October 2016

Content

Dear members of the Eurasian Dry Grassland Group,

We are pleased to present the new issue of the EDGG Bulletin, which comprises a report of the 13th Eurasian Grassland Conference. The Executive Committee is deeply grateful to the local organizers for the well-organized event and a lot of pleasant moments. The issue also includes reports from IAVS grantees, as well as the first call for the 14th Eurasian Grassland Conference, to be held in Riga (Latvia) and Klaipeda (Lithuania). This volume also includes a paper on the standardised EDGG sampling methodology, with its rationale and detailed illustrated description. The paper also provides the current versions of the guidelines, field forms and data entry spreadsheets as open-access Online Resources. Finally, the Forum section is devoted to the presentation of the paper of Burrascano et al. 2016, entitled Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity, which highlights the important conflicts between grassland biodiversity conservation and European policies to mitigate climate change by increasing carbon sequestration, which often lead to afforestation and consequently loss of grassland biodiversity.

We would like to take the opportunity again to emphasize that the Bulletin welcomes submissions of scientific articles (in the form of Research papers, Forum papers, Reviews or Reports). While we do not provide peer-review, we offer linguistic editing after acceptance, and your paper will achieve high visibility if published in the Bulletin because it is open access and sent to more than 1000 grassland specialists throughout the world. You can find the author guidelines on the EDGG homepage. Since July 2016, the Bulletin also has a profile in ResearchGate to which you can contribute by uploading your Bulletin articles (https://www.researchgate.net/journal/1868-2456_Bulletin_of_the_Eurasian_Dry_Grassland_Group).

We would also like to remind you that our Bulletin is an excellent way to inform the group members about your recent grassland-related publications and forthcoming events relevant for EDGG members. We hope that reading the Bulletin will inspire you to new ideas and discoveries that, in turn, will find their place on the pages of future volumes.

Anna Kuzemko, Idoia Biurrun & the Editorial Board

At the top:
Trifolium arvense **at the steppe slope in National Nature Park "Karmeliukove Podillya" (Central Ukraine)** ***(Photo: Anna Kuzemko)***

The basic aims of the EDGG are:

- to compile and to distribute information on research and conservation in natural and semi-natural grasslands beyond national borders;
- to stimulate active cooperation among grassland scientists (exchanging data, common data standards, joint projects).

To achieve its aims, EDGG provides seven instruments for the information exchange among grassland researchers and conservationists:

- **the Bulletin of the EDGG** (published quarterly);
- **the EDGG homepage** (www.edgg.org);
- e-mails via our **mailing list** on urgent issues;
- **the Eurasian Grassland Conference** - organized annually at different locations throughout the Palaearctic Realm;
- **EDGG research expeditions and field workshops** to sample baseline data of underrepresented regions of Palaearctic Realm;
- **EDGG vegetation databases;**
- **Special Features** on grassland-related topics in various peer-reviewed journals.

Eurasian Dry Grassland Group (EDGG)

The **Eurasian Dry Grassland Group (EDGG)** is a network of researchers and conservationists interested in Palaearctic natural and semi-natural grasslands. It is an official subgroup of IAVS (http://www.iavs.org) but one can join our group without being IAVS member. We live from the activities of our members. Everybody can join EDGG without any fee or other obligation.

The EDGG covers all aspects related to dry grasslands, in particular: plants - animals - fungi - microbia - soils - taxonomy - phylogeography - ecophysiology - population biology - species' interactions - vegetation ecology - syntaxonomy - landscape ecology - biodiversity - land use history - agriculture - nature conservation - restoration - environmental legislation - environmental education.

To become a member of the Eurasian Dry Grassland Group or its subordinate units, please, send an e-mail to Idoia Biurrun, including your name and complete address, and specify any of the groups you wish to join. More detailed information can be found at:

http://www.edgg.org/about_us.htm

As of 31 October 2016 the EDGG had 1170 members from 66 countries all over the world. While we are well-represented in most European countries, few European countries are still not or hardly covered by members. Moreover, the extra-European part of the Palaearctic realm (which according to our Bylaws is the geographic scope of EDGG!) is still grossly underrepresented.

EDGG Subgroups

The members are automatically included in the regional subgroup of the region in which they reside. If you additionally wish to join the Topical Subgroup Grassland Conservation and Restoration just send an e-mail to the Membership Administrator (idoia.biurrun@ehu.es or Stephen.Venn@Helsinki.Fi).

Arbeitsgruppe Trockenrasen (Germany) (contact: Thomas Becker - beckerth@uni-trier.de), Ute Jandt - jandt@botanik.uni-halle.de: 246 members

Working Group on Dry Grasslands in the Nordic and Baltic Region (contact: Jürgen Dengler - juergen.dengler@uni-bayreuth.de): 94 members

South-East European Dry Grasslands (SEEDGG) (contact: Iva Apostolova - iva@bio.bas.bg): 287 members

Mediterranean Dry Grasslands (Med-DG) (contact: Michael Vrahnakis - mvrahnak@teilar.gr): 315 members

Topical Subgroup Grassland Conservation and Restoration (contact: Péter Török - molinia@gmail.com): 70 members

EDGG Executive Committee and responsibilities of its members

Didem Ambarlı: Editor-in-Chief of homepage, Deputy Conferences Coordinator, didem.ambarli@gmail.com

Idoia Biurrun: Membership Administrator, Deputy Editor-in-Chief of Bulletin, Deputy Field Workshop Coordinator, Deputy IAVS Representative, Deputy Editor-in-Chief of homepage, idoia.biurrun@ehu.es

Jürgen Dengler: Coordinator for Special Features; Field Workshop Coordinator, juergen.dengler@uni-bayreuth.de

Monika Janišová: Deputy Editor-in-Chief of the EDGG Bulletin; monika.janisova@gmail.com

Anna Kuzemko: Editor-in-Chief of Bulletin, Book Review Editor, Facebook Group Administrator, anya_meadow@i.ua

Péter Török: IAVS Representative, Contact Officer to other organisations, Deputy Coordinator of Species Features, Deputy Secretary-General, Deputy Book Review Editor, molinia@gmail.com

Stephen Venn: Secretary-General, Deputy Membership Administrator, Deputy Policy Officer, Deputy Facebook Group Administrator, Stephen.Venn@Helsinki.Fi

Michael Vrahnakis: Conferences Coordinator, Policy Officer, Deputy Contact Officer to other organizations, mvrahnak@teilar.gr

Report

Post-conference report for the 13th Eurasian Grassland Conference 2016 in Sighisoara, Romania

Between the 20th and 24th of September 2016, 85 participants from 25 countries met in Sighisoara in Southern Transylvania for the 13th annual conference of the Eurasian Dry Grassland Group (see Fig 1. for a breakdown of the countries).

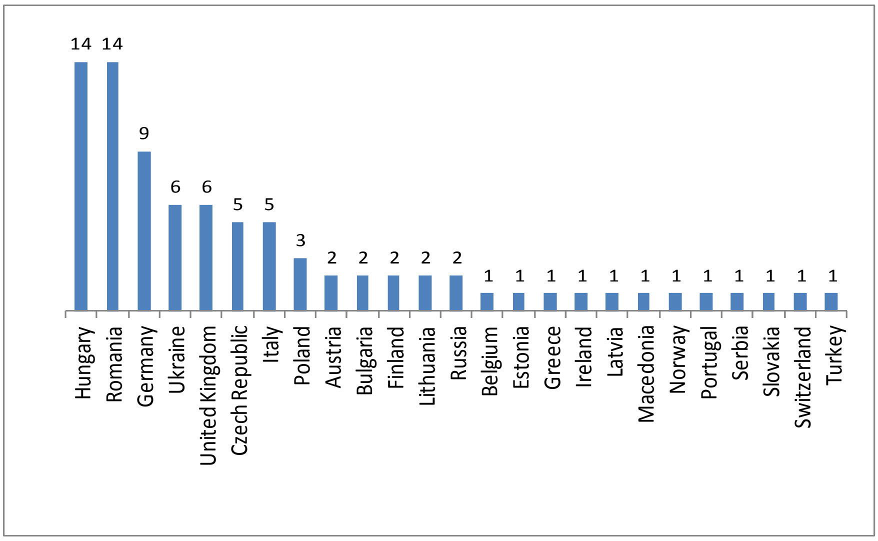


Figure 1. ***Breakdown of the 25 countries of the 85 participants***

In contrast to the previous 12 "EDGM, European Dry Grassland Meetings", this year it was decided to change the name to "Eurasian Grassland Conference" to reflect the changing scope of these events. Nevertheless, the conference in Sighisoara continued many of the traditions of previous events, and below we provide some pictures and numbers as a reminder to those who joined, and to give an impression to readers who were not there!

The focus of this year's conference was Management and Conservation of Semi-Natural Grasslands: from Theory to Practice. Following the theme "from theory to practice", the pre-conference workshops focused on:

- Scientific Writing, led by Péter Török (University of Debrecen);
- Establishing and Maintaining National Grassland Databases, led by Kiril Vassilev (Bulgarian Academy of Sciences);
- Reflecting Ecology in Policy, led by Jabier Ruiz, Caitriona Maher (European Forum on Nature Conservation and Pastoralism) & Clunie Keenleyside (Institute for European Environmental Policy)

The main conference took place in the newly renovated hall of the Municipality of Sighisoara, which was kindly lent to us free of charge. The Mayor Ovidiu Mălăncrăvean welcomed all the participants at the opening of the conference. The excellent food and a lot of additional assistance was provided by Mihai Serengeu of the central Park Hotel. Our special thanks to these two.

The first keynote was given by Professor Joern Fischer of Leuphana University of Lüneburg in Germany, summarising the results of his 5-year transdisciplinary project in Southern Transylvania, the region where the EGC took place.

His research team integrated social and ecological research methods to address the issue of sustainable land use in the region. Based on their findings they produced future scenarios for the social and ecological landscape to stimulate de-

Figure 2: ***Joern Fischer giving the first keynote talk of the conference (photo: L. Gherghiceanu).***

Figure 3. ***One of the scenarios ("Balance brings Beauty") created and visualized by Joern Fischer (picture by Jan Hanspach, Leuphana University of Lüneburg)***

bate about what conservationists and other actors could do to promote sustainable development, not only in the study region but perhaps also in other similar landscapes (Fig 3.).

