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On the indiscriminate use of imported emission factors in environmental impact assessment: A case study in Chile

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ABSTRACT

Environmental Impact Assessment (EIA) aims to determine if the environmental effect of an activity or project complies with standards and regulations. A primary component of the environment to evaluate is air and the effect that various activities can have on its quality. To this end, emission factors (EFs), which are empirical coefficients or mathematical relationships, are normally used. The present research critically analyzes the implications and consequences of using imported EFs in environmental impact studies (EISs), taking as case of study the situation in Chile. Among the main results, the widespread use of EFs in EISs in the country and the lack of assessments of their actual applicability stand out. In addition, the official guidelines related to emissions estimation that are used for EIA in the country mostly include EFs derived elsewhere, without considering the recommendations or restrictions that the original sources indicate for their use. Finally, the broad use of default values defined for the Metropolitan Region in Central Chile, is highly questionable for a country that extends north-south along more than 35° of latitude, with wide variability in climate, traffic conditions, population, soil types, etc. Finally, it is very likely that situations similar to those observed in the present work occurs in other countries with young environmental impact assessment systems, and therefore, that the results herein presented should be of general interest and relevance.

1. Introduction

Environmental impact assessment (EIA) is understood as the identification and evaluation of the potential impacts of proposed projects, plans, programs, or legislative actions, relative to the physical–chemical, biological, cultural, and socioeconomic components of the environment (Canter, 1998). In Chile, the Law 19.300 on the General Bases of the Environment, modified by Law 20.417 in 2010, defines environmental impact assessment as the procedure, administered by the Environmental Assessment Service (SEA, by its acronym in Spanish) that, based on an environmental impact study or declaration, determines if the environmental impact of an activity or project complies with applicable regulations (SEGPRES, 2012). This identification and evaluation of possible impacts must be done prior to the implementation of the project to which it applies.

A main component of the environment to consider is air. Air pollution affects the health of people, plants and animals, causes deterioration in buildings and a decrease in visibility conditions (i.e., for air traffic purposes). In fact, it is recognized as one of the main environmental problems at both in a global level and in Chile. Indeed, a recent World Health Organization report states that "air pollution is the biggest environmental risk to health, carrying responsibility for about one in every nine deaths" (WHO, 2016). In Chile, government institutions recognize that more than 56% of the country population is exposed to air pollutant concentrations that surpass environmental quality regulations, which results in more than 4000 premature deaths a year (Gobierno de Chile, 2014).

To assess the impacts of a project on air quality it is necessary to identify the emission sources and the types and quantities of pollutants emitted. At this stage, it is normal to use so-called emission factors (EFs), i.e., fixed coefficients or mathematical relationships that allow the estimation of emissions associated with particular situations, in accordance with the type of project or activity.

The EFs most commonly used in Chile are those proposed by the US Environmental Protection Agency (US EPA, hereafter "EPA"), that have an empirical nature. An empirical model is based on observation of real case situations or experiments. It fits observed facts and allows predictions of what will occur in certain circumstances under conditions

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similar to those of the process through which it was obtained (FAO, 1997). However, this final aspect is typically not recognized or just ignored (Osses de Eicker et al., 2010), as it is also the case of the actual range of applicability of these EFs within the framework of environmental impact assessment. This is the main issue addressed by the current contribution, with the case of Chile and the consequences of the uninformed use of these EFs as a basis for study. Thus, the primary objective of this paper is to analyze this situation in order to raise awareness of the limitations involved in the use of imported EFs. From this base, it is our intention to promote a more suitable and informed use of EFs in environmental impact assessment in Chile and other countries with relatively young (and somewhat "immature") environmental assessment systems, and therefore facing similar situations (Cardenas and Halman, 2016).

2. Theoretical background

2.1. General background

According to the EPA definition, the EFs are "representative values that attempt to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant" (EPA, 1995a). Thus, an EF is the average rate at which a pollutant is emitted to the atmosphere as a result of a certain activity. In exchange in Chile they are understood as "an average of the results of emission measurements carried out at a large number of sources with different combustion technologies, ages, fuel qualities and sizes, which allows them to be representative of a wide variety of sources that use the same generic fuel" (CONAMA, 2009). From the very definition it is possible to observe a difference between the EPA concept and the initial conceptualization of EFs in Chile. Indeed, while the CONAMA definition makes reference only to combustion processes, that of the EPA refers in more general terms to the result of an activity, i.e., not necessarily an activity that involves a combustion process, e.g., the particulate matter (PM) emission by excavation or re-suspension by road traffic (in these cases the PM emission is independent of the combustion process).

