Life cycle assessment of Austrian and Slovenian raw wood production

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Abstract

Forestry will play an increasingly important role as a raw material contributor since climate change mitigation requires a shift from fossil-based materials to renewable bio-based materials. As consequence, an increase in wood demand is expected. Slovenia has a forest coverage of 58 % while almost half of Austria is covered by forest (48 %). In these countries, the forest-based sector has thus an important role. We look at the environmental impact of forestry in Slovenia and Austria under an increase in wood demand. This contribution has a threefold purpose: 1) To describe the environmental impact of Slovenian and Austrian forestry and forest products with a focus on sawlogs, 2) To describe the environmental impact of a change in demand in forest products, 3) To provide life cycle inventory data for Slovenian and Austrian forestry and importing countries for other LCA needs, for example, LCAs in the construction or biorefinery sectors and for benchmarking purposes. This contribution explores the use of the European Life Cycle Inventory of Forestry Operations (EFO-LCI) database (Cardellini et al. 2018). The life cycle impact assessment applies the 16 impact categories as recommended by the European Commissions for LCA/Environmental Footprint in Europe (EC, 2013) and provides additional indicators for the climate footprint, important for biobased materials.

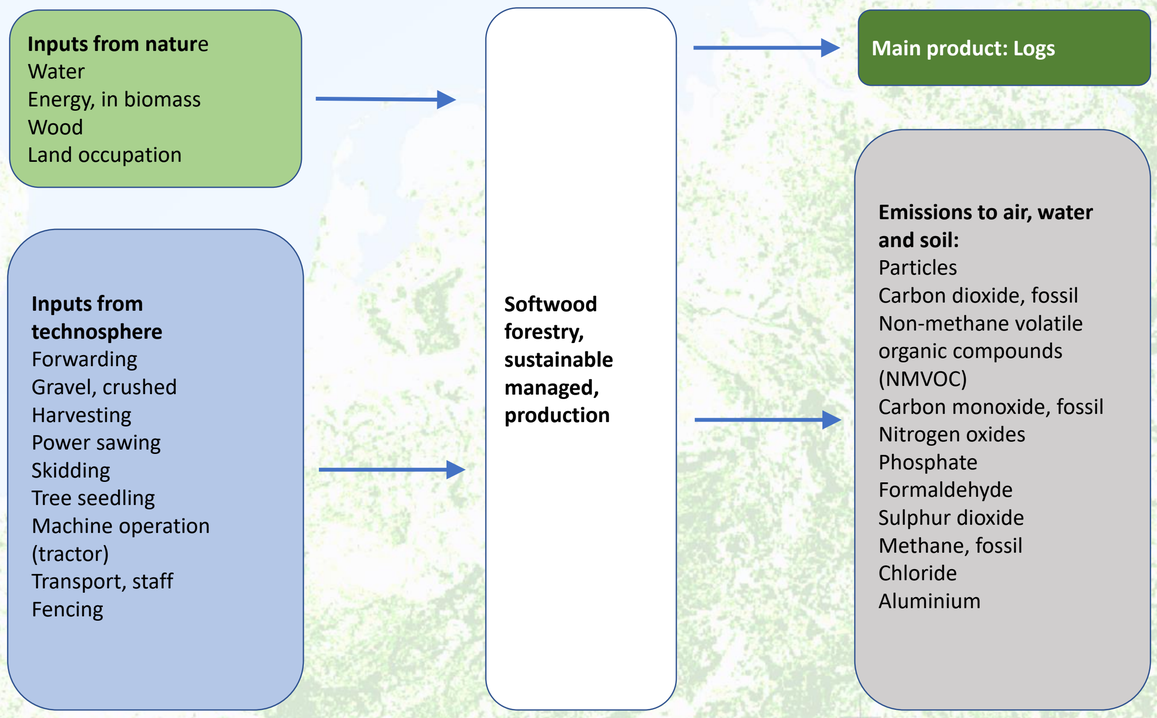


***Figure 1**: System boundary for the cradle-to-gate (forest road) LCA.*

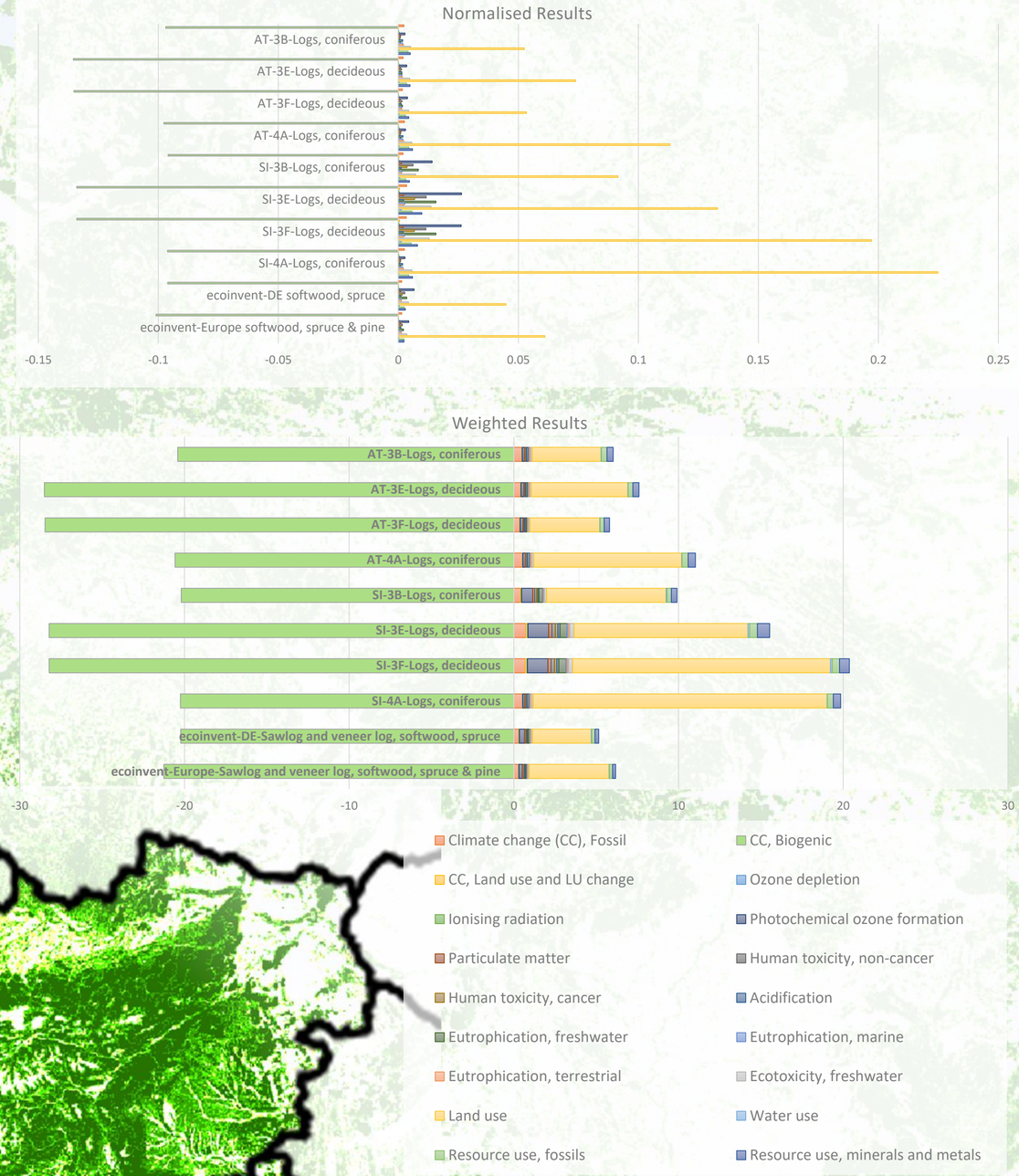
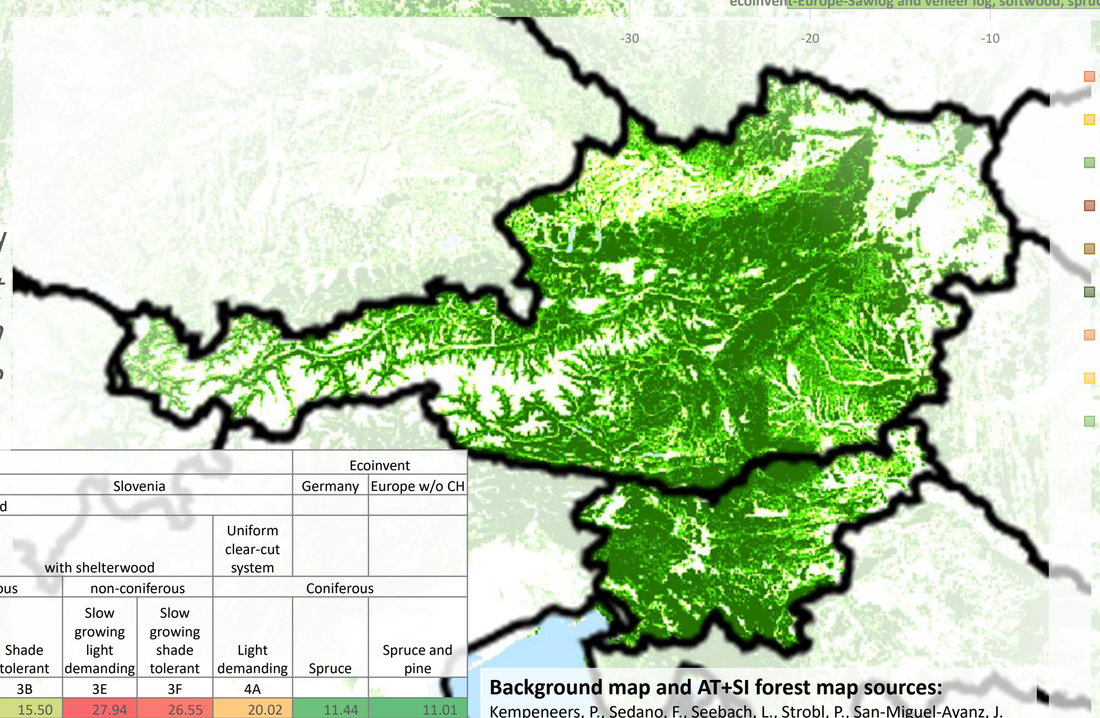


