9th European Heathland Workshop

Bredene - Genk, België
13-17 september 2005

Colofon

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9th European Heathland Workshop

13th to 17th September 2005
Bredene and Genk, Belgium

Organized by the Institute of Nature Conservation

Heathlands in a changing society
Abstracts and excursion guide

Edited by Geert De Blust

9th European Heathland Workshop

programme

Monday, 12 September	
	Arrival of participants at workshop venue Hotel Europa, Bredene
Tuesday, 13 September	**Lectures and posters**
9:00 – 9:20	Welcome / Introduction *Geert De Blust, Nigel Webb*
Theme 1: History of heath and heathland landscapes	
9:20 – 9:40	Written in the Hills: an interdisciplinary approach to the historical role of *Calluna vulgaris* within Scotland's uplands. *A.H. Kirkpatrick, A. Davies, A. Hamilton, N. Hanley, A. Ross and F. Watson*
9:40 – 10:00	Heath Landscapes in military zones: archaeological value and directions for future management. *Inge Verdurmen*
Theme 2: Heathland communities: composition and structure in relation to environment and area	
10:00 – 10:20	The "European" dwarf shrub heath in a global context. *Ingmar Gorissen*
10:20 – 10:40	Effects of heathland fragmentation on the heathland plant community. *Katrien Piessens, Olivier Honnay, Martin Hermy*
10:40 – 11:10	Coffee break / posters
11:10 – 11:30	Bird abundance and vegetation on moorlands: testing relationships across regions. *Graeme M Buchanan, James W Pearce-Higgins and Murray C Grant*
11:30 – 11:50	People and heaths: A way forward. *John Underhill-Day, D. Liley, R Clarke and R. Rose*
11:50 – 12:10	Heathland succession at Nørholm Hede, Denmark. *Inger Kappel Schmidt and Torben Riis-Nielsen*
12:10 – 12:30	Spatial modelling for the future of heathland in England – guiding Biodiversity Action Plan targeting and species recovery. *Nigel Symes and David Hoccom*
12:30 – 14:00	Lunch / posters
Theme 5: A future for the European heath: heathland in an ever changing society	
14:00 – 14:20	Safeguarding the Heathlands of Europe. Conservation, management, recommendations. *Mons Kvamme and Peter Emil Kaland*
14:20 – 14:40	Urban Heaths LIFE Project – Combating urban pressures degrading European Heathlands in Dorset, England. *Heather Tidball*

14:40 – 15:00	Restoration of Dune Heaths along the Danish West Coast – a project supported by LIFE-Nature. *Hanne Stadsgaard Jensen*
15:00 – 15:20	NOVANA, terrestrial monitoring exemplified by the EU-LIFE project of restoring dune heathlands *Knud Erik Nielsen*
15:20 – 15:40	Perspectives of heathland restoration and farming for rural economies in Europe. *Bart Boers, Herbert Diemont and Wim Geraedts*
15:40 – 16:00	Coffee break / posters

Theme 3: Ecosystem research: the impact of natural and anthropogenic drivers and pressures on heath

16:00 – 16:20	Management of British heathlands and public access - Latest research results from English Nature's projects *Isabel Alonso*
16:20 – 16:40	Early stages of *Calluna vulgaris* regeneration after burning of coastal heaths on Tarva, central Norway *Liv S. Nilsen, Line Johansen and Liv G. Velle*
16:40 – 17:00	Effects of prescribed burning on the nutritional state of *Calluna* and *Deschampsia* in heathlands. *Abdelmenam Mohamed, T. Niemeyer, B. Jirjahn and W. Härdtle*
17:00 – 17:20	Cold-season carbon and nitrogen dynamics of heath ecosystems. *Klaus Steenberg Larsen*
17:20 – 17:40	Heath nitrogen cycling at manipulated 'CLIMAITE' *Louise C. Andresen, Per Ambus, Claus Beier, Sven Jonasson and Anders Michelsen*
17:40 – 18:00	Impact of pig farm nitrogen emission on adjacent heathland ecosystems. *Anja Vilsholm, Helle Vibeke Andersen, Helge Ro-Poulsen & Anders Michelsen*
	Dinner
Evening programme	Visit to Brugge

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Wednesday, 14 September Lectures and posters | Excursion

Theme 4: **Heathland management and restoration: large scale restoration and fine tuned management**

9:00 – 9:20	The heathlands of Hiddensee – what to do to sustain them? *Eva Remke*
9:20 – 9:40	Management experiments in Central European dry heatlands (Czech Republic). *Iva Keizer*
9:40 – 10:00	The Viking Heaths project in the Orkney Islands. *Lynne Farrell*
10:00 – 10:20	Heathland change in the 20th century-a case study from Dorset, UK. *Richard Archer, Dante Munns and John Underhill-Day*
10:20 – 10:40	Sod-cutting as a restoration measure in wet heathlands in Flanders. *Hans Backx, M. El-Kahloun and P. Meire*
10:40 – 11:00	Coffee break / posters
11 – 11:20	A comparison of efficacy of soils stripping and soil acidification techniques for the restoration of heathlands on that that has been improved for agriculture. *Anita Diaz, I. Green and M. Tibbett*
11:20 – 11:40	Can management compensate effects of atmospheric nutrient deposition in heathland ecosystems? *Werner Härdtle, M. Sieber, S. Fottner and T. Niemeyer*
11:40 – 12:00	Effects of bracken control treatments on bracken performance, vegetation dynamics and non-target species in heathlands of Western Norway. *Kristine Ekelund, Inger Elisabeth Måren and Vigdis Vandvik*
12:00 – 12:20	Reptiles need a change in heathland management practice in the Netherlands. *Anton H.P. Stumpel*
12:20 – 12:40	A new equipment for heathland management - and its future consequences *Torben Høj Nielsen & Hans Jørgen Degn*
12:40 – 13:45	Lunch

13:45 – 18:30	**Excursion: Relicts of Atlantic heath near Bruges**. → The *Erica cinerea* reserve (St.-Andries, Brugge). Guides: *Luc Maene and Herman Stieperaere* → The Gulke Putten reserve (Wingene). Guides: *Eckhart Kuijken, Christine Verscheure, Tom De Beelde and Herman Stieperaere*
19:00	Dinner

Theme 5: continued

20:20 – 20:40	The Heathland Centre Western Norway. Dissemination of knowledge and teaching. *Kristine Ekelund and Peter Emil Kaland*
20:40 – 21:00	How nature education can amaze people in the cross-border park 'De Zoom-Kalmthoutse Heide'. *Dries Kools and Sofie Regniers*

Introduction to the excursion

21:00 – 21:20	The Strabrechtse Heide, a dynamic mosaic of wind, water and clouds. A pre-visit presentation of the Strabrechtse Heide. *Jap Smits*

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Thursday, 15 September	Excursion: Heathlands in the Campine region of Antwerpen (BE) and Noord-Brabant (NL)
8:30 – 10:00	Coach ride to the Kalmthoutse Heide
10:00 – 13:00	→ Kalmthoutse Heide Visitors and nature education centre 'De Vroente': demonstration of educational activities; *Dries Kools and Sofie Regniers* Walk through the reserve: management strategies. Guides: *Karel Molenberghs and Geert De Blust*
13:00 – 14:30	Packet lunch and coach ride to the Strabrechtse Heide (NL)
14:30 – 17:00	→ Strabrechtse Heide Cycling-tour through the reserve (bicycles and tandems): results of the different management measures, including prescibed burning. Guides *Jap Smits and colleagues*
17:00	Departure to visitors centre 'Mijl op Zeven', de Peel (NL)

Discussion:
Fire as a tool in nature management; opportunities and threats
Organisation: *Staatsbosbeheer / the Dutch National Forest Service.*

18:00	Dinner
19:00 – 19:05	Welcome by *Mr. Arjan van der Zee*, Staatsbosbeheer, district manager Peel en Kempen
19:05 – 19:10	setting the scene by *Peter van den Tweel*, director of Staatsbosbeheer Regional Unit South
19:10 – 19:30	Opposing views: the plea from a person in favor and one against using fire as a management tool
19:30 – 20:15	Discussion, facilitator *Hans Kampf*, senior policy adviser, Nature Division, Department of Knowledge, Ministry of Agriculture, Nature and Food Quality
20:15	Break
20:30 – 21:15	Discussion continued
21:15 – 21:30	Conclusion and closing of the discussion evening
21:30 – 22:15	Coach ride to Hotel NH Molenvijver, Genk

Friday, 16 September — **Lectures | excursion**

Theme 2: continued

9:15 – 9:35	Resource-based definitions of habitat in heathland landscapes and implications for conservation: a test with butterflies *Hans Van Dyck and Wouter Vanreusel*
9:35 – 9:55	Transferability of predictive habitat models between areas: butterfly models tested in three Flemish heathlands. *Wouter Vanreusel, Hans Van Dyck and Dirk Maes*
9:55 – 10:15	Habitat quality and biodiversity indicator performances of a threatened butterfly versus a multispecies group for wet heathlands in Belgium. *Dirk Maes and Hans Van Dyck*

Excursion: Heathlands on the edge of the Kempen plateau.

10:30 – 16:30	→ Mechelse Heide Management of the reserve and large scale restoration of sand exploitation pits. Creating new heath landscapes. Guides *Bert Vanholen and Jos Gorissen* Packet lunch → Ziepbeek Plateau valleys with wet heath. Guides *Bert Vanholen and Jos Gorissen*
17:00 – 18:00	Bokrijk Open-Air Museum, *Farmhouses of the Heathland Agriculture*. Guide *An Schoefs* Drink
19:00	Dinner in Hotel NH Molenvijver, Genk

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Saturday, 17 September	Excursion: the heathland – brook valley complex
9:00 – 9:30	Coach ride to the Zwarte Beek, Visitors Centre 'De Watersnip'
9:45 – 10:05	Introduction to the reserve of the Zwarte Beek *Katia Nagels*
10:05 – 10:25	Ecological land management in a military context. *Hans Jochems en Johan Vanswijgenhoven*
10:30 – 13:00	→ Excursion in the outfield: the Beverlo military terrain; heathland management and military use. Guides *Katia Nagels and Marcel Van Waerebeke*
13:00 – 13:45	Visitors Centre 'De Watersnip', packet lunch
13:45 – 14:00	Former land use; the functional relations between the out fields and the brook valley. *Joël Burny*
14:00 – 18:00	→ Excursion through the brook valley neighbouring the heathlands. Guides *Joël Burny, Martine Lejeune and Geert De Blust*
19:15	Dinner in Hotel NH Molenvijver
	Farewell

→ POSTERS

Edaphic arthropods community in *Calluna vulgaris* heathlands in the Cantabrian mountain range (NW Spain)
Cuesta, D.; Salgado, J.M.; Taboada, A. and Calvo, L.

Effects of livestock and wildlife grazing on heathlands vegetal diversity in NW Spain.
Leonor Calvo, Marcos, E., Valbuena, L., Tárrega, R. and de Luis, E.

Seed banks and fire; A study of west Norwegian heathlands
Inger Elisabeth Måren and Vigdis Vandvik

Conservation Status of oligo-mesotrophic waters in Flanders
Steven De Saeger, Luc Denys, Hans Bosch and Desiré Paelinckx

Nutrient content and sheep digestibility variation of heather (*Calluna vulgaris*) of different ages.
Garmo, T.H., Velle, L.G. and Øpstad, S.L.

Influence of grazing on C and N content of mountain heathlands in Spain.
Elena Maria Marcos, Calvo, L., Ayala, N., Tárrega, R., Valbuena, L. and de Luis, E.

Impacts of climate change on vulnerable European shrubland ecosystems.
Inger Kappel Schmidt, Claus Beier and VULCAN partners

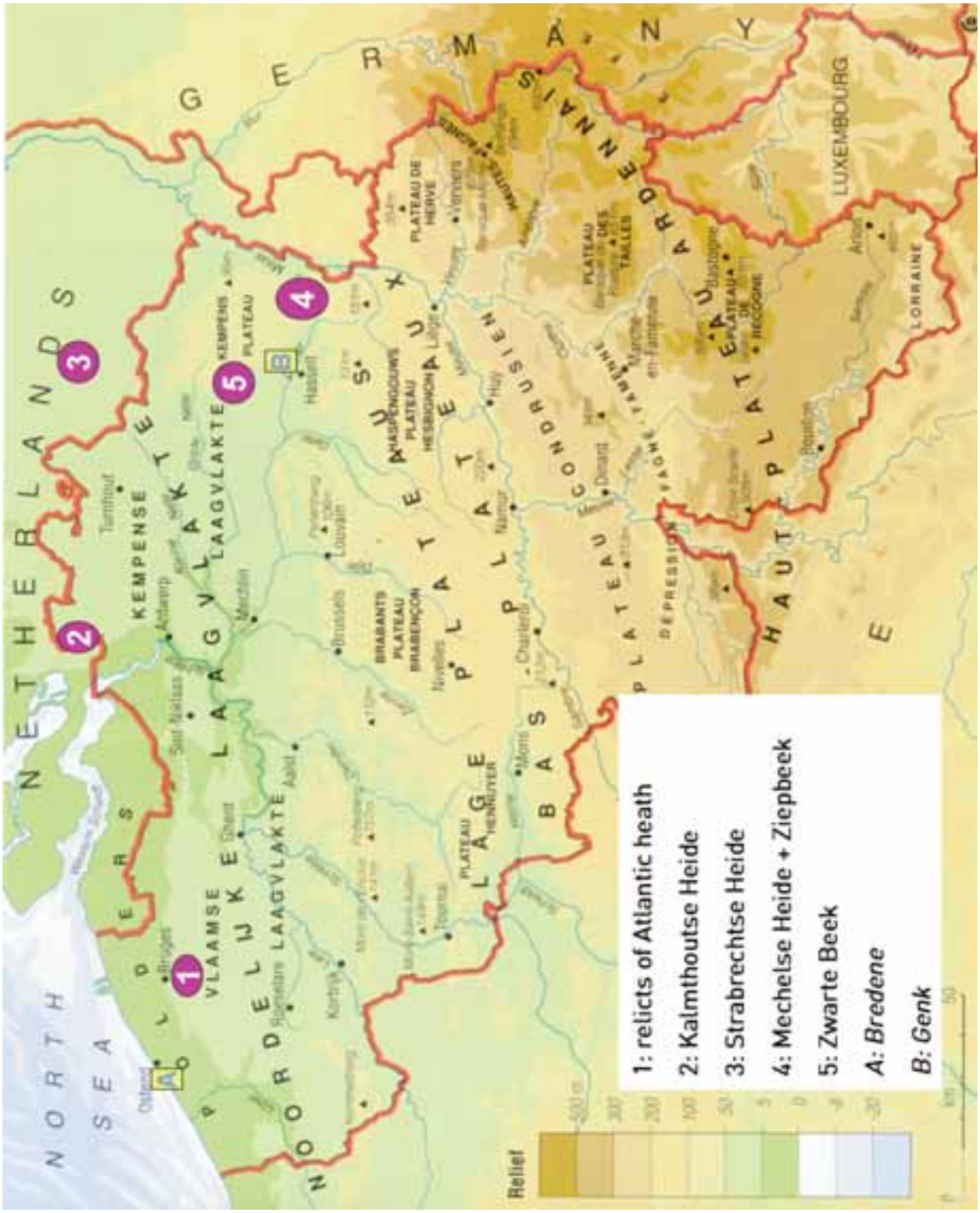
CLIMAITE – CLIMAte change effects on biological processes In Terrestrial Ecosystems.
Inger Kappel Schmidt and Claus Beier

Metapopulation dynamics of the parasitic *Cuscuta epithymum* in heathlands
Klaar Meulebrouck, E. Ameloot, K. Verheyen and M. Hermy

Nutrient ecological and economic figures of thumb for heathland management in the Lüneburger Heide nature reserve, Northern Germany
Werner Härdtle, Jan Müller, Tobias Keienburg and Johannes Prüter

Population development of heathland bird species in the Lüneburger Heide nature reserve, NW-Germany
Jann Wübbenhorst, Johannes Prüter and Tobias Keienburg

Excursion guide, general map



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Lectures

Written in the Hills: an interdisciplinary approach to the historical role of *Calluna vulgaris* within Scotland's uplands.

A.H. Kirkpatrick, A. Davies, A. Hamilton, N. Hanley, A. Ross and F. Watson.
School of Biological and Environmental Sciences, University of Stirling, AHRC Research Centre for Environmental History, Universities of Stirling and St. Andrews and Department of Economics, University of Stirling.

Sub-montane plant communities dominated by heather (*Calluna vulgaris*) are particularly well represented in Scotland, forming a substantial component of today's protected landscapes. However Scottish upland areas are often presented as either the last remnants of wilderness or as an artificially depopulated and thus degraded landscape. The "Written in the Hills" project is seeking to draw on the disciplines of ecology, palaeoecology and history to establish an interdisciplinary methodology to identify changes in floristic diversity for a number of Scottish sites over the last 800 years. Paying particular attention to the role of heathlands, this paper will present progress to date and will discuss the lessons learned about the nature of interdisciplinary research.

Written in the Hills: an interdisciplinary approach to the historical role of Calluna vulgaris within Scotland's uplands.

Heath Landscapes in military zones: archaeological value and directions for future management.

Inge Verdurmen | Vakgroep Kunstwetenschappen en Archeologie, Free University of Brussels, Belgium.

The LIFE project 'Integrated restoration of natural habitats on Military areas in NATURA2000', concentrates on nature development and management of mainly heath landscapes in twelve military zones, situated in the provinces of East and West Flanders, Antwerp and Limburg in Belgium. A project was designed to bring into focus the archaeological, landscape-historical and paleo-ecological values of these domains and to try to incorporate these findings in specific guidelines for the cultural heritage of the military domains. This project is carried out by the department of Archaeology and Art History of Brussels Free University.

The significance of these military zones lies in the date of their creation: the beginning of the 19th century. The military domains were established on large sandy areas where the heath landscapes were common used by the inhabitants of the surrounding settlements. The transformation of these heath areas into military camps brought with it that most of them escaped from conversion into arable land and/or pinewood. Due to these events, the military zones contain mostly fossilized landscapes from the phase of the great cultivations. This also implies that the possibility of finding nearly undamaged archaeological remnants and traces of historical land use in these military domains is very high.

Our study tries to evaluate the possibility of further research of these fossil landscapes by means of an interdisciplinary approach. A whole range of sources was used to reconstruct and analyse the landscape but the greater part of our information was obtained by studying the different historical maps and going through the Central Archaeological Inventory (CAI). The study of place names, topography, hydrography, pedology and the use of aerial photography completed this detailed examination. The limitation in time has made it impossible to carry out surveys on all military domains. Therefore two camps, Brasschaat en Leopoldsburg, were selected and roughly inspected.

The study shows that in most of the domains the same two phases occurred. The first phase extended from the Middle Ages till the 18th century and sketches the first attempts from the local farmers to cultivate the heath that surrounded them. An important factor was the erection of farms in the middle of the extensive heath plains by religious institutions such as abbeys and convents. The second phase covers the 19th and 20th century and shows the shift in cultivation from the local powers to the central government. They stimulated the creation of large-scale pinewood plants that converted the heath plains into systematically arranged forests along a geometric pattern of straight roads and parcels. Each of these two phases has left several traces in the actual landscape as we could record during the field inspection. Important relicts from the first phase are patterns of channels for drainage or irrigation, the network of roads in the heath plains etc. In the second phase the accent lies on the geometric pattern that was used to lay out the extensive forests and which remains visible in several forests today. Because the military domains can be seen as unique storages of archaeological, cultural-historical and paleo-ecological patrimony, it's essential to chalk out an integrated management plan. Consultation among archaeologist, historians, landscape specialists and biologists can provide clear guidelines to minimize the destruction and maximize the potential of the heath in the military zones.

Heath Landscapes in military zones: archaeological value and directions for future manage-

The "European" dwarf shrub heath in a global context.

Ingmar Gorissen | Kapellenstraße 43 b D 53721 Siegburg, Germany.

Dwarf shrub heaths on oligotrophic-acid soils are distributed all over the blue planet. Species of Ericales are almost always represented: in South Africa more than 500 species of Erica, in temperate parts of Eurasia and America more than 60 species of *Rhododendron*, more than 20 species of *Gaultheria* or *Vaccinium*. Species rich are a.o. *Arctostaphylos, Bejaria, Cassiope, Corema/Empetrum, Disterigma, Elliotia, Gaylussacia, Kalmia, Ledothamnus, Pernettya, Phyllodoce* or *Tepuia*.

But heaths are more. Acidophilic dwarf shrubs can be found inside *Berberidaceae (Berberis), Fabaceae (Cytisus, Genista, Pultenaea etc.), Betulaceae (Betula), Caprifoliaceae (Lonicera), Cupressaceae (Juniperus, Microbiota), Myrthaceae (Myrteola), Rosaceae (Cotoneaster, Dryas, Rubus, Spiraea)* and *Salicaceae* (more than 30 Salix). The southern hemisphere and tropical high mountains show many dwarf shrubs, among others species of *Asteraceae (Brachyglottis, Helichrysum, Olearia, Senecio* etc.*) Proteaceae (Protea, Leucospermum* etc.*)* and *Bruniaceae*. In SE-Australia, Tasmania and New Zealand the most important families are *Epacidraceae (Cyathodes, Epacris, Dracophyllum, Leucopogon, Pentachondra, Richea, Leucopogon* etc.*)* and *Scrophulariaceae (Hebe)*. Worldwide possibly more than 1200 true dwarf shrub species form heath habitats.

The "European" heath has no exact border. Many species show a distribution range that extends to Asia, N-Morocco, or that is circumpolar or amphi-atlantic. Some genera and species however, have a more narrow distribution area inside Europe, especially in the more Atlantic or Mediterranean parts of the continent. European dwarf shrubs are composed of *Cistaceae (Cistus, Halimium), Ericaceae (Erica, Rhododendron, Calluna), Fabaceae (Adenocarpus, Chamaecytisus, Cytisus, Echinospartium, Genista, Pterospartum, Stauracanthus, Teline and Ulex)* and *Salicaceae* (some alpine species of *Salix*); all together about 140 true European species. Two areas are real hot spots: NW Iberia and the arctic Scandinavia/NW Russia.

From the Atlantic to the Caucasus and the Ural, the heath represents a wide spectrum of species and landscape diversity. Many different dwarf shrub areas - heath-regions - with own species or own communities are present. Very popular are for instance NW-Germany/ The Netherlands (with "Lüneburger Heide" and "Veluwe"), Bretagne and large parts of Britain. But Europe has many other heath regions too, with some inner-Iberian or SE-European heaths as outstanding examples. From a pan-European overview and survey of dwarf shrubs, we conclude that Europe counts about 68 different heath regions (Gorissen 2004).

Gorissen, I. (2004): Dwarf shrub heaths of Europe - from Atlantic to Caucasus and Ural. Selbstverlag Siegburg (Germany), 184 pages.

The “European” dwarf shrub heath in a global context.

Effects of heathland fragmentation on the heathland plant community

Katrien Piessens, Olivier Honnay and Martin Hermy | Laboratory for Forest, Nature and Landscape Research, University of Leuven, Belgium.

Heathland, like many other (semi-)natural land use types, has become more and more fragmented during the last centuries. This fragmentation has resulted in a reduced area and an increase in the degree of isolation of the remaining heathland patches. This can have serious effects on the heathland plant community inhabiting these patches.

The northwestern part of Belgium has long been characterized by the presence of extensive heathland areas. Since the end of the 18th century onwards however, these heathlands have been subjected to a fragmentation process, leading to a more than 99% reduction in heathland area in the region! Hence this forms a perfect study area to examine fragmentation effects. Therefore, we surveyed 153 heathland patches that were already heathland on the maps of De Ferraris (1775) for the presence or absence of plant species typical of heathland or related vegetation types such as grassheath and acid grassland. All patches were digitized using a GIS to allow the calculation of area and an isolation measure for each heathland patch.

