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# Report of the technical assessment of the forest management reference level submission of Liechtenstein submitted in 2011

# Contents

# I. Introduction and summary

## A. Overview

1. This report covers the technical assessment (TA) of the submission of Liechtenstein on its forest management reference level (FMRL), submitted on 29 April 2011 in accordance with decision 2/CMP.6. The TA took place (as a centralized activity) from 23 to 27 May 2011 in Bonn, Germany, and was coordinated by the UNFCCC secretariat. The TA was conducted by the following team of nominated land use, land-use change and forestry experts from the UNFCCC roster of experts: Mr. Nagmeldin G. Elhassan (Sudan), Mr. Giacomo Grassi (European Union), Ms. Rehab Ahmed Hassan (Sudan), Mr. Vladimir Korotkov (Russian Federation), Mr. Rae-Hyun Kim (Republic of Korea), and Mr. Kevin Black (Ireland). Mr. Nagmeldin G. Elhassan and Mr. Giacomo Grassi were the lead reviewers. The TA was coordinated by Ms. María José Sanz-Sánchez (UNFCCC secretariat).

2. In accordance with the “Guidelines for review of submissions of information on forest management reference levels” (decision 2/CMP.6, appendix II, part II), a draft version of this report was communicated to the Government of Liechtenstein, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

## B. Proposed reference level

3. Liechtenstein has proposed a projected FMRL of 0.0001 million tonnes of carbon dioxide equivalent (Mt $CO_2$ eq) per year for the period 2013–2020. This consists of net emissions of 0.0025 Mt $CO_2$ eq per year for forest pools and net removals of –0.0024 Mt $CO_2$ eq per year by the harvested wood products (HWP) pool. Emissions from natural disturbances are not included in the reference level.

# II. General description of the reference level

## A. Overview

4. Liechtenstein adopted the use of a projected reference level using three linked models and by assuming two management scenarios (see para. 15 below). The model inputs are based on national forest inventory (NFI) information, current and potential use HWP and the effects of material substitution.

## B. How each element of footnote 1 to paragraph 4 of decision 2/CMP.6 was taken into account in the construction of the reference level

### 1. Historical data from greenhouse gas inventory submissions

5. The FMRL projection is based on the NFI permanent sample plot data. The inventory information, such as age-class and forest structure, is used to generate historical and projected estimated time series using the MASSIMO forest model (similar to the approach taken by Switzerland (see annex)). However, the modelled time series is

constructed based on the mean of outputs from two different scenarios (which may vary from current management; see description of model in para. 15 below).

### 2. Age-class structure

6. The age-class structure of the managed forests is derived from a Swiss NFI conducted in Liechtenstein. The Party provided additional information on the age-class structure for 1986, 1998 and 2010 during the TA. These data clearly show a shift to the left (i.e. old to young forests) in the age-class structure, which is consistent with an increase in harvest and a slight decrease in the biomass increment profile from 2002 to 2008 (table 3, FMRL submission). The increasing biomass increment (2013 to 2020), for the baseline and optimized harvest scenarios are a function of shifts in age-class structure. The larger biomass increment over the reference period for the optimized increment scenario is also due to the optimization of increment at harvest. The historical age-class data are used as one of the initialization factors in the MASSIMO model based on two management scenarios, which produce different final age-class structures over the projected time series. Thus it is assumed that the resulting projected reference level is, in part, a function of an age-class structure shift brought about by a combination of historical and projected management activities assumed in the baseline and optimized increment scenarios referred to in paragraph 15 below.

### 3. The need to exclude removals from accounting in accordance with decision 16/CMP.1, paragraph 1

7. Liechtenstein does not apply any methodologies for factoring out indirect human-induced activities. This is justified, based on scientific studies carried out in the region, as the effect of factors such as elevated $CO_2$ and nitrogen deposition are not well understood and therefore cannot be included because of considerable scientific uncertainty. However, factoring out of both the age-class legacy and indirect human-induced activities are provided for in the adopted methodology and reference level approach (see para. 28 below).

### 4. Other elements

<u>Forest management activities already undertaken</u>

8. The current forest legislation (Liechtensteinisches Landesgesetzblatt, 1991) aims to ensure sustainable forest management while still fulfilling other functions, including forest protection, provision of social amenities, sustained timber supply to the forestry industry and biodiversity.

9. Current harvesting trends suggest an increase in annual harvest of approximately 400 $m^3$ per year, which is broadly consistent with the baseline assumption used in the projected harvest level.