Figure 4. ***Dr. Cristina Craioveanu talking about the evolution of semi-natural grasslands in her keynote (photo: L. Sutcliffe).***

The second keynote talk was given by Dr. Cristina Craioveanu together with Professor László Rákosy of the Babes-Bolyai University in Cluj-Napoca, Romania. It focused on the evolution of grasslands in Transylvania and their present day value and conservation, and how research can contribute to this.

In total, there were 26 talks clustered around the topics of grassland policy and socio-economics, management and restoration, ecology and biodiversity, and historical evolution. 32 posters were presented on a wide range of grassland-relevant topics, as well as one poster on arable weeds in low-intensity cultivation systems. We would like to congratulate again the winners of the Young Investigator Prizes for outstanding talks or posters by researchers under the age of 35: Csaba Tölgyesi, Orsolya Valkó, Tsvetelina Terziyska, Szilvia Raócz, Ágnes Balázsi and Eugen Görzen (Fig. 5). Prizes for the winners were kindly donated by John Wiley & Sons, Inc. and Pelagic Publishing.

Figure 5. ***The awards ceremony for the Young Investigator Prizes (from top to bottom and left to right: Csaba Tölgyesi, Ágnes Balázsi, Eugen Görzen, Tsvetelina Terziyska, Szilvia Raócz and Orsolya Valkó (photos: A. Kuzemko, J. Dengler, P. Török).***

Figure 6. ***The clock tower just above the conference location in Sighisoara. The medieval citadel is one of the few in Europe still inhabited today (photo: D. Ambarli).***

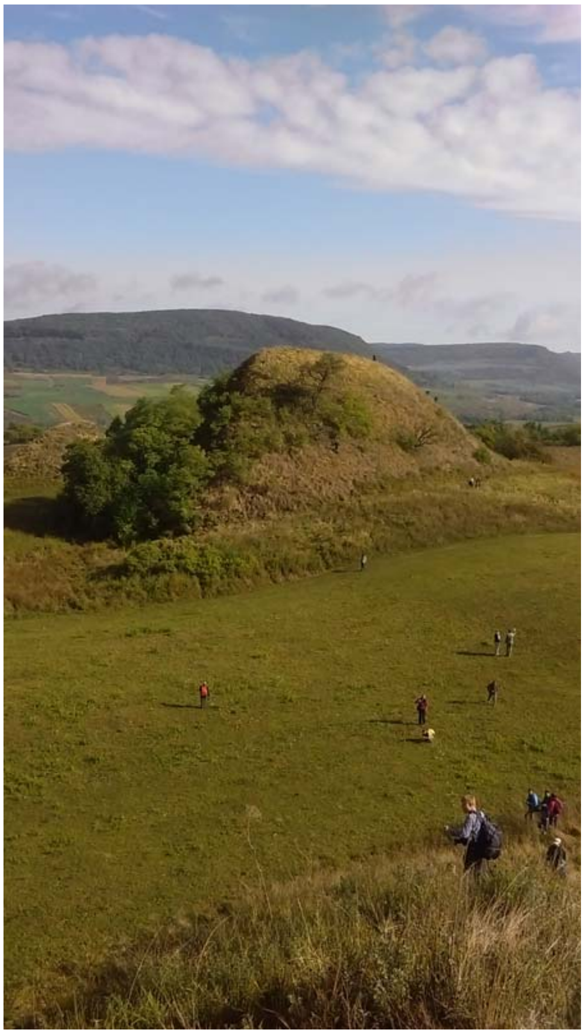


Figure 7. ***Slumping hills in Apold, which support a high diversity of plant species ranging from dry grassland species such as Stipa spp. to more mesic species (photo: M. Vrahnakis).***

Figure 8 and 9. ***Grassland party with local dancers in the barn in Viscri (photos: J. Dengler, L. Gherghiceanu).***

Post-conference excursion (Photos: L. Gherghiceanu, J. Dengler)

After the first day of talks, we took a tour in the beautiful citadel of Sighisoara (Fig. 6) and learnt that there are much more interesting historical facts about the town than the myth of Dracula. The town was first settled by the German-speaking Transylvanian Saxons in the 12th century, and survived many attacks and bombardments to become a thriving centre of trade and craft.

The mid-conference excursion took the participants to two sites with slumping hills (*movile*) that are characteristic for Transylvania (Fig. 7). The group visited the office of the NGO Fundatia ADEPT, the main local organizer. ADEPT has been working for over 10 years in the region to promote biodiversity conservation through small-scale, low-intensity farming.

A walk through the grasslands of Viscri was followed by the grassland party, with excellent food, local dancers and musicians (Fig. 8 and 9).

The post-conference excursion was attended by about 40 participants, guided by the local ecologist László Demeter. It gave them the opportunity to explore the mountain hay meadows of the Csik mountains/Gyimes region of Transylvania, as well as try their hand at practical landscape conservation (scything)!

The conference brochure and the book of abstracts are available to download from the conference homepage at http://egc2016.namupro.de/.

The conference organizers would like to thank all the participants of the 2016 EGC in Sighisoara for their interesting talks and posters and many stimulating conversations, and we hope you will visit this beautiful region again!

Useful links:
Website of the EGC 2016 in Sighisoara: http://egc2016.namupro.de
Publications on the natural heritage of the area by Fundatia ADEPT: www.fundatia-adept.org/?content=publications
Pogany-havás association: http://poganyhavas.hu/main.php
General information about the region of Târnava Mare in Southern Transylvania: http://www.discovertarnavamare.org
European Forum on Nature Conservation and Pastoralism: http://www.efncp.org
Institute for European Environmental Policy: http://www.ieep.eu
The blog of Joern Fischer and his team: https://ideas4sustainability.wordpress.com

Laura Sutcliffe
John Akeroyd
Liliana Gherghiceanu
Owen Mountford
Nat Page
Eszter Ruprecht
(Local Organising committee)

Didem Ambarli
Mike Vrahnakis
(EDGG Executive Committee)



Cirsium tuberosum, Dipsacus fullonum, Colchicum autumnale—some species from the Transylvanian grasslands visited during the mid-conference excursion (photos: J. Dengler)

Report From IAVS Grantees

Anikó Csecserits, Hungary

First of all I would like to say a great thanks for the IAVS and EDGG supporting my participation on the 13th EGC in Sighişoara, Romania. It was a great experience for me!

I have taken part in several conferences (formerly meetings) organized by the EDGG and these were all very interesting and friendly, thus I was waiting for a similar experience. And I was not disappointed: in contrast, the hospitality and kindness of the conference organizers was excellent, the presentations were very good and the social events were perfect.

It was very interesting for me to hear about the situations of grassland conservation in different countries, I liked especial the presentations about the Romanian and Turkish grasslands. It was really good to hear about the effects of the recent social changes in Transylvania, which in turn caused changes in land-use and the main grazing animals, and therefore the vegetation of grasslands.

There were many presentations describing grassland vegetation dynamics and the reasons behind it. I liked very much the presentations about the effect of shrub encroachment, about the seed dispersal potential of geese or effects of burning on different animal and plant groups. Another group of presentations described the present vegetation of grassland, searching for the reason for the present state of grasslands and searching for good indicators. These all are also important questions for practical nature conservation. I think, it could be formulated more simply: we should know - as exactly as it possible - what should we conserve? Should we conserve the present land-use, the present species composition, the present structure of vegetation or something else? In which situations can the natural dynamics be left undisturbed and in which not? And what can we do with the present global effects: climate change, invasive species and pollution? I think it is always important to speak about these questions in order to formulate more precise research aims and thus probably we get better answers.

And last but not least I would like to write a little about my impression about the town of Sighişoara. In Hungary if somebody hear the name of this city, the first thing is what come in her/his mind is, that this is the place, where one of our most important (if not the most important) poet, Sándor Petőfi died in a battle during the war of independence in 1849. And his favourite landscape (and birth place) was the Hungarian Lowland, a huge grassland at that time! In one of his famous poems he wrote about the huge herds of cattle and horses grazing on this grassland. If possible, I would like to cite a detail from it, because it describes the vegetation of this area so well: a mosaic of grassland, shrubs and trees. (sorry, the English translation is not the best)

„Near the inn is the dwarfed poplar wood,
Yellow is the sand with melons rich;
There where the screaming hawk her nest doth build,
Where, undisturbed by children, she may rest.
There grows the sad, sad "orphan's hair" and blossoms
Blue, of buckthorn, 'bout whose cooling stems
The parti-colored lizards wind themselves
To rest themselves in noonday heat. Beyond,"

Sándor Petőfi: Az Alföld (Lowland), detail, translation:

http://mek.oszk.hu/03900/03966/html/poetry3.htm#bm235

Denys Vynokurov, Ukraine

It was very nice well organized conference. It was held in the heart of the Medieval town of Sighişoara, included in the UNESCO World Heritage List. There were very interesting posters and presentations. I have got a lot of new ideas about grassland management and conservation from different experienced researchers from all over Europe. I participated in both excursions. The first one introduced us to Transylvanian Steppes. Here we saw such species as Stipa pulcherrima, S. capillata, Artemisia pontica, Inula ensifolia, Aster amellus etc. The second excursion was in the Csik Mountains. During both excursions we felt the local flavor with pálinka, goulash, ciorbă and other traditional dishes. I will remember also very nice Romanian national music and dances.

Dragana Cavlovic, Serbia

Held in charming medieval city of Sighişoara, EDGG conference was enchanting by itself.

Very well organized, no delays, professional, obliging.

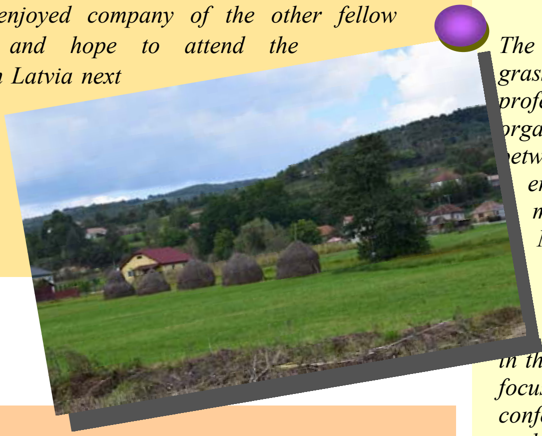
All sessions have had content that is closely related to my current research and PhD thesis, and therefore very interesting to me. Both oral and poster sessions were of high quality and very substantial.

