SOCIO-ECONOMIC INEQUALITIES AND THE INEQUITABLE DISTRIBUTION OF ENVIRONMENTAL RISKS IN CHILEAN METROPOLIS LOCAL SPACES: A PERSPECTIVE OF ENVIRONMENTAL JUSTICE

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INTRODUCTION

The predominant model in Latin American cities is that of the Fragmented City, characterized by complex, and more and more heterogeneous, urban landscapes, where the physical distance between the spaces occupied by the different socio-economic groups has been reduced in the last few years, adopting new symbols and meaning. These new forms and magnitudes of social and space segregation have their greater expression in reduced scales of analysis (Borsdorf *et al*, 2006; Hidalgo, 2004), or local spaces. In the case of Chile, these spaces correspond to several communes that conform metropolitan areas of the larger cities.

On the other hand, the development of the cities in Latin America has not considered conveniently environmental degradation, and has constructed infrastructures without considering sufficient criteria of security against natural threats and risks that, due to a process such as climate change, would generate situations that are completely different to those experienced at present. That is to say, there has existed an inadequate process of the appropriation of nature, a high vulnerability of the poor population and great inequality in the distribution of income (Lavell, 1999). For this reason, it does not seem strange that 90% of

the victims of natural disasters live in developing countries, under high-risk conditions (Vargas, 2002).

Market mechanisms, accepted and applied without restrictions in countries like Chile, are highlighting an increasingly exclusive appropriation, commodification and privatization of the more valued spaces within the cities (Romero y Vásquez, 2007). In this sense, it is assumed that the distribution of the population in the urban spaces, and therefore their accessibility to quality environments and

greater security when facing risks, is more and more strongly conditioned by the level of income of each social group. Therefore, lower income groups end up acceding to the more environmentally degraded zones that are more contaminated and that present greater threats than the rest of the city and, therefore, settlements are formed that concentrate greater degrees of vulnerability towards environmental dangers or worse effects on the people and ecosystems health (Romero et al., 2008).

Evidence exists that in diverse cities the negative environmental effects caused, for example, by the deposits of toxic waste, are not distributed homogenously in the population, instead one can observe an overload of these problems in sectors inhabited by communities of low income or pertaining to some ethnic minority (EPA, 2002; Krieg and Faber, 2004; Fisher *et al*, 2006). Additionally, records exist to suggest that, as with the negative environmental effects, the favourable environmental functions, like those granted by the vegetation, are also asymmetrically distributed in the population (Pedlowski *et al*, 2002; Iverson and Cook, 2000; De la Maza, 2002; Escobedo *et al*, 2006). They are scarcer in the poor sectors, which, at the same time, are the most deteriorated by cumulative environmental impacts. Among the environmental services rendered by the vegetation in the cities can be found; regulation of the climate, improvement of the air quality, provision of habitat to biological species, elevation of the aesthetic quality, and finally, the favouring of the infiltration of rainwater in the ground, thus diminishing the volume of superficial draining and floods (Pedlowski *et al*, 2002). All these functions have demonstrated to be

effective in the decreasing the vulnerability of the inhabitants of the cities facing environmental dangers such as extreme heat and flooding.

The occurrence of disasters and human exposure to the environmental risks rather than being the result of a "punishing natural environment" seem to be the result of the social configuration of the vulnerabilities. As Hipple (2007) indicates, the risk social configuration is a key concept for the reduction of natural disasters . In this sense, the risk must be understood based on its two central components: I) threat or potential danger and II) vulnerability when facing said dangers. In other words, for risk to exist, there must exist a condition of threat to which an entity/something/someone is exposed and vulnerable; it is not possible to be vulnerable if there is no threat and the threat is non-existent if there is no vulnerable system (Cardona; 2001).

When incorporating the notion of vulnerability as a component of the risk, it finally entrusts responsibility to the society faced with the occurrence of disasters. Therefore, one talks of socio-natural disasters when referring to events that are products of the selfsame social system.

In Chile almost nine out of every ten people live in cities (INE, 2002). In the last few years, the metropolitan areas of Santiago and Concepción have increased their size and the speed of their physical growth (Romero y Vásquez, 2007; Romero y Vásquez, 2005a; Romero y Vásquez, 2005b) although their rates of population increase have decelerated. The maintained application of neoliberal premises to the management of urban territories in Chile shows clear signs of un-sustainability after more than thirty years. The limitless growth of the urbanized areas, the fortification of the socio-environmental segregation, and the increase of the differences of environmental quality in the areas and landscapes occupied by the rich and poor strata of the urban population, constitute manifestations of un-sustainability. Recent studies have demonstrated how the spaces occupied by poorer people that belong to Socio Economic Groups (SEG) D in the city of Santiago, are the most exposed to extreme heat, elevated concentrations of particulate matter in the atmosphere

and lack of vegetated spaces (Vásquez y Romero, 2007a; Vásquez y Romero, 2007b)

STUDY AREA

The Commune of San Pedro of La Paz

The commune of San Pedro of La Paz belongs to the Great Concepcion, Bio-Bío Region, located in Southern Central Chile. This commune is located to the South west of the Bio-Bío River, 36º50' Latitude South and 73º05' Longitude West. It is made up of a 112.5 km2 surface area which includes 14 km of coastline, 22 km of riverbank and two natural lagoons (figure 1).

