4-year terms.

In **The Regional level**, the Law 19.175 published on 1993, about Government and Regional Management (Ley 19.175 Orgánica Constitucional sobre Gobierno y Administración Regional, publicada en el Diario Oficial en marzo de 1993), establishes the existence of a Regional Commissioner, who has in charge Regional Ministerial Secretaries (Secretaría Regional Ministerial, SEREMI), which are entities separated from the Ministries at national level. They are under the Commissioner in regard to the elaboration, execution, and coordination of policies, plans, budgets, and projects of development. The Law also establishes the existence of the Regional Government (Gobierno Regional, GORE), constituted by the Commissioner and the Regional Council (Consejo Regional, CORE). In it, the Commissioner does not act as President's representative, but as executive entity of the GORE. This entity has general

attributions in land planning matters, productive activities, and social, cultural development of the region.

At **Provincial Level**, The superior administration of each Province falls into a *Gobernación*, which is ruled by the governor, who is subordinate of the commissioner, and counts with the President's confidence. Each province has a Provincial Economic and Social Council, which is a consulting entity of the governor about project of regional development and regional budget and also is representative of social organisations.

In the **Local or Communal Level,** each commune (territorial division) is managed by the **Municipality** (the communal government), which is defined as the autonomic corporation of public rights, with juridical personality and own patrimony, which has as finality meet the needs of the local population and ensure its economical, social and cultural development. Municipalities are constituted by the major and the council, both elected by citizens from the Commune. They have normative, decisional and supervisory character, and they are in charge of the effective public participation (Government of Chile, 2005).

The following figure **(figure 2.1)** illustrates the State administration levels, institutions and whether they are appointed or elected charges.

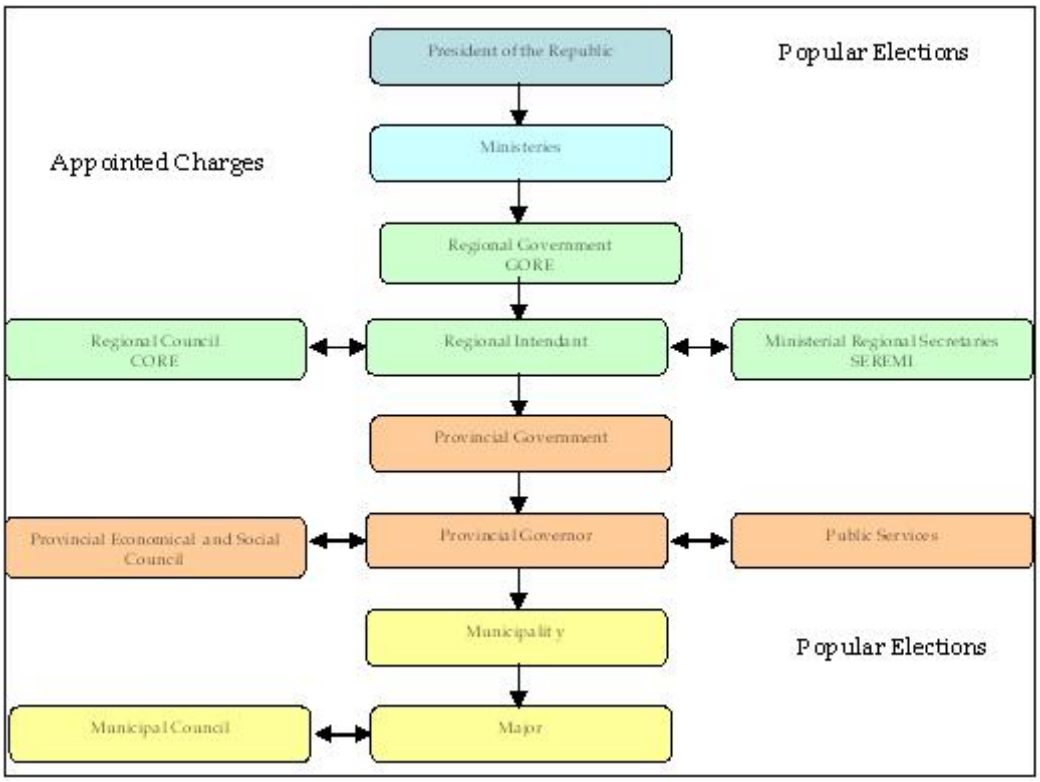

Figure 2. 1 State Administration

According to the Municipality Constitutional Organic Law, last updated on September 2004 (Ley Orgánica Constitucional de Municipalidades, última actualización publicada en el Diario Oficial en septiembre de 2004), it is municipalities responsibility, the planning and regulation of the commune among other functions. To achieve with these responsibilities, municipalities are able to develop, approve and execute the **Communal Regulator Plan** (Plan Regulador Comunal, PRC), the **Communal Development Plan** (Plan de Desarrollo Comunal, PLADECO), the **Sectional Plan** (Plan Seccional), and every program needed to accomplish it. These and other territorial planning instruments will be introduced in the section 2.3 of this chapter.

The earlier mentioned Law described the Communal Development Plan as the main instrument of the communal development. This Law also indicates that in the elaboration and execution of the PLADECO, the Major as well as the Council should consider citizen participation and the needed coordination with the public services related with the communal development. This Plan must harmonise with the Territorial Planning Instruments (TPI) like the PRC and the Sectional Plan. These Instruments have as proponent, the Major, and they must be presented and evaluated in the Environmental Impact Assessment System (Sistema de Evaluación de Impacto Ambiental, SEIA), according to the Environmental Bases Law (1994) (Ley 19.300: Bases Generales del Medio Ambiente, publicada en marzo de 1994).

2.2 POLITICAL AND INSTITUTIONAL ASPECTS

Territorial planning in Chile is governed by a series of specific and partial instruments that address different public sectors, such as transport, housing, agriculture, energy, environment, public works, etc.

The State regulation and the influence of the market over the land use have meant that certain areas face significant environmental pressure. Situations such as changes in land use, underdeveloped agriculture sectors, unofficial occupations of urban periphery zones, location of sanitation systems, use of areas with high natural and manmade risk, establishment of production activities in zones of environmental fragility, all of this underline this situation (Dourojeanni, 1997).

For this reason, the Chilean Environmental Policy for Sustainable Development (Política Ambiental para el Desarrollo Sustentable) (CONAMA, 1998) made by The National Commission of Environment defines a need to go beyond land use planning outlined in regulatory plans and incentives for territorial traffic jams solutions, and establish a coordinated policy for land use.

At present, land use and planning by the government is undertaken according to the guidelines established by the General Urbanism and Construction Law (Ley General de Urbanismo y Construcciones, publicada en abril del año 1976) and the General Urbanism and Construction Ordinance (Ordenanza General de Urbanismo y Construcciones, publicada en junio del año 1992). Under these norms, land use planning is fundamentally geared towards urban areas and neglects other territories (SERPLAC RM., 2005a).

On land, the planning is overseen by the Ministry of Housing and Urbanization (MINVU), which has primary responsibility establishing laws, regulations and general guidelines for urbanization, residential buildings, infrastructure and urban development and planning. It must also, prevent the generation of new urban areas in rural zones, and the construction in rural areas of new settlements, industries or infrastructure, among others.

CONAMA and MINVU in 2002 signed an agreement of technical cooperation in order to strengthen the environmental aspects of land use planning. Their intention was to develop new methodologies and indicators in order to accomplish their objectives about land planning by preventing the duplicities usually occurring under partial administration of each institution and improving their resources. In this context, CONAMA coordinates the Environmental Impacts Assessment System, promoting the inclusion of land use planning in the SEIA. So, the environmental variable in the design of public policies, plans and programs regarding land use planning was proposed, in order to benefit the sustainable use of the land.

Different public services also have specific jurisdictions related to land use planning, For instance, the National Tourism Bureau (Servicio Nacional de Turismo, SERNATUR), has a role improving and maintaining the tourist potential of the Country. It possesses some capabilities regarding the regulation of land for tourism, such as declaring zones and areas of interest for tourism and coordinates the zoning plan for such areas. The Ministry of Public Works (Ministerio de Obras Públicas, MOP) develops and plans the country's main infrastructure works, which obviously have a significant impact on land. One of its divisions, the Water Authority (Dirección General de Aguas, DGA), is related to land use planning via the National Water Policy (Política Nacional de Aguas), which takes care of optimizing the use of the water resource.

The Ministry of Agriculture (MINAGRI) and its bodies are in charge of the development of the rural zones. This institution has certain jurisdiction to address this area in territorial and environmental terms, but does not have, in practice, the necessary influence and impact to make the Ministry an important promoter of territorial ordering. Among its attributes are those related to create "conservation district for soil, forests and water" in areas affected by erosion. It also corresponds to the Agriculture and Livestock Service (Servicio Agrícola y

Ganadero, SAG), one of its bodies, to be informed of any change to land use in the rural sector.

Additionally, so as to deal with the inter-agential nature of the territory issue, the Chilean State has set up diverse instances of an inter-ministerial nature, being the National Commission of Coastal Zone Use (Comisión Nacional de Uso de la Zona Costera), the Mixed Commission of Agriculture and Urbanism (Comisión Mixta de Agricultura y Urbanismo), and the Pro-Rural initiative that are most related to land use.

Therefore, it is noticed that the Chilean State has many institutions dealing with land use, but we will put our focus in the four most important ones: MINVU, MINAGRI, CONAMA and the Municipality. The following chart (**figure 2.2**) shows these entities and the area of interest of each one over the land use.