Thursday excursion was splendid. Beautiful landscapes, extraordinary scenes of nature, people, culture.. And researchers "ant-like" climbing movile (see photo2)… just splendid.

I even had an opportunity to observe, and keep track of potentially invasive species near the roads, such as Heilanthus taxa, which is much more present than Aster lanceolatus (one of the most invasive species in neighbor Serbia).

I learned a lot about Transylvania, traditional management of grasslands, and culture as well. I had a great time, enjoyed company of the other fellow researchers, and hope to attend the Conference in Latvia next year.

P.S. The food was delicious!



Solvita Rusina, Latvia

The programme of the conference covered various diverse topics, including both scientific and practical aspects of grassland management. Hence, the conference provided the opportunity to enhance knowledge about already known management and conservation methods and to discuss other potential solutions. Two excursions provided an excellent ground to experience different management methods and to evaluate them through a discussion among experts from various fields.

The half-day workshop "Reflecting Ecology in Policy" was an excellent workshop. It was a great opportunity to discuss the problems and challenges in developing new agri-environment schemes with highly experienced experts in agri-environmental policy. The workshop was very timely given the fact that the evaluation of the previous Rural Development Programme has almost ended and new ideas for the period from 2020 onwards are being elaborated. Results-based agri-environment schemes were presented as one of the most recent developments in targeted conservation measures. As a result of the participation in this event, new professional contacts have been established.

Eugen Görzen, Germany

The EGC 2016 in Sighişoara was a perfect platform to meet other grassland researchers and environmentalists from all over Eurasia in a professional but likewise familiar atmosphere. The event was very well organized and the organizing committee achieved a proper balance between the sessions, filled with interesting talks and nice poster presentations, and accompanying events like the excursions to the hay meadows in the Csík Mountains, the HNV Grasslands at Târnava Mare or the visit of Viscri. In between, I also had enough time for inspiring conservations and discussions with other participants.

The conference location of the EGC 2016 in Transylvania seemed extraordinary appealing to me, not only due to its amazing setting in the historic old town of Sighişoara, but also because my research is focused on Transylvanian semi-natural grasslands. And in fact, this conference was a great opportunity for me to meet and have a vivid exchange with other grassland researchers and nature conservationists working in Transylvania, including the people of Fundatia ADEPT.

Being interested in the practical implementation of grassland conservation and management measures, I also attended the pre-conference workshop "Reflecting Ecology in Policy", led by Jabier Ruiz, Caitriona Maher and Clunie Keenleyside. It was exciting to debate about the big challenges in the interface between policy and grassland conservation and to learn from experts who already had a lot of experience in the fields of conservation policy and the implementation of measures in different European countries. The only problem with the workshop was the limited time available which could be extended at future events.

Thanks to the IAVS to for the travel grants! I am pleased that I was able to attend the EGC 2016 and I am looking forward to the next EDGG events!

Nina Polchaninova, Ukraine

I really appreciate the IAVS financial support that helped me to take part in the conference. The first workday was of a great importance for me as it concerned environmental policy, management and dry grassland restoration – the subject our research team works on. I gained valuable experience to apply in our future research in the steppes of eastern Ukraine. The second day was full of new impressions: unknown landscapes, autumnal Transylvanian grasslands, informative historic excursion, and Romanian national cuisine and dances, which won my heart. The third day forced me to think again about the biodiversity conservation and maintenance. So, in three words, that was useful, captivating, delicious! The conference gave me a boost of energy and information, and inspired me to continue comprehensive studies of steppe communities. Special thanks go to the conference organizers who resolved all the problems and made our stay in Sighisoara comfortable and unforgettable.

Photos: A. Csecserits, D. Vynokurov, S. Rusina, N. Polchaninova

Announcement

EGC 2017

14th Eurasian Grassland Conference

Semi-natural grasslands across borders

in Riga, LATVIA and Klaipėda, LITHUANIA

4-11 July 2017

First call

The 2017 Eurasian Grassland Conference will take place from 4th to 11th July 2017 in Riga, the capital of Latvia and Klaipėda, the third largest city of Lithuania.

This is the 14th annual conference of the EDGG, which aims to promote exchange and collaboration between those interested in all aspects of semi-natural and natural grassland research and conservation across Palaearctic realm. The conference is intended to bring together latest research, and to link this to practical management and policy contributing to the sustainability of semi-natural and natural grasslands. Emphasis will be placed on the cases where grassland ecosystems are shared between man-made geographical borders: between villages, regions, states, countries. What differences are encountered due to different policies applied on grassland management, conservation and restoration? How different the elements of grassland ecosystems respond to these borders? What provisions and synergies are needed to deal with marginality of grasslands?

The conference will include the following sessions:

- Ecological, biogeographical and phytosociological boundaries
- Grasslands on borders: environmental and agricultural policies
- Overcoming marginality of semi-natural grasslands in agricultural landscapes
- Networking and best practices for grassland conservation

All other topics related to semi-natural and natural grasslands are also welcome. A special issue of an ISI listed journal related to the conference is planned, to which all contributors to the conference will be invited to submit papers.

Preliminary programme

4-5 July	Pre-conference excursion (optional, Eastern Latvia)
5 July	Technical workshops (optional) (R programme for beginners)
6 July	Talks and Posters – Sessions I and II
7 July	Mid-conference excursion (Western Latvia)
8 Jul	Talks and posters – Sessions III and IV; EDGG General Assembly
9 – 11 July	Post-conference excursion (optional, Western Lithuania)

Venue

The conference will be held at the Academic Center for Natural Sciences of the University of Latvia situated in the heart of Riga.

Excursions

Three excursions are planned. Pre-conference excursion will cover the Eastern Baltic dry semi-natural grasslands of the Daugava River Valley, Latvia; mid-conference excursion will be to the Abava River Valley – the pearl of dry calcareous grassland diversity in Latvia. Post-conference excursion will be to Western Lithuania. We will visit the Curonian Spit – 98 km long and 0.4-4 km wide sand dune peninsula, and the Nemunas River Valley – the largest Lithuanian river.

Registration

The conference web page is expected to be launched soon (all EDGG members will be informed by e-mail when the website is available). Fees will be announced in the Second Circular in December

Important dates

Early Bird registration deadline – 31 March 2017
Late registration deadline – 30 April 2017
Abstract submission deadline – 30 April 2017

Contact persons

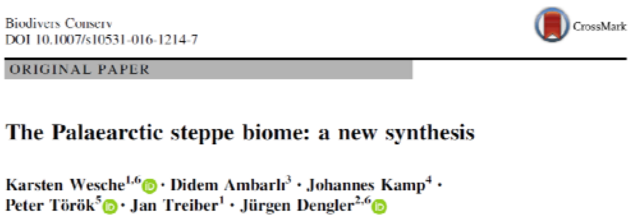
Solvita Rūsiņa / University of Latvia, local coordinator, solvita.rusina@gmail.com
Mike Vrahnakis / EDGG Executive Committee, EGC coordinator, mvrahnak@teilar.gr
Didem Ambarli / EDGG Executive Committee, EGC coordinator, didem.ambarli@gmail.com

The Curonian Spit, Lithuania. Photo: http://whc.unesco.org/en/list/994

EDGG Special Features

Second EDGG Special Issue in *Biodiversity and Conservation* published

The second Special Issue organised by EDGG (eds. J. Dengler, D. Ambarli, J. Kamp, P. Török & K. Wesche) in the journal Biodiversity and Conservation after 2014 appears in November 2016. It is exclusively devoted to the **natural steppes of the Palaearctic biogeographic realm**. With about 19 articles on about 400 pages it provides many new insights into what is globally one of the most threatened biomes. Of particular relevance is the 35-page synthesis paper with various online supplements, a pdf of which can be requested from the editors or retrieved from their ResearchGate pages.



Biodivers Conserv
DOI 10.1007/s10531-016-1214-7

ORIGINAL PAPER

The Palaearctic steppe biome: a new synthesis

Karsten Wesche[1,6] · Didem Ambarlı[3] · Johannes Kamp[4] · Peter Török[5] · Jan Treiber[1] · Jürgen Dengler[2,6]

Jürgen Dengler (juergen.dengler@uni-bayreuth.de),
Didem Ambarli (didem.ambarli@gmail.com),
Johannes Kamp (johannes.kamp@uni-muenster.de),
Peter Török (molinia@gmail.com) &
Karsten Wesche (karsten.wesche@senckenberg.de)

11th EDGG Special Issue in Tuexenia published

The 11th Special Issue edited by EDGG (eds. T. Becker, A. Csecserits, B. Deák, Monika Janišová, L.E. Sutcliffe & V. Wagner) in the journal Tuexenia appeared in July 2016. It compiles six papers about a broad range of grassland types ranging from serpentine grasslands to alpine grasslands and dealing with questions of syntaxonomy, plant functional traits, experimental recruitment, disturbance, and vegetation dynamics of European grasslands (http://www.tuexenia.de/index.php?id=14).

3rd EDGG Special Issue in Hacquetia published

The third Special Issue edited by EDGG (eds. O. Valkó, S. Venn, I. Biurrun, R. Labadessa, J. Loos & M. Zmihorski) in the journal Hacquetia is already available on line and will appear in paper in December 2016. It compiles eight papers dealing with vegetation ecology, syntaxonomy and zoology of a wide range of grassland and steppe habitats from East Europe to central Asia. It also includes a report of the EDGG activities from 2015 to 2016 (https://www.degruyter.com/view/j/hacq.2016.15.issue-1/issue-files/hacq.2016.15.issue-1.xml)

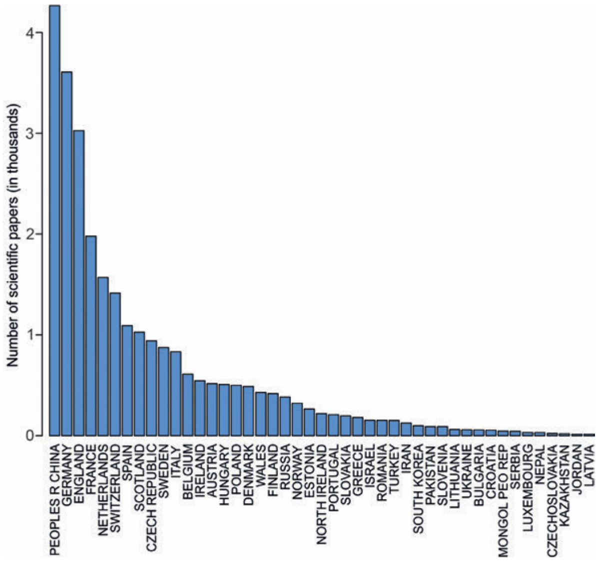


Figure 1 in Valkó et al. 2016 (editorial): Number of scientific papers as found in ISI Web of Knowledge referring to steppe or grassland diversity, sorted by study area.

