Potentials of Latin American Pollutant Release and Transfer Registers as a Source of Local Data for Environmental Assessments

Margarita Ossés de Eicker[†], Thomas F. Ruddy[*†], Rainer Zah[†] and Hans Hurni[‡]

[†] Empa, Swiss Federal Laboratories for Materials Testing and Research, Technology and Society Laboratory, Lerchenfeldstrasse 5, 9014 St. Gallen, Switzerland.

MaggieOsses@yahoo.com, Thomas.Ruddy@empa.ch, Rainer.Zah@empa.ch.

[‡] University of Bern, Institute of Geography, Hallerstrasse 10, 3012 Bern, Switzerland.

Hans.Hurni@cde.unibe.ch.

[*] To whom correspondence may be addressed. Tel.: +41 71 274 7500; Fax: +41 71 274 7862.

Abstract

Pollutant Release and Transference Registers (PRTRs) are a potential source of data to develop local emission- and consumption factors for industrial activities because of the type of environmental data collected and the accompanying information on industrial processes. This is true in cases in which the emissions and consumption values in them are derived from measurements, not estimated with non local emission factors. This study analyses the potential of the Chilean and the Mexican PRTRs as sources of local data for three main environmental assessment methods, namely LCA, EIA and air emission inventories, as well as for greenhouse gas emission reports at the national and corporate levels. We conclude that the development of air emission factors for air emission inventories of the main air pollutants will be possible in the near future. The collection of all additional data needed for greenhouse gas emissions reports, as well as for LCA and EIA would be also possible if the present data collection system in the PRTRs were modified. Nevertheless, countries would have to

consider the costs of obtaining this additional data and would have to adapt their legislation accordingly. Although the results of the present study indicate that the PRTRs evaluated still have shortcomings, it is expected that the registers will continue to improve due to the support coming from the authorities, the pressure of bi- and multilateral agreements, international trade and the increasing environmental awareness of the population. Moreover, the inclusion of more measured data in the PRTRs would not only make it possible to develop local environmental data for further assessments, but would also improve the quality of the PRTRs for their original purpose of monitoring harmful substances released or transferred at the national level and at the level of individual facilities.

Keywords: Life Cycle Assessment, Environmental Impact Assessment air emission inventories

1. Introduction

The present article evaluates the characteristics of the Latin American Pollutant Release and Transfer Registers (PRTRs), which are inventories of emissions, wastes and harmful substances, basically originated by industrial activities. In particular, we analyze how suitable they are or could be for delivering environmental data which can be used to develop local emission- and consumption factors for environmental assessments.

The increasing involvement in international environmental agreements and a rising environmental awareness of the public and governments are encouraging Latin American countries to improve their knowledge of the environmental impacts of their activities, including industry, along the whole life cycle of their products (UNEP 2006). Among the urban activities in Latin America, industrial activities deserve special attention due to the fact that they are some of the main contributors to the worsening of the environmental situation (Jenkins 2000).

The environmental loads associated to industrial activities can be assessed using different methods depending on the specific objectives that a study is supposed to achieve (Finnveden and Asa 2005; Ruddy and Hilty 2008). Such environmental assessment methods include, for instance, air emission inventories (EMEP/EEA2009; Power and Baldasano 1998), Environmental Impact Assessment (EIA) (Morris and Therivel 1998; World Bank 1996) and Life Cycle Assessment (LCA) (ISO 1997; Rebitzer et al. 2004). In addition, the particular assessment of so-called greenhouse gases are taken into account in corporate and national greenhouse gas emission inventories under the Kyoto Protocol.

There are international and regional initiatives undertaken to support life cycle assessment issues in Latin America (Curran 2006; Skone 2001; Sonnemann and De Leeuw 2006), as well as ongoing efforts to develop local LCI data (Coltro et al. 2003; Coltro et al. 2006; Da Silva and Kulay 2005; Silva and Kulay 2003), and in the case of Brazil, its own database (Caldeira-Pires 2006). However, these efforts do not seem to be enough and Latin America is lacking by and large locally developed environmental databases which could support environmental assessment methods. Such scarcity is basically due to deficiencies in the data and data collection by industry in Latin America, which in turn is related to the lack of financial resources and technical know-now. According to a recent survey done by the World Bank (2005), the monitoring of air, water and toxic emissions at industrial facilities is at best imperfect, and monitoring equipment is often obsolete. Furthermore, the data collection and measurement methodology are questionable, and there is usually a lack of trained personnel at industrial sites. Finally, there are unclear information channels among the actors involved (Arena 2001; World Bank 2005).

Due to the lack of local databases, analysts in Latin America are forced to use in their studies environmental databases from other countries, which have been based on technologies, operational controls, local emission limits and management practices which are not necessarily similar to those used in Latin America and thus, may deliver inaccurate results

(Aguayo et al. 2001; Dessus et al. 1994; Jenkins 2000; Kolominskas and Sullivan 2004; Sullivan and Gouldson 2007). In fact, the 2006 IPCC guidelines and the GHG Protocol Initiative recommend the use of customized instead of default emission factors for inventories of greenhouse gases (IPCC 2006; WRI and WBCSD 2004).

