Concluding remarks and future research needs in heathlands

Henk Siepel August 25, 2017

During this symposium we saw a nice overview of the new developments in heathland research in Europe. **Calvo et al**. started with a keynote on the importance of maintaining biodiversity in mountain heathlands in Spain. A biodiversity having its roots in the extraordinary location of these heathlands on the boundary of the Atlantic, the Euro Siberian and the Mediterranean biogeographical regions. Nevertheless, it is of utmost importance to keep a form of maintenance management sustaining biodiversity values as high as these used to be and in that balancing between the frequency of disturbances and the needed maintenance of the vegetation, where possible with traditional management tools, or as a future challenge to find new methods, that are economically sound. **Fagundez** nicely illustrated this biodiversity dominated by *Erica mackayana* and *Ulex gallii*. Plant diversity appeared to be highest in well managed grazed parts, preventing a few species to become very dominant and outcompete the rest, while abandoned sites had a significant lower diversity. A future challenge could be to investigate how animal diversity follows this rule. One can expect a similar pattern, but a slightly different situation as finding the highest diversity on relative recently abandoned sites (2-5 years) is defendable as well. **Schellenberg** studied the demography of the dominant plant species in the lowland heathlands and found management to be the controlling factor in heather and heathland vitality, where she focussed on reproductive capacity of heather in various life-stages. How can we keep this dominant plant species in its vital phase and support plant and animal biodiversity in these areas as well? Maintenance of heather in these heathlands as the structural component underpins the biodiversity value as pointed out by **Dictus** in Belgium giving the picture of the complete heathland landscape with ponds and woodlots, providing the requirements of larger animal species as birds and amphibians. What should ideally be the ratio of these extra components to the vast heathland area to support sustainable population of these species and are there enough possibilities for exchange with other remote populations? **Nienartowicz et al.** pled for management aiming to reset the afforestation of heathlands as this process is a threat for the pioneer communities of *Arctosaphylo-Callunetum* succeeded by the *Pohlio-Callunetum*. Due to decreased frequency of disturbance one might try to find a new kind of resetting management. Maybe in line with the ecological-socio-economic system, one may give permission to locals to cut trees for firewood on the heathlands. Afforestation of heathlands either naturally or intentional is one of the main drivers in heathland decline. The rationale of it is however discussed by **Velle et al.** in their poster, they plea to include also hidden costs in the total balance of afforestation and not blind star on the presumed extra carbon stock to combat climate change, but take into account various ecosystem services, for instance the view of the open landscape as a cultural service, just as **Walmsley et al**. advocate in their poster.

Our heathlands are under continuous pressure as again illustrated by **Nielsen et al.** that showed incredible low pH values of heathland soil down to 2.6 in the top organic soil layer. Depending on the buffering capacity of the soil below, this acidification may become a threat to ecosystem functioning as Al can become soluble and might be toxic to plants or animals feeding on these plants. The cause of this acceleration of acidification is of human origin: the increased and still high N deposition, which not only decreases pH but also disturbs stiochiometry in the plants, giving rise to outbreaks of *Lochmaea suturalis* as shown by **Diaz et al.**. Killing off vast areas of heather has severe consequences for the pollinators in these areas, as these partly rely on the nectar production of *Erica* and especially *Calluna*. Stands of mature heather were most vulnerable, stressing again the finding of **Schellenberg**

to keep a balanced demography of heather in the entire area. N deposition effects have been studied extensively in lowland heathlands, where at the moment the highest deposition levels occur, but also mountain heathlands have a rather low critical load or no-observed-effect-level of around 14.6 kg $N.ha^{-1}.a^{-1}$ as show **Marcos et al.** in their poster. Phosphate may have an overlooked importance in the interpretation of the findings. **Fagundez & Muñoz-Barcia** reported in their poster, using aerial photographs of the past decades, a dramatic change of heathlands towards forests, partly intentional by plantations, partly by lack of traditional management. **Lovegrove et al.** in their posters repeated a formerly made detailed map and concluded that rare species and biotopes have become even more rare, probably due to cessation of traditional management or N-deposition, the latter in a SWOT-analysis, found to be the most complex for managers to deal with.