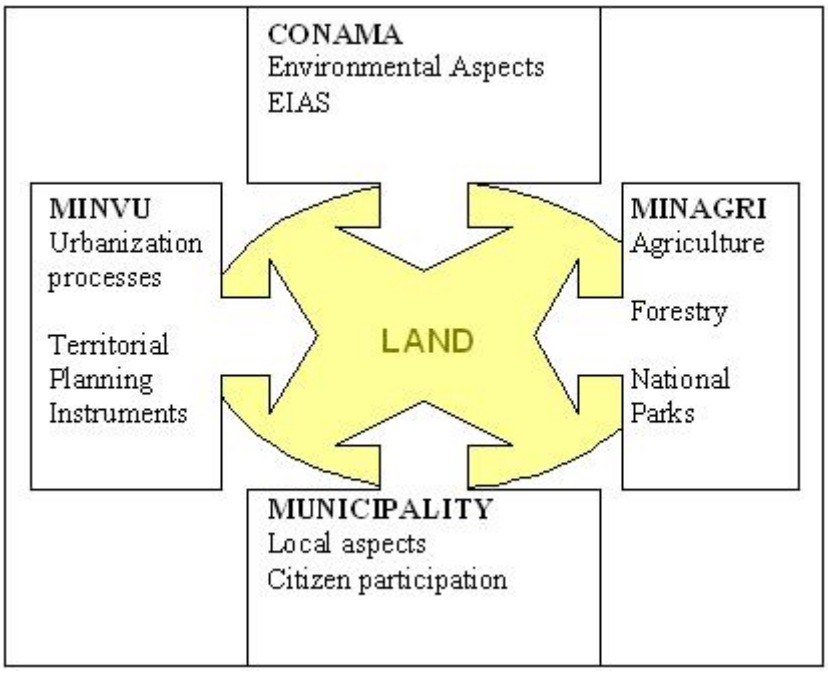

Figure 2. 2 Main State Institutions involved in land use, and their area of interest

Nevertheless, there are many institutions interested in land use, as it is detailed earlier, with their own scope and interest, but the most important aspects in land use falls in MINVU, which regulates and promotes the urbanization process, and develop the TPI in all spatial scales; MINAGRI, which develops the rural areas in base of incentive and protection of agriculture and forestry activities, preservation of national parks and areas of natural interest; CONAMA, which coordinates with the other institutions the environmental dimension of the projects, plans and activities of the privates and other institutions; Municipalities, which deals with the development in

local level of a community, and articulate the public participation in activities or plans regarding land use.

2.3 TERRITORIAL PLANNING INSTRUMENTS IN CHILE

The urban planning in Chile divides the action levels in regional, inter-communal, communal or specific areas of a city. The urban planning is executed through Territorial Planning Instruments (TPI), which are defined as a conjunction of norms intended to orientate and/or regulate the development of a specific area. They can be laws, ordinances or plans, and the action level of that instrument gives the level of detail.

The importance of these instruments falls in that they constitute a mechanism which points to promote the reduction of uncertainties of the private actions in the urban development. That means the "game rules", with different stakeholders, even the State must operate under these rules.

The following are the different TPI ordered from mayor to minor hierarchy.

National Policy of Urban Development (Política Nacional de Desarrollo Urbano – PNDU). Whit the purpose of looking for guide concepts for the urban planning in Chile, this policy gives coherence with the social and economical policies prevailing in the country. The National Policy of Urban Development was issued in 1979 by the Chilean State.

General Law of Urbanism and Constructions (Ley General de Urbanismo y Construcciones – LGUC) The General Law of Urbanism and Constructions and the General Ordinance of Town Planning and Constructions are the most important norms, arranged by the Chilean State for the management of the urban territory. It contains the principles, attributions, legal authorities, faculties, responsibilities, rights, sanctions and norms that govern the agencies, professional, officials and privates, in the actions related to the urban planning, urbanization and construction.

General Ordinance of Urbanism and Constructions (Ordenanza General de Urbanismo y Construcciones – OGUC) The General Ordinance of Urbanism and Constructions in turn, contain the regulation dispositions of the General Law and it regulates the administrative procedures in the process of urban planning, urbanization and construction, as well as the technical standards in design and construction. Also, the technical norms form part of this body of regulations, which contain and define the characteristics that the

projects should possess, the materials and the systems of construction and urbanization.

Regional Plan of Urban Development (Plan Regional de Desarrollo Urbano – PRDU): This Plan is developed by the MINVU and approved by the Regional Government. It contains a regional diagnosis, strategic guidelines and maps. The regional diagnosis contains a study of land uses, hydrological systems and water quality, the identification of protected nature areas and natural risks zones, a description of the main economic activities, social information, etc. The strategic guidelines point to the city growing projections through the development of certain economic and productive activities. It also represents an operational base or framework, which takes and manages the main regional proposals with the finality of supporting in the decision-making (SERPLAC RM., 2005a).

Inter-Communal Regulator Plan (Plan Regulador Intercomunal – PRI): This instrument is developed for cities with less than 500.000 inhabitants and it is made by the MINVU with consultancy to the Administrative Institution of the State, the *Gobernación*. It orientates, promotes and regulates the urban development of urban and rural areas of two or more Communes that can be integrated in one urban unity. It must follow the conditions established in the Regional Plan of Urban Development and also it must include orientations about the infrastructure in the common area within the Communes, a study about the transportation system, the drain system, natural risk zones for flood and alluvium risk zones, and the natural protected areas (SERPLAC RM., 2005a).

Communal Regulator Plan (Plan Regulador Comunal - PRC): The Communal Regulator Plans are planning instruments which orientate, promote and regulate the urban development of the communal territory, especially of its towns and public areas. These plans are developed by the Municipalities and they refer to the structure of towns, urban limit, infrastructure, road system, drain and hydrological system, green areas and basic services, zoning, land use conditions.

The PRC must include a feasibility study for extend or provide drinking water and sewage system, local ordinance and maps. Modifications to this plans can be made with a Sectional Plans, instrument that consist in documents developed to modify some issues of the PRC such as to reformulate or accurate land use urban norms, to increase or to decrease risk or protected areas indicated in upper hierarchical instruments (SERPLAC RM., 2005a).

The following is an example of the objectives and the specific technical requirements stipulated for the MINVU to the consulting firms in the Terms of References of a PRC, according to the General Law of Urbanism and Construction, its Ordinance and the General Environmental Law and its Regulation (SEREMI MINVU RM., 2005).

These technical requirements, which serve as base of the regulatory matters of the planning instruments, must be referred among others, to: communal equipment, road and transportation infrastructure capacity, territory risks and protection, feasibility of the infrastructure of drinking water and wastewater system, storm water run-off, environmental impact assessment and all the necessary information for the formulation of the PRC Study.

Communal Regulator Plan Objectives (SEREMI MINVU RM., 2005).

- Give fulfillment to the General Law of Urbanism and Construction and its General Ordinance, in it concerning the urban planning of communal level and its implications
- Identify predominant roles in the urban centers of the commune
- Promote the harmonic development of the communal territory, especially in populated centers
- Predict norms to achieve adequate conditions of hygiene and security in the buildings and urban spaces, and of comfort in the functional relation among the housing zones, work, and equipment and recreation areas.
- Formulate a proposal of organization of the built system, predicting the needs of space and more adequate locating of activities; to do compatible the different activities in the territory.
- Establish dispositions respect to land use or zoning, location of the common equipment, parking
- To organize by hierarchy the road structure, urban limits, densities and intensity of land use and land urbanization priorities decision for urban expansion

Communal Regulator Plan Technical Requirements (SEREMI MINVU RM., 2005).

- Communal Base Plan (aerophotogrammetric maps and the corresponding digital restitution)
- Intercomunal Regulatory Plan (aerophotogrammetric maps and the corresponding digital restitution)
- Formulation of the preliminary PRC
- Formulation of the project PRC (It must content: plan, memory, local Ordinance, land use zoning plan, transport infrastructure plan, restriction zoning plan)
- Communal equipment study
- Drinking water system feasibility study
- Wastewater system feasibility study
- Rainwater system feasibility study
- Environmental protection and natural risk study
- Road capacity assessment study
- Environmental impact assessment
- Communal analysis study

Territorial Planning Levels, Institutions and Instruments

The following chart (**Figure 2.3**) shows in detail the different territorial planning levels, the State Institutions involved and the instruments specifying the character of each one, which can be indicative or normative, depending if the instrument suggests or forces to be executed.

Level	Institutions	Instruments	Character
National	MINVU MIDEPLAN CONAMA SAG	PNDU LGUC OGUC	Indicative Normative Normative
Regional	MINVU COREMA SERLAC	PRDU	Indicative
Provincial	Gobernación	None	None
Intercommunal	None	PRI	Indicative and Normative
Communal	Municipality	PRC Sectional Plan	Normative

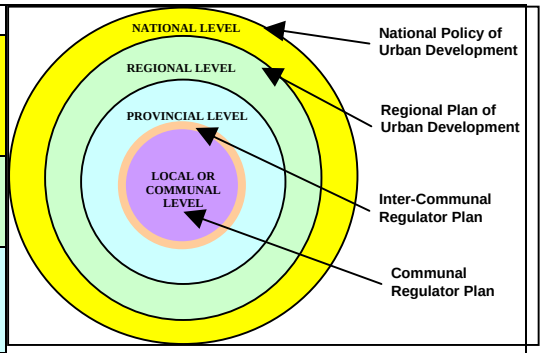

Figure 2. 3 TPIs, Institutions, level and character

Territorial Planning Instruments Administrative Approval Procedure

The following chart (**Figure 2.4**) the Territorial Planning Instruments revision and approval process is indicated, according to the General Law of Urbanism and Construction and its Ordinance, as likewise, as the General Environment Law and the Regulation of the Environmental Impact Assessment System establishes (CONAMA, 2005a).

