Dynamic Material flow analysis (MFA) as a tool for efficient forest management policies

Alexis Boutin[1], Julien Alapetite[1], Jean-Yves Courtonne[2]

1. TerriFlux, 38430 Moirans, France / 2. STEEP team, Univ. Grenoble Alpes, CNRS, Inria, Grenoble INP, LJK, 38000 Grenoble, France

CONTEXT MFA for French forests management

Conceiving an efficient forest management policy first requires a good understanding of the initial situation and the current forest dynamics. This produces a large amount of data and many spreadsheets. Using the Material Flow Analysis (MFA) the results are presented as a Sankey diagram, which highlights the main flows and helps to identify the key aspects to be studied.

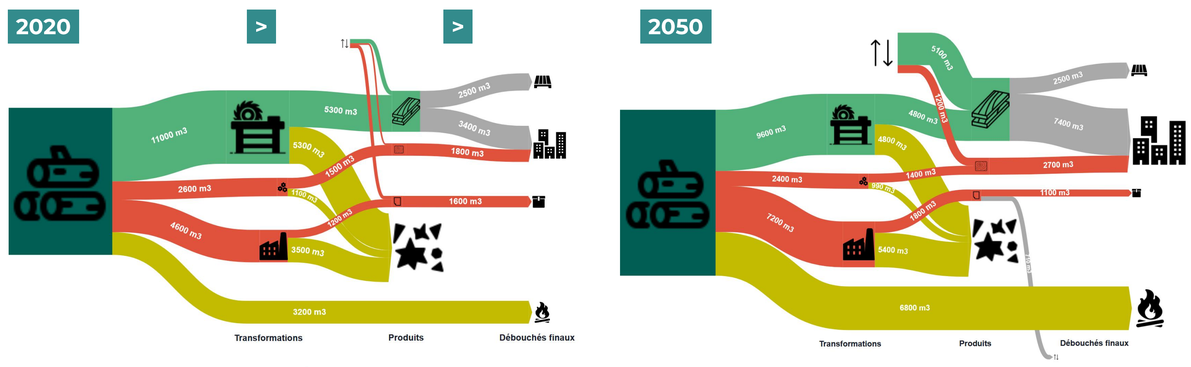
However, most of the MFA studies conducted so far are static, providing the “pictures” of the flows for one time step only.

Dynamic MFA extends this framework by considering the temporal dimension and allowing the tracking of the evolution of flows and stocks over years. The development of such a method is still at the research stage and needs further development to be commercially available.

The following work was carried out as part of the BACCFIRE project, aimed at measuring the carbon stocks and attenuation potential of scenarios in the forestry sector. The static Sankey diagram of the national forest industry is shown below.

GOAL Towards dynamic MFA

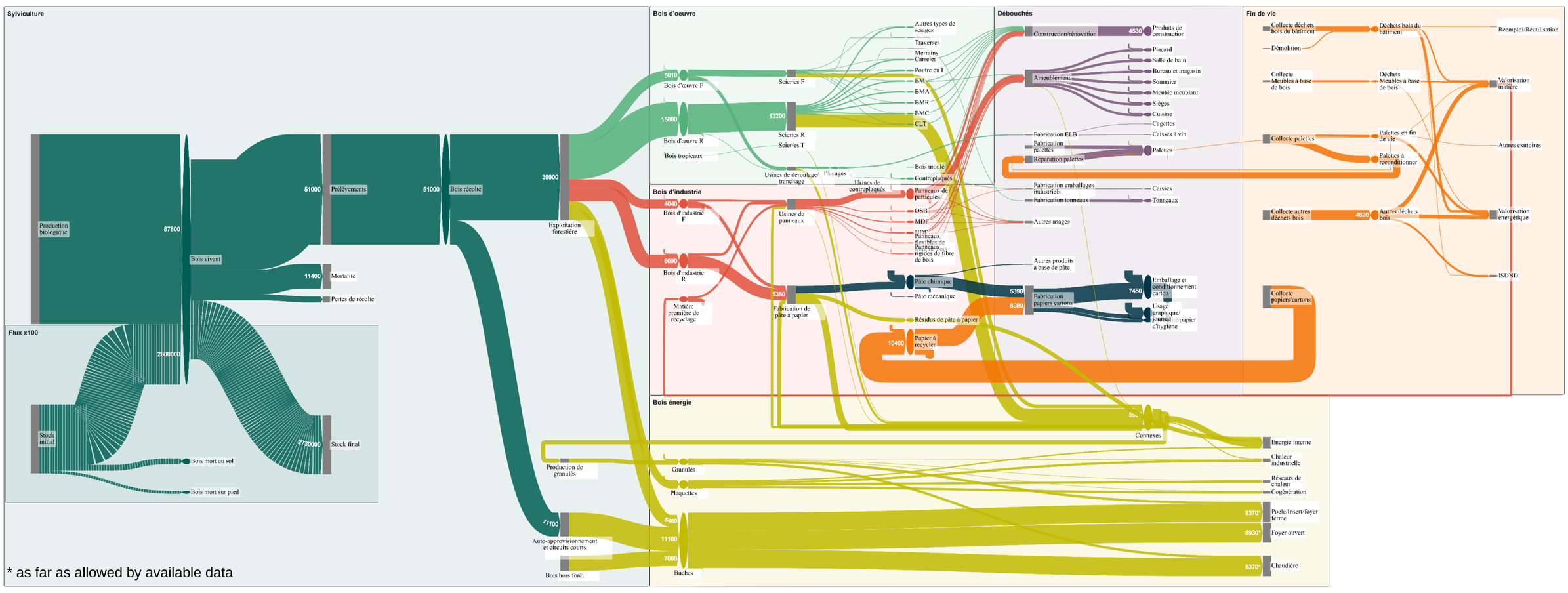
A dynamic Sankey diagram takes as inputs for period N the outputs of period N-1, considering the stocks if needed. The aim is to apply the approach presented below to the BACCFIRE diagram to make prospective scenarios.