## C. Pools and gases

### 1. Pools and gases included in the reference level

10. Liechtenstein reports on carbon stock changes for the biomass, litter, dead wood, soils and HWP pools.

11. The Party includes carbon stock changes in the soil pools using the YASSO model and presents the data in the FMRL submission. However, soils are not mentioned in the listed pools under the relevant section on page 4 of the submission. The expert review team (ERT) encourages Liechtenstein to include soils in the text under this section.

12. The YASSO model includes the inputs and emissions of $CO_2$ from the dead wood pool.

### 2. Consistency with inclusion of pools in the estimates

13. Emissions from fires and drainage of forest land are not included in the FMRL submission. This is consistent with the approach adopted in the 2011 national inventory report (NIR) (page 164), where emissions from fires and drainage are assumed to be zero.

14. HWP have been included in the FMRL in a transparent manner using the approach proposed in document FCCC/KP/AWG/2010/18/Add.1.

## D. Approaches, methods and models used

### 1. Description

15. Liechtenstein uses the same modelling framework to construct the reference level time series as that used for Switzerland. This is based on the MASSIMO forest management model, a HWP consumption drive model and the YASSO soil model using two scenarios: (a) baseline and (b) optimized increment. The scenarios were developed based on consideration of NFI data, current and potential wood consumption, and existing harvesting trends. The baseline scenario assumes that the current level of harvest remains relatively constant. The optimized increment scenario is based on the hypothesis that both increment and end product utilization are maximized through long-term management and cascading towards long-term end products with subsequent energy generation. The Party argues that the ‘real’ projected harvesting rate would fall between the two scenarios and, therefore, uses the mean values of the output of the two scenarios when calculating the submitted reference level emissions/reductions for the period 2013–2020. This assumption is partially justified by the comparison of data extrapolated from historical harvesting trends with the scenario output data, which clearly demonstrates that the baseline and optimized increment represent the upper and lower limits of the projected harvest. The ERT understands this approach and considers this to be in accordance with decision 16/CMP.1.

### 2. Transparency and consistency

16. During the TA, and following consultation with the Party, additional information on the functionality of the MASSIMO, YASSO and HWP models, and assumptions used in the scenario projections were provided (see annex). This improved transparency with regard to the way in which projected trends were derived.

## E. Description of the construction of the reference level

### 1. Area under forest management

17. The definition of forest area is outlined in the FMRL submission. This is consistent with definitions used in the 2011 NIR. During the review, the Party confirmed that the forest management areas used in the projection were derived from the NFI (6.17 thousand hectares (kha)).

18. The areas under forest management are expected to increase over the projected time series. This is based on a 0.14 kha increase in managed forest land over the period 1990 to 2009 (2011 NIR and the common reporting format (CRF) table 5.A). Rates of deforestation are also low (0.02 kha (see the greenhouse gas inventory submitted in 2011)). In the original submission and during the review, information on forest areas used in the calculation of the FMRL was not provided (also see para. 19 below). The ERT recommends

that the Party includes a summary of forest areas used in the FMRL submission and how these relate to forest areas remaining forest as submitted in the 2010 NIR and CRF.

### 2. Relationship of the forest land remaining forest land category with the forest management activity reported previously under the Convention and the Kyoto Protocol

19. A time series of projected and historical areas under forest management and the relationship with those areas reported under forest land remaining forest land is not provided in the FMRL submission. The ERT could not assess the consistency of areas reported across different submissions. The ERT encourages the Party to include a time series of forest management and forest land remaining forest land areas reported under the Convention to improve transparency.

20. Carbon stock changes over the historical time series in the FMRL submission are different from those reported under land remaining forest land in the 2011 NIR and CRF tables. The ERT accepts that this discrepancy could be due to differences in methodological approach (i.e. inventory stock change versus models). Clarification is required to explain this divergence of the historical trends. The ERT notes that possible reasons for this discrepancy are that the models are not calibrated or that the management activities assumed do not reflect the current or ‘business as usual’ approach (see comments on optimized increment and baseline scenarios in paras. 22 and 23 below). During the review, the Party acknowledged these time series inconsistencies and that technical adjustments may be needed in the future to account for any methodological changes in future commitment periods, which are now excluded from the submitted FMRL.

### 3. Forest characteristics

21. Forests in Liechtenstein include productive and unproductive areas, both are managed for sustainable timber supply or for other functions (see reference to current management practice in para. 8 above).

22. The MASSIMO model scenarios use the current age-class structure as a starting point for the projection simulations. The management objective of the optimized increment scenario is to enable forest regeneration where the rotation age is defined at maximum mean annual timber increment resulting in a change in forest structure. It is conceivable that the shift to the left in the age-class distribution will continue under the baseline scenario assumption. The ERT recognizes that combinations of forest structure characteristics in the two scenarios are appropriately used to provide an accurate estimate of the ‘business as usual’ reference level.

