



THE GRAS-MODEL (GRASSLAND-SUCCESSION-MODEL)

A simulation model for the succession of grassland biotopes under various management regimes (developed for the Eifel National Park)

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Overview

Context

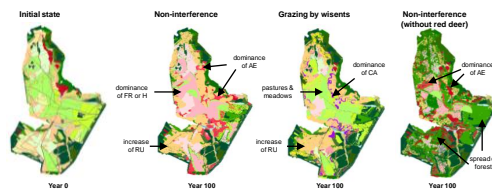
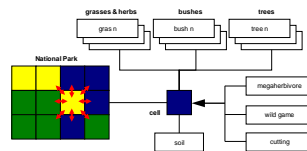
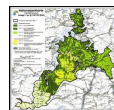
Objectives

Study site

Model description

Results

Conclusion





Context

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- Establishment of the Eifel National Park 2004
- Management of the open grasslands in the former military training site Vogelsang
- Model as support for decision making concerning goals and perspectives for the grasslands

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Objectives

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Simulation of grassland succession under various land use forms (hay-making, grazing, non-interference)

- Tool to extract and analyse processes relevant for succession
- Decision support system for all actors that deal with management of grasslands on the landscape level

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Study site

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Eifel National Park:

- established 2004
- 10,800 ha
- 70% forest

Simulated area:

- former military training site Vogelsang
- 1,500 ha of semi-natural grassland

Elevation:

- 400 m (NE) above sea level
- 580 m (SW) above sea level

Climate gradient:

- NE: 8°C, 700-800 mm precipitation
- SW: 6°C, 1000-1200 mm precipitation



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Study site

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Soils:

- acid brown soils (Cambisol), $\text{pH}_{\text{CaCl}_2}$ 4-5
- shallow depth

Predominant plant communities:

- mountain hay meadows
- mountain pastures
- fallow grasslands
- shrubberies (common broom (*Cytisus scoparius*), blackthorn (*Prunus spinosa*) or black- and raspberries (*Rubus* spp.))
- forests (spruce (*Picea abies*), birch (*Betula pendula*), beech (*Fagus sylvatica*) or oak (*Quercus robur*))



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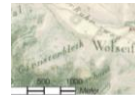
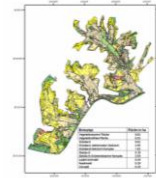


Model Description

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Dataset:

- Vegetation mapping
 - Analysis of species composition \Rightarrow most relevant succession stages
 - Coexistence of different succession stages within the Eifel National Park (space for time substitution) \Rightarrow most important processes of succession
 - Information about the speed of processes: data about historical land use in the area (historical maps and aerial photographs)
- \Rightarrow **Calibration of processes on well-known vegetation developments**



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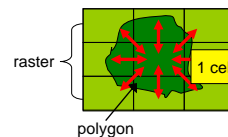
Model Description

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Important for grassland succession: Neighbourhood relationships between different habitats

Cellular automaton

- Modelled area: divided into cells
 - Each cell: defined by position, width and length, soil type, land use form and set of representative species
 - Competition of species for space: within each cell and between adjacent cells
- \Rightarrow **Emergence of vegetation succession from competition**




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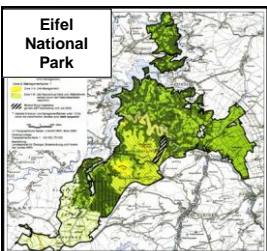


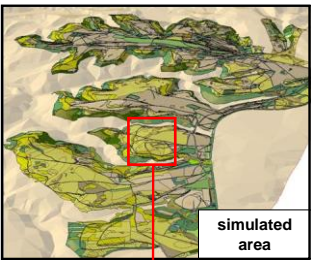
Model Description

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Spatial explicit data as model input






simulated area

digital map:
Polygon map with about 2500 polygons of biotope types




digital map:
Raster map with about 500,000 cells (10m x 10m)
spatially explicit input data (biotope type, land use, soil properties, ...)

