

WP1 Shared modelling framework and learnings

D1.2 – Description of scientific methods

Task 1.2 Framework for foreground life cycle inventory of bio-based sectors

Modelling a market mix from FAOSTAT data

Lead Contractor: Aalborg University

Author(s): Karen Nørgaard Bollesen, Massimo Pizzol, Agneta Ghose

PROJECTS DETAILS			
Project title		Aligning Life Cycle Assessment methods and bio-based sectors for improved environmental performance.	
Project acronym	ALIGNED	Start / Duration	01/10/2022 – 36 months
Type of Action	RIA	Website	www.alignedproject.eu

Summary

This tutorial serves as a tool for users seeking to model a market mix for selected biomass products, starting from the Forestry Production and Trade data from FAOSTAT. By utilizing the tutorial, the user can generate overviews of annual production quantity of biomass for different countries.

The tutorial includes:

- A description of the FAOSTAT webpage, specifically the data for Forestry Production and Trade and how to retrieve the data.
- A description of " Market_mix_from_Faostat_data ": This file contains a mock-up for an example of downloaded data to produce a market mix. It shows the data and calculations which can be performed on the data.
- A description of the R code to perform the same calculations but automated. This targets more expert users.



1. The FAOSTAT Forestry Production and Trade data

FAOSTAT provides a collection of production and trade data related to various countries, quantities and types of woody biomass types and years (Figure 1). These data can be used as input to model different woody biomass market mixes. The data can be accessed either at the [direct link](#) or by navigating to the FAO website, selecting the 'Data' tab, followed by the 'Forestry' sub-menu and finally, the 'Forestry Production and Trade' dataset (FAO, Forestry Production and Trade, 2023).

The webpage comprises of four different tables with datapoints available for the user. These are categorized as “Countries”, “Elements”, “Items” and “Years”. To accurately reflect the user's specific case, it is important that the user select datapoints which reflects it.

The screenshot displays the FAOSTAT data selection interface. It features four main filter panels: 'COUNTRIES' (listing countries like Afghanistan, Albania, Algeria, etc.), 'ELEMENTS' (listing Production Quantity, Import Quantity, etc.), 'ITEMS' (listing Wood fuel, coniferous, Industrial roundwood, etc.), and 'YEARS' (listing years from 2016 to 2021). Each panel includes a search bar, a list of options with radio buttons, and 'Select All' and 'Clear All' buttons. Below the filters are four sections for output configuration: 'Output Type' (Table, Pivot), 'File Type' (CSV, XLS), 'Thousand Separator in 'Show Data'' (None, Comma, Period), and 'Output Formatting Options' (Flags, Notes, Codes, Units, Null Values). At the bottom, there are two large buttons: 'Show Data' and 'Download Data'.

Figure 1 - Overview of data selection for Forestry Production and Trade (FAO, Forestry Production and Trade, 2023).

Action: Access the [FAOSTAT data](#) and read the official [documentation](#) if needed.

To download data points for simulating a market mix for woody biomass over a given period, certain data points must be selected. However, the selected elements may vary depending on the user's specific case. The recommended data points are as follows:

Countries/regions/special groups: In this section, the user can select the specific geographical location for their case. This segment is divided into three categories, namely "Countries", "Regions" and "Special groups". The "Countries" group comprises of 131 individual countries, whereas the "Regions" are a combination of various countries/areas. Lastly, the "Special groups" category encompasses grouped countries from divergent geopolitical areas. Underneath is an overview of datapoints from the three different selections:

- **Countries:** Germany, Italy, Sweden, Denmark, France and more.
- **Regions:** The items are separated into either 'Total' or as 'List'. The list consists of a list of regions and separated cardinal directions for each region.
 - o World, Africa, Eastern Africa, Middle Africa, Northern Africa, and more.
- **Special groups:** The items are separated into either 'Total' or as 'List'.
 - o European Union (27), Least Developed Countries, Land Locked Developing Countries, Small Island Developing States, Low Income Food Deficit Countries and Net Food Importing Developing Countries.

Action: Choose all the countries that belong to the market area relevant to the user's case. *The choice should be based on the expectation on the size of the market. For example, choose a list of specific neighbouring countries like Germany, Sweden, Norway and Denmark to model a local market close to Denmark. Or chose a region like "Europe" for a larger market to Denmark (the region will include a list of all countries in the area).*

Elements: This section is designated for selecting the precise category of forestry production and trade for the user's case. This means overall production, imported, and exported woody biomass. The specific datapoints that are available for selection are illustrated below:

- Production Quantity, Import Quantity, Import Value, Export Quantity and Export Value

Action: Choose "Production Quantity".