According to the data of the last Population and Housing Census from 2002, San Pedro is one of the most populated communes of the 52 which form part of the region of the Bio-Bío amassing a total population of 80,447 inhabitants, 99.6% of whom live in urban areas. It is important to emphasize that, in recent years, this commune has been receiving important contingents of population originating from other communes of the Metropolitan Area of Concepcion, of the Bio-Bio region and from other zones of the country. As a result of the population increase that the commune has experimented, diverse real estate projects of residential activity and infrastructure have begun to occupy hill sectors next to the Great and Small lagoons of San Pedro and the coastal wetlands and dunes

Commune of Peñalolén

The commune of Peñalolén, one of the ten communes of greater territorial extension in the province of Santiago, has a surface area of 54.9 Km2. Of the total surface of the commune, 58.6% is considered urban. The geography of the commune can be classified in three zones: i) the valley below the San Carlos canal, with an average height of 560 meters above sea level (m.s.l.); II) the zone that runs from the San Carlos canal to the San Ramon Fault, at 900 m.s.l., where High Peñalolén and the Cousiño Macul vineyard are found and III) the zone that runs from the Fault to the summit of San Ramon

Hill, at 3000 m.s.l.,, where the Peñalolén and Macul streams ar e located (figure 1). In 2002 Peñalolén housed 216,060 inhabit ants, placing it within the twelve most populated communes in the country and in sixth position in relation to the Metropolitan Region of Santiago. According to the INE forecast for 2007 the population would increase to around 240,032 inhabitants.

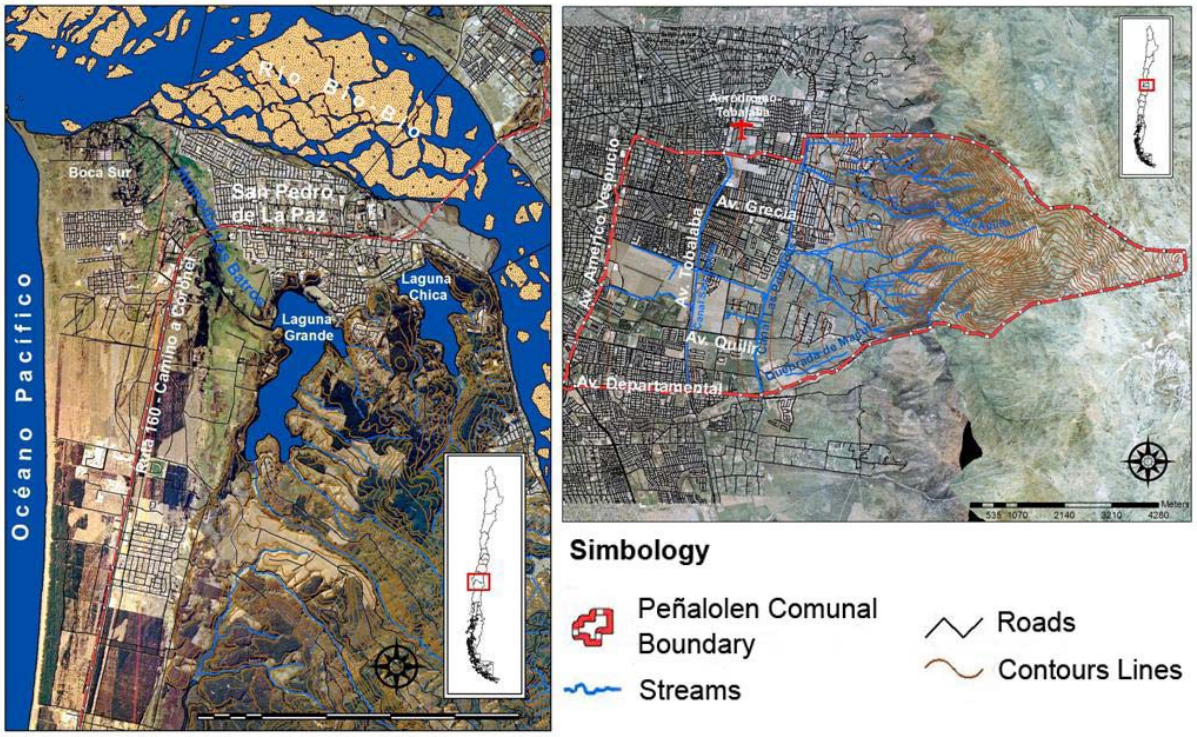

Figure 1: The Commune of Peñalolén and San Pedro of La Paz.