First, the effects of fragmentation on the entire plant community of these heathland patches were determined. We found that smaller patches contain less heathland specific plant species than larger patches. However, effects of isolation turned out to be far more important in explaining species richness and composition. This indicates the existence of a rescue effect, by which extinction of a species in a heathland patch is prevented by the colonization of species from neighbouring patches. Species having a short-living seed bank seemed to be more sensitive to isolation than species having a long living seed bank, which indicates that the seed bank can act as a rescue effect in time, allowing the species to survive periods when environmental conditions are harsh through their seed bank.

Next, area and isolation effects were studied at the individual species level. Logistic regression models revealed that the presence of almost three quarter of the species studied was affected by fragmentation. For the majority of these species, isolation was the most important factor determining their presence or absence in a heathland patch. Differences in isolation sensitivity could be almost exclusively attributed to differences in seed bank characteristics, with species having long living seeds being less affected by isolation, an effect which was also found at the community level.

From this, it can be concluded that fragmentation has serious effects on the heathland plant community. The fact that isolation effects turned out to be most important indicates that also small heathland patches can contain a diverse heathland plant community. Hence management should not only focus on large patches. Especially species that do not form a persistent seed bank, which often already are the rare species in the area, seem to be severely threatened by ongoing fragmentation.

Effects of heathland fragmentation on the heathland plant community

Bird abundance and vegetation on moorlands: testing relationships across regions

Graeme M Buchanan, James W Pearce-Higgins and Murray C Grant | Royal Society for the Protection of Birds, Edinburgh, UK.

Upland heaths (or moorlands) within the UK support nationally and internationally important populations and assemblages of breeding birds. These assemblages include EU Annex 1 species, and birds of UK conservation concern. Many of these upland areas are dominated by dwarf shrubs, including *Calluna vulgaris* and *Vaccinium* spp, together with coarse grasses (*Nardus stricta* and *Molinia caerulea*) and some smooth grasses (e.g. *Festuca* spp.) The nature of the vegetation of these areas has changed since the middle of the last centaury, with a 25 % decrease in the area of heather moorland in Scotland between the 1940s and the 1980s and by 20% in England and Wales over a similar period. These changes are associated with increasing grazing pressures due to substantial increases in the number of sheep and deer in the UK uplands., . Such changes in land management, together with their associated alteration of the composition and structure of moorland vegetation may have deleterious effects on the bird populations of these moorlands. Concern over putative declines in the populations of some species means there is a need for effective conservation management of moorlands for birds, although it is unclear which moorland habitat features are most critical for bird conservation. If effective conservation management schemes are to be developed that benefit moorland birds, they need to be based upon a sound understanding of the habitat associations of the birds. Similarly, it is essential to test whether relationships are consistent across different upland regions of the UK, if they are to be used to advise on management across the whole country. Here we describe the relationships between bird abundance and moorland vegetation composition and structure. The abundance of nine moorland bird species was measured across 154, 2 km2 plots in 4 upland regions, together with detailed measurements of the composition and structure of the vegetation characteristics of these sites. Additionally, a range of management, topographical and landscape scale habitat variables were measured. After controlling for the effects of these latter, 'non vegetation' variables, we examined the relationships between the detailed vegetation measures and bird abundance using generalised linear models. These relationships described the full range of observed bird-vegetation associations. We then tested for consistency in these relationships across regions, by testing the significance of a regional interaction term.

Vegetation composition, especially in terms of dwarf shrub and graminoid cover, was an important correlate of the abundance of all species, while the abundance of six species was correlated with the extent of variability between dwarf shrub and graminoid dominated vegetation. The abundance of all nine species was correlated with aspects of vegetation structure (height and density), while the extent of variation in vegetation height across plots was correlated to the abundance of five species. The majority of relationships appeared to be consistent across regions, suggesting that these relationships are applicable across the uplands of the UK, and as such could be used to inform the conservation management of moorland habitats across the country.

People and heaths: A way forward

John Underhill-Day, D. Liley, R Clarke and R. Rose | Royal Society for the Protection of Birds, RSPB, Wareham, Dorset, UK.

The introduction of recent legislation in the United Kingdom that permits public access to most heathlands as open space for air and exercise, has increased the potential pressures from people on this fragile habitat. These pressures are already high on many urban heaths, leading to disturbance, wildfires, eutrophication and other undesirable side effects of human use.
A number of recent studies have established links between the intensity of human use by people and the density and breeding success of several characteristic bird species, including woodlarks *Lullula arborea* and nightjars *Caprimulgus europaeus*.

Generally such studies have used the extent of adjoining urban development or the use, density and distribution of footpaths as a surrogate for the degree of human use, and by implication, disturbance.
A number of visitor surveys on heathland sites have investigated the patterns of human use, mostly on single sites, where, in some studies, sample sizes have been small, or the sample has been biased. Where such studies have been comprehensive and large scale, the results have been applicable only to the site that has been studied.

A new approach has been investigated in Dorset, England, where a visitor survey has been undertaken simultaneously on twenty heaths, based on random sampling methods. The results have allowed conclusions to be drawn on the patterns of visiting to the Dorset heaths in general. In addition, by ascertaining the postcodes of those questioned, it has been possible to investigate the catchments from which different categories of access point draw their visitors. Finally, the study questioned visitors on the routes they took on the heath during their visits, enabling a picture to be built up of typical routes and distances taken by the main user groups.

It is hoped that a greater understanding of the patterns of use by heathland visitors will facilitate further studies as to how these can be manipulated to reduce the impacts on heathland wildlife.

People and heaths: A way fo

Heathland succession at Nørholm Hede, Denmark

Inger Kappel Schmidt[1] **and Torben Riis-Nielsen**[2]

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Succession on Nørholm Hede (Heath) in Jutland, Denmark, has been studied for 100 years. The heath was grazed by sheep and cattle until about 1890. Since then, the 350 ha. heath has been left for free succession. In 1913, the owners initiated a conservation action for the heath to preserve "the picture of wide heathland". The succession from heather dominated heath over crowberry heath or grass dominated heath towards forest has continued without human interference for about 100 years. Since 1921 the vegetation has been studied in 17 (later 20) permanent vegetation plots, each of 10 x 10 m. The ground vegetation has been analyzed 9 times from 1921 till 1996. Immigration of trees was registered in a 400 x 400 m permanent grid established in 1921 and analyzed 9 times between 1921 and 1996.

Succession develops from heather towards crowberry, purple moor-grass or wavy hair-grass dominated heath. The succession can roughly be described by a tetraed model, which integrates succession on genuine heath and succession on nutrient poor formerly cultivated fields. Naturally regeneration of heather as cyclic succession may occur, mostly on land which has not been cultivated previously. The succession pattern on land, which has not been cultivated previously, only shows sparse increase in grass abundance but a larger increase in crowberry. The intensity by which the old fields have been cultivated influences the speed of the succession and the likeliness that the land turns into grass dominated vegetation. Formerly disturbed or cultivated land, which has been untouched for centuries, developed a crowberry stage followed by prevalence of purple moor-grass. The most recent abandoned cultivated land developed a crowberry stage followed by prevalence of wavy hair-grass.

The different outcome of the succession may to a large extent be related to former land-use. The results show no clear correlation between vegetation changes and the increase in atmospheric nitrogen deposition as experienced since 1950 as it is commonly suggested. The decrease in lichen abundance or the increase in grass abundance occur before the increase in N-deposition. The succession pattern may rather be a direct consequence of the lack of grazing and therefore be mainly explained by natural succession. Nevertheless, increased atmospheric N-deposition may be an important driver as it increases the frequency of heather beetle attacks and as such triggers the observed changes in species composition. This is the case on nutrient poor heathlands in the westernmost part of Denmark.

When Nørholm Hede was left for free succession, there were almost no trees present. To the east, southeast and south the heath was surrounded by a dike, which was planted with mountain pine in 1890. The mountain pine can be found over most of the heath today. In general, the number of trees increases exponentially with a doubling time of approximately 10 years for all species. The most common species (by number) are birch, mountain pine, alder buckthorn and oak. There are also numerous rowan, aspen and Scotch pine. Mountain pine is the pioneer tree on the most nutrient poor heath whereas birch dominates on gravel, disturbed areas and formerly cultivated fields. The most common coniferous species (mountain pine, Scotch pine, white spruce) have lower increase in numbers compared to the most common deciduous species (birch and oak).

Heathland succession at Nørholm Hede, Denmark

Spatial modelling for the future of heathland in England – guiding Biodiversity Action Plan targeting and species recovery.

Nigel Symes and David Hoccom | Royal Society for the Protection of Birds, RSPB, Sandy Country, UK

Lowland heathland in England has suffered large-scale reductions in scale, increased fragmentation and abandonment of management as it's economic worth declined, particularly in the mid to late 20th C. Consequently many species, including birds declined, contracted their range, and became vulnerable to the effects of ecological change.

Major heathland restoration programmes have been underway since the late 1980s, and with large-scale financial support have achieved much of the required restoration. Meanwhile the UK Government undertook the development of the UK Biodiversity Action Plan (UK BAP); lowland heathland is one of the priority habitats within the UK BAP, for which costed 10 year targets were set in 1995, for restoration and re-creation. These targets are now being reviewed.

Numbers of birds breeding on heathland have increased in response to restoration, but their ranges have not expanded, and so they remain vulnerable, and are listed as Birds of Conservation Concern (BoCC). The RSPB strategy for vulnerable species prioritises re-colonisation of former range.

In the development of a long-term strategy for the conservation of heathland birds, the RSPB identified a critical problem with spatial planning of range expansion potential; data on extent and distribution of existing heathland was imprecise, and there was no data on the extent and distribution of heathland re-creation potential.

Using various sources, all identifiable areas of lowland heathland in England have been mapped in a GIS and all areas of heathland potential have been mapped against criteria. This data has been used to identify priority areas for re-creation to inform the UK BAP targets review and costs calculated. The data is also being used to model priority areas for targeting range re-colonisation by key bird species.

This is the first attempt in the UK to identify and prioritise at a national level the re-creation of a priority ecosystem. Because of its reliance on simple, publicly available data sources, and use of standard GIS software, it is hoped that this could be the template for similar strategic spatial planning of biotope recovery elsewhere.

Spatial modelling for the future of heathland in England – guiding Biodiversity Action Plan targeting and species recovery

Safeguarding the Heathlands of Europe. Conservation, management, recommendations.

Mons Kvamme and Peter Emil Kaland | The Heathland Centre, Lygra, Norway | Department of Biology, University of Bergen, Norway

"Safeguarding the Heathlands of Europe" (HEATHGUARD), is an EU-financed project within the "Culture 2000 Framework Programme in Support of Culture". It aims to compare heathland conservation methods and management practices in different regions of Europe, in order to develop recommendations for Pan-European guidelines of heathland preservation.

The Heathguard project has been based on the experiences from Heathcult. Heathcult focused on visualizing the most important aspects of heathland nature and culture all over Europe. In the Heathguard project, the different methods and experiences of heathland management and preservation have been compared, from four complementary regions of Europe. The participating institutions have been Cairngorm National Park (Scotland), Lüneburger Heide (Germany), The Heathland Centre at Lygra (Norway) and Peneda-Gerês National Park (Portugal).

Despite regional and local diversity in flora and fauna, heathlands in Portugal, Germany, Scotland and Norway are resulting from essentially the same types of management. In particular the small scale, low-intensity farming methods related to the heathlands have been more or less the same all over Europe. They have produced a landscape, where the similarities in land use history and management traditions by far outnumber the differences there may be due to differences in geographical settings and cultural background.

Due to the modern socio-economic development, heathlands are rapidly disappearing today in most of Europe, and they have thus become an endangered type of landscape. The relative importance of the many threats do however vary between different areas.
The project do therefore try to show how important it is to preserve heathlands in different parts of Europe. The variation in climate, geology and topography imposes considerable variation in heathland biodiversity, and this cannot be safeguarded in one protected area alone. The many different cultural traditions and diverse adaptations to local natural resources, can only be satisfactory taken care of at a representative selections of locations. To make sure that both the theoretical and practical knowledge behind this variety of land use practices are passed on to future generations, it is important that a sufficient numbers of heathland areas are preserved in complementary regions throughout Europe.

One of the targets of the general activity by all four partners is to increase public awareness of the heathlands as a unique natural and cultural resource. The landscape is therefore maintained by using methods of traditional management. In addition pressures on the heathlands imposed by modern environmental changes have to be met. The partners have solved these challenges in different ways, and conservation therefore varies in terms of organisation and management methods.

Safeguarding the Heathlands of Europe. Conservation, management, recommendations.

Urban Heaths LIFE Project – Combating urban pressures degrading European Heathlands in Dorset, England.

Heather Tidball | Urban Heaths Partnership, Dorset County Council, Bournemouth, UK.

At the end of the 18th century the Dorset Heathlands stretched across 500km2 of southern England broken only by river valleys. Today only 14% remains, in over 100 fragments separated by new land uses – poor quality agricultural land, urban areas and conifer plantations. Despite this the Dorset Heathlands remain one of the major European heathland areas and a key centre for biodiversity within the Atlantic bio-geographical region.

About 30% of the Dorset Heathlands are in or immediately adjacent to the Poole/Bournemouth conurbation with its population of nearly 450,000 people. The use and abuse of the heathlands by local communities threatens the integrity of the heaths and the rare species they support. These urban pressures include: – uncontrolled, deliberately set fires; trampling of habitat and protected species by humans, horses, bicycles and motor vehicles; erosion; disturbance to rare breeding birds: enrichment by dog waste and tipping; opposition to management practices such as the removal of trees and introduction of grazing.

A four year project was co-funded by EU LIFE-nature in 2001 to combat these urban pressures. The most damaging activity that the project addressed was the frequent, deliberately set, uncontrolled fires. A co-ordinated approach by land owners and managers, the Dorset Fire and Rescue Service and Dorset Police has resulted in a 60% reduction in the average number of fires each year. Improvements to infrastructure and fire fighting equipment and procedures mean that when fires do occur they are extinguished more quickly and do not spread as far. This reduction in heathland arson is contrary to an upward trend for arson generally.

A team of seasonal wardens patrol the heaths during spring and summer both to deter misuse and to educate visitors about the importance of the heaths and the possible effects of seemingly harmless actions like walking off paths.

A community education programme has been designed to raise awareness of the importance and fragility of the heaths and the need for active management. A school's education programme has materials for each of the Key Stages of the National Curriculum for England and Wales.

This project is now coming to an end and has been successful in reducing damage to the heathland habitats and promoting a sense of ownership for the heaths amongst local communities. The Urban Heaths LIFE Project was carried out by a partnership of ten organisations interested in reducing the urban pressures on the heaths. The partners are; Borough of Poole; Bournemouth Borough Council; Christchurch Borough Council: Dorset County Council; Dorset Fire and Rescue Service; Dorset Police; Dorset Wildlife Trust; East Dorset District Council; English Nature; The Herpetological Conservation Trust.

Urban Heaths LIFE Project – Combating urban pressures degrading European Heathlands in Dorset, England.

Restoration of Dune Heaths along the Danish West Coast – a project supported by LIFE-Nature.

Hanne Stadsgaard Jensen | Danish Forest and Nature Agency, Thy State Forest District, Thisted, Denmark.

Dunes and dune heatlands are considered threatened and vulnerable in Europe, and several habitat types found in these areas are designated priority habitats under the EU Habitats Directive. The Danish West Coast is home to relatively large continuous areas of these nature types, around 50,000 ha in total, but the conservation status is in general not favourable. In particular, overgrowth with non-native species, lack of natural dynamics and deposition of ammonium have a negative influence on the status of dune heath habitats.

In the years 2001-2005, a large-scale project, supported by the EU LIFE-Nature fund, has been trying to restore some of the most threatened dune heath areas, in a joined effort by 4 State forest districts, 4 counties and the Armed Forces. 11 sites in the Natura 2000-network have been selected for management, and around 6.000 ha, which is more than 10% of the total dune heath area in Denmark, will be affected by the project activities.

Management measures include clearing of plantations of non-indigenous conifers, such as *Pinus mugo* and *Pinus contorta* in order to restore the dune heath habitats and create more continuous areas. Various degrees of overgrowth with self-sown trees of mainly the same species is another measure applied, as well as restoration of natural hydrology and of breeding habitats for amphibians.

Overgrown areas are either cleared manually or by machinery, depending on the topography and accessibility of the area in question. Grazing, cutting and prescribed fire are other measures implemented in order to re-establish some of the natural dynamics. It is essential that some of the nutrients are removed from the dune heaths in order to counter the increasing enrichment with nutrients from atmospheric deposition of ammonium.

The project includes a monitoring element, both short-term and long-term, carried out by the University of Copenhagen and the Danish Environmental Research Institute (NERI), respectively.

The preliminary results from the long-term monitoring will be presented by Knud Erik Nielsen from NERI.

NOVANA, terrestrial monitoring exemplified by the EU-LIFE project of restoring dune heathlands

Knud Erik Nielsen | National Environmental Research Institute, Department of Terrestrial Ecology, Silkeborg, Denmark.

The main objective for the Danish nature-monitoring programme will be to obtain the necessary information to honour the obligations embedded in the EEC Directives for birds and habitats. The presentation deals with the principles and procedures used for the development of the monitoring programme. An EU-LIFE project dealing with dune heath restoration is used to exemplify the principles of the terrestrial monitoring programme.

Dunes are highly dynamic and diverse environments. The combination of dry and moist spots, north and south exposed slopes, open and dense vegetation provides different biotopes. Due to succession and succession reset by sand movement or by local disturbances many plants and animals co-occur, each characteristic for a certain successional stage or a combination of stages. In NW-Europe, acidification and eutrophication, drainage and changes in land use cause accelerated vegetation succession in coastal dunes. During the last decades these impacts results in a loss of open and species rich vegetation and a widespread encroachment by tall grasses and bushes. However, the discrimination between changes due to nitrogen deposition and changes due to natural succession and absence of management is not clear-cut.

The overall aim of the Danish dune heath project is to restore favourable conservation status for 5700 ha of coastal dune areas, mostly dune heath areas along the west coast of Denmark. Along a north south gradient in the western parts of Denmark four dune heath areas have been investigated order to establish the conservation status of the areas.

The generalised criteria formulated in the Habitat-directive have been made concrete and should tell precisely what kinds of information need to be sampled in the field. Criteria should comprise relevant parameters/properties for the habitat type in question with sets of parameters and intervals needed to be fulfilled to obtain favourable conservation status. A value outside the acceptable limits/value should then act as a trigger of restoration for a given location. The monitoring programme is not only designed to detect any changes in conservation status for species and habitats but its intention is also to give answers to why the changes have happened involving habitat-related parameters. The Danish Habitat monitoring programme is “bridging the gap” between the traditional biodiversity monitoring and the monitoring of effects on air-pollution.

The practical way to investigate large terrestrial areas and to establish the conservation status has not been tried before in Denmark. The experience from the research of conservation status of four major dune heath localities along the west coast of Denmark have been used to design a terrestrial monitoring

programme for natural habitats highly restricted towards the needs of the habitat-directive. In order to say anything scientifically about the development of habitat nature it is fundamental that the monitoring is based on sampling of data, which can be reproduced. It is also fundamental that the strategies of sampling are based on representative principles.

The purpose of this investigation is to

- to give a status of selected areas in the project
- to test and evaluate the suggested parameter defining favourable conservation status for the coastal habitats included in the project areas
- to investigate if the proposed conservation objectives for the coastal habitat types is or will be fulfilled
- to develop, test, and evaluate a common standard for monitoring.

Perspectives for heathlands

Wim Gereadts [1], Bart Boers [2] and Herbert Diemont [3]
1 Geldersch Landschap, The Netherlands
2 Nationaal Park de Hoge Veluwe, The Netherlands
3 Alterra (Wageningen Univerity and Research centre), Wageningen, The Netherlands

In this contribution we highlight some perspectives for an economic sound base of heathland management in balance with the conservation of heritage and nature values. The National Park de Hoge Veluwe in the Netherlands provides an example of how the so called 'Planet-People-Profit approach' can provide an economic sound base, contributing also to the regional economy. Another approach to achieve an economic viable base is to combine farming and nature conservation in starting a modern slyle heath farm. This approach is now considered by het Gelders Landschap in the province of Gelderland in the Netherlands.

Heathlands in Europe evolved from agricultural practice and in some cases from military use. The decline of heathlands started in most regions in the 19th century. Nowadays, some 10 percent of the heathlands survived. A lot have still an agriculture use, others are preserved because heathlands are a favourable habitat for hunting (red grouse) or are in demand as a nature and amenity area.

In particular in nature conservation areas, the annual recurrent management costs may be as high as 500 euro per hectare. The income generated in nature areas does usually not cover the costs. As a result encroachment of woodland and shrubs, such as gorse and of grasses can be expected. Thus management has to be improved, but the question is whether the economic base for heathland management will be strong enough to provide the means. This is why it is fortunate that English Nature initiated the HEATH project (Heathland: Environment,Agriculture,Tourism and Heritage) on rehabilitation of heathlands with different partners in the UK, France, Germany and The Netherlands (including our organizations) with EU funding through Interreg NWE.

In our presentation we first discuss the perspective of sustainability for heathland management. Sustainable land use is becoming more and more important. The principle of sustainable development which is relevant for land use is usually summarized as the 3 P`s: Planet, People and Profit. Land use should take care of the environment, heritage and nature (Planet), but also generate jobs (People) and provide a return on investments (Profit). An example on how this could work in nature areas is the National Park de Hoge Veluwe where an entrance fee is payed. This Park has already a significant positive impact on the regional economy and generates many jobs outside the Park.

Another possibility to incorporate sustainability in heathland management emerges because of the changing EU agricultural policy. The foundation Het Gelders Landschap does not only own heathland, but also productive agricultural land, which not always will provide sufficient income in the future, because of the changes in the Eu agricultural policy. It is thought that combining agricultural land and heathlands in a modern heath farm, including specific breeds of cattle adapted to heathlands, may provide a new future.

Whatever the specific solutions, which will be different for the various regions in Europe, there are new opportunities for heathlands not only to contribute to nature conservation and heritage, but also to a vital countryside in Europe. It is hoped that in a few years the HEATH project will provide useful information and examples for decision makers on how heathlands can contribute to conserve Europe`s heritage and nature, while providing a positive input in rural economies in Europe.

Perspectives for heathlands

Management of British heathlands and public access - Latest research results from English Nature's projects

Isabel Alonso | English Nature, Northminster House, Peterborough, UK.

Heathland is a priority habitat in Britain and many of the remaining sites are not in good ecological condition to support all their characteristic species. For this reason, heathlands have been the object of continued research on practical management issues. English Nature has funded research on the following main topics during the last five years:

- Grazing of lowland heathlands
- Impact of development and public access on heathland birds and other wildlife
- Condition of both upland and lowland heathland stands
- Hydro-ecological guidelines for wet heaths
- Survey studies

The presentation will summarise briefly the main results of a few projects, in particular those related to the reintroduction of grazing, the impact of some policy and planning decisions on threatened species and studies into the ecology and functioning of wet heaths.

Management of British heathlands and public access – Latest research results from English Nature's projects

Early stages of *Calluna vulgaris* regeneration after burning of coastal heaths on Tarva, central Norway

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The early regeneration of *Calluna vulgaris* after burning was studied in 17 wet and dry heath sites in central Norway dominated by *Calluna vulgaris*. Patches of old and younger wet heath and old dry heath were burned. The mean temperatures reached in the various categories of heath varied from 680 to 740 ºC, highest in wet heath that had not been burned for at least 50 years. Cover, frequency, height and number of seedlings of *Calluna vulgaris* were studied in 1 m^2 plots. Regeneration of *Calluna vulgaris* was evident in the year of burning, but only from seeds. Even heath with a short burning interval lacked vegetative regeneration. The *Calluna vulgaris* cover increased yearly and passed 50 % three years after burning. The spatial extent of regeneration was evident in the year of burning, and highest in heath with a short burning interval. The height increased regularly on all sites, but was most rapid in dry heath, probably because of better microclimatic conditions. There were more seedlings in the heath with a short burning interval. Even though only seed germination occurred, the density of *Calluna vulgaris* increased rapidly, which is positive for the conservation and management of coastal heaths in central Norway.

