Sustainability issues related to forest bioenergy

Helmut Haberl

Institute of Social Ecology Vienna (SEC),
Alpen-Adria Universitaet Klagenfurt, Wien, Graz

and

Integrative Research Institute on Transformation in Human-Environment Systems (IRI THESys),
Humboldt-Universität zu Berlin

Joint Workshop on “Forests, bioenergy and climate change mitigation”, 19-20 May 2014, European Environment Agency, IEA Bioenergy, European Commission & IINAS, Copenhagen K, Denmark, 19-20 May 2014

Global LAND Project

Austrian Academy of Sciences
Österreichische Akademie der Wissenschaften
ÖAW

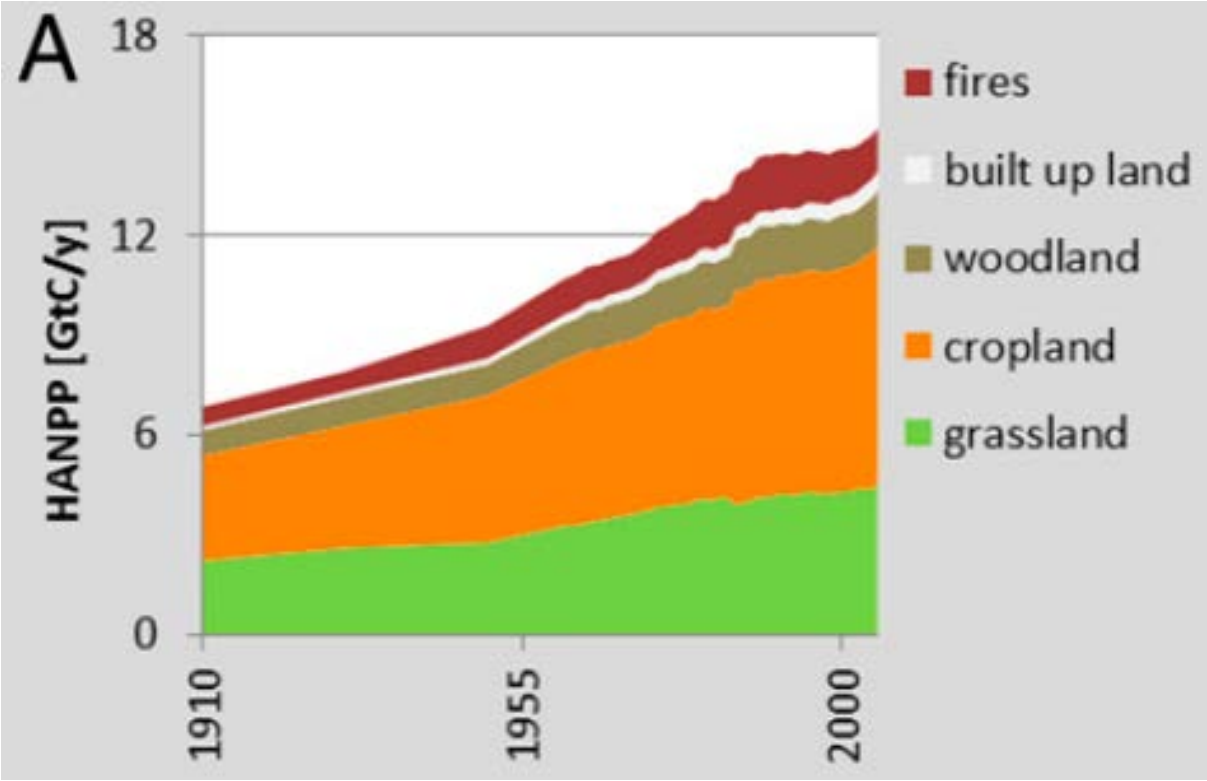
FWF Der Wissenschaftsfonds.

BMWF
Bundesministerium für Wissenschaft und Forschung

VOLANTE

ALPEN-ADRIA UNIVERSITÄT
KLAGENFURT I WIEN GRAZ
iff social ecology vienna

Background: Human appropriation of global terrestrial NPP 1900-2006



- 1900: 13% of potential NPP
- 2006: 25% of NPP_{pot}
- **2050**
  - 27-29% without strong bioenergy growth
  - Up to 45% with strong growth of bioenergy

