

New LCA Software (Subject Editor: Andreas Citroth)

Apeironpro, Software for Life Cycle Assessment (LCA) and Environmental Performance Evaluation (EPE)

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Abstract

Background, Aims and Scope. In the world there are more than thirty LCA software products, but they do not have inventories or an evaluation method either with regional applicability, especially for Colombia. A special software for Life Cycle Assessment and the Environmental Performance Evaluation has been developed, which considers the environmental impacts generated by products during their life cycle and processes involving productive activities. It accounts with inventories applicable to Colombia, for processes and services like electrical energy production, transport and waste disposition. The Ecotoxicity evaluation method was adapted to Colombia with national legislation and agreements for polluting reduction signed by country and the EPI (Environmental Points of Impact) was established for 353 substances.

Methods. The software allows users to use the methodology which corresponds to the standard ISO 14030 and 14040 directives. The database uses the SPOLD international format. For ApeironPro software, database information used from monitoring air emissions and effluents on factories in the region were realized by the Environmental Research Group from Pontificia Bolivariana University and secondary type information has been obtained starting from studies realized by environmental organizations and factories in the country which are interested in the management of quality environmental indicators. The antiquity of the information was restricted from the last 5 years, 1998 to 2003, in order to possess temporal representativity. The Ecotoxicity method uses information of the Environmental Ministry and Environmental Institutes of Colombia for the actual current load (F), and target norm for total load (F_k), using information with national legislation and agreements for polluting reduction signed by the respective countries. The software was designed in Web ambience with the database in MySQL, while the programming language was JAVA from Sun Microsystems.

Results. The software has inventories for energy (electricity from coal, natural gas, fuel oil, hydroelectricity) transport (mean air, truck, motor bus), processes (plastics, rubber, sugar, paints production, detergent production, combustion in heaters, foundry of copper, iron, gold), waste disposal (incineration and landfill).

Discussion. The Ecotoxicity method was analyzed for seven impact categories: climate change, acidification, stratospheric ozone depletion, photo-oxidant formation, eutrophication, ecotoxicity and depletion of abiotic resources (coal, oil, natural gas, copper, nickel).

Conclusions. For Colombia, the highest environmental impact is associated with the ozone layer depletion (235.7 Ecopoints/g) while the lowest is associated with depletion of coal (8.6×10^{-7} Ecopoints/g), although this is reasonable since Colombia is the tenth largest producer of coal in the world.

Recommendations and Perspectives. Latin America and Colombia need more inventories for their processes and to identify the more significant environmental impacts of their industries. This work is an initial step in the research about Life Cycle Assessment and can also improve the work in ecolabels for Colombia.

Keywords: Apeironpro software; Colombia; ecopoints; ecotoxicity; environmental performance evaluation (EPE); environmental points of impact (EPI); ISO14030, ISO14040; LCA

Introduction

Given the necessity to carry out studies of Life Cycle Assessment (LCA) and Environmental Performance Evaluation (EPE) of a permanent form in Colombia, and considering the specific requirements of environmental information to carry out valid environmental evaluations in the local conditions, and looking, in addition, to harness the development of initiatives of green markets and the Colombian ecolabel (green Colibrí), the Pontificia Bolivariana University and the company developer of AVANSOFT software, with the support of COLCIENCIAS, have developed a computer science tool that allows one to carry out studies of EPE and LCA under the international norms and with local applicability.

1 Environmental Database for Colombia

ApeironPro is dependent on an important environmental database where data of emissions to the air, water or the ground, of diverse processes like the generation of electrical energy, transport, productive processes and waste disposition are to be found, all with data for Colombia. The database uses the international format SPOLD [1], which is internationally accepted and is used widely in different Life Cycle Assessment (LCA) software throughout the world, thereby facilitating the interchange of data for inventories.

For the database of ApeironPro software, information of a primary type, systematized from monitories of air quality, is used and the water made by the Environmental Research Group (in Spanish, Grupo de Investigaciones Ambientales, GIA) of the Pontificia Bolivariana University and data of a secondary type, obtained from studies made by environmental and industrial organizations in the country interested in the handling of indicators of environmental quality, is taken into account. The antiquity of the information is restricted to the last 5 years, 1998 to 2003.

The inventories of the database of software are divided into four modules, including energy, transport, processes and waste scenarios, giving one first approach to the inventories of more utility to make a study of LCA or EPE.

Energy. The information used is published by the Mining-Energetic Planning Unit for electricity from coal, natural gas and oil fuel [2]. The inventory of hydroelectricity and thermoelectrical sources was developed by the GIA (primary data) and for some of the main industries of the country.

Transport. The information for road transport uses the emission factor CORINAIR [3] and the methodology MOBILE 5A [4], with inventories for trucks, cars and bus. The information for air transport, takes the world-wide data from emissions for motors used in airships into account, as published by the Civil International Aviation Organization – ICAO [5].