23. The optimized increment scenario aims at removing additional harvest residue in the form of slash and brushwood for energy consumption. This is consistently reflected in the lower soil carbon stock change over the projection period, when compared with the baseline scenario (figure 5 of the FMRL submission). This is also consistent with the theoretical functionality described in the YASSO model. During the review, the Party indicated that the amount of slash and harvest residue removed for energy consumption would not significantly influence the nutrient status of harvested stands and subsequent growth increment. These assumptions were based on literature studies (see annex, English (2007) and Wittkopf (2005)).

### 4. Historical and assumed harvesting rates

24. Details in the submission of the historical harvesting rates (1986–2009), including assortment categories, show an increase in harvest of approximately 400 $m^3$ per year. This is due to an increase in the growing stock in Liechtenstein. The lower range of the projected

harvest, as indicated by the baseline scenario, grows at approximately the currently observed rate of increase. As a result, the long-term (2008 to 2100) stock increment remains relatively constant. In contrast, the optimized increment scenario (upper range assumption) assumes a large increase in harvest and utilization of harvest residues to maximize HWP storage, but still aims at maximizing stock increment from 6.9 $m^3$ $ha^{-1}$ per year in 2008 to 9.1 $m^3$ $ha^{-1}$ per year by 2100. This optimization would result in changes to forest structure as discussed in chapter II.E.3. The Party demonstrated that the extrapolated harvesting rates, based on current rates, fall within the lower (baseline) and upper (optimized increment) scenarios used. Therefore, the Party justifiably used the mean value of both scenarios for the reference level. These assumptions are consistent with an observed increase in domestic wood utilization and demand in both the construction and energy sectors.

### 5. Harvested wood products

25. The ERT commends Liechtenstein on the inclusion and description of HWP in both the historical and the projected time series. Following initial consultation with the Party, a transparent explanation of the model functionality, decay function constants and important assumptions regarding the construction of the HWP time series was submitted (see annex).

26. The projected range in HWP storage over the period 2013 to 2020 varies from –0.003 to –0.007 Mt $CO_2$ eq per year, depending on the scenario applied. The adjusted domestically produced HWP projection is based on domestic consumption rates of 50 per cent for the baseline and 56 per cent for the optimized increment scenario. There is also evidence that the projected domestic consumption is higher than the currently reported rates in 2000 (see annex). The increase in domestic consumption is based on Swiss studies, which show an increased market demand for domestic products. Similar wood utilization trends have been observed for Liechtenstein.

### 6. Disturbances in the context of force majeure

27. Submitted statistics and cited publications in the Party submission indicate that force majeure events are rare for the region and their effects and secondary influences, such as subsequent insect infestations, are not included in the projected reference level.

### 7. Factoring out

28. The Party does not apply any methodologies for factoring out indirect human-induced activities in the models. This is justified, based on scientific studies carried out in the region showing that elevated $CO_2$ concentrations do not influence productivity, while nitrogen deposition is reported to decrease gross growth. However, the ERT points out that the use of a projected reference level is considered to factor out dynamic age-class effects. In addition, given the present state of scientific knowledge, the effects of elevated $CO_2$ concentrations and indirect nitrogen deposition are considered to be approximately the same in the reference level and in the commitment period estimates, and therefore they can be assumed to factor out.

## F. Policies included

### 1. Description of policies

29. The Party provides in its submission a detailed description of the implemented policies that were considered in the construction of the reference level.

### 2. How policies are taken into account in the construction of the reference level

30. There is an indication that the Energy Efficiency Act of 2007 may increase demand for forest fuel end products. There is also evidence of an increased demand for construction timber, which may in part explain the threefold increase in production of long-term products, under the optimized increment scenario. There are no details in the Party’s fifth national communication regarding how implemented policies may influence future wood demand or production. It is unclear how the upper range of the projected harvest is considered in the context of policies introduced. However, recent trends do suggest that increased timber supply can be absorbed by domestic demand in the future, particularly if it is assumed that exports in the optimized increment scenario decrease.

## III. Conclusions and recommendations

31. Liechtenstein has constructed the projected FMRL on a transparent basis suitable for consideration by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol. The Party has included HWP in the projection, recognizing that a technical correction may be needed for the inclusion of HWP, on an agreed basis. It should be noted that further technical corrections may be implemented if any new methodologies or assumptions which are now excluded from the submitted FMRL are included in future commitment periods. The ERT notes that the Party has constructed the projected reference level taking into consideration all the elements outlined in footnote 1 to paragraph 4 of decision 2/CMP.6. The methodology used complies with the principles set out by decision 16/CMP.1.