Effects of prescribed burning on the nutritional state of *Calluna* and *Deschampsia* in heathlands.

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In Europe, heathlands are important ecosystems for preserving biodiversity on the species and landscape level. Because of changes in the land use and the increased atmospheric deposition, European heathlands have dramatically declined in area during the last decades. This study reports the effects of prescribed burning, as a means of managing *Calluna* dominated heathlands, on the dynamic of plant available nutrients with particular reference to N and P. We hypothesis that winter-prescribed burning leads to an additional N availability, that gives P more importance in the context of nutrient limitation in heathland ecosystems. Our study area was the nature reserve "Lüneburger Heide" (NW Germany) where deposition rates are representative for most parts of lowland heathlands in NW Europe (N 22.8 kg ha-1 a-1). In order to investigate the nutrient dynamics after application prescribed burning, we analysed the plant available nutrients in the upper soil layer (O-horizons), the nutrient output by leaching and the shoot nutrient contents of *Calluna vulgaris* and *Deschampsia flexuosa*. In addition, we discuss changes in the N/P-ratio of stands of both species subjected to prescribed burning. Our results show that prescribed burning resulted in a drastically increased NH4+ availability in the upper soil. This increase is significantly correlated with air temperature. For both species no significant changes in the foliar C/N-ratios were found after prescribed burning, whilst *Deschampsia* showed an increased P deficiency after prescribed burning expressed by increased N/P-ratios. By contrast, the nutritional state of *Calluna* did not change significantly, suggesting that prescribed burning favours the competitive capacity of *Calluna* against *Deschampsia*. In conclusion, our results indicate that prescribed burning clearly improves the amount of plant available N, but decreases the P supply for *Deschampsia*. This gives *Calluna* an advantage to out-compete *Deschampsia* at burned heathlands, using the key factor P-limitation.

Effects of prescribed burning on the nutritional state of Calluna and Deschampsia in heathlands.

Cold-season carbon and nitrogen dynamics of heath ecosystems.

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High-latitude ecosystems are characterized by a long cold season and a short growing season. Still, the carbon (C) exchange between ecosystems and the atmosphere and the cycling of nutrients have until recently been investigated mainly during the short growing season, when rate of gas exchange between the atmosphere and plants plus microbes is high and nutrient cycling presumably is rapid due to high temperatures. However, recent research has shown that the cold season processes (from late autumn to early spring) may be quantitatively much more important than previously thought accounting for up to 50% of total annual carbon emission.

The influences of cold season physical and biological processes on the ecosystems are probably different from the growing-season processes because of snow built-up, low or no plant photosynthesis, freeze-thaw cycles etc. Climate modellers predict future human induced temperature and precipitation changes to be highest in high-latitudes, and especially during the cold season - it is therefore a paradox that this is the time of year we know the least about. Although winters in temperate areas are milder than at higher latitudes periodic frost and snow events may play an important role in C and N cycling here as well. But as for high-latitude ecosystems, most research have until now focused on the growing season.

My project aims to investigate cold season processes in greater detail than hitherto done. In two heath areas, one in the sub-arctic (Abisko, N. Sweden) and the other in the temperate zone (Mols bjerge, E. Jutland) I study the ecosystem exchange of CO2, and the cycling of nitrogen using stable isotope techniques. Although the two sites are situated in two different climate zones they have many common features thus allowing a comparison over a broad climatic gradient.

Heath nitrogen cycling at manipulated 'CLIMAITE'

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CLIMAITE is a newly initiated Danish research center investigating effects of climatic changes upon heath ecosystems http://www.climaite.dk. The aim of CLIMAITE is to develop a conceptual understanding of how climatic and environmental changes in concert will affect biological processes in the heath ecosystem. It is based on climate changes predicted for Denmark in 2075 and manipulates CO2 concentration, temperature and precipitation at the field scale in a full factorial design. Effects of treatments on individual species, ecosystem structure and ecosystem functioning will be investigated through targeted studies on the soil, plants, meso- and micro fauna and microorganisms. The studies include changes in carbon and nutrient balances and circulation, stress tolerance and adaptation, species competition and plant tissue chemistry and herbivory. The experimental set up is currently under construction at a *Calluna*-graminoid heath in Denmark.

Element cycling is expected to alter when climate changes. Nitrogen is often limiting primary production at heathlands and of importance to soil microbial activity. A change in the N cycle comprising plants, soil microorganisms and litter may hence appear as increased decomposition of soil organic matter, altered plant species dominance, changed composition of the microbial community and changes in the availability of organic and inorganic nutrients.

In heathland soil, the dissolved N is mostly in organic form for instance as amino acid-phenolic complexes. Plants have been shown to take up amino acids as intact compounds, hence, shortcutting the mineralisation-immobilisation cycle, driven by soil microorganisms. By injecting isotopically labeled 15N-ammonium and amino acids into the soil in situ, N uptake can be traced in soil microorganisms and in different plant species.

At a sub-arctic heath the results on N uptake potentials suggest that competition is more pronounced between plant species than between plants and microorganisms. All plant species had higher uptake potential for inorganic ammonium than for the amino acids, with the opportunistic graminoids having a higher 15N-uptake rate than average across plant functional types, and the dwarf shrubs having a lower 15N-uptake suggesting slower N acquisition. 15N-labelling experiments during the off-season (November and February) at a temperate heath have furthermore shown, that graminoid, evergreen and deciduous species have a significant N uptake potential at winter (Andresen and Michelsen 2005). This all-year N acquisition potential may be a plant competitive strategy when sharing limited resources, and a consequence of dry summer seasons (Jensen et al. 2003). Forthcoming studies in the CLIMAITE research centre involving 15N-labelling experiments, may reveal N niche differentiations in temporal, spatial or N-form patterns and effects of changes in temperature, CO2 concentration and precipitation.

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Impact of pig farm nitrogen emission on adjacent heathland ecosystems

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Intensive animal production contributes to a considerable amount of atmospheric nitrogen in many modern agricultural areas. Ammonia evaporating from animal production units leads to eutrofication of sensitive natural ecosystems such as heathland: Firstly, evaporated ammonia can be transported as particles over long distances, thereby contributing to a general increase in the deposition of atmospheric nitrogen. Secondly, the high deposition rate of ammonia leads to locally increased nitrogen depositions close to animal production units.

The focus of this project is on the environmental impact of pig producing farms as isolated ammonia sources. The aim is to investigate how long distance single pig farms influence adjacent heathland ecosystems.
Results of this project will be useful in development of environmental management plans, including implementation of air cleaning systems at the farms, and in decisions on establishment or extension of pig farms close to sensitive natural ecosystems.

In order to investigate the impacts of ammonia from pig farms on heathland ecosystems, atmospheric ammonia concentrations are measured together with the nitrogen concentration and nitrogen-isotope ratio in plants and soil. Measurements are carried out in western Jutland, Denmark, along transects at two different pig farms bordering heathland and at transects in comparable non-disturbed heathland.
Atmospheric ammonia concentrations are measured monthly during a period of 1 year using passive diffusion (Alpha) samplers.
Samples of dominant plant species and top soil will be taken during peak biomass and will be analyzed for total nitrogen concentration and 15N/14N isotope ratio.

Our first results show dramatically elevated atmospheric ammonia concentrations close to the pig farms. The concentrations drop exponentially with increased distance to the farm. However, more than 1/2 km from the farm, the atmospheric ammonia concentrations are still twice as high as the local background concentration.
Analyses of plant and soil N and isotopic composition are expected to reflect the steep gradient of N deposition from the pig farms, resulting in elevated N concentrations and relatively low 15N abundance in plants and soil close to the pig farms.

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The heathlands of Hiddensee – what to do to sustain them?

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There are two different types of heathland at Hiddensee – heathland within coastal sand dunes and heathland on gravel barrier beaches ("Strandwälle"). The coastal sand dunes are situated mainly in the south (Gellen) and the western-central (Dünenheide) whereas the latter could be found only in the eastern-central part (Strandwallfächer) and on a small adjacent lying island (Fährinsel).

Driving natural forces for the sand dune systems are the highly acidic and nutrient poor status of the parent sand material, mobility of the sand and, at least for Hiddensee, only to minor extend the salt spray. For the barrier heathland the continuing grazing by different wild herbivores and livestock has today the major impact on keeping the landscape open.

Problems in form of the immobility of sand, the encroaching grasses (*Deschampsia flexuosa, Calamagrostis epigejos, Carex arenaria*), bushes (*Prunus serotina, Juniperus communis, Rubus caesius agg.*) and trees (*Pinus sylvestris, Betula pendula, B. pubescens, Populus tremula)* and the dying of *Calluna vulgaris*, are currently predominant.

Actions taken are manual and mechanical bush removal, irregular (largely unmonitored) small scale sod cutting, year round sheep grazing (Fährinsel; "Koppelhaltung"), summer grazing of cattle ("Koppelhaltung") and since 2004, grazing by a sheep flock and herdsmen ("Huteschafhaltung"). Monitoring is existing only for the sheep flock and has started in 2003/ 2004. Initial results are presented. The measures taken are keeping the status quo until now, but a likewise continuation will not be enough during the coming decades.
Important topics to tackle ranked after their necessity are:

- coordination of actions
- raise local support
- mobilisation of sand by creating wind channels
- initial actions to create proper grazing grounds for the sheep flock e.g. burning of small areas and small scale mowing
- deforestation of larger areas

The first two are of equal importance and go hand in hand, but without a clear message what should be done, no support can be achieved. The coordination of management practices for the various areas is not sufficiently done. The central dune landscapes are partly managed by different conservation bodies which are hard to get together.
But apart from all problems within the areas, the main problem is the open rejection against most conservation actions from the local people. If this is not solved in the near future, conservation measures will not succeed to any further state than the one currently existing.
Initial stages to solve this are yearly public heathland days, but clearly more needs to be done.

Management experiments in Central European dry heathands (Czech Republic)

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The distribution area of *Calluna*-dominated heathland is mainly (sub-)Atlantic, but extends into Central-Europe. Central European heathlands have analogue origin as Atlantic heathlands, i.e. non-intensive agricultural use (e.g. grazing) over long periods of time on nutrient poor soils. The Central European heathlands differ from the Atlantic fields in a larger proportion of herbaceous plant species, many of which have an eastern distribution. They face the same problems as the western heathlands: loss of natural values due to nutrient accumulation associated with the abandonment of traditional management and atmospheric inputs. In order to study the applicability of West European management systems for nature conservation in a continental area the following experiments were carried out.

Vegetation development in dry heathlands was studied following experimental burning, sod-cutting and mowing (once at the start of the experiment) in an area with continental climate in the southern part of the Czech Republic (Podyjí National Park). In 1992, a series of management experiments started. Species composition was recorded in 8 permanent 4 x 4 m plots using 25 x 25 cm grids. Vegetation recovery after different treatments was recorded. All the plots were sampled repeatedly each summer from 1992 to 2004.

The results show that (1) *Calluna vulgaris* recovered successfully after burning. Here *Calluna* regenerated by seed, in addition to vegetative regrowth from roots or stem bases. (2) Heathland recovery after sod-cutting to mineral soil was successful, but varied in time between the plots. (3) Mowing promoted a striking increase in grass cover, which was followed by some recovery of *Calluna*. (4) After all treatments, species richness first increased, but later decreased as the vegetation cover regenerated. In sod-cut plots the highest species numbers were found.

The most successful treatment (recovery of *Calluna*, plant species numbers) was sod-cutting. Burning yielded medium results, but mowing resulted in dominancy of grasses. However, large scale practice of sod cutting seems not realistic here due to the high costs.

Management experiments in Central European dry heathands (Czech Republic)

The Viking Heaths project in the Orkney Islands

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When the 7th European Heathland Workshop was held in Orkney in 2001, this project was at the planning stage. The Heritage Lottery bid has now been approved and about £1 million will be made available through the Fund and through partner contributions. A Steering Group with representatives from Scottish Natural Heritage, Orkney Islands Council, Farming and Wildlife Group, Royal Society for the Protection of Birds, and Orkney Islands Enterprise will be set up to guide the project. Four staff will be in post by May 2005 to take forward the work.

The aim of the project is to re-establish heathland in areas which formerly supported the habitat but where it has since been fragmented. Areas of existing upland and lowland heath will be reconnected , providing good, continuous heathland to support characteristic and special heathland species. Examples of the areas and the processes involved will be provided.

The Viking Heaths project in the Orkney Islands

Heathland change in the 20th century - a case study from Dorset, UK.

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The recent history of heathlands in the UK has been typified by declines in total area and fragmentation of the surviving remnants. Most UK heathlands today are in institutional ownership, with their future heavily dependent on agri-environment funds for the costs of management.

The restoration of heathland from alternative land uses has been mostly small scale and sporadic, even though the UK government has accepted ambitious national targets for heathland restoration of 6,000 ha by 2005.

At Rempstone in Dorset, England, an opportunity has arisen to restore some 400 ha of former heathland from conifer forest, and to re-establish links with the adjoining heathlands to re-create one of the largest continuous areas of heathland in the UK. Unusually, records exist of the precise boundaries of the heaths early in the 20th century, together with details of when and how these were progressively converted to agriculture and forestry. Further studies have revealed the current extent of the surviving heathland fragments and the specialist heathland flora and fauna that is associated with these.

This paper will examine the former status of the heaths, how and why they disappeared and examine the viability of restoring them to form part of a larger heathland landscape, and the practical problems which will need to be solved to achieve this.

Sod-cutting as a restoration measure in wet heathlands in Flanders.

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Wet heathland (*Ericion tetralicis*) is an endangered habitat throughout its entire distribution area. Large areas were reclaimed for agricultural land use or urbanization while in many of the remaining areas the original, low productive and species rich vegetation is replaced by *Molinia caerulea*. Due to this strong decline in area (and consequentially the loss in biodiversity), wet heathlands have a high priority with regards to conservation and restoration. However, in many sites a (strong) reduction of available nutrients in the topsoil is necessary for a successful restoration. A method often used is sod cutting. To evaluate the effect of sod cutting on restoration of wet heathland in the Buitengoor nature reserve (Mol, Belgium), two treatments (sod cutting vs. non sod cutting), were compared for vegetation characteristics, species richness and available nutrients in the soil. For several plant species, nutrient concentrations in aboveground plant material were determined. The N/P-ratio was calculated, to assess nutrient-limitation.

The results indicate that sod cutting was successful as a restoration measurement. Sod cutting increased species richness (7.2 species. 0.25m-2 vs. 3.4 species. 0.25m-2), and reduced *M. caerula* cover. Standing crop was significantly lower in sod-cutted areas (58.6 g.m-2 vs. 247.0 g.m-2). Ammonium and phosphorus concentrations in the soil were significantly lower in the non-sod cut sites (762 µmol. kg-1 dry weight vs. 178 µmol. kg-1 dry weight for ammonium; 27,4 µmol. kg-1 dry weight vs. 2,7µmol. kg-1 dry weight for phosphorus). Bulk density was significantly higher in sod-cut area (78.5 % vs. 46.4%), while free iron concentrations were significantly lower (127.2 µmol.kg –1 dry weight vs. 932.5 µmol.kg –1 dry weight). This indicates that phosphorus availability in the sod cut treatment was restricted due to the formation of precipitated complexes (with iron). Phosphorus and ammonium in the soil were negatively correlated with bulk density. No clear solution for the difference in soil moisture was found although the difference in vegetation cover was probably the main factor since the sampling sites in the sod cut and non-sod cut area were only 4-5m apart.

All species, but one (*Drosera intermedia*), were P-limited. However, a comparison in *M. caerula* individuals between both treatments demonstrated that individuals from the non sod-cut treatment had a significantly higher internal phosphorus concentration (0.32 mg/g vs.0.26 mg/g) and a lower N-concentration (7.77 mg/g vs. 8.99 mg/g). Many studies mentioned the role of nitrogen on the expansion of *M. caerula*; our study however suggests that phosphorus also is an important factor with regards to the expansion of this species.

Also, the results support the theory that *M. caerula* can alter the environment for its own benefit. A gradual increase in *M. caerula* results in higher coverage, which on its turn results in a higher soil moisture and consequently a higher phosphorus availability. Higher phosphorus concentrations on its turn allow *M. caerula* to increase in biomass and eventually *M. caerula* will be the dominating species. Suggested mechanisms to prevent domination by *M. caerula* are sod cutting, or installing a groundwater regime comparable to those that are present in vegetation types like *Cirsio-molinietum*, where the groundwater level drops slightly during the summer period thus creating a limitation in phosphorus.

Sod-cutting as a restoration measure in wet heathlands in Flanders.

A comparison of efficacy of soils stripping and soil acidification techniques for the restoration of heathlands on that that has been improved for agriculture.

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The re-creation of lowland heath on land that has been improved for agriculture, is an important means of reducing the fragmentation of heathland. Such re-creation requires a reversal of the increased soil pH and nutrient availability that is effected during agricultural improvement. A range of methods have been used to attempt to achieve this goal. In this paper we describe an experiment that compares the efficacy of soil stripping and sulphurous amendments in the re-creation of acid grassland and lowland heath plant communities. A single fully factorial experiment spreads over 10 fields on two farms in Dorset, UK. Two sulphur amendment methods, a soil stripping method and a control were compared. The sulphur amendment methods were applied on plots that measured 50m by 50m and used sources of sulphur that were readily available for agricultural use and were easily applicable to the fields using standard agricultural machinery. They were an i) elemental sulphur (So) treatment in the form of Brimestone 90Tm an agricultural fertiliser that consists of 90% S and comes in an easy-to-apply pellet rather than power state ii) a ferrous sulphate (Fe(II)SO4.7H2O) treatment in the form of Mistrale "Wet Copperas" 50Tm a wet powder sold as a moss killer and which contains 13% sulphur and 19 % iron. The soil stripping treatments were applied in plots within the same randomised array. Plant community composition and number of heather plants on each plot were assessed in June 2001, 2002, 2003 and 2004. The invertebrate community was sampled by pitfall trapping in June 2002 and June 2004. Adjacent areas of heath were also sampled for their plant and invertebrate communities. Results showed that the sulphur treatment was the most effective at suppressing agricultural grasses and promoting the growth of sown heather. It was however unsuitable for use on sloping land due to surface flow of acidity in the first few months of the acidification process. In the first year the sulphur treatment also had a very marked impact on invertebrate communities. The total number of invertebrates had recovered by 2004 but the community was still rather different to that typical of surrounding heathlands.

A follow-on experiment was set up to investigate whether modification of application rate in the sulphur treatments affects success in terms of initial restoration of heathland plant and animal communities. This took the form of a fully randomised block of treatment plots, set up on each farm where elemental sulphur was applied at the following rates: 0.00 Kg/ha, 1.44 Kg/ha, 2.88 Kg/ha, 3.84Kg/ha, 5.76 Kg/ha. Results showed that the best suppression of the agricultural weeds occurred at the highest dose of sulphur but that this also had the most detrimental effect on invertebrate communities. We suggest that the best overall compromise dose for the soil in our system may be 3.84 Kg/ha and that this may be a useful starting point as a dosage for other systems. However, the effect of a particular dose will be influenced by the specific soil properties of each site and so we recommend that test are carried out either side of 3.84Kg/ha to establish the optimum dose for the site in question.

A comparison of efficacy of soils stripping and soil acidification techniques for the restoration of heathlands on that that has been improved for agriculture.

Can management compensate effects of atmospheric nutrient deposition in heathland ecosystems?

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The increased deposition of nutrients from the atmosphere has contributed to widespread changes in both the structure and function of many heathland ecosystems throughout Europe. Therefore heathland management nowadays is considered as an important tool, to modify ecosystem impacts caused by atmospheric nutrient loads. In our study we compared the effect of three heathland management measures (mowing, prescribed burning, sod-cutting) on the nutrient balances of heathland ecosystems (for N, Ca, Mg, K, P). We hypothesise that low-intensity management measures (mowing, prescribed burning) are unable to compensate atmospheric nutrient loads, particularly as regards N. Our study area was the nature reserve "Lüneburger Heath" (NW Germany) where deposition rates are representative for most parts of the lowlands of NW Central Europe (N: 22.8 kg ha-1 a-1). In order to calculate nutrient balances, we analysed the present-day input (atmospheric deposition), the output due to the removal of a particular ecosystem compartment (above-ground biomass, organic layer, A-horizon), and increased leaching rates caused by the application of the management measures. Our results show that heathlands subjected to prescribed burning and sod-cutting, leaching rates will increase significantly within the first years after the measures have been applied. However, the effect of increased nutrient losses by leaching is very small compared to nutrient losses caused by the removal of the above-ground biomass, the organic layer and A-horizon. The total amounts of nutrients removed by sod-cutting are equivalent to between 37 and 152 years of atmospheric inputs (for N: 89 years), as the organic layer and A-horizon represent a huge storage for all nutrients, particularly for N, Ca and K. By contrast, the amounts of N removed by mowing and prescribed burning are equivalent to only five years of atmospheric inputs. As these measures are not applicable within a shorter time interval than 10 years due to the regeneration of the vegetation, heathlands subjected to low-intensity management measures will accumulate N on the long-term. N removal by means of mowing and prescribed burning thus cannot compensate atmospheric N deposition in the heathland studied. In addition, under prescribed burning balances will be positive for Mg and Ca, as high amounts of these nutrients are deposited by ash. As output/input relations for P exceed those for N, it is likely that N/P-ratios in the vegetation and soils on the long-term will increase. Hence, we assume that heathland ecosystems nowadays limited by N may shift to more P-limited ones on the long-term.

Can management compensate effects of atmospheric nutrient deposition in heathland ecosystems?

Effects of bracken control treatments on bracken performance, vegetation dynamics and non-target species in heathlands of Western Norway

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Some of the least degraded heathlands in Europe are now found on the west coast of Norway. Here, as in European heathlands in general, invasion by bracken is becoming a serious threat to conservation. Indeed, bracken eliminates common herbs, grasses and heather and disrupts post-fire succession, causing the heathland to eventually develop into vegetation types with low conservation interest. Since one of the main keys to bracken control lays in exhausting the rhizome reserves of buds and carbohydrates, traditional management by harvesting bracken for bedding and thatch controlled the spread of bracken in the past. The discontinuation of this tradition is one of the reasons of the rapid bracken spread in outfields and heathlands today, along with lack of cattle grazing and increased nutrient availability from acid rain and artificial fertilizer. In this study we assessed the effects of six bracken control treatments: 1) spraying once with the herbicide asulam, 2) spraying with asulam followed by cutting once a year, 3) spraying once with the herbicide gratil, 4) spraying with gratil, followed by cutting once a year, and 5) cutting once yearly or 6) twice yearly. Treatments 1 and 3 were applied both inside and outside bracken patches to assess any possible negative effects of herbicides on the target heathland vegetation. The effects of the different treatments on bracken height and cover, vegetation composition and individual species were measured. The fastest reduction of bracken height and cover was seen using asulam and gratil spraying in combination with cutting, followed by cutting twice yearly. Both herbicides had negative effects on the non-target vegetation, however, and the best treatment for promoting heathland vegetation and desirable heathland species was cutting twice yearly. Successful management or restoration will depend on combining modern bracken control with traditional management techniques such as cutting in combination with grazing. Effective bracken control is expensive, time consuming and labour intensive.

Effects of bracken control treatments on bracken performance, vegetation dynamics and non-target species in heathlands of Western Norway

Reptiles need a change in heathland management practice in the Netherlands

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Reptiles are largely dependent on heathlands and heather vegetations for their survival in the Netherlands. They form a threatened animal class and all species are legally protected. Reptiles are still declining and the densities of the surviving populations are low. From the remaining heathlands in the Netherlands, about 20% is a potential reptile habitat. These points of departure oblige us to manage their habitats optimally. Nevertheless, the current management of heathlands is focused on interests for plants and landscape and does not take the needs of reptiles into account. For the sake of reptiles and other specific heathland fauna, it is high time to adapt the management measures and to tailor them to their needs.