Two Special Issues on grassland classification

Two further EDGG-edited Special Features are far developed and likely will be completed in 2016: Jointly with the European Vegetation Survey Working Group of IAVS, we are publishing a Virtual Special Feature of Applied Vegetation Science (eds. J. Dengler, E. Bergmeier, W. Willner & M. Chytrý) on Broad-scale classification of European Grasslands. A follow up Special Issue of Phytocoenologia (eds. M. Janišová, J. Dengler & W. Willner) is devoted to Classification of Palaearctic grasslands.

Call for contributions to two new EDGG-edited Special Features

We would like to remind you here the call for contributions to the 12th EDGG Grassland Special Feature in Tuexenia (Vegetation and conservation of grasslands in Central European s.l.; deadline for paper submission 20 November 2016) and the 4th EDGG Special Issue in Hacquetia 2018 (Fauna, flora, vegetation and conservation of Palaearctic natural and semi-natural grasslands; deadline for paper submission 28 February 2017). More detailed information about these new Special Features can be found in the EDGG Bulletin 31: 8.

Jürgen Dengler,
juergen.dengler@uni-bayreuth.de
(Special Feature Coordinator of EDGG)

Research paper

Assessing plant diversity and composition in grasslands across spatial scales: the standardised EDGG sampling methodology

Jürgen Dengler[*,1,2], Steffen Boch[3], Goffredo Filibeck[4], Alessandro Chiarucci[5], Iwona Dembicz[6,1], Riccardo Guarino[7], Benjamin Henneberg[8], Monika Janišová[9], Corrado Marcenò[10], Alireza Naqinezhad[11], Nina Y. Polchaninova[12], Kiril Vassilev[13] & Idoia Biurrun[14]

1) Plant Ecology, Bayreuth Center of Ecology and Environmental Research (BayCEER), University of Bayreuth, Universitätsstr. 30, 95447 Bayreuth, GERMANY; juergen.dengler@uni-bayreuth.de
2) German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, DeutscherPlatz 5e, 04103 Leipzig, GERMANY
3) Institute of Plant Sciences, University of Bern, Altenbergrain 21, 3013 Bern, SWITZERLAND; steffen.boch@ips.unibe.ch
4) Department of Agricultural and Forestry Sciences, University of Tuscia, 01100 Viterbo, ITALY; filibeck@unitus.it
5) Department of Biological, Geological and Environmental Sciences, Alma Mater Studiorum University of Bologna, Via Irnerio 42, 40126 Bologna, ITALY; alessandro.chiarucci@unibo.it
6) Department of Plant Ecology and Environmental Conservation, Faculty of Biology, Biological and Chemical Research Centre, University of Warsaw, ul. Żwirki i Wigury 101, 02-089 Warsaw, POLAND; iwodem@op.pl
7) Dept. STEBICEF – Botanical Unit, University of Palermo, via Archirafi 38, 90123 Palermo, ITALY; guarinotro@hotmail.com
8) Animal Ecology II, Bayreuth Center of Ecology and Environmental Research (BayCEER), University of Bayreuth, Universitätsstr. 30, 95447 Bayreuth, GERMANY; ben_henneberg@web.de
9) Institute of Botany, Slovak Academy of Sciences, Ďumbierska 1, 974 00 Banská-Bystrica, SLOVAKIA; monika.janisova@gmail.com
10) Department of Botany and Zoology, Faculty of Science, Masaryk University, Kotlářská 2, 61137 Brno, CZECH REPUBLIC; marcenocorrado@libero.it
11) Department of Biology, Faculty of Basic Sciences, University of Mazandaran, P.O. Box 47416-95447, Babolsar, Mazandaran, IRAN; a.naqinezhad@umz.ac.ir
12) V.N. Karazin Kharkiv National University, 4 Svobody Sq., 61077 Kharkiv, UKRAINE; polchaninova_n@ukr.net
13) Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. G. Bonchev Str., 1113 Sofia, BULGARIA; kiril5914@abv.bg
14) Department of Plant Biology and Ecology, University of the Basque Country UPV/EHU, PO. Box 644, 48080 Bilbao, SPAIN; idoia.biurrun@ehu.es

*) Corresponding author

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Abstract: This paper presents the details of the EDGG sampling methodology and its underlying rationales. The methodology has been applied during EDGG Research Expeditions and EDGG Field Workshops since 2009, and has been subsequently adopted by various other researchers. The core of the sampling are the EDGG Biodiversity Plots, which are 100-m² squares comprising, in two opposite corners, nested-plot series of 0.0001, 0.001, 0.01, 0.1, 1 and 10 m² square plots, in which all terricolous vascular plants, bryophytes and lichens are recorded using the shoot presence method. In the 10-m² plots, species cover is also estimated as a percentage and various environmental and structural parameters are recorded. Usually the EDGG Biodiversity Plots are complemented by the sampling of additional 10 m² normal plots with the same parameters as the 10-m² corners of the first, allowing coverage of a greater environmental diversity and the achievement of higher statistical power in the subsequent analyses for this important grain size. The EDGG sampling methodology has been refined over the years, while its core has turned out to generate high-quality, standardised data in an effective manner, which facilitates a multitude of analyses. In this paper we provide the current versions of our guidelines, field forms and data entry spreadsheets, as open-access Online Resources to facilitate the easy implementation of this methodology by other researchers. We also discuss potential future additions and modifications to the approach, among which the most promising are the use of stratified-random methods to *a priori* localise the plots and ideas to sample invertebrate taxa on the same plots and grain sizes, such as grasshoppers (*Orthoptera*) and vegetation-dwelling spiders (*Araneae*). As with any other method, the EDGG sampling methodology is not ideal for every single purpose, but with its continuous improvements and its flexibility, it is a good multi-purpose approach. A particularly advantageous element, lacking in most other sampling schemes, including classical phytosociological sampling, is the multi-scale and multi-taxon approach, which provides data that allow for deeper understanding of the generalities and idiosyncrasies of biodiversity patterns and their underlying drivers across scales and taxa.

Keywords: biodiversity; bryophyte; EDGG Biodiversity Plot; invertebrate; lichen; methodology; multi-taxon study; relevé; scale-dependence; species richness; vegetation-environment relationship; vegetation sampling.

Abbreviations: EDGG = Eurasian Dry Grassland Group; GIS = geographic information system; QA = quality assessment; SAR = species-area relationship. .

This article contains Online Resources, which are available from the EDGG homepage (http://www.edgg.org) as well as from the ResearchGate account of the first author (https://www.researchgate.net/profile/Juergen_Dengler).

Introduction

Understanding the unequal distribution of species diversity is one of the greatest challenges in ecology. Standardized sampling protocols for diversity assessments are therefore essential to reflect diversity patterns across spatial scales and to compare the diversities of different ecosystems. Palaearctic grasslands harbour a high diversity of various taxa (Allan et al. 2014) and hold the majority of world records in vascular plant species richness for grain sizes smaller than 100 m² (Wilson et al. 2012; Dengler et al. 2014; Chytrý et al. 2015). In addition, bryophyte and lichen diversity can also be high in these habitats (Dengler 2005; Müller et al. 2014; Boch et al. 2016; Dengler et al. 2016). However, there are also particularly species-poor grassland types in the Palaearctic (Dengler 2005; Dengler et al. 2016), making Palaearctic grasslands as a whole suitable as a model system to analyse diversity patterns and their underlying drivers. The acquisition of knowledge on these topics is of great importance in the development of appropriate conservation measures and in order to maintain these highly diverse ecosystems and the ecosystem functions they provide (Soliveres et al. 2016).

The majority of studies analysing the effects of abiotic, biotic and historical factors on species diversity implicitly assume that these factors are universal, and thus studying biodiversity patterns at one grain size provides answers for all grain sizes. On the basis of the nowadays readily available and relatively standardised coarse-grain data, most such studies, and thus general ecological knowledge, are based on coarse-grain analyses. These typically rely on data collected at grain sizes of hundreds or thousands of square kilometres, while fine-grain analyses across large spatial extents are largely lacking (Beck et al. 2012). However, it has long been hypothesized that the prevailing drivers of biodiversity vary strongly between grain sizes (Shmida & Wilson 1985). This assumption has indeed found strong support in several recent meta-analyses (Field et al. 2009; Siefert et al. 2012). Studying patterns and drivers of biodiversity at small grain sizes over several orders of magnitude can be particularly insightful, as at this level, (plant) individuals of different species interact with each other and their environment (see examples in Reed et al. 1993; Dupré & Diekmann 2001; de Bello et al. 2007; Giladi et al. 2011; Turtureanu et al. 2014). However, such studies are still rare and mainly restricted to the local, or very rarely to the regional scale. Often comparisons of studies, or even joint analyses of their combined data, are impeded by the idiosyncrasies of the plot sizes and sampling schemes used. The situation is even worse for phytosociological data that are available in large quantities and are suitable for many purposes (Dengler et al. 2011; Chytrý et al. 2016), as plot sizes (Chytrý & Otýpková 2003), as well as sampling quality (Chytrý 2001), vary greatly. Thus, such phytosociological legacy data are a complex source for studies on diversity patterns and their scale dependence.

