Bestimmung von Baum-Volumina über einen paneuropäischen Gradienten

Ansatz und Herausforderungen

Geobotanik Kolloquium 25.02.2015 – Steffen Ehrmann et al.

Stammholzvolumen

Wie kann man konsistent das Volumen, die Biomasse und den Kohlenstoff-Anteil verschiedener Arten in verschiedenen Regionen berechnen?

Baumhabitus unterschiedlich aufgrund verschiedener Faktoren

- Art
- Alter (Bestand, Baum)
- Standort (Makroklima, Nährstoffversorgung)
- ...

Kompliziert!

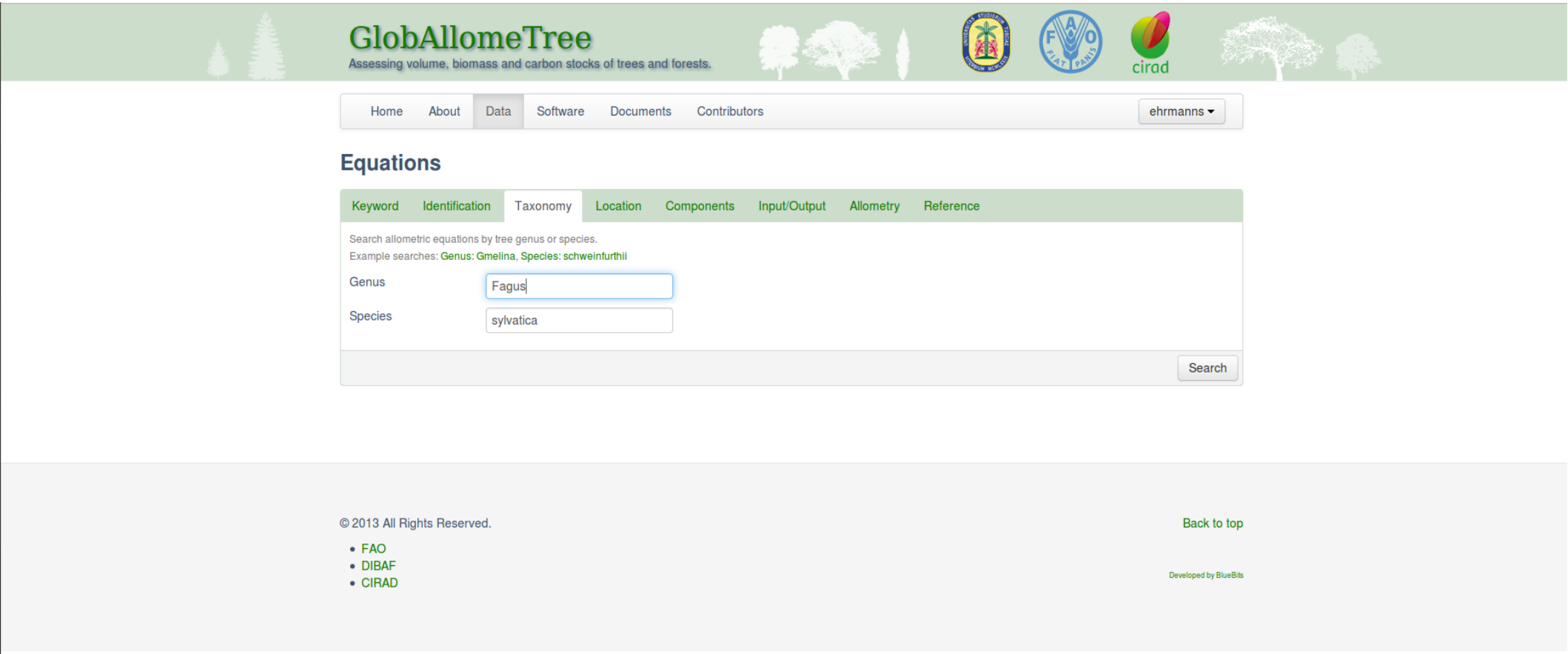
Suche

Literatur- und Datenbankrecherche

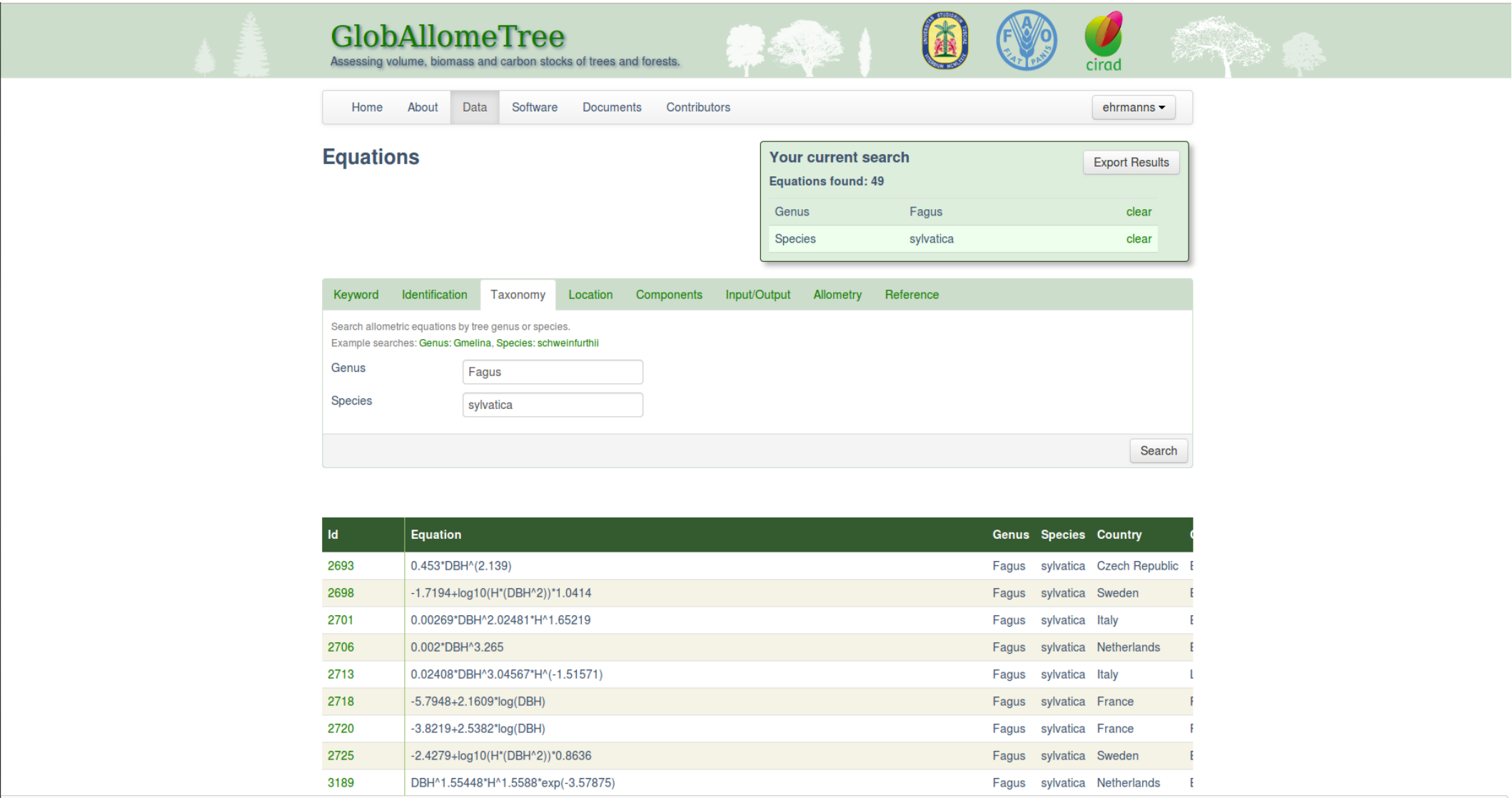
1. Zianis et. al (2005)
2. GlobAllomeTree.org
3. Anleitung nationaler Waldinventuren
4. „graue Literatur“?!