Source: Own elaboration

OBJECTIVES

To evaluate and analyze the spatial interrelationships between the distribution of environmental hazards and the socio-economic levels of the population, in the communes of Peñ alolen and San Pedro de La Paz, considered representative of the metropolitan areas of Santiago and Concepcion, respectively. Secondly, to analyze the distribution of the environmental hazards and their relationship with some of the mechanisms that act on the physical vulnerability of socio-economic groups.

METHODOLOGY

To obtain the block-by-block socioeconomic status of the population, information from the 2002 National Institute of Statistics Census of Population and Housing was processed through the REDATAM +G-4 computer system. The socio-economic classification used considers the educational level of the head of the house and the quantity of goods (wealth) each household possesses (Adimark, 2002).

To identify environmental hazards, risk studies of regulatory plans of both communes were used. The coverage used was that that corresponded to threats of flooding, water-logging and landslide. In San Pedro de la Paz information on the threat of tidal flooding, wind deflation, discharge of polluted water and unauthorized solid waste landfills was also considered.

To relate the spatial distribution of environmental hazards with the areas occupied by different socio-economic groups exposed to the negative environmental impacts being considered geo-processing procedures.

Finally, a description of the mechanisms that act on the physical vulnerability of the SEG, considering, above all, the distribution of public green areas and civil works for flood control in the commune of Peñalolén, was made.

RESULTS

Distribution of environmental hazards according to socio-economic groups

Figure 2 shows the spatial distribution of natural hazards in both communes. It is noted that much of the territory is under some threat, mainly due to the location in areas where geophysical processes occur with great force. In the case of Peñalolén this bas ically involves the effects caused by matter and energy flows that are moving downstream from the Andes, heading

towards the Intermediate Depression or Santiago Valley, primarily through a large number of streams that exist in the Andean foothills.

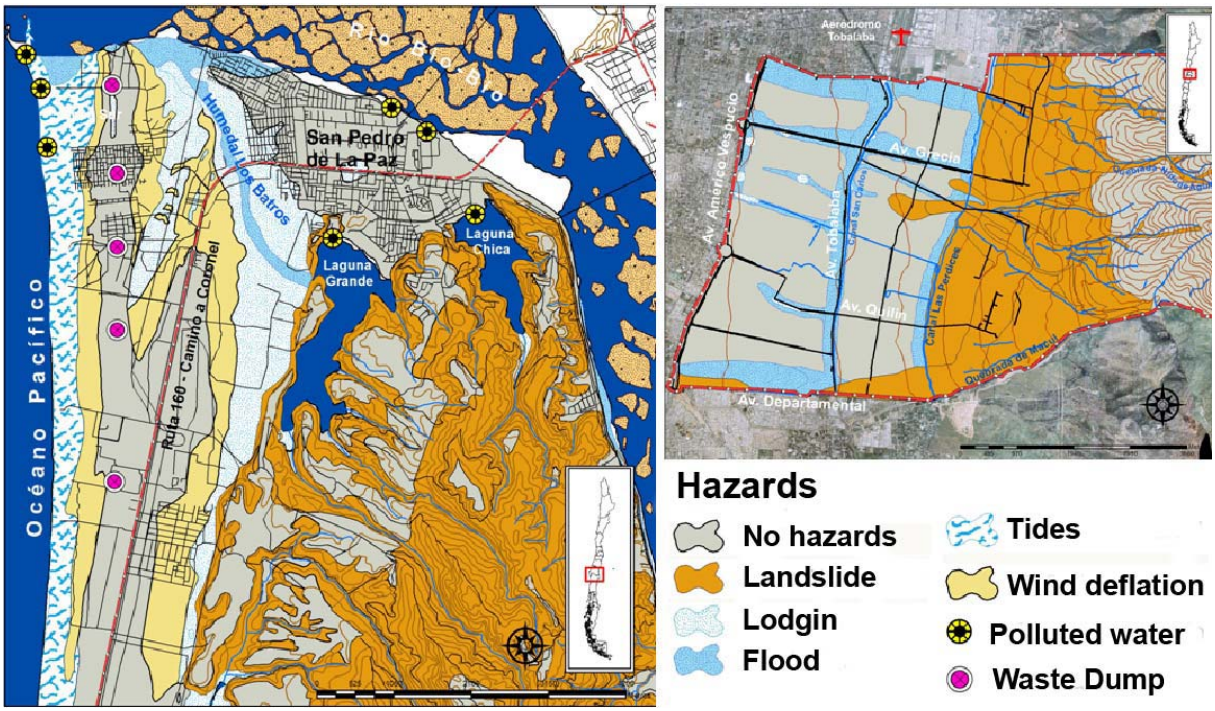

Figure 2: Distribution of threats in the communes of San Pedro de la Paz and Peñalolén.

Source: own elaboration based on Communal Regulatory Plans and data from the EULA Centre of Environmental Sciences of the University of Concepción.