# Annex

## Documents and information used during the technical assessment

## A. Reference documents

Submission on Reference Levels for Forest Management under the Kyoto Protocol by Liechtenstein, 29 April 2011. Available at <http://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_liechtenstein_2011.pdf>.

National greenhouse gas inventory of Liechtenstein submitted in 2010. Available at <http://unfccc.int/5270.php>.

National greenhouse gas inventory of Liechtenstein submitted in 2011. Available at <http://unfccc.int/5888.php>.

Fifth national communication of Liechtenstein. Available at <http://unfccc.int/resource/docs/natc/lie_nc5.pdf>.

English M. 2007. Ökologische Grenzen der Biomassenutzung in Wäldern, *BFW-Praxisinformation*. 13: p.200.

Wittkopf S. 2005. *Bereitstellung von Hackgut zur thermischen Verwertung durch Forstbetriebe*. Fakultät Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt. München: Technische Universität München.

## B. Additional information provided by the Party[1]

### 1. Scenario assumptions

**Baseline scenario**

Wood harvest stays +/- constant, about 20 per cent under the level of the period 1988–1998 but 30 per cent over the situation in 2000. Growing stock in the forests is staying constant, with slightly increased consumption and a weakened timber industry. The forest is to be managed in the years to come in the way observed on the basis of the two national forest inventories (NFIs) in Switzerland (NFI I 1983–1985; NFI II 1993–1995). In applying this exploitation characteristic for Liechtenstein's forests lower yield quantities result than in real terms in the period 1989–1998. On the other hand, growing stock stays on practically the same level during the whole period of 100 years (+4 in 100 years).

**Optimized increment scenario**

This scenario is based on the working hypothesis that increment in the forests of PL should be as extensive as possible and should be used entirely for the production of long-lived wood products with subsequent end-utilization for energy generation. Table 1 shows values of wood products consumption in the situation of 2000 and in the year 2030. The aim of this scenario is to maximize increment performance in the forest in the long term through appropriate management. This is achieved through the selection of suitable turnover periods and consistent regeneration in the uniform (even-aged) high forest. This created equal age-

[1] Reproduced as received from the Party.

class distribution after one rotation period. Only half as many trees are removed during thinning (intervention up to final harvest) as in the baseline scenario. Considerably larger volumes of brushwood and bark are removed from the forest for energy use than in the baseline scenario. As a result, smaller volumes of logging slash and bark remain in the forest.

## 2. Model description

### MASSIMO forest management model

The MASSIMO (Management Scenario Simulation Model) forest model is an empirical stochastic and dynamic forest model based on the individual tree. It comprises four partial models for regeneration, growth and management scenarios including wood harvesting and mortality (cf. Figure 1). These four processes are depicted on the basis of empirical formulae. The latter were derived from data from NFI I and NFI II, which, in turn, were collected from approximately 6,000 sample areas with around 70,000 individual trees.

*Growth model*
The growth model is the main component of MASSIMO. The growth function was derived from the inventory data from NFI I and NFI II and calculates, at ten-year intervals, the basal area increment of individual trees as a function of location conditions, forest structure and competition conditions.

