VSD+PROPS Dynamic Soil Vegetation Model Overview

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From VSD to VSD+

- Shifting goals:
- biodiversity
 - effects of N deposition on plant species diversity
 - this requires: N availability, C/N ratio, NO₃/NH₄ concentrations,
- climate
 - carbon sequestration in forests
 - greenhouse gases (N₂O emissions)

→New formulations of C and N processes (explicit C and N balance)



■ Very Simple Dynamic soil acidification model

to simulate the acidification (and recovery) of non-calcareous (forest) soils

scenario analyses & target load calculations (& critical loads)

regional/national scale calculations in support of effects-based work under LRTAP Convention

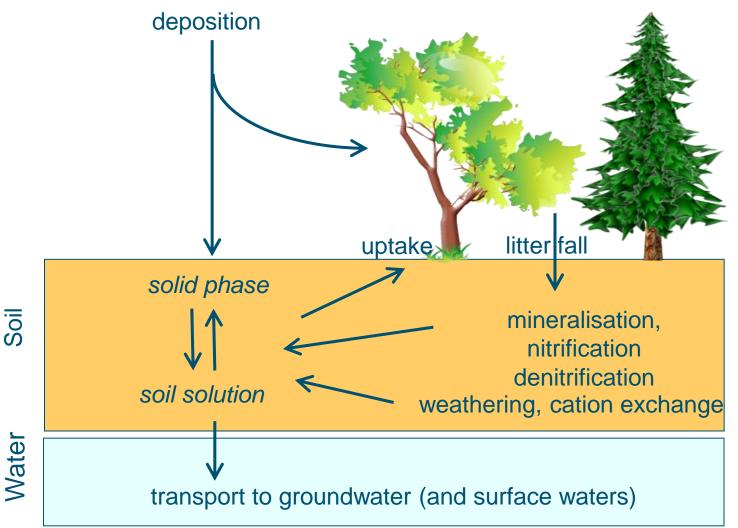


VSD+

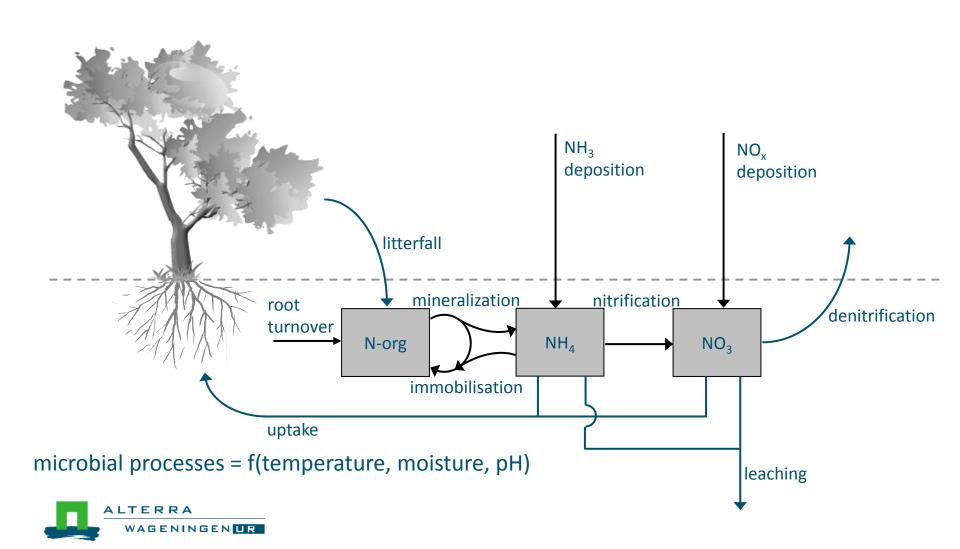
VSD+ (VSD + explicit C and N modelling) o dynamic modelling of soil acidification o soil eutrophication (N availability) o carbon sequestration