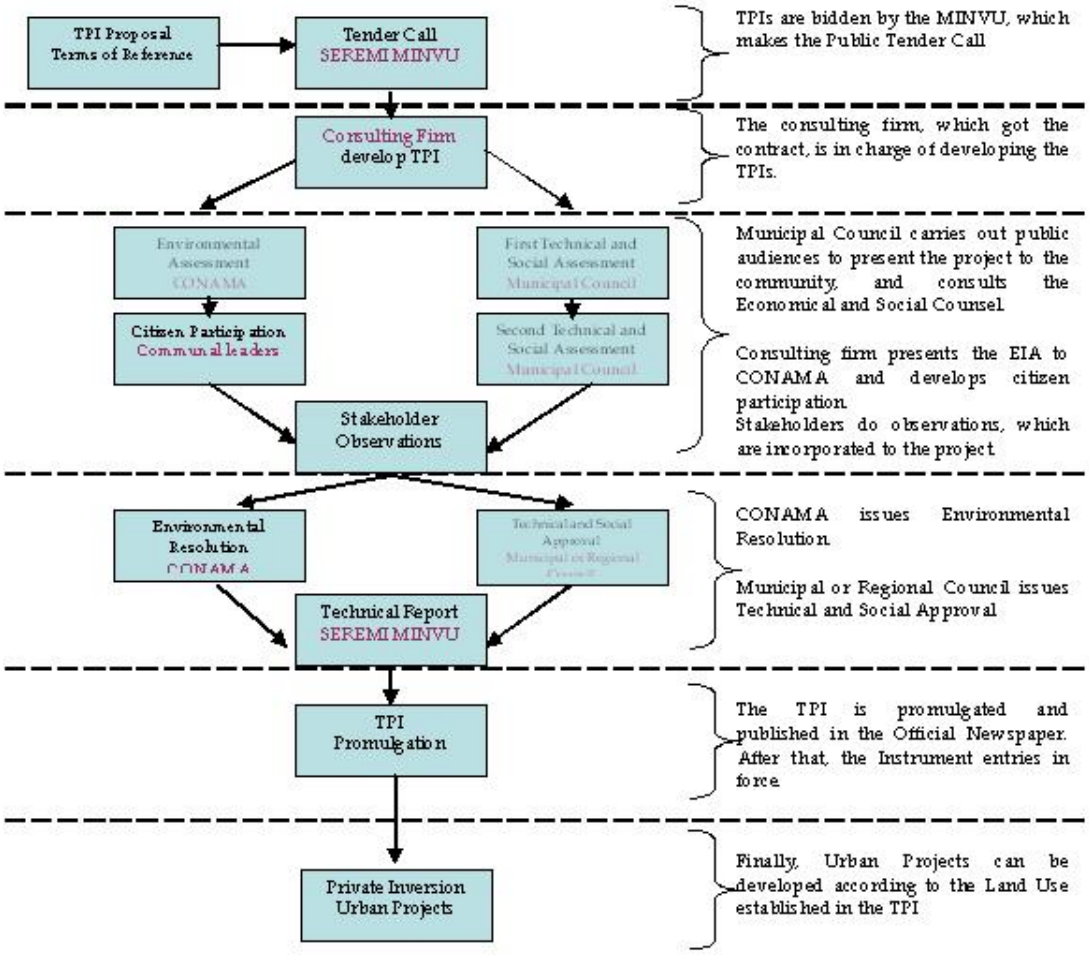

Figure 2. 4 Territorial Planning Instruments Administrative Approval Procedure

Nevertheless, once ended the study and delivered the TPI, there is not a defined methodology to assess, correct, and feedback the designed TPI. Therefore, a continuous monitoring for sustainable land use planning, according to the guidelines of that instrument does not exist.

This deficiency some times leads to these TPIs have large designing mistakes, and given the complexity of the approval process, modify them is almost impossible, coverall for time and high cost that implies (CEPAL & OCDE, 2005). Also it is important to consider that sometimes, the approval

process may take too much time and the city might have a fast dynamism and vertiginous growth and development, so once the TPI is finally approved, it can be staled by that time. It is possible to emphasize, when that occurs, the identification of responsibilities is a troublesome process, which nobody wants to take care of. Therefore, the TPIs are conserved in each Municipality, until its death-end, and they are bidden again, in order to update them. And then they are re-considered for update.

Thus, the development of a methodology that allows monitoring the TPIs, based in sustainability indicators, or environmental indicators would allow a constantly collection of information to assess and correct these instruments, and also feedback the whole process, since it will permit to design reference terms and administrative bases for the following updates and adaptations, based on local and specific information, obtained by local sustainability indicators.

2.4 THE ENVIRONMENTAL DIMENSION

The urban environment encompasses all such interactive phenomena as they take place within the spatial confines of urban areas. The rapid process of urban growth or a faster urbanization in other words, is allowed to take place in an uncontrolled and unregulated manner. This might lead to urban conditions that could result in a less healthy urban environment. In fact, this has been the case in many of the developing countries including Chile, which have faced a rapid urban growth for a variety of reasons, especially because cities have become neuralgic points of the economic activities, work places, school offering, and equipment, among others.

To control the use of land and to provide statutes to its planning and development in rural as well as in urban areas of Chile, the TPIs must be developed and updated according to the cities needs, to avoid disorganized and uncoordinated growth creating serious civil and environmental problems.

However, Chile has not a national system of territorial planning that allows ensuring the identification of biological diversity areas located outside the formally protected ones. Therefore, Chile has not a policy, plan or program that regards to keep in mind these areas at the moment of the decision-making regarding land use. A first approach was a pilot project developed with the aim of the German Society of Technical Cooperation (GTZ) that represents an advance towards the establishment of a system of environmentally sustainable territorial planning, this project received the name of Environmentally Sustainable Territorial Ordering, (SERPLAC RM., 2002), and was executed in the Metropolitan Region.

The goal of this project was to develop a technical basis to drive and define the policies of regional planning, which tends to a regional environmentally sustainable development in the Metropolitan Region of Chile, the capital of the country. This project is not longer being executed due to diverse reasons; the scale resolution of the developed GIS (geographic information system) was not suitable for decision-making, and the information generated was not normalized as a standard source of information for public services; a territorial ordering was proposed by OTAS, but it was never considered as a normative instrument. This caused that some public institutions and privates did not undertake the suggested strategies of territorial development. Finally, there were no development of this project in other Regions, neither were the next steps accomplished by giving continuity to this project.

To compensate the lack of a system of territorial planning, the different authorities have started to use diverse sector mechanisms for territorial planning, in order to reach certain degree of integration among the land use policies and preservation of the nature (although, at now only 2% of the territory is under planning) (CEPAL & OCDP, 2005). Nowadays, the MINVU and CONAMA carry the most significant planning effort, where TPI are incorporated to the Environmental Impact Assessment System.

In Chile since 1997 begins the establishment of criteria for the implementation of the Environmental Impact Assessment defined in the Regulation of the Environmental Impact Assessment System approved on 1997 and last updated on 2001 (CONAMA, 1997), for the TPIs, defined as a requirement in the General Environmental Law, where each planning instrument must be environmentally evaluated. Since then, this procedure is known as "Strategic Environmental Assessment" (SEA). Then SEA looks forward to drive the decisions of private investors, State institutions, and Municipalities in order to prevent or mitigate the adverse environmental effects. In concrete, SEA represents a formal and systematic process for the incorporation of the environmental aspects into the formulation of TPIs.

2.4.2 Environmental Territorial Planning

Whenever the environmental dimension of the TPIs is mentioned, without any doubt, there is no clarity, neither consensus about this dimension. The answer of this deficiency can be attributed to several reasons, some of them mention the lack of new paradigms on environment, cities, urban ecology among other concepts used to refer to these topics; others refer to the environmental dimension of these instruments that involves complex and

interdisciplinary contents (CONAMA, 2005b). Thus also, this absence of clarity could be explained by the lack of knowledge and proficiency of the stakeholders, such as planners, public services employees, public authorities and privates and the insufficient coordination among them. Nowadays, these deficiencies are been rectified by developing inter-sector cooperation plans and programs and national strategies that have normative character and by creating strong environmental agencies in each institution (Sustentable, 2002).

The current situation shows that territorial planning in Chile has not properly considered the environmental dimension, but there have been developed some important approaches in this issues (CONAMA, 2005b).

It is supposed that a territorial plan is environmentally sustainable when:

- It is conceived environmentally. The plan must have a previous environmental diagnosis of the territory, environmental objectives, and a strategy to accomplish these objectives must be formulated.
- In the revision and approval processes of the plan, the administrative procedures and methodologies must be clearly identified, in order to assure that the environmental considerations of the plan had been properly included.
- In the implementation and operation process of the plan, mechanisms to identify the environmental impacts must be developed in order to check if these impacts are the expected ones.
- During the plan evaluation process, indicators must be developed in order to verify if the plan accomplishes its objectives and to feedback and improve it.

2.4.3 Environmental Indicators in Land Use

To contextualize the environmental impact assessment of the Territorial Planning Instruments, it is estimated that this evaluation is part of a greater process, which is to operate an environmentally sustainable territorial planning. By the same thing, the role of the territorial planning is recognized as an instrument of environmental management. Thus also, criteria are suggested to fortify the mentioned environmental dimension, recognizing that it contributes in the decisions making process where the adequate environmental considerations are included, besides the traditional economic and social considerations. To accomplish that, CONAMA has set up a series of environmental indicators regarding land use in urban areas, and for the planning instruments. The following tables (**2.2 & 2.3**) show examples of what can be found on CONAMA's indicators web page.

Table 2. 2 Indicators for land use in urban areas

INDICATOR	DESCRIPTION	SCOPE	LIMITATIONS
Green areas in urban zones	Square meters of green areas per inhabitant for the communes with the mayor population of each province in the region	It indicates how urban planning is including the recreational variable. It is supposed that "a more green areas a better quality of life"	The definition of green areas correspond to the surface intended for this use according to the TPI, but it does not imply that these areas are necessary implemented
Green areas implemented per inhabitant	Square meters of green areas implemented per inhabitant in the commune of the region	This indicator shows the variability in the availability of green areas for recreational activities.	It indicates the quantity in surface of green areas, but it does not indicate the quality, by means of their recreational capacity
Changes in land use	Number of hectares of agricultural land that have been changed into other use per year	This indicator gives quantifiable information, what allows estimate the expansion of the urban surface in impairment of the agricultural land	It represents the changes in land use, approved in the last years. But it does not provide concise information about the impact of this change, from the economical and environmental point of view
Fragility of the soil	Surface in danger by erosion.	This indicator sizes in a certain way the soil degradation problem in the region, and it is implemented in order to improve it.	It is a proxy of the availability and state of the soils. Unfortunately, there is no systematic information about erosion.