***Figure 2**: Normalised and weighted Environmental Footprint 3.0/EN 15804 indicators showing that the selected datasets for Austria and Slovenia have in sum a higher environmental impact than the reference datasets from ecoinvent. Land use is a hot spot, however, for all investigated forestry datasets, the weighted impact is negative, due to the amount of carbon stored in the wood.*

***Table 1**: Characterised results for 1 m³ wood with colour codes indicating low impact (green), to red (higher impact), for each impact category relative to the other datasets investigated.*

Data source	EFO-LCI								Ecoinvent	
Geography	Austria				Slovenia				Germany	Europe w/o CH
Management group	Even-aged									
	with shelterwood			Uniform clear-cut system	with shelterwood			Uniform clear-cut system		
Species type	Coniferous	non-coniferous		Coniferous		non-coniferous		Coniferous		
	Shade tolerant	Slow growing light demanding	Slow growing shade tolerant	Light demanding	Shade tolerant	Slow growing light demanding	Slow growing shade tolerant	Light demanding	Spruce	Spruce and pine
Impact category [Unit] per 1 m³ \ Forest unit code	3B	3E	3F	4A	3B	3E	3F	4A		
Climate change (CC), Fossil [kg CO_2 eq]	18.84	15.87	13.78	20.13	15.50	27.94	26.55	20.02	11.44	11.01
CC, Biogenic [kg CO_2 eq]	-784.71	-1096.30	-1094.54	-790.92	-776.56	-1084.85	-1084.85	-778.65	-777.91	-817.48
CC, Land use and LU change [kg CO_2 eq]	0.22	0.38	0.45	0.24	2.20	4.16	4.16	0.21	0.91	0.56
CC,total [kg CO_2 eq]	-765.65	-1080.06	-1080.31	-770.55	-758.85	-1052.75	-1054.14	-758.42	-765.55	-805.92
Ozone depletion [kg CFC11 eq]	3.84E-06	3.18E-06	2.76E-06	4.03E-06	3.13E-06	5.61E-06	5.36E-06	4.13E-06	2.28E-06	2.20E-06
Ionising radiation [kBq U-235 eq]	1.15	0.97	0.84	1.25	0.87	1.57	1.48	1.22	0.69	0.67
Photochemical ozone formation [kg NMVOC eq]	0.112	0.142	0.154	0.120	0.570	1.069	1.063	0.112	0.266	0.176
Particulate matter [disease inc.]	5.56E-07	4.92E-07	4.32E-07	6.17E-07	7.81E-07	1.29E-06	1.22E-06	5.87E-07	5.50E-07	5.98E-07
Human toxicity, non-cancer [CTUh]	1.96E-07	3.01E-07	3.42E-07	2.22E-07	1.41E-06	2.66E-06	2.64E-06	2.05E-07	6.16E-07	3.83E-07
Human toxicity, cancer [CTUh]	1.08E-08	1.47E-08	1.60E-08	1.23E-08	6.11E-08	1.14E-07	1.13E-07	1.16E-08	2.62E-08	1.65E-08
Acidification [mol H+ eq]	9.86E-02	8.14E-02	6.96E-02	1.05E-01	6.49E-02	1.17E-01	1.10E-01	1.01E-01	5.86E-02	5.99E-02
Eutrophication, freshwater [kg P eq]	1.50E-03	2.41E-03	2.82E-03	1.64E-03	1.33E-02	2.52E-02	2.51E-02	1.43E-03	5.58E-03	3.45E-03
Eutrophication, marine [kg N eq]	3.48E-02	2.87E-02	2.48E-02	3.65E-02	2.93E-02	5.29E-02	5.11E-02	3.53E-02	2.32E-02	2.29E-02
Eutrophication, terrestrial [mol N eq]	3.75E-01	2.99E-01	2.52E-01	3.94E-01	2.11E-01	3.70E-01	3.51E-01	3.80E-01	2.11E-01	2.26E-01
Ecotoxicity, freshwater [CTUe]	218	203	184	241	307	580	550	238	180	152
Land use [Pt]	43051	60545	43762	92762	74947	108996	161611	184271	36792	50021
Water use [m³ depriv.]	2.53	3.00	3.06	2.96	7.47	13.99	13.75	1.61	4.15	2.66
Resource use, fossils [MJ]	267	223	193	286	205	369	350	284	157	153
Resource use, minerals and metals [kg Sb eq]	3.16E-04	3.09E-04	2.75E-04	3.75E-04	2.92E-04	6.23E-04	5.07E-04	3.75E-04	1.87E-04	1.48E-04



Background map and AT+SI forest map sources:

Kempeneers, P., Sedano, F., Seebach, L., Strobl, P., San-Miguel-Ayanz, J. 2011: Data fusion of different spatial resolution remote sensing images applied to forest type mapping, IEEE Transactions on Geoscience and Remote Sensing, in print.

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Schuck, A., Van Brusselen, J., Päivinen, R., Häme, T., Kennedy, P. and Folving, S. 2002. Compilation of a calibrated European forest map derived from NOAA-AVHRR data. European Forest Institute. EFI Internal Report 13, 44p. plus Annexes;

Conclusion and outlook

The environmental impact of Slovenian and Austrian forestry is most important for its occupation of land. The harvesting (sawing) of the trees is a main contributor to emission to air. However, this is offset by the ability of trees to store carbon from CO_2 in the atmosphere. An increased demand in forest products could lead to more intensive production, with more output per area used, which could result in lower environmental impact per m³ of wood harvested. The investigated database (EFO-LCI) could provide life cycle inventory data for Slovenian and Austrian forestry and importing countries for other LCA needs, for example, LCAs in the construction or biorefinery sectors and for benchmarking purposes. Timing of harvest and different rotation lengths could be further explored.

Sources

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