This datapoint refers to the solid volume or weight of all the produced woody biomass within the forestry. This includes products that may immediately be consumed for another process, such as wood pulp. This data point encompasses woody biomass produced from all sources, including public, private, and informal sources, within the country (FAO, Forest Products Definitions, NA, s. 2).

Items/Items aggregated: This section is for the specific category of woody biomass within the dataset. The "Items" section comprises of 60 types of woody biomass. Additionally, there are 50 different types of "Items aggregated" woody biomass. Examples of these can be seen underneath:

- **Items:**
 - Wood fuel, Industrial roundwood, Sawlogs and veneer logs, Pulpwood, Other industrial roundwood and more.
- **Items aggregated:** The items are separated into either 'Total' or as 'List'.
 - Forest products (export/import)
 - Roundwood
 - Pulpwood and particles
 - And more

Action: Choose the product of interest. For example: "Sawlogs and veneer logs, coniferous" or "Sawlogs and veneer logs, non-coniferous".
These data points focus on roundwood that has been sawn lengthways and stripped of bark to create stave bolts. This includes both conifers (softwoods) and non-conifers (hardwoods/broadleaves) (FAO, Forest Products Definitions, NA, s. 1), ensuring that all types of sawlogs and veneer logs are included in the dataset. (FAO, Forest Products Definitions, NA, s. 4)

Years: This section is for the user to define which years the woody biomass is from. The data selection ranges from the year 1961 to 2021.

Action: Choose a suitable period within the user's case.
Preferably spanning over a decade to ensure adequate data for trend analysis.

Data download: After the forestry datapoints has been selected, the subsequent step is to select the desired data download format. There are four options for consideration:

- **Output Type:** Table and Pivot.
- **File Type:** CSV and XLS.
- **Thousand Separator in 'Show Data':** None, Comma and Period.
- **Output Formatting Options:** Flags, Notes, Codes, Units and Null Values.

Thereafter, the selected data should be available for the user.

Alternative visualization of data:

It is also possible to visualize the Forestry Production and Trade data, before downloading it. Through this feature, the user can see visual representation of certain datapoints, such as:

- Map overview by countries
- Line chart by years and volume (m3)
- Pie chart by percentage and country
- Column chart by country and volume (m3)

This functionality can be accessed either through the "Visualize Data" tab located below the header or via this [link](#). To ensure that the visual data accurately reflects the user's specific case, it is required to select datapoints for "Item", "Element", "Area", "From Year", "To Year", and "Aggregation". Moreover, it is only possible to select one datapoint for each section, thereby it is e.g., not possible to show data for two different countries simultaneously.

Action: choose the output file, which is the most suitable for the user's specific case.
To run the Excel spreadsheet one must select "Table" for Output Type, "XLS" for File Type and "Comma" for Thousand Separator in 'Show Data'.
To run the R or python script one must select "Table" for Output Type, "CSV" for File Type and "None" for Thousand Separator in 'Show Data'.

2. Mock-up model in Excel

The file “Market-mix-from-Faostat-data.xlsx” provides a mock-up example of calculating a marginal mix starting from FAOSTAT data. The file contains data for Denmark, Germany and Sweden, from the years 1961-2021 and the other data points highlighted in the previous section.

In the sheet “Downloaded data” is the three countries laid out, shown as FAOSTAT shows it, when the data is downloaded from their webpage.

The sheet “Data selection” includes a subset of the downloaded data obtained by filtering for only one product (Sawlogs and veneer logs, coniferous) and for a specific range of years (2008-2020).

The sheet “Market mix” includes the calculations for a market mix visible for each of the countries. The SLOPE function within Microsoft Excel is utilized for each of the countries. This is a statistical function, which returns the slope of the linear regression throughout the data points. Positive slope values indicate an increment, whilst negative values indicate a decline in production. Hence, zero or negative values are not considered in the market mix.