San Pedro, on the other hand, is dominated by the oceanographic processes of the coast of the Pacific Ocean and the dynamic hydrological system Laguna Grande, Laguna Chica and Los Batros Wetlands, which manifests itself in a more diverse range of environmental threats

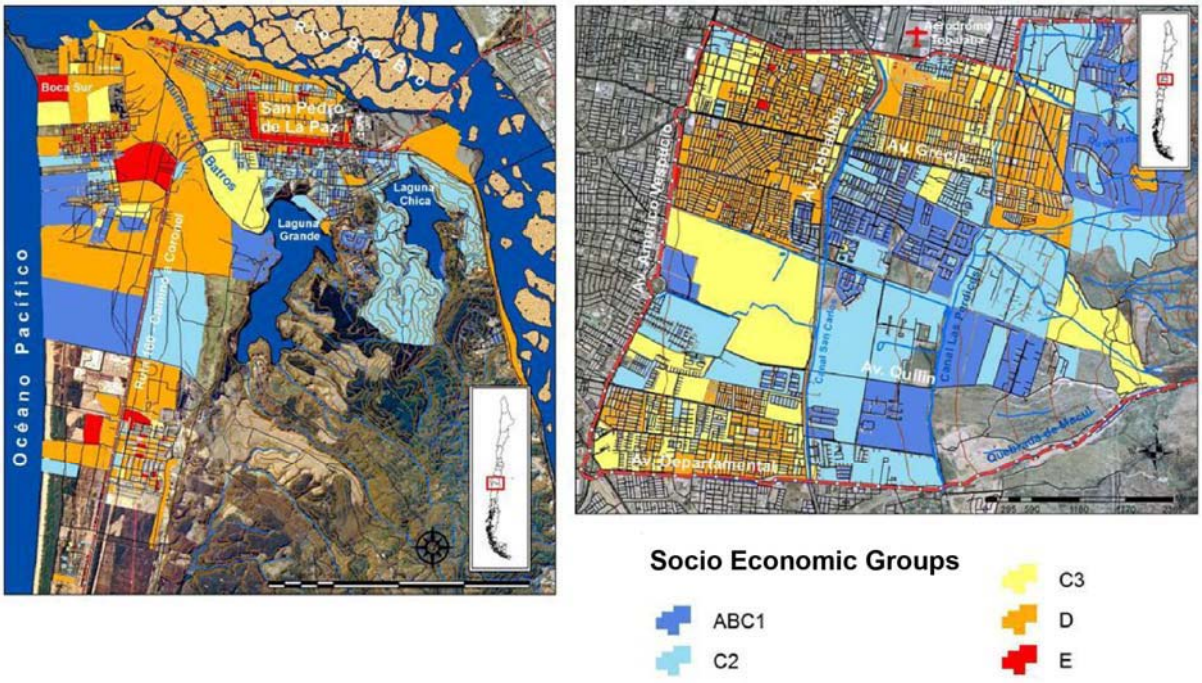

Figure 3: Distribution of SEG in the communes of San Pedro de la Paz and Peñalolén
Source: Own Elaboration

In San Pedro the arrival of high-income residents (ABC1) has also been recent and it has been focused in the areas near the lagoons, where the environmental amenities associated with them are concentrated. Also, the coastal area that was initially occupied almost entirely by low SEG (D and E), has attracted new building projects for the more wealthy people.

In the case of San Pedro, if the location of illegal landfills is related to levels of socio-economic population, we can see that although they are distributed in a linear fashion across six kilometres (Figure 4), they are never found in areas inhabited by the richest SEG. By contrast, the location of these waste deposits has a high correspondence with the spatial distribution of lower-income SEG (D and E).

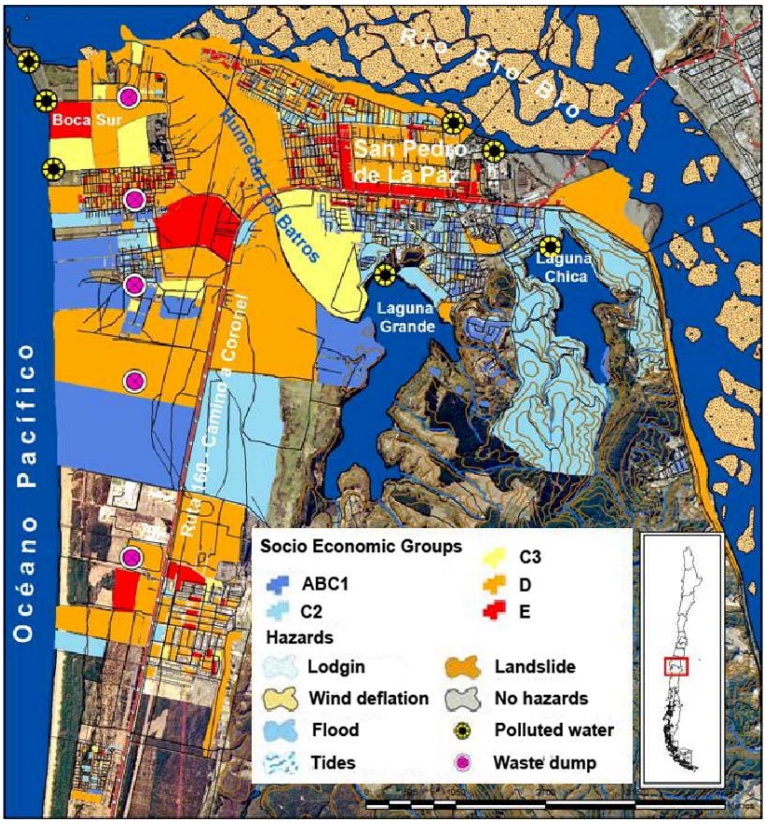

Figure 4: Distribution of illegal waste dumps in relation to socio-economic levels in the commune of San Pedro de la Paz.