Processes: Accounting for inventories for such processes as rubber, paper, sugar, textile, cement, detergent and paint production; heating and foundry combustion [6].

Waste scenarios: This involves information for the biggest landfill in Colombia (5,000 t/day) and incineration for organics, pathologic and hospital wastes [7]. **Table 1** shows the information of the database.

Table 1: Summary of the database

Module	Inventories
Electricity	Electricity from coal, natural gas, fuel oil and hydroelectricity
Transport	Transport by truck, auto, bus
	Transport by plane
Processes	Plastics PVC, PEAD, PEBD, ABS, rubber, sugar, copper, iron, aluminum, gold foundry
Waste scenario	Incineration of pathologic hospital and organic wastes, landfill disposition

2 Environmental Impact Assessment Method – Colombian Ecoscarcity

Using the environmental impact assessment for life cycle assessment 'ecoscarcity' [8], the Ecopoints for seven reference substances on impacts like global warming, ozone depletion, photochemical oxidants formation, acidification, eutrophication and depletion of abiotic resources like water, crude oil, copper, nickel, natural gas were calculated. Then, for an application of characterization factors, you can recognize the Ecopoints for 363 substances.

Using Eq. (1), the evaluation is realized in Ecopoints for each environmental effect:

$$EIP = \frac{F}{F_k} \times \frac{1}{F_k} \times C \tag{1}$$

where:

- EIP = Environmental Impact Point
- F = current flow (t/a),
- F_k = critical flow (t/a), and
- C = constant, 10¹² /year

Table 3: Basic structure of ApeironPro software

Model	Inventory	Evaluation Method	Interpretation / Impact Assessment
The model of the real data used by the user within their company or for its product are entered.	It includes data of the consumption of raw materials, energy, fuel, emissions and pourings found in sectorial studies.	Based on the premise that the natural atmosphere can only be contaminated up to a limit determined by the environmental legislation or international agreements for the reduction of polluting agents; if the impact is greater, waste must be avoided.	From the results established by ApeironPro software, it will also be possible to make a comparison of the most significant impacts to the atmosphere by industrial sector.

Table 2: EIP for Colombia

Impact Category	Reference substance	Ecopoint/g Col
Global warming	CO ₂	0.02
Acidification	SO ₂	14.07
Ozone layer depletion	R11	235.68
Photochemical ozone creation	CO	0.0187
Eutrophication	DQO	1.51
Ecotoxicity	Hg	106.57
Resource Depletion	Water	4.88E-02
	Crude oil	4.98E-04
	Natural gas	3.18E-03
	Coal	8.60E-07
	Copper	7.20
	Nickel	0.0629

For Colombian conditions, the Ecopoint concerning the importance of each category was calculated (**Table 2**).

According to the results of **Table 2**, the biggest environmental impact in Colombia is associated with ozone layer depletion (235.7 EIP/g R-11), and the lowest one is associated with coal depletion (8.6E-07 EIP/g coal), a finding which is logical since Colombia is the third largest coal producer in the world.

3 Structure of the Software

ApeironPro is a software based on Web technology that includes the databases to carry out the studies of LCA and EPE with applicability to the national technological conditions. The operation of software consists of taking the data entered by the user (Model) to multiply them by an Ecobalance or Life Cycle Inventory, which contains the environmental data (consumption of raw materials, fuel consumption, consumption of energy, emissions to the air and pourings). Some inventories are fed in software or the same user can even enter them. The resulting data are multiplied by the Ecopoints and calculated for Colombia with the Ecoscarcity – Colombia 2004 method. The information generated shows

- the Ecopoints by their limit of the system
- the Ecopoints for different stages from the process
- the Ecopoints by more significant environmental effect.

Table 3 shows a summary of the parts that compose software and how these elements are connected.

The software is designed in Web ambience to the MySQL database, and its programming is in JAVA from Sun Microsystems. The software can be utilized by the Internet. It has an interface and it imports the inventories of the SPOLD format.

The reports can be exported to Microsoft Excel and the user can manipulate the information or use Acrobat reader.

4 Conclusions

For the application of the Ecoscarcity method for environmental evaluation, the Colombian legislation supported agreements for reducing pollution in their country and for reducing the capacity of the environment for supporting this load of contamination.

The biggest environmental impact in Colombia is associated with ozone layer depletion (235.7 Ecopoints/g R-11), and the smallest is associated with coal depletion (8.6E-07 Ecopoints/g coal), and this is logical since Colombia is the third largest coal producer in the world.

5 Recommendations and Perspectives

Latin America and Colombia need more inventories for their processes and for identifying the more significant environmental impacts of their industries. This work is an initial step in the research about Life Cycle Assessment and can also improve the work in ecolabeling for Colombia.

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