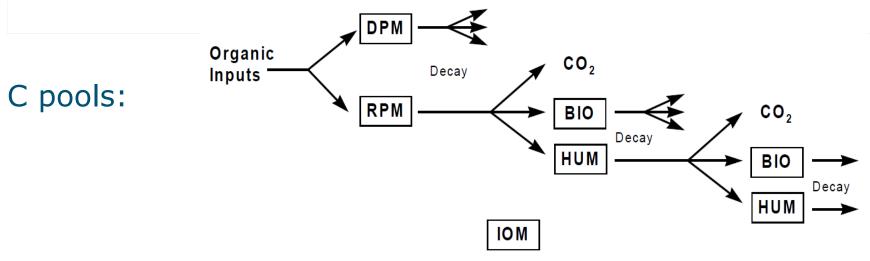
VSD+



N processes in VSD+



RothC model

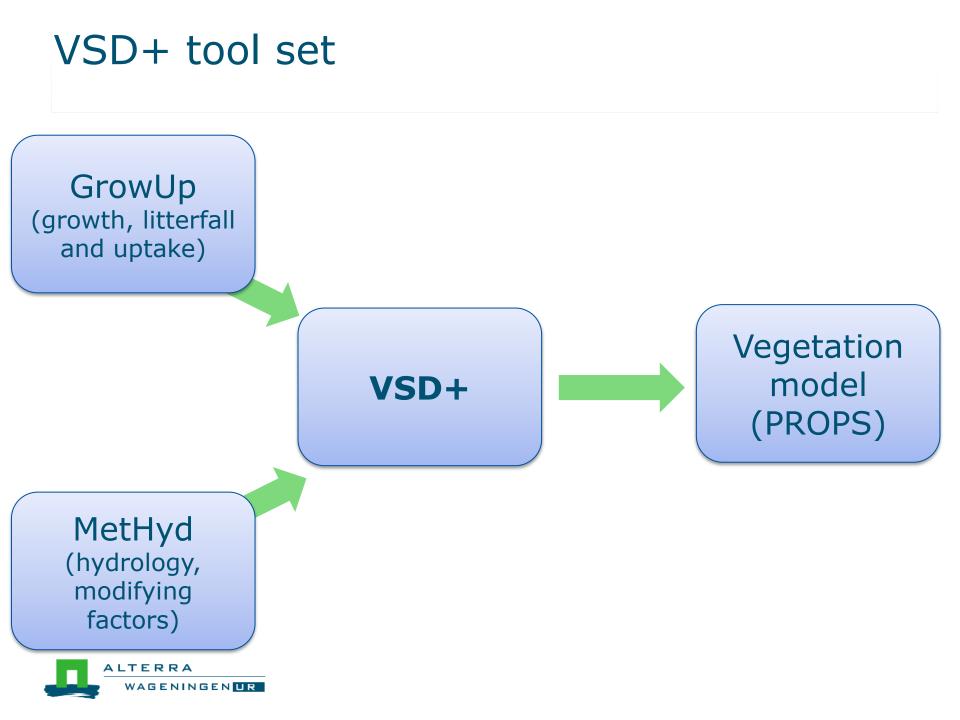


RPM : Resistant Plant MaterialDPM : Decomposable Plant MaterialBIO : Microbial BiomassIOM : Inert Organic Matter

N dynamics:

- fixed N contents for DPM, RPM and BIO
- $N_{HUM} = f(N_{DPM}, f_{RPM}, f_{BIO})$, but is reduced when N uptake > N deposition + N mineralisation