One potential local source of environmental data describing the consumption of energy and resources and the generation of emissions is comprised by Pollutant Release and Transfer Registers (PRTRs) (World Bank 1998). PRTRs are inventories of potentially harmful substances released to air, water or soil, as well as wastes transferred to treatment and disposal sites. They contain information on the industrial sector at least, but may include other sectors as well. Several industrialized countries have developed their PRTRs. In Latin America Mexico has already a PRTR and Chile is in the process of developing it.

The original aim of PRTR was not to develop databases with emission or consumption factors which could be used in further environmental assessments. Nonetheless, the information contained in the PRTRs about environmental loads and technical characteristics of the industrial activities makes these registers potentially useful to develop local databases for environmental assessments of principal industrial activities. The use of PRTR data for additional applications can help identifying additional sources of funding and improving the overall efficiency of data collection, paving the ground for more systematic environmental information processing and, in the long term, the development of environmental information systems (Hilty et al. 2006). However the question must be analyzed as to whether the PRTRs in Latin America have shortcomings that hamper their use as a source of data.

Goal and Scope

The goal of this article is to analyze the suitability of Latin American PRTRs for supplying local environmental data on industrial activities, which can be used in environmental assessments and reporting schemes. This article intends to provide government agencies and research bodies with a critical view of the PRTRs and to identify the modifications that should be done to the PRTRs to improve their suitability as source of environmental data.

2. Methodological framework

This study considers the potential application of data delivered by the PRTRs for three main environmental assessment methods, namely LCA, EIA and air emission inventories. Further, the suitability for environmental reporting schemes is assessed, particularly for national and corporate reports on greenhouse gases under the Kyoto Protocol.

First, the specific data requirements for each method are evaluated. Then, the question is analyzed as to whether the PRTRs delivers such necessary data at present or could be adapted to deliver such data. Moreover, the quality of the currently or potentially available data is discussed. Finally, the suitability of the PRTRs as source of data for the selected assessment methods and reporting schemes is discussed.

3. Data requirements of the environmental assessment methods considered

Table 1 summarizes the main characteristics of the methods considered.

Table 1 Characteristics of the environmental assessment methods considered

Characteristics	Environmental assessment methods		
	Air emission inventories	**Environmental Impact Assessment (EIA)**	**Life Cycle Assessment (LCA)**
Object of study	Group of activities in a defined area.	A single projected activity in a specific location.	A clearly defined and described system (product or service).
System boundary	All environmentally relevant air emissions are taken into account that occur within a region of interest, which may be a city, a country or a region, considering often the time span of one year (they can also reflect shorter time spans and be developed for example on a daily or hourly basis). In this study the inventories developed for a year were considered.	The system boundary can vary. Usually it includes consumption of materials and energy and the generation of emissions and wastes. It seldom considers the extraction of resources and may or may not consider the disposal of waste and wastewater. EIA considers emissions and consumption levels over a long period of time.	The system boundaries are chosen to correspond to the study object (system description) and the questions that are to be answered by the study. In all cases, the material and energy flows within the system are followed back to the sources (that is, to the resources consumed). Independently of the actual system boundaries, all types of emissions, wastes and wastewater, as well as the consumption of resources within the complete system boundaries are taken into account.
Potential applications	Assessment of emissions, comparison between sources, further application as input for modeling concentration of air pollutants.	Permitting of new facilities. EIA of measures proposed in trade agreements.	Evaluation of the environmental impacts of a given activity, comparison between products.

According to the different characteristics of the assessment methods, different types of input data are needed. Table 2 summarizes the data requirements for the three methods examined here.

Table 2 Data requirements of the environmental assessment methods selected

Data requirements	Environmental assessment methods		
	Air emission inventories	**Environmental Impact Assessment (EIA)**	**Life Cycle Assessment (LCA)**
Range of activities to be covered	All main activities in the area of interest.	Only the activity under study.	Only the activities that are part of the life cycle of the product or service under study.
Energy consumption data	Not necessary. An exception is made when emissions have to be estimated with emission factors based on energy consumption, such as the AP42 database.	Mostly not necessary. An exception is made when emissions have to be estimated with emission factors based on energy consumption, such as the AP-42 database.	Necessary, with complete information about consumption of each energy carrier.
Other resource consumption data	Not necessary.	Water consumption often considered. Consumption of other resources may be necessary.	Information about all resources is necessary: ores, raw materials, auxiliaries, transportation and land use.
Emissions data	Necessary. Usually, air emissions only.	Necessary. Air and water emissions, wastes and wastewater.	Necessary. Air and water emissions, wastes and wastewater.
Final product data	Not necessary. An exception is made when emissions have to be estimated with emission factors based on amount of final product.	Variable. Mostly not necessary. An exception is made when emissions have to be estimated with emission factors based on the amount of final product.	Necessary, with complete information about generation of final products, co- and byproducts. The product may be a physical product or a service.