Source: www.sinia.cl

Table 2. 3 Indicators for territorial planning

INDICATOR	DESCRIPTION	SCOPE	LIMITATIONS
Number of valid TPI per region	The valid TPI per region are counted, according the communal and inter-communal regulator plans	It is considered as optimum that the whole territory is under some TPI. A simple way to see this situation is across the existence of the regulator plans.	The regulation of uses does not imply the incorporation of criteria of sustainability, neither warranty homogeneous developments of all aspects in the regulator plan. It does not consider the surface involved
Number of TPI per type and province	The valid TPI per region are counted, according the communal and inter-communal regulator plans	It is considered as optimum that the whole territory is under some TPI. A simple way to see this situation is across the existence of the regulator plans	The regulation of uses does not imply the incorporation of criteria of sustainability, neither warranty homogeneous developments of all aspects in the regulator plan. It does not consider the surface involved

Table 2. 3 Indicators for territorial planning – continuation

INDICATOR	DESCRIPTION	SCOPE	LIMITATIONS
Regional surface under TPI	It is determined by means of regional surface under a TPI, such as a regulator plan	It is considered as optimum that the whole territory is under a TPI. A simple way to see this situation is across the existence of the regulator plans	The regulation of uses does not imply the incorporation of criteria of sustainability, neither warranty homogeneous developments of all aspects in the regulator plan. It does not consider the surface involved

Source: www.sinia.cl

By considering the Environmental Impact Assessment System as the main instrument of environmental management with its obligatory character and these environmental indicators, it can be concluded that both must be integrated into one instrument in order to strengthen the environmental evaluation, to create continuity in monitoring and to correct and feedback the system as a dynamic process in time.

2.5 THE ECONOMICAL DIMENSION

The economical dimension of territorial planning falls in their TPIs, as it is obvious that the development of productive activities and the construction of equipments and infrastructure will be under the directive framework planted by this instrument, which can have global, regional or communal character. Thus, it regulates and controls the dynamics of the influence area. Therefore, the consideration about territory in the small, medium, and large-scale economical policies have received a new impulse in the last decades, around to understand the factors which determine the concentration process of the economical activities and city services. As well as, to explain which ones are the factors that can drive some locations to show higher dynamisms and competitive capacity (Espinoza, *et al*., 1994).

Therefore, it is known that the market and private investors have a high responsibility in the urban development. It was evident when the private participation suffered a strong change on the urbanization process, passing from a 23% in 1980 to an 81% in 1997 (MINVU, 2001).

These changes on the private participation cause adequate responses to the new demands on the urban process, innovating in supply of products and services, and therefore developing new development trends. It implies a strong change with respect to cities 40 years ago, because of the vertiginous growth.

Thus, the TPIs have had to be updated or reformulated to give response to these new demands of dynamism and growth.

In Chile, the economical dimension of territorial planning also is given by the resources with which counting each territory, for which the settled strategies should offer feasible solutions in function of this. In this manner, some cities or communes would be able to work by incorporating cleaner and more efficient technologies to the production lines in some industries or agriculture activities, or they can develop plans and programs to improve the decrease of the generation of waste through recycling, the promotion of mixed uses of the land, and some other initiatives suggested in the TPIs.

To achieve the earlier mentioned goals, it is necessary to count with an integrated territorial planning instruments; it means by incorporating all the TPIs guidelines and objectives and also avoiding contradictions between them and the involved institutions and territorial programs. These targets can be reached by developing standard sustainable land indicators. These indicators are dynamics and might be shared by all the government institutions in order to they all have the same information and have the same access to them. This could avoid conflicts in decision taking and improve their resources.

In Chile, the only indicators managed in that way have relation with economical or social information independently, but they are not considered as sustainable land indicators, because they are unconnected and they are not linked among each sustainable development issue. Nevertheless, they set up an important approach in this issue. This information is available on the Undersecretary of Administrative and Regional Development (Subsecretaria de Desarrollo Regional, SUBDERE) web site. The mission of the SUBDERE is to devise, to fortify and to evaluate politics of decentralization, for the purpose of modernizing the public management, to prompt the harmonic development of the territories and to deepen the democracy.

The SUBDERE has two different indicator programs, the Municipal Indicators National System, (Sistema Nacional de Indicadores Municipales, SINIM) and the Integrated Territorial Management System (Gestión Territorial Integrada, GTI).

The SINIM is a management indicators system that yearly, reflects the performance of the municipality, contributing information of support to the management and takes it of decisions of all the actors related to the municipal action (SUBDERE, 2005a).

The GTI System's aim is projected to incorporate the territorial perspective in the products, goods and services that public institutions develop, therefore what it was expected was that the public services operate with territorial integrated processes that promote and incorporate the regional needs and their solutions in the develop of their tasks (SUBDERE, 2005b).

Hence, it can be concluded that both programs deals with economical and social indicators but they do not include the environmental dimension as a third and equal component of theirs programs, therefore, they need to incorporate this dimension in order to become sustainable indicators.

2.6 THE SOCIAL DIMENSION

Planning is the scientific, aesthetic, and orderly disposition of land, resources, facilities, and services attained through careful and thoughtful attention to the physical, economic, and social efficiency and well being of urban and rural communities. Land planning searches to act on the existing territorial order to induce new settings of development, use and occupation of the territory that must be adjusted to an objective image that should be previously arranged by the society. Because of all TPIs are developed for people welfare, and they should seek for social equity, the social dimension of them is important as the economical and the environmental ones.

The equity is given by the equal access that should have all the people -of low economic incomes and high, men, women, children, young and elderly- to satisfy at least the essential good and services such as adequate dwellings, health services and efficient education, employment opportunities, basic services (aqueduct, sewer system and energy), conditions of air, water and land done not contaminate, cultural activities, security and general welfare, participation decisions-making and in the development of their territory, among others.

Therefore, past experiences in land planning in Chile have shown how many TPIs can affect the social structures in a town. When a planning instrument has been unwell formulated or not respected, as it should be, situations of illegal human settlements, undesirable migratory processes, and development of submerged economies have occurred (Allesch, Alvarez & Constanzo, 1995-1996). For instance, when a TPI defines an urban expansion area for basic housing, without providing the future residents the basic equipment or services, or work possibilities according to the number of families, the above situations have taken place. The result of these irregularities can bring large problems to the Municipalities, which have to receive a great number of work demands, which commonly cannot be met.

Other social impact from the TPIs, is the loss of agricultural areas, that are transformed into urban areas, and the diminishing care about the architectural and natural patrimony. Mainly these phenomena are due to

policies and plans that do not integrate rural and urban areas, and their interconnections. For these reasons, the social aspect in the TPIs has been incorporated specifically at local level and this has allowed a development of more efficient public participation strategies, although just with informative and consultative character, where the involvement of the community has allowed to correct many deficiencies of the proposal TPIs before been approved and put into action; to manage public expectancies, and also to give transparency to the elaboration and approval processes of the instruments.

In Chile there are 345 Municipalities. Most of them, 70% (240 municipalities) manage communes with less than 25.000 inhabitants; 37 municipalities attend to communes with less than 5.000 inhabitants and 48 municipalities lend services to communes with more than 100 thousand inhabitants. The information available for decision-making at local level used to be not equally available for each one of the 345 Municipalities, but nowadays these limitations have being rectified thanks to the development and massive incorporation of communication and information technologies, especially internet access, where the information has been standardized and frequently updated. This shows important improvements for the Chilean public administration compared with the last decade.

Land planning in Chile is developed on the base of the existing information that each Municipality and the MINVU provide to the consulting firm in charge of developing the TPI. If there is not enough information, it must be generated by the consulting firm according to the terms of reference of the contract. The social and demographic information of each one of the 345 Municipalities is available at the SUBDERE web page (http://www.subdere.gov.cl/1510/propertyvalue-26025.html) in the Communal File that can be found in the National System of Municipality Indicators (SUBDERE, 2005a).

In spite of the fact that this information can be considered as indicators, it does not constitute SDIs because they only constitute a database that sometimes is used as reference for decision-making, but it doesn't involve a holistic view of the territory and it only refers to demographic or social information. In addition, this information is not linked with environmental or economical related information. The following is an example for the Municipality of Santiago obtained from the Communal File of the SINIM web site.

Table 2. 4 General Information of the Municipality of Santiago

General Information (Antecedentes Generales)	
MUNICIPALITY (MUNICIPALIDAD)	**SANTIAGO**
MAYOR (ALCALDE)	Raúl Alcaíno Lihn
POLITICAL PARTY (REFERENTE POLÍTICO)	ILB
POLITICAL PACT (PACTO)	Alianza
ADDRESS (DIRECCIÓN)	Plaza de Armas s/n
MUNICIPAL PHONE NUMBER (TELEFONO MUNICIPAL)	2806000-2806031-2806032
FAX	6333927
WEB SITE (PÁGINA WEB MUNICIPAL)	http://www.munistgo.cl
EMAIL	santiago@munistgo.cl

Source: Communal File of SINIM web site

Table 2. 5 Complementary information of the Municipality of Santiago

Complementary Information (Información Complementaria)	
Geographical and Censal Information (Datos Geográficos y Censales) (Source Census 2002)	
Communal surface (superficie comunal en km2)	22
Inhabitants per km2 (habitantes por km2)	8.963,93
Communal population (población comunal)	200.792
Male population (población masculina)	99.155
Female population (población femenina)	101.637
Rural population percentage (porcentaje de población rural)	0,00%
Urban population percentage (porcentaje de población urbana)	100,00%
Percentage of population on the commune of the region (porcentaje de población comunal en la región)	3,31%

Source: Communal File of SINIM web site

Remainder available information refers to the Municipal Council, human and financial resources of the Municipality, public education and health systems of the commune, and poverty information.