(viele) Allometrische Gleichungen

Exkurs: Globallometree



Exkurs: Globallometree



GlobAllomeTree

Assessing volume, biomass and carbon stocks of trees and forests.

Home | About | Data | Software | Documents | Contributors | ehrmanns

Equations

Your current search — Export Results

Equations found: 49

Genus	Fagus	clear
Species	sylvatica	clear

Keyword | Identification | Taxonomy | Location | Components | Input/Output | Allometry | Reference

Search allometric equations by tree genus or species.

Example searches: Genus: Gmelina, Species: schweinfurthii

Genus: Fagus

Species: sylvatica

Search

Id	Equation	Genus	Species	Country
2693	0.453*DBH^(2.139)	Fagus	sylvatica	Czech Republic
2698	-1.7194+log10(H*(DBH^2))*1.0414	Fagus	sylvatica	Sweden
2701	0.00269*DBH^2.02481*H^1.65219	Fagus	sylvatica	Italy
2706	0.002*DBH^3.265	Fagus	sylvatica	Netherlands
2713	0.02408*DBH^3.04567*H^(-1.51571)	Fagus	sylvatica	Italy
2718	-5.7948+2.1609*log(DBH)	Fagus	sylvatica	France
2720	-3.8219+2.5382*log(DBH)	Fagus	sylvatica	France
2725	-2.4279+log10(H*(DBH^2))*0.8636	Fagus	sylvatica	Sweden
3189	DBH^1.55448*H^1.5588*exp(-3.57875)	Fagus	sylvatica	Netherlands

globallometree.org/data/search/?q=&Ecosystem=&Population=&Genus=Fagus&Species=sylvatica&Country=&Biome_HOLDRIDGE=&Bi...in_Z_gte=&Min_Z_lte=&Max_Z_gte=&Max_Z_lte=&Output=&Equation=&Author=&Reference=&Year=&order_by=&page=1#taxonomy

Exkurs: Globallometree

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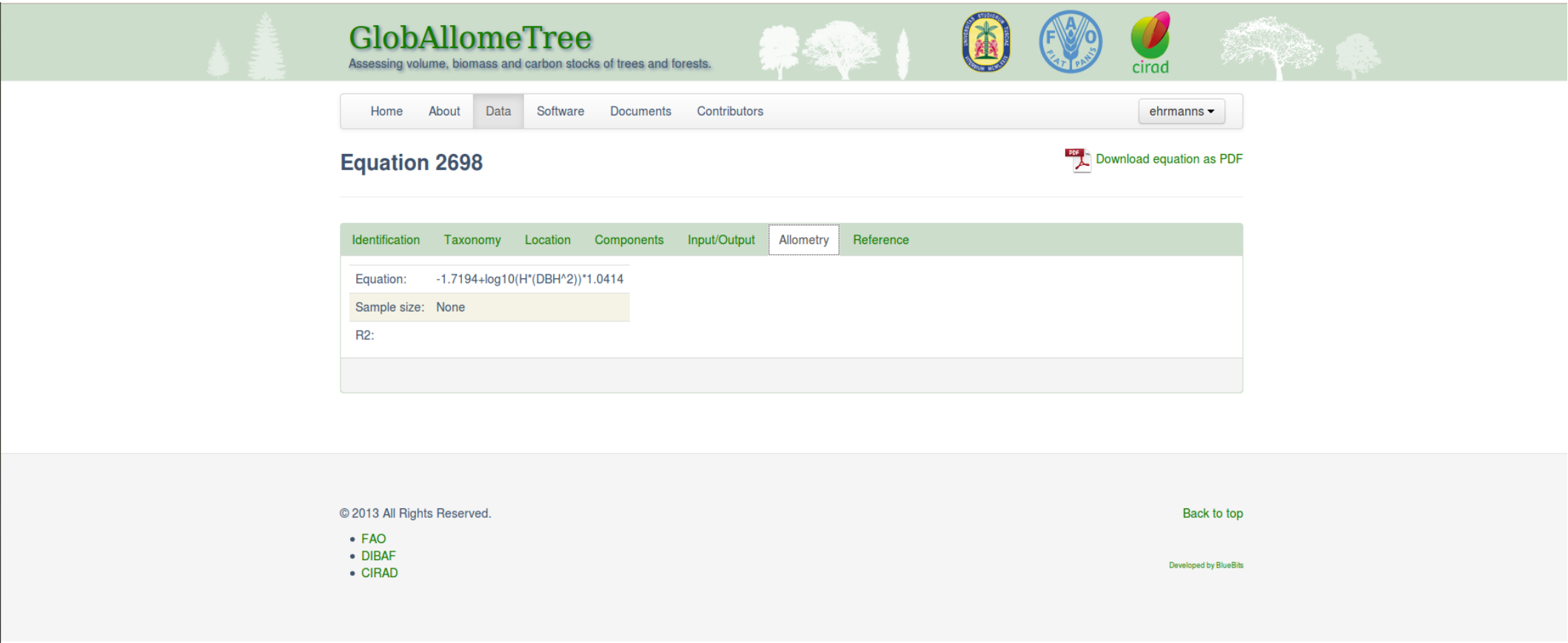
Equation 2698