Management measures in heathlands have been evaluated and their effects on reptiles monitored in the Netherlands and in northwestern Europe during the last 30 years. Heathland management is carried out on a botanical basis and the practice is subject to trends. Heathlands are the product of a former agricultural system. The accompanying management measures have been directed either at production or at the preservation of flora: managers try to rejuvenate the heather and to impoverish the mineral substrate. Therefore, they practice measures such as removal of turfs, mechanical mowing, burning and grazing. All these measures influence the structure of the vegetation and that is why they conflict with the interest of reptiles. Reptiles need old mature heather with a very complex structure that can only develop in a natural way after some decades. Heather vegetations in reptile habitat ought not to be treated as an agricultural heath, but as a natural heath, being scrub vegetation. Their management is very simple and cheap in principle: do nothing and only cut trees if the development into forest proceeds too far. However, as almost all remaining heathlands are disturbed, tailoring of measures is often needed, but only on places where heather is absent and always at a small scale. If heather is lost or if grasses have encroached too far, the removal of turfs is the only way for restarting the development of heather.

This approach is not generally accepted by heathland managers and all heathlands are still treated in the traditional way. There is an urgent need to designate a number of nature reserves where the main goal is to protect and appropriately manage reptile habitat. This will also have positive effects on other rare and typical heathland fauna in need of protection, such as certain birds and invertebrates.

Reptiles need a change in heathland management practice in the Netherlands

A new equipment for heathland management – and its future consequences.

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As a supplement to traditional methods of heathland management, Ringkjøbing County has developed a new machine which cuts the vegetation (including trees up to about 4 m high) and collect the materials at the same time. Depending on the area it manages about 2 hectare per day.

The material has a maximum length of about 30 cm. It is used in different ways. The raw material is used on footpaths and riding paths. With some preparation it is sold to riding-grounds for horse shows, or as cover material in flower gardens.

With some success, but not yet fully developed, we managed to produce fuel pills. Small ones for central heating installations, and large ones for individual fireplaces. Several other possible uses have been investigated. Some more promising than others.

The expected income from these products vary from no income to a profit to the owner. Still improvements are needed – and possible - concerning the harvesting, further processing, and marketing of the product.

Consequences.
The most promising aspect of this method is possibly not the technical one, although it has several advantages: It works deeper than other movers, it removes material from the site, and it can utilize vegetation of lower quality than previously (higher grass content, even dead heather). The most positive perspective is that it can generate a profit under these conditions.

An important criterion of success regarding heathland management is the possibility to change expensive traditional management of the same type into a management that yields a profit. Still most heathland management costs money.

Protection of the small heathlands in Denmark is rather limited. The law states that the owner must not actively change the heath (e.g. by planting or ploughing), but he has no obligation to manage, nor do authorities have a right to do it. So succession to woodland is allowed. It is our hope that more private owners will manage their heathland when it is no longer connected with costs, but perhaps produces a little money – besides a better heathland.

The Heathland Centre Western Norway; Dissemination of Knowledge and Teaching.

Kristine Ekelund and Peter Emil Kaland | Department of Biology, University of Bergen, Norway.

The Heathland Centre is an ecological museum, representing the traditional heathland landscape. Most of the 2 km^2 area is still owned and run by the local farmers at Ytre Lygra. The uncultivated land is dominated by *Calluna* heathland, which is maintained by traditional management methods involving heather burning and all-year-round grazing by an old Norse breed of sheep. The Heathland Centre is unique as it is the only place within the heathland area of Europe where heathlands, owned and authentically managed by local farmers, are also accessible to the public in the form of tourism, education and recreation. It is a national competence centre for management of heathlands. Knowledge is communicated through an exhibition on the Norwegian and European heathlands, a documentary film about authentic heathland management, guided walks in the heathlands and around the farms. Courses in heathland management for farmers and land-use managers, education for school classes and students, and sale of information material is also available.

For school classes of all levels, The Heathland Centre presents an integrated view of nature, land use, and cultural knowledge: as, for example, traditional uses of resources from the land and sea, the natural flora and fauna, settlement history, the coastal landscape's environmental history, the local building practices, and the natural and cultural assets connected to the marine environment. The overall aim of the teaching program is to make pupils aware of their own cultural heritage; what is a cultural landscape, how was the 5000 year-old sustainable production system of the heathlands traditionally managed, and why and how do we preserve these landscapes today? To achieve these goals, an activity-based outdoors teaching program has been developed. The program contains teaching material for different levels to enable the schools to be prepared before they come, and give them the opportunity to continue the teaching process after the visit to The Heathland Centre. This material consists of 18 different activity sheets which contains background information, activities to carry out in the field (the heathland, marine environment, the farm), a description of how it traditionally was carried out (if management activity), questions and suggestions for further discussions, tips for further reading and websites, and registration forms etc. if needed. The activities can be implemented in the national interactive teaching program "Miljolare". The Centre has also produced 10 papers about the local flora, fauna, climate, geology, marine environment, ecology and traditional management and settlement history. The teaching material is developed in cooperation with teachers from primary and secondary school, college and different institutes at the University of Bergen. It is available at The Heathland Centre's website

(http://www.lyngheisenteret.no).

The Heathland Centre Western Norway; Dissemination of Knowledge and Teaching.

How nature education can amaze people in the cross-border park 'De Zoom-Kalmthoutse Heide'.

Dries Kools and Sofie Regniers | Natuureducatief Centrum De Vroente, Kalmthout, Belgium

The Campine heathland, the fens, the pine forests and dunes cross the border between Belgium and the Netherlands, thus forming the 'Grenspark De Zoom – Kalmthoutse Heide'. This unique nature reserve is situated around the Nature Education Centre (NEC) De Vroente, which also functions as visitors centre. Heathlands played a key role in the overall farming system located in the northern part of the Campine region. It used to be the property of the lord or it belonged to convents and abbeys. The village inhabitants were allowed to use the land to grow their cattle on or to cut peat, generally in exchange for taxes or services rendered. In this region the common land was known as "vroenten".

De Vroente is given the task to develop nature and environmental educational activities. The aim is to provide citizens with thrilling and creative incentives for establishing sustainable relationships with their environment, bringing them into closer contact with nature and offering them greater social involvement in nature and environmental policy-making. De Vroente is creating innovative educational services for various target groups. One key audience is the educational sector but De Vroente is also keen on reaching out to families, youth leaders, social and cultural organisations, companies,... and individual citizens. The educators offer for all age categories a tailored program. Emphasis is placed on the experience of nature and on programmes in the heathland close by. 'To experience personally' is the base of all the educational activities of De Vroente. Therefore the educators incorporate always active observation, listening and involvement moments. Every year around 10 000 people participate in these programs.

In addition to primary education for the different groups aimed at, De Vroente also offers tailored training for nature guides, teachers, students, youth leaders, nature-educators,... In this way, De Vroente wants to reach more people than only the ones who come to visit De Vroente (multiplier effect).

De Vroente is a centre of the Ministry of Flemish Community, General Environment and Nature Policy Division. The centre forms part of the Flemish community's Nature, Environment and Education network. In De Vroente one can have a look at three different expositions: 1) a permanent exhibition about the nature reserve De Kalmthoutse Heide, 2) an art exhibition which changes every month, and 3) a self-made exhibition about a certain nature subject which changes every 4 months (at the moment about the historical use of heathlands). The exhibitions are (freely) accessible from the age of 10-12 year since they contain a lot of interactive elements. Every year almost 15 000 people visit these exhibitions.

The total offer of programs can be consulted at the website, at the moment only available in Dutch:

http://www.devroente.be

How nature education can amaze people in the cross-border park 'De Zoom-Kalmthoutse Heide'.

The Strabrechtse Heide: a dynamic mosaic of water, wind, clouds and spectacular views
A pre-visit presentation of the Strabrechtse Heide (Brabant, The Netherlands)

Jap Smits | Ranger Staatsbosbeheer (Dutch National Forest Service), Eindhoven, The Netherlands

Location

The Strabrechtse Heide is located in the south of the Netherlands in the province of Brabant at 20 km of the Belgian border, south of the city of Eindhoven.
With about 17 square km, or 2000 ha, its the largest heathland reserve in the south of the Netherlands. The reserve is bordered in the north by de highway A67 Antwerp/ Düsseldorf, in the east by woods of the municipality and agricultural fields, in the south by an provincial road and in the west by a small river called 'Rul' or 'Kleine Dommel' (the 'Small Dommel').

Management

Two nature conservation organisations, Staatsbosbeheer and the Brabants Landschap manage the reserve. The west side of the reserve, including the biggest heath fen of the country (Beuven), is owned and managed by the local municipality of Someren.
About 230 ha are still private property and managed by Staatsbosbeheer.

The reserve is managed as a half open heathland area with scattered small bushes and fens. To keep the heathland open from trees and to prevent the spread of grasses like *Molinea caerulea* and *Deschampsia flexuosa*, a herd of Campine heathland sheep is used. This almost extinct breed of heathland sheep was re-introduced in the early nineteen seventy's. Today the herd counts 240 sheep. Together with the sheep, a small herd of 50 cows, partly Blonde 'd Aquitaine and partly Aberdeen black, are grazing the area. They are property of a local farmer. The grazing only takes place during the growing season, from the first of May till the first of November. Besides traditional management measures such as sod cutting and mowing, Staatsbosbeheer and the Brabants Landschap are still burning heath vegetation, although always in combination with sheep or cattle grazing. Finally, Staatsbosbeheer uses 16 ha as cornfields that are fertilised with sheep dung and heath sods.

Protection

The nature reserve the Strabrechtse Heide is protected by the Habitat directive or SAC (Special Area of Conservation) and is proposed as a Bird Directive or SPA (Special Protected Areas). The Beuven and surroundings are designated as protected Wetland area.

Threat

The main threat for the Strabrechtse Heide is desiccation caused by the drainage of the surrounding agricultural land and by groundwater extraction for agricultural purposes and drinking water supply. By cutting of a small river which transported 6 million m3 a year of untreated water trough the reserve, the problem of pollution was solved. Unfortunately however, this solution led to even more desiccation.

Public

The Strabrechtse Heide attracts 350.000 visitors a year. Staatsbosbeheer is now developing a recreational entrance with a small visitor centre, an insect garden and a heathland garden.

Future

In the future, Staatsbosbeheer will try to manage the Strabrechtse Heide more as an ancient agricultural landscape. That means that, compared with current management, more emphasis will be put on small-scale and extensive farming activities.

The Strabrechtse Heide: a dynamic mosaic of water, wind, clouds and spectacular views

A pre-visit presentation of the Strabrechtse Heide (Brabant, The Netherlands)

Resource-based definitions of habitat in heathland landscapes and implications for conservation: a test with butterflies

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Habitat has been long recognized as a key concept in ecology and hence in conservation biology. In general terms, habitat refers to the environment used by an organism or by a community of different organisms. Habitat associations using, for instance, land cover data are useful to study the distribution of species at coarse-grained level to prioritise areas for conservation. However, the identification of more specific habitat variables within and among different vegetation types is often necessary to understand the presence of habitat specialist species at a fine-grained scale to develop effective conservation strategies. Detailed ecological knowledge on the environmental variables that together comprise a specific habitat for a given species becomes key information to conserve and to restore populations of conservation interest in human-dominated landscapes. In such a landscape the quantity, configuration and quality of habitats do not only depend on the environmental setting and the associated spontaneous processes, but also on management regimes. For organisms like several butterflies there is evidence that they can even rely on specific habitat conditions created by traditional management. The observation that habitat specialist species keep on declining and even disappearing from reserves under traditional management maintaining general vegetation types has caused considerable worry among reserve managers. So there is a growing need to improve the efficiency of management to conserve regionally threatened species in nature reserves. One way to address this issue is to improve our functional insight into what exactly a habitat comprises for a given species and what this means to adapt conservation management strategies. A resource-based habitat approach has recently been proposed (Dennis et al. 2003, 2005). We illustrate this conceptual bottom-up approach combining maps of the distribution and abundance of different resources in a geographic information system (GIS) to delineate functional spatial habitat units at high spatial resolution for regionally threatened butterfly species in a heathland landscape in NE-Belgium (National Park Hoge Kempen). Traditionally habitat patches tend to be simple physical vegetation units (or compact continuous entities), while using this method habitat zones are clusters of resources that may extend in a more scattered way into different vegetation units. We discuss resulting current and potential habitat maps as conservation tools that are now used by the reserve managers to adapt their management scheme in relevant zones of the National Park.

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Transferability of predictive habitat models between areas: butterfly models tested in three Flemish heathlands

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Models for predicting species absence/presence are becoming more and more widely used in nature conservation and have a broad range of conservation applications (Guisan & Zimmerman 2000, Manel et al. 2001). Model output which is accurate enough can be used for making conservation decisions and, when spatially detailed enough, even for guiding reserve management. The efficiency of this type of models is mostly tested on the area for which they were developed. Although strongly recommended (Fielding & Bell 1997), predictive models are rarely validated on independent areas (Whittingham et al. 2003). The rare cases for which this was tested give contrasting results (Seoane et al. 2005, Whittingham et al. 2003 and references herein). Transferability and extrapolation of models was recently described as an 'unsolved problem in wildlife-habitat relationship modelling' (Seoane et al. 2005). However, predictive models become only really valuable for conservation when they can be extrapolated to areas for which information on target species distribution is lacking.

Most published models for predicting species distribution explain absence/presence using combinations of relatively large-scale abiotical and/or climatological variables. The relation between these variables and the occurrence of the species is hence indirect. The relationships between these variables and the resources that directly drive species occurrence could differ between areas. This could result in models that are over-fitted to the area for which they were developed and forms a possible explanation for poor transferabilities.

We argue that predictive models which are based on functional relationships between a species and its environment (essential resources) could predict distributions more realistically and spatially detailed and have a potential for being easier to transfer to independent areas. We tested these hypotheses for two threatened butterfly species in three heathland areas in Flanders (National Park Hoge Kempen, Vallei van de Zwarte Beek/Kamp van Beverlo and Landschap De Liereman). We built generalized linear models with species-specific essential resources as variables and tested the accuracy of these models within and between areas. We found that most of our models could be transferred to new areas under given conditions. We will discuss these findings and the implications for conservation.

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Transferability of predictive habitat models between areas: butterfly models tested in three Flemish heathlands

Habitat quality and biodiversity indicator performances of a threatened butterfly versus a multispecies group for wet heathlands in Belgium

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We analyzed whether a single species (i.e., the threatened Alcon Blue butterfly, *Maculinea alcon*) was a useful indicator for the quality and area of wet heathlands in Belgium. During a survey of 18 wet *Erica tetralix* heathlands, we identified 624 species from 20 different taxonomic groups. Sites with the single indicator species *M. alcon* were significantly richer in typical wet heathland species and in Red List species but did not show significant differences in biotope quality (i.e., the number of different typical wet heathland biotope attributes) than sites without. In addition, we used a multispecies indicator approach including a group of nine species from five different taxonomic groups (two birds, two dragonflies, two butterflies, two vascular plants and one grasshopper). High quality sites (5-9 species from the multispecies indicator group present) tended to have more Red list species than low quality sites (0-4 species from the multispecies indicator group present) but did not expose differences in overall species richness, typical wet heathland species or in biotope quality. The number of species in this umbrella group, however, was positively correlated with both the diversity of typical wet heathland species and with biotope quality. Furthermore, the complementary information of the species in the multispecies indicator group usefully signalled distinctions in biotope area and configuration, vulnerability to fragmentation, eutrophication, desiccation and contained species of different trophic levels; this was not the case for M. alcon as a single indicator species. We discuss the use of a single indicator and of a multispecies group as conservation umbrella and advocate a much wider use of combined knowledge from different taxonomic groups in conservation planning and evaluation.

Habitat quality and biodiversity indicator performances of a threatened butterfly versus a multispecies group for wet heathlands in Belgium

Ecological land management in a military context.

Hans Jochems and Johan Vanswijgenhoven | LIFE-project 'Integrated restoration of natural habitats on Military areas in NATURA2000' Flemish Ministry of Environment, afdeling Natuur, Vlaams Bezoekerscentrum De Watersnip, Koersel, Belgium;

Military areas are critical assets for training and testing activities, but they also harbour diverse and often rare flora, fauna and cultural resources that must be protected. Military management is mostly aggressive while ecological management can be regarded a soft discipline. These two managing disciplines vary in time (periods, seasons, years,..) and in space, they obey very different laws and guidelines, and respond differently to a change in policy. At the same time, these at first glance very different managing options? have large opportunities towards combining each other's core businesses.

A quick look at the endangered habitats in a GIS shows a high responsibility for the Military Domains in Flanders, and indeed in Europe. The need to maintain military readiness must be balanced with the needs to protect this exceptional environment. If military training is performed with complete disregard to environmental consequences, a site's valuable natural resources could be irretrievably lost. In addition, the quality of the training would gradually be degraded because the training areas would no longer resemble the terrain where actual fighting might occur. Conversely, if protection of the environment becomes the dominant consideration, the ability of the armed forces to train could be limited. As a consequence, the ability of the armed forces to protect the sovereignty of the country could be jeopardized. Since neither of these extremes is acceptable, it is obvious that the military must work closely with environmental experts to determine the methods that meet the best overall interests of the training area.

For this combination to work effectively, the land management must be adaptive and robust enough to be able to cope with an ever changing military and ecological environment. The different partners must develop management plans that are realistic and support the local goals and strategies. Plans developed without consideration of technological or fiscal limitations are doomed to failure. The planners must establish priorities, based upon considerations such as risk to human health, environmental payback on investment, and total cost, to help in the sound allocation of limited resources. If existing technologies are ineffective or too expensive to use, it must consider deferring the work and promoting further research. An integrated natural resources plan is essential to the long term protection of the natural resources on a training area. The plan establishes the management practices necessary to fully support the performance of the military mission while limiting any damage to wildlife, vegetation, soils and waterways.

To accompany the management plans, it is advantageous to establish formal committees consisting of members of the military sector, local community leaders, and representatives of environmental groups. These committees provide an excellent forum for the exchange of information, the identification of potential problems, and on many occasions, the successful resolution of problems. When committee discussions are conducted in an open and objective manner, they can lead to solutions that often satisfy all parties.

A good environmental protection program needs the commitment of the entire military establishment. A program that relies on the efforts of a small cadre of environmental professionals is doomed to failure. Every person within the military can take actions, or fail to take actions, that result in environmental damage. It is, therefore, necessary to make all military personnel aware of their environmental responsibilities.

In our presentation, we will show how these different scenarios are made visible within a European LIFE-project in Flanders, Belgium. An example of a land management scenario for a multiple-hectare military base in Flanders will help clarify the value of adaptive land management. For a military base, multiple short- and long-term land management objectives will be established to achieve simultaneous objectives over time, including:

conducting tank training for on-the-ground military realism
sustaining habitat areas for a legally protected endangered species
educate local military personnel
nurturing positive relationships with local and regional communities
provide a good cooperation framework between the different ministries involved

Ecological land management in a military context.

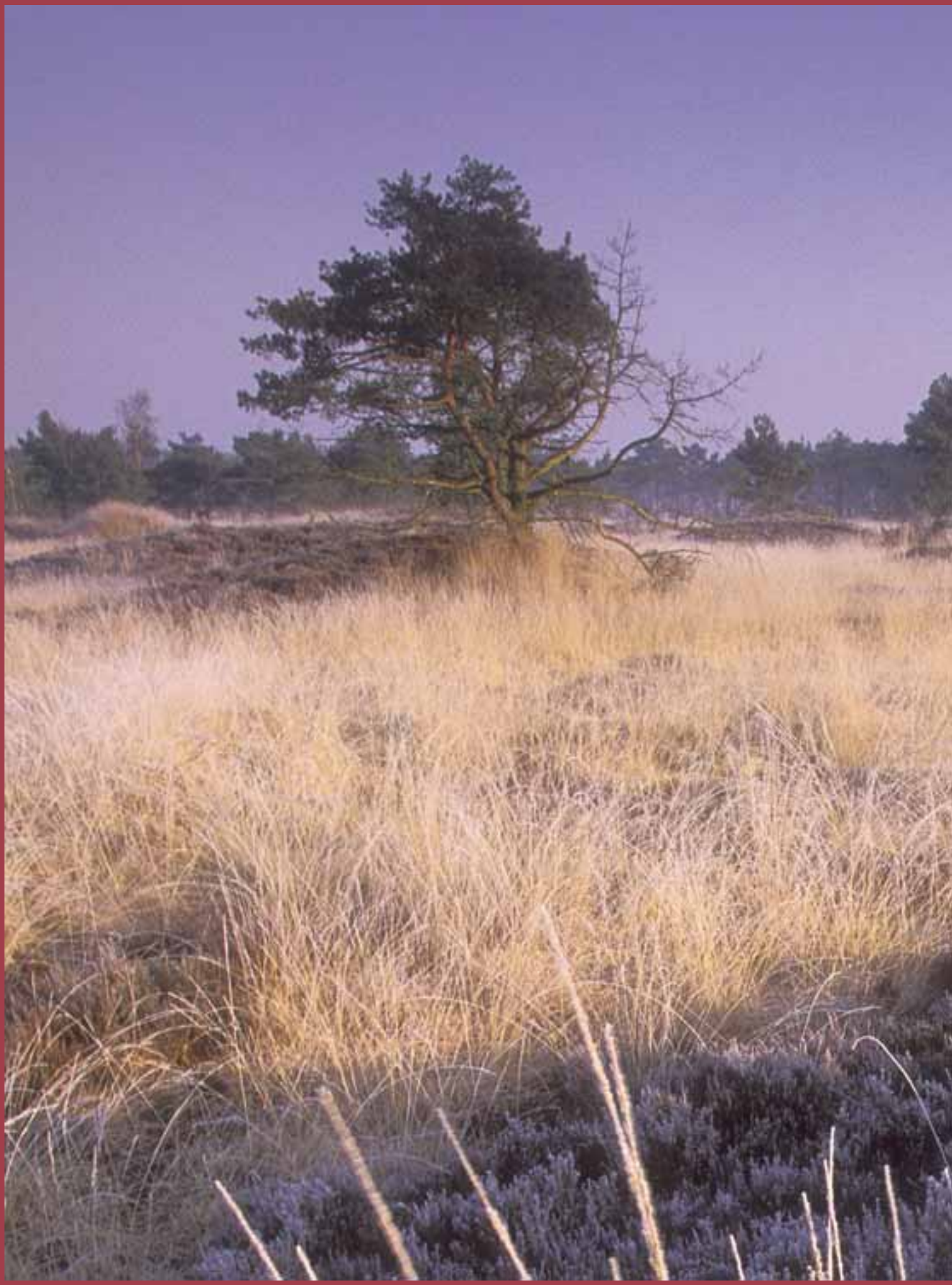
Erica tetralix L. community in Latvia

Liene Salmina | Latvian Fund for Nature, Latvia.

The distribution, habitat preferences and species composition of *Erica tetralix* community in Latvia were studied. Vegetation was studied in Sakas Grini Nature Reserve, which is a potential Natura 2000 site. Relévés with and without *Erica tetralix* were described and Spearmen rank's correlation analysis was used to identify species with the highest positive correlation with *Erica tetralix*. The association between species composition and mean Ellenberg and Düll indicator values were examined using canonical correspondence analysis. Factors influencing distribution of *Erica tetralix* were analysed comparing selected climate parameters among regions with and without *Erica tetralix* by means of Mann – Whitney U-test.

