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Assessment methods: *Life cycle analysis, eco-design, industrial and territorial ecology*

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ELSA cluster: life cycle analysis of process sustainability

The *Environmental Lifecycle and Sustainability Assessment cluster* (ELSA) is a multidisciplinary research group dedicated to the environmental and social life cycle analysis of processes and to industrial ecology. ELSA brings together researchers, teachers and students from several institutes of research and higher education in the Languedoc-Roussillon (LR) region. Its members thus benefit from the pooling of other members' expertise and knowledge.

ELSA was founded in 2008, with the Region's support, as part of the EcoTech-LR platform, which brings together five organizations: INRA, CIRAD, EMA, Montpellier SupAgro, and IRSTEA. ELSA's role within that platform is the cross-cutting task of environmental and social assessment of the processes under study, whether in agriculture, water and waste management, biomass energy production, or land use planning.

ELSA members work together to:

- advance the methodology of environmental and social assessments;

- disseminate those methodologies by developing collaborations with industrial partners, consultants and local communities, and the State;
- provide training to students and professionals;
- brief the scientific community through seminars, conferences, etc.

With a current staff of 30 researchers, half of them permanent, the ELSA cluster has had very strong growth over the past four years. In 2012, ELSA was involved in 21 research projects (9 ANR projects, 4 FUI, 3 ADEME, and 4 international projects).

In the area of science facilitation, the ELSA cluster organizes two to three events a year; since its inception it has held two research symposia (one international and one national), two international seminars and four awareness days. Since 2011, the ELSA cluster has extended its international reach through the Interreg EcoTech-Sudoe project (an international life cycle analysis and eco-design network for innovative environmental technologies), which has enabled networking and exchanges between eight French, Spanish and Portuguese laboratories. The ELSA cluster is open to any new collaborator or institution wishing to take advantage of the arrangement, upon acceptance by the administrators. ■



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▲ Turning over green waste compost on Réunion.

GIROVAR Project participatory modelling for the co-construction and evaluation of scenarios for integrated organic waste management

On Réunion island, the management of a number of growing organic waste dumps (sewage sludge, manure, green waste, food waste) poses serious problems, mainly because of siloing of the various industries, even while these organic materials could be of great service in agriculture. The project Integrated Organic Waste Management through Agricultural Enrichment on Réunion (GIROVAR), being conducted by a consortium of seven partner organizations (co-ordinated by the UPR “Recycling & Risk” in collaboration with the UR “Renewable Resource Management and Environment”) in the conurbation of towns in the west of Réunion, is looking into the service potential of organic waste recycling. A participatory research method is used to identify integrated land management scenarios whereby the potential benefit could be realized, the aim being to make possible all current and planned developments in the various sectors concerned without endangering the regional system’s sustainability. It is essential for the scenarios identified to be rigorously and objectively evaluated from an environmental, logistical, regulatory, economic and social standpoint.

As regards the environmental aspect, territorial ecology research has produced ways of assessing the effect in terms of island-wide eco-efficiency (through a study of the island’s “metabolism”). However, these methods cannot determine what services could emerge or what environmental impacts these scenarios may ultimately have. By coupling the territorial ecology approach with a systemic evaluation framework (“Driver-Pressure-State-Impact-Response”), the environmental



◀ The logic behind the GIROVAR project and its stages.

assessment seeks to produce a spatio-temporal analysis of the changes in environmental impacts that would be generated by the management scenarios being considered, to estimate how great the change of state might be in the various environmental areas (land, air, water...), and to gauge the risk of harm or the likely benefit of these impacts.

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DEPART project

from waste management to the circular economy—the emergence of new partnership practices in port areas

In industrial ports, massive amounts of matter and energy are exchanged and transformed. Hence, ports are gradually assimilating the principles and tools of industrial and territorial ecology in order to optimize their matter and energy flows and to foster collaborative practices of recycling and recovery of liquid, solid or gaseous industrial wastes. Such actions are now seen as essential in maintaining competitiveness in industrial and port activities and in reducing the pressure exerted on the environment. However, the adoption of such practices does not depend only on the intrinsic characteristics of the matter and energy flows (quantity, quality, variability, etc.); The cultures of cooperation of the various territorial actors and their understanding of the major issues and problems in the study area are all fundamental in mobilizing stakeholders to engage in territorial resource management. Before deploying and generalizing this type of approach, the first requirement is to establish a diagnosis, to characterize and evaluate the above criteria.