The methods considered have different data requirements and, as a consequence, they make it possible to conduct a comprehensive evaluation of the suitability of the PRTRs as source for environmental data. For emission inventories, the data requirements are simple. Neither energy consumption nor information on the final products is needed. Only air emission data is considered, but it must be available for all relevant industrial sectors within the area under study. EIA focuses on individual industrial plants, but for those, all relevant emissions to air, to water and to soil and also the resource consumption have to be known in order to assess the environmental impacts. Finally, LCA is the method requiring the most comprehensive data. All environmental flows have to be known for each processing stage of a product or activity. LCA studies focus on activities defined as average in a country or even a larger geographic area, considering different technologies and environmental performance.

4. Data requirements of the environmental reporting schemes considered

For the inventories on greenhouse gas (GHG) emissions at national- or corporate level, only these emissions to air are taken into account. Direct greenhouse gases and the so-called precursors are considered. The first group includes carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and other halogenated gases. The precursor gases are nitrogen oxides, carbon monoxide, Non-Methane Volatile Organic Compounds, sulfur dioxide and ammonia. However, emphasis is put on direct GHGs.

In the national reporting on GHG emissions under the Kyoto Protocol all human activities in a country (industry, households, agriculture and transportation), as well as natural sources are taken into account. National GHG reports are used to document compliance with emission limits and the fulfillment of reduction goals and also for emissions trading at the international level. Emissions trading is a practice of tradable quotas (a market-based economic instrument distinct from a carbon tax) based on the principle of allowing emitters to satisfy a limitation

(i.e. the “cap” in cap-and-trade systems) through measures taken at the least-cost location. Trading may take place between developed countries, as is the case with European Union Emission Trading Scheme. Favorable locations can also be found in developing countries, where an additional dollar can often achieve a greater climate change mitigation effect than in countries where extensive mitigation measures have been taken. Under the Kyoto Protocol this can be done through Clean Development Mechanism or Joint Implementation projects, depending on the countries involved.

In the corporate inventories of GHG emissions a single organization is assessed. Industrial activities, as well as commercial and administrative activities are considered. Corporate inventories are used to document the fulfilling of commitments in a global supply chain. Such commitments may be either voluntary in nature to satisfy stakeholders such as investors or protestors, or legal (then known as compliance) to satisfy the governments of the nation-state where the company is domiciled (home country) or operates a factory (host country). It is in the company’s interest to manage risk by maintaining its own inventory, which may duplicate efforts by governments or intergovernmental organizations like the United Nations. Furthermore, in this way companies can distinguish their efforts from those of other companies. Thus three alternative scopes can be taken into account: Scope 1 considers GHG emissions from sources that are owned or controlled by the reporting entity. Scope 2 considers the emissions that are a consequence of the activities of the reporting entity, but occur at sources owned or controlled by another entity, for instance, emissions from the consumption of purchased electricity, heat or steam. Scope 3 considers other emissions, such as the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, electricity-related activities not covered in Scope 2, outsourced activities, waste disposal, etc.

In the national reporting scheme, data may be estimated with default emission factors provided by IPCC in its guidelines (IPCC 2006; IPCC/OECD/IEA 1997) or with national

emission factors. The latter is considered a better option by UNCCC. Similarly, in the corporate reporting scheme data are estimated using the Corporate Accounting and Reporting Standard developed by the World Resources Institute and the World Business Council for Sustainable Development (WRI and WBCSD 2004). Again, default emission factors can be used but custom (i.e. individualized) emission factors are preferred. These customized emission factors have to be generated by local measurements.

5. Characteristics of the Mexican and the Chilean PRTRs

In Latin America, Mexico was the first country to develop a Pollutant Release and Transference Register (PRTR) in the Nineties. Chile has been in the process of developing one since 2002. Other Latin American and Caribbean countries have also expressed their interest in developing PRTRs in a series of meetings, such as the PRTR Conference for the Americas, held 21-23 April 2004 in Mexico City (UNEP 2004). Moreover, an officer of the United Nations Institute for Training and Research (UNITAR) has indicated that other Latin American countries will soon start the development of PRTRs.[1]

5.1 The Mexican PRTR

The Mexican PRTR (SEMARNAT 2008), administrated by the Mexican Secretariat of the Environment and Natural Resources (SEMARNAT), aims to integrate information on emission sources under federal, state and municipal jurisdictions. However at present it still contains only information from the industrial sectors under federal jurisdiction, which according to previous analysis are the most relevant sectors from an environmental point of view. Facilities under federal jurisdiction have to report their emissions to air, water and

[1] Ocaña Correa, J. 2008. Personal communication to M. Ossés de Eicker. Associate Task Manager POPs Enabling Activities. Division of GEF Coordination, United Nations Environment Programme (UNEP), International Environment House. 15 chemin des Anèmones CH-1219, Chatelaine, Geneva, Switzerland. Tel.: +41 22 917 8195; fax: +41 22 797 3460.

wastes, as well as the use, process, production or transfer to treatment and disposal sites of substances potentially harmful for the environment. A total of 104 substances, both regulated and non-regulated, are taken into account for the report to the PRTR. Regulated substances have to be measured following the methods given by legislation. Non-regulated substances can be estimated with documented procedures. See Table 3 for further description of the characteristics of the Mexican PRTR, which are relevant for its suitability as source of data for environmental assessments.