Download equation as PDF

Identification | Taxonomy | Location | Components | Input/Output | Allometry | Reference

X:	DBH
Unit X:	cm
Unit Y:	kg
Z:	H
Unit Z:	m
W:	None
Unit_W:	None
U:	None
Unit_U:	None
V:	None
Unit V:	
Min X:	12
Max X:	64
Min Z:	11
Max Z:	29
Output:	Biomass
Output TR:	log10
Age:	None
Veg component:	Complete tree (aboveground - excluded fruits)

Exkurs: Globallometree



Möglichkeiten

	Biomasse	Volumen	
Quercus robur	-	$V = D130^{a} \cdot H^{b} \cdot \exp(c)$	Dik (1984)
Fagus sylvatica	$B = a \cdot D130^{b}$ $B = a + \log(H \cdot D130^{2}) \cdot b$	$V = a \cdot 10^{-3} + b \cdot 10^{-3} \cdot D130^{2} \cdot H + c \cdot 10^{-3} \cdot D130^{2}$	Pellinen (1986)
...			

mit:

a, b, c	= Baumart-spezifische Parameter
D130	= Durchmesser auf Brusthöhe
H	= Höhe

Möglichkeiten

Biomasse	Volumen
wenige Gleichungen vorhanden	viele Gleichungen vorhanden
keine Information über 'erntbares Stammholz'	'erntbares Stammholz' direktes Ergebniss
Biomasse direktes Ergebniss	keine Information über Biomasse
gesamte oberirdische Biomasse	lediglich Volumen des Stammes
meist basierend auf (mehreren) duzend Bäumen	meist basierend auf (mehreren) hunderten Bäumen

Umrechnung?