As we can see, all the available data or indicators constitute very useful information that can be merged with economical and environmental local information about land use, in order to develop the needed indicators for sustainable land use planning. International experiences have shown that when the socio-economic development of a country is measured by a set of indicators covering the economy, the environment, the social sectors and the spatial aspects of development, policy decisions making and the monitoring of progress towards achievement of development goals, for instance, the Development Planning Unit Government of the British Virgin Islands (the DPU,

2005), that consider several indicators to monitor the progress of sustainable development, as it can be seen at its web site.

2.7 ANALYSIS

The main challenge that today faces the governments, from municipal levels to national, is to know how to design and to apply evaluation systems capable to manage, to promote and to reconcile the three large objectives that carry sustainable development: the economic growth, the equity (social, economic and environmental) and the environmental sustainability (Dourojeanni, 1997). For this it is necessary to understand that the ways to achieve this development are different for each country, in dependence of the way and level of development in which they be found.

2.7.1 Institutional problems

In the Chilean case an additional complexity is given, because there are several responsible governmental managing entities related to land planning, in consequence, sometimes too many stakeholders appear (Municipalities, Regional Government, Two Ministries separately acting or in conjoin as a part of a commission, and CONAMA). The sectorial administration sometimes impedes to improve the same programs with the same objectives, but that are developed by different governmental agencies belonging to the above mentioned institutions. These duplicities can be seen not only when programs (for instance urbanization, housing, pavement programs) are developed, but also when problems occur. In that case, the institutions are usually trying to be set free of responsibilities and the citizens hardly can identify whom and where to consult for their problems. Nowadays, inter-sectorial cooperation programs that seek for rectifying and improving that, in order to make a better use of human and economic resources, are undertaken. For instance, The Covenant of Technical Cooperation for the Incorporation of the Environmental Dimension in the Territorial Planning Instruments between CONAMA and MINVU (Sustentable, 2002).

With this Institutional reality, the adoption of principles of integral evaluation and management of the land (which can attenuate the practical difficulties of the land planning), become a very hard task to accomplish, since limited views and scopes impede the holistic assessment of the resource.

For the available planning instruments, the institutional difficulties are translated in three main facts:

a) First, the TPIs present a large institutional dispersion; some of them are develop by municipalities, other by provincial or regional governments.

b) Second, the concrete applicability, many of the instruments do not obey to a global policy, for the city or region.

c) Third, the lack of clarity regarding responsibilities per level of management (National, Regional, Provincial, Communal), does not allow the appropriate usage of the benefits of the vertical (top-down) articulations.

Additionally, the sector character or specificity of these instruments does not allow suitable responses with the nature of the urban problems, because since they are inter-sector, they need inter-sector solutions.

If we could plot the urban problems, we will realise something evident: it is impossible to overlap the problems and wait for them to coincide exactly in the same polygon, nor in the same politic-administrative unity. Thus, there is not sense looking for responses from the same and unique administration structure. A solution suppose to change the current administrative logic, in other words, it means the acceptations of the multi-sector nature of the urban problems.

Since CONAMA is not a Ministry, it is just a coordinator entity that has not power to oversee the actions of Ministries, Municipalities, and privates regarding land use, neither to create new laws in the matter. Thus, this entity cannot do so much about the environmental dimension in land use. Therefore, the environmental aspect in land planning is relegated to a previous assessment of projects or TPIs, what is called, strategic environmental assessment (CONAMA, 2005a).

At local level, there is not an integral system of land planning, which can lead to an inter-communal development. There are no integrated sectorial policies in a common scheme, and Municipal land planning strategies are not interconnected. All this leads to the decision-making process works under a short-term perspective (Schiappacasse & Muller, n.d.).

2.7.2 The lack of indicators

Chile has not yet a methodology to set up sustainability indicators to monitoring the policies, plans and programs regarding land use, at the moment the indicators used give mainly information about productivity, or economical matter, that is the case of The Degraded Soils Recovery Incentives Program of MINAGRI, which evaluates the economical benefits of the farmers, who have been beneficiated by this program. Also this Ministry has as indicators in the loss of area for agriculture actives, which is rural area converted into urban, which cannot be used for agriculture.

CONAMA, has several indicators regarding planning and land use, particularly related with plans and green areas. But, there is no link between these indicators to some analysis system or public policies assessment about the matter; they are published just for public information. However, they are the first step, since CONAMA wants to have an environmental indicators system, to contribute antecedents and goals about advances and challenges in the public management, they can be found in the web site: www.sinia.cl.

The MINVU is the state entity with most power, it sets laws and norms, and also control the development of TPIs, but there is not continuous monitoring or an information system about these instruments, they just work with previous analysis, and the way that they can learn about that is when their actions cause a great negative impact, "the hit warns" and it is manifested by the community, that is an informal and dangerous way of feedback, due to in territorial planning the changes are long-lasting and many of them have a irreversible character. For instance, in many times entire villages suffer from flood, every winter, because they are located in risk flood areas, that symbolized the lack of control and monitoring of activities regarding TPIs. Then, those extreme events can be used as feedback in land use planning (CEPAL & OCDE, 2005).

The development of a methodology that allows monitoring the TPIs, based on sustainability land use indicators would allow collecting dynamic information about the evolution of the territory, the population, the local economy, infrastructure developed projects, green areas, biodiversity, etc. All this information could be used to assess and eventually correct these instruments, by monitoring its conditions in time. Sustainability land use indicators will allow to feedback the whole process too, since it will permit to design reference terms and administrative bases for the following updates and adaptations of the TPI, based on the local and specific information above mentioned. Further, with this methodology, Integrated Territorial Planning Instruments can be developed as a local, regional, provincial and national medium-term objective. Integrated Territorial Planning could involve form the Urban Development Regional Plan (PRDU) to local TPIs as a Sectional Plan, by

incorporating TPIs guidelines and objectives in one monitoring strategy based on the sustainability land use indicators.

Finally, this methodology could help to develop long-term city planning, for instance, by visualizing the city we want in 30 more years as an objective-image, setting plans and projects to achieve the goals in time and using a Integrated Territorial Planning strategy based on sustainability land use indicators as a methodology to assess, correct and feedback the plans, project and even the first proposed goals. This would also allow identifying some weakness and future challenges according to the city evolution.

To achieve this proposal, we can take international examples such as the Integrated Development Plan (IDP) of Joburg 2030 (Malbert & Kain, 2004). This IDP framework is based on an overall vision for city development that contains a broad scope of sector strategies that are continuously guided and assessed by organized stakeholders named City Scorecards, and outreaching consultation efforts to constitute a strong platform for further actions towards what they call *Sustainable Urban Development*. In spite of all the existing difficulties we can find in the Chilean administration, territorial planning is an issue that can be undertaken and managed in a holistic manner, because there are institutions, resources, information and capacities able to develop this task that need to be standardized and coordinated in one strong methodology and long-term strategy. To underline this statement, International experiences will be presented in the next chapter.

CHAPTER 3 – PROPOSAL OF SDIs FOR LAND USE PLANNING IN CHILE

"Chile faces challenges similar to those of other countries worldwide. Its unique ecosystems, which range from the driest desert in the world to the southernmost temperate rainforests, have a high level of endemism and are considered an international priority for conservation".

Biodiversity Support Program..

In this chapter, an international review of sustainability indicators will be presented, especially in land use planning matter. The reason of that, as we saw in the past chapter is the lack of use of indicators for the Chilean institutions to assess and monitoring the different planning instruments, regarding sustainable development. And with those international experiences, a proposal of a simplified methodology to set up sustainability indicators that can be used for the territorial planning instruments in Chile will be offered.

The second part is to show examples of sustainable development indicators used in different countries or cities to monitor, they could give a clue about what type of indicators can be use by the different spatial scales, and territory characteristics.

3.1 METHODOLOGICAL FRAMEWORK

To obtain sustainable land planning in Chile, monitoring is needed. Therefore the development of SDIs has great importance in monitoring land use planning decision. Indicators can provide information needed to evaluate if decisions cause positive or negative impacts. As it is know, TPIs are important tools for regulating land use in Chile, and they must be monitoring constantly. Thus, decision-making process for land planners and policy makers can be improved by means of feedback TPIs, information systems and periodical data collection and analysis.

In order to support the decision-making process several frameworks to set up indicators has been developed. For instance The United Nations Organisation according to Agenda 21, has developed a core set of 58 indicators and a methodology to use for all countries to assess sustainable performance (UN, 2005). The indicators involved social, environmental, economic and institutional aspects.

For land planning according to The United Nations Conference on Environment and Development (UNCED), sustainability in land management has to cover five fundamental pillars:

1. **Productivity**: maintain or enhance production or services.
2. **Security**: reduce the level of production risk, and enhance soil capacity to buffer against degradation processes
3. **Protection**: protect the potential or natural resources and prevent degradation of soil and water quality
4. **Viable**: be economically viable

5. **Acceptability**: be sociable acceptable, and assure access to the benefits from improved land management.

Although these pillars are particularly refer to rural areas, they can be used as guidance to determinate the objective, scope and concern, of the TPIs. Indicators must be developed in order to monitoring if these objectives are being fulfilled by the decision taken regarding land use. The following figure ( )explains that the TPI is controlled by an governmental institution, depends on the territorial level, an the ITP sets the guidelines for the occupation of the territory. The next step is to construct a model based on the economical, social and environmental aspects. And it is where the indicators will be set up. Thus, indicators will give us the useful information about the evolution of that aspects within a given region, province or commune.