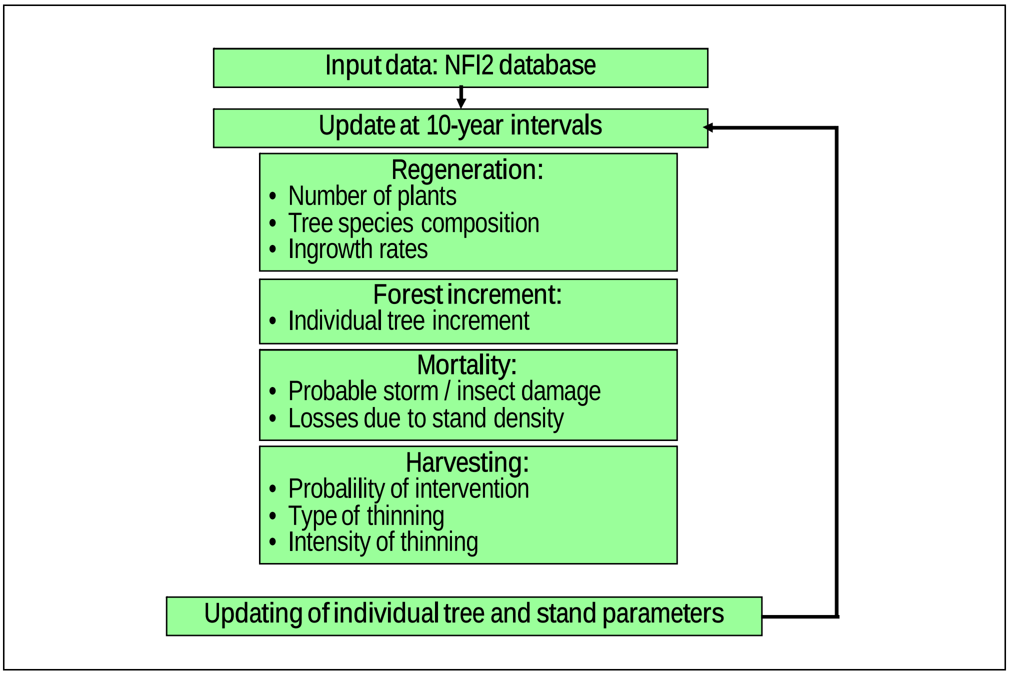


Figure 1. Scenario model flow chart

*Wood harvesting*
In MASSIMO, wood harvesting is defined as the probability that an individual tree will be logged at a certain point in time. This probability is estimated on the basis of logistical regression models. The explanatory variables here are the stand and location characteristics (i.e. development stage, tree species composition, stand age and location quality), the logging conditions (e.g. accessibility and the logging techniques used), harvesting costs and protective functions. The regression model was derived from data from the Swiss NFI. They

indicate the harvesting and losses measured in the period between the two NFI surveys of 1985 and 1995.

*Natural mortality*
The data for natural mortality were also derived from the empirical data from LFI. Otherwise, please define] I and LFI II. However, the simulated stand structures can change considerably in the context of a 100-year simulation. For example, if the harvest volumes are reduced in the model calculation, the stand density increases accordingly. This could lead to increased mortality. A raised mortality level of this kind had to be taken into account in the MASSIMO model. However, corresponding data records for the adaptation of the model are unavailable for the most part. Thus, an additional density-dependent mortality function was developed. This is based on long-term forest yield studies carried out by WSL on selected NFI samples with extensive stand volume and on expert knowledge. These data were used to define an upper limit for stand density.

The following correlations were extrapolated: if a simulated stand has reached the maximum stand basal area,[2] the rate of mortality increases exponentially with increasing basal area. Mortality also increases exponentially in very old stands, that is, from an age of 150 years in the Swiss central plateau and from 250 years in the Alps.[3]

*Conversion into carbon*
The NFI figures are mostly specified in terms of stemwood with bark and stump. As opposed to this, this study focused on the carbon content of all of the biomass. The following conversion operations are required to convert stemwood with bark and stump into carbon or carbon dioxide ($CO_2$). The cubic mass of wood (in cubic metres ($m^3$)) is converted into solid mass (t) through multiplication by the wood density. Branches, leaves and roots are added to the mass through multiplication by a specific expansion factor (BEF). The exact conversion figures are described in Thürig, Schmid et al. (2007). Around 50 per cent of biomass is carbon. To convert the carbon into the corresponding volume of $CO_2$, the volume of carbon is multiplied by 3.67.[4]

**YASSO soil model**

*Simulation of the decomposition of forest litter and dead wood*
The changes in the carbon stored in the soil were estimated with the help of the YASSO soil model.[5] YASSO is a simple soil model which simulates the decomposition of forest litter and dead wood to humus. This model requires only a few input parameters: the annual volume of forest litter, its chemical composition and basic climate parameters. No information on soil structure is required. Thus, the decomposition rates in different locations are differentiated only in terms of the quality of the forest litter and basic climate parameters, but not in terms of the soil structure.

*YASSO soil model*
Figure shows the different individual modules taken into account in the model. In terms of litter, a distinction is made between non-woody litter (leaves, needles and fine roots), fine woody litter (fine branches < 7 cm) and roots) and coarse woody litter (branches > 7 cm and stems). Thanks to this differentiation, the mechanically delayed decomposition of woody forest litter can be modelled as compared with that of leaves and needles. The annual volumes of forest litter were estimated using the MASSIMO model. The tree components calculated in MASSIMO, such as needles, branches and roots, were assigned specific

2 50 $m^2$ $ha^{-1}$ to 75 $m^2$ $ha^{-1}$ depending on the tree species composition and the stage of development.
3 Thürig (2005a) p.95.
4 For the conversion of carbon into $CO_2$ see annex 1 of submission .
5 Liski, Peltoniemi et al., 2005.

lifetimes. To calculate the annual litter production of needles, for example, the total volume of needles was divided by the specific lifetime of the needles.

The three groups of litter differentiated in YASSO vary in terms of their chemical composition. They contain different proportions of water-soluble components, cellulose and lignin-type elements. These three chemical groups decompose at different speeds, with the rate of decomposition decelerating from the first to the last. These components become humus at an advanced stage of decomposition. The YASSO model differentiates between two types of humus which, again, have different rates of decomposition.