If energy and construction demand increases by +2,5%/year between 2020 and 2050, importations should increase too.

RESULT A French forest industry: a picture worth a thousand words

Imagined as an aggregation and reference tool, the diagram integrates the data of all the previous diagrams of the industry. It also relies on the constitution of detailed* tree species groups.



* as far as allowed by available data

METHODS A four steps process

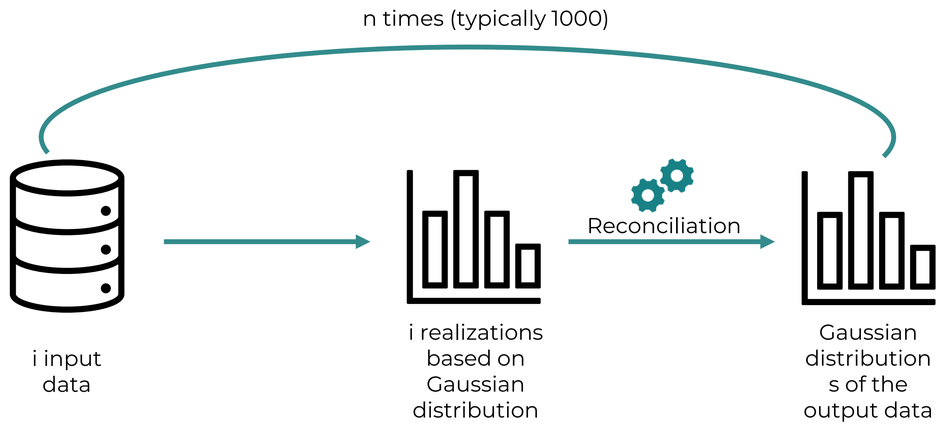
TerriFlux’s work for BACCFIRE was divided in three parts:

1/ We combined different structures of previous studies to create the most detailed one for BACCFIRE.

2/ We collected data and converted them into a common unit, to obtain a single, coherent size, diagram.

3/ We used the reconciliation algorithm of OpenSankey to compute unknown flows (under some hypothesis) and to slightly modify flows values to make them coherent, thus going a step further compared to incomplete and incoherent diagrams available to date, due to lack of knowledge or available data. Using this detailed static diagram as a starting point to a dynamic one to build prospective views is being explored by TerriFlux.

Data reconciliation is used to phase out inconsistencies. The model imposes mass conservation laws, which implies constraints on the supply-use tables.



CONCLUSION An operational tool

The use of TerriFlux’s software allowed the establishment of the first holistic Sankey diagram of the French forest industry.

This diagram is being improved with detailed data on energy, construction and distinction between tree species.

PERSPECTIVES A parametrized model follows

The next step to this work is to “dynamise” the model, which has already been proven to be difficult, due to lack of recent data. Some are published annually (by French government for example), but a certain amount come from “one-shot studies” which are not actualized regularly. Hence, the reference period of this work has been chosen to be 2019-2020, the most recent period with available data, but it has been impossible to obtain coherent data for 2023 for example. A parametrized model to make projections should be built from historic variations and scheduled changes.

About TerriFlux

TerriFlux is a young Deeptech cooperative company, a software publisher, stemming from Inria in 2021 and located in Grenoble.

All economic activity relies on real flows of materials and energy. Based on this observation, TerriFlux offers tools enabling a detailed analysis and understanding of these flows. One of these tools is the OpenSankey software, accessible for free in its simplest version. Five projects on French forests have been conducted, or are being conducted using OpenSankey, which has become the reference tool for MFA in the forest and timber industry (as well as in other sectors).