L'UMR Espace-Dev, avec l'aide de NEXA et le projet Européen Forward, propose une formation de spécialisation et d'ouverture en métabolisme insulaire.

Le séminaire prendra la forme d'une école d'été avec 4 séances (2 séances théoriques le Jeudi 19 et Vendredi 20 mai et 2 séances pratiques, Lundi 23 et Mardi 24 mai).

Le séminaire pourra se suivre à distance avec l'heure GMT +4 de La Réunion. Il sera en anglais de travail avec la possibilité de traductions entre les participants si besoin.

Le professeur Mario Giampietro, actuellement en Afrique du Sud, est chercheur à l'Institut de Sciences et Technologies de l'Environnement à Barcelone (ICTA-UAB). Il a fondé une méthode de métabolisme social (territorial) multi-échelle MuSIASEM (systèmes agro-alimentaires, énergie, eau, travail). Son équipe a réalisé des analyses dans les contextes insulaires comme Galapagos et l'Île Maurice. Dans cette île, à Maurice, une étude a été financé par le gouvernement et par la FAO afin de modéliser des scénarios de transition agroécologique pour les cultures de canne en 2014 (voir l'article en PDF ci-joint). MuSIASEM est complémentaire des méthodes MFA-EW habituelles.

Ce séminaire a un volet théorique et un autre pratique. Si vous êtes intéressé.e.s à participer il suffit d'écrire un email à Pablo Corral-Broto : pablo.corral-broto@univ-reunion.fr
Si vous voulez que dans les séances pratiques on puisse travailler avec les données de vos terrains, n'hésitez pas à nous contacter.

Le séminaire est conçu pour former des étudiant.e.s en master, doctorant.e.s, ingénieur.e.s d'étude et de recherche, et tout autre personne enseignante-chercheuse ou chercheuse. Il peut aussi intéresser des professionnel.lle.s réunionais.e.s

L'idée est de constituer un groupe de travail capable de réaliser des publications et des études collectives pour expertiser les transitions écologiques dans La Réunion, en première phase, et dans d'autres contextes insulaires.

Course Outline

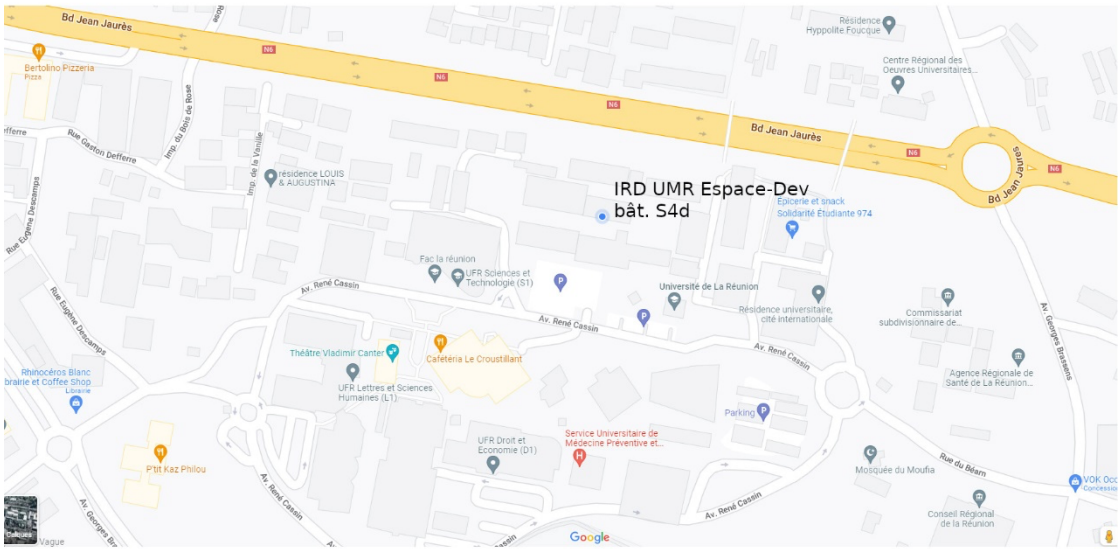
Using the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM) Methodology towards a "Governance in Complexity" of Sustainability

Contact : pablo.corral-broto@univ-reunion.fr

Session 1 (2 days) : Thursday 19th and Friday 20th May, 9am-4pm

Session 2 (2 days) : Monday 23rd and Tuesday 24th May, 9am-4pm

Place : UMR ESPACE DEV (IRD, Bâtiment S4 d, Parking Faculté de Sciences, Campus Nord Moufia, Saint-Clotilde)



Session 1: Concepts and Theory (2 days)

DAY 1 – **Morning Part 1** – ***Implications of complexity on the validity of scientific inputs used for governance*.** "All models are wrong, some are useful". How do we know that "all models are wrong" (hierarchy theory and the essence of impredicativity) and when it is that "some [models] are useful" (post-normal science)? Moving from *scientific evidence* (quantitative results from inside a given epistemic box) to *quantitative storytelling* (quantitative results exploring the usefulness of different epistemic boxes). Closing DISCUSSION.