The companies report all the information through their annual operation certificates ("cédula de operación anual" COA) in an electronic format. Based on the information provided by the facilities, the SEMARNAT prepares public reports presenting data on annual emissions aggregated by industrial sector. The information is updated yearly and is freely available to the public on the Internet. The public report prepared by the authority includes an assessment of the quality of the data collected. In 2009 Mexico released the third PRTR public report based on information resulting from obligatory reports from industry from 2007.

The information obtained in the time period between the years 1997 to 2001 was scarce, basically because at that time the report was voluntary. Because of this lack of regulatory pressure it could be expected that in that period the reports came from facilities with a good environmental performance. High uncertainties might have been associated with the values presented in former versions of the Mexican PRTR. This situation should improve in future when regulatory pressure can be expected to evoke a better response from industry. The obligation to report was established by law in 2001 and the regulation of the law was published in 2004. An officer of the PRTR indicated that for those years it is estimated that about 80% of the facilities that had to report did so (Gallegos Rogriguez 2008). The authority is aware of the need to work together with the industrial sector to increase the quality of the information provided by the facilities. Common errors found in the reports are errors in the conversion of units and errors in the selection of the appropriate substance for report

(substances with similar names are often interchanged). Furthermore, it has been recognized that the validation of data must be improved.[1]

5.2 The Chilean PRTR

The Chilean PRTR (CONAMA 2006) administered by the National Commission of the Environment (CONAMA), is a project started in year 2002. In contrast to other countries, the PRTR in Chile was not created as a completely new data system, but rather was developed on the basis of already existing reporting infrastructure. It uses the information that the industrial facilities are obliged to report on their emissions and hazardous wastes to governmental offices. The third PRTR public report was published in 2009 containing the information gathered from 2007. The developers of the PRTR have developed a unique report form with which the facilities can report all information requested by the PRTR and all corresponding authorities. This report is accessible for submission in an electronic format via the Internet.

The type of facilities that have to report, the type of emissions and the report threshold are defined by legislation. Both emissions to water and the generation of hazardous wastes have to be measured following procedures stated by the legislation. Emissions to air are still not obligatory at the national level. See Table 3 for a more detailed description of the Chilean PRTR.

[1] Gallegos Rogriguez, M. 2008. Personal communication to M. Ossés de Eicker. Director of Industrial Regulation and PRTR. General Direction of Management of Air Quality and RETC. Secretariat of the Environment and Natural Resources. Avenida Revolución 1425, nivel 34, San Angel-Tlacopac, Delegación Álvaro Obregón, Mexico, Distrito Federal CP 01040, Mexico. Phone +52 55 56243389/91. mrgallegos@semarnat.gob.mx.

Table 3: Characteristics of the Mexican and the Chilean Pollutant Release and Transfer Registers (PRTRs)

Characteristics	Mexican PRTR	Chilean PRTR
Industrial activities considered	Sectors under federal regulation: oil and petrochemical, industrial chemicals, paints and dyes, metallurgy, automotive, pulp and paper, cement and lime, asbestos, glass, electricity generation and treatment of hazardous wastes. Facilities also under federal jurisdiction are those classified as generators of hazardous wastes and those that discharge wastewaters into national water bodies. However, the authorities are working on the extension of the RETC to sectors under state and municipal jurisdiction.	For air emissions: steam- and/or hot water boilers, cellulose production, primary and secondary metal castings, heat-electric power plants, production of cement, lime or gypsum, glass production, ceramic, iron and steel industry, petrochemical production, asphalts and electric power supply units. For wastes and emissions to water: all activities
Data on air emissions	Poor coverage of measured air emissions, basically particulate matter, sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, for some activities also heavy metals, dioxins and furanes, volatile organic carbons and hydrochloric acid. Many other substances are estimated with emission factors, basically US EPA AP-42 air emission factors (EPA 1995).	Only particulate matter is widely measured. Most emissions are estimated by the environmental authority using activity data from the facilities and air emission factors, basically from the US EPA AP-42 database (EPA 1995).
Data on water emissions	Yes, following pollutants and water quality indicators are measured: total nitrogen, total phosphor, oils and grease, suspended solids, settleable solids, Biological Oxygen Demand (BOD5), fecal coliform bacteria, parasites, arsenic, cadmium, cyanide, copper, chrome, mercury, nickel, lead and zinc. The amount of wastewater is also reported. Information about the management and treatment of wastewater is included.	Yes, if they surpass a given threshold. A large list of pollutants is considered, which are measured. The amount of wastewater is also reported. Information about the management and treatment of wastewater is included.
Data on wastes	Yes, common solid wastes and hazardous wastes are considered.	Only hazardous wastes are considered
Data on main-, sub- and co-products generation	Yes	Yes
Data on water consumption	Yes	No
Data on electricity consumption	Yes	Yes
Data on fuel consumption	Yes	Yes

Data on consumption of raw materials	Yes	Yes
Description of production process	Yes, including combustion devices and stacks	Yes, including combustion devices and stacks
Description of emission control measurements	Yes	Yes
Data management in the PRTR	Facilities report to the PRTR through the "annual operation certificate", on electronic format	Facilities report to different authorities which in turn redirect the information to the so-called "PRTR node". The PRTR experts are working on a unique report electronic format similar to the Mexican annual operation format that should be used by the facilities to simultaneously inform all corresponding authorities and the PRTR.
Data availability	Not all data is publicly available. Moreover, some data is collected from the facilities through the annual operation certificate COA, but not included in the PRTR. For instance, emissions to water that do not surpass the threshold indicated in legislation. But this means that the information could be accessed.	The data on emissions and wastes which is regulated by legislation is publicly available. The data on emissions estimated by the authority is only available at an aggregated level.