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Model Description

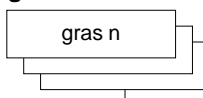
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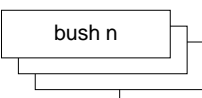
Cellular automaton

competition for space

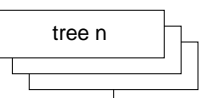
grasses & herbs

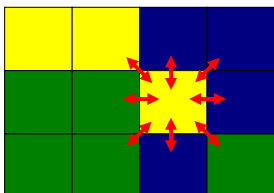


bushes

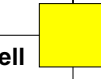


trees

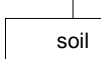




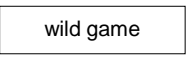
cell



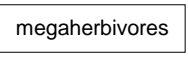
soil



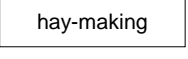
wild game




megaherbivores



hay-making




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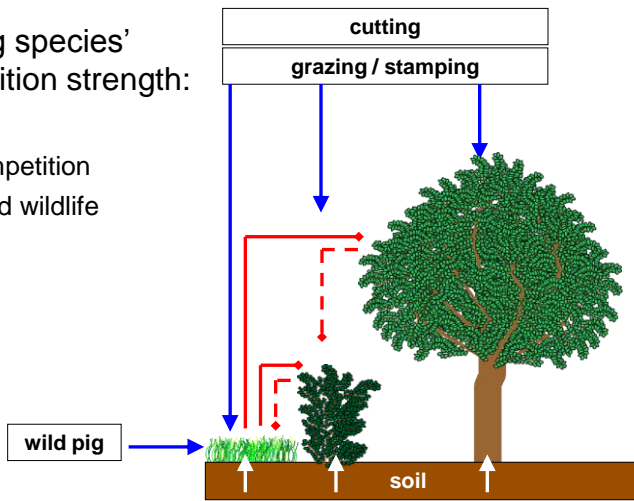
Model Description

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Factors influencing species' growth i.e. competition strength:

- Interspecific competition
- Management and wildlife
- Soil properties




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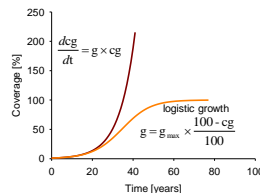


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Calculating species' growth according to land use



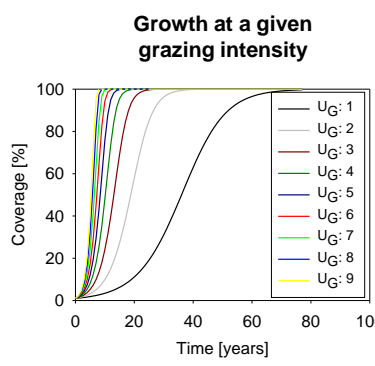
$$g = g_{max} \times \frac{100 - c_g}{100} \times f(\text{cutting}) \times f(\text{grazing}) \times f(\text{stamping})$$

$$f(\text{grazing}) = \left(1 - \frac{U_G}{9}\right) \times \frac{100 - I_G}{100} + \frac{U_G}{9}$$

