The AF Filières project: application of PSUT frameworks for regional analyses of agriculture and forestry supply chains and footprints in France

Jean-Yves Courtonne, Julien Alapetite, Vincent Wawrzyiak, Michela Bevione

To cite this version:

Jean-Yves Courtonne, Julien Alapetite, Vincent Wawrzyiak, Michela Bevione. The AF Filières project: application of PSUT frameworks for regional analyses of agriculture and forestry supply chains and footprints in France. ESEE 2019 - 13th International Conference of the European Society for Ecological Economics, Jun 2019, Turku, Finland. pp.1-4. hal-02430898

HAL Id: hal-02430898
https://inria.hal.science/hal-02430898

Submitted on 7 Jan 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

The AF Filières project: application of PSUT frameworks for regional analyses of agriculture and forestry supply chains and footprints in France

Jean-Yves Courtonne[1], Julien Alapetite[1], Vincent Wawrzyiak[2], Michela Bevione[1].

1. Univ. Grenoble Alpes, Inria, CNRS, Grenoble INP, LJK, 38000 Grenoble, France
2. Auvergne-Rhône-Alpes Energie Environnement, 69100 Villeurbanne, France

Short abstract

The communication will present the methods, results and implications of the AF Filières project which main objective is to improve knowledge on agri-food and forest-wood material flows, both at the scale of France and of the 13 French regions. Results allow in particular a better understanding of potential competition between different types of biomass uses (feed, food, energy, industry etc.). Environmental footprints associated with these material flows are also studied and an iterative knowledge improvement process is set in co-construction with stakeholders. Physical Supply and Use Tables are used at every step of the analysis.

Extended abstract

Biomass is nowadays at the heart of key stakes: energy transition for climate change mitigation, sustainable food supply, supply of bio-based industrial products (for construction, chemistry and so on). Recent years have seen efforts by policymakers to get a more holistic grasp on these topics instead of treating them in silos. In France the national strategy for bioeconomy precisely aims at ensuring consistency between strategies designed individually for the forest, agriculture, and energy sectors. Indeed, biomass resources being limited, potential competition between different uses needs to be properly analyzed. The communication will present the methods, results and implications of the AF Filières project (www.flux-biomasse.fr). This research project, started in September 2017 and scheduled to end in October 2019, is funded by Ademe, the French Environment & Energy management agency. The main purpose of the project is to improve knowledge on agri-food and forest-wood material flows, both at the scale of France and of the 13 French regions. Environmental footprints associated with these material flows are also studied. Initial results are confronted with supply chain experts and an iterative improvement process is set. Finally we develop a software to facilitate updates and progressively transfer the ability to conduct such analyses to relevant stakeholders.

--- Materials and methods ---

The following analysis is conducted for each supply chain (SC): supply-chain material flow analysis (SC-MFA), flow tracking using Input-Output techniques, and coupling material flows with environmental footprints.

SC-MFA at national and regional scale is based on an improved version of the methodology described in Courtonne et al. (2015). First, we use physical supply and use tables (PSUTs) in order to define the structure of the SC: we start by listing products of interest, sectors of interest and flows that can exist between them. Products and sectors are entered in the form of hierarchical lists (also called dimensions), which allow users to later provide either detailed or aggregated data. Second, a reference unit is chosen in order to respect mass

conservation. For each product, conversion factors are computed according to hypotheses on moisture content, non-biomass content etc. For instance, the chosen reference unit for the wood supply chain is the wood fiber equivalent, as previously used in Bösch et al. (2015). Third, input data is provided to the model either in the form of flow value and uncertainty, min-max bounds, or linear constraints linking flows (e.g. transformation yields). Fourth, variables are classified to determine whether they are redundant, non-redundant, determinable or non-determinable and data is reconciled using constraint optimization. Intervals are computed for non-determinable variables and Monte-Carlo simulations are used to estimate a confidence interval for each flow (given the uncertainty of input data). Results are finally visualized in the form of maps and Sankey diagrams. At this point, results and all input data and hypotheses are made public and SC experts are encouraged to contribute to improve the model.
It must be stressed here that an asset of the PSUT framework is its scalability: it is easy to explain to practitioners using small examples but it can at the same time handle large models (for instance, the multi-regional model for the forest-wood SC contains about 20.000 variables). Although the methodology is directly inspired by STAN software (Cencic et al., 2008), the originality of our program is to easily handle large quantity of data without the need for a graphical user interface other than Excel. Because it aims at progressively improving knowledge by pointing to current uncertainties, our approach shares some common ground with the “incremental MFA” framework described in Lupton et al. (2017), although we do not rely on Bayesian inference.