Bearing this in mind, standardised multi-scale diversity sampling schemes, often combined with the sampling of abiotic factors and sometimes also non-plant taxa, have been proposed, among them the *Whittaker plots* (Shmida 1984), the plots of the *Carolina Vegetation Survey* (CSW; Peet et al. 1998) and the *BIOTA South Observatories* (Jürgens et al. 2012). Inspired by these, as well as by similar attempts by colleagues (Hobohm 1998; Dolnik 2003), students of the first author tested these ideas in their theses (Löbel 2002; Boch 2005; Allers 2007). On the basis of these studies, Dengler (2009) then proposed the so-called *flexible multi-scale approach for standardised recording of plant species richness patterns*, which can be seen as a methodological framework that allows many different implementations, but with a common core. Starting in the same year, this sampling approach gave rise to the Research Expeditions of the European Dry Grassland Group (EDGG; http://www.edgg.org; Vrahnakis et al. 2013), which were meanwhile renamed as Field Workshops of the Eurasian Dry Grassland Group (Venn et al. 2016). Here we use the term "field pulse" to refer to both types, inspired by the Carolina Vegetation Survey (Peet et al. 1998), "pulse" implying an intensive event of relatively short duration, but repeated over time. The first event in Transylvania in 2009 (Dengler et al. 2009; Dengler et al. 2012a; Turtureanu et al. 2014) was followed by eight more internationally attended field pulses conducted from Spain in the west to Siberia in the east and from Sicily in the south to Poland in the north (Vrahnakis et al. 2013; Venn et al. 2016). These field pulses created a huge common data pool for joint analyses (Dengler et al. 2016) and yielded a whole series of papers on diversity patterns (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016), and also on species composition and syntaxonomy (Dengler et al. 2012a; Pedashenko et al. 2013; Kuzemko et al. 2014). While the sampling approach generally turned out to be very effective for a wide range of different research questions, the joint fieldwork also led to numerous small modifications and additions. Moreover, participants in the field pulses adopted the sampling methods in their own projects (e.g. Baumann et al. 2016; Cancellieri et al. 2017; M.J. and colleagues in Ukraine, unpublished) and even researchers not related to the EDGG started to use this approach (e.g. Mardari & Tănase 2016; A.C. and colleagues in Italy, unpublished).

The EDGG sampling approach, with the EDGG Biodiversity Plots as its core element, is thus evidently effective and attractive. To date, however, no complete in-depth and up-to-date description of this approach has been published. Accordingly this paper presents the current version of our approach, with the latest modifications, subsequent to the 9th EDGG Field Workshop 2016 in Serbia, critically assessing its pros and cons as well as potential extensions and demonstrating potential applications. We believe that our proposal and rationales can also contribute to a better standardisation of other sampling approaches, for example, in phytosociology (compare Mucina et al. 2000). To facilitate the adoption or modification of our approach in other studies, we provide the sampling forms and spreadsheets for data handling in conjunction with this article.

Description of the EDGG sampling methodology and its rationale

The ***description of the methodology*** is always indicated in ***bold-italics***, followed by the justification in normal font. The outlined methodology has been applied in the EDGG field pulses since 2009 (Dengler et al. 2009), unless indicated otherwise. Where appropriate, the methodological explanations are concluded with *practical hints* for their implementation in *italics*.

A. Location and arrangement of the plots

A.1 In each study site, the EDGG Biodiversity Plots (100 m²) are selected subjectively in quasi-homogenous stands of ad-hoc recognizable different vegetation types regarding both site conditions and floristic composition (Photos 1–6). This approach aims at encompassing as much as possible the geographic and ecological heterogeneity within the *a priori* defined "study universe" (e.g. all wet grasslands of a region). Unlike the practice of some phytosociologists (see Glavac 1996), the occurrence of diagnostic species or concurrence with recognised syntaxa are explicitly excluded as selection criteria. Our approach on the one hand ensures that ecological gradients are representatively covered with a limited sample size, i.e. spatially rare types are relatively over-represented, which is important for analyses of diversity-environment relationships. On the other hand, limiting the number of biodiversity plots per site avoids the risk of over-sampling and pseudo-replication. With the implicit philosophy of relating the number of biodiversity plots per site to its ecological heterogeneity, our approach mimics *ad hoc* the *post-hoc* heterogeneity-constrained random resampling (Lengyel et al. 2011).

A.2 The study-plot sizes are 1 cm²; 10 cm², 100 cm², 1000 cm², 1 m², 10 m² and 100 m² (Fig. 1). Using plot sizes always differing by one order of magnitude is also the philosophy of other widespread multi-scale approaches. For example, Shmida (1984), Peet et al. (1998) and Jürgens et al. (2012) use the same set of plot sizes, excluding only the smallest ones and adding 1000 m². These plot sizes also include three of the most frequently used plot sizes in phytosociology, namely 1, 10 and 100 m² (Chytrý & Otýpková 2003). Having the plot sizes on a geometric scale is beneficial for many ana-

Photo 1. ***EDGG Biodiversity Plot during the EDGG Field Workshop in Sicily, Italy, 2012 (Photo: T. Becker).***

Photo 2. ***EDGG Biodiversity Plot during the EDGG Research Expedition in Khakassia, Russia, 2013 (Photo: J. Dengler).***

Photo 3. ***EDGG Biodiversity Plot during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

Photo 4. ***EDGG Biodiversity Plot during the EDGG Field Workshop in Serbia, 2016 (Photo: J. Dengler).***

lytical purposes, while the tenfold area increase from one plot to the next largest one is less sampling-intensive and avoids unusual sizes (like 256 m²), which occur in area-doubling approaches (e.g. Chiarucci et al. 2006). We did not include 1000 m² in our standard procedure because complete sampling of such an area in species-rich Palaearctic grasslands can be extremely time-consuming. For example, Dolnik (2003), who is a very experienced field botanist, needed up to seven hours to sample nested plots of up to 900 m² (without replication of subplots) in not particularly rich grassland types of the Curonian Spit (Russia). In contrast, adding smaller grain sizes compared to the other standard sampling schemes, requires only minimal extra effort but is highly beneficial for analyses such as species-area relationships (SARs).

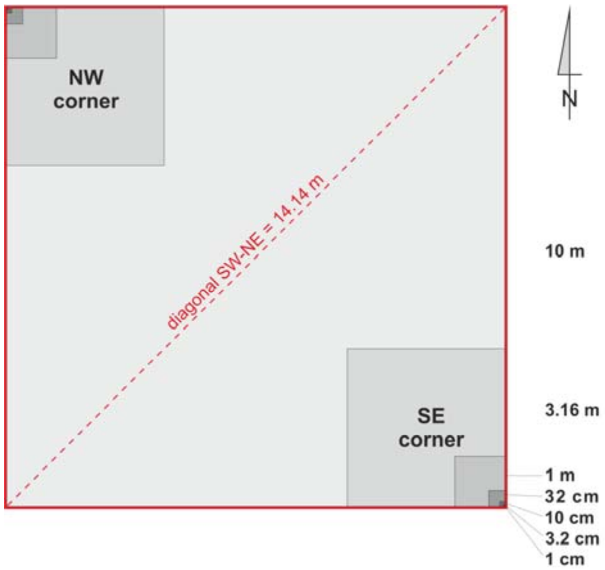

Fig. 1. ***General arrangement of a 100-m² EDGG Biodiversity Plot and the two series of nested subplots in its NW and SE corners. To establish the 100 m² as a precise square, first the NE-SW diagonal of 14.14 m is delimited (Drawing: I. Dembicz).***

A.3 All plots have a square shape. Some widespread multi-scale recording schemes use different plot shapes depending on grain size (e.g. Shmida 1984; Stohlgren 1995; Peet et al. 1998). However, since plot shape significantly influences species richness (Stohlgren 2007; Bacaro et al. 2015; Güler et al. 2016), constant shape is important for cross-scale studies and analyses of SARs. Among all the possible shapes (squares, rectangles, circles, hexagons, irregular forms), squared plots have a multitude of advantages: (a) apart from circles and hexagons, they are the most compact form, and thus, on average, reflect the least pronounced abiotic gradient and therefore the closest link between environmental conditions, species composition and richness; (b) unlike circles and hexagons, square plots can easily and precisely be delimited in the field with little effort and (c) small squares can be aggregated to larger ones, which is not possible for circles or hexagons. While circles (e.g. Jonsson et al. 1992; Olano et al. 1998; Szwagrzyk et al. 2001) and hexagons (e.g. Jurasinski & Beierkuhnlein 2006) might be beneficial for very specific sampling purposes, we consider the square to be the most practical shape for multi-purpose phytodiversity sampling approaches, also considering that the great majority of legacy data has also been recorded on plots of that shape. *In practice, the 100-m² plot is established first by measuring a diagonal (14.14 m), marking the two corners not to be used for the nested-plot series, fixing a fibreglass measuring tape at 0 m and at 20 m at these two corners and pulling it at the 10-m mark until both sides are straight lines (Fig. 1). According to our experiences, we do not recommend metal measuring tapes as they are too stiff to allow precise delimitation of the squares in the corners. Also the 10-m² plots (3.16 m edge length) are best delimited using fibreglass measuring tapes and metal pegs, while for 1 m² (1 m edge length) and 0.1 m² (0.32 m edge length) it is more convenient to bend a 2-m folding rule at a right angle and to lay it on the ground. For the three smallest grain sizes, 0.01 m² (0.1 m edge length), 0.001 m² (0.032 m edge length) and 0.0001 m² (0.01 m edge length), in many cases the best way is not to lay-out the inner margins, but just directly measure the position of plants that*

Photo 5. ***EDGG Biodiversity Plot in an alpine steppe of Mt. Damavand, Iran, 2016 (Photo: A. Talebi).***

Photo 6. ***EDGG Biodiversity Plot during an advanced student field course in NE Brandenburg, Germany, 2016. The student group in the background is determining grasshoppers that just have been collected on the diagonal of the 100-m² plot (Photo: J. Dengler).***

are presumably close to the non-marked inner margins from the outer margins that are marked with the measuring tape anyway.