In Latvia *Erica tetralix* is found on the eastern limit of its distribution range. There are six *Erica tetralix* localities recorded in Latvia, all found in the Coastal Lowland. The main habitats of *Erica tetralix* are wet heath fragments and wet sparse pine dominated forests on podsolic soils with ortstein layer, covered by a thin (3 -10 cm) peat layer. Both habitat types were characterised by high water level fluctuations. The coverage of *Erica tetralix* ranged from 1 % to 90 % of the relevé reaching its highest coverage in wet heath fragments. There was a high positive correlation of *Erica tetralix* with *Sphagnum compactum, Sph. contortum, Sph. cuspidatum, Sph. magellanicum, Sph. russowii, Carex nigra and Andromeda polifolia*, but negative correlation with *Hylocomium splendens, Pleurozium schreberii* and *Molinia caerulea. Sphagnum angustifolium*, and *Sphagnum capillifolium* did not show any correlation with *Erica tetralix* and neither did *Calluna vulgaris*. It can be concluded, that the optimal habitat of *Erica tetralix*, where the species dominates, is characterised by the presence of different *Sphagnum* species, *Carex nigra* and *Andromeda polifolia*. These differences in species composition also reflects ecological differences, as illustrated by CCA. Floristic variance was explained mainly by moisture, soil reaction and light conditions.

There were statistically significant differences among the regions along the western coast of Latvia and the rest of Latvia in terms of mean t° C in January, number of days t > 0°C, number of days with snow cover, mean absolute minimal winter temperature, maximal depth of soil freezing and mean annual precipitation. However, there were no statistically significant differences among the regions along the western coast of the Baltic Sea. The main factors influencing differences in distribution of *Erica tetralix* along the western coast of Latvia were geology and soils. Indeed, the highest species concentration and the only site in Latvia of wet heath with *Erica tetralix*, are found in areas where podsolic soils dominate. Already at a distance of 10 to 30 km from the Baltic Sea, the climate conditions differ significantly from those recorded at the coast. It can be concluded, that the optimal climate conditions for *Erica tetralix* only exist along the very coast of the Baltic Sea.



Edaphic arthropods community in Calluna vulgaris heathlands in the Cantabrian mountain range (NW Spain)

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Heathlands dominated by *Calluna vulgaris* are one of the characteristic vegetation communities in the Cantabrian mountain range (NW Spain). Although their distribution is scarce, these communities represent one of the most southern locations for this type of heathland. European Union Habitats Directive (Habitats Directive 92/43 ECC) recognised heathlands as an important habitat (Habitat 4020). This decision has contributed to the development of different research activities that seek to improve the conservation management of these habitats. Functional and ecological roles of edaphic arthropods are an important part of the heathland dynamics. Studies focusing on edaphic fauna responses to changes in heathland vegetation and soil characteristics, could contribute significantly to their conservation management.

We present the first edaphic arthropod records for *Calluna vulgaris* heathlands in the Cantabrian mountain range (León, NW Spain). We selected four heathland zones between 1550 and 1670 m altitude. Arthropods were captured with pitfall traps (alcohol 35% and detergent). We placed 48 traps randomly in each zone (192 traps in total). Arthropods were collected each 15 days during July and August 2004.

23 groups of arthropods were collected in total. Abundantly captured groups were the same in all heathland areas. *Collembolan* were the most abundant, representing 37% of the total catch. The other representative groups from all heathland areas were: *Hymenoptera* (19%), *Diptera* (14%), *Coleoptera* (8%), *Aranei* (7%), *Acaromorpha* (7%), *Hemiptera* (3%), *Thysanoptera* (1%) and *Opilionida* (1%). Differences in total number of arthropod groups for each area (varying between 16 and 21), were due to the presence of rarely collected groups. It is worth pointing out that heather beetle larvae (*Lochmaea suturalis*) represented 2% of the total catch.

Presence of arthropod groups seemed to depend on the environmental variables that characterised each heathland area (proximity to a stream, leaf litter depth, soil humidity, presence of mosses...).

Edaphic arthropods community in Calluna vulgaris heathlands in the Cantabrian mountain range (NW Spain)

Effects of livestock and wildlife grazing on heathlands vegetal diversity in NW Spain

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Heathland communities in the Cantabrian mountain range (NW Spain) have been historically used for domestic livestock grazing in transhumance pastoral systems. Grazing by sheep, goats, cattle and horses is a major determinant of vegetation dynamics in this type of ecosystems. Herbivore foraging is influenced by vegetation patterns and, in turn, their grazing drives vegetation dynamics. In addition to this, burning and cutting were regularly used to provide pastures as part of heathlands management practices. However, during the last decades traditional management nearly disappeared in the Cantabrian mountain range, due to changes in agricultural practices and socio-economical reasons. Moreover, agricultural policies have favoured a reduction in the number of domestic grazing animals.

We present the results of monitoring the effects of grazing by domestic livestock and game species on the vegetation diversity and composition of the Cantabrian heathlands. Three study areas were selected in the province of León (NW Spain). The first one is used by domestic livestock, mainly sheep and horses. The second one is used by game species, mainly deer. And the third area represents a mature stage with no records of grazing. Study areas are located in the Eurosiberian Region, and their climate is characterised by an average annual temperature of 5.5 oC, an average annual rainfall of 1319.5 mm, and a warm season with no (or less that two months) aridity period. Soils in all mountainous areas are podsols, with different underlying rocks. We selected random patches of a significant extent with both *Calluna* and *Erica* species for all study areas. Ten experimental plots (2m x 1m) were chosen and marked in each study area. Percentage cover of every vascular plant species was estimated visually. The data were used to determine the abundance, diversity and its two components, richness (number of species) and evenness. The original situation consisted of a high percentage cover of *Calluna* in the three study sites without significant differences between areas. We found significant differences between areas regarding structural parameters, species richness, diversity and evenness related to the degree of grazing activity. In general, areas with longer period of grazing by domestic livestock had higher vegetation diversity than areas with game species or without animals grazing. Therefore, grazing had a significant effect on plant species richness, which declined in un-grazed plots. Cattle's grazing is of potential value as a management tool for increasing vegetation richness, especially herbaceous species.

Seed banks and fire; A study of west Norwegian heathlands

Inger Elisabeth Måren and Vigdis Vandvik | Institute of Biology, University of Bergen, Bergen, Norway.

Dormant seeds in the soil serve a dual function in plant populations. They are "memories of populations' and communities' past", and at the same time are a potential for future persistence and survival. Hence, the longevity of seeds in the soil affects the resilience of plant communities. Heathlands are influenced by many factors leading to vegetational change. Burning and grazing has been the most commonly employed management practices of the west Norwegian heathlands. Propagule input is an important and integral part of the successional process where the successful recruitment may be limited either by the availability of seeds, or by the availability of safe sites where the seedlings may germinate and establish. Local seed availability may be affected by e.g. seed-source density, seed production, dispersal strategy and predation, while microsite availability may be affected by e.g. competition, disturbance, and grazing. In the open heathland landscape seed-sources may be sparse, and while the availability of safe sites may be the major limitation in heavily grazed heathland areas, seed limitation may become the most important limiting factor as grazing pressure decreases. A proper understanding of how heathlands respond to disturbance must take account of seed production-, dispersal-, seed bank- and germinability dynamics. In cyclic vegetation types such as heathlands, seed banks are particularly important so that the species can survive locally with time.

Few studies have focused on the temporal changes in seed banks during cyclic heathland succession. Very few studies deal with the role of the seed bank in post-fire recovery, and particularly in heathlands. In this study we investigated the relationship between vegetation composition and seed bank in burnt heath of varying age (recently burnt – 30 years since last fire). This is a relatively long time sequence, and instead of studying the development through time, using one site, we used a chronosequence, namely the substitution of space for time. A total of 50 species were found to germinate from the seed bank, while 65 species occurred in the vegetation analysis. 15 species only occurred in the seed bank, while 32 species occurred only in the vegetation. The main component of the seed bank was *Calluna vulgaris*, constituting 48 %. *Erica tetralix* was the second largest contributor; constituting 34 %. The 10 most commonly occurring species of the seed bank constituted 98 % of the germinated seeds. *Calluna vulgaris* showed a higher germination rate in the two first years following fire. This might be caused by changed chemical properties of the soil following a heath fire; charcoal particles deposited on the surface might absorb germination inhibitors and allelophathic chemicals, and may contribute to explain why we see an increased germination rate in *Calluna* immediately following a fire. Thus, the size and the quality of the viable seed bank may both be determinants of successful heathland management and restoration on successional sites. These findings emphasize the need for continued management measures in order to maintain heathlands.

Conservation status of oligo-mesotrophic waters in Flanders

Steven De Saeger, Luc Denys, Hans Bosch and Desiré Paelinckx | Institute of Nature Conservation, Brussels, Belgium.

Each EU member state has to realise a program to monitor and report the conservation status of its Natura 2000 habitats. This conservation status is defined in terms of

- the evolution of the natural range,
- the spatial coverage of the habitat
- the condition of its specific structures and functions (including the conservation status of characteristic species).

The EU sets out the reporting format, the evaluation matrices and the definitions of the key terms, but individual countries or regions need to elaborate their own approach to data gathering and monitoring. Here we discuss the Flemish approach for the habitat types 3110 (Oligotrophic waters containing very few minerals of sandy plains, *Littotelletalia uniflorae*) and 3130 (Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*), typically occurring in the oligo- to mesotrophic waters of the semi-natural heathlands.

The primary information source documenting the natural range and area of the Natura 2000 habitats, is the Biological Valuation Map. This is a detailed map of land cover of Flanders at a scale of 1/10.000, based on repeated and detailed field surveys combined with aerial photograph data. From 2003 on, this survey is improved by direct mapping of habitats in the field. Data resulting from this mapping exercise are presented and problems related to the accurate definition of the range of oligo-mesotrophic waters, are discussed.

Specific habitat structures and functions are evaluated by means of tables of general criteria for conservation status (diversity, abundance of typical species, disturbances,...). Evaluation metrics included the account for specific requirements regarding sustained conservation, as well as the implementation of other monitoring programmes, particularly the EU Water Framework Directive. Finally, a comparison of the Flemish methodology with approaches proposed by neighbouring regions, is made.

Nutrient content and sheep digestibility variation of heather (*Calluna vulgaris*) of different ages

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In Lygra, Western Norway, heather (*Calluna vulgaris*) and grass samples were collected in March, June, August/September and October 2003 and 2004. Heather at these sites varied in age, burned 1993/94 and 2000. All above ground plant materials of grasses and last year shoots of heather were sampled and dried at 60 ∞C for 48 h. Dried plant samples were milled through a 1.0 mm screen for nutrients and in vitro digestibility analysis, or a 1.5 mm screen for in situ digestibility measurement. Crude protein content, NDF and minerals were analysed according to standard procedures. In vitro DM digestibility was determined by 48 h incubation with rumen fluid in an ANKOM fibre apparatus. Ruminal degradability of DM (CP and NDF) in the herbage samples was estimated in situ. The content of indigestible DM (and NDF) in herbage samples was estimated from 6 d (144 h) in situ incubation. Crude protein (Kjeldahl-nitrogen x 6,25) was determined by an auto-analyser after Kjeldahl-dissolution.
Each March for two years, sheep grazing in the area were weighed and blood sampled for serum analysis.

Table 1. In vitro dry matter digestibility (%), in situ (in sacco, 72 h) dry matter degradability (%)and crude protein of heather and grasses.

Sampling period	In vitro digestibility		In situ degradability		Crude protein	
	Grasses	Heather	Grasses	Heather	Grasses	Heather
March	31,3	37,5	35,8	41,9	12,1	8,4
June	61,5	47,2	63,4	54,7	16,1	8,2
August/September	59,2	42,7	64,9	46,8	14,9	7,0
October	50,7	44,1	55,1	51,2	12,4	6,8

Heather of different ages varied only slightly for in vitro DM digestibility (1-2.5 %-units) and in situ degradability (1-3.5 %-units), which was highest for the youngest heather stands. Plant samples revealed the highest digestibility and degradability values in summer (June) and lowest values in winter (March). Grass values were always higher than heather (4-20 %-units), except in winter. Differences in grass values varied significantly between the winter and summer samples (25-30 %-units). Heather differences, however, remained relatively constant (10 %-units) (Table 1). Heather contained a high proportion of estimated indigestible DM; 47 and 55 % for summer and winter samples, respectively. Crude protein content of heather varied only slightly between sampling times, and was almost half the CP content of grass (Table 1).
The winter period can be a hard time for the indigenous sheep grazing on coastal heather vegetation. Sheep lose weight during winter (6-13 %), yearlings exhibit the highest weight loss. Serum protein levels were also low in March. The low digestibility and low protein content of heather, the main fodder for sheep during winter, may explain these results.

Influence of grazing on C and N content of mountain heathlands in Spain

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Heathlands dominated by *Calluna vulgaris* have been maintained in W and NW Europe as a result of grazing by domestic animals and cutting for peat and fuel. Grazing can influence plant community structure, soil chemical and physical properties, and the distribution and cycling of nutrients within the plant-soil system. So, grazing partially controls the quantity and chemical composition of soil organic matter and the distribution of C and N in the ecosystem. In this paper, we examine the effects of grazing on C and N content of soil and vegetation.

Three study areas were selected in the province of León (NW Spain). The first one, called Vegarada, is used by domestic livestock, mainly sheep and horses. The second one, Riopinos II, is used by game species. And the third area, Riopinos I, is not used for grazing. Study areas are located in the Eurosiberian Region, and their climate is characterised by an average annual temperature of 5.5ºC and an average annual rainfall of 1319.5 mm. Soils in all mountains areas are podsols, with different underlying rocks. We selected random patches of a significant extent with both *Calluna* and *Erica* species for all study areas. Ten soil samples were collected at 10 cm depth in each area. Soil samples were air-dried, sieved and analysed for C and N. Ten shoots of *Calluna* and *Erica* were also taken from each area to analyse C and N content. The mean biomass (total dry weight per m2) of *Calluna* and *Erica* was measured in each area. We found differences in soil C and N content in the three study sites, but no differences were detected when the vegetation is compared.

nfluence of grazing on C and N content of mountain heathlands in Spain

CLIMAITE – CLIMAte change effects on biological processes In Terrestrial Ecosystems

Inger Kappel Schmidt[1] and Claus Beier[2]

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Human activity lead to increased atmospheric CO^2 concentrations that again will affect the global climate causing global warming and changes in precipitation patterns. CLIMAITE is a multidisciplinary national Danish research initiative studying the biological effects of such climatic changes in terrestrial ecosystems. The aim of CLIMAITE is to develop a conceptual understanding of how climatic and environmental changes in concert will affect biological processes in terrestrial ecosystems. This will improve our understanding of interactions between external stress factors and biological processes and provide a stronger scientific background for societal and political actions to counteract negative consequences of climatic changes. CLIMAITE will particularly focus on two issues related to biological processes and climate change, which are believed to play a key role for the biological effects of climate change:

Multiple environmental changes involving simultaneous changes in three factors: atmospheric CO^2 concentrations, temperature and water availability. Each of these factors directly affect biological processes and there is increasing evidence that the combined effects of these changes will be very complex and include strong interactions between factors, and that the combined effects will be difficult to predict from the effect of the individual factors.

Temporal variation patterns including extension of the growing season, increased frequency of freeze/thaw cycles, number of frost free days, and frequency of extreme weather events etc. are believed to play significant roles for the biological effects as compared to just average changes in the affecting factors.

CLIMAITE will advance time by 70 years and artificially create the climate anno 2075 in the field according to climate predictions for Denmark. The research is based on a large scale field experiment with climate manipulations alone and in combination:

CO_2 – a Free Air Carbon Enrichment (face) increases CO^2 concentration to 510 ppm

Temperature – night time warming with reflective curtains increases the air and soil temperature

Prolonged drought – precipitation will be removed for 4-8 weeks in early summer by automatic rain covers.

The experiment is situated in a grass rich heathland 50 km NW of Copenhagen. The effects of the treatments on individual species, ecosystem structure and ecosystem functioning will be investigated through targeted studies on the soil, plants, meso- and micro fauna and microorganisms. The studies will include changes in carbon and nutrient balances and circulation, stress tolerance and adaptation, species competition and composition and plant tissue chemistry and herbivory. The research will take advantage of novel research tools including field scale ecosystem manipulations, stable isotope techniques, controlled herbivory and DNA techniques.

CLIMAITE involves a consortium of 6 research groups from Risø National Laboratory, University of Copenhagen, Royal Veterinary and Agricultural University and the National Environmental Research Institute.

Impacts of climate change on vulnerable European shrubland ecosystems.

Inger Kappel Schmidt[1], Claus Beier[2] and VULCAN partners
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VULCAN -Vulnerability assessment of shrubland ecosystems in Europe under climatic changes - is a EU project investigating the effects of changes in climate on the functioning of shrublands in order to support political decisions as well as management practices to sustain the quality of this habitat type in Europe. VULCAN combines 2 different approaches to study these effects. The first approach is known as "space for time" substitution, where the long term effect of a pressure on the ecosystem, e.g. temperature, at any particular site is studied by moving to another site, which is already exposed to the change in focus. In Vulcan, this was done by carrying out the same studies in comparable ecosystems in UK, Denmark, the Netherlands, Hungary, Spain and Italy – 6 sites, which are naturally exposed to large differences in the climatic conditions we wanted to study. The other approach applied in VULCAN was "ecosystem manipulations", which means that the ecosystem is exposed to the changes in the field by realistic manipulations of climate (in VULCAN these were passive night-time warming and extended summer drought). In summary one could say that we superimposed manipulations with water and temperature on existing gradients with respect to the same factors. This combination of gradients and experimental manipulation of temperature and precipitation increases the potential for evaluating the generality of the observed responses to the changes in the climatic drivers.

The experimental manipulations applied in VULCAN were:

Experimental *warming* was done by covering the study plots by a curtain reflecting the infrared radiation during night thereby increasing the temperature by c. 1 degree.
Experimental *drought* was done by covering the study plots with a transparent polyethylene (PE) plastic curtain during rain events for 1-2 months to remove all incoming water
Untreated *control* plots placed next to the warming and drought treatments were used for reference.

The effects of the treatments on the plants, soils and fauna were studied throughout the project together with risk assessment of the vulnerable shrublands. We observed effects of both warming and drought on a number of key processes. The experimental warming increased aboveground biomass in the northwestern Calluna vulgaris heathlands in NL, UK and DK, whereas no increase was observed in the water stress southern sites. Warming also increased the growing season by ca. 14 days in all sites. Species showed different response, e.g. Empetrum nigrum in Wales was negatively affected by winter warming whereas C. vulgaris increased the cover. Species numbers and seedling recruitment decreased at the Spanish site after drought. Warming affected both C and N cycling in the soil. The results indicate carbon loss from soils in the northern sites after warming. Drought had a long-term negative effect on water storage capacity in the soils. At the Dutch heath, nitrate leaching was high due to high N-deposition. Warming doubled the leaching of N. A synergistic effect was found between climate manipulations and eutrophication and other disturbances. In general, these changes may decrease ecosystem stability. To counteract climate change, it is necessary to increase the robustness of these shrublands as we did not find responses/indicators, which are unique for climate change.

www.vulcanproject.com

Metapopulation dynamics of the parasitic *Cuscuta epithymum* in heathlands

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Cuscuta epithymum (L.) L. (common dodder or clover dodder) is an annual holoparasite on which few ecological research is available. In Flanders (Belgium), this species occurs in heathland vegetation and is classified as 'endangered' on the Red List of higher plants.

With an extensive research within four heathland nature reserves in the province of Limburg (Flanders) during summer 2004, we tried to get a better insight into the factors which determine the abundance and fitness of *C. epithymum*. We studied the vegetation composition and structure of management patches in a gradient from a very open to closed vegetation, all within the potential habitat for *C. epithymum*. If the parasite was present, fitness-related properties were measured.

The results indicate that besides the substantial differences between the four reserves, management has a significant impact on the distribution and fitness of the parasite. Low, relatively open vegetation mainly composed of young *Calluna vulgaris*, proved to be the optimal habitat for this species. The parasite was found to thrive only in places with low aboveground competition caused by regular disturbance. This suggests that *C. epithymum* is a pioneer species with low competitive abilities.

We further found that in heathlands, common dodder had a far broader range of hosts than commonly assumed. However, the parasite seems to prefer young dwarf-shrubs of *Calluna vulgaris*, *Erica tetralix* and *Genista pilosa*.

A seed bank experiment, although a pilot study, yielded a low seed density and further suggested a limited seed dispersal capacity. The seeds of common dodder have both physical and physiological dormancy, because either mechanical scarification or cold stratification is required for dormancy breaking. However, this topic demands further research.

The major aim of our future research is to quantify the impact of different ecological factors on colonization and extinction patterns and on the fitness and growth of the *Cuscuta* populations in heathlands. A better understanding of these phenomena will be obtained through seed experiments, the study of the spatial and temporal dynamics of *C. epithymum* populations and finally, by modifying a dynamic model that incorporates landscape dynamics using the population data to predict the fate of populations under different circumstances.

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Metapopulation dynamics of the *parasitic Cuscuta epithymum* in heathlands

Nutrient ecological and economic figures of thumb for heathland management in the Lüneburger Heide nature reserve, Northern Germany

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In the course of a research project, which lasted from 2001 to 2004, nutrient-ecological and economic figures of thumb for heathland management in the Lüneburger Heide nature reserve (Northern Germany) have been measured.

The background of these investigations was the question whether by the use of suitable management practices it is still possible today to preserve the remaining heaths – in accordance to their role during traditional heathland farming – as nutrient sources, or whether the heaths have experienced a functional change to nutrient sinks due to high atmospheric nutrient input, which is supposed to lead to large-scale vegetation change in the long run.

In order to make up the balance of nutrient dynamics, atmospheric input of the elements nitrogen, phosphorus, potassium, calcium and magnesium has been studied. For nitrogen, for example, there is an input of about 23 kg/ha*a.

Output of nutrients in the Lüneburger Heide nature reserve is achieved by management practices like prescribed burning, mowing, sheep grazing, "plaggen" and "schoppern". In order to calculate the nutrient amounts removed by these practices, nutrient stocks in biomass and topsoil were measured at first. After that, the amounts of removed biomass and topsoil were measured. Highest nutrient stocks were found in the topsoil. Furthermore, nutrient amounts removed by leaching were measured.

In order to describe the temporal effectiveness of nutrient removal by the different management practices, the concept of the "Theoretical Effective Period" was introduced. It is defined as the period of time, in which the input of nutrients by deposition is equivalent to the output by a single management treatment (constant deposition rates assumed).

In close cooperation with the privately owned Verein Naturschutzpark Association (VNP), which is responsible for heathland management in the Lüneburger Heide nature reserve, economic figures were investigated simultaneously, especially the costs of the different management practices per hectare heath treated. Figures of thumb for the total annual costs of heathland management result from the combination of the costs of the single management practices.

By combining the management practices' "Theoretical Effective Periods" and their costs, indicators for their cost-effectiveness can be calculated.

An investigation of the visitors' willingness to pay for heathland management gives rough figures for the total benefit resulting from heathland management.

Reference: Keienburg, T. & Prüter, J. (eds., 2004): Feuer und Beweidung als Intrumente zur Erhaltung magerer Offenlandschaften in Nordwestdeutschland – Ökologische und sozioökonomische Grundlagen des Heidemanagments auf Sand- und Hochmoorstandorten. – NNA-Berichte 17, 2, Schneverdingen, 221p.

Nutrient ecological and economic figures of thumb for heathland management in the Lüneburger Heide nature reserve, Northern Germany

Population development of heathland bird species in the Lüneburger Heide nature reserve, NW-Germany

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As in other parts of Atlantic Europe, the extension of Northwestern German heathlands has considerably decreased during the last two centuries. Nowadays the largest remaining heathland patches in Germany, originating directly from the coherent old cultural landscape, can be found in the Lüneburger Heide nature reserve (with a total area of 234 km^2, including about 3,000 ha of heathlands and another 3,000 ha of former military training areas). Large parts of this open or thin wooded landscape are owned and managed by Verein Naturschutzpark Association. Since about 20 years the whole variety of heathland management and restoration methods, including sheep grazing, mowing, "plaggen", shrub removal and burning has come into practice.