At present only particulate matter and in some cases, carbon monoxide, sulphur dioxide and nitrogen oxides are measured. The other air emissions are estimated by the environmental authority using data on the activity rate received from the facilities and air emission factors usually taken from the US EPA AP-42 air emission factors database (EPA 1995). In future, and according to the changes introduced in legislation, more air pollutants will be measured. An officer of the Chilean PRTR indicated that improvements could be done to the PRTR if more resources were assigned to the control part, i.e. for evaluating the accuracy of the information provided.[1]

[1] Escobar Melero, J. 2008. Personal communication to M. Ossés de Eicker. Environmental Information Systems, Environmental Solutions Division, DICTUC S.A. Av. Vicuña Mackenna 4860, Comuna Macul, Santiago 6904411, Chile. Tel.: +56 2 354 4886; fax: +56 2 354 4954. jescobar@dictuc.cl.

The thorough description of the industrial processes provided in the company reports for the PRTR, particularly with respect to their technological characteristics as well as emission control measures makes it possible to define consumption- and emission factors for different alternatives of the same activity. Further, the potential amount of data would make it possible to statistically calculate the uncertainties associated with the consumption- or emission factors developed.

The data in the PRTRs evaluated still does not cover a broad spectrum of activities and measured pollutants. However, the activities environmentally most relevant are covered and the PRTRs are expected to be expanded to further activities. The amount of measured air emissions at present is quite scarce. Furthermore, the measurement of more air pollutants will require important resources and the development of necessary skills by those persons involved in data collection. Thus, the extension of the PRTRs to more measured air pollutants would take more time than the extension to more activities.

With respect to data quality, one main advantage of a PRTR is that it contains real-world data that is based on regular measurements and process information. Moreover, the data is provided by the local enterprises, a fact which would guarantee a certain level of acceptance by industry of the emission- or consumption factors developed upon the data. Further, the data going into the PRTR is controlled by the government, ensuring a data quality assessment. Finally, the PRTR data includes background information about the data (metadata), which includes a description of the method used for data collection.

5.3 Discussion

In the following, we will discuss the potentials and shortcomings of PRTRs as a source of environmental data, taking into account their characteristics mentioned in the previous sections, as well as the data requirements of the environmental assessment methods considered in this article.

The PRTRs evaluated can deliver the data on air emissions necessary to develop Latin American air emission factors. These can be used in air emission inventories and in supporting reports on greenhouse gases at national or corporate level. But this will require increasing the amount of measured emissions to air. A disadvantage of emission factors developed upon PRTR measured data is that they could overestimate the environmental loads of those activities which have to report emissions only if they surpass a given threshold. Nevertheless, in the case of Mexico this bias could be corrected by including the information supplied by the facilities through the annual operation certificate, which at present is not included in the PRTR.

The data in the Mexican and the Chilean PRTR could in future also be used to develop local LCI data for LCA or EIA of industrial activities. Nonetheless, this would only be possible if the level of response of the industry would become high enough to obtain representative data. Moreover, additional data on more types of emissions and wastes would be necessary, as well as on water consumption in the case of the Chilean PRTR.

Driving forces that can enhance the collection of measured data in Latin America are multi- and bilateral agreements, international trade and the increasing environmental awareness of the population. Let us look at some examples:

- For instance, if the IPCC continues or even increases the pressure on countries to develop national greenhouse gas emission factors for their reports, this could become a motivation for Latin American countries to extend the amount of measured air emissions.
- Similarly, the pressure being exerted on companies involved in global supply chains by consumers and civil society organizations could enhance and speed the development of customized emission factors for corporate reports. More and more companies with presence in the international market will be forced to adopt environmental management systems which entail the measurement of a comprehensive set of emissions and consumptions.