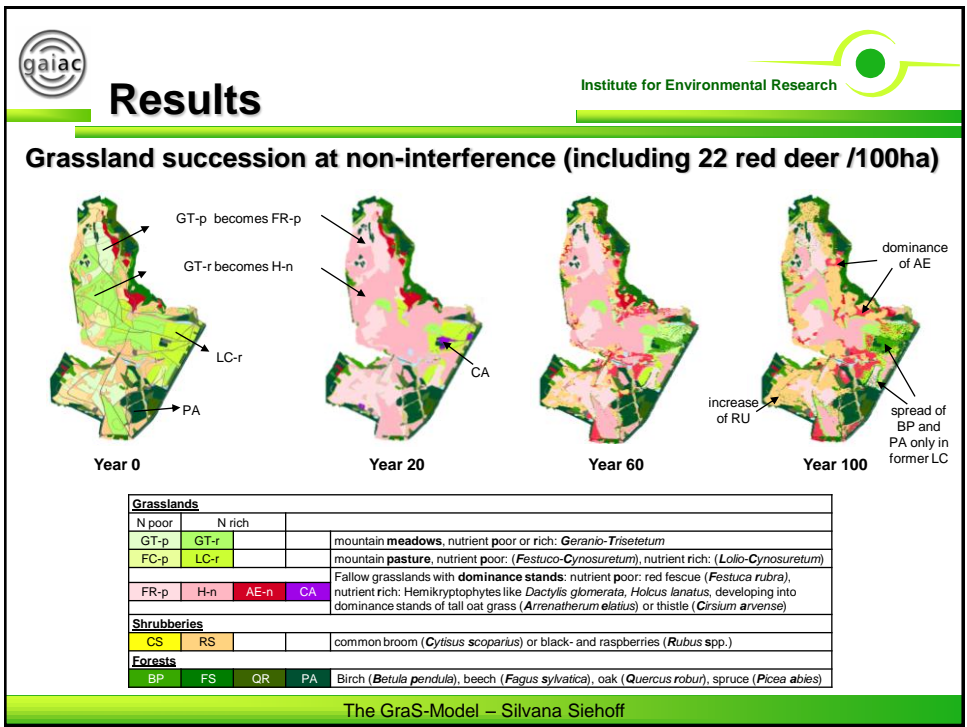
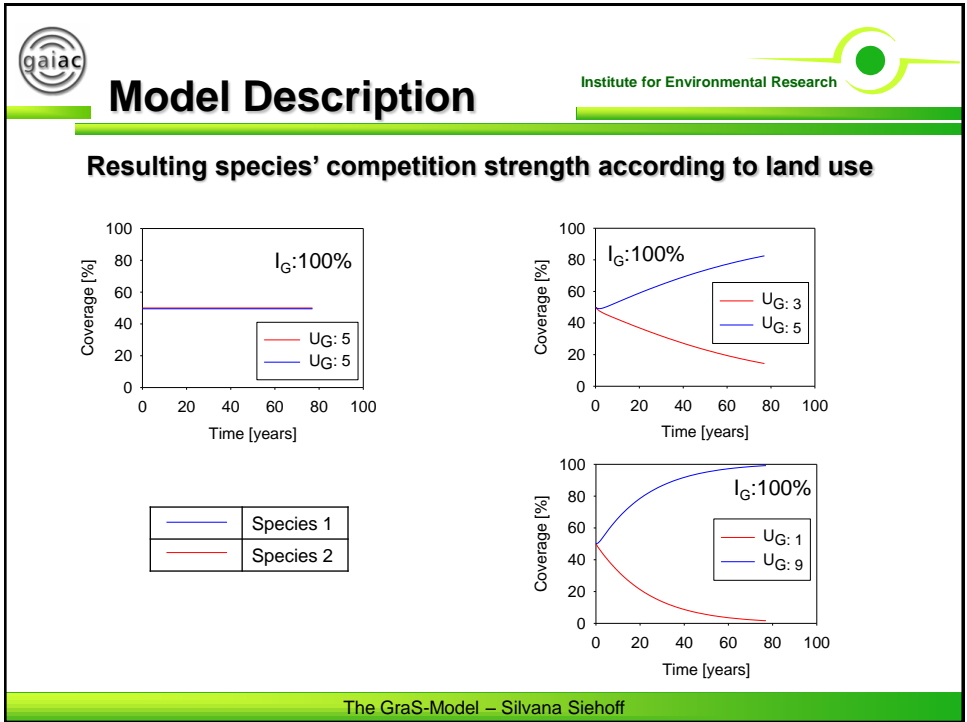
$0 < f(x) < 1$