Based on the results of year by year investigations of breeding territories in the heathlands, the population development of typical heathland bird species is documented. Comparing the population development of a wide range of bird species in the Lüneburger Heide nature reserve, it is very likely that it is the current combination of habitat (heathland) management, support of small-scale landscape dynamics, visitor management and linking of habitats, which successfully contribute to keeping or even increasing current population numbers. Predator control traditionally has been and still is carried out very moderately. For each bird species, population development inside the nature reserve is at least as good as from the supra-regional point of view, in most cases population numbers in the nature reserve are stable, even while declining supra-regionally.

Small-scale structural diversity, high density of ecotones, old heaths and shrub phases, areas with open soil, forest-heath-gradients, semi-open wet areas, dynamics of succession and single elder or solitary trees, are considered as important habitat conditions for high bird species diversity.

After a severe loss of habitats in Northern Germany since the mid of the 20th century, the Black Grouse (*Tetrao tetrix*) population is currently restricted to heathland sites in the NE of Niedersachsen. The Lüneburger Heide nature reserve is the only place within Niedersachsen, where a Black Grouse population can be found outside military training areas. The local population is ± stable on a local level. There are good indications for the existence of a metapopulation-system of Black Grouse over the whole remaining area of distribution in Niedersachsen. Therefore, it can be looked upon as the only viable population of Black Grouse in the Mid-European lowlands.

Nightjars (*Caprimulgus europaeus*) give a good example of adapting to new habitat situations. Whilst being quite constant in their total numbers they have increasingly changed their preferred habitats from thinned coniferous forests, which have become denser with more deciduous trees, to the borders of former military training areas, which currently develop into heaths with single trees or very thin regenerating forests.

Excursions

© Yves Adams

Heathlands in Belgium, Flanders

Geert De Blust, Institute of Nature Conservation, Belgium

Regional differences.

As in other parts of Europe, the species composition of the heathlands of Belgium is highly determined by climate and soil conditions (nutrient level, humidity and acidity or buffer capacity). Superimposed are the impacts of former and current land use and management.

In the lowlands of the western part of Belgium (province of West-Vlaanderen), 20 – 30 km away from the sea, heathland vegetations are characterised by the presence of some species with a very distinct Atlantic or more southern distribution: *Erica cinerea, Carex binervis*. However, remnants of these heaths are very small and isolated. Real coastal heath is absent. In the lowlands of the north and on the low Kempen plateau (altitude < 100 m) in the north-eastern part of the country (the provinces of Antwerp and Limburg), 80 - 200 km away from the sea, these Atlantic species are absent (apart from *E. cinerea* occuring in an isolated area in the east, near the river Meuse), while species with a more continental or northern distribution such as *Vaccinium oxycoccus* and *Andromeda polifolia*, appear (although very rare, but this is caused by other factors but climate). Also *Vaccinium myrtilus* is typical for the lowland heaths of the centre and the east of the country. Plant species composition of dry and wet heath of this region is similar to that of the heaths of The Netherlands, north-west Germany and south Jutland.
Further east, in the regions of the Hautes Fagnes and the Plateau des Tailles, on the highest parts of the Ardennes Plateau (altitude > 550 m) (provinces of Liège and Luxembourg), the flora of the heath is characterised by the presence of species with a typical boreal or sub-montane distribution: *Empetrum nigrum, Vaccinium vitis-idaea, Vaccinium uliginosum, Trientalis europeae, Arnica montana*.

Climatic factors cause this differences. The mean annual temperature in the heathland regions of the west and north-east is 9,5 °C with, on average, 50 (W) to 80 (NE) days of frost. On the heights of the Ardennes Plateau mean annual temperature is 6,5 °C with 110 – 120 days of frost per year. Differences in annual precipitation are equally pronounced with 750-800 mm in the west and north-east and >1300 mm in the region of the Hautes Fagnes.

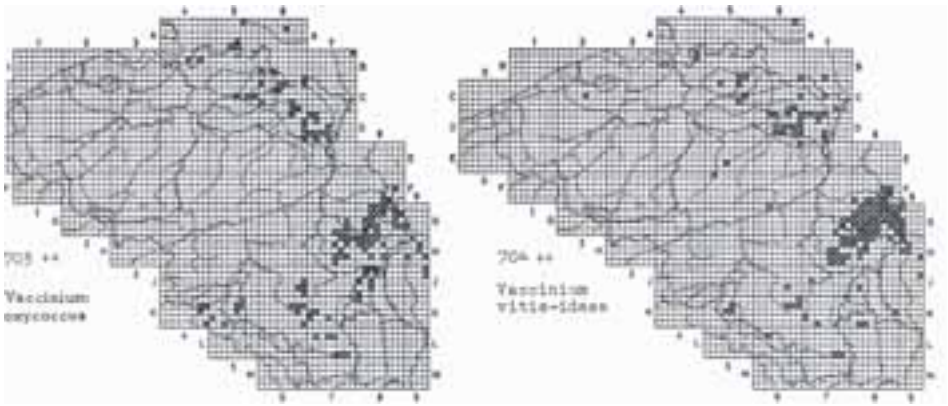
It is evident that different phytogeographic regions coincide with this climatic gradient. Thus, on a regional scale we distinguish between the Flanders district, the Campine district and the Ardennes district, the main areas for heath in Belgium. On a European level the western and north-eastern lowlands belong to the Atlantic province while the eastern plateaus are part of the Subatlantic province (Bohn et al., 2003) or the Continental region, sensu European Topic Centre on Nature Protection and Biodiversity (2001).

The soils in the heathland regions are poor in minerals, moderately buffered to highly acid. In the Campine district and the Flanders district, sand or loamy-sand soils on Pleistocene

Former heathland regions of Belgium

Phytogeographic regions of Belgium
(De Langhe *et al.*)

Phytogeographic position of Belgium on a European scale (European Environment Agency)



Distribution of Vaccinium Oxycoxxus and V. vitis-idea in Belgium (cells are 4x4 km)

cover sands, prevail. In general, species numbers are low. Dry heath vegetations occur on extensive Holocene inland dunes as well, representing the different succession stages of the xero-series. On the Kempen Plateau, the soils content gravel and are highly permeable. More to the south, heath can be found on sandy-loam and sometimes on acid clay. Here, vegetations are more divers with species such as *Hypericum humifusum, Polygala serpillifolia, Galium saxatile* and *Danthonia decumbens*. In the Brabant district, in the centre of Belgium, isolated spots of heath can be found on the tops and sides of eroded hills. Finally, in the Ardennes district heath soils consist of a mixture of Pleistocene sand or loam deposits and eroded bedrock material, mainly acid clay. Often, this texture has a very poor drainage capacity, resulting in the formation of thick peat layers on top of the soils.

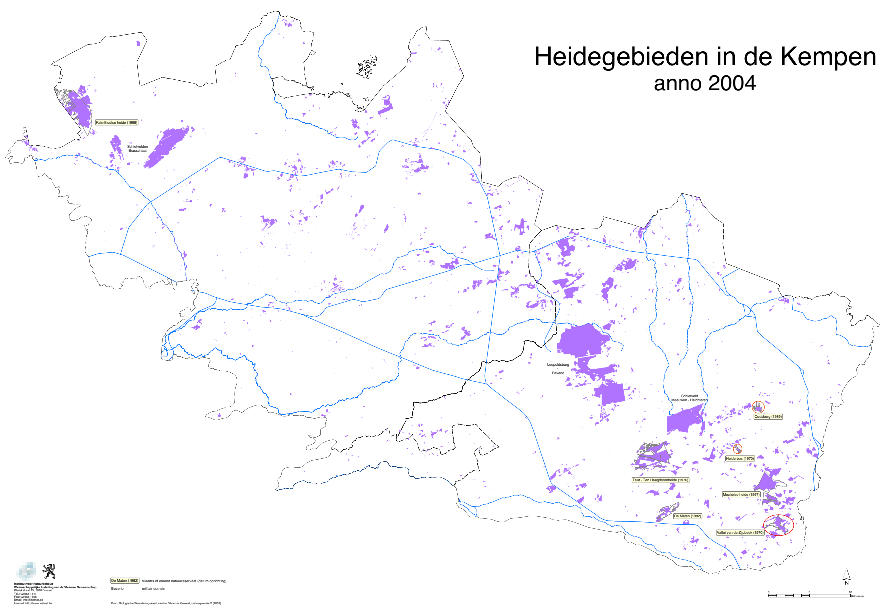
Actual area of heath.

Although the 'heathland regions' as such are quite extensive in Belgium, the actual area of heath is very limited. Indeed, only 5% of the heath that was still present in the first half of the 19th century (that as about 50 years after the period of maximal extent of heath), remains today. In many regions however, this is even less. And thus in the Flanders district and the Ardennes district, proper heath is now very rare. In the whole of Flanders, only 13000 ha remains. In this, Calluna heath dominates (see table 1).

Heathland ecosystems in Flanders (2000).

Semi raised bog	Wet heath	Dry heath	Shifting dunes	Heathland pools	Total
50 ha	3200 ha	8250 ha	700 ha	800 ha	13000 ha
	60% dominated by grasses	30% dominated by grasses			

Actual heath vegetations in the Campine region, small and scattered

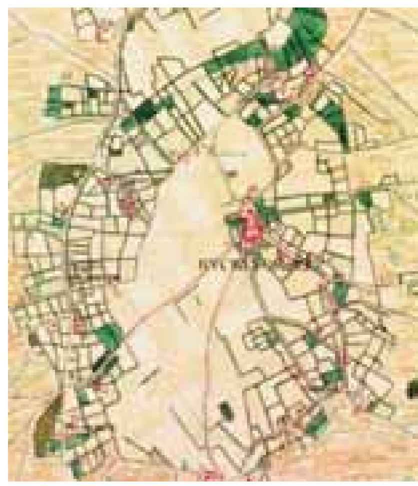


Former heathland use.

Apart from the dwarf shrub vegetations on raised bogs, heath in Belgium has an antropogenic origin. Established as a plagio-climax after clearing and burning of the forests, heathland was maintained by the farmers who managed the heath as grazing grounds, periodically turned it into arable land, and prevented any further succession towards woodland by extracting the natural resources of the heath up to the limit, leaving an extremely impoverished ecosystem.

Practices differed according the region. In the west, near Bruges, heathlands were institutionalised commons with strong and well established 'rights of use'. Fertility of arable land was maintained by sowing broom (*Sarothamnus scoparius*) and by regularly including a period of fallow that allows the grass and heath vegetation to re-establish for a while. This practice gave raise to the so-called post-podzolic soil (plaggeptic haplohumod), typical for this region and characterized by the Bh/fe horizon that is crumbled due to microbial activity. In the Campine region, heathlands were also commons. Here, fields were fertilized by using litter and manure from the sheep and cattle stable along with a variety of other organic waste. Cut heather and sods served as bedding in the stables ('plaggen-culture', 'plaggenwirtschaft'). After centuries of farming in this way, the soils of the old arable land thickened with organic material and the inevitable sand, however little it may have been, brought from the heath. The result is another typical antropogenic soil, the 'plaggen-soil' (plaggepts). Large flocks of sheep not only provided manure for the fields but also wool for the wool manufacture. Hence, the vast heath was indispensable for local economy.

As in Flanders and parts of the Campine region, the use of broom as an appropriate fertilizer and fodder and fuel provider, was widespread in the Ardennes. Here, however, fertilization of temporary fields was also realized by the practice of 'écobuage'. After mowing or cutting a heath, the useful fodder and bedding were collected, the parcel superficially drained and the litter and crumbled humus layer was left to dry. Once dry, the remains were put on heaps and covered with neatly arranged sods in the form of an igloo. Then the heaps were burned from inside out and finally, the ashes and clay -these sods contain a lot of clay- were spread over the parcel, yielding a new temporary field for rye and buckwheat. In the Ardennes, heathland also played an important role as grazing grounds for the large scale breeding of horses.



Landscape pattern at the end of the 18th century in the Campine regions (Map of Count De Ferraris, 1770-1777)

Ecobuage in the Ardennes (beginning of the 20th century)

The reclamation of heath.

Although the heath was completely embedded in local agriculture and economy, changing economic conditions, improved technology, population growth and interests of foreign rulers, gradually led to the total transformation of the heath landscapes. In many places, however, despite the complete change in land cover and land use, the actual landscape pattern still reminds of the traditional organization of heathland agriculture.

In the western part, in Flanders, reclamation started already from the 11th century on, with peak activities in the 13th - 14th century. In more fertile areas where individual private property was well established, exploitation was undertaken by the owners. In poorer regions, systematic and organized reclamation was initiated by abbeys, aristocracy and sovereign landlords. There, however, due to a declining economy, strong institutionalized commons and the resistance of local communities, a lot of the reclamation projects failed. And thus, a few heaths could remain until the 18th century.
In the Campine region much more of the heath remained till long after the Middle Ages because of the very unfertile soils, the minor economic importance of the region (farther away from the centres of growth) and, again, the vital role of the heath for agriculture and wool industry.

The final reclamation movement started in the 18th century. Successive rulers issued various decrees and legislation. The aims were

- → to stimulate exploitation (by exemption from taxation or lowering of taxation)
- → to protect forests and woodland
- → to stimulate improvement of agricultural techniques
- → to stimulate privatization of land

The ordinance of empress Maria Theresia (1772) was quite clear: private persons, municipalities, religious and secular institutions were obliged to sell heathland or to reclaim it themselves and the owner of heath had to clear 1/10 of the area yearly. As a stimulus, they received a 100% exempt from taxation for 30 years, followed by 50% for the next 30 years. However, despite of the advantages that appeal to a lot of rich city dwellers, the ordinance didn't yield a rapid and fundamental transformation of the countryside, except for some new afforestation projects. Disputes about properties and strong opposition by village-communities, hindered an overall successful implementation. And thus, at the end of the Austrian period, only 10 to 15% of the heath was reclaimed.
During the following French period, only minor initiatives regarding exploitation were undertaken. The transfer of the commons to the municipalities, was however an important change, as it facilitated the future developments.

Landscape pattern and land cover change. The hamlet of Bel, near Geel, Campine region, Belgium.

When Belgium became independent in 1830, the attempts to exploit the heathland were intensified. For the Campine region, which was far less developed than other regions of the country, major projects were organized by the central government. They included the improvement of the road system and the development of a network of canals and irrigation systems (Service de défrichement et d'irrigation de la Campine, 1845), both conditions needed for the further development of the area. Persons, buying parts of municipal commons, were responsible for the exploitation. This time, reclamation through local private initiative was successful, for a good deal because of the crisis in textile industry and the growing food need. And thus, between 1834 and 1866 the area of municipal common heath decreased with 66%. A new law in 1847 obliged the further privatisation of the commons. The municipalities were forced to sell and the owners had to develop their newly acquired properties. As a compensation, the houses built and the yields produced were free of tax. The area of agricultural land and pine plantations increased again. A 100 years later, the exploitation of heathland was finished. However, the appreciation of heath had changed by then, so that the few large areas that remained were protected as nature reserves, so far as they were not part of vast military training grounds.

Bohn U. and R. Neuhäusl. 2003. Map of the Natural Vegetation of Europe. Scale 1:2 500 000. BfN, Münster, Landwirtschaftsverlag.

The use of heath at the beginning of the 20th century

Reclamation of heath in the Limburg Campine region at the beginning of the 20th century

Gulke Putten nature reserve

(Wingene, B) Eckhart Kuijken, Christine Verscheure, Tom De Beelde and Herman Stieperaere | **9th European Heathland Workshop Excursion** | 14 September 2005.

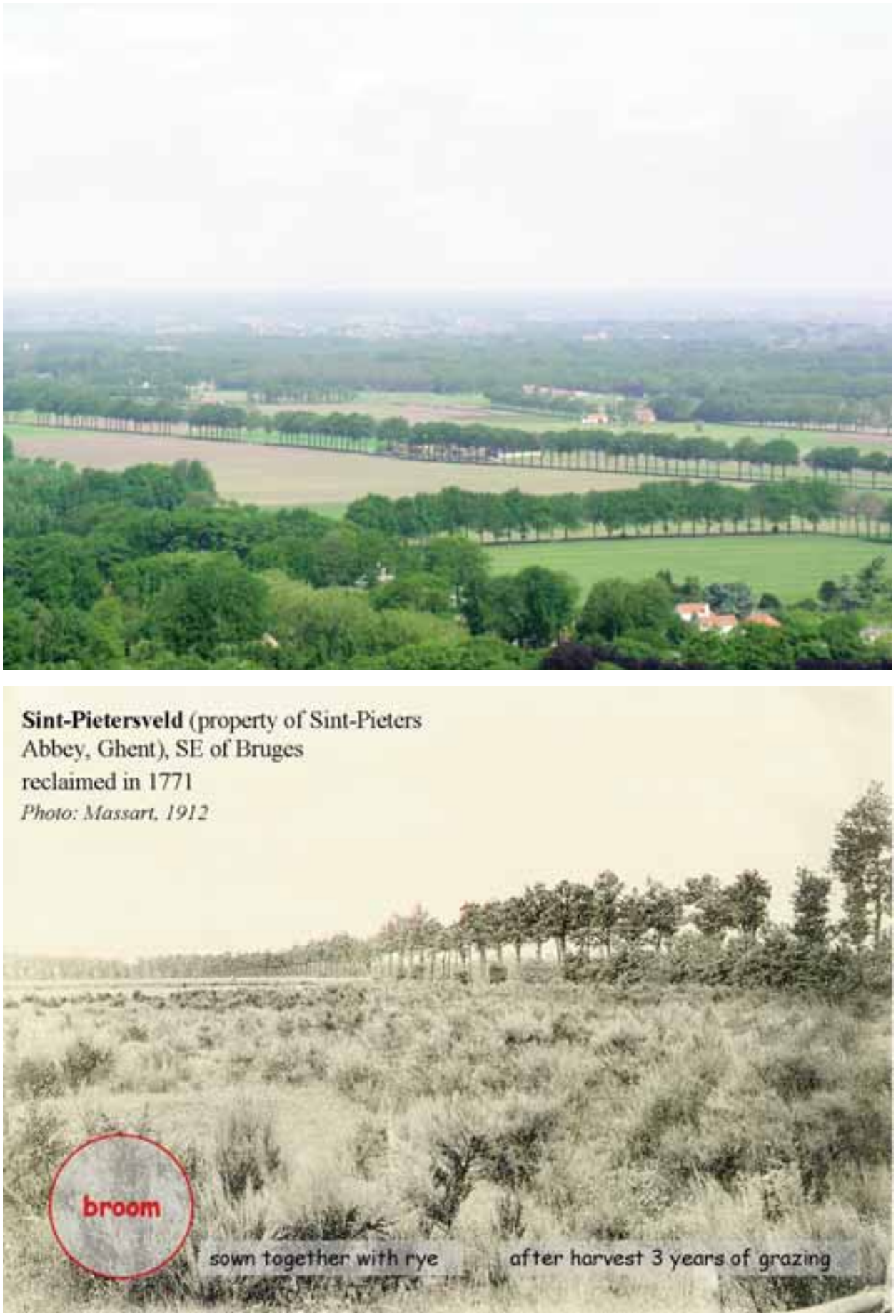
Until the 18th century the Bulskampveld was the largest uncultivated area ('wastine') south of Bruges in the western part of Flanders, covered by heathland-like vegetations and shrub (*Querco-Betuletum*) on poor sandy soils. Grazing, coppicing and removal of humus were the most important activities. In the wet depressions with seepage shallow fishponds were established. Gradually the edges of this area became afforested. The remaining central parts of the original heathland were reclaimed in the early 1800s for agricultural and forestry purposes following strict draught-bord patterns (locally 125x125 m units). Today the landscape still reflects this typical structure with impressive alleys and small square parcels. In a few sites with only extensive exploitation or military function some of the late medieval heathlands survived. In the surrounding landscape agriculture or forestation (mainly *Pinus*) became more intensive.

At the beginning of the 20th century a Radio Transmitting Station was established; after cutting most of the woody vegetation a 'modern' antennae park was erected. This enabled the revival and survival of the heathland habitats as the further management of this site consisted of intensive mowing to keep clear the antennae and feeder lines and prevent burning risks. These conditions and continued management during almost 80 years were clearly favourable for the conservation and development of rich heathland habitats and species.

From 1969 onwards the last uncultivated wet heathland parcel (1,5 ha) was discovered by Herman Stieperaere and became managed for conservation, followed by the most important parts of this sending station (coppice and heathland relicts) up to 16 ha. Due to the work of volunteers the area became well known as the Gulke Putten nature reserve. Nowadays 69 ha of the sending station are under conservation concession by the NGO 'Natuurpunt' from the Defense Ministry. In addition the association could purchase 30 ha of adjacent woodlands with relicts of heathland with support of a EU LIFE project.

From a phyto-geographical point of view, the reserve is quite unique. Its vegetations are known as intermediary variants of the North Atlantic heath of the Campine region, the Netherlands and North Germany on the one side and the Atlantic heath of South West England and Brittany on the other side. This heath is not only characterised by a high diversity but is also the place where strict Atlantic species can be found, such as *Carex binervis* and *Ulex europaeus* (and in the region of Bruges also *Erica cinerea*). Beside of dry and wet heathland habitat types of *Ericion tetralicis* and *Calluno-Ulicetea*, especially the species-rich acid grasslands cover a relatively important surface and represent one of the best-developed examples of *Nardetalia* in Flanders (thanks to the long lasting mowing regime).

Beside *Erica tetralix* and *Calluna vulgaris*, we find numerous interesting species in the Gulke Putten reserve, e.g. *Apium inundatum*, *Botrychium lunaria*, *Carex binervis*, *C. lasiocarpa*, *C. pallescens*, *C. panicea*, *Dactylorhiza maculata*, *Drosera intermedia*, *D.*



Land use changed, but the old landscape pattern, dating from the reclamation period, still structures the landscape.

Ferraris map 1770
central heath, fishponds and surrounding woodland

Orthofoto 1990
forests, draught-bord patterns (early 1800s), agriculture

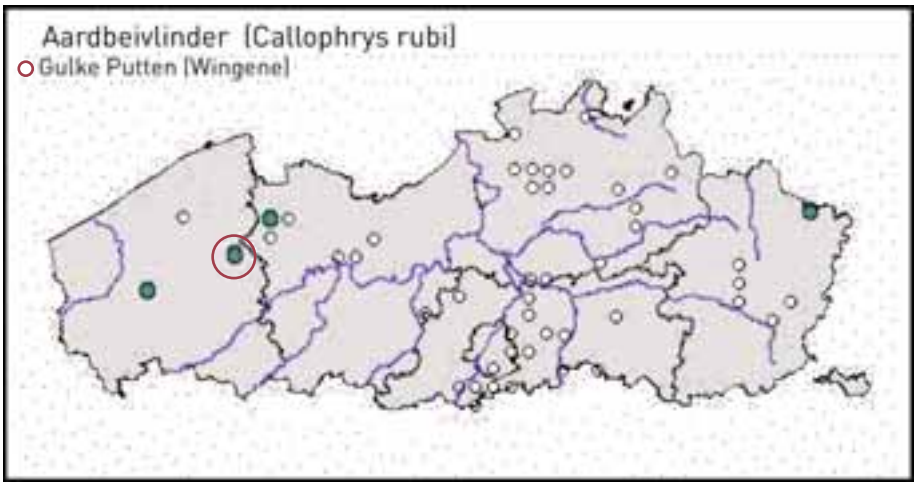
rotundifolia, *Eriophorum polystachion*, *Euphrasia stricta*, *Illecebrum verticillatum*, *Lycopodiella inundata, Myrica gale*, *Narthecium ossifragum*, *Pedicularis sylvatica*, *Platanthera bifolia*, *Polygala serpyllifolia*, *Viola canina*, *V. lactea*, and the bryophytes *Cephalozia connivens*, *Cladopodiella francisci*, *Kurzia pauciflora* and *Sphagnum papillosum*.
In Flanders, most of these are Red List-species. Also an exceptional high number of 12 *Hygrocybe* species and other rare fungi is to be mentioned. Finally some typical fauna elements occur, often in relict populations (*Pyrgus malvae*, *Callophrys rubi*, *Saturnia pavonia*, *Lacerta vivipara*, *Anguis fragilis*, *Anthus trivialis*, etc.). Some habitat structures are managed in favour of these species, thus maintaining this regional biodiversity hot spot.