All decomposition processes in the model are described by exponential decay. The corresponding decomposition rates reflect the activity of the micro-organisms. These are influenced by the climate parameters, temperature and summer drought. The warmer and wetter it is, the more active the micro-organisms are and the more material they respire and release into the atmosphere as $CO_2$.

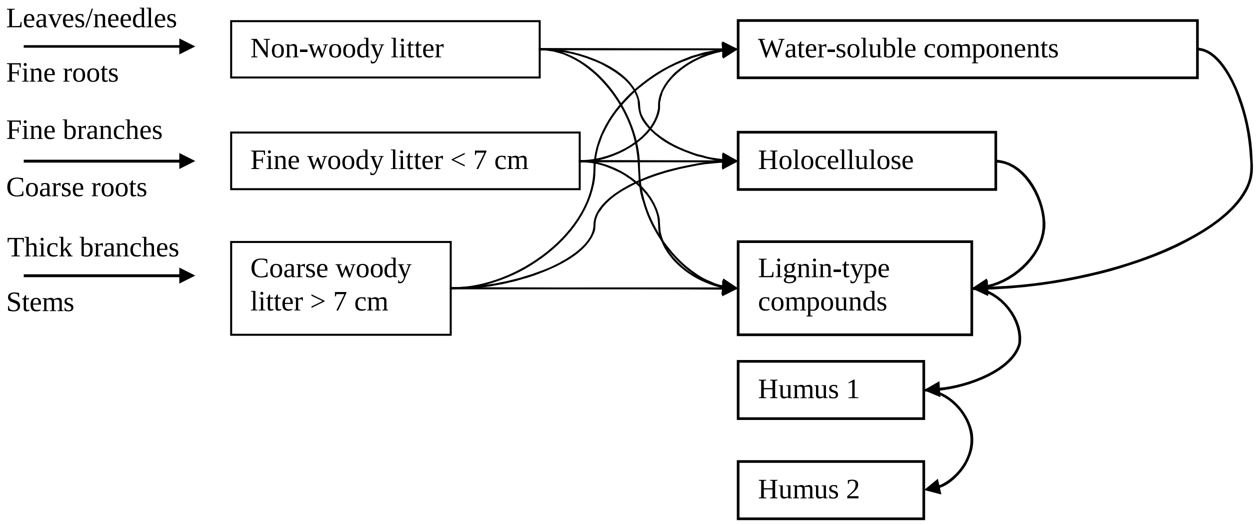


Figure Structure of the YASSO soil model

**Harvested wood products (see also RL submission)**

*System boundaries*
The model incorporates all wood uses within Switzerland's civilizational cycle (of the Principality of Liechtenstein respectively). The carbon stock effects of wood products in Switzerland and abroad[relevant for Liechtenstein? please check all references to Switzerland in this annex and delete/amend as appropriate, or give a footnote explaining why Switzerland is being referred to] are calculated taking foreign trade into account in another mode. .

*Input into the model*
The five input fluxes into the model include:[please check format]

- Industrial round wood (stemwood and industrial wood) from Switzerland;
- Fuel wood (including hedgerow timber used for energy generation) from Switzerland;

- Imports made by the timber industry: (1) round wood and wood residues; (2) semi-finished products; (3) three-quarter-finished products; and (4) furniture and prefabricated houses (each calculated individually in the model);
- Imports of mechanical pulp and chemical pulp for paper production (not relevant for PL);
- Paper imports for final consumption.

***Output from the model***

The seven output fluxes include:

- Exports made by the timber industry: as in the case of the imports, they include (1) round wood and wood residues; (2) semi-finished products; (3) three-quarter-finished products; and (4) furniture and prefabricated houses;
- Exports of mechanical pulp and chemical pulp for paper production (not relevant for PL);
- Exports of lignin residues (not relevant for PL);
- Paper exports (not relevant for PL);
- Outgas from the incineration of wood as the system's main output in terms of volume; solid residues are not taken into account due to their minimal significance (approximately 2 per cent);
- Waste wood that is not burned in waste wood incinerators or in waste incineration plants. It either leaves Switzerland for use abroad (for example as chipboard) or is deposited in landfill – or, possibly, illegally burned;
- Waste paper which is disposed of in the sewage system, composted or disposed of in another way.

*Consumption-controlled model*

The system is modelled on a consumption-controlled basis. The remaining wood fluxes and stocks are calculated as a function of time through the specification of the wood uses and foreign trade volumes of the parameters listed in Table 1. In this way, for example, the volume of industrial round wood is determined through the subsequent uses made of the wood. As opposed to this, the acquisition of fuel wood is specified. The consumption values and selected proportionate values for the year 2000 are indicated in Table 1.