Source: Own Elaboration based on data of EULA Centre.

Figure 5 shows the areas occupied by each SEG, one hundred meters around the clandestine dumps. The only SEG that has no cases located within one hundred meters of waste dumps is ABC1, even considering that this group is very well distributed in the coastal zone. Overall, the area occupied by each SEG increases in a systematic manner in line with falling levels of wealth, with the exception of SEG E, which, although it occupies higher surfaces areas than the ABC1 groups C2 and C3, it is located well below the SEG D. The latter group holds 86% of the areas near landfills, being the most affected by their negative environmental effects. The groups C2 and C3 do not reach significant values.

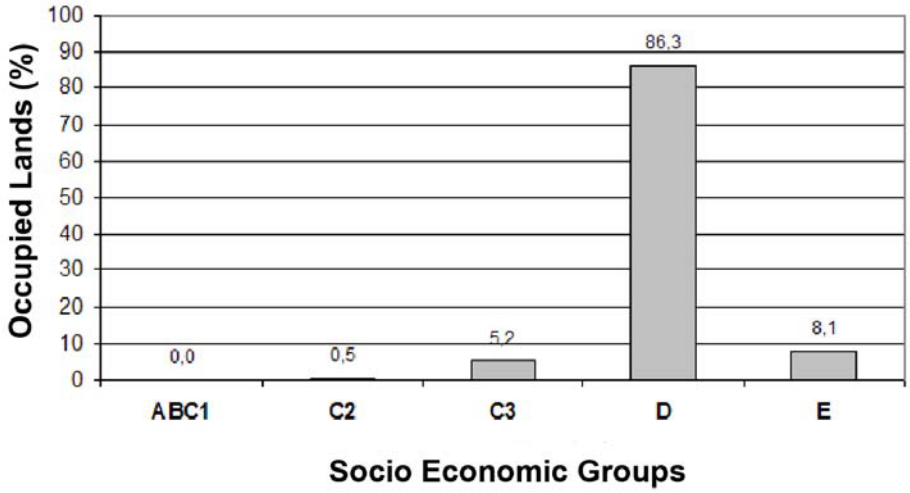

Figure 5: areas occupied by different SEG in a one hundred meter circumference around illegal landfills.

Source: Own Elaboration

The discharge of contaminated water, generally occurs in uninhabited sectors although two points located in lagoons very near the location of residential sectors of the C2 layer, predominant in that area, can be clearly identified. Another two discharge points of contaminated waters are located on the shore of the Bio-Bio River and on the marine coast, in areas occupied by social sectors D and E, respectively.

It is possible to observe that 47.7% of the homes of the highest socioeconomic level (ABC1) are located in threat-free zones (figure 6). Nevertheless, 20.3% and 16% of the surface occupied by this SEG are under the threat of tidal flooding and aeolian deflation respectively, mainly due to their recent and inconvenient coastal location (figure 7)

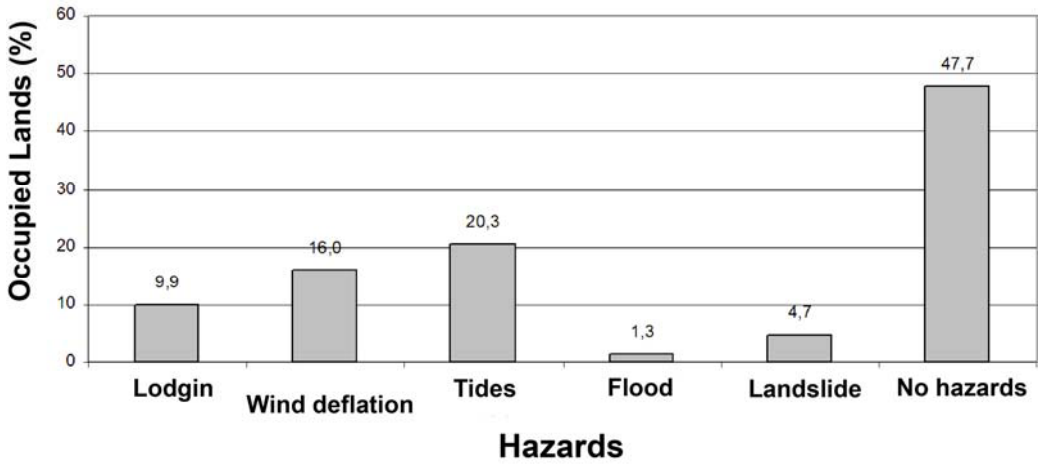

Figure 6: spaces occupied by socioeconomic levels ABC1 under threat of a natural origin in the commune of San Pedro of La Paz.