This nature reserve is recognised as a 'special area of conservation' (Natura 2000 network) under the EU-Habitat Directive. It is part of the Flemish Ecological Network and is protected by physical planning instruments. Only the recent part owned by 'Natuurpunt' (33 ha of woodland) is recognised and subsidised as private nature reserve by the Flemish Government. The reserve and its surroundings have a protected landscape status, which also includes monuments and industrial archaeology.

The critical condition of the relicts of Atlantic heathland all over East and West Flanders was the main criterion for the European Commission to finance a project for restoration and expansion of these habitats. This project fitted in a LIFE Nature Programme started in 1999 and ended in 2003. Other comparable project areas next to Gulke Putten are Maldegemveld and the heath relicts that can be found at the aerodrome of Ursel. Important actions were e.g. the acquisition of land in view of "curing" the intermediary heath, the increase of better management of precious relicts, the re-development of heath habitats by selected methods of remodelling management and raising awareness of the public.

Species rich grassland
Species rich wet heath

After a couple of years of grazing by Galloways cattle, broom re-appeared in abandoned agricultural grassland. Species composition evolves towards the vegetation present at the beginning of the 20th century (compare with the photo of Massart, 1912 of the Sint-Pietersveld)



Callophrys rubi, distribution in Flanders

Nowadays, Gulke Putten has already increased up to almost 100 ha and management could be improved to an optimum by purchasing very specific working tools. The year round grazing project with 'Galloway' cattle was started (2001) in the new concession areas (40 ha) of mostly abandoned grasslands and shrub (*Querco-Betuletum* with *Salix* spp., *Amalanchier lamarckii*, etc.) and heathland patches, next to a *Molinia* dominated parcel with sheep grazing since 30 years.

The positive management and restoration results make the Gulke Putten reserve a very valuable reference for curing other Atlantic heath areas in East and West Flanders. Unfortunately, the environmental conditions of the area are less favourable, with high levels of atmospheric ammonium depositions and ground water influenced by nitrates from intensive agriculture in the vicinity. Monitoring and research is realised by scientists from mainly the University of Ghent, the Royal Botanical Garden of Meise and the Institute of Nature Conservation (Brussels). Guided visits are organised by the site managers, as the core area is not open for the public.

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Small scaled sod cutting and mowing yielded rare vegetations and turned the parcel in a patchwork of different succession stages

The Kalmthoutse Heide nature reserve (Kalmthout, B)

Geert De Blust, Institute of Nature Conservation | **9th European Heathland Workshop Excursion** | 15 September 2005.

Situation

The Kalmthoutse Heide (= the 'heath of the municipality of Kalmthout') is situated 25 km north of Antwerpen (Antwerp) (Flanders, Belgium), next to the Dutch border. The central part of the heathland, almost 1000ha, is one of the largest strict nature reserves in Flanders. It is the core of the 2000ha protected complex heath landscape of the Kalmthoutse Heide and the 3750 ha Dutch-Flemish cross-border nature park 'De Zoom – Kalmthoutse Heide'.

Towards proper protection

The Kalmthoutse Heide was established as a 'state' nature reserve (today 'reserve of the Flemish community') in 1968. However, efforts to preserve the heath date already from the beginning of the 20th century. In 1910 the first meeting to start a campaign in favour of the Kalmthoutse Heide was organized by a number of people in Antwerp, amongst whom a lot of artists. In the previous years they had discovered the beauty of the area, thanks to the railway, build in 1854, that passed along. In 1913, the first NGO devoted to the protection of nature, the Society for Natural and Urban Beauty, that originated from this campaign, together with the official Royal Commission for Monuments and Landscapes, pleaded for the foundation of a reserve. Decades of struggle and debate between those supporting the preservation of the heath and those advocating its economic development, followed. The law on the conservation of monuments and landscapes from 1931, that allowed the state to impose restrictions on proprietary rights, in order to conserve landscapes that are of exceptional aesthetic, historic or scientific importance, marked a new phase in the struggle for the Kalmthoutse Heide. The classification as a monumental landscape took place ten years later, in 1941. The municipality, however, was not pleased with this decision, observance was weak and attempts to change the regulation were handed in regularly. So, the proper protection combined with a targeted management of the heath, was only reached in 1968 when the state leased the greater part of the area from the municipality of Kalmthout and founded the nature reserve. Afterwards, the Kalmthoutse Heide was recognized as a wetland of international importance under the Ramsar convention, and designated as special Bird and Habitat Protection Sites under the European directives.

The physical environment

The deep substrate of the area consists of clay layers, deposited 1 to 2 million years ago (Lower-Pleistocene) in a large riverbed or along the shores of the then North Sea. From the Weichselian on (75 000 B.P.), these clay layers were covered with cover sands. Then, in the Tardiglacial period and the beginning of the Holocene (15 000 to 10 000 years ago), huge continental dune ridges were formed. They became vegetated and completely fixated till the

Neolithicum (4000 to 3000 years ago) when large scale aeolian dynamics started again and dunes rolled over the landscape. Early human settlement may have been at the root of this disturbances. The aeolian erosion and sedimentation are still going on, although, locally periods of dune fixation and soil formation (podzolisation) could succeed each other. As a result, the soil conditions and dune forms in the reserve are very complex today. Shifting dunes alternate with low lying depressions; a lot of sites have soils with thick and impermeable iron pans, while others nearby don't show any soil formation at all. Old dunes may even have different (paleo-)podzolic soils separated by sand layers, one on top of the other. And finally the presence, depth and thickness of the clay varies throughout the heathland. No wonder that the hydrology is equally complex and conditions differ from place to place. Because the reserve is in total an infiltration zone, situated on the watershed of the rivers Scheldt and Meuse, no rivulets or brooks flow through the area. The whole system depends on precipitation. Deep semi-confined groundwater aquifers used to prevent excessive percolation, and thus the average groundwater table in the depressions felt hardly below surface. However, groundwater extraction for drinking water supply and other purposes in the vicinity, diminished the hydraulic head of the aquifers and consequently, the phreatic water levels lowered considerably. The fight against desiccation is hence one of the major concerns of management today.

vegetation mosaic (photo Marc Slootmaekers)

the heath reserve of the Kalmthoutse Heide in the vicinity of the port of Antwerp (photo Marc Slootmaekers)

Man's impact on the landscape

The vegetation pattern of the Kalmthoutse Heide reflects the different site conditions. They themselves are the result of past and present geomorphological, hydrological and pedological processes. However, as the heath formation in this region is in the first place a man made vegetation, former use of the area contributed a lot to the present structure of the landscape. The major transformation of the region started in the 12th century when 11 000 ha, covered with heath and peat-bogs, became property of the Abbey of Tongerlo that began the exploitation. From the 14th until the 16th century, peat was extracted on a large scale. The peat served as fuel, exported to the cities of Bergen op Zoom and Roosendaal. The areas where peat was cut stretched out from the north of the reserve (De Nol) to far beyond the actual nature park. A dense network of canals and ditches not only served the transport of the peat to the cities and merchants, but also drained the area, a situation that facilitated its further development into grassland in the 18th century. Some of these small canals can still be found in the landscape and are, because of the special cultural historical value, even classified as a monument. The last large scale peat transport dates from 1733. On an individual base, local farmers continued occasionally peat exploitation in the remaining heath until the end of the 19th and beginning of the 20th century. However, the quality being rather poor by then, they had to be content with the peaty layer of wet heath soils or with dredging the peaty debris out of the heath pools. Most of the heathland pools in the Kalmthoutse Heide owe their shape and size to these activities, while a lot of the shallow and rectangular depressions in wet heath are remnants of former farmers labour.
But it was not only peat that was of value. Also sand could be sold. And thus, between 1860 and 1865 sand was dug on a large scale from the dune system of the Boterbergen and was used, among other materials, to fill the Spanish ramparts around Antwerp. About 30 years later at the turn of the century, the highest dune of the Kalmthoutse Heide, the Vossenberg (40 to 45 m high) was levelled completely for the construction of the elevated railway bank that connects the main railway stations east of the centre of Antwerp. These activities were profitable because sand could be easily transported by train. The same train, indeed, that also made influential citizens of Antwerp discover the idyllic landscapes of the Kalmthoutse Heide and who, at the end, succeeded in abolishing any further demolition of the heath.
Before these large scale exploitation, local inhabitants already used the white sand found in the A_2 horizon of the heathland soils. Sand was dug out and washed in the pools. The bright sand was then sold to embellish the earthen floors of the Campine farmhouses. The fabrication of heather brushes and the production of honey were other activities that add to the locals' incomes.
For agricultural use, the heath served as grazing ground for sheep and cattle until World War I. The last large herd of sheep with a shepherd ranged over the heath in 1912. In general, heather was mown and cut every 7 to 8 years. Controlled burning took place occasionally in late February.

remnants of small scale sand and peat exploitation (photo Marc Slootmaekers)

The dunes of Kalmthout

The Kalmthoutse Heide is well known for its extent dune complexes. In the northern and eastern fringe area, they form long and undulating chains; to the west and in the centre, dunes are arranged in broad parabolic patterns. They all enclose vast depressions with different heath pools. Vegetations with *Corynephorus canescens*, *Carex arenaria* and *Spergula morisonii* are well developed. *Ammophila arenaria* is very rare and declines yearly. Being a typical grass species of the active coastal dunes, it is not yet clear if the species is natural in this place or is a remnant of an earlier introduction in an attempt to reclaim the dunes. Cryptogams are abundant on stabilized dunes. Until recently, vegetations with *Cladonia* were well developed, especially on the small and sparsely vegetated dune heads in mature dry heath (see table 1). Other common cryptogams are *Cornicularia aculeate*, *Polytrichum piliferum*, *P. juniperinum* and *Campylopus introflexus.*

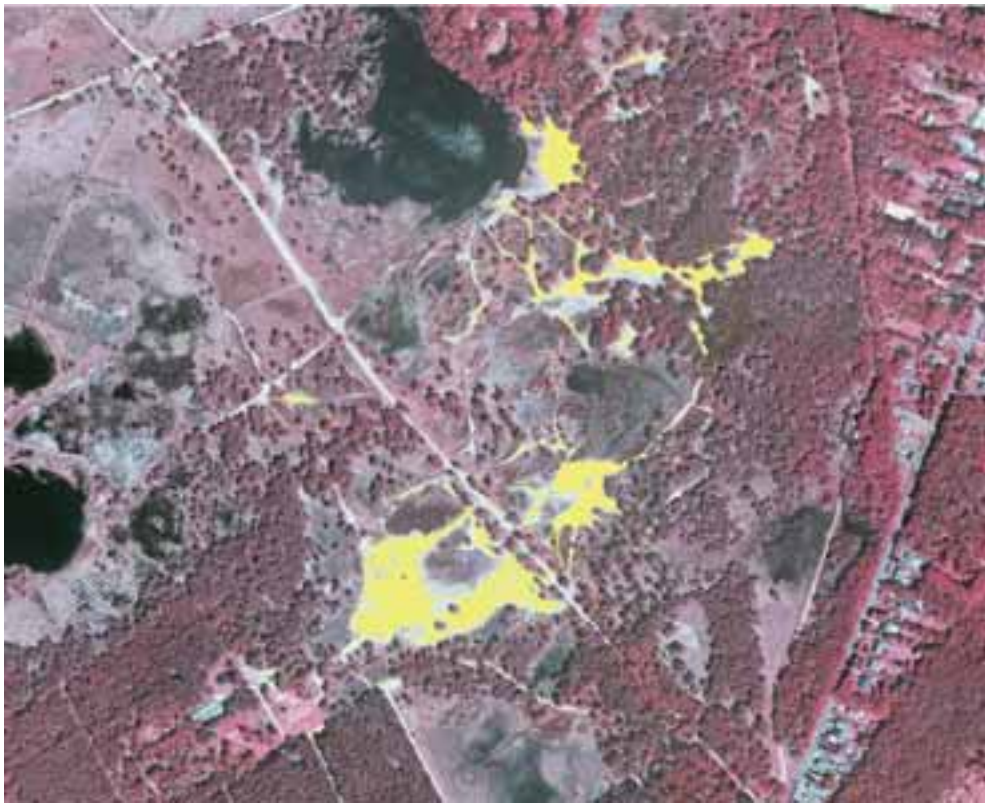
***Cladonia* species of the dunes of the Kalmthoutse Heide**

C. macilenta	*C. furcata*
C. portentosa	*C. glauca*
C. chlorophaea	*C. gracilis*
C. coccifera	*C. subulata*
C. fimbriata	*C. uncialis*
C. floerkeana	*C. ramulosa*

As suggested, dune vegetations are changing. Especially the area of bare shifting sand is decreasing dramatically. In a zone in the south of the reserve, intensively used by visitors, the area of uncovered sand diminished with 80% during the period 1978 – 2002. On the one hand, this is caused by the rapid spread of *Corynephorus canescens* and *Agrostis vinealis*, two grasses that form part of the early dune vegetations and by *A. tenuis*, a grass that is characteristic for more fertile sandy soils. On the other hand, *Campylopus introflexus* and the two *Polytrichum* species colonize vast dune areas. Besides, the first is not restricted to the proper dunes, but also takes all open places in dry and moist heath. Today, it is the most common moss species of the reserve. This makes this bryophyte, native in the southern hemisphere, one of the most successful invasive alien species in heathland today.
There is a lot of evidence that this sudden increase of the fixation of the dunes is caused by high levels of nitrogen precipitation. The result not only is that a particular habitat, where a lot of organisms depend on, disappears, but also that aeolian activity ceases and dune formation comes to an end. Moreover, dune formations tend to flatten out, because rainsplash soils erosion exceeds wind driven sedimentation of sand. The processes of colonisation and flattening of the dunes finally can strengthen each other. When the vegetation grows denser, the amount of wind blown sand decreases, while during heavy rain storms, erosion of the dune tops and sides still continues for a while. Then, newly established vegetations

Campylopus introflexus

uncovered sand in the southern part of the Kalmthoutse Heide, 1978



uncovered sand in the southern part of the Kalmthoutse Heide, 2002

on the dunes, not hindered any more by sedimentation, increasingly stabilize the shifting dunes, so that even less loose sand is available for the growth and formation of dunes. The managers of the reserve and of the cross-border nature park De Zoom – Kalmthoutse Heide, take measures to counteract this unwanted evolution. On the small scale (some 100's m^2) experiments have been started to remove the moss and grass carpet on dunes that were not vegetated 3 to 4 years ago. Doing so, at least temporary, an important habitat will be available again. It will be analysed if this small scale intervention can be the start of

colonization of shifting sands, Kambuusduinen, Kalmthout (foto: Karel Molenberghs)

small scale removal of mosses and grasses, Kambuusduinen, Kalmthout

local renewed wind dynamics. However, large scale deforestation on the weather-side (west) of the dune complexes, will yield more fundamental solutions. Because of the international cooperation in the frame of the cross-border nature park, this approach is now feasible and will be carried out in the near future.

The dry and wet heath

The dry *Calluna* heath is rather poor in plant species, but for invertebrates and birds, these heath is very important. The good habitat quality is maintained as much as possible by grazing. After decades without management, when the Kalmthoutse Heide was not yet preserved, grazing with sheep was introduced in 1972, shortly after the foundation of the nature reserve. In the starting phase, the sheep were Lüneburger Heidschnucken from the zoological garden of Antwerp. In 1976, a new shepherd came to graze the heath with his flock of 'Brabantse Voskop', a breed of Campine heathland sheep. They were interbred with other sheep to yield animals that were best adapted to the local conditions. The herd grew to a number of 500 to 600. After a couple of years of shepherding, grazing took place in large removable enclosures, divided over the reserve. Today, the greater part of the heathland is enclosed by a permanent fence that allows the animals to graze semi-wild.
In summer, the supply of fodder is abundant because of the density of *Molinia caerulea*. Feeding 500 sheep is no problem then. In winter, only *Calluna* is available and then 500 animals are far too much, especially because a large part of the terrain is very wet, and the animals concentrate on the dryer parts. Moreover, the nutritional value of a diet that consists only of *Calluna* is insufficient, so that supplementary fodder has to be provided. However, because it is the objective to impoverish the ecosystem, this is undesirable and thus the herds –except for some tens of animals- have to be kept outside the reserve during winter. In late spring, when grass and heath turn green again, the grazers can return to the area. Availability of sufficient winter pastures is thus a necessity. But the reserve is totally surrounded by forest, productive agricultural land or residential areas, and hence this condition poses one of the major obstacles for the optimal management of the heath. Therefore, establishing an actual version of the former infield –outfields functional relationship, is a most important challenge for the managers.
Since 1997, a small herd of Galloway cows was introduced in the reserve. With their different grazing behaviour the cattle added significantly to the variation in habitat pattern and vegetation structure. As for the sheep, they only graze the heath during the growing season.

sheep on the Kalmthoutse Heide

main landscape units of the reserve and the protected landscape

The *Erica tetralix* dominated heath in the reserve is of particular importance. Wet heath is not only threatened by eutrofication and acidification, but also by desiccation. Consequently, its maintenance is best ensured in the larger reserves with sites that are still uninfluenced by drainage activities from outside the protected area. The most interested vegetation of the wet heath of Kalmthout have a well developed bryophyte layer with different species of

Sphagnum and liverworts.
A special type of wet heath grows at the feet of steep shifting dunes, bordering old depressions. Being old, these depressions have a podzolic soil which continues under the dunes. Rainwater that percolates in the younger dunes, stagnates on that soil's iron pan, forming a seepage zone at the feet of the dunes. There the hydrological conditions are very stable through all years. Consequently, the vegetation shows some peat growth, a phenomenon that is very rare in this heathland region nowadays. It is also notable that tree growth is very moderate and that establishment of seedlings is almost lacking, despite the absence of any management and the presence of huge seed sources on the dunes.
Another peculiarity of the wet heath in Kalmthout are the vegetations dominated by *Rhynchospora* species. They are abundant on the paths in the wet heath and in open temporary inundated depressions with only slightly fluctuating water levels. After the big fires of 1996 and 1997, this vegetation colonized a great deal of the open space, left in the *Erica* heath.

The heathland pools

The heathland pools of the Kalmthoutse Heide are very acid (pH 3.6 – 4.5). Nevertheless, they are important for biodiversity, for instance for dragonflies of which 32 species (that is almost half of the dragonflies of Belgium) live in the reserve and for amphibians such as *Bufo calamita* and *Rana arvalis*. Heathland pools differ according their water regime that on its turn, highly depends on the characteristics of the substrate and the position in the landscape. Pools with a hard-pan and surrounded by dunes, hold their water constantly. If supplementary water is not available, than the pools show the characteristic water level fluctuations, in accordance with the precipitation / evapotranspiration ratio. Temporary desiccation occurs. Finally, on sites without an impermeable substrate or with a discontinuous clay-layer, the pools dry out very frequently, as they are permanently influenced by the groundwater extraction from outside the reserve. To prevent and counteract unwanted lowering of the groundwater levels in pools and wet heath, all the old drainage ditches are damed up or have an adjustable weir that enables the control of the water levels. More fundamentally however, cooperation between the relevant public departments is established in order to define and to take the appropriate measures that yield long-term solutions regarding groundwater extraction and drainage.
Only a few pools have been suffering from agricultural drainage water. In the past decades, the main source of eutrofication was, besides precipitation, the presence of large colonies of laughing gulls. They disappeared due to management efforts and the closing-down of a major food source, the uncovered rubbish-dumps in the wide neighbourhood. However, a new 'problem' seems to arise: the concentration of large flocks of Canada goose that choose some of the heathland pools to moult.

feathers of moulting geese concentrate in the Biezenkuilen, Kalmthout

Management of the reserve

Apart from grazing, especially mechanical sod-cutting of *Molinia* dominated sites, mowing and tree cutting, are the main management measures applied in the Kalmthoutse Heide. When the possibility occurs, agricultural land that borders on the reserve and is designated as nature area on the regional zoning plans, is purchased. It is the objective of the manager of the reserve to restore the species-rich acid grasslands (*Nardetalia*) and meadows for waders. One part of the area is therefore mown, from the other the top soil is removed.

sod cutting in *Molinia* dominated vegetation and re-establishing of heather

Information about the reserve and the cross-border nature park and on heathland in general, is available in the visitor centre, 'De Vroente'. A permanent and some thematic temporary exhibitions make visitors familiar with the history of the region and the characteristics of the heathland ecosystems. This centre is also active in developing and offering primary and secondary schools and interested groups, appropriate nature and environmental educational programmes.
Several signposted walking trails, a bicycle path and a bridle path give visitors the opportunity to explore the major part of the heath. To avoid disturbance, sensitive places and important nesting sites are excluded from this network.

Main entrance and visitor centre
Putsesteenweg 129,
2920 Kalmthout
++ 32 (0)3 620 18 30

trails in the cross-border park 'De Zoom – Kalmthoutse Heide'

staatsbosbeheer

The Strabrechtse Heide nature reserve (south of Eindhoven, NL)

Jap Smits and Geert De Blust **|9th European Heathland Workshop Excursion** | 15 September 2005.

Situation and significance

The Strabrechtse Heide is situated in the province of Brabant (The Netherlands), south of the city of Eindhoven, at 20 km of the Belgian border. The reserve is partly enclosed by woods, agricultural land and the rivulet 'Rul' or 'Kleine Dommel' and partly bordered by the highway Antwerp-Düsseldorf and a major provincial road.
The total area of the reserve is over 1500 ha. The Dutch National Forest Service (Staatsbosbeheer, SBB) is responsible for the management of 1230 ha, other parts are managed by the nature conservation foundation 'Brabants Landschap'. The municipality of Someren has a very high responsibility, being the owner and manager of the largest heathland pool in The Netherlands, the Beuven.
The Strabrechtse Heide is protected by the European Habitat directive and is proposed as a special protected area under the European Bird Directive. From a conservation perspective, the following species, permanently present or using the area during migration, are of major importance: *Anangallis tenella, Lobelia dortmanna, Maculinea alcon, Grus grus* (common crane), etc.

The substrate of the whole area is formed by old cover sand (Weichselian). They consists of very fine sand and loamy sand with discontinuous layers of loam. It is evident that the presence of loam determines to a high degree the hydrology and hence soil and vegetation development.

Threats

Besides problems of acidification and eutrofication, associated with atmospheric deposition, the main threat of the Strabrechtse Heide is desiccation. This is caused by the drainage of the agricultural land that makes no part of the reserve and by groundwater extraction for agricultural purposes (irrigation) and drinking water supply. In the protected area, water conservation is pursued by means of weirs and the filling of ditches. In the resent past, a serious problem was the organic pollution of the Beuven, caused by a brook, especially during high discharges. As a result, a thick mud layer was deposited and reed dominated the larger part of the once open heathland pool. Very rare species of the Littorellion the area was famous for, almost disappeared. To restore the original situation, the pool was cleaned by removing the mud and most of the reed (winter 1985/1986) and the rivulet was diverted to prevent further influx of polluted water during periods of high discharge. With an adjustable inlet, water from the brook can be supplied to the Beuven, in order to ensure that the buffer capacity of the water is maintained. Prevention of new eutrofication, associated with the inlet water, is attained through a nutrient sink basin. The target species (for instance Lobelia dortmanna) re-established quickly from the seed bank.

Thus the intervention seemed to have been successful. However, after a couple of years, it turned out that other parts of the reserve suffered from increased desiccation because the brook no longer flow through the area. Today, a new water management plan is elaborated, together with the stakeholders of the surrounding region.