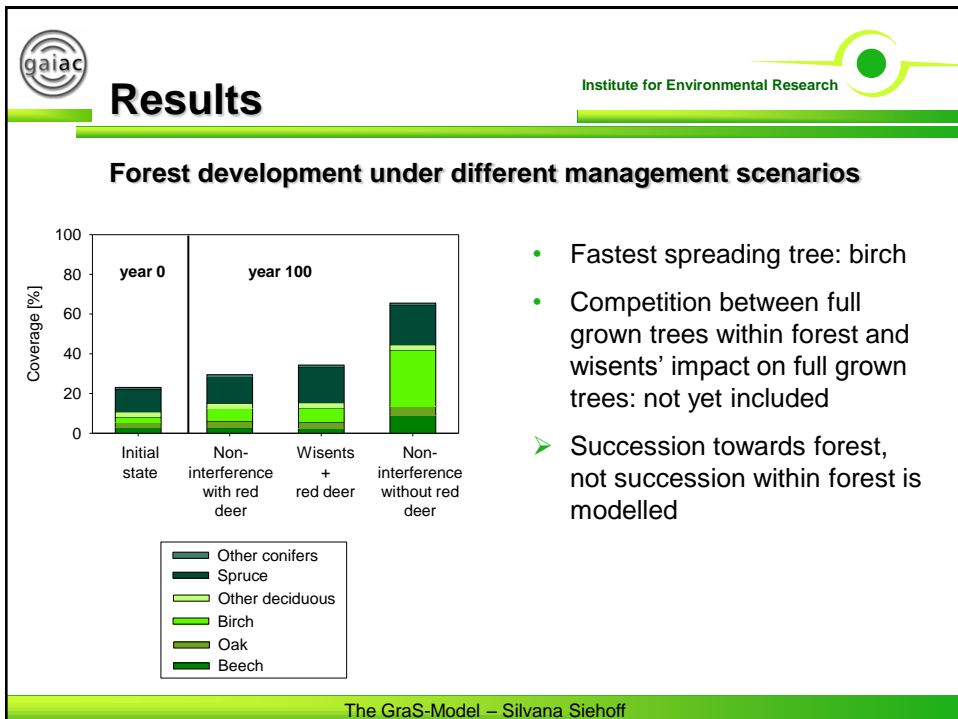
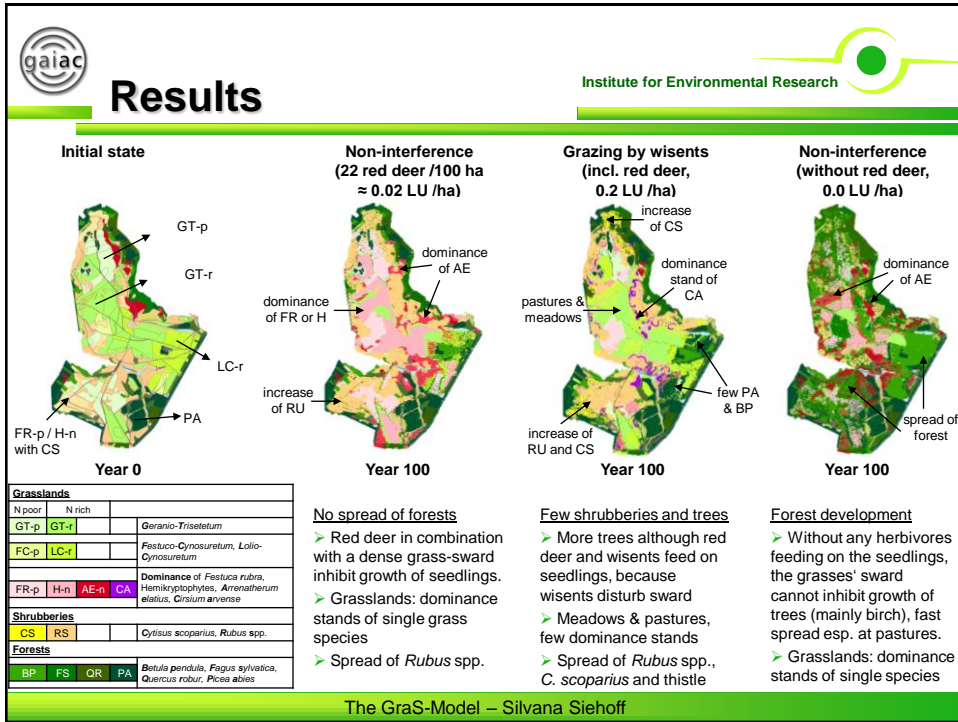
U_G : Utilization number (Briemle *et al.* 2002)
→ similar to Ellenberg indicator numbers but for utilization