That information will be used to construct **the perceived state of the territory**, which will be compared with the **development objective**, which is what we want as territory. With that comparison we can estimate if the social, environmental and economic aspects of the region are in concordance with what we want. How indicators will be settled regarding land planning, we can formulate improvements in it or modification if there are problems or lack of control of certain activities. And, also it allows us to know what are the strengths in the model and the TPI. What finally will become the feedback, what is the information suitable for improving, updating and monitoring the TPIs.

The detailed explanation of each step will be presented below, and it will be divided in three steps: the construction of the image objective, the DSPRI framework for setting of indicators will be offered, and a criterion for sustainability indicators selection will be presented.

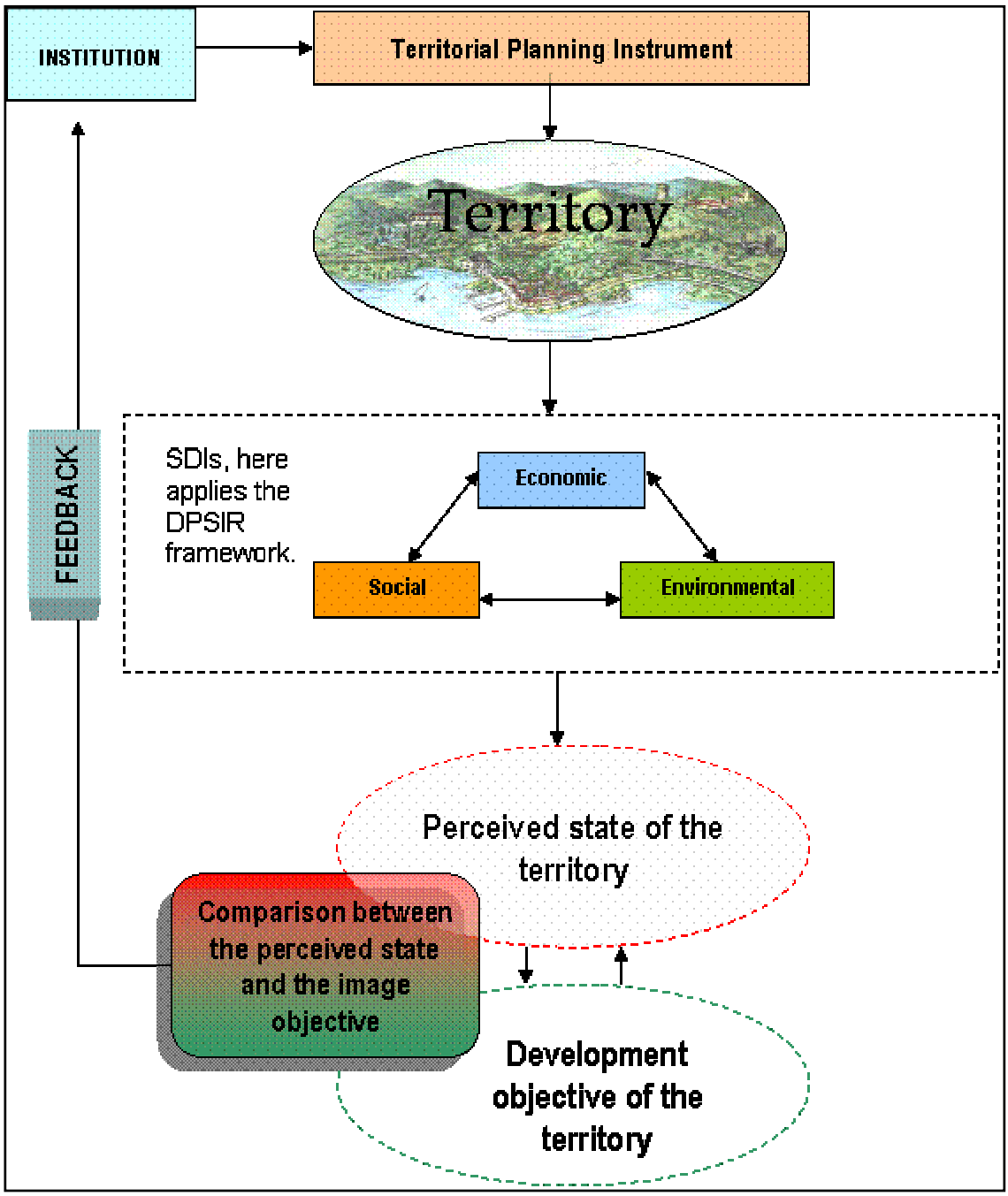

Figure 3. 1 General framework for setting up indicators in TPIs

The first step to setting indicators is to develop a model of what is wanted (**development objective of the territory**). That is what we want to have as region. At the most basic level, the region must provide services, infrastructure, productive activities, in order to support that the basic needs of the community can be satisfied. Here TPIs can be referenced, they must drive and control the land use in the region to these needs can be met. Here a special reference of Max-Neef (1986) work, will be presented, he suggests there are nine basic human needs: subsistence, protection/security, affection, understanding, participation, leisure, creation, identity/meaning and freedom.

Therefore, sustainability in land use can be understood as the way that we can meet these needs with land use planning for all members of the community (**Table 3.1)**. And those basic needs for land planning can be interpreted as:

Table 3. 1 Land use planning and human needs.

SUBSISTENCE	Ensure sufficient food production, and the development of economical activities, also connectivity to create trade e.g. roads systems, communication, harbors etc.
PROTECTION	To provide housing, avoid human settlement on risk areas.
AFFECTION	To build places for personal interrelationships, for example, squares, and parks.
UNDERSTANDING	Enough schools and educational building to cover the need for education for all community members.
PARTICIPATION	To develop tools for public participation in land use planning matter.
LEISURE	Develop and protect areas for enjoyment and relaxation, such as, green areas, squares, park, and to conserve areas of natural value.
CREATIVITY	Allow the construction of places for cultural development, such as theatres, cinemas, stadiums etc.
IDENTITY	Preserve the characteristics of the regions, that is for both, the natural system, preserving ecosystem, and the human-made system, to protect the architectural values of buildings.
FREEDOM	To regulate the land use, drive the occupation processes, but not set strict prohibition of activities.

Source: Self-elaboration

Therefore, the image objective of the region can be constructed in a basic level for the previous human basic needs. It must be considered that these necessities can be fulfilled in different ways according with the cultural characteristics of the society, and the historical period.

3.1.1 The DPSIR Framework

The second task is set indicators that can be measure if the real state of the region, is similar with the image objective. The success of setting up indicators depends on the methodology used for the analysis and selection of appropriate indicators. For this exercise The Driving Forces, Pressure, State, Impact, Response Framework DPSIR, will be used.

The DPSIR framework was developed by The European Environmental Agency (EEA), which explains the relation and interrelation between environmental monitoring and indicators. It should be noted that this framework is related to "policy-making", and it addresses various aspects, which are also of relevance for monitoring the environmental effects of plans and programs (Barth & Fuder, 2003). A very brief overview of this framework will be given, while it is impossible to describe the complex scientific discussion in detail (Barth & Fuder, 2003).

According to the DPSIR framework, social and economic developments can exert pressure on the environment, which leads to a change in the state of the environment. As a result, impacts on human health, the environment and other goods occur (Barth & Fuder, 2003). A description of the DPSIR framework is presented in the next table (**3.2**).

Table 3. 2 Description of the DPSIR framework

The framework assumes cause-effect relationships between interacting components of social, economic, and environmental systems, which are:	
• **D**riving forces of environmental change	Describe the social, demographic and economic developments in societies and the corresponding changes in life styles etc. (e.g. agriculture, tourism, urbanism)
• **P**ressures on the environment	Describe developments in release of substances, physical and biological agents, the use of resources and the use of land. (e.g. changes in land use, illegal occupations)
• **S**tate of the environment	Give a description of the quantity and quality of physical, biological or chemical phenomena in a certain area. They may, for instance, describe the wildlife resources. (e.g. soil erosion and pollution, land degradation)
• **I**mpacts on population, economy, ecosystems	Are used to describe, which impact results from the driving forces. (e.g. diminished agriculture productivity, natural areas loss)
• **R**esponse of the society	Refer to responses by groups and individuals in society, as well as government attempts to prevent, compensate, ameliorate or adapt changes in the state of the environment. (e.g. land protection, modifications in the TPIs)

Source: modified from CEROI (2003)

3.1.2 DPSIR framework in relation to land use planning

The aim of managing land resources is to safeguard human needs, economical activities and terrestrial ecosystems. It is, therefore, important to quantify and identify the current state of, and impacts on, land use and how these are changing with time. In land use assessment at different levels, the following generic questions could be asked:

State of land use

- How is it being used? (Urban, rural, preserved areas, forests, etc)
- How much is there? (Areas per use of the land, availability for potential activities, demands, etc)

Time trends

- State over time (urbanization process, illegal occupation development, etc?)
- Within or outside agreed limits?

What is causing the problems?

Pressures on the land use

- Human - domestic
- Industrial
- Agricultural

State of Action on policies

- Is the TPI working towards targets?

The DPSIR model can be used as an analytical framework for assessing land use issues. This allows a comprehensive assessment of the issues through examination of the relevant **D**riving forces and **P**ressures on the environment, the consequent **S**tate of the environment and its **I**mpacts, and the **R**esponses undertaken, and of the interlinkages between each of these elements. A generic DPSIR framework for land use is shown in **Figure 3.2**, it is a modification from the framework used by Kristensen (2004).