Umrechnung

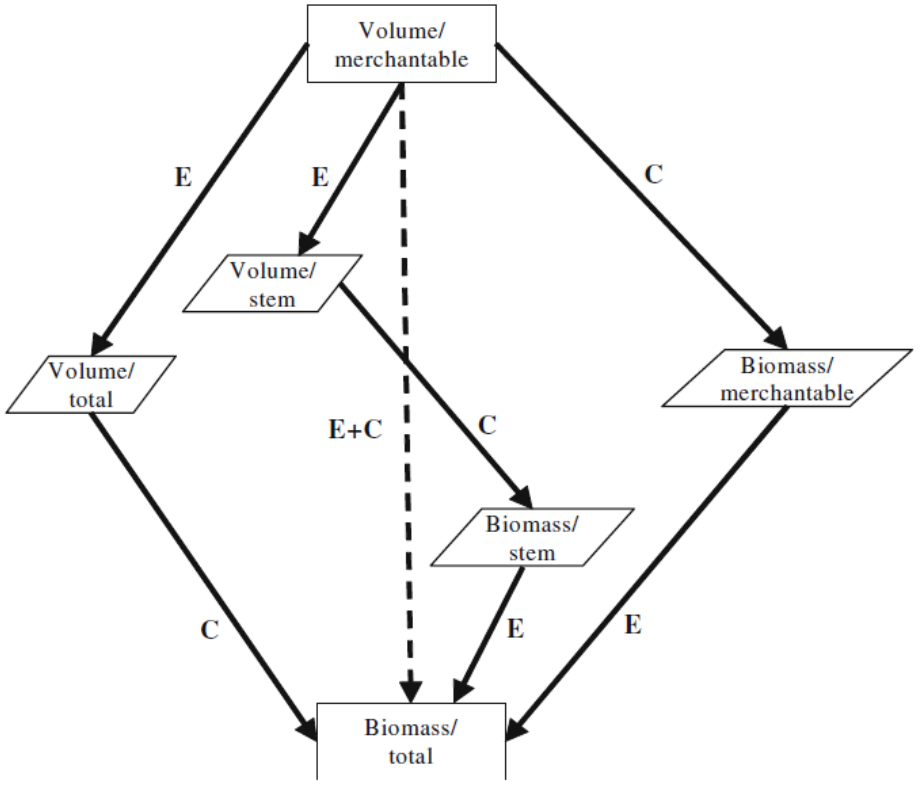


Fig. 1 Various ways to estimate total biomass from merchantable volume. *E* stands for expansion, *C* for conversion. *Stem* refers to the frequently used definition, when all parts of the stem are included, but all branches and leaves are excluded. The examples do not cover all possible combinations of including various tree parts as listed in the text

Somogyi et. al (2007)

Volumen ↔ Biomasse

$$B = V_{merch} \cdot BEF \cdot D$$

$$B = V_{merch} \cdot BCEF$$

mit:

B = Biomasse [kg]
V_{merch} = erntbares Stammvolumen [m^3]
BEF = „Biomas expansion factor“
D = Holzdichte [$kg*m^{-3}$]
BCEF = „Biomass conversion and expansion fact

BEF oder BCEF?

Umrechnung – BEF

2006 IPCC Guidelines for National Greenhouse Gas Inventories

„Biomass Expansion Factors (BEF) expand dry weight of merchantable wood to account for non-merchantable components of the tree, stand or forest.

→ Must be converted to dry-weight by multiplying with wood density (D).

→ best results when BEF based on dry weight and locally valid wood densities.“

Aalde et. al (2006)

Umrechnung – Holzdichte

TABLE 4.14
BASIC WOOD DENSITY (D) OF SELECTED TEMPERATE AND BOREAL TREE TAXA

Taxon	D [oven-dry tonnes (moist m^{-3})]	Source
Abies spp.	0.40	2
Acer spp.	0.52	2
Alnus spp.	0.45	2
Betula spp.	0.51	2
Fagus sylvatica	0.58	2
Fraxinus spp.	0.57	2
Larix decidua	0.46	2
Picea abies	0.40	2
Picea sitchensis	0.40	3
Pinus pinaster	0.44	4
Pinus radiata	0.38 (0.33 - 0.45)	1
Pinus strobus	0.32	2
Pinus sylvestris	0.42	2
Populus spp.	0.35	2
Prunus spp.	0.49	2
Pseudotsuga menziesii	0.45	2
Quercus spp.	0.58	2
Salix spp.	0.45	2
Tilia spp.	0.43	2

1 = Beets et al., 2001
2 = Dietz, 1975
3 = Knigge and Shulz, 1966
4 = Rijsdijk and Laming, 1994

Aalde et. al (2006)

viele zusätzliche Angaben

Beispiel *F. sylvatica:*

→ 690 kg * m^{-3} (1)

→ 700 – 900 kg * m^{-3} (2)

→ 540 – 910 kg * m^{-3} (3)

ungünstig

(1) de.wikipedia.org/wiki/Holz
(2) https://cedarstripkayak.wordpress.com/lumber-selection/162-2/
(3) http://www.didgeridoo-physik.de/CADSD/holzdaten/holzdaten-frameset.htm

Umrechnung – BCEF

2006 IPCC Guidelines for National Greenhouse Gas Inventories

„Biomass Conversion and Expansion Factors (BCEF) combine conversion and expansion.