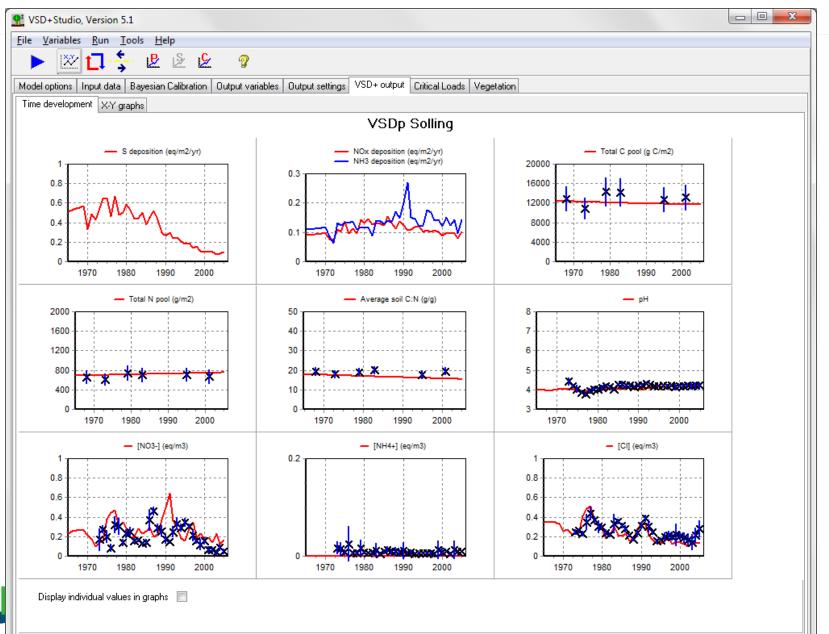
VSD+ tool set



VSD+ user interface (screenshots)

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Model options	Input data Bayesian Ca	libration Outpu	it variables Output setti	ngs VSD+ou	utput Critical Loads Veg	tation					
SiteInfo	VSDp Solling	cRC00	0.004379	rf_nit	0.33						
period	1965 2005	RCOOpars	0.96 0.90 -0.039	rf_denit	0.2						
thick	0.9	TempC	8.	N_gupt	D:\UserData\models						
bulkdens	1.208	percol	D:\UserData\models	Ca_upt	D:\UserData\models						
Theta	D:\UserData\models	Ca_we	0.005218895	Mg_upt	D:\UserData\models						
pCO2fac	20	Mg_we	0.026769245	K_upt	D:\UserData\models						
parentCa	-1	K_we	0.003619	P_upt	0.						
Clay_ct	4	Na_we	0.003028	NIf	D:\UserData\models						
CEC	74.1	SO2_dep	D:\UserData\models	Clf	D:\UserData\models						
bsat_0	-1.	NOx_dep	D:\UserData\models	QIIf	0.25						
ECa_O	0.028	NH3_dep	D:\UserData\models	Precip	D:\UserData\models						
EMg_0	0.009	Ca_dep	D:\UserData\models								
EK_0	0.001	Mg_dep	D:\UserData\models								
Excmod	Gaines Thomas	K_dep	D:\UserData\models								
IgKAIBC	0.540000021457672	Na_dep	D:\UserData\models								
IgKHBC	3.26999998092651	Cl_dep	D:\UserData\models								
expAl	3.	knit	10								
IgKAlox	8.54	kdenit	4.								
Cpool_0	12516.392578	Nfix	0.								
CNrat_0	18.144791	Nupeff	0.92								
RCOOmod	None	rf_miR	0.33								

VSD+ user interface (screenshots)



GrowUp

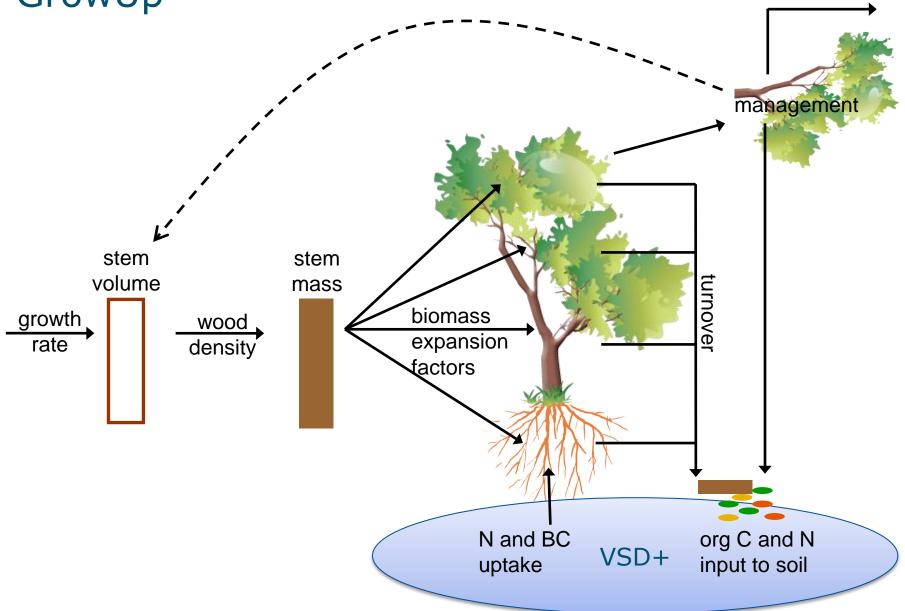
Tool to calculate:

