# Geotraceability and life cycle assessment in environmental life cycle management: towards sustainability

Aldo Ometto[a,1], Mateus Batistella[b], Américo Guelere Filho[c], Gérard Chuzel[d] and Alain Viau[e]

[a] Professor (Engineering), Enginerring School of São Carlos, University of São Paulo, Institute Factory of Millennium, Brazil.
[b] Researcher (Environmental Science), Embrapa Satellite Monitoring, Brazil.
[c] Researcher (Engineering), Enginerring School of São Carlos, University of São Paulo, Institute Factory of Millennium, Brazil.
[d] Researcher (Agricultural Science), Cemagref, France.
[e] Professor (Geographic Science), University of Laval, Canada.

**Abstract.** Sustainability is an emerging concept in product chains and integrates environmental, social, and economic aspects during the product's life cycle. Recently, the demand for environmental quality has required information about the products'life cycle. Life Cycle Assessment (LCA) includes the inventory analysis, where the inputs, outputs and feedback mechanisms of matter and energy for each phase of the product life cycle are systematized, and the Life Cycle Impact Assessment, when the environmental impacts potentials are calculated. A powerful tool to describe the history, use, and location of a product is called geotraceability. This paper presents an environmental life cycle management for storing and retrieving product life cycle data within a food chain (tracing), as well as following the location of the product in real time (tracking), particularly for recall operations in case of a crisis. Information about inputs and outputs can be structured and integrated through LCA. Geographic information can be obtained from satellite imagery and positioning systems. The development and integration of these tools will add value to products and enhance food safety to consumers, as well as the environmental quality within the production area, fostering environmental sustainability to the product life cycle.

**Keywords.** Environmental Life Cycle Management, Geotraceability, Life Cycle Assessment, Sustainability

[1] Professor (Engineering), Enginerring School of São Carlos, University of São Paulo, Institute Factory of Millennium, Brazil. Av. Trabalhador São-Carlense, 400, City Code: 13566-590 São Carlos/SP - Brazil; Tel: +55 (16) 3373 8608; Fax: +55 (16) 3373 8235; Email: aometto@sc.usp.br; http://tigre.prod.eesc.usp.br/producao/docentes.htm

## 1 Introduction

Sustainability presents many definitions but the basic principles and concepts remain constant: balancing the economy aspects, protection for the environment, and social responsibility, so they together lead to an improved quality of life for ourselves and future generations. "This concept of sustainability encompasses ideas, aspirations, and values that continue to inspire public and private organizations to become better stewards of the environment and promote positive economic growth and social objectives. The principles of sustainability can stimulate technological innovation, advance competitiveness and improve our quality of life" [1].

The environmental, social, and economic impacts of the products have to be analyzed according to their life cycles. Product life cycle thinking is important in the path towards sustainability by expanding the focus from the production process to the product life cycle (figure 1).

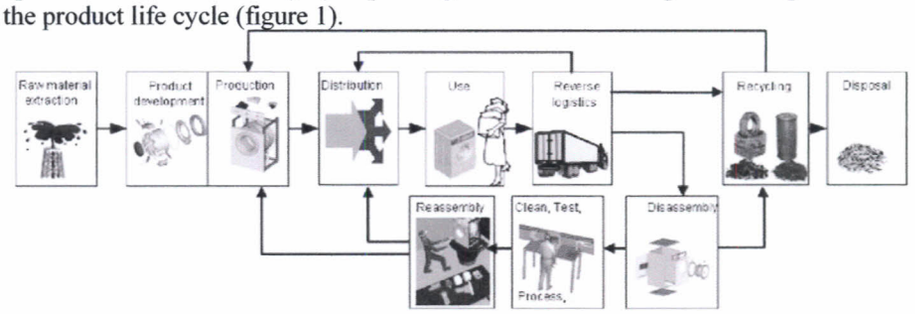


**Figure 1**. Product Life Cycle [2].

The importance of such topic is related to recent demands and regulations taking place in some countries, especially in the European Community, based on an Integrated Product Policy, including the:

- Directive on Waste Electrical and Electronic Equipment (WEEE - 2002/96/EC) and Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (2002/95/EC);
- General food law 178/2002, "hygiene package" (Regulation 852-853-854/2004), and implications for non EU Countries of the new legislation on Food and Hygiene; geotraceability systems can comply with requirements along the whole food chain;
- European action plan for organic food and farming: the principle of a "trace and track" decisional operational system based on a multicriteria approach could be applied to organic farming and further away, for example, to landscape management or risk assessment;
- Environmental Technology Action Plan (ETAP), which encourages developing countries to use environmental technologies, for their potential to improve both the environment and economic competitiveness; a geotraceability system can promote new communication technologies to provide management tools allowing

impact mitigation on natural resources and fostering best land use practices.