→ one single multiplication to transform growing stock to aboveground-biomass, thus more convenient.

→ best results when derived locally, based directly on merchantable volume.“

Aalde et. al (2006)

Umrechnung – BCEF

TABLE 4.5 (CONTINUED)
DEFAULT BIOMASS CONVERSION AND EXPANSION FACTORS (BCEF), TONNES BIOMASS (M^3 OF WOOD VOLUME)$^{-1}$

BCEF for expansion of merchantable growing stock volume to above-ground biomass ($BCEF_S$), for conversion of net annual increment ($BCEF_I$) and for conversion of wood and fuelwood removal volume to above-ground biomass removal ($BCEF_R$)

Climatic zone	Forest type	BCEF	Growing stock level (m^3)				
			<20	21-40	41-100	100 -200	>200
Temperate	hardwoods	$BCEF_S$	**3.0** (0.8-4.5)	**1.7** (0.8-2.6)	**1.4** (0.7-1.9)	**1.05** (0.6-1.4)	**0.8** (0.55-1.1)
		$BCEF_I$	1.5	1.3	0.9	0.6	0.48
		$BCEF_R$	3.33	1.89	1.55	1.17	0.89
	pines	$BCEF_S$	**1.8** (0.6 -2.4)	**1.0** (0.65 -1.5)	**0.75** (0.6-1.0)	**0.7** (0.4-1.0)	**0.7** (0.4-1.0)
		$BCEF_I$	1.5	0.75	0.6	0.67	0.69
		$BCEF_R$	2.0	1.11	0.83	0.77	0.77
	other conifers	$BCEF_S$	**3.0** (0.7-4.0)	**1.4** (0.5-2.5)	**1.0** (0.5-1.4)	**0.75** (0.4-1.2)	**0.7** (0.35-0.9)
		$BCEF_I$	1.0	0.83	0.57	0.53	0.60
		$BCEF_R$	3.33	1.55	1.11	0.83	0.77
Mediterranean, dry tropical, subtropical			<20	21-40	41-80	>80	
	hardwoods	$BCEF_S$	**5.0** (2.0-8.0)	**1.9** (1.0-2.6)	**0.8** (0.6-1.4)	**0.66** (0.4-0.9)	
		$BCEF_I$	1.5	0.5	0.55	0.66	
		$BCEF_R$	5.55	2.11	0.89	0.73	
	conifers	$BCEF_S$	**6.0** (3.0-8.0)	**1.2** (0.5-2.0)	**0.6** (0.4-0.9)	**0.55** (0.4-0.7)	
		$BCEF_I$	1.5	0.4	0.45	0.54	
		$BCEF_R$	6.67	1.33	0.67	0.61	

Note: Lower values of the ranges for $BCEF_S$ apply if growing stock definition includes branches, stem tops and cull trees; upper values apply if branches and tops are not part of growing stock, minimum top diameters in the definition of growing stock are large, inventoried volume falls near the lower category limit or basic wood densities are relatively high. Continuous graphs, functional forms and updates with new studies can be found at the forest- and climate- change website at: http://www.fao.org/forestry/