PNAS

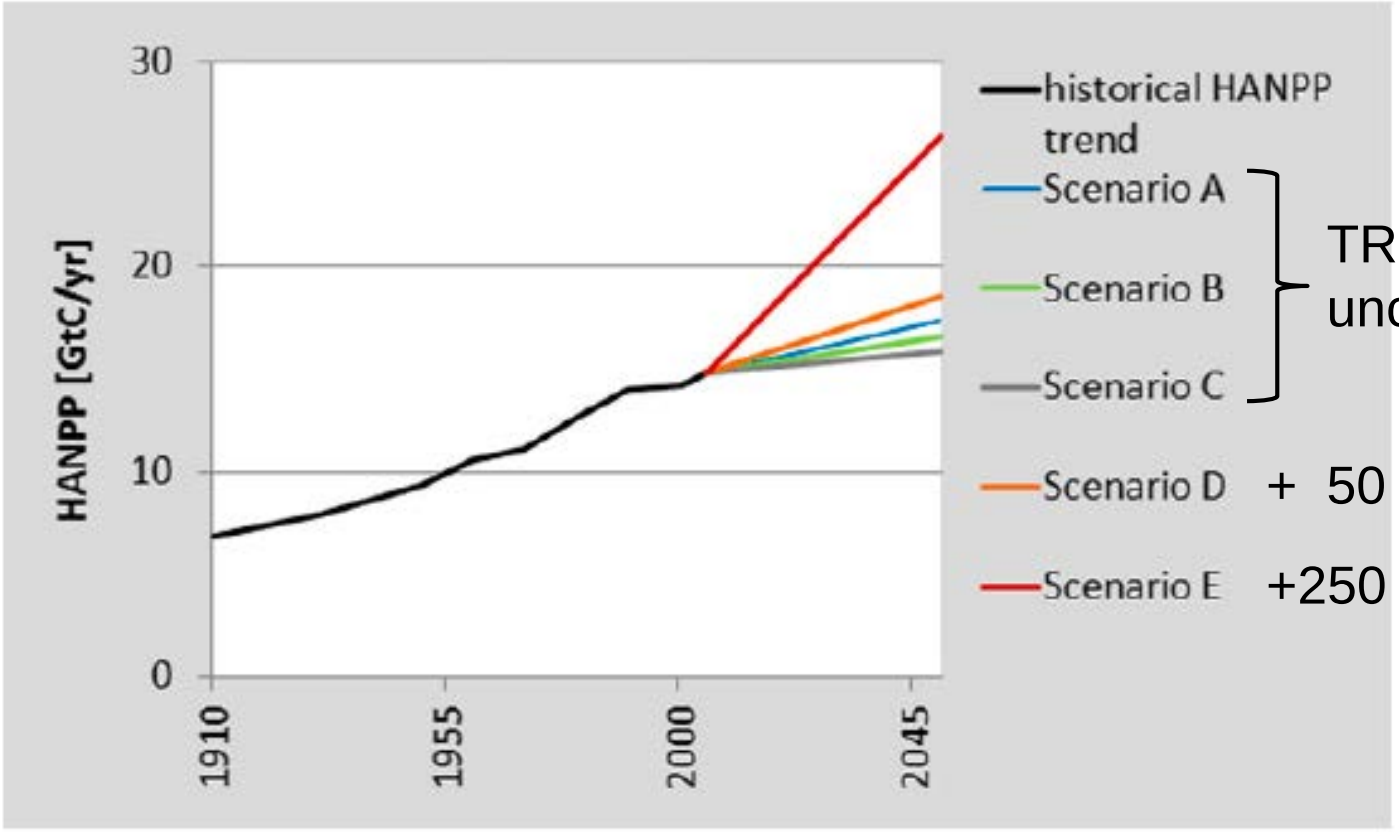
Global human appropriation of net primary production doubled in the 20th century

Fridolin Krausmann[a,1], Karl-Heinz Erb[a], Simone Gingrich[a], Helmut Haberl[a], Alberte Bondeau[b,c], Veronika Gaube[a], Christian Lauk[a], Christoph Plutzar[a], and Timothy D. Searchinger[d]

[a]Institute of Social Ecology Vienna, Alpen-Adria University, A-1070 Vienna, Austria; [b]Mediterranean Institute of Biodiversity and Ecology (IMBE), Aix-Marseille University, Centre National de la Recherche Scientifique (CNRS) - Institut de Recherche pour le Développement (IRD) - Université d'Avignon Pays du Vaucluse (UAPV), F-13545 Aix-en-Provence Cedex 04, France; [c]Potsdam Institute of Climate Impact Research, D-14412 Potsdam, Germany; and [d]Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, NJ 08544