This paper focuses on a cutting edge aspect related to environmental management taking in account the life cycle thinking. In fact, our goal is to integrate geotraceability and life cycle assessment as tools for an environmental life cycle management.

## 2 Environmental Management

Environmental management can be defined as the management of human activities so that natural resources are used adequately to meet human needs and the environment's continuing capacity to provide those resources is sustained [4].

This approach is illustrated in figure 2, which shows the phases required to achieve the environmental viability of an activity.

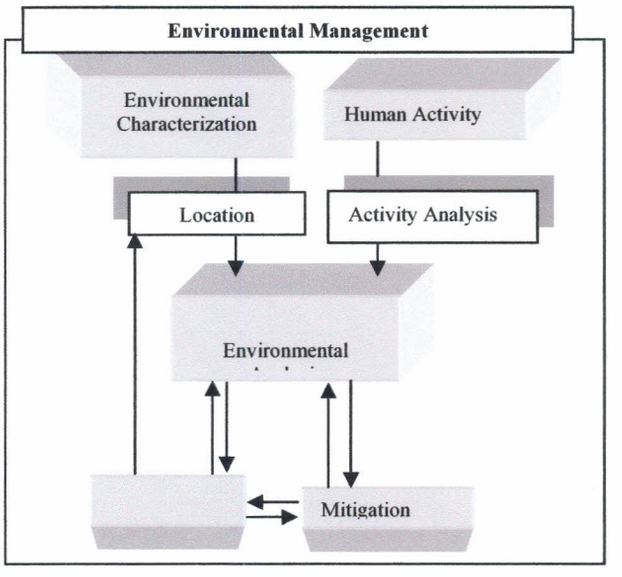


**Figure 2.** Environmental management diagram [3]

Knowledge about the environmental aspects of a production area, including physical, chemical, biological, social, economic, and cultural characteristics, is of primary importance to determine the potential of such area regarding the product's life cycle. Knowledge about the human activity is also crucial, as it will indicate potential impacts on matter cycles and energy fluxes. The environmental analysis evaluates the need of impact mitigation.

## 3 Geotraceability

Geotraceability is the ability of describing the history, the use, and the location of a product, allowing tracing and tracking from its production to its consumption. Thus, it is necessary to retrieve and store information about the characteristics and the history of the product (tracing), as well as to follow its real time location (tracking), in particular for recall operations in crisis situations, such as the avian influenza.

The importance of such tools is evident, as they integrate a spatial component to the product life cycle, adding value to market products, to certification and labeling in retail business, and to communication with consumers, with the potential. to subsidize future policies for the sector.

Geotraceability may be used to increase confidence in products being acquired by consumers through the knowledge of their trajectory, safety, and quality from production to consumption. The process is carried out through standard spatial indicators, in conformity with defined norms, to integrate information from various sources, quality, and scales of observation. Much has to be improved in terms of standardization, but efforts have been made in several countries. All these issues are associated with the availability of information and knowledge about the product chain.

Some food chains are particularly important due to the emerging sanitary risks attached to international commercial relations [6]. For obvious reasons, beef is among the most important products to be tracked and traced using a spatially explicit system.

In Brazil, various sectors are interested in such tools, as they may become crucial in the near future. Recently, a specific support action proposed by a partnership among Cemagref (France), University of Laval (Canada), Embrapa (Brazil), and Cirad (France) was funded by the European Commission. Its goal is to develop an operational management and geodecisional prototype to track and trace agricultural production, with a major focus on the beef chain (figure 3). The prototype will be implemented in Campo Grande, where Embrapa Beef Cattle is located.