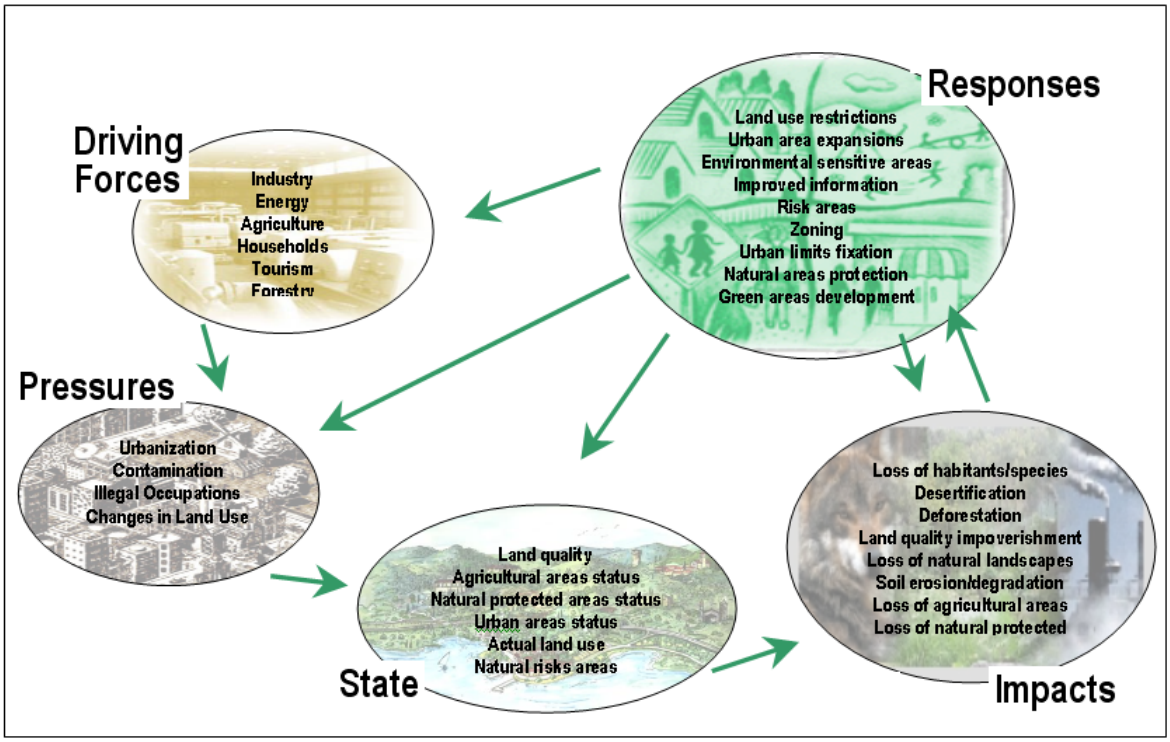

Figure 3. 2 A generic DPSIR framework for land use.

Source: modified from Kristiensen (2004)

The state of land use is determined by natural factors such as geology and climate and also by the pressures exerted by human activities. Many of the pressures and the underlying driving forces are common to all or a number of the issues. For example, agriculture is a significant driving force in terms of ecological quality, nutrient and organic pollution, and hazardous substances.

3.1.3 Criteria for indicator selection

According with the Organization for Economic Co-operation and Development, OECD (1993), there are three criteria for the selection of appropriate indicators, policy relevance, analytical soundness and measurability. And they are described in the following table (**3.3**).

Table 3. 3 Criteria for set up indicators according to the OECD (1993)

POLICY RELEVANCE AND UTILITY FOR USER
• Provide a representative picture of environmental condition, pressures on the environment or society's response; • Be simple, easy to interpret and able to show trends over time; • Be responsive to changes in the environment and related human activities; • Provide an a basis for environmental comparison; • Be either national in scope or applicable to regional environmental issues of national significance; • Have a threshold or reference value against which to compare it so that users are able to assess the significance of the values associated with it.
ANALYTICAL SOUNDNESS
• Be theoretically well founded in technical and scientific terms; • Be based on international standards and international consensus about its validity; • Lend itself to being linked to economic models, forecasting and information systems.
MEASURABILITY
• Readily available or made available at a reasonably cost/benefit ratio; • Adequately documented and of known quality; • Updated at regular intervals in accordance with reliable procedures.

Source: modified from OECD (1993)

The indicators for the TPIs should focus on preventive maintenance of environmental condition, social welfare, and economical growth, to provide all information needed for and continuous monitoring of the TPIs, integrating the socio-economic and environmental information that is required for better-informed sustainable land use planning strategies.

For policy makers, or in that case, land use planners, indicators nor only have to provide information about the state of land use, they need information about on performance and efficiency as well. These indicators respectively describe if we are improving in the issues, and if it matters, that is to describe if the actual use is right or wrong.

Efficiency indicators present information that is important from environmental, social and economic point of view. "Do more with less" is not just a slogan for environmentalist. It is also a challenge to governmental institutions, private investors and researchers (Smeets & Weterings, 1999).

Performance indicators monitor the effects of policy measures. They indicate whether or not targets will be met, and communicate the need for additional measures.

In the following point a review of international experiences is presented. What is looked there is to show an example of which type can be used for monitoring land use planning, and the influences from the TPIs. Many of the indicators presented are related with more environmental aspects than land use, but anyway they constitute an approach in the issue.

3.2 INTERNATIONAL EXPERIENCES

In this part a review of international experiences in setting sustainability indicators, is presented, a special focus will presented in land use. The objective of that is to have an idea of what is being used in other cities as indicators. Although not all the indicators presented are specifically related with land use, they can give an approach of indicators for sustainable development.

3.2.1 The Belgian experience

The description of the international and national situation for the various sustainable development themes of the federal report on sustainable development in Belgium has been compiled by using some 80 indicators. The indicators were chosen from a number of lists (Organization for Economic Co-operation and Development OECD, United Nation – Commission on Sustainable Development CSD, and the federal planning bureau), and if needed indicators were added from various sources (BFP, 2005).

The following table (**3.4**) shows the types of indicators are used in the Belgian indicator system. The distribution of SDIs from the table was made with 4 types of the DPSIR framework; the type "Impact" is included in the type "State". Thus, each ISD is regarded to a driving force, or a pressure, or a state, or a response.

Table 3. 4 SDIs used by the Belgian Government

	INDICATOR
DRIVING FORCES	
Demographic	Population per gender and age
	Number and household structure
Economics	GPI
	Consumption of eco-labelled products
	Products according to environmental and social standards
	Consume and production of renewable energy
	Pesticide consumption
	GM food production
Interrelation between economic and social aspects	Energy consumption per person
	Water consumption per person
	Energy intensity
	Transport intensity

Table 3. 4 SDIs used by the Belgian Government – continuation

PRESSURE	
Social	Work hours per economic sector
	Work stress
	Smokers per gender and educational level
Environmental	Greenhouse gasses emissions
	Atmospheric pollutants emissions
	Heavy metal emissions into air and water
	Nitrogen emissions into water
	Municipal waste production
Economic	Investment from privates and public administrations
	Financial investment
STATE	
Social	Poverty
	Employment
	Unemployment
	Long lasting unemployment
	Life expectancy at the birth and life expectancy in good health
	Asthma prevalence in children
	Asbestosis cases
Environmental	Endangered species
	Commercial fish stocks in precaution
	Concentrations of ozone precursors
Economic	Net stock with fixed capital
	Debt of households
	Debt of the public administrations
RESPONSES	
Federal strategy of SD: Contents, Implemented and Quality	Contents of the federal Plans of SD: classification of measurements of the two foregrounds according to topics
	Implementation of the 1st Plan
	Reactions of the organizations of the civil company to the public investigations on the federal Level of SD
Budget / Public Finances	Expenditure of R&D financed by the authorities
	Expenditure of social security
	Receipts of social security
	Expenditure for the environmental protection
	Environmental receipts
	Expenditure for the official Development aid

Source: BFP (2005)

The early indicators were detailed in a series of variables, which explain in detail the data needed, for example the indicator "number and structure of houses" has a set of variables: population, number of person per house, house average taxation and proportion of households of a person.

Even though these indicators are not totally related with land use or territorial planning, they can be utilized by the administration to assess the state and the sustainable performance of a region at different scales, in order to guide the TPI to a sustainable planning, and to evaluate if these instruments are suitable to the strategy of development of the region, in meaning of goal accomplishment.

3.2.2 The Bavarian Experience

Regional Monitoring in the Field of Land-Use Planning and Spatial Planning in Bavaria, Germany.

A monitoring system, which works with two different sorts of descriptive indicators, is used in the sector of regional monitoring in Bavaria. Regional Monitoring has been conducted since 1972, based on the Regional Planning Act, which provides for the collection and evaluation of major regional facts and data. The Bavarian legislation also requires that the government reports every four years to the Parliament on the implementation of the regional development plan. Monitoring is conducted with the help of the Regional-Information-System (RISby), which deals with the following aspects:

1. Show regional development disparities
2. Discover different trends
3. Show interdependencies
4. Assess political measures

For the identification of different trends, indicators for driving forces are used which show for example developments in demographic issues such as population growth in a certain area, a rise in unemployment etc. Response indicators are being employed for the assessment of political measures. They provide information on the effects of certain measures, e.g. subsidies for enterprises, which operate in those parts of a country with less well-developed infrastructure etc.

The following table (**3.5**) shows a series of environmental indicators developed by the Bavarian Environmental Protection Agency with special regard to the strategic environmental planning of the Bavarian State Ministry of Regional Development and Environmental Issues. The Driving–Pressure-State-Impact-Response (DPSIR) framework of the European Environmental Agency (EEA) was used for the indicator classification and for the description of the coherences between the environmental problem fields and the responsible driving forces (sectors) along the causal chain. The selection criteria are the following: Availability and quality of required data, relevance (time, spatial, factual reference), coherence to environmental problems, orientation to policy targets, sensibility of remedial actions, suitability for communication, compatibility with other indicator sets and suitability for assessment and valuation (Barth & Fuder, 2003).