The DEPART project (2010-2012) was co-funded by ADEME and involved six partners (Auxilia, Mydiane, Vianova System, Systèmes Durables, EMA, *Université Toulouse II*). Its goal has been to innovate in its methodological approach to industrial and territorial ecology by proposing and validating the adoption of a methodology based more on stakeholders' perceptions, the skills available and the needs felt than merely a flow analysis. Its specific context is port areas. A range of tools (territorial analytical grid, geographic information system, territorial intelligence tree, etc.) were developed and used to optimize the collection and use of territorial data drawn from existing documents and databases but also from targeted interviews with key players in the territory and/or the areas of activity under study. These tools were iteratively tested and developed at the ports of Fos-sur-Mer and Le Havre.

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Environmental assessment methodology for activities distributed over a broad area

European Directive 2001/42/EC proposes the establishment of a procedural tool, a "Strategic Environmental Assessment" (SEA), which must be applied right from the first stages of the development of plans and programmes likely to have a "significant" influence on the environment. This includes programmes related to local areas and their management (e.g., in France, territorial coherence plans, local urban planning...). However, there is no formal process for making such assessments.

Methodological developments are needed so that a comprehensive assessment may be done of environmental impacts within a territory and development choices endorsed. A current thesis at UMR ITAP, within the ELSA cluster (co-direction by ITAP/EMA/UMR TETIS [AgroParisTech/CIRAD/IRSTEA] with the collaboration of the Syndicat Mixte du Bassin de Thau) aims to develop an environmental analysis methodology as a tool for optimizing development choices in a particular area.

► *The main methodological barriers to LCA implementation within a territory.*

Study of the environmental impacts of the insertion of preconditioning by fast pyrolysis in biomass energy supply chains



▲ Sawmills' activities generate a large quantity of waste that can be converted into energy. Brazil.

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Timber harvesting in Amazonia generates a significant amount of waste: in the Brazilian state of Pará, for 2.5 million m³ of sawn timber produced in 2010, 4 million m³ of waste was generated. That biomass, now little regarded, could be a valuable input for an energy generation industry; but, given wood's low energy density and how scattered the resource is (in Pará, forestry operations take place in more than a thousand sawmills), the distances over which transport is feasible are limited, for economic and environmental reasons. This makes the undertaking a difficult one. Fast pyrolysis, a process of biomass preconditioning resulting in a liquid fuel known as pyrolysis oil or bio-oil, can significantly enhance the energy/mass ratio of the wood waste, so reducing the cost of transport. As bio-oils are liquid fuels, homogeneous and pure, they afford more recovery possibilities than raw biomass: co-refining with petroleum feedstocks; combustion in boilers, diesel engines, and extraction of molecules for simultaneous chemical upgrading.

The work of the UR "Biomass & Energy" (CIRAD), in collaboration with the University of Brasília (UnB) and the Brazilian Forest Service, aims to quantify, by means of an LCA, the environmental benefits of the incorporation of fast pyrolysis into biomass supply chains. The ultimate goal is to determine the contexts where fast pyrolysis is most relevant and most favours the emergence of a biomass-based energy production process, and to optimize the environmental benefits of the use of sawmill waste. This work is being undertaken as part of a doctoral programme co-supervised by CIRAD and UnB and the research project Multi-resource Adaptation to Gasification (AMAZON), co-funded by ANR, France / Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brazil.

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At present a number of different tools may be used for these assessments (LCA, material flow analysis, input-output analysis, exergy, energy, ecological footprint, environmental risk analysis). Of these, LCA has been identified as a potentially promising tool for local decision support. However, LCA is originally a product/service oriented approach. It has been proposed that the scale of the systems under review be expanded by incorporating an analysis of territorial systems. To date, no studies have been done for one entire territory. This may be explained by the presence of certain methodological obstacles:

- (i) definition of functional unit(s) and reference flow,
- (ii) selection of system boundaries, (iii) system modelling, and (iv) development of appropriate local decision support indicators. Accordingly, recommendations will be made on how to adapt the LCA methodological framework to the environmental assessment of whole territories. The work proposed by the thesis will be applied to the study of land use scenarios within the territory of Thau Lagoon (France).

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