Source: Own Elaboration.

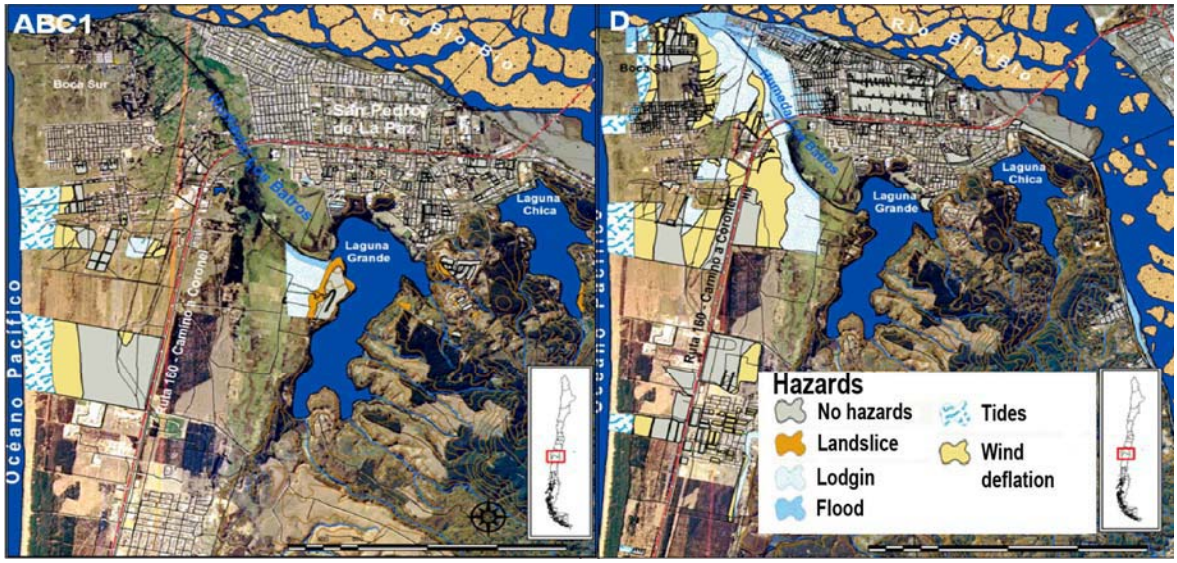

Figure 7: Distribution of the environmental threats for SEG ABC1 and D in the commune of San Pedro of La Paz.

Source: Own Elaboration on the basis of a risk study of the Communal Regulating Plan.

Even though 35.9% of the surface occupied by the group of socio-economic level D is located in sectors without threat (figure 8), 48.1% of the areas in which this population of low average income resides is exposed to threats of flooding and Aeolian deflation. In the case of the flooding, they mainly affect the inhabitants of this socio-economic group located in sectors near or directly pertaining to the Batros wetland.

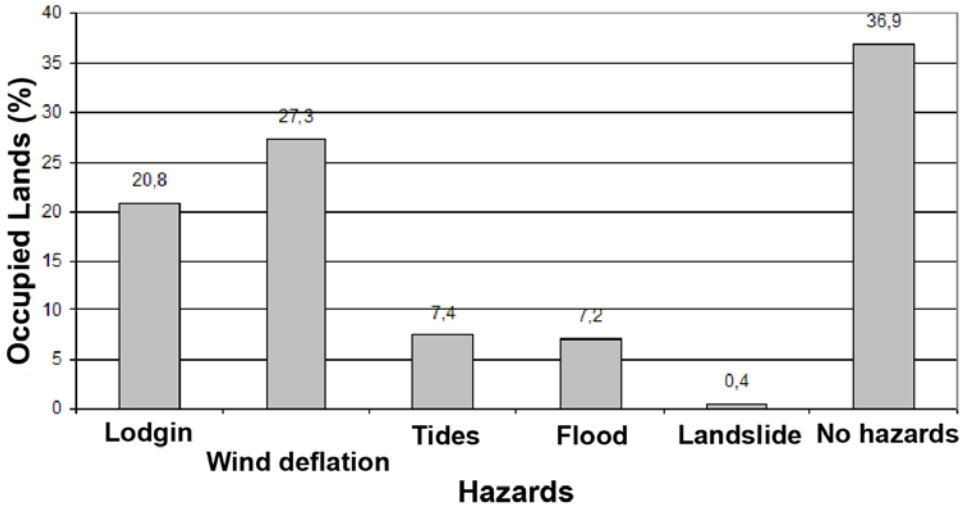

Figure 8: spaces occupied by socio-economic levels D under threats of natural origin, in San Pedro of La Paz.