Table 1**. Defined parameters in the year 2000 (for Switzerland, figures for PL in point 2 of the explanations above**

| Use/Import/Export Parameters | [Million $m^3$/y] | [kg DM /I*y] | Other parameters | Proportional value in relation to 2000[6] |
|---|---|---|---|---|
| New structural wood | 0.87 | 62 | Proportion of wood residues for industrial roundwood (in energy) | 40% of the new wood |
| New finish wood | 0.87 | 62 | Proportion of wood residues for ½-finished products | 30% of the new wood |
| New wood products | 0.76 | 54 | Proportion of wood residues for ¾-finished products | 20% of the new wood |
| Paper consumption[7,8] | 3.94 | 245 | Recycling paper | 63% of paper consumption |
| Fuel wood | 1.26 | 90 | Additives in paper | 13% of paper volume |
| Import timber industry | 2.70 | 193 | Proportion of waste paper | 9% of paper use |
| Export timber industry | 2.21 | 158 | Proportion of fuel waste wood | 60% of volume that leaves the waste wood sector |
| Import mechanical pulp, chemical pulp | 1.99 | 93 | Raw wood → chemical pulp factor | 4.5 $m^3$ raw wood for 1 t chemical pulp |
| Export mechanical pulp, chemical pulp | 0.55 | 19 | Raw wood → mechanical pulp factor | 2.8 $m^3$ raw wood for 1 t mechanical pulp |
| Import paper[9] | 2.53 | 157 | Production ratio of chemical pulp to mechanical pulp | approx 51% chemical pulp and 49% mechanical pulp |
| Export paper[4] | 2.56 | 159 | Proportion of lignin used to generate energy | 80% of total lignin produced |

The consumption volumes used in the different areas of application were derived on the basis of current statistics and studies.[10] The consumption volumes were converted into kilograms of dry matter per inhabitant and year (kg DM/I*y). To simplify matters it was assumed that 1 $m^3$ of wood corresponds to 500 kg DM and consists of 50 per cent carbon. The population of Switzerland was specified throughout as 7.0 million inhabitants (PL: 34,000 inhabitants).

**Details of harvest and domestic consumption rate under different management scenarios**

Table 2 shows the harvest and consumption rates under different scenarios.

[6] Left constant for all calculations.
[7] Paper consumption is composed of the sum of domestic and imported paper.
[8] The conversion factor is assumed as 2.3 $m^3$ wood per tonne of paper.
[9] The conversion factor is assumed as 2.3 $m^3$ wood per tonne of paper.
[10] Wüest, Schweizer et al., 1994; Arioli, Haag et al., 1997; Basler & Hofmann, 1997; VHe, 1997; Quetting, Mehlisch et al., 1998; BfS/BUWAL, 2000; Peter und Iten, 2001; Hofer, Taverna et al., 2004.

Table 2 **Description of 'situation 2000', baseline and optimized increment scenarios (values)**