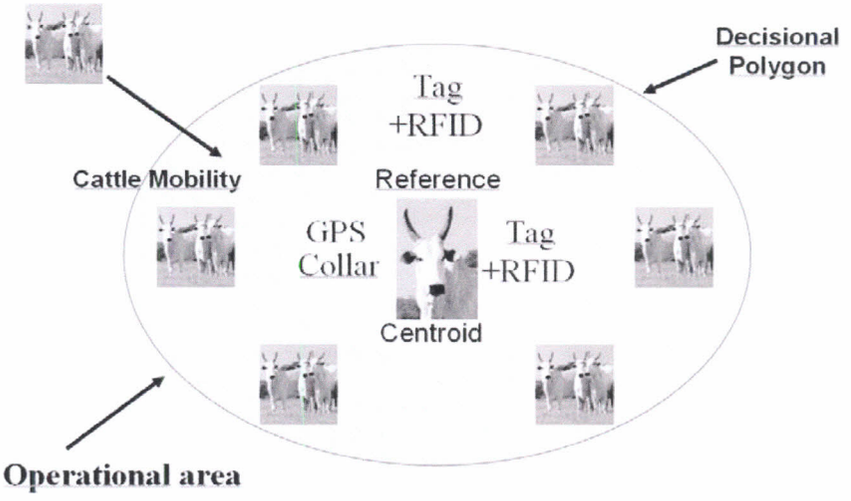


**Figure 3.** Framework for an operational management and geodecisional prototype to track and trace beef production .

## 4 Life Cycle Assessment

The first examples of environmental assessments of products were carried out for packaging in the 1960s. Twenty years later, the interest about environmental impacts grew and Life Cycle Assessments (LCA) were used in several European countries to compare different packaging processes. Recently, many complex products have been assessed through LCA and. companies have used it in product development, environmental management, marketing, and labeling. Consumer organizations have also used LCA in counseling consumers [7].

Life Cycle Assessment (LCA) is a tool for the systematic evaluation of environmental aspects related to a product or service system through all stages of its life cycle. LCA provides an adequate instrument for environmental decision support. Life cycle assessment has proven to be a valuable tool to document the environmental considerations that need to be part of decision-making towards sustainability. A reliable LCA performance is crucial to achieve a life-cycle economy [5].

The International Organization for Standardization (ISO) defines the methodological structure of LCA in four phases [5] (figure 4):

**Goal and scope definition:** the product(s) or service(s) to be assessed are defined, a functional basis for comparison is chosen and the required level of detail is defined.

**Inventory of extractions and emissions, called Life Cycle Inventory (LCI):** the energy carriers and raw materials used, the emissions to atmosphere, water and soil, and different types of land use are quantified for each process, then combined

in the process flow chart and related to the functional basis. **Life Cycle Impact assessment (LCIA):** the effects of the resource use and emissions generated are grouped and quantified into a limited number of impact categories which may then be weighted for importance. **Interpretation:** the results are reported in the most informative way possible and the need and opportunities to reduce the impact of the product(s) or service(s) on the environment are systematically evaluated.

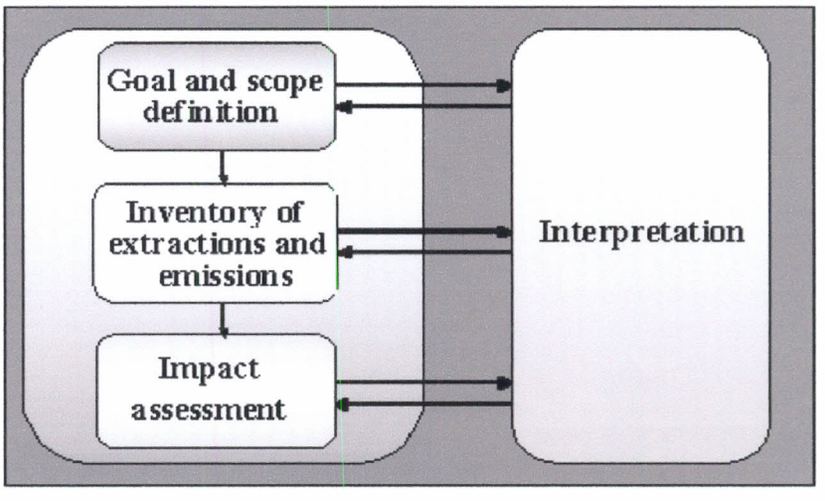


**Figure 4.** The phases of LCA [5]

The main expected results from the LCA are to identify and quantify the environmental loads involved; e.g. the energy and raw materials consumed, the emissions and wastes generated; to evaluate the potential environmental impacts of these loads and to assess the options available for reducing these environmental impacts [5].