Source: Own Elaboration

It is interesting to emphasize that there exists a high percentage of the surface occupied by the socio-economic levels ABC1 who are exposed to mass removals principally as a consequence of the occupation of steep sectors on the hills around both lagoons.

In the case of Peñalolen the situati on is the opposite, since it is the spaces occupied by the inhabitants of high income (ABC1) that mainly live in areas exposed to the threats of mass removal and flood. Figure 9 shows that 67,1% of the surface inhabited by ABC1 homes is under some type of threat, with exposure to mass removals, with 53,9% of the total, being the most significant. On the contrary, 45.4% of the spaces occupied by the low to mid socio-economic level (D) are located in sectors without threat (figure 10).

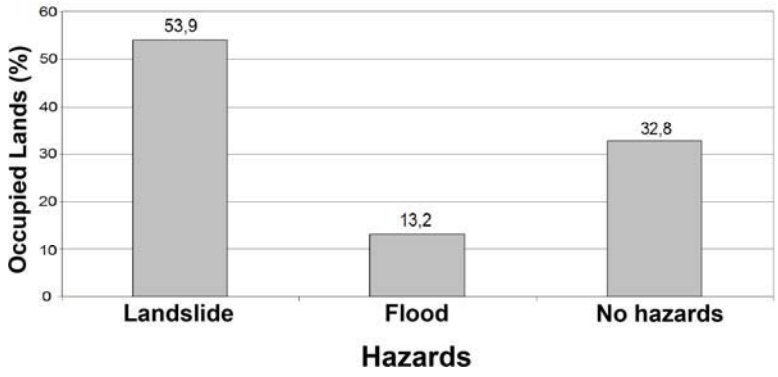

Figure 9: spaces occupied by socio-economic level ABC1 under environmental threats of natural origin in the commune of Peñalolén.

Source: Own Elaboration.

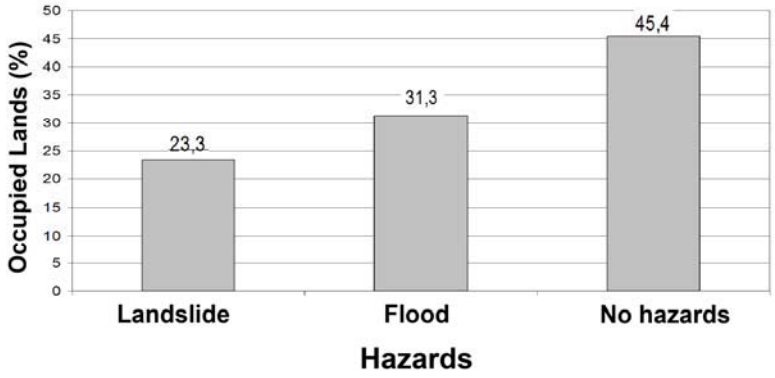

Figure 10: spaces occupied by levels socioeconomic D under threats of natural origin in the commune of Peñalolén.

Source: Own Elaboration

The difference in the types and magnitude of the threats which these two SEG are exposed to, is explained, fundamentally, by the position that each occupies within the river basin that gives origin to the commune of Peñalolén. In figure 11 it is clearly observed that sectors ABC1 reach a noticeable exposure to mass removals of sediments because they are located in inclined and unstable sectors of the alluvial fans and close to multiple streams. These areas are in high demand for real estate projects because they offer great environmental amenities such as scenic quality.

On the contrary, the initial location of the poorest sectors in the low part of the river basin means that they are exposed, above all, to floods produced by the accumulation of volumes of water originating from the high part of the river

basins, lead initially by their natural channels , that soon penetrate in the urban sector generally in form of paved streets and avenues.

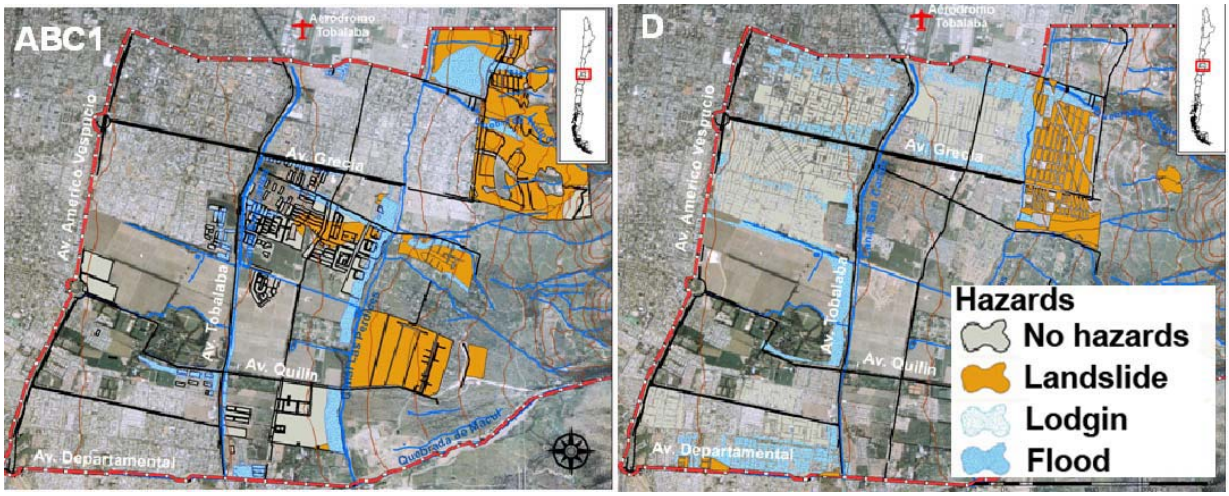

Figure 11: Distribution of the environmental threats for GSE ABC1 and D in the commune of Peñalolén.