A.4 The plots < 100 m² are nested and replicated twice in two opposite corners of the 100-m² plot (Photo 6). Since relative variability of species richness and of practically any other relevant parameter increases towards smaller plot sizes (see Dengler 2006), it is important to replicate the grain sizes below the largest ones. For analyses of species-area relationships, it is beneficial to use the average values of the replicates, while using just one plot per grain size (e.g. Löbel 2002; Dolnik 2003) can significantly distort results (Dengler & Boch 2008). While the standard error of the estimates for grain-size richness values decreases with the number of replicates, it turned out during the EDGG field pulses that using only two replicates is a good compromise between precision and time efficiency. *Practically, the two subseries of nested plots are placed in the NW and SE corners of the 100 m² plot.*

A.5 The plots are normally oriented along the cardinal directions (deviations are recorded); GPS coordinates are recorded in decimal degrees (WGS 84) from the NW and SE corner of the 100-m² plot, using the averaging function to achieve the best-possible precision *(since 2009),* ***and these corners are permanently marked with buried magnets*** *(introduced after field pulse 2016)**.*** These measures are aimed at enabling future re-visitation with precise re-location of the same plots. With this minimal additional "investment" of time and material, the EDGG Biodiversity Plots become real permanent plots, making them the best possible solution to study vegetation dynamics without any distortions (i.e. pseudo-turnover) through inaccurate re-location (see Chytrý et al. 2014).

A.6 In addition to the EDGG Biodiversity Plots (100 m²), "normal plots" of 10 m² are sampled with the same parameters as the 10-m² subplots of the Biodiversity Plots (see below), but with no nesting. These plots are much less time-consuming than EDGG Biodiversity Plots and the additional sampling of "normal plots" allows higher replication and better coverage of environmental gradients for this major grain size. Since the normal plots are in every respect identical to the 10-m² subplots from the corners of the EDGG Biodiversity Plots, they can be combined in one analysis, which improves the statistical power of the analyses at 10 m² (see examples in Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016), and ensures that, despite limited sampling time, enough plots are recorded for meaningful vegetation classification (Dengler et al. 2012a; Pedashenko et al. 2013; Kuzemko et al. 2014).

B. Species recording

B.1 All living terricolous *(i.e. soil-dwelling)* ***vascular plants, bryophytes, lichens and macro-"algae" are recorded.*** Besides vascular plants, we also record all other photo-autotrophic terricolous taxa that are macroscopically visible, meaning that we aim at generating a complete picture of the vegetation. Bryophytes and lichens can contribute very substantially to the overall "phytodiversity" (acknowledging that lichens taxonomically are not plants but symbioses of fungi with photoautotrophic partners) of grasslands (Dengler 2005; Müller et al. 2014; Boch et al. 2016; Dengler et al. 2016). Moreover, multi-taxon studies are generally very insightful (e.g. Zulka et al. 2014; Manning et al. 2015) and the three main taxonomic groups of vegetation: vascular plants, bryophytes and lichens, show quite contrasting relationships to environmental drivers (Löbel et al. 2006; Lenoir et al. 2012; Polyakova et al. 2016). *In practice, dead material of perennial plants is not considered, while dead annuals from the same year are recorded when present. We do this because we consider that a record of a plant community should reflect a complete year, not just a season (Dengler 2003). Theoretically, a better solution would be two recordings per year in communities with a pronounced spring-ephemeroid aspect and combining both relevés into one (Dierschke 1994), but this is impractical for a one-time field pulse.*

B.2 Presences-absence recording with the shoot-presence system for all plot sizes. There are two common ways to record plant species presence in plots, *rooted presence* (similar to but not identical with the grid-point system) and *shoot presence* (any-part system) (Williamson 2003; Dengler 2008). While for larger grain sizes the results of both methods differ only negligibly, the richness recorded with rooted presences deviates more and more negatively from shoot presence values with decreasing plot sizes, which is theoretically obvious (Williamson 2003), but has recently also been demonstrated empirically for grasslands (Güler et al. 2016; Cancellieri et al. 2017). Therefore, data derived from both methods cannot be directly compared. We decided to use shoot presence because (a) this method is advantageous when analysing SARs as both ways of recording necessarily show deviations from a power law at small spatial scales, but these distortions are much stronger and occur at a far larger grain size for rooted presence than for shoot presence (Williamson 2003; Dengler 2008) and (b) shoot presence, i.e. assuming an individual as occupying an area and not only the point where it penetrates the soil surface, better reflects which species are interacting in the studied plot. *In practice, recording shoot presence is challenging for the three smallest grain sizes of 1 cm², 10 cm² and 100 cm². Here it is important that the observer is very careful not to distort the original arrangement of the vegetation when placing the pegs in the corners and establishing the plots. For these smallest plots, a single observer should do the*

Photo 7. ***Using a preliminary version of the disc for standardised assessment of vegetation height during the EDGG Field Workshop in Serbia 2016 (Photo: I. Dembicz).***

recording. The observer should always look from the same angle into the plot and start recording plants from the highest to the lowest layers, without recording additional plants of the higher layer after they have been bent away to sample plants of the lower layers, nor after the plots have been affected by wind, etc. Our experience suggests that representative results can be achieved with the shoot presence method if one observer works fast and thoroughly.

B.3 Additional percentage cover estimations for the 10-m² plots. Traditionally, phytosociologists recorded plant performance in a plot with the combined cover-abundance scale of Braun-Blanquet (1964) or one of its many modified/ refined versions (e.g. Wilmanns 1998). This approach has multiple shortcomings, in particular the combination of two different criteria, cover and abundance which, in the strict sense, precludes most mathematical analyses but which is often ignored. Furthermore, most numerical approaches do not calculate with the cover-abundance scale, but back-transform each cover-abundance class to the mean of its range, introducing a double-error of transformation: first from what is seen in the field to an abstract category and then back to a real cover value, which in some cases can be quite different from the original value. Imagine, for example, a cover of 5%, which belongs to the traditional Braun-Blanquet cover-abundance category "2", which then usually is back-transformed to a cover value of 15% (because 2 stands for 5−25%), meaning that this step introduced a three-fold error. Last but not least, the Braun-Blanquet scale and almost all similar scales are too coarse for recording species-rich grasslands of high evenness (where almost all species are in the category 2m or 2a) or in very sparse vegetation (where most species have less than 1% cover. However, it is a big difference, i.e. a factor of 10,000, whether the cover is 0.0001% or 1%, which is not reflected in traditional scales). *To facilitate realistic cover estimates, we (a) use "estimation aids" such as the calculation to which fully filled square typical cover percentages within a 10-m² plot would correspond (**Table 1**) and (b) advise participants that they should always double-check that the cumulative cover of species of one group is at least as high as the independently estimated cover of that group.*

Table 1. Areas of completely filled squares that correspond to certain percentage cover values in 10-m² plots.

Percentage cover value	Area in m²	Area in cm²	Edge length of square in cm
5	0.5	5000	70.7
4	0.4	4000	63.2
3	0.3	3000	54.8
2	0.2	2000	44.7
1	0.1	1000	31.6
0.5	0.05	500	22.4
0.1	0.01	100	10.0
0.05	0.005	50	7.1
0.01	0.001	10	3.2
0.005	0.0005	5	2.2
0.001	0.0001	1	1.0

C. Structural and environmental variables (in each 10-m² plot)

C.1 Cover of vegetation layers: Cover of the tree (woody > 5 m), shrub (woody 0.5−5 m), herb (woody < 0.5 m and herbaceous) and cryptogam layers are estimated as percentages (since 2009). Additionally, the herb layer is subdivided into the functional groups phanerophytes, chamaephytes, graminoids, legume forbs and other forbs, allowing for overlap between these (adopted after 2016). This last step does not only provide valuable data in itself, but also allows for cross-checking the consistency of species cover data (see B.3).

C.2 Maximum height of tree, shrub and herb layers.

***C.3 Measurement of "standard height" of the vegetation** (since 2016; prototype during field pulse, improved version afterwards; **Photo 7**):* At five random points in the plot, a circular plastic disc with a central borehole (22.5 cm diameter, 117 g) is released along the inverted penetrometer (see below), the handle of which is placed on the ground. The height where the falling disc is stopped by the vegetation is measured at the borehole. The five measurements provide a reproducible measure of the height at which the vegetation becomes dense, as well as of its spatial variability.

Photo 8. ***Clipping biomass during the EDGG Field Workshop in Serbia 2016 (Photo: J. Dengler).***

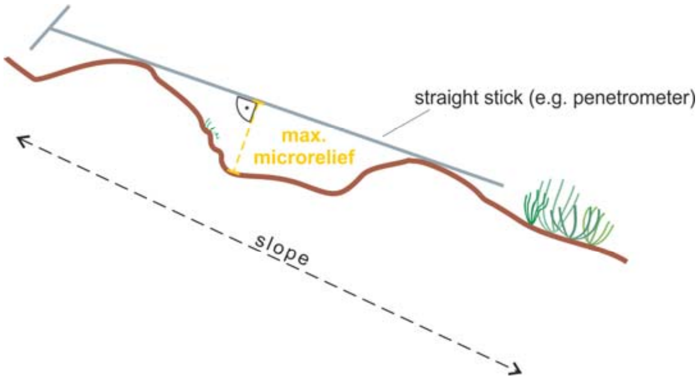

Fig. 2. ***Illustration of how to measure the maximum microrelief (orange line) in a plot (in our case the 10 m² plots) (Drawing: I. Dembicz).***

C.4 Aboveground biomass *(first variants during field pulse 2015; current version after the field pulse 2016;* ***Photo 8****)*: Within each 10-m² plot, we clip the aboveground biomass within two random areas of 20 cm × 20 cm to the soil surface. We then pool both samples, i.e. a total surface of 800 cm², after which we dry and weigh them. Sampling two separate areas allows a much better estimate of the mean biomass per 1 m² within the 10 m² plot than a single plot would do (as in 2015). Due to the relatively small total surface, the amount of biomass is still practicable, even during longer field pulses, i.e. the material can be transported and pre-dried. While in 2015, we separated the three fractions into living vascular plants, living non-vascular plants and litter, since 2016 we have taken just one combined sample for biomass s.l. because the previous approach was too time-consuming. *Practically, the area to be sampled can be delimited by a specifically manufactured steel frame or more easily by a frame created by bending a folding ruler four times. The inner edge is 19 cm, but since it is impossible to fix the position 100% during biomass cutting, this is a good approximation of the intended size. Drying is done in an oven at 65 °C until the weight remains constant.*

C.5 Cover of litter and deadwood: Percentage cover after virtually removing all vegetation. Note that the widespread approach of phytosociologists to estimate only that part of the litter that is visible from above, i.e. not covered by living vegetation, precludes using litter cover as a predictor of vegetation attributes, because the two variables would then not be independent of each other.