DAY 1 – **Morning Part 2** – ***Using the concept of the metabolic pattern of social-ecological systems to operationalize the Drivers-Pressures-States-Impacts-Responses (DPSIR) causal framework*.** How can we apply the complexity frame of reference to the generation of quantitative analysis supporting the governance of issues of sustainability? For starters, we can combine: (1) the state-pressure relation (non-equilibrium thermodynamics); (2) the flow-fund model of Georgescu-Roegen (bio-economics); and (3) relational analysis (relational biology), towards an identification of the structural and functional elements composing a complex adaptive system and an integration of the quantitative analysis of their characteristics across different levels and scales. Closing DISCUSSION.

DAY 1 – **Afternoon Part 1** – ***Using quantitative storytelling (QST) to flag the existence of uncomfortable knowledge about the quality of narratives used in EU policy*.** What is uncomfortable knowledge and how is it relevant for discussions of sustainability? What is wrong with the models currently used to inform energy policy (in relation to alternative sources of electricity, biofuels and scenarios of decarbonization) and agriculture policy (in relation to agricultural futures and food security)? Closing DISCUSSION.

DAY 1 – **Afternoon Part 2** – ***Quantitative examples of a critical appraisal of the quality of the narratives used in EU policy*.** (1) What did go wrong with the *Energiewende*? What are the requirements of power capacity, the electricity uses and the relative emissions when considering different mixes of peak, baseload and intermittent electricity?; (2) What does the future of EU agriculture look like? The externalization through imports of farm labor, land and water

requirements and environmental impact to social-ecological systems outside the EU translates into a continuous elimination of farmers inside the EU. What are the implications of this and how can we include a better consideration this mechanism in our policy narratives?; and (3) Generating quantitative assessments of the feasibility, viability and desirability of different type of biofuels requires first to define: (3.1) the required supply mix; (3.2) the availability of primary sources; and (3.3) the level of openness of the system (an acceptable level of imports). When considering these points, how promising does the past, present and future of EU biofuels look?

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DAY 2 – **Morning Part 1 –** ***Illustrating with practical examples the "Marauder's Map"—a novel toolkit for the auditing of the metabolic pattern of social-ecological systems*****.** Synthesizing the concepts from Day 1 to provide a toolkit capable of addressing the four central sustainability concerns: (1) the DESIRABILITY of social practices; (2) the technical and economic VIABILITY of end-uses (how production factors are used inside the metabolic pattern of a society); (3) the biophysical and ecological FEASIBILITY of the primary flows "taken from" and "dumped into" the biosphere; and (4) the metabolic security associated with the level of OPENNESS of the economic process (dependence on imports and externalization of socio-economic and ecological impact to other systems). Closing DISCUSSION.

DAY 2 – **Morning Part 2** – ***Illustrating the various components of the toolkit*****.** (1) The end-use matrix and how to check the desirability of social practices and the viability of end-uses inside the technosphere; (2) the environmental pressure matrix and how to study the environmental impacts associated with those pressures/related social practices, using the concept of environmental loading ratios; and (3) assessing the effect of externalization through a distinction between *local* and *external* end-use matrices (needed to produce the imported commodities) and between *local* and *external* environmental pressures matrices (associated with the production of imported commodities). Closing DISCUSSION.

DAY 2 – **Afternoon Part 1** – ***Using quantitative storytelling (QST) to flag the existence of uncomfortable knowledge in policies referring to the bioeconomy, related to the quality of those narratives*****.** What is wrong with the models used to inform energy and agriculture policy in relation to the modern drive towards a "circular bio-economy"? What type of key performance indicators can and should we develop in relation to this objective? Closing DISCUSSION.

DAY 2 – **Afternoon Part 2** – ***Quantitative examples of the analysis of the metabolic pattern of social-ecological systems relevant for assessing the quality of the narratives used in policies referring to the bioeconomy*****.** (1) Quantitative assessments of the requirement of primary flows (and the related requirement of primary sink and primary supply capacity)—examples of environmental pressures matrices; (2) quantitative assessment of secondary inputs (flows and funds) required to express the functions associated with the reproduction of societal identity—examples of end-use matrices; and (3) the biophysical analysis of recycling—actors to be considered in quantitative assessments of the availability of tertiary flows and their impact on the consumption of primary flows and secondary inputs.

Session 2: Practicum (2 days)

DAY 1 – **Morning Part 1** – ***Characterizing the DESIRABILITY of social practices looking at the endosomatic metabolism in the ANABOLIC compartment (simplified end-use matrix).*** When

considering the endosomatic metabolism inside the STATE of a society (human activity), one deals with the activities expressed both by individuals and by households. The auditor's toolkit presented in this course enables the representation and characterization of the DESIRABILITY of a metabolic pattern associated with the daily life of individuals. The primary relevant attributes include household demography, dwelling characteristics, profile of daily activities of the members of the household, availability of technical services, energy diet and food diet, and level of help received from society in terms of hours of work from the service sector. The toolkit will be illustrated using several visualizations based on benchmark analytical claims. Closing DISCUSSION.