General management

The Strabrechtse Heide is a relict –although very large– of the former 175.000 ha of heathland that covered vast areas in the province of Brabant in the 19th century. Today, only about 8.000 ha remains. The landscape of the reserve is very varied, with dry and wet heath, pools, blowing sands, pine and oak forests, alder woods and reed-lands, meadows, pastures and old arable land with wooded banks. In accordance with this historically developed landscape, the Strabrechtse Heide is managed as a half open heath with scattered bushes and pools. In the near future, more emphasis will be put on small scaled traditional farming of the former fields so that the functional interrelations that existed for centuries between outfields and infields, can be restored.

Mainly through grazing, the heath of the Strabrechtse Heide is kept free from excessive tree growth. The sheep used are 'Campine heathland sheep'. This breed that almost became extinct, was re-introduced in the early nineteen seventy's. Partly by shepherding, partly in closed fences, these sheep also control the spread of Molinia caerulea and Deschampsia flexuosa. In addition, cattle, Blonde 'd Aquitaine and Aberdeen Black, grazes in the reserve. The other traditional nature conservation measure mostly applied in the Strabrechtse Heide, is mechanical sod cutting. 5 to 8 cm of humus and root layer are removed in order get rid of dominating grasses. Very exceptional -and always subject to debate, parts of the heath are burned. This is done from January till March and only in the grazed areas. Blowing sand is kept open artificially by cutting trees.

Situated in a very densely populated region, the Strabrechtse Heide is a major site for nature and landscape oriented recreation. About 350.000 visitors come to the reserve each year. Targeted information on the Strabrechtse Heide is available at the main entrances. Six signposted walking trails, a bicycle path and a bridle path run through the area.

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The valley of the Zwarte beek and Beverlo Military Area (Koersel, Beringen, B)

Hans Jochems and Willy Vanlook | **9th European Heathland Workshop Excursion** | 17 September 2005.

Introduction

The valley of the Zwarte beek is situated in the North-Eastern part of Belgium, in the Flemish province of Limburg . The river starts its life in the Campine area and flows along about 30 kms before she joins the Demer River, which is a part of the hydrological basin of the Schelde. The upstream part of the valley is surrounded by the Beverlo Military Area, a vast training and shooting range of the Belgian Defence Forces.

The area is characterised by a sandy soil, which resulted in the creation of large heathland complexes with their characteristic shrub vegetation (*Calluna vulgaris, Erica tetralix, Erica cinerea, Myrica gale*). The valley has a peaty dark soil which resulted in the black colour of the river water when they cut peat. This is probably the origin of the name for the Zwarte beek (= black rivulet).

Characteristics

Because of its hydrological system, its natural character and strongly meandering structure, the Zwarte beek and the surrounding heaths had a high nature conservation value, not only at the regional Flemish level but certainly also on a north-western European level. Since the beginning of the twentieth century many heathlands have been transformed into grasslands and arable land. Heathland areas also decreased due to reclamation for agriculture and afforestation for mining industry, urbanisation, industrialisation and recreational areas.

Most lowland rivers in Belgium and adjacent countries have been severely "improved": they have been dug out, broadened and often rectified. As a result of these activities not only the ecological characterisation of the rivers has been totally changed, but more importantly the eco-hydroligical relations with the watershed have been destroyed.

Thanks to the estate as a military training camp there was no need to improve the rivers or to bring these heathlands under cultivation. This fact actually protected these landscapes in the past for an ever increasing degradation.

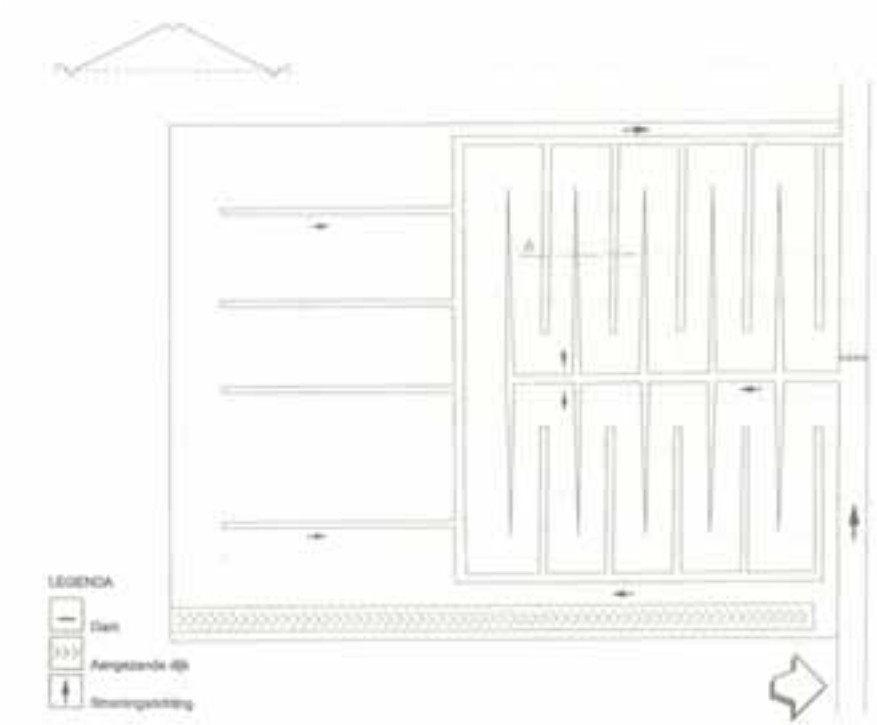
In the seventies several other human activities threatened this rich natural heritage. Some parts of the wetlands were drained, eutrofication from agricultural uses in nearby areas threatened oligotrophic heath habitats. Other activities such as the creation of blueberry fields, new housing-estates, intensive agricultural practices and illegal dumping took their toll too.
But there were other plans, which would lead to an impoverishment and loss of the valley's biodiversity. Large parts of the former grasslands and heathlands became meanwhile woods in a spontaneous way or were afforestated.

In this region the largest part of the heathlands are situated inside the military training grounds (Kamp Beverlo or Militair domein Leopoldsburg), which border the valley of the Zwarte beek. The primary function of the areas is military use and this has protected most of the natural values. The pressure from recreation in these military areas has increased significantly during the last decennia, calling for creative solutions between the different partners involved.

Irrigation systems

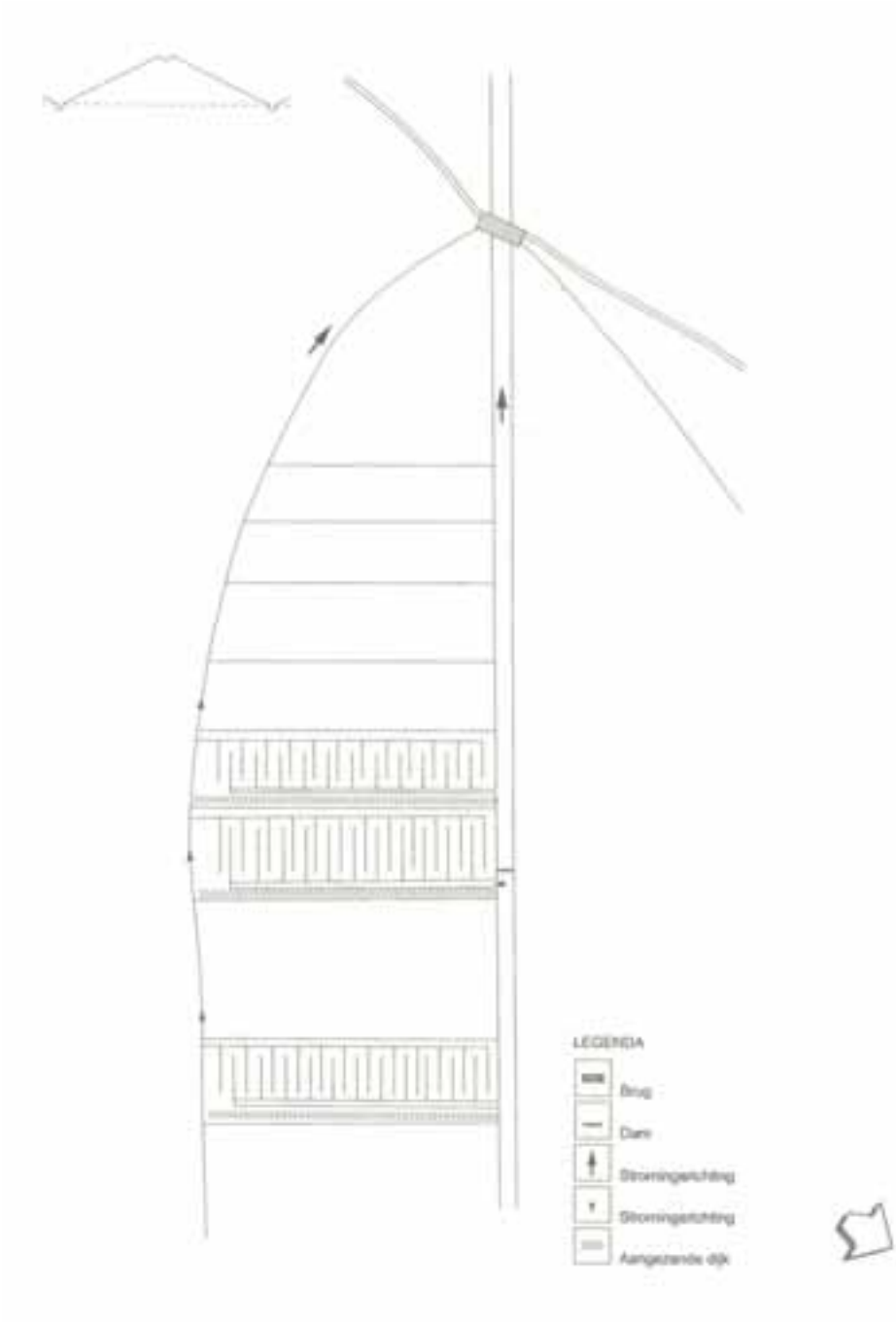
In the valley of the Zwarte beek, remnants of different irrigation systems can be found. The management of the reserve pays a lot of attention to the preservation of these evidences of former land use. Measures taken are founded on the detailed studies of Joël Burny who wrote a standard work on the historical ecology of the area. The following drawings are from that book:

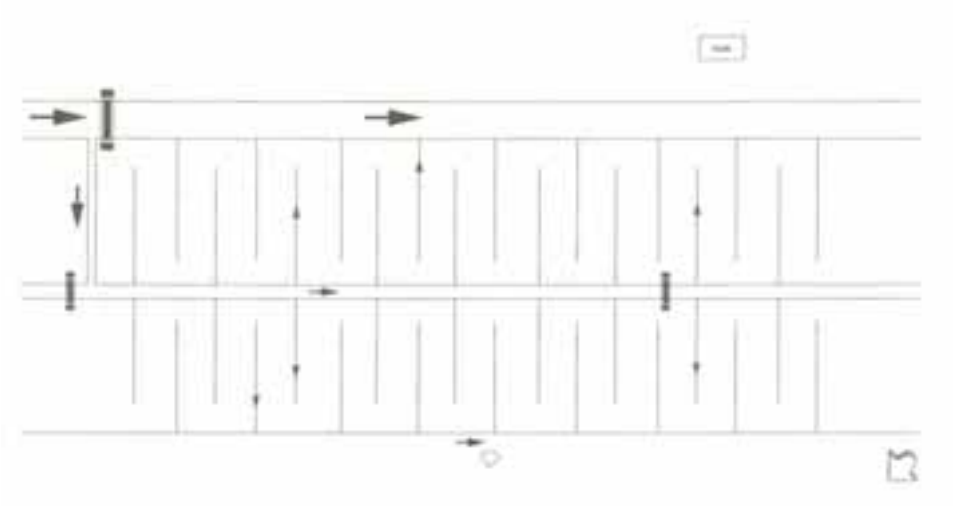
Burny J. 1999. Bijdrage tot de historische ecologie van de Limburgse Kempen (1910 – 1950). Tweehonderd gesprekken samengevat. Natuurhistorisch Genootschap in Limburg, reeks XLII aflevering 1. 211p.



The brook is temporary dammed up, water flows in the inlet ditch and the small side ditches. These become narrower to their end. Irrigating water flows over the meadow and is collected by the outlet ditches that brings the remaining water back to the Zwarte beek, downstream from the inlet point. On the higher side of the meadow, there is influx of seepage water that is also diverted to the brook

Other irrigation systems in the valley of the Zwarte beek have a separate big outlet ditch that collects the water of successive meadow-parcels





A third system (from the nearby Striemerbeek), with a central irrigation ditch that obtains water from the brook and distributes it into the small inlet ditches of the adjacent meadows. Small ditches in between the inlets drain the water to the major outlet ditch that runs parallel to the central irrigation ditch. Analysed at exactly the same place of the photo taken by Massart.

Photo of the irrigation system (Massart 1912)

The Provincial Open-Air Museum Bokrijk (Genk, B)

Geert De Blust, Institute of Nature Conservation, Brussels | **9th European Heathland Workshop Excursion** | 16 September 2005.

This text is based on the published museum guides

- → Mark Laenen. 1989. Provincial Open-Air Museum Bokrijk. Ludion, Brussels, 167p.
- → Laurens De Keyzer & Michiel Hendryckx. 2001. The Open-Air Museum Bokrijk. Ludion Guides, Ghent-Amsterdam, 128p.

The Open-air museum of Bokrijk, known for its magnificent collection of old Flemish houses and farms, was established in 1953. The first buildings were erected by C. Wellens (1888-1958), an artist who drew and painted many of the farms of the Campine region. The first curator of the museum was Jozef Weyns (1913-1974), who laid its scientific foundations and divided it into three sections, each of which represented a particular type of rural development, illustrated in the museum by its architecture and everyday objects. The "Poor Heathlands" has buildings from the Antwerp and Limburg Kempen, the "Fertile Uplands" buildings from the Maasland, Limburg Haspengouw and Brabant, while the "Fertile Lowlands" features buildings from East and West Flanders.

The layout of the museum follows the principle of reconstructing actual settlements, as in the open-air museums Den fynske Landsby at Odense (DK) and the Museumdorrf at Cloppenburg (D). Thus, in Bokrijk the 'museum-village' has been constructed in the Kempen / Haspengouw section. This does not represent a real village, but is simply a way of grouping and presenting the buildings around a village green. So, the village is arranged in accordance with one of the patterns that is typical of Campine villages, namely the triangle (see also illustration in article "Heathlands in Belgium, Flanders"). This green, known as the 'biest', 'opstal', 'dries' or 'heuvel', was communal. At the edge of the green was a pound providing drinking water for the animals and water to douse fires.

Compound farmstead from the Antwerp Kempen
Farmhouse-cowshed from Vorselaar
Antwerp, ca. 1600

Cave-hut from Koersel

The houses and other buildings of the Kempen peasants were generally constructed in wood, loam and clay, using techniques known as 'half-timbering' or 'timber-framing'. The 'kort-woningen' were the humblest dwellings, while the long farmhouse belong to the commonest types of farm building. In the long farmhouse, the living-rooms and work buildings were all situated under one roof, with the exception of the bake-house. The compound farmstead is a typical Kempen variant of the farm made up of separate buildings which occurs elsewhere in Flanders. It consists of a farmhouse with animal pens, a separate barn, a bake-house, a pigsty and in exceptional cases a stable. The farmhouse-cowshed building is the Kempen's version of the 'hall'type of farmhouses which occur in north Germany and certain parts of The Netherlands. The Kempen farms all have the same type of cowshed, a deep-litter house with a pit, in which the cattle were kept throughout the winter in order to collect manure.

Practical Information :

Domein Bokrijk Information center B-3600 Genk, Tel. 011/265.300
Fax 011/265.310 - E-mail: bokrijk@limburg.be

http://www.limburg.be/bokrijk/eng/

The Open Air Museum is open from March 29 till September 30, every day from 10 a.m. till 6 p.m. The rest of the provincial domain is open all through the year.

The Mechelse Heide (Maas-mechelen, B) and the Ziepbeek (Lanaken, B)

Geert De Blust | **9th European Heathland**

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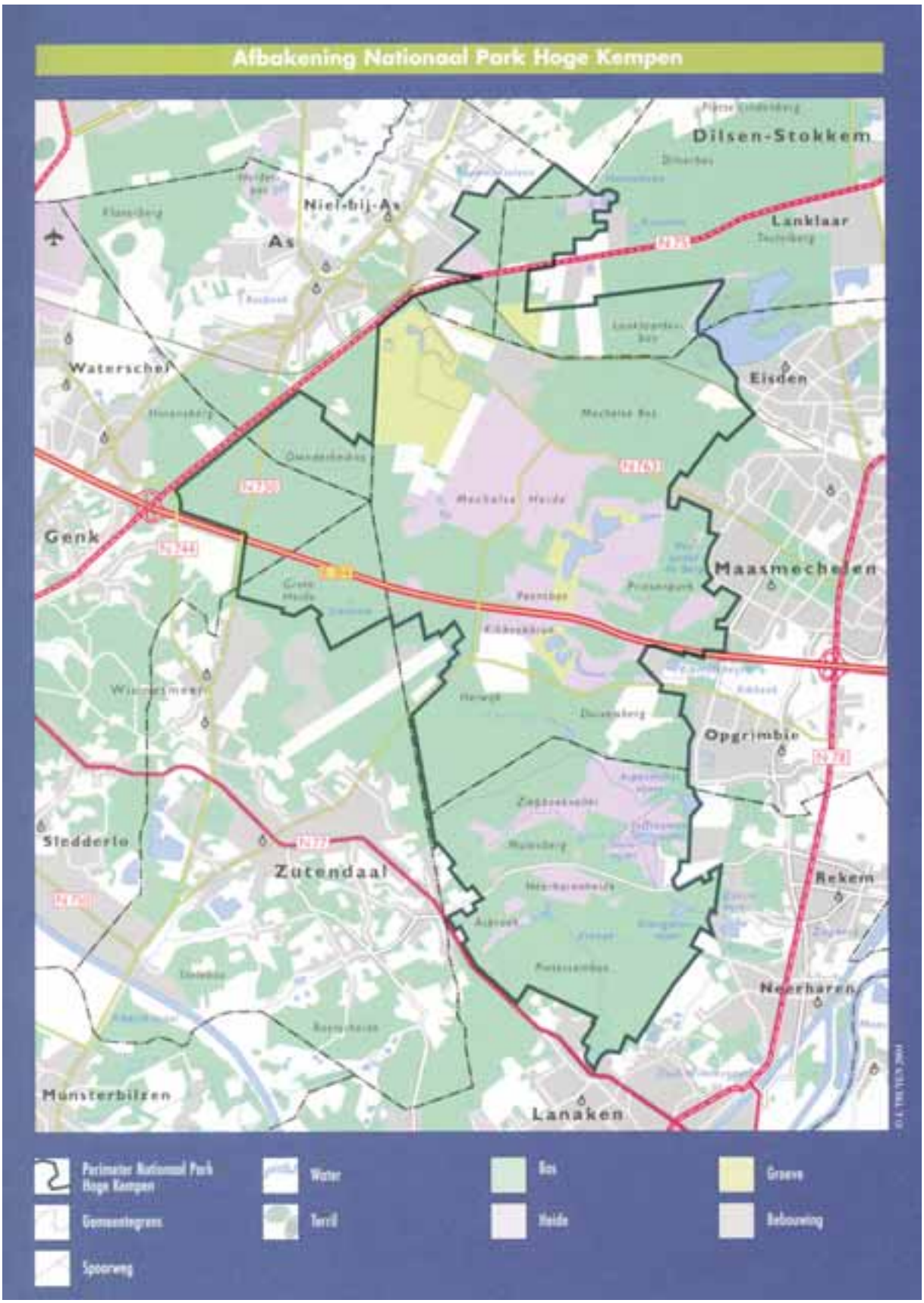
Situation and significance

The Mechelse Heide and the reserve of the Ziepbeek are located on the eastern side of the Kempen plateau, 5 to 10 km west of the alluvial plain of the river Meuse. Established as nature reserves in 1967 and 1970 respectively, these heathland reserves of about 700 and 170 ha in size, are among the largest in the region. Except for some hectares, the heaths are owned by the municipalities and rented by the Ministry of the Flemish Community in order to manage them properly. The nature reserves form part of an extensive complex of large forests and heathlands situated in the centre of the Kempen plateau. On the east side, this complex is bordered by the river Meuse, a unique gravel river with, during the last decade, a promising more natural development of river and floodplain habitats.
Since 1990, the whole area is organized as the 'Regional Landscape "Kempen and Maasland"', a co-operation of the Flemish government, local authorities and NGO's that pursue the implementation of an integrated nature conservation and nature-oriented recreation policy. Moreover, in 2000, the process to establish the first National Park "Hoge Kempen", started. In this park of almost 6000 ha, the focus will lay on nature conservation and development. An elaborated plan to manage the different habitats appropriately, to restore disturbed land and to develop corridors in order to diminish fragmentation, is executed. The whole is accompanied with an recreation plan, that will ensure sustainable integration of recreation and nature conservation.
The Mechelse Heide and the Ziepbeek are both protected according the EU Bird Directive and Habitat Directive. Special Protection Areas are 2344 ha and 2381 ha respectively.

Environment and management

The geophysical characteristics of the heathland of the Mechelse Heide and the Ziepbeek are completely determined by their situation on the eastern edge of the Kempen plateau. This plateau was formed by the sediments deposited by the river Meuse during the Elster glacial period (about 300.000 years ago). After the Elster glacial period, the river Meuse cut, during successive phases, in the deposits. Influenced by tectonic activity in the region and by river erosion, the talus of sediments gradually rose above the surrounding land, resulting in an inversion of the relief. On the eastern side, the topography is characterised by the presence of terraces and dry valleys. The exposition to the east together with the material of substrate and soil, mainly coarse gravel and fine sands, yield a rather warm micro-climate. On the plateau, wet heath and pools are only found in places with an impermeable substrate layer that hinders free percolation through the gravel. Thus the Mechelse Heide is dominated by dry heath. The presence of *Erica cinerea* is remarkable. Heath, dominated by large broom, *Sarothamnus scoparius* is another characteristic of the Mechelse Heide. The



The national Park "Hoge Kempen". Delimitation in the master plan.

The dry heath of the Mechelse Heide

Sand-pit 'Kikbeekbron' south of the Mechelse Heide. Exploitation and restoration.

Ziepbeek reserve, mainly situated at the lower end of the plateau, is a large valley system with a small rivulet, the 'Ziep', that takes its rise in the edge of the plateau. Along that brook and in a large zone with seepage water, a rich wet heath with a lot of threatened species developed. Locally peat growth can be observed. In the higher part of the valley, bog-myrtle, *Myrica gale*, dominates the vegetation. The question how to manage these vegetations in order to prevent them to be overgrown completely *Myrica*, occupies the managers for quite a long time.

In both the reserves, signs of current and former human use are obvious. In the Mechelse Heide it are the industrial sand exploitation activities that pose major problems. At a depth of 40 to 50 m very fine white sand can be found, the raw material for the fabrication of high quality glass used for e.g. optical lenses. As a consequence large sand-pits border the central part of the heath. Arrangements have been made with the exploitation companies to restore the pits so that they can be integrated in the original landscape. Thus, already during active exploitation, the steep sides are re-shaped, eventually heather is re-introduced and the vegetations are managed to prevent undesired spread of pines at the cost of the diverse heathland vegetation. For this purpose, Norwegian fjord horses perform very well. In the valley of the Ziepbeek, it are the former fishing ponds and meadow irrigation systems that are notable. The latter are analysed, as is also done in the valley of the Zwarte beek, to gain the insights, necessary to incorporate these cultural historical remains in the management plan of the reserve. However much this landscape and the brook look natural, it became clear from the historical ecology study of Joël Burny, that, especially the rivulet and the whole drainage system of the valley, were shaped and maintained by man for centuries. Today, control of water levels, sod cutting and partially mowing, are the main management measures taken in the reserve. Practices that don't differ so much from former use. Production of biomass or energy is no longer the objective, these same management techniques now serve to sustain a unique biodiversity.

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