- uptake of N, Ca, Mg and K
- input of C and N from litterfall and root turnover
- for forests only
- includes management actions (planting, thinning, clear-cut)
- two forest types:
 - uniform age
 - mixed uneven aged (natural rejuvenation)

GrowUp available through CCE website



GrowUp



PROPS – **PRO**bability of **P**lant **S**pecies

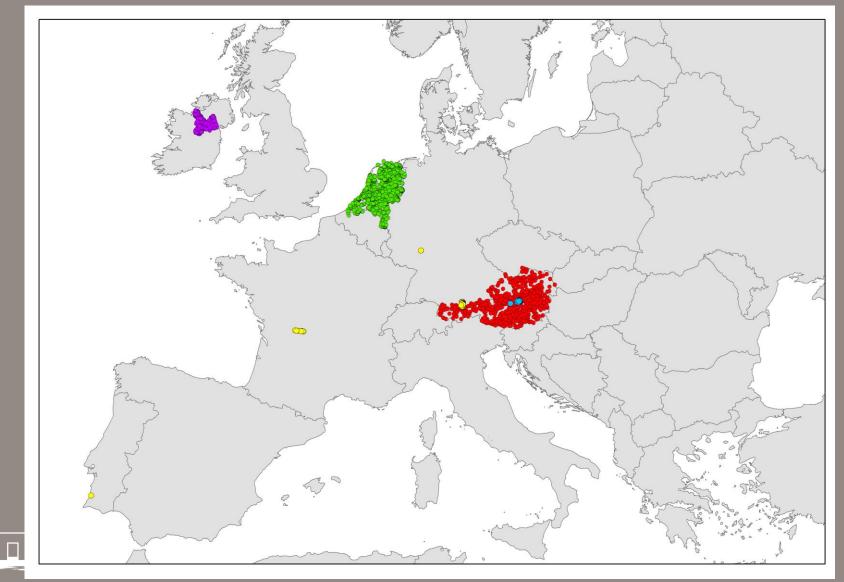
- calculates the chance/probability/suitability that a plant species is present (not abundance!)
- based on measured/measurable abiotic conditions

Derived from:

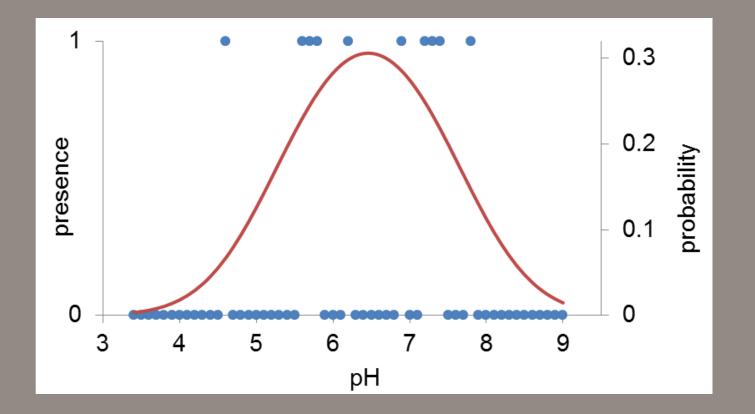
- relevés with simultaneously <u>measured</u> abiotic conditions (N, pH)
- climate data



Relevés with measurements of abiotic conditions



Fitting of response functions





Response functions

- 2 dimensional response functions:
 pH
 N (N-total, CN, NO₃)
- $logit(y) = a + \beta_1 pH + \beta_2 N + \gamma_1 pH^2 + \gamma_2 N^2 + \delta pH \cdot N$
- probability = 1/(1+exp(-logit(y)))



Results

Number of plant species with response functions

- pH + N-total: 406
- pH + CN ratio: 330
- pH + NO₃: 146



2. Extension number of species

Problem:

■ only few relevés where abiotic conditions have been measured ⇒ response functions for few species

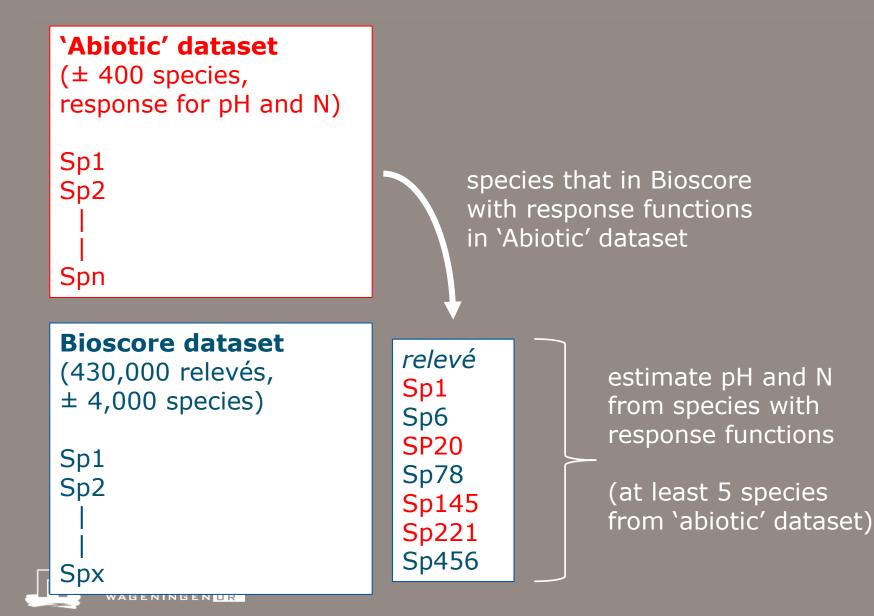
how to get abiotic conditions for other relevés?

Datasets:

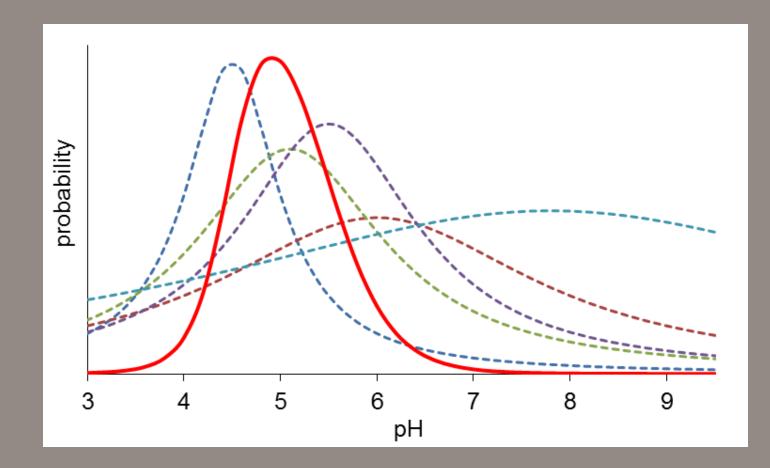
- Abiotic' dataset: ± 4600 relevés with measurements of abiotic conditions
- Bioscore dataset: ± 430,000 relevés without abiotic conditions



estimation of abiotic conditions



estimation of abiotic conditions





Results

Number of plant species with response functions

abiotic' database
pH + N-total: 406
pH + CN ratio: 330
pH + NO₃: 146

 Bioscore database

 PH + N-total:
 2306

 PH + CN ratio:
 2309

 $PH + NO_3$:
 1781



PROPS model summary:

Probability *y* for occurrence of a plant modelled as:

$$z = \text{logit}(y) = \log \frac{y}{1-y} = a_0 + \sum_{i=1}^n a_i \cdot x_i + \sum_{i=1}^n \sum_{j=1}^n a_{i,j} \cdot x_i \cdot x_j$$

with $a_{i,j} = a_{j,i}$ for all *i*, *j*. Number of variables x_i is n = 4 (normalized/log-transformed): soil solution pH and [N], precipitation, temperature.