Growth at a given grazing intensity



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Conclusion

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Objectives:

Simulation of grassland succession

- ✓ Plausible predictions of vegetation dynamics (according to experts of the area).
- ✓ The processes included are appropriate to simulate interspecific competition (model verification).
- Model validation: will be performed for the first years.

Tool to analyse processes relevant for succession

- ✓ Analysis of single processes, e.g. impact of red deer on forests formation.

Decision support system

- ✓ Many sometimes compensating processes included (e.g. grazing: feeding on seedlings & disturbance of the sward).
- ✓ high spatial resolution of simulation result.
- ✓ With the outcome from a chosen management procedure, one can easily accomplish an efficiency control of ecological restoration.
- Still to check: transfer to other sites.
⇒ Should be easily accomplished due to the usage of the utilization numbers.

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Further developments

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Red deer



Heck cattle

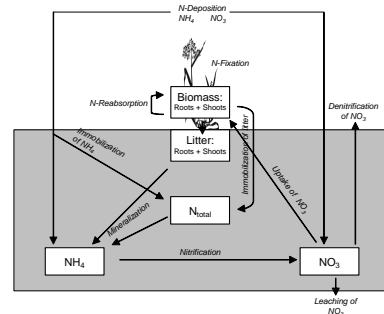


Wisent



Konik horse

- Megaherbivore and wildlife dispersal and behaviour
- Nitrogen cycle



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Thank you for your attention!



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Literatur

Briemle G., Nitsche S., Nitsche L. (2002). Nutzungswertzahlen für Gefäßpflanzen des Grünlandes. Schriftenreihe für Vegetationskunde 38, 203-225.

Lennartz G., Preuss T., Fürste A., Theißen B., Toschki A., Strauss T., Tischler B., Schäffer A., Roß-Nickoll M. (2006). Abschlussbericht „Modellierung von Landschaftsentwicklungszenarien für die Managementzone im Nationalpark Eifel unter Berücksichtigung verschiedener Managementvarianten einschließlich spezieller Untersuchungen der Heuschrecken, Tagfalter und Vögel sowie der Ableitung von Monitoringparametern für die Offenlandentwicklung“, Lehrstuhl für Umweltbiologie und –chemodynamik der RWTH Aachen und Forschungsinstitut für Ökosystemanalyse und –bewertung e.V. (gaiaac) im Auftrag der Landesanstalt für Ökologie, Bodenordnung und Forsten Nordrhein-Westfalen.

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List of representative species

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Grasses & herbs	Bushes	Trees
<ul style="list-style-type: none"> • <i>Festuca rubra</i> agg. • <i>Arrhenatherum elatius</i> • <i>Cynosurus cristatus</i> • <i>Lolium perenne</i> • <i>Trifolium repens</i> • <i>Cirsium arvense</i> <p>Groups:</p> <ul style="list-style-type: none"> • Hemicryptophytes (“Horstpflanzen”) • Hemicryptophytes (“Rosettenpflanzen und Therophyten”) • Hemicryptophytes (“Schaffpflanzen”) • Hemicryptophytes (“Kletterpflanzen”) 	<ul style="list-style-type: none"> • <i>Rubus spec</i> • <i>Prunus spec</i> • <i>Cytisus scoparius</i> 	<ul style="list-style-type: none"> • <i>Betula pendula</i> • <i>Fagus sylvatica</i> • <i>Quercus robur</i> • <i>Picea abies</i>

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