C.6 Fractions of abiotic soil surface: Percentage cover of the three texture classes: stones and rocks (diameter > 63 mm), gravel (2−63 mm) and fine soil (< 2 mm) at the soil surface after virtually removing all vegetation, litter and deadwood, thus, summing up to 100% cover. Note that the widespread approach of phytosociologists to estimate only that part of the soil surface that is visible from above, i.e. not covered by living or dead vegetation, precludes using these fractions as predictors of vegetation attributes because they would then not be independent.

C.7 Slope aspect and inclination: Practically measured by placing the penetrometer (see below) on the ground along the slope line. Aspect is measured in degrees with a compass and (mean) inclination in degrees with an inclinometer. Nowadays, smartphone apps are available that do both in a very convenient way when placing the smartphone on the 85 cm long penetrometer.

C.8 Microrelief: Is defined as the maximum distance to the ground when placing the penetrometer (see below) to the ground in the most rugged part of the plot, measured perpendicular to the device (since 2014; **Fig. 2**). Formerly, we took this measurement plumb-vertical, but this approach strongly confounded measurements of microrelief by slope inclination.

C.9 Soil depth: Is measured at five random points (to allow calculation of mean and standard deviation) using our soil depth indicator (penetrometer; ***Photo 9***). This is a steel pole of 85 cm length and 1.0 cm diameter, pointed at one end and with a handle at the other. It is pushed into the ground until it hits a rock or the soil becomes so dense that it cannot be pushed further. Each depth measurement is noted separately, even if it is "0 cm" (rock at the surface) or ">80 cm" (no resistance at any depth). It is obvious that this measurement should preferably always be done by the same person of average weight and strength. The "odd" length of the penetrometer is because this was the length of our first device. However, it turned out that a device of this length still can be reasonably well carried in checked-in luggage during air travel, while a length of 1 m would already cause problems.

C.10 Soil samples: A mixed soil sample of the uppermost 10 cm of the mineral soil is taken from five random locations within the 10-m² plot (***Photo 10***). This sample is air-dried during the field pulse (***Photo 11***) and afterwards dried at 65 ° C. From this sample, we determine as a minimum the following parameters: **(a) skeleton content** (i.e. mass fraction of particles > 2 mm), **(b) texture class** (mostly estimated with a finger test − see Schlichting et al. 1995; Ad-hoc-AG Boden 2005 – sometimes measured, which is time-consuming and costly); **(c) pH** (in a suspension of 10 g dry soil in 25 g aqua dest.); **(d1) humus content** (as loss at ignition at 430 °C until constancy) or, if resources allow, **(d2) C and N contents** (with a C/N analyser), including correction for C from carbonates.

C.11 Land-use: Is problematic to assess during a one-off visit. We try to categorize each plot based on traces, such as faeces, grazing marks, presence/absence of pasture weeds, into **pasture** (i.e. livestock grazed), **meadow** (i.e. mown) or **un-used** in recent years (abandoned semi-natural grassland or natural grassland) (e.g. Turtureanu et al. 2014). Additionally, we use burning traces to decide whether the plot was **burned during the current year** or not. Any more precise information on land-use, the management regimes, their timing and duration (e.g. livestock type, number of animals, combination of mowing, grazing and fertilization, peculiarities in grassland history, etc.) that is available is recorded. Unfortunately, our experience is that during a one-off visit such data can hardly be gathered consistently, so that in none of the field pulses so far were we able to use more detailed land-use parameters for analyses.

Photo 9. ***Applying the penetrometer to determine the accessible soil depth during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

D. Data management

To facilitate and standardise data collection and management, the EDGG provides and regularly updates a series of documents, i.e. instructions, templates for printed forms and spreadsheets, the currently up-to-date versions of which accompany this article. All these documents are open access and can be modified according to personal needs. Online Resource 1 contains a detailed list of equipment needed for sampling like that done during EDGG field pulses, depending on the duration and number of participants (***Photo 12).*** Online Resource 2 provides detailed practical instructions on how to implement the EDGG sampling in the field, while Online Resource 3 describes the data handling and recording after the fieldwork. Online Resources 4 and 5 are the current templates for biodiversity plots and for normal plots. Online Resources 6 and 7, finally, are spreadsheets (*.xlsx format) for the efficient data entry of species data and header data, respectively. They include some embedded functions that facilitate work and provide some simple data checks (filling in the species list for 100-m² plots automatically based on the two corners, checks of consistency of cover values, calculation of mean and standard deviation for parameters with multiple measurements, descriptive statistics for parameters across all plots to check for outliers/entry errors). From these two spreadsheets, the relevant datasets for the multiple analyses, be it in R or any other statistical software, can be derived with a few clicks.

The data of the EDGG field pulses and some related sampling schemes are stored in a common database, registered in the Global Index of Vegetation-Plot Databases (GIVD; Dengler et al. 2011) as EU-00-003 (Dengler et al. 2012b). These data are available for common data analyses by the contributors and their partners. Moreover, the field pulse data of the 10-m² plots are contributed to existing national or regional partner databases of the European Vegetation Archive (EVA; Chytrý et al. 2016) and the global counterpart “sPlot” (Purschke et al. 2015) so that they are available for continental or global analyses.

E. Possible extensions of the methodology

E.1 Other spatial scales: The most meaningful additional scale would be 1000 m² (31.62 m × 31.62 m) since this is a common grain size in many biodiversity sampling schemes worldwide, albeit mostly realised as 50 m × 20 m (e.g.

Photo 10. ***Taking a soil sample during the EDGG Field Workshop in Khakassia, Russia, 2013 (Photo: J. Dengler).***

Photo 11. ***Drying and sorting of soil samples during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

Photo 12. ***Equipment needed for the EDGG sampling methodology, spread to be packed by the different teams during the EDGG Field Workshop in Serbia, 2016 (Photo: C. Marcenò).***

Shmida 1984; Peet et al. 1998; Jürgens et al. 2012). There are several ways to arrange nested plots within 1000 m² in a way that is compatible with the EDGG Biodiversity Plots: (a) place one EDGG Biodiversity Plot in the centre of the 1000 m² plot; (b) place two EDGG Biodiversity Plots in two opposite corners; (c) place single nested series of 0.0001−100 m² in two corners or (d) the variant shown in Dengler (2009: Fig. 1). One should be aware that adding 1000 m² drastically increases the time needed for sampling (compare the times for a single nested-plot series up to 900 m² as reported by Dolnik 2003). Therefore, one should only opt for this addition when there are adequate resources available to sample the 1000 m² as comprehensively as the 100 m². Most conveniently this can be done in relatively species poor vegetation with low cover values, e.g. in some open herbaceous vegetation of Southern Africa (Jürgens et al. 2012) or in transitions from steppes to semi-deserts in Iran (where a group including A.N. is currently doing this). Sampling smaller grain sizes than 1 cm², i.e. 1 mm² and 10 mm², is also possible, but requires a special device (Dengler et al. 2004). Finally, it can make sense to “insert” additional plot sizes with full sampling (including cover values and environmental data), such as 16 m² or 25 m², if this is a national standard for sampling herbaceous vegetation for phytosociological purposes. In this case, however, this additional plot size should not be used in SAR analyses, to avoid bias.

E.2 Higher replication at smaller scales: Since the coefficient of variation of species richness strongly increases with decreasing plot size (Dengler 2008 and references therein), increasingly more replicates would be necessary for smaller plots to estimate mean species richness with the same precision. Thus, the original approach of Dengler (2009) proposed that towards each smaller scale within the 100-m^2 plots, and down to 0.01 m^2, the number of sub-plot replicates is doubled. Due to time constraints and because it is hardly possible to arrange such an increasing replication that is both nested and unbiased with respect to the 100-m² area (i.e. does not have higher sampling intensity in some regions than in others), this approach was never adopted during the EDGG field pulses. However, Dengler et al. (2004) and Boch (2005; see Dengler & Boch 2008) used four and five series of nested plots (0.0001−10 m²) within the 100-m² plot. Recently Cancellieri et al. (2017) adopted the idea of Dengler (2009: Fig. 2), although with a limited nested series composed of only three spatial scales.

E.3 Stratified-random sampling: Step A.1 of the EDGG sampling methodology is aimed at approximating a dataset similar to one gained with stratified random sampling, but when such an *a priori* stratification is not feasible due to time constraints or lack of suitable information layers for use in a Geographic Information System (GIS). Basically, the sampling approach of Dengler (2009) is applicable in subjectively delimited habitat types, with stratified random sampling (or an approximation of it) or with fully random sampling (for the pros and cons of these sampling approaches, see Wildi 1986). Only fully random sampling allows calculation of true spatial means of attributes, such as species richness (e.g. Dengler & Allers 2006; see also the grid-based random approach by Cancellieri et al. 2017, which was inspired by Chiarucci et al. 2012), but this usually leads to a strong underrepresentation of rare habitat types (Diekmann et al. 2007). Stratified-random sampling theoretically allows one to get a dataset that is more balanced with regard to environmental gradients (than fully random sampling would) and even to approximate spatial means (when taking the fractional extent of the strata into account), while avoiding the potential biases of subjectively locating the plots. However, stratified-random sampling requires that the main environmental gradients are rather clear *a priori* and available as GIS layers for the study region, which is not usually the case for EDGG field pulses, one of whose main aims is to study undersampled regions. If the prerequisites are met, we recommend considering a stratified-random approach (and aim to implement it in the Field Workshop 2017 in Central Italy; see Filibeck et al. 2016). This approach means that random coordinates within each level of one or several crossed main environmental factors are generated within a GIS and then sampled in the field. For example, one could stratify the region by elevation and bedrock type or by land-use type and slope position. It is self-evident that one needs to decide for one, two or a maximum of three gradients, each subdivided into a small number of categories, because otherwise the number of plots necessary would soon become unrealistic. One should however be aware of the potential problems of a stratified-random approach, even when these prerequisites are met. On the one hand, the *a priori* assumption about the main gradient(s) might turn out to be wrong and then the sampling would not be optimal. For example, Baumann et al. (2016) used EDGG Biodiversity Plots with elevational stratification, only to find out that the elevational gradient in their case was of subordinate importance for the species richness patterns. On the other hand, stratified-random sampling significantly increases the time needed to find and reach the plots in the field, which in some cases might even turn out to be impossible due to inaccessibility.