- Furthermore, the requirement of presenting an EIA in order to obtain project finance from organizations such as the World Bank will be also an important driving force for obtaining more accurate environmental data, i.e. measured data.
- Moreover, in future it is possible that EIA will be increasingly required during the preparation of the negotiations of international trade agreements, as recently was the case with Chile. Before concluding the agreement Chile conducted a review of certain environmental impacts from the proposed U.S.-Chile Free Trade Agreement (FTA), particularly those environmental impacts related to changes in the pattern and magnitude of trade flows attributable to the FTA (USTR 2003).
- New initiatives from the private sector are also emerging, such as the carbon principles developed by three giant US banks (Breeze 2008; The Carbon Principles 2008). These principles are performance standards to evaluate and address carbon risks in the financing of electric power projects. This means an improvement over older principles, such as the so-called Equator Principles (2008) or the IFC's performance standards (IFC 2008), which address social and environmental factors, but are relatively weak on the more recent goal of climate change mitigation (McCabe 2008)

Over the longer term, if data is required in comparable quality, synergies may be attainable through increased cooperation among the governmental offices, research groups and other stakeholders who are responsible for preparing data for the various approaches. Cash-strapped governments should be relieved to recognize that the data acquisition can be in many cases funded by companies. Nevertheless, governments should not leave the responsibility and the lead in environmental issues to the private sector, but should make the necessary regulations to ensure good data availability that can support their decisions on environmental issues.

The fact that a country has a PRTR based on measured data can have an additional benefit for the companies involved. The infrastructure developed by the company for collecting

measured data for a PRTR is very compatible with Environmental Management Systems (EMS) and they can support each other. An EMS which help the company manage the environmental aspects related to its activities, minimize its environmental loads and report on its environmental performance to their stakeholders. Furthermore, such data could be useful to model the material flows in whole industries and assess the efficiency of recycling activities (Krivtsov et al. 2004). Related to this, Kolominskas and Sullivan analyzed the potentials and limitations of PRTRs for supporting cleaner production initiatives (Kolominskas and Sullivan 2004).

It must be said that an EMS requires the collection of data in addition to that for a "basic" PRTR. All emissions to air, water and soil and all wastes have to be taken into account, as well as the consumption of energy and material resources. Information about the treatment of wastes and wastewater, as well as about the recycling of materials must be included. The generation of all main-, co- and byproducts is monitored. (However, in the Mexican PRTR, this data is collected.) Another important difference is that when collecting data within a EMS not only the usual activities are taken into account as they take place during stable operation conditions, but also unstable conditions (production starts and stops) as well as potential accidents. Other differences are that for an EMS data has to be collected with no regard to threshold limits, and the information on emissions must be related to the individual physical sources of emissions in the facility.

The implementation of an EMS is resource demanding, but it has important benefits for the company as well, in addition to improving environmental efficiency in the company. It can help companies to achieve a competitive advantage in the international market. One example is sustainability reporting (GRI 2008), which includes information about the social, economic and environmental performance of a company. Sustainability reports are used to benchmark organizational performance with respect to laws, norms, codes, performance standards and voluntary initiatives, to demonstrate organizational commitment to sustainable

development and to compare organizational performance over time (GRI 2008). Sustainability reporting is spreading worldwide under the Global Reporting Initiative, however still mainly among large companies. Another example is the Carbon Disclosure Project, a database of replies by companies to a questionnaire about the risks they perceive including their emissions of direct greenhouse gases (CDP 2008). The Carbon Disclosure Project encourages investment in such companies as those carrying out operations generating relatively low GHG emissions.

The conclusions drawn from the two PRTRs evaluated in this study are expected to apply also to the PRTRs to be developed in future in Latin America. The emission- and consumption factors developed on PRTR data could be administrated in a national database or they could be incorporated into already existing international databases. The integration in an existing database is less resource demanding than the development of local databases. A further advantage of this integration is that it improves data sharing. In this direction, the database developed by the IPCC on greenhouse gas emission factors IPCC-EFDB (IPCC 2003) is an example of a platform for sharing emission factors with supporting scientific information. At present this database contains basically only the default emission factors developed thus far by IPCC, as well as some US EPA AP-42 air emission factors (EPA 1995) and the emission factors from the EMEP/EEA Guidebook (EMEP/EEA 2009). However, if the international community supports this project, the EFDB might become a very useful data source.

If the Latin American PRTRs are constructed in a similar way, their data could be shared between countries. Nevertheless, the generation of sharable and comparable data requires a previous definition of common criteria regarding measuring techniques and data collection and verification, especially considering the wide range of monitoring techniques available (Michulec et al. 2005) and the broad variety of techniques usually applied by companies reporting to PRTRs (Sullivan and Gouldson 2007). Furthermore, sharing of PRTR data

among countries would require solving difficulties with regard to data confidentiality. Finally, the role of international organizations already involved in the development of PRTRs in Latin America, such as United Nations Institute for Training and Research (UNITAR), the Organisation for Economic Co-operation and Development (OECD) and the Commission for Environmental Cooperation (CEC) will be of primary importance for enhancing the exchange of experiences and the sharing of methodologies between the countries.

6. Conclusions

Latin American countries are developing means to better inform the local population about the pollutants and harmful substances generated by industrial activities in the region. In this context and following the experience in industrialized countries, some Latin American countries started the development of so-called Pollutant Release and Transference Registers (PRTRs). A PRTR is an inventory of potentially harmful substances released from industry (and in some cases from other sectors as well) to air, water and soil, as well as wastes transferred to treatment and disposal sites. Some of the data delivered by the industrial facilities to build the national PRTR are measured and some other data are estimated using international emission factors. Because of the type of environmental data collected and the accompanying information on industrial processes, PRTRs are a potential source of data to develop local emission- and consumption factors for industrial activities, on the condition that the emissions and consumption data are actually measured, and not derived from elsewhere.

