
Forest transitions through a socioecological lense: long-term perspective on forest change and biophysical enabling processes in the U.S. and Europe

Andreas Magerl^{*1}, Simone Gingrich¹, Sarah Matej¹, Karlheinz Erb¹, Julia Le Noe¹, Lisa Kaufmann¹, Geoffrey Cunfer², Matthew Forrest, Florian Weidinger¹, Cody Yuskiv³, Stefan Schlaffer⁴, and Christian Lauk¹

¹Universität für Bodenkultur Wien = University of Natural Resources and Life [Vienne, Autriche] – Autriche

²College of Arts and Science - University of Saskatchewan – Canada

³College of Law, Saskatchewan – Canada

⁴Vienna University of Technology – Autriche

Résumé

Forest Transitions describe the change from deforestation to reforestation in terms of expansion of forest area, biomass, or both. (Re)growing forests play a central role in global climate change mitigation, sequestering atmospheric carbon(dioxide). In numerous industrialised countries, forests have been undergoing a regrowth phase following periods of intensive deforestation. Economic development and wood product scarcity have been thoroughly studied as drivers facilitating reforestation in these countries. On the contrary, the impact of biophysical processes contributing to forest recovery yet causing environmental problems, such as agricultural intensification and fuelwood substitution by fossil fuels, remains poorly understood. We apply a socio-ecological approach to investigate forest transitions in the United States, Austria and France, from the late 19th to early 21st century, focusing on their underlying biophysical processes. Drawing from social ecology, carbon- and energy flow accounting methods, in line with IPCC guidelines are employed, operationalized for studying long-term historical shifts in land-use, material and energy resource patterns and applied to the three case studies. We collected historical and contemporay forest inventories from the United States Forest Service (1958-2019) and preceding expert estimations (1909, 1920,1932,1941,1948). For the case of Austria and France, we obtained data from previous publications (Gingrich et al 2016, pp. 417–431 in <https://doi.org/10.1007/978-3-319-33326-7>; Le Noë et al 2020 <https://doi.org/10.1111/gcb.15004>). We used these data to assess changes in forest area, forest carbon stocks in biomass and the wood harvest between 1907-2017 on a subnational level, and disaggregated by productive managed and protected forests, as well as unproductive woodlands. Additionally, we analysed agricultural intensification, fuelwood substitution, and other factors such as forest grazing, derived from historical national statistics publications. Our empirical findings reveal some common characteristics that all case studies share, but also individual specifics of the forest transition pathways. Forest transitions were characterized by expansions in forest area and biomass among all three case

*Intervenant

studies, with regionally varying biomass stock dynamics in the U.S. Forest regrowth aligned with the emergence of fossil fuel-based social-metabolic systems and no decline, but rather shifts in the use of harvested wood. In the U.S., a wildfire suppression regime additionally contributed to forest regrowth. In the United States and Austria, increased biomass density is indicative of forest aging, whereas in France, thinned-out forests suggest a younger and rejuvenated forest composition. We identify agricultural intensification, forestry shifts, and climate change-induced alterations in biomass growth as significant drivers for forest change. Our research underscores the necessity of adopting a long-term perspective on ecosystem dynamics and associated biophysical processes to inform future land use strategies in climate change mitigation.

Mots-Clés: social ecology, biophysical processes, material and energy use, agriculture, problem shifts