Edited by Wolfgang Lucht, Potsdam Institute of Climate Impact Research, Potsdam, Germany, and accepted by the Editorial Board May 5, 2013 (received for review July 4, 2012)

HANPP scenarios with/without additional bioenergy



Krausmann et al., 2013, PNAS

Ecosystem services from forests (MEA)

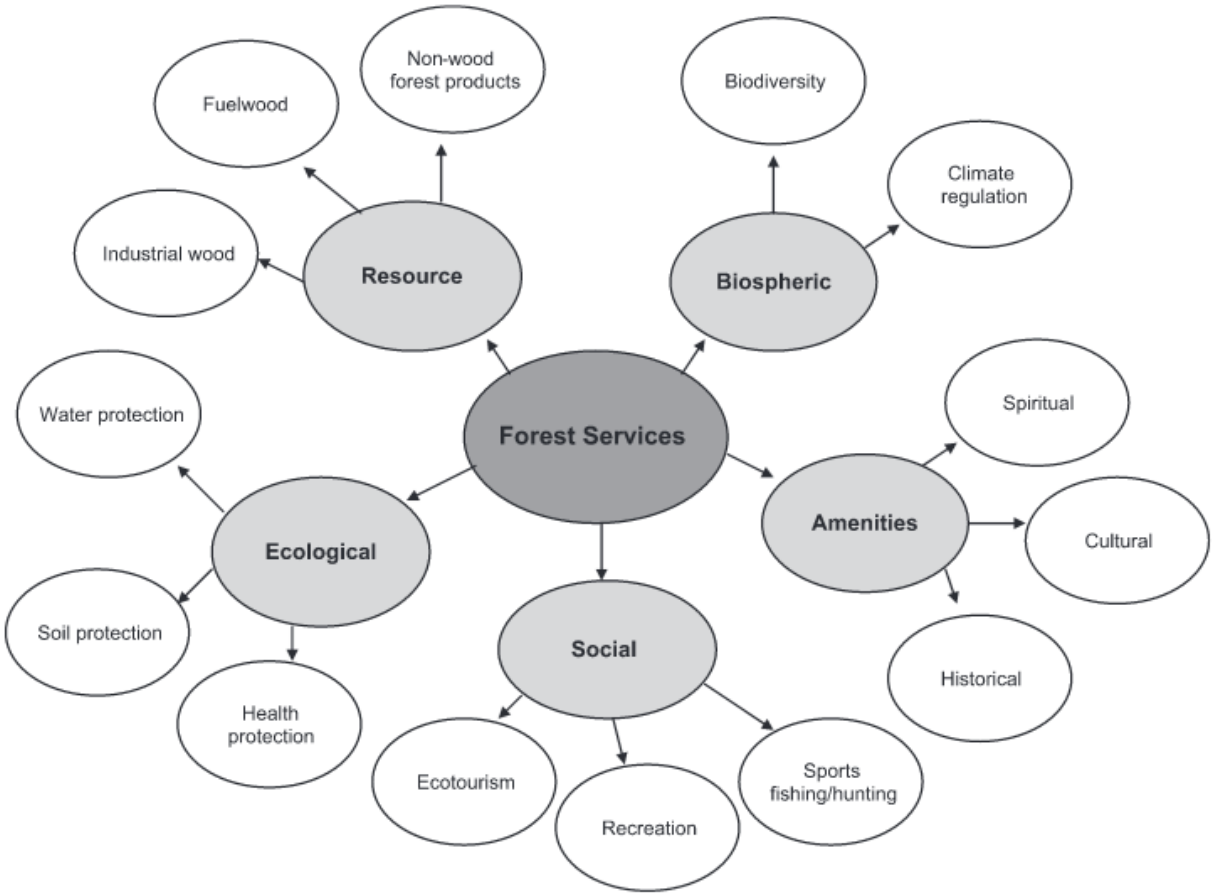


Figure 21.6. Major Classes of Forest Services

Multiple trade-offs, many not well understood!