The PSUT framework also makes it very easy to conduct Input-Output Analysis (IOA). In Courtonne et al. (2016), we showed how PSUTs could be transformed into symmetrical tables on which either Absorbing Markov Chains (AMC) or IOA techniques could be implemented. AMC and IO are dual frameworks, however it seems more natural to the authors to use AMC to analyze how resources flow downstream, and to use IOA to analyze what upstream flows are embodied in a given final demand. Hence, both AMC and IOA computation are used to track flows from production to consumption and vice-versa. Limits of the method should be discussed: by default, the method implies mass allocation of co-products (instead of e.g. economic allocation) and a “perfect-blend” hypothesis is taken (once in a region, we assume a product has the same destination whatever its origin).

Eventually, material flows are coupled with environmental footprints in order to analyze how these footprints flow through the economy. For this purpose, we study the Agribalyse LCA database which is considered the state-of-the-art for French agri-products. The detailed analysis of the database helps avoiding double-counting and also understanding which parts of the impacts occur on farm site and which parts occur in previous stages (fabrication of farm inputs etc.), or subsequent stages (transportation, transformation etc.). The study of the economic weight of the SC (in terms of value added and employment) is also part of the project but has not yet started. The ultimate objective being to get a holistic view of the situation in terms of material flows, environmental footprints and socio-economic indicators.

--- Results and implications ---

Auvergne-Rhône-Alpes Energie Environnement (AURA-EE), the environment agency of the AURA region (7.6 million inhabitants) is a partner of the project and is responsible for communication and result dissemination. We believe the partnership between a research team and a public agency is key to ensure the tools developed meet practitioners needs.

At the moment, the most advanced work is the one conducted on the forest-wood SC where both national and regional models have been introduced to stakeholders. These come from diverse institutions (national or regional, public or private) and were invited to webinars where main results and possible forms of contributions were presented. Among those contributions, some are requests concerning new ways to display results (either in excel files or on the website), and some others are pointing to better sources of information in their region. The main interests they express are: (i) having an overall view of wood uses on their territory, which is a preliminary step to analyze potential competition, (ii) having an order of magnitude of inter-regional flows, (iii) objectifying which flows are rather well known and which ones could benefit from a specific study. It can be noted that most contributors are project managers in the fuelwood sector which is consistent with the rather ambitious targets set at national and regional level for fuelwood development. After several rounds of discussion, it was decided by regional authorities to include the project's Sankey diagram of wood flows in AURA in the region's official planning document for biomass mobilization. Some other regions may do the same in the coming months and projects partners are currently reflecting on proper ways to maintain this continuous improvement approach after the project is over.

Software development throughout the project is precisely aiming at progressively transferring modeling skills from Inria's STEEP research teem to AURA-EE environment agency. These software tools, built on python and javascript frameworks, are designed to be modular. Both the SC-MFA (for data reconciliation) and the visualization parts (e.g. interactive Sankey diagrams) will be made open source at the end of the project.

On the agri-food side, only national scale studies have been conducted at this point with the new software. Nearly twenty SC-MFAs have been conducted on crops (cereals, oleaginous, protein crops, potatoes, sugar beets etc.) and one has been conducted on the milk supply chain. Studied resources can be raw or transformed products, as well as by-products of transformation industries. Again, the chosen PSUT framework proved to be versatile enough to account for the variability of the studied SCs. Meat is scheduled to be studied in 2019 as well as fodder crops. We are therefore aiming at an overall view of French agriculture by the end of 2019, at least at the national scale. All these analyses are pursued in partnership with the *Avenir Elevages* ("Livestock future") research group. Their main interest is to estimate the flows of resources that are targeted towards feed in order to better measure food-feed competition. Of course, one can think of other fields of application for those MFAs, all the more if they are coupled with environmental and socio-economic footprints. Contributing to bringing new elements to the debates on biofuels or on food chains relocalization are such examples.

--- References ---

Bösch, M.,Jochem, D., Weimar, H., Dieter, M. (2015). Physical input-output ac- counting of the wood and paper flow in Germany. Resources. Conservat. Recycl. 64, 99e109.

Cencic, O., Rechberger, H. (2008). Material flow analysis with software stan. J. Environ. Eng. Manag. 18 (1), 3–7.

Courtonne, J.-Y., J. Alapetite, P.-Y. Longaretti, D. Dupré, and E. Prados (2015). Downscaling material flow analysis: The case of the cereal supply chain in France. *Ecological Economics* 118: 67–80.

Courtonne, J-Y., Longaretti, P., Alapetite, J. and Dupré, D. (2016), Environmental Pressures Embodied in the French Cereals Supply Chain. Journal of Industrial Ecology, 20: 423-434.

Lupton, R. C. and Allwood, J. M. (2018), Incremental Material Flow Analysis with Bayesian Inference. Journal of Industrial Ecology, 22: 1352-1364.