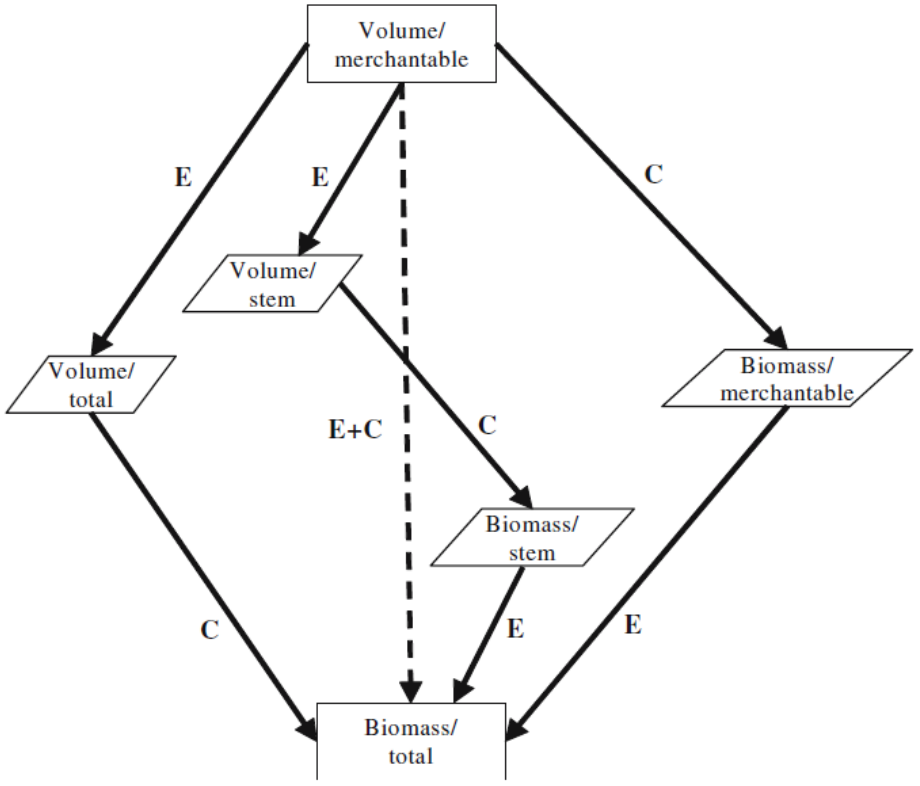
Average BCEF for inhomogeneous forests should be derived as far as possible as weighted averages. It is good practice to justify the factors chosen. To apply $BCEF_I$, an estimate of the current average growing stock is necessary. It can be derived from FRA 2005 at http://www.fao.org/forestry/

$BCEF_R$ values are derived by dividing $BCEF_S$ by 0.9

Aalde et. al (2006)

Sources: *Boreal forests*: Alexeyev V.A. and R.A. Birdseye, 1998; Fang J. and Z.M. Wang, 2001; *temperate forests*: Fang J. *et al.*, 2001; Fukuda M. *et al.*, 2003; Schroeder P. *et al.*, 1997; Snowdon P. *et.al.*, 2000; Smith J. *et. al.*, 2002; Brown S., 1999; Schoene D. and A. Schulte, 1999; Smith J. *et al.*, 2004; *Mediterranean forests*: Vayreda *et al.*, 2002; Gracia *et al.*, 2002; *tropical forests*: Brown S. *et al.*, 1989; Brown S. and A. Lugo, 1992; Brown S., 2002; Fang J.Y., 2001.

Umrechnung



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BCEF!