Source: own elaboration on the basis of study of risk of the Communal Regulating Plan.

DESCRIPTION OF THE MECHANISMS THAT ACT ON THE PHYSICAL VULNERABILITY OF THE SOCIO ECONOMIC GROUPS

The difference in the levels of income for each group can be understood as a determining factor in the configuration of vulnerabilities. In this sense, the homes of strata D do not count on the same capacity of access to certain services and goods that allow them to reduce their vulnerability when facing the dangers to which they are exposed.

Another important thing is related to the capacity of certain socio-economic groups to unfold mechanisms that allow them to diminish, to a certain degree, their vulnerability in the face of natural dangers and threats. For example, in Peñalolén, 67.1% of the surfaces inhabited by ABC1 homes are under some type of threat, mainly mass removal. Nevertheless, these groups count on an income level that allows them access to private residential projects, closed condominiums that are equipped with pipelines and infrastructures for the conduction of waters and sediments outside their limits. That is to say, the increase in the rates of waterproofing and consequently, of the flows of sediment and rainwater run-off caused by the construction of residential areas

in sites of the Andean foothills, has transformed into negative externality and has transferred waters downhill, where the residential areas of more vulnerable sectors are located, originating a highly disproportionate effect that can be defined as environmental injustice.

In short, different socio-economic groups can present a relatively similar exposure level when faced with naturally threats, like the floods or mass removals of sediments. However, the difference in their behaviour lies in that those that have greater capacity of access to goods and services have at their disposal, either individually or socially, appropriate infrastructures for prevention and protection.

On the other hand, although the homes of low socio-economic levels are exposed to reduced percentages of threats, their vulnerability can be high due, for example, to the construction materials of their houses and the deficient infrastructure of the settlement.

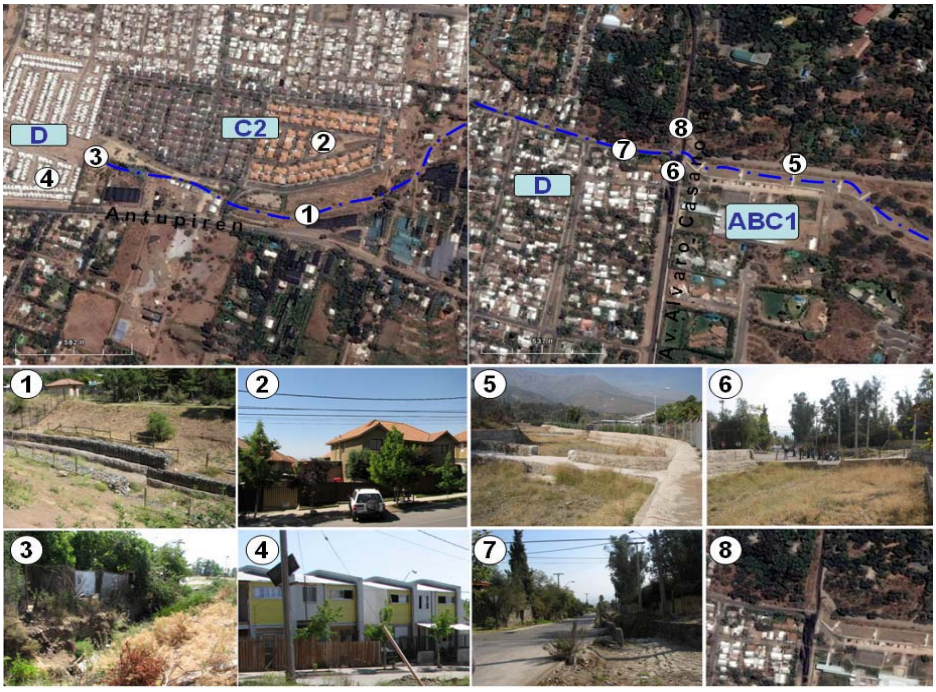

Figure 12: Built infrastructure distribution destined to diminish the vulnerability to floods according to socio-economic levels of the population in two ravines of the Andean foothills of Peñalolen.

Source: Own Elaboration/Google Earth

Nevertheless, it is possible to appreciate how these protective installations only exist in the sectors dominated by SEG ABC1 and C2, and, on the contrary, downstream underneath the ravines these disappear leaving the lower socio-economic groups more exposed.

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