DAY 1 – **Morning Part 2** – ***Characterizing the VIABILITY of social practices looking at the exosomatic metabolism in the ANABOLIC compartment (detailed end-use matrix).*** When considering the exosomatic metabolism inside the STATE of a society (technical activity), we deal with a combined set of activities (and associated end-uses) expressed across different levels of organization inside its different constituent components. The analysis of the required investments of fund and flow elements inside the end-use matrix can be used to carry out diagnostic analysis (characterization of existing metabolic patterns) and simulations of the viability of alternative metabolic patterns (exploring the plausibility of scenarios/anticipations). These two applications of the end-use matrix will be illustrated using quantitative analysis based on benchmark analytical claims. Closing DISCUSSION.

DAY 1 – **Afternoon Part 1** – ***Characterizing the FEASIBILITY of the system state by looking at the metabolic characteristics of the CATABOLIC compartment (local environmental pressure matrix and end-uses in the primary sectors).*** The expression of a metabolic STATE of a society entails an environmental pressure on the surrounding environment determined by the activity of the CATABOLIC compartment (the compartment involved in the destruction of favorable gradients to provide a supply of exergy and other useful materials to the ANABOLIC compartment). The analysis of this pressure requires analyzing the relation between the end-uses of the anabolic compartment (the requirement of secondary inputs) and those of the catabolic compartment (the requirement of primary flows). By conducting this analysis, it becomes possible to track the set of *primary flows* (resources and environmental services needed from the surrounding ecosystems both in terms of supply capacity and in terms of sink capacity) required to produce the secondary inputs used by the society. The tracking of primary flows on which society relies allows the identification of ecological funds associated with their supply and sink. By comparing the size of primary flows with supply and sink capacities, it becomes possible to calculate environmental loading ratios and thereby to assess the probability that *environmental pressure* will generate impact. In this way, we can assess the feasibility domain of the exploitation of primary flows in relation to the availability of their primary supply and sink capacity. Closing DISCUSSION.

DAY 1 – **Afternoon Part 2** – ***Characterizing the level of OPENNESS of the metabolic pattern by looking at the dependence on IMPORTS (lack of sovereignty).*** Food and energy flows consumed in societal end-uses can also be measured using a non-equivalent metric based on the definition of categories of food and energy commodities. In this way, it becomes possible to account for the trade of such flows and to identify levels of food and energy security. These two types of flows (food and energy, which can each be further divided into primary and secondary flows) will be measured within a given a set of categories of commodities to characterize: (1) total consumption; (2) internal production; and (3) imports. Following, the level of openness of the metabolic pattern of these two flows—its dependence on imports—will be assessed. Using the benchmarks calculated for the internal production of the various commodities (end-uses and environmental pressures), we will then be enabled to assess in virtual terms: (1) the externalized end-use matrix (the quantity of

secondary inputs that would be internally required by the system if the imported commodities were to have to be produced locally); and (2) the externalized environmental pressure matrix (related to the quantity of supply and sink capacity that would be required of the system's environmental surroundings, to allow the local production of the required primary flows).

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DAY 2 – **Morning Part 1 –** ***Assessing and comparing the DESIRABILITY of social practices in the ENDOSOMATIC metabolism using actual benchmarks.*** Hands-on TRAINING EXERCISE using available datasets and the auditor's toolkit presented in this course to assess and compare the DESIRABILITY of social practices within the ENDOSOMATIC portion of a metabolic pattern.

DAY 2 – **Morning Part 2** – ***Assessing and comparing the VIABILITY of social practices in the EXOSOMATIC metabolism using actual benchmarks.*** Hands-on TRAINING EXERCISE, complementing the previous, building and using the end-use matrix to compare the VIABILITY of social practices within the EXOSOMATIC portion of a metabolic pattern; emphasis on auditing the flow-fund key performance indicators that viability depends on.

DAY 2 – **Afternoon Part 1** – ***Assessing the feasibility of the metabolic pattern by looking at local environmental pressures and environmental loading ratios.*** Hands-on TRAINING EXERCISE, complementing the previous, building and using the environmental pressure matrix (according to a certain definition of sequential pathways and economic supply systems associated with the local production of commodities) to compare the FEASIBILITY of social practices across a system's metabolic pattern. Further, using the environmental pressure matrix as a basis, assessment of key performance indicators related to the environmental loading ratios of selected commodities.

DAY 2 – **Afternoon Part 2** – ***Assessing the level of OPENNESS of the metabolic pattern by looking at dependence on IMPORTS.*** Hands-on TRAINING EXERCISE, complementing the previous, using available datasets to: (1) calculate the level of OPENNESS of a social-economic system in relation to food and energy security (commodities externalization matrix); and (2) calculate, starting from the data vectors in the local end-use matrix and the local environmental pressure matrix, the resulting virtual quantities in the externalized end-use matrix and the externalized environmental pressure matrix.