Shvidenko et al., 2005. in: Millennium Ecosystem Assessment

Example: trade-off between maximizing productivity vs. C stock

	Grassland	Young forest	Old forest
Stock (t C ha^{-1})	6 - 9	100 - 350	200 - 700
Sequestration (yrs)	1	25 - 100	100 - 350
NPP (t C ha^{-1} yr^{-1})	6 - 9	4 - 7	2 - 4
Biomass C/N	50 - 100	200 - 300	>350

Fig. 1 Land management trade-off: maximizing productivity vs. carbon stocks. Given fixed resource availability, land managers can maintain highly productive ecosystems with a low standing biomass such as grasslands. The dominant tissues are leaves and roots with a low C/N ratio (~50). The same resources could be used to grow forest. With time forest accumulate considerable amounts of carbon in their biomass but forest that grow old have a lower net primary production than young forest and grasslands. Woody biomass has high C/N ratios (~400) and with an increasing share of woody biomass in the total biomass, the C/N ratio of the ecosystem decreases. Consequently, the time integral of productivity will be lower for an old forest compared with grassland, but at the same time, the time integral of nitrogen export will be lower for an old forest (closed nitrogen cycle) compared with a grassland (open nitrogen cycle). Hence, increasing the biomass pool size is the sustainable way of capitalizing from forests in the C-sequestration vs. C substitution debate. Ranges in the figure are for temperate ecosystems based on (Van Tuyl *et al.*, 2005; Luyssaert *et al.*, 2007, 2008; Schulze *et al.*, 2009; Keith *et al.*, 2009).

C stocks and flows relevant for the full climate impact of forest bioenergy

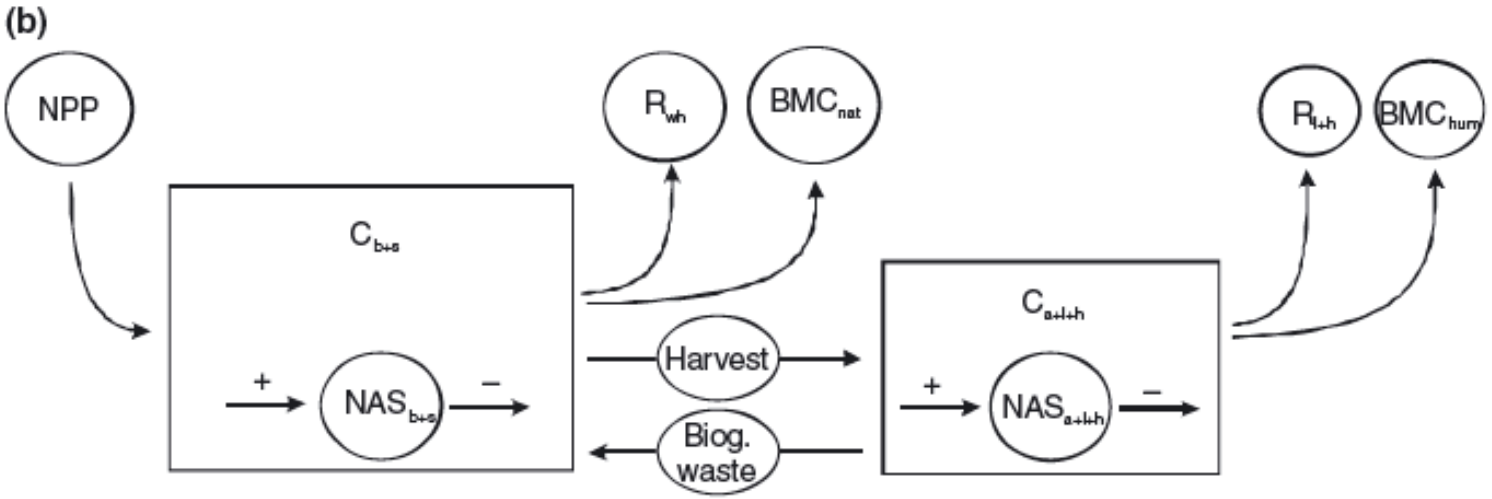


Fig. 1 Stylized representation of stocks and flows of C in land ecosystems (a) without humans, (b) with humans. The squares denote stocks (kg C) and the circles flows (kg C $year^{-1}$). Complexities arising from plant metabolism are excluded from the graph by starting with net primary production (NPP) which is defined as gross C absorption by plants (GPP) minus C released by plant respiration.

Issues to be considered

- If increasing wood harvest in forests for bioenergy should be accepted as a climate-change mitigation measure, its benefits needs to be unequivocal.
  Unresolved issues:
  - Counterfactual (e.g., benefits of C sequestration vs. bioenergy)
  - Temporal issues resulting from stock/flow dynamics
  - Multifunctionality of forest products (timbers vs. fuel)
- Multifunctional role of forests
  - Possible climate benefits are only one among several criteria for sustainable forest management
  - Full suite of ecosystem services, including regulating and cultural services needs to be considered