## 5 Environmental Life Cycle Management

Environmental Life Cycle Management (ELCM) is the environmental management based on life cycle thinking.

The application of geotraceability and LCA can be practical tools for an ELCM. Based on figure 2, the environmental characterization, location, the environmental analysis which takes in account the caring capacity, and monitoring can be carried out through geotraceability. The human activity analysis can be carried out through LCA, as following: the Activity Analysis can be made by the LCA scope definition and LCI; the Environmental Analysis can be made by the LCIA, considering the caring capacity; and the Mitigation options can be made by the LCA interpretation (figure 5).

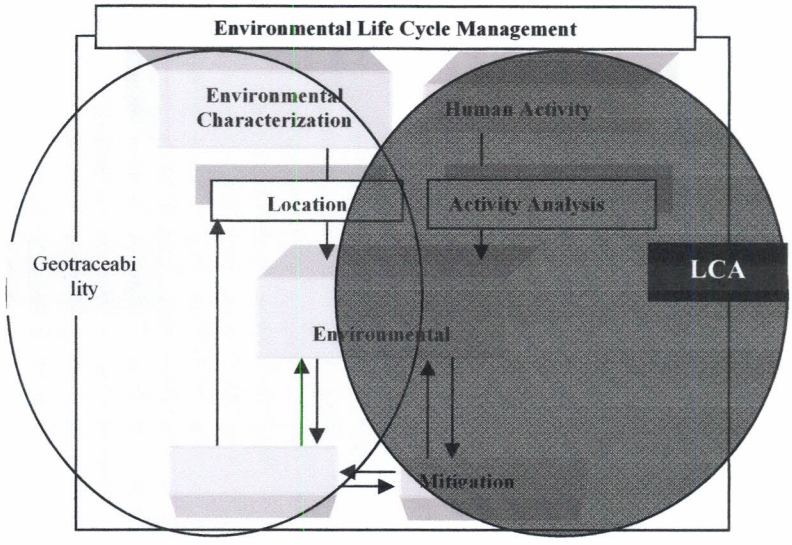


**Figure 5**. Geotraceability and LCA application in ELCM

## 6 Conclusion

Geotraceability and LCA are important tools with the potential to introduce, in a practical way, the life cycle thinking in environmental management (i.e., ELCM).

The adoption of geotraceability systems and LCA can enhance product safety and quality, providing industries, consumers, and all stakeholders with a level of information compatible with the demands of a global market and with the need of effective environmental management, taking in account the environmental characteristics and the product life cycle.

## 7 References

[1] Environmental Protection Agency – EPA – US. Available at: <http://www.epa.gov/sustainability/>. Accessed on: Jan. 15th 2007.
[2] Franke, C. Product Life Cycle. CRI. TUBerlin: 2004.
[3] Souza, M.P. Instrumentos de Gestão Ambiental: teoria e prática. Riani: 2000
[4] Tolba, M.K. Development without destruction: involving environmental perceptions. Dublin, Ireland: Tycooly International Publishing Ltd. 1982
[5] United Nation Environment Programme – UNEP. Evaluation of Environmental Impacts of Life Cycle Assesment. Available at: <http://www.unep.org/lci/>. Accessed on: Jan. 25th 2007. 2003.
[6] Vinholis, M. B., Azevedo, P. F., 2000, Efeito da rastreabilidade no sistema agroindustrial da carne bovina brasileira, World Congress of Rural Socology, Rio de Janeiro, v.1, pp.1-14.
Wenzel, H.; Hauschild, M. And Alting, L. Environmental Assessment of Products. 1997