Probability *y* obtained as:

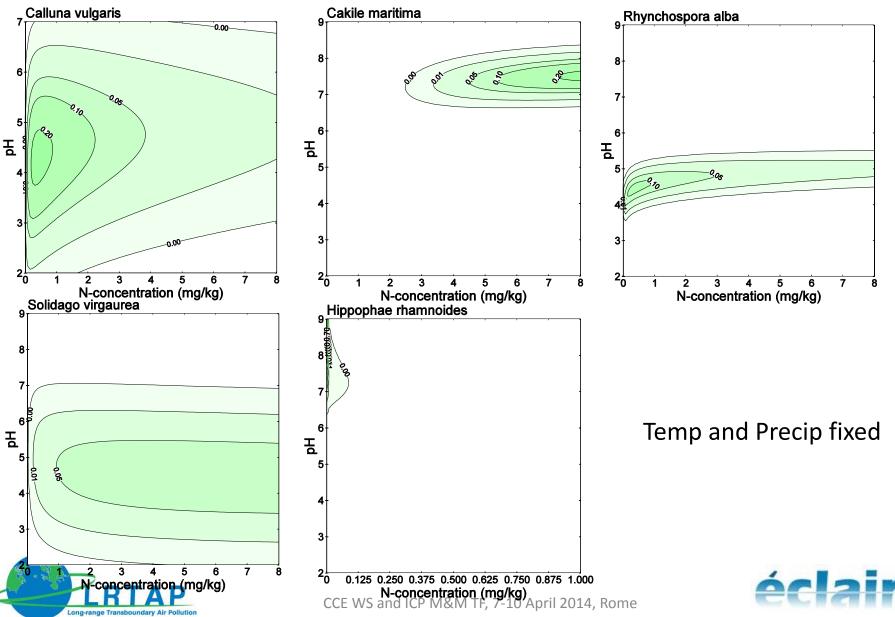
$$y = \frac{1}{1 + \exp(-z)}$$

The 15 coefficients for many plant species are derived from relevés with both biotic and abiotic observations and extrapolated ...





From PROPS DataBase: Isolines of occurrence probability for single species (in [N]-pH plane):



3. Preselect species in PROPS calculations

2300 species with response functions

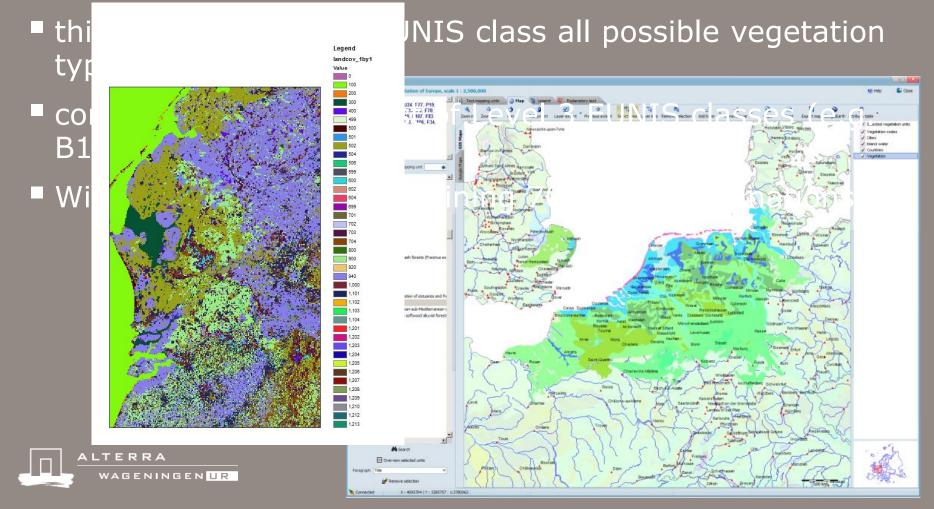
a-priori selection of species is required

EUNIS classification is used in M&M work \Rightarrow species selection related to EUNIS



Step 1: Overlaying

• overlay of EUNIS map (level 2; e.g. B1) with Map for the Natural Vegetation for Europe.