Prozedere

2 Entscheidungen:

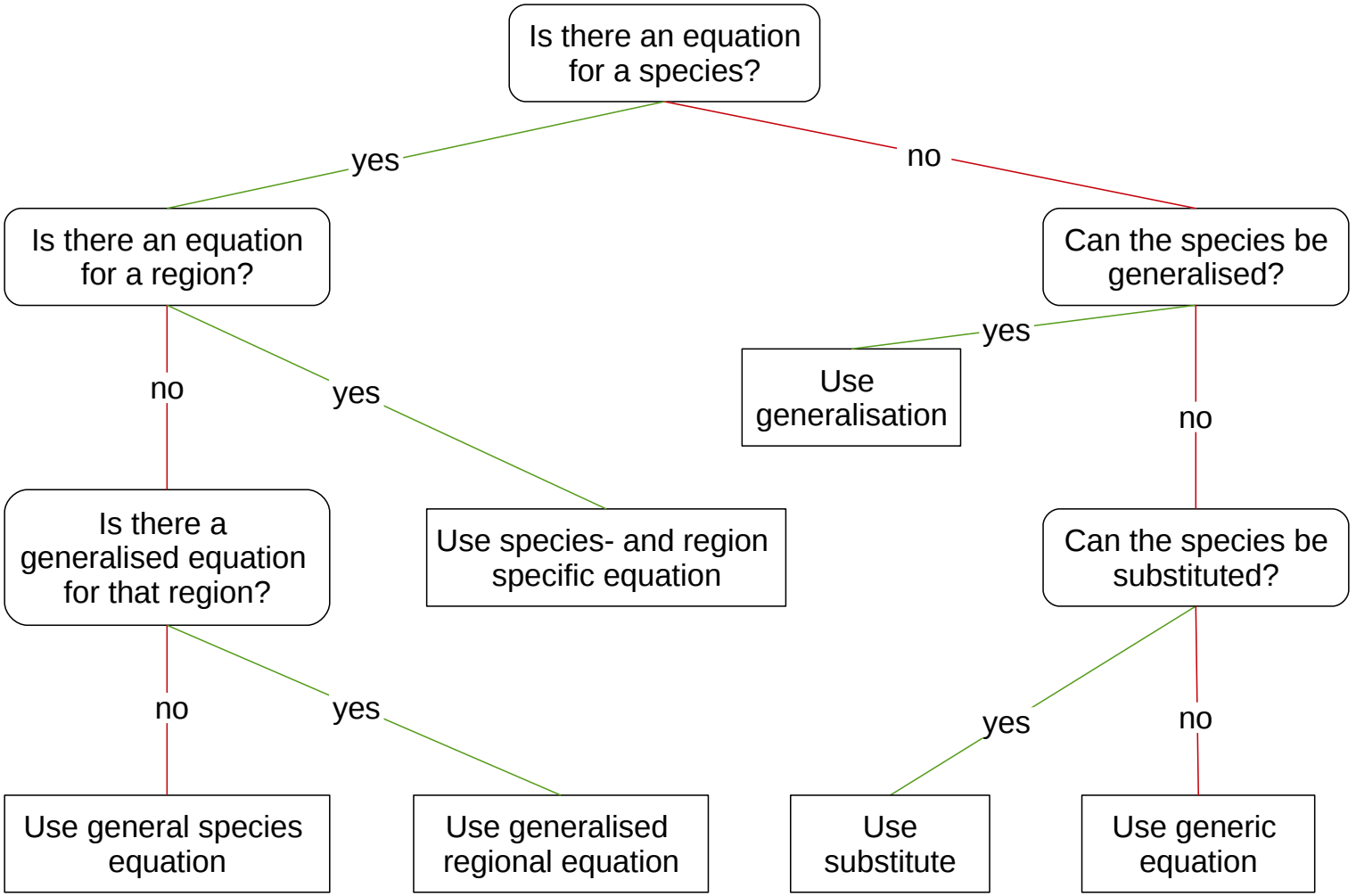
1. Volumen als primäres Maß
2. BCEF für Expansion und Konversion zu Biomasse

zu Beachten:

3. Wie wurde das Volumen definiert?
   - Welche Kompartimente des Baumes?
   - Welcher Bereich (Durchmeßer, Höhe) wurde zur Ermittlung der Gleichung gemeßen?
4. (Volumengleichungen mit ähnlicher Anzahl Regressionsparameter)

Aufbau einer Volumen-Gleichungen Datenbank

Selektion der Gleichungen



Pro Art und Region wiederholen

Und dann? Und sonst?

1. zusätziche Gewichtung mit Bodennährstoffen?
2. zusätzliche Expansion auf „belowground biomass“?
3. Umrechnung in „Kohlenstoff“ (Multiplikation mit 0.5)
4. Hochrechnen auf Bestände und Verwendung zur Darstellung und Auswertung

Validierung

Biomasseberechnung nach FVA (Hr. Kändler)
→ Korrelation Volumen~Biomasse; cor=~0.9

Überprüfung der Bestimmtheitsmaße
→ steht noch aus.