E.4 Better assessment of beta diversity: Through the multi-scale sampling, the EDGG Biodiversity Plots provide a straightforward tool to assess beta diversity at the smallest scales (i.e. within 100 m²). As Polyakova et al. (2016) demonstrate, the *z*-values of the power-law SARs are a measure of standardised, multiplicative beta diversity, which allows comparisons of within-plot species turnover between EDGG Biodiversity Plots of different ecological conditions or regions (see also Dengler & Boch 2008; Turtureanu et al. 2014). Assessing beta diversity across larger spatial extents than 100 m², for example across 1 km² or 1000 km² in a comparable manner, is not straightforward with the EDGG sampling methodology because beta diversity values are largely determined by the spatial (and ecological) extent of the study universe (Chiarucci et al. 2009). The approach of constrained-rarefaction offers a way to make data from study regions of different spatial extent comparable (Chiarucci et al. 2009). However, even this would not account for potentially different ecological/syntaxonomical delimitations of the "study universe" in different field pulses (if, for example, in one only *Festuco-Brometea* were sampled and in another all types of semi-natural grasslands). Therefore, if the assessment of landscape-scale beta diversity is a major aim of a study, one should consider the appropriate placement of the EDGG Biodiversity Plots. One should decide on the landscape scale of interest, e.g. 200 km² (a circle with a radius of 7.98 km), in which the plots should be located randomly. In this respect E.4 can well be combined with E.3. If a less formal, *ad hoc* solution is required, one could think of placing a set of five (or another fixed number) EDGG Biodiversity Plots within the survey perimeter haphazardly, with the only restriction that each of these should represent a different grassland type or, if only one type is considered, come from a different grassland patch.

E.5 Non-terricolous taxa of the vegetation: Also saxicolous (species growing on rocks), lignicolous (species growing on deadwood) and epiphytic taxa (species growing on the bark or evergreen leaves of other plants) belong to the overall phytodiversity. Therefore, we recommend to sample also these taxa. Particularly, saxicolous bryophytes and lichens can contribute significantly to the overall richness in rocky grasslands (e.g. Boch 2005; Boch et al. 2016). Unfortunately, such sampling requires specific equipment (e.g. a knife to collect lignicolous and epiphytic species as well as a hammer and a chisel to collect samples of saxicolous lichens that cannot be identified in the field) and special expertise in the identification of these species. For non-experienced observers aiming at sampling non-vascular plants, one possibility might be the sampling of so called macro-cryptogams, which are easily discernible in the field (e.g. excluding crustose lichens and very small bryophytes). Their richness can be used as an indicator for the overall richness of cryptogams (Bergamini et al. 2005).

E.6 Animal taxa: Given the high potential value of multi-taxon studies to understand patterns and drivers of biodiversity (e.g. Allan et al. 2014; Zulka et al. 2014; Manning et al. 2015; Soliveres et al. 2016), it is highly desirable to also sample animal taxa, for which sampling at the given spatial scales makes sense and can be performed during a single visit. In any case, it must be decided which of the grain sizes can be sampled meaningfully, given that animals, unlike plants, are on the one hand mobile and on the other hand not always discernible even if they are present (i.e. records usually represent activity, not presence). In contrast to plants, typically only one or perhaps two of the standard grain sizes can be sampled and matched with the phytodiversity data. Vegetation structure and, in some cases, plant species composition and richness, have a strong influence on species composition, richness, activities and abundances of many above and belowground invertebrate taxa (Lawton 1983; Borges & Brown 2001; Birkhofer et al. 2011; Simons et al. 2014). For example, spiders as predators are influenced indirectly by

Photo 13. ***Sampling vegetation-dwelling spiders on a 100-m² EDGG Biodiversity Plot during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

changes in microclimatic conditions, prey abundance, sites for building webs, sheltering and/or oviposition (Gunnarsson 1990; Halaj et al. 1998; McNett & Rypstra 2000). Therefore, collaboration of botanists and zoologists in biodiversity assessments is highly desirable.

During the Field Workshop in Navarre, Spain, vegetation-dwelling **spiders (*Araneae*)** were sampled by N.Y.P. on the 100-m² plots with standard sampling methods, such as sweep-netting and hand collecting (Duffey 1974; ***Photo 13***). As the biodiversity plots are relatively small for sweep-netting, one sample of 15 sweeps was taken inside a given plot and three samples adjacent to it. Using repeated sweeps at the same plot is ineffective for spiders, as they fall on the ground and do not ascend into the vegetation again immediately. Some biodiversity plots could not be sampled because of an extremely low sward. Spider diversity data have not been analysed yet, but this sampling has led to the description of a new spider species (Kastrygina et al. 2016). Where it is possible (but this is evidently not the case during EDGG field pulses with only one visit per site), we recommend to start in early spring with pitfall trapping, using at least five traps per each EDGG Biodiversity Plot. The trap exposition may vary from 5–10 days monthly to a month. Spiders are recommended to be collected during the whole vegetation period because of the different seasonal activities and maturation times. If there is no opportunity to conduct such long-term studies, it is possible to limit them to spring and early summer. Sweep-netting is effective from late spring until mid-summer. The suction method using a Tullgren funnel is effective for plots with low vegetation in the same period. In general, it is preferable to add one autumnal sample. Quadrat samples (hand-collecting in 25 cm × 25 cm plots on the ground and/or litter layer) can reveal less mobile ground-dwelling species. This method can be particularly well combined with the vegetation data, as one can take as many samples as required inside a vegetation plot. To estimate the complete spider community in a given EDGG Biodiversity Plot, one would need to combine all the above-described methods.

Recently, students of the first author, including B.H., sampled **grasshoppers (*Orthoptera*)** in EDGG Biodiversity Plots (***Photo 14***). Given the relatively low number of species, *Orthoptera* are easier to identify than many other insect taxa. Phytophagous *Orthoptera* are usually polyphagous, meaning they are not limited to just one family of food plants but rather consume a wide range of plant species across different plant families. Therefore, it can be assumed that the occurrence of certain species of *Orthoptera* will not depend on the occurrence of certain plant species, but will rather follow factors like the microclimate, vegetation structure (Gardiner et al. 2002), plant-cover or land-use. The sampling of *Orthoptera* should take place during warm sunny days in late summer (August − September) to ensure detection of mostly imagines (which are easier to determine than juveniles). Days of sampling should not follow a day of intense rainfall. We used the sweep-netting method because it is the most rapid method in the field and does not require expensive equipment. The most commonly used net size is 38 cm diameter (Bomar 2001; Gardiner et al. 2005). Within each 100-m^2 EDGG Biodiversity Plot, first the NE-SW diagonal (i.e. the one through the corners without 10-m² vegetation plots) was swept by advancing one step forward after each sweep. By doing so, the sweeping of the diagonal was completed after about 15 consecutive sweeps. In addition, the whole 100-m^2 plot was sampled again three times by walking around and sweeping within the plot for about five seconds each time to ensure that the whole plot area was sampled. After each sweep the *Orthoptera* caught in the net were transferred into plastic boxes for subsequent identification and counting. While the described method generally worked well, it becomes problematic in vegetation plots with taller vegetation (>50 cm plant height), as the catching efficiency may be impeded by vegetation structure (Gardiner et al. 2005).

In the Swiss Biodiversity Monitoring, apart from vascular plants and bryophytes, also **land snails (*Gastropoda*)** are sampled on the same 10 m² plots (Koordinationsstelle BDM 2014). Other invertebrate groups that are potentially suitable

Photo 14. ***Sampling grasshoppers on a 100-m² EDGG Biodiversity Plot during an advanced student field course in NE Brandenburg, Germany, 2016 (Photo: J. Dengler).***

for inclusion in the EDGG Biodiversity Plots include **leafhoppers (*Auchenorrhyncha*)** (e.g. Primi et al. in press).

E.7 More and better standardised environmental data: Clearly, the greater the amount of standardised abiotic data that are associated with the recorded biodiversity data, the more analytical opportunities they offer. The EDGG sampling methodology requires parameters and measurement methods that generate reliable data during a single visit using limited time and resources. Among soil parameters, good candidates that were collected during some field pulses but not fixed as standard yet are electrical conductivity (EC), which is particularly relevant when sampling in arid areas or saline habitats, and H- and S-value, from which cation exchange capacity (CEC) and base saturation (BS) can be derived. If the EDGG Biodiversity Plots are distributed within a relatively narrow region and revisiting all of them within one or a few days of constant dry weather is feasible, also soil water-content (volumetric or gravimetric) would be a valuable parameter.

E.8 Quality assessment: There are relatively many studies (see review by Morrison 2016) that measured the impact of observer-related discrepancies in vegetation sampling and warn against the resulting biases in species richness, cover estimates, and visual estimates of other vegetation features. However, this issue is still surprisingly disregarded or overlooked in the vast majority of published researches based on analysis of plot-based data across spatial and environmental gradients. Nevertheless, most studies on observer-related error found mean values of pseudo-turnover (i.e. of the difference in species composition between two observers, or teams of observers, surveying the same plot) ranging from 10% to 30% (Morrison 2016). In a study with fine-scale plots in temperate European grasslands, Klimeš et al. (2001) found that the discrepancy in vascular plant richness between individual observers ranged from 10% to 20%. These figures are large enough to potentially bias statistical inference and to flaw the search for correlation between environmental variables and species richness. Many studies underlined that pseudo-turnover figures are much reduced when plots are surveyed by a team of botanists rather than by a single researcher. This is already a standard practice in the EDGG field workshops, where each “corner” of the nested series in an EDGG Biodiversity Plot is always surveyed by at least two people (thus the whole Biodiversity Plot is usually surveyed by 4−6 researchers), and the additional normal plots are similarly surveyed by a team of at least 2−3 people. On the other hand, it is to be taken into account that as the participants in EDGG field pulses typically come from many different countries, they will have very different (