Step 2: species assignment

- For each unit of the EuroVegMap units we got a list of typical/relevant species
- These can be linked to the PROPS list

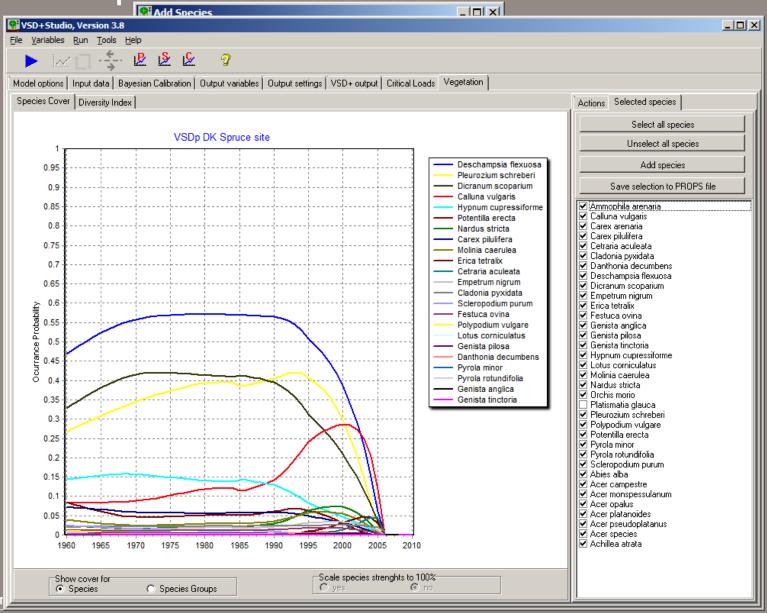


In VSD+Studio it is implemented as follows:

UNIS classes and associated vegetation types	Plant species
 F2.4-[Pinus mugo] scrub F3.1-Temperate thickets and scrub F3.2-Mediterraneo-montane broadleaved deciduous thickets F4.1-Wet heaths F4.2-Dry heaths I-tow creeping shrub-lichen tundras Moss-lichen tundras with low creeping shrubs Sparse lichen-rich dwarf birch tundras Low creeping shrub-moss tundras Sparse dwarf shrub-lichen mountain tundras Oceanic low creeping shrub-moss tundras Oceanic low creeping shrub-moss tundras Oceanic dwarf shrub tundras Oceanic dwarf shrub tundras Oceanic dwarf shrub tundras Orocantabrian Juniperus communis subsp. alpina- and Cotoneaster integ Orocantabrian Juniperus communities Rocky heaths Frisian-Danish coastal heaths Coastal rocky heaths with Ulex gallii subsp. gallii f. humilis in combination Coastal rocky heaths Scottish toreo-montane heaths Scottish coastal rocky heaths South wedish coastal rocky heaths South Swedish coastal rocky heaths South Norwegian coastal rocky heaths South Norwegian coastal rocky heaths South Norwegian coastal heaths Trish-British Atlantic-montane heaths South Norwegian coastal rocky heaths South Norwegian coastal rocky heaths South Norwegian coastal rocky heaths South Norwegian coastal heaths 	Ammophila arenaria Calluna vulgaris Carex pilulifera Cetraria aculeata Cladonia pyxidata Danthonia decumbens Deschampsia flexuosa Dicranum scoparium Empetrum nigrum Erica tetralix Festuca ovina Genista anglica Genista anglica Genista pilosa Genista pilosa Genista pilosa Genista tinctoria Hypnum cupressiforme Lotus corniculatus Molinia caerulea Nardus stricta Orchis morio Platismatia glauca Pleurozium schreberi Polypodium vulgare Potentilla erecta Pyrola minor Pyrola rotundifolia Scleropodium purum



Species options



WAGENINGEN <mark>UR</mark>

Summary

PROPS

response functions (pH, N, T, prec.) for 2300 species
a-priori selection of species based on vegetation type

relatively few species for Scandinavia, Iberic peninsula, south-east of Europe



MetHyd, GrowUp and VSD+PROPS single site versions available from the CCE website:

www.wge-cce.org/Methods Data/The VSD suite of models

Also available there: *Instruction videos*

Questions concerning models: luc.bonten@wur.nl













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