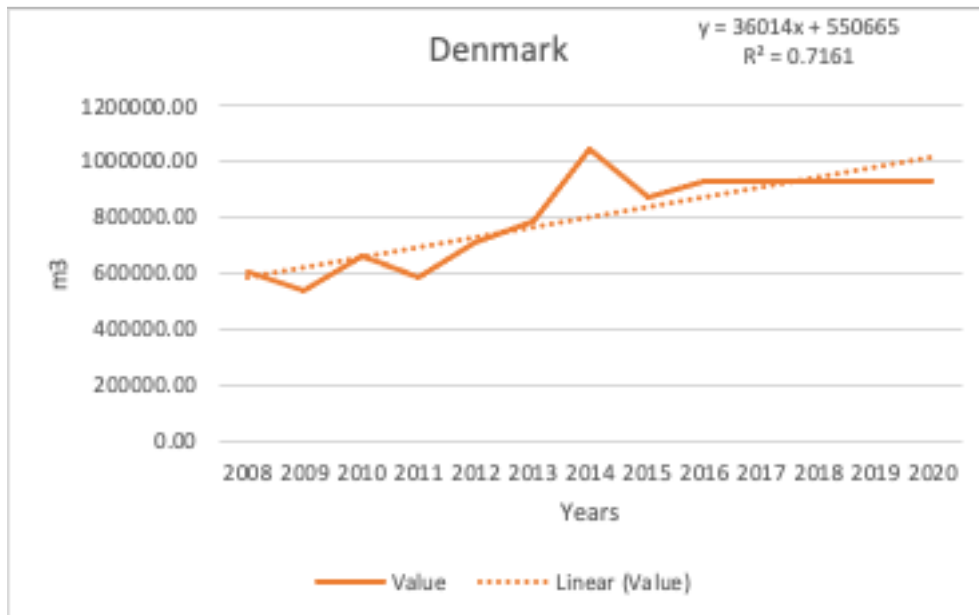


Figure 2 shows the data points for production of sawlogs and veneer logs in Denmark from 2008 – 2020. Using these data points the linear regression was calculated (with the SLOPE function in Excel)

Table 1 – Shows the market mix calculated from the increment in production of coniferous sawlogs and veneer logs from 2008 –2020. The increment was calculated by assessing the slope of the trend in production of sawlogs and veneer logs in each country. The market mix was calculated by dividing the slope of each country by the total average increment.

Denmark	Slope	Slope unit
Sawlogs and veneer logs, coniferous	36013,74	m3/year
Germany		
Sawlogs and veneer logs, coniferous	768559,88	m3/year
Sweden		
Sawlogs and veneer logs, coniferous	509890,11	m3/year
Total average increment		
Sawlogs and veneer logs, coniferous	1314463,73	m3/year
Market mix share - Denmark	0,027	
Market mix share - Germany	0,585	
Market mix share - Sweden	0,388	

3. R and python code for automated calculation of market mix.

The files “Market-mix-from-Faostat-data.R” and “Market-mix-from-Faostat-data.py” provide respectively the R and python code for calculating a market mix automatically starting from the data provided by FAOSTAT (cf. Sect 1 of this document).

Recommended software: R-4.3.0 or higher. Python 3.11.0 or higher.

The code includes several functions to manipulate the data and calculate a “marginal market mix”, i.e. a life cycle inventory representing a market for a specific wood product and the supply share by a number of different suppliers. This is done by using a simple linear regression applied to the time series data on production quantities by each country, for a specific time period (e.g. years 2010-2020). The suppliers are identified as supplying countries. The marginal mix is determined in three steps:

- The average annual production increment over the time period is calculated using the slope coefficient of the linear regression for all countries included in the analysis and for the selected time period.
- The countries are ranked by average annual production increment, where countries with the largest increment in production over time are ranked first.
- The mix is composed by calculating the share, or normalized value, of each supplier to the total annual production increment.

Table 2 - An example of average production increments for the product 'Sawlogs and veneer logs, coniferous', period 2008-2020 and measured in m3, obtained from the linear regression, including the uncertainty (standard error of the mean “SE”) on the estimated slope.

Area	Increment	SE
Denmark	36013.74	6836.959
Germany	768559.88	285001.488
Sweden	509890.11	108578.587

Table 3 - An example of the resulting market mix. This indicated how much of the supply of one unit of 'Sawlogs and veneer logs, coniferous' is provided by each supplier country. Note that results are identical to those provided by the excel version (presented in Sect 2).

Area	Supply
Germany	0.585
Sweden	0.388
Denmark	0.027

Further examples and plot are provided in the notebook *Market-mix-example.ipynb*.

References

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