Compared to former periods, the heathlands nowadays form only a small fraction of the landscape. These changes in the landscape over time give nice information on our own history and the history of land use during the past millennia. **Bastiaens & Meylemans** unrevealed part of the history of our heathlands using a new technique with LIDAR, high resolution aerial views, with which all kinds of structures can be discovered, being usually too large or too complex to recognise in the field. **Vandvik** in her keynote, continued on this historical matters proposing that the continuous management of man in heathlands by burning and grazing not only kept this type of landscape for millennia, but also was a driving role in the evolution of species therein, for instance the smoke-responsive seed germination of *Calluna* and other heathland species might be enforced with this type of management. One reason extra to keep the traditional management tools of grazing and alternate burning in mind! However, more research is needed on the animal response to grazing densities as stressed by **WallisDeVries**, he saw different responses to grazing depending on densities and successional stages. We learned from **Hopf et al.** that grazing in itself cannot prevent heathland to become overgrown by trees, so additional measures to keep the heathland open are advocated , especially in a forested environment. The advice to graze heathlands is already practised by **Holmelund**: she comes up with nice examples of restored heathland having a diversity of plant species advocated earlier this symposium by **Fagundez et al.** and **Nienartowiecz et al.**. Sheep (or goat) grazing after burning gives the expected results within a couple of years. The question however remains here what should be the surface area managed at a time and the frequency in management, with respect to both the occurrence of animal diversity (remind the sustainable animal population in the contribution of **Dictus**), as well as maintaining a balanced demography of *Calluna* as shown by **Spellenberg**. Having solved this question, we may follow the advice of **Woestenburg** and restore the traditional heathland farm system under modern conditions and combining nature protection with (a modest) food production, but probably high quality food, that when wisely labelled and branded may provide enough income to cover all costs. When heathlands are used as kind of agro-production system, application of agri-environment schemes may help to keep management economically sound these days. **Alonso & Hewins** reported on the effects of one of these agri-environment schemes: the Higher Level Stewardship and concluded that most heathland stand did a bit better with grazing, but that not all targets could be met.

In his keynote **Härdtle** gave an overview of the various restoration techniques used in heathland landscapes, from restoring traditional management to higher impact measures as topsoil removal and sod transplantation. The challenge is to restore heathland to some historical reference, as we heard from **Bastiaens & Meylemans** and **Vandvik** to keep biodiversity sustainable. A matter, which has become complicated by climate change, ongoing cultivation and increased N deposition. Effects of climate change can be observed first at the limits of the geographical range of heather; in Norway **Velle et al**. reported on the die-back of *Calluna* due to severe winter droughts at low temperatures, a situation to be

expected more frequent in future. In the Netherlands we see an almost complete weathering of soil minerals due to increased acidification by N deposition. **Vogels et al**. report on the first experiments to restore the basic soil system by adding rock dust in such an amount that the original concentration of cations can be met again. Restoration of heathlands has become more and more complicated due to the extra threats of N deposition and climate change. **Wiersinga** reported on a special program in the Netherlands (OBN program or translated Improvement of Quality of Nature) for research on ecological restoration; a program that can be easily copied to other countries or regions. In the Netherlands provinces nowadays are responsible for the execution of this restoration to meet the standards of Natura 2000 as we heard from **Van der Veen** in the province of Gelderland and **Dekker** in the province of Drenthe and during the excursions we have seen some of the results in the experimental sites. It is already quite an effort to keep the traditional heathlands in a good shape (see the sites at De Hoge Veluwe), it takes even more to redevelop agricultural land back to the heathlands it was a century ago (as we saw in Stroohuizen on Wednesday and Noorderveld on Thursday). The entire topsoil is very nutrient rich and the only but costly remedy is to remove this topsoil and reset the succession of drift sand to heathland. **Van Diggelen et al**, in his keynote lecture, paid attention to the differences in soil biota between these different nutritional states and how these affect the whole system. **Weijters et al.** gave examples on vegetation development after topsoil removal on a 160 ha large former agricultural enclave in a heathland area, which area we visited yesterday and we all could see some of the improvements. **Loeb et al.** reported on the experiments with translocation of hay or sods to help colonization of this vast area, both in plant species as well as some soil biota, known to be slow colonizers. After five years a significant development in the direction of a *Violion* community was visible compared to the control sites. **Vermeulen et al**. reported on the development of Carabid beetles in the same experimental set-up, where they found a negative effect of acidification and a positive effect of liming. Note that liming here is on former agricultural soil that has absolutely no phosphate limitation (top soil removal took place to get rid of the excess). This kind of large scale restoration gives good results over time, also in Flanders as we learned from **Naedts** in the Visbeek area, where various plant species recolonized the area and even more expanded their populations. Restoration of heathlands sites however is just the start of maintaining a biodiverse landscape. Monitoring is often forgotten, but give good results to improve restoration methodology and showing to the public what has been achieved with the tax money: **Panter et al**. gave a nice example of an audit approach in Eastern England. And when tax money is not available one may negotiate with many other parties and try to find some money for restoration in return to sand and gravel extraction as **Taylor** showed.

So, we have learned a lot this symposium, but we learned as well that much more research is needed: determined critical loads for heathlands are based on vegetation changes, what about changes in stoichiometry of plant species that affect herbivores? And what about the long-term effect of this critical load: leaching of cations and exhaustion of weathering minerals? And if so, how do we restore these long-term effects? How can we mitigate the expected effects of climate change, the expected increased frequency of extreme events as drought periods, either in summer or winter. And we now know step by step more about management of heathlands, where burning and grazing as traditional measures serve well, but densities of sheep or goats need to be determined keeping in mind the production level of the vegetation, the period of the season, the size of the area, whether it should be in fences or with shepherd. That means that we should have a more structural way of doing research on effects of grazing keeping in mind and reporting on all these variables!

Soil type and conditions, as well as current climate formed our heathlands, with an important role of mankind, let us take our responsibilities also in future.