Table 3. 5 SDIs used in the Bavarian experience

FIELD	IMPACTS	INDICATORS
Nature and Landscape	Loss of natural and biological diversity, impacts on ecological processes and the landscape	Areas reserved for nature protection
		Farming preserving nature
		Endangered species
		Fragmentation of areas
Ecosystems	Impacts on ecosystems, eutrophication, acidification, accumulation of hazardous substances	Biological water quality of rivers and streams
		Development of atmospheric input of hazardous substances
		Nitrate contamination of groundwater
Climate	Anthropic climate change with impacts on ecosystems, economy, social conditions (e.g. human health)	Carbon dioxide emissions from energy use
Human Health	Impacts and risks on human health caused by substances, noise, radiation	Air quality index regarding NO2 , SO2 , CO, O3 and PM10
		Development of noise emissions caused by road traffic
		Index of hazardous substances in human milk
Resources	Lack of resources (soil/land, energy and raw materials) with economic, ecological and social impacts (sustainability)	Land take for settlement and traffic
		Primary energy consumption and ratio of renewable energies
		Companies operating environmental management systems (EMAS)
		Amount of urban waste and recycling ratio

Source: Barth & Fuder (2003)

According to The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL), the Bavarian approach is a very helpful tool for obtaining the data necessary for an effective monitoring. It mentions however that the system might need to be extended on areas which have not been integrated so far. Another problem area was identified regarding the availability of data on the local level of communities, since the system works with a lot of data obtained on a regional or federal state level.

3.2.3 The Municipality of Nauen Experience

Monitoring in land use planning – Project of a "Model SEA" of the Municipality of Nauen, Brandenburg, Germany

This project has as aim to investigate if landscape planning is a suitable instrument for fulfilling the Strategic Environmental Assessment (SEA) Directive requirements. The purpose of the SEA-Directive is to ensure that environmental consequences of certain plans and programmes are identified and assessed during their preparation and before their adoption (European Commission, 2005) Thus, the project team drew up an environmental report for a land-use plan of the municipality of Nauen in Brandenburg based on the landscape plan.

The environmental objectives of the SEA Directive have been related to suitable indicators. The environmental report makes use of environmental quality objectives. With the help of national and environmental quality objectives of overriding importance it has been possible to develop specific ones for the municipality of Nauen.

The proposed monitoring measures were based on the following criteria:

1. Cost-efficiency
2. No specific knowledge necessary for data collection
3. No special equipment necessary for data collection
4. Meaningful data
5. Ability to show trends
6. Reproducibility and accuracy
7. Possibility of easy information and data transfers
8. Use of existing data
9. Availability of background values

Two ways were used to collect the data needed. On the one hand, the Federal State, environmental authorities, and environmental organizations collected the data. The municipality was responsible for requesting the data regularly. On the other hand, the Municipality is obliged to collect and process the relevant data itself. The aim was to promote environmental education in schools and to raise the population's interest in the objectives and problems of land use planning (Barth & Fuder, 2003).

The approach aims at creating a monitoring system, which is apt for investigating whether or not the environmental quality objectives are being fulfilled. In the following table (**3.6**) the detailed monitoring arrangements for two environmental objectives is presented.

Table 3. 6 SDIs used in Nauen

ENVIRONMENTAL OBJECTIVE	**CLEAN AIR**	
Data source	**Existing data**	**Data to be collected**
- Air quality net of Nauen in Brandenburg - Annual air quality report - Nature association (NGO)	- Ozone, NO - Floating dust - Arrival/ departure of crane and stork	Observation of potential changes in urban climatic conditions / establishment of spot-check areas in different parts of town: Indicators: blooming of flowers, sprouting of trees - Observation of lichen (indicator of SO) - Observation of singing birds.

Table 3. 6 SDIs used in Nauen – continuation

ENVIRONMENTAL OBJECTIVE	SUSTAINABLE USE OF SURFACE WATER	
Data source	**Existing data**	**Data to be collected**
- Public health department - Water quality inventory - Fishing association	- Existence of blue-green algae and coli - Water quality (bio indicators) - Classification according water quality classes - Occurrence, kind and number of sensitive/rare species	Observation/measurement - Water level (spring, summer, autumn) - Medium annual draining off. - Examination of water samples as regards indicators like algae - Water measurements concerning pollutants.

A criticism of this project is that the model-cause study used, aims monitoring the completion of the environmental objectives at first place. Monitoring, in this case, must to concentrate on the implementation of a plan or program and theirs significant environmental effects, instead of measure the achievement of general environmental goals ((Barth & Fuder, 2003). Indicators on the fulfilment of the environmental objective might result in information, which can be useful for monitoring, but it is not the genuine aim of monitoring the environmental effect of a plan or program.

3.1.4 The Heinz Center Approach

Other interesting approach for setting indicators on land uses, was developed by the h. John Heinz III Center for Science, Economics and the Environment, for the Project *The State of the Nation's Ecosystem*: *Measuring the Lands, Waters, and Living Resources of the United States,* which presents a set of indicators for ecosystem such as forests, farmlands, grasslands, coasts oceans within others. And, also for what is important in land planning, urban and suburban areas. These indicators describe the overall dimensions of these systems, their chemical and physical properties, their biological components, and the goods and services people derive from them. They focus on the condition of ecosystems, rather than on what forces might be acting to change them, or actions taken by government or the private sector (The Heinz Center, 2002).

For Urban and Suburban areas, the set if indicators are based in four aspects: System dimensions, chemical and physical conditions, biological components, and human uses. And they described the trends in land use, land cover, and ecological setting between urban and rural environment. And they are presented in the table **3.7**.

Table 3. 7 Indicators from the Heinz Center

SYSTEM DIMENSIONS		**CHEMICAL AND PHYSICAL CONDITIONS**	
Indicator	**Description**	**Indicator**	**Description**
Area of urban and suburban lands	How much land do "urban and suburban areas" occupy? How much of this land is developed, and how much is forest, grasslands and shrublands, wetlands, and croplands?	Nitrate in urban and suburban stream	How much nitrate is found in urban/suburban streams?
Suburban/rural land use change	How are patterns of development changing at the boundary between suburban and rural areas?	Phosphorous in urban and suburban stream	How much phosphorus is found in urban/suburban streams?
Patches of forest, grassland and shrubland, and wetland	How large are urban/suburban forests, grasslands and shrublands, and wetlands, which provide green space and wildlife habitat?	Air quality (high Ozone levels)	How common are air pollution levels that exceed federal guidelines in urban/suburban areas?
Total impervious area	How much urban/suburban land is covered with buildings, concrete, asphalt, and other "hard," or impervious, surfaces?	Chemical contaminatio n	What levels of artificial compounds and heavy metals are found in water and soil?
Stream bank vegetation	What fractions of urban/suburban stream banks are vegetated?	Urban heat island	How much hotter are urban/suburban areas than less developed areas nearby?
BIOLOGICAL COMPONENTS		**HUMAN USES**	
Indicators	**Description**	**Indicator**	**Description**
Species status	How many of the plants and animals that once inhabited areas that are now urban/suburban are locally at risk or absent?	Publicly accessible open space per resident	How much public open space is there per urban/suburban resident?
Disruptive species	Are there more or fewer "disruptive species" such as white-tailed deer and Scotch broom in urban/suburban areas?	Natural ecosystem services	What other important ecosystem services are provided by urban/suburban areas?
Status of animal communities in urban and suburban stream	What is the condition of fish and bottom-dwelling animals in urban/suburban streams?		

Source: the Heinz Center (2002)

In this case, the indicators show information about the environmental conditions in urban areas, and in suburban areas, allowing made comparison between them. It also allows analyses trends in the occupation of the land, and the environmental condition of the urban areas and its periphery.

CHAPTER 4 - CONCLUSIONS

Sustainable land planning is the use of land to meet changing human needs (agriculture, forestry, conservation), while ensuring long-term socioeconomic improvements and environment preservation. Its objective is to harmonise the complimentary goals of sustainable development, providing environmental, economic, and social opportunities for the benefit of present and future generations, while maintaining and enhancing the quality of the land resource.

Thus, an optimal use of this important resource is needed, which can assure that these activities can be developed in concordance with the needs of the community and the respect of the nature. To reach this, a clear previous land use planning is indispensable, and also a monitoring system of the occupation and land use is equally needed.

Government takes and important role to control the occupation process of the land. To do so, as it said, monitoring is an important aspect, and therefore the development of indicators for the sustainable development on the land use and its planning are an fundamental issue for the optimization of the use of this resource.

Economical activities and social "processes" can be improved with the use of sustainability indicators. It has relation with the optimization of the use of natural resources, their availability and their relation with other activities, for instance biodiversity preservation can promote tourist activities and also orientating the control of pollutants. Finally, another important advantage of the use of sustainability indicators is that they could help to delimitate the aims and uses of the land according to its load capacity and the existing demand of it.

For many developing countries, monitoring governmental decisions on land use planning is a challenge. Moreover, the development of sustainable development indicators is a new and complex task for land managers and governmental institutions.

Land use planning in Chile is regulated by several factors, which include ministerial policies and laws, specific national, regional, or local governmental initiatives, and private investors. Thus, in many cases, appear institutional problems in decision making, due to the different interest that some ministries have on land use, what sometimes difficult to development of a clear land use planning.

One of the deficiencies on land use planning in Chile, is that the government and its institutions still have not developed a formal monitoring process for land use planning from a sustainable development point of view. That means, integrating economical, environmental and social aspects. But, there are important approaches in setting environmental indicators of land use, that is case of the SINIA initiative of CONAMA, where a series of environmental indicators can be found.

At regional and local levels, the main tools for land use planning in Chile are the territorial planning instruments, (PRDU and PRC, respectively). They define, and regulate the land use occupation processes. But to develop these TPIs, just a previous analysis of the land conditions and uses is required. Chilean institutions still not have a formal monitoring procedure or methodology to assess the impacts of the region provoked by those TPIs.

The DPSIR framework (Driven forces, Pressures, State, Impacts, Responses) can be a clear and useful methodology to set up sustainable development indicators on land use planning in Chile, specially referred to a territorial planning instrument. Due to this methodology is a tool especially developed for policy makers, which allows evaluating policies, norms and institutional initiatives with and sustainable point of view.

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