EFs are normally expressed as mass of the pollutant emitted per unit of weight, volume, distance or duration of the emission activity, e.g., kilograms of PM per ton of combusted coal. These factors facilitate the estimation of emissions from various sources of air pollution. Thus, the general equation for the emissions estimation proposed by the EPA (1995a) is of the type:

$$E = A * EF * \left(1 - \frac{RE}{100}\right) \quad (1)$$

where E is the emission rate, A is the activity rate, EF is the emission factor, and RE is the overall emission reduction efficiency (%). The activity rate is an indicator of the operation of the emission source, e.g., how much fuel was consumed by a boiler in a given time. Meanwhile, the overall emission reduction efficiency is associated with the existence of an emission control mechanism or device. Thus, RE is the percentage of emissions that are captured or eliminated by the control system, which in Chile is known as the abatement rate. If emissions are estimated for a long time period (e.g., one year), the device and emission control efficiency terms should account for upset periods (or accidents) and routine operations (EPA, 1995a).

It should also be mentioned that EFs can be presented as either a numerical value or a mathematical expressions that depend on certain parameters or variables, which relates to how the EF originated and the amount of studies carried out for its development.

2.2. EFs development

EFs are the result of numerous measurements at emission sources (CONAMA, 2009). For example, if there is a smokestack, a series of measurements of the pollutants released by it must be taken and the obtained values subsequently averaged; these averages would be the emission factors for the different contaminants. An emission factor basically originates in this way, which appears simple. However, the actual process of EFs application is inherently more complex since it requires that the source be in operation, and when an environmental impact study is carried out, a prediction of the project emissions and likely impacts is made before it is in operation. Therefore, it is impossible to estimate the actual emissions associated with the activities of the project without resorting to relationships that are previously determined for similar activities.

2.3. Nature of the use of EFs in environmental impact studies in Chile

Law 20.417, i.e., the Chilean environmental legislation, defines in its Article 10 the types of projects and/or activities that must enter the Environmental Impact Assessment System (SEIA, for its acronym in Spanish) (SEGPRES, 2012). If the project generates any of the effects indicated in Article 11 of the aforementioned law, it enters the SEIA as an environmental impact study (EIS). If not, it enters as an environmental impact declaration (EID). In general, EIDs are less exhaustive and rigorous and simpler than EIS. In any case, in both EIS and EID the existence or absence, respectively, of any of the characteristics and/or circumstances mentioned in Article 11 must be justified. Among these criteria are the risk to public health due to the quantity and quality of effluents, emissions or waste, and significant adverse effects on the quantity and quality of renewable resources, including air (MMA, 2012a).

To assess if a project or activity may significantly affect air quality exceeding allowable limits defined by existing regulations, it is firstly necessary to quantify the emissions of the project or activity. It is here that emission factors are used to estimate emissions related to works in the construction, operation and closure stages of projects. Thus, an incorrect decision based on the unsuitable use of EFs can affect, complicate or delay the environmental approval of a project or, still worst, overlook a serious impact risk. Finally, once emissions are estimated, it is commonly required that the transport and fate of a pollutant of interest be modeled in order to estimate if it can indeed affect a potential receptor (e.g., an inhabited area). Again, if emissions at the source are wrongly determined, modeling of its effects on a sensitive receptor will be controversial as well.

3. Methods

For the present analysis of the use of EFs in environmental impact studies in Chile, all EISs of already approved projects (with a favorable Environmental Qualification Resolution, RCA for its acronym in Spanish) in the January 2010–April 2015 period were analyzed. The information considered is public and available on the web site of the SEA (www.sea.gob.cl), the governmental institution in charge of coordinating the process of environmental impact assessment of projects, and therefore the SEIA. For the analysis of the studies and the characteristics of the use of EFs in these EISs, 6 criteria were considered: (1) Does the EIS use EFs for emissions estimation? (2) What EF sources do the EISs consider? (3) Does the EIS make reference to the empirical nature and/or quality of the EF? (4) In the EFs that employ mathematical expressions, are default values used? (5) In the EFs that employ mathematical expressions, is an analysis of the sensitivity of the EF to the parameter values carried out, or, at a minimum, is a comment on the matter made? (6) Are the emissions obtained from EF subsequently used in a pollutant transport model?

The main results of the analysis based on the described criteria as well as the potential scope of the various situations found are discussed in the following sections, with special attention given to the consequences and implications of the imported nature of the EFs used, and the use of "default values" over the emission estimates presented in EISs within the SEIA in Chile.