| | Situation 2000 minus Lothar effect | | | Szenario Baseline | | | Scenario Optimized increment | | |
|---|---|---|---|---|---|---|---|---|---|
| **Description of the developed scenarios for the Principality of Liechtenstein** | Yield was 17'000 m3; per capita consumption corresponds to Swiss values (except for fuelwood); assumptions on foreign trade are based on indications of F. Näscher. | | | Slightly increased consumption (C+F+O) + 10% in PL, + 20% fuelwood consumption, +32% roundwood exports; reduced exports of C+F+O BY - 22%; +/- constant imports of C+F+O). Increase/decrease of values between 2000 to 2030. | | | Important increase of C+F+O-consumption (+35%) and of fuelwood-consumption (+85%); reduced roundwood exports (-26%); important increase of C+F+O-exports (+62%); reduced C+F+O-imports (-26%). Increase/decrease of values between 2000 to 2030. | | |
| **Consumption data in Principality of Liechtenstein** | total | unit | kg/I*y | total | unit | kg/I*y | total | unit | kg/I*y |
| **C**onstruction (C) | 4'216 | m3 | 62 | 4'760 | m3 | 70 | 6'800 | m3 | 100 |
| **F**inishing (F) | 4'216 | m3 | 62 | 4'760 | m3 | 70 | 5'440 | m3 | 80 |
| **O**ther wood products (O) | 3'672 | m3 | 54 | 3'740 | m3 | 55 | 4'080 | m3 | 60 |
| Paper and paperboard | 19'159 | m3 | 245 | 19'159 | m3 | 245 | 19'159 | m3 | 245 |
| Fuel wood (inc hedgerow timber) | 6'800 | m3 | 100 | 8'160 | m3 | 120 | 12'580 | m3 | 185 |
| Sum of wood consumption | 38'063 | m3 | 523 | 40'579 | m3 | 560 | 48'059 | m3 | 670 |
| | | | | | | | | | |
| **Export** | total | unit | kg/I*y | total | unit | kg/I*y | total | unit | kg/I*y |
| Export roundwood, (without wood residues) | 6'800 | m3 | 105.3 | 9'000 | m3 | 140.4 | 5'000 | m3 | 95.3 |
| Export semi-finished products | 700 | m3 | 10.3 | 500 | m3 | 7.4 | 1'000 | m3 | 14.7 |
| Export 3/4: packaging, building mat, oth wood products | 10 | t | 0.3 | 20 | t | 0.6 | 50 | t | 1.5 |
| Export furniture/houses | 10 | t | 0.3 | 20 | t | 0.6 | 50 | t | 1.5 |
| Export chemical pulp | - | t | 0 | - | t | 0 | - | t | 0 |
| Export mechanical pulp | - | t | 0 | - | t | 0 | - | t | 0 |
| Export paper and paperboard | - | t | 0 | - | t | 0 | - | t | 0 |
| Export C+F+O | 740 | m3 | 10.9 | 580 | m3 | 8.5 | 1'200 | m3 | 17.6 |
| Wood residues in PL arising from exports (C+F+O) | 286 | m3 | 4.2 | 230 | m3 | 3.4 | 480 | m3 | 7.1 |
| | | | | | | | | | |
| **Import** | total | unit | kg/I*y | total | unit | kg/I*y | total | unit | kg/I*y |
| Import roundwood, wood residues | - | m3 | 0 | 50 | m3 | 3.6 | - | m3 | 0 |
| Import wood residues | - | m3 | 0 | - | m3 | 0 | - | m3 | 0 |
| Import roundwood | - | m3 | 0 | 50 | m3 | 3.6 | - | m3 | 0 |
| Import semi-finished products (minus chemical pulp) | 6'300 | m3 | 92.6 | 6'700 | m3 | 98.5 | 4'500 | m3 | 66.2 |
| Import 3/4: packaging, building mat, wood products | 1'200 | t | 35.3 | 1'000 | t | 29.4 | 1'000 | t | 29.4 |
| Import furniture/houses | 1'500 | t | 44.1 | 1'300 | t | 38.2 | 1'100 | t | 32.4 |
| Import chemical pulp | - | t | 0 | - | t | 0 | - | t | 0 |
| Import mechanical pulp | - | t | 0 | - | t | 0 | - | t | 0 |
| Import Paper and paperboard | 7'412 | t | 218.0 | 7'245 | t | 213.1 | 7'245 | t | 213.1 |
| Sum of imports (C+F+O) in PL | 11'700 | m3 | 172.1 | 11'540 | m3 | 169.7 | 8'700 | m3 | 127.9 |
| Imports as products (C+F+O) utilizable in PL | 10'566 | m3 | 155.4 | 10'301 | m3 | 151.5 | 7'864 | m3 | 115.7 |
| Wood residues in PL arising from imports (C+F+W) | 1'134 | m3 | 16.7 | 1'240 | m3 | 18.3 | 836 | m3 | 12.3 |
| | | | | | | | | | |
| **Wood consumption from PL forests** | m3 | | kg/I*y | m3 | | kg/I*y | m3 | | kg/I*y |
| Production (C+F+O) | 2'278 | | 33 | 3'539 | | 52 | 9'656 | | 142 |
| wood residues produced (for energetic use) | 769 | | 11 | 1'311 | | 19 | 3'652 | | 54 |
| production of pulp, mechanical and chemical | - | | 0 | - | | 0 | - | | 0 |
| Fuel wood (inc hedgerow timber) | 6'800 | | 100 | 8'160 | | 120 | 12'580 | | 185 |
| Export roundwood and wood residues | 7'163 | | 105 | 9'546 | | 140 | 6'478 | | 95 |
| **Total** | 17'010 | | 249 | 22'556 | | 331 | 32'366 | | 476 |
| % of total consumption in the year 2000 resp. in 2030 | 44.7% | | | 55.6% | | | 67.3% | | |

Explanation for figures "wood consumption from PL forests"

Production (C+F+O) = Consumption (C+F+O) – Sum of Imports as products (C+F+O) + Export (C+F+O)

Wood residues, fuel wood, Export roundwood and wood residues: calculated with the simbox model, values for 2000 are deduced from historical data and statistic of foreign trade.