This study analyses the potential of the Chilean and the Mexican PRTRs for supplying local data for three main environmental assessment methods, namely LCA, EIA and air emission inventories, as well as for greenhouse gas emission reports at the national and at corporate levels.

The present study indicates that the PRTRs evaluated still have shortcomings. Nonetheless, it is expected that the registers will continue to improve in general and will

include more and more accurate measured data. This, due to the support to come from the authorities, the pressure of bi- and multilateral agreements, international trade and the increasing environmental awareness of the population.

Based on the analysis conducted, we conclude that the data delivered by the PRTRs would make it possible in the near future to develop air emission factors for air emission inventories of the main air pollutants. The development of all additional consumption- and emission factors needed for greenhouse gas emissions reports, as well as for LCA and EIA would be also possible, however only if the present data collection system in the PRTRs is modified. If the countries are interested in the collection of this additional data, they will have to consider the costs of demanding this additional data and would have to adapt their legislation accordingly, because the Mexican experience indicates that the response of industry is not good enough when reports are voluntary, but it largely improves when reports are required by legislation.

The inclusion of more measuring data in the PRTRs would not only make it possible to develop local environmental data for further assessments, but it would improve the quality of the PRTRs for their original purpose of monitoring harmful substances released or transferred at the national level and at the level of individual facilities. Finally, the PRTRs based on measured data are not only a potential source for emission- and consumption factors. If they are combined with environmental management systems, they can contribute toward making companies more aware of the impacts generated at each stage of the production process and facilitating the development of measures to improve process efficiency and environmental performance. Thus, PRTR based on measured data represent an opportunity for companies in Latin America to become more sustainable.

Acknowledgments

The authors warmly acknowledge the aid given by Jaime Escobar from DICTUC, Chile and Maricruz Rodriguez Gallegos from SEMARNAT, Mexico in supplying information about the Chilean and the Mexican PRTRs, respectively.

References

Aguayo, F., Gallagher, K. P. and Citlalic González, A. 2001. Dirt is in the eye of the beholder: The World Bank Air Pollution Intensities for Mexico. Global Development and Environment Institute Tufts University.

Arena, A. P., 2001. Spreading Life-Cycle Assessment to Developing Countries: Lessons from Argentina. Journal of Industrial Ecology 4(3): 3-6.

Breeze, W., 2008. Capturing carbon. Environmental Finance 9(8): 20-21.

Caldeira-Pires, A. 2006. Projeto brasileiro de inventário do ciclo de vida para a competitividade da indústria brasileira. Accessed February 2008 from acv.ibict.br/publicacoes/folder.2005-11-18.7629570308/Apresentacao_Armando_%2020102006.ppt/view.

CDP The Carbon Disclosure Project, 2008. Accessed June 2008 from www.cdproject.net/index.asp.

Coltro, L., Garcia, E. and Queiroz, G., 2003. Life cycle inventory for electric energy system in Brazil. International Journal of Life Cycle Assessment 8(5): 290-296.

Coltro, L., Mourad, A. L., Oliveira, P. A. P. L. V., Baddini, J. P. O. A. and Kletecke, R. M., 2006. Environmental profile of Brazilian green coffee. International Journal of Life Cycle Assessment 11(1): 16-21.

CONAMA Comisión Nacional del Medio Ambiente, México, 2006. RETC Registro de Emisiones y Transferencia de Contaminantes. Accessed May 2008 from www.retc.cl.

CP The Carbon Principles, 2008. Accessed June 2008 from http://carbonprinciples.org/.

Curran, M. A., 2006. Report on activity of Task Force 1 in the Life Cycle Inventory programme: Data registry - Global life cycle inventory data resources. International Journal of Life Cycle Assessment 11(4): 284-289.

Da Silva, G. A. and Kulay, L. A., 2005. Environmental performance comparison of wet and thermal routes for phosphate fertilizer production using LCA - A Brazilian experience. Journal of Cleaner Production 13(13-14): 1321-1325.

Dessus, S., Roland-Holst, D. and van der Mensbrugghe, D. 1994. Input-based pollution estimates for environmental assessment in developing countries. Working Paper No 101. Organisation for Economic Co-operation and Development OECD Development Centre.

EMEP/EEA European Monitoring and Evaluation Programme/European Environment Agency, 2009. Air pollutant emission inventory guidebook. Accessed June 2009 from www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009

EPA U.S. Environmental Protection Agency, 1995. Introduction to AP 42, Volume I, fifth edition. Accessed December 2007 from www.epa.gov/ttn/chief/ap42/.

Finnveden, G. and Asa, M., 2005. Environmental systems analysis tools - an overview. Journal of Cleaner Production 13: 1165-1173.

GRI The global reporting initiative, 2008. Accessed June 2008 from www.globalreporting.org.

Hilty, L. M., Arnfalk, P., Erdmann, L., Goodman, J., Lehmann, M. and Wäger, P. A., 2006. The relevance of information and communication technologies for environmental sustainability - A prospective simulation study. Environmental Modelling & Software 21(11): 1618-1629.

