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Land register of contaminated sites in an industrial chilean region: Identification and evaluation of suspected sites

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Abstract

This work introduces the outcomes of the first process for the identification and evaluation of sites potentially contaminated in the Region of the Bio Bio, Chile. The methodology combined qualitative and quantitative elements from Austrian and German risk assessment procedures, calibrated and adapted to the Chilean reality. The developed process consists of collecting historical and current registers on soil use, effects of materials handling on the population's health, and the description of the site conditions. The first analytical step corresponds to an image algebra analysis, through which the most vulnerable areas of the region are established. The sites identified inside the most vulnerable areas are classified into five priority classes, giving an approximate degree of endangerment from these sites. Through the experience, from a total of 507 sites identified as suspicious of contamination, five sites were classified under the highest priority. The results of this analysis have allowed Chilean authorities to focus their resources on the detailed investigations to be carried out in the five priority locations, whilst planning the future strategy to follow for the practical management of all sites found as currently posing a risk to the environment and to the society.

1. Introduction

In Chile, as in most South American countries, the subject of contaminated sites is an environmental issue that authorities have just started to deal with. In this regard, Chile currently presents an interested environmental-normative body that has started to prepare the national legal document, as well as to foster research on regional and national levels. Regulations have just been started to form the legal framework in which all management activities for contaminated sites will take place. However, the situation of Chilean contaminated sites up to this date has not yet been explored, neither concerning the amount and location of the potential contaminated sites, nor concerning the associated risks upon human health and environment (Agüero et al., 2005; Bezama, 2006). For that reason, since 2003 the Chilean National Environmental Commission (CONAMA) has worked on the identification of priority regions in which to perform the first evaluations of the dimensions of the soil pollution situation.

The Region of the Bio Bio, due to its social and economic importance at a national level, has been selected as one of these priority regions (Agüero et al., 2005). This region is divided into four provinces: Ñuble, Bio Bio, Concepción (where the regional capital, the city of Concepción, is located) and Arauco, which adds up a total of 52 communities and a total population of 1 861 562 inhabitants. The regional economy is based on strong exporting forest, fishing and chemical industries. In terms of population and productivity, as well as its culture and educational activities, this is the second most important region of Chile, after

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the Metropolitan Region of Santiago (CONAMA, 2005; INE, 2002).

The large number of industries present in the Region of the Bio Bio opens a broad range of potential sources of contamination for soil, surface and ground waters. These industrial activities generate different types of solid and liquid wastes and off-gases, many of which are not treated suitably by their emitting sources. On the other hand, the high industrial concentration in the surroundings of urbanized sectors, mainly in the province of Concepción, is a major incentive to carry out a study on the impact of different wastes on environmental resources such as soil, surface and ground waters. According to Seguel (2002), the total amount of industrial wastes generated in the Region of the Bio Bio amounts to about 350 000 tons per year. Most of the generated waste corresponds to the forestry sector (including sawmills and pulp and paper, cardboard, chipboards and other companies, comprising ca. 21% of the regional waste generation), and the iron and steel industry (17% of the regional waste generation).

Within the framework of a joint collaborative project between the University of Concepción (Chile) and the University of Leoben (Austria), an identification and evaluation procedure for sites potentially contaminated (SPC) was developed and calibrated with the Chilean situation (Agüero et al., 2005; Bezama et al., 2005; Bezama, 2006). The goal of this work is to present an analysis of the outcomes of an identification and evaluation experience, which may serve as a guideline for future elicitation processes either in Chile or in other developing countries.

2. Methods and practical approach

The strategy followed in this first study corresponds to a combination of the identification method proposed by the Fundación Chile (2004), with the investigation and evaluation processes for sites potentially contaminated (SPC) used currently in European countries such as Austria and Germany. An important aspect of this evaluation process is that it considers preliminary information and establishes a hierarchy among the recognized SPC. Such hierarchy ranking can allow authorities to use their (often limited) budgets for future detailed analyses on soil and groundwater pollution only in the sites found more certain to be polluted or posing a higher risk to the population and the environment. In general terms, the methodology consists of the following steps (Bezama et al., 2005):

- Development of a list of SPC prepared on the basis of the developed activities at the different zones with the collected historical data, as well as with the data delivered by the Operative Committee on Contaminated Sites (see Acknowledgements) for the Region of the Bio Bio.
- Identification of vulnerable areas in the region, considering wild life, groundwater and the human health as risk receptors.
- Performing a first priority evaluation and risk assessment for all identified SPC.
- Development of a site inspection plan, from which all information needed for a second risk assessment evaluation could be gathered or generated.
- Application of the inspection form to the SPC identified in the first evaluation.
- Performing the second risk assessment in order to prioritize and classify the identified SPC.

The present study has been carried out within the context of certain factors that constrain the possibility of including all of the required data for elaborating the work at hand. An important restrictive aspect is the deficit of information and resources in certain studied zones of the region. This is mainly observed in the rural and isolated areas, where the required thematic information associated with contaminated sites (e.g., local databases, demands and registers) is not available. The present work therefore considers the currently existing and available information of the region, regardless if it is either exhaustive or comprehensive or not evaluated or scarce and inexact.

2.1. Identification of SPC in the Region of the Bio Bio, Chile

For a proper identification of SPC, it is imperative to count on reliable information. Considering this situation, a series of public services were consulted, as presented in Table 1. In order to obtain a better differentiation of the SPC register, CONAMA has defined five main categories according to the past activities carried out at the site: (1) Industrial Activities, (2) Landfills and Illegal Dumping Sites, (3) Mining Activities (Mining Environmental Liabilities), (4) Petrol Stations, and Hydrocarbons Storage Zones, and (5) Environmental Liabilities (receptors of contamination). The collected information was classified according to these categories. All of the information collected has composed the first register of SPC for the Region of the Bio Bio, Chile.

Table 1
Sources of information for preparing the register of sites potentially contaminated (SPC) in the Region of the Bio Bio

Type of information	Source[a]
List of industrial establishments	University of Concepción, Health Regional Ministry Service
List of landfills and illegal dumping sites	CONAMA
List of SPC, province of Arauco	CONAF
List of environmental liabilities in the region	CONAF
List of SPC, community of Coronel	Municipality of Coronel
List of petrol stations in the region	SAG, INFOR
List of mining environmental liabilities	SERNAGEOMIN

[a] CONAF: National Forest Corporation, SAG: Chilean Agriculture and Cattle Service, INFOR: National Forest Institute, SERNAGEOMIN: National Service on Geology and Mining.