IFC International Finance Corporation. The World Bank Group, 2008. Environmental and social standards. Accessed July 2008 from www.ifc.org/ifcext/sustainability.nsf/Content/EnvSocStandards.

IPCC Intergovernmental Panel of Climate Change, 2003. Database on greenhouse gas emission factors (IPCC-EFDB). Version 1.10. Accessed March 2008 from www.ipcc-nggip.iges.or.jp/efdb/main.php.

IPCC 2006. 2006 IPCC Guidelines for national greenhouse gas inventories. Accessed March 2008 from www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm.

IPCC/OECD/IEA Intergovernmental Panel for Climatic Change/Organisation for Economic Co-operation and Development/ International Energy Agency, 1997. Revised 1996 IPCC Guidelines for national greenhouse gas inventories. Accessed February 2008 from www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm.

ISO International Standard Organization, 1997. ISO 14040. Environmental management - Life Cycle Assessment - principles and framework.

Jenkins, R., Ed. 2000. Industry and environment in Latin America. Routledge, London.

Kolominskas, C. and Sullivan, R., 2004. Improving cleaner production through pollutant release and transfer register reporting processes. Journal of Cleaner Production 12(7): 713-724.

Krivtsov, V., Wäger, P. A., Dacombe, P., Gilgen, P. W., Heaven, S., Hilty, L. M. and Banks, C. J., 2004. Analysis of energy footprints associated with recycling of glass and plastic - case studies for industrial ecology. Ecological Modelling 174(1-2): 175-189.

McCabe, J., 2008. Five years around the Equator. Environmental Finance 9(8): 16-18.

Michulec, M., Wardencki, W., Partyka, M. and Namiesnik, J., 2005. Analytical techniques used in monitoring of atmospheric air pollutants. Critical Reviews in Analytical Chemistry 35(2): 117-133.

Morris, P. and Therivel, R., Eds., 1998. Methods of environmental impact assessment. The natural and built environment series 2. UCL Press, London.

Power, H. and Baldasano, J. M., Eds., 1998. Air pollution emissions inventory. Computational Mechanics Publication, Southampton.

The Equator Principles, 2008. Accessed July 2008 from www.equator-principles.com/principles.shtml.

Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G., Rydberg, T., Schmidt, W.-P., Suh, S., Weidema, B. P. and Pennington, D. W., 2004. Life cycle assessment: Part 1: framework, goal and scope definition, inventory analysis and applications. Environment International 30(5): 701-720.

Ruddy, T. F. and Hilty, L. M., 2008. Impact assessment and policy learning in the European Commission. Environmental Impact Assessment Review 28(2-3): 90-105.

SEMARNAT Secretaria del Medio Ambiente Recursos Naturales y Pesca. Instituto Nacional de Ecologia, 2008. Registro de emisiones y transferencia de contaminantes. Accessed April 2008 from www.semarnat.gob.mx/gestionambiental/calidaddelaire/Pages/retc.aspx.

Silva, G. A. and Kulay, L. A., 2003. Application of life cycle assessment to the LCA case studies single superphosphate production. International Journal of Life Cycle Assessment 8(4): 209-214.

Skone, T. J., 2001. www.LCAccess - Global Directory of LCI resources. International Journal of Life Cycle Assessment 6(2): 73-75.

Sonnemann, G. and De Leeuw, B., 2006. Life Cycle Management in developing countries: state of the art and outlook. International Journal of Life Cycle Assessment 11(SPEC. ISS. 1): 123-126.

Sullivan, R. and Gouldson, A., 2007. Pollutant release and transfer registers: Examining the value of government-led reporting on corporate environmental performance. Corporate Social Responsibility and Environmental Management 14(5): 263-273.

UNEP United Nations Environmental Programme, 2004. Conferencia de las Américas sobre Registros de Emisiones y Transferencia de Contaminantes (RETC), 21 to 23 April, Ciudad de México.

UNEP United Nations Environmental Programme, 2006. GEO Year Book 2006. Accessed February 2008 from www.unep.org/geo/yearbook/yb2006/.

USTR U.S. Trade Representative, 2003. Final environmental review of the U.S.-Chile Free Trade Agreement, technical report. Accessed July 2008 from www.ustr.gov/assets/Trade_Agreements/Bilateral/Chile_FTA/asset_upload_file411_5109.pdf

World Bank 1996. Environmental assessment sourcebook. Accessed August 2007 from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTENVASS/0,,contentMDK:20282864~pagePK:148956~piPK:216618~theSitePK:407988,00.html.

World Bank 1998. Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production. Accessed 02.01.2006, from www.ifc.org/ifcext/enviro.nsf/Content/PPAH.

World Bank 2005. Estimating pollution load: the Industrial Pollution Projection System (IPPS). Accessed November 2007 from www.worldbank.org/nipr/ipps/ippsweb.htm.

WRI and WBCSD World Resources Institute and World Business Council for Sustainable Development, 2004. A Corporate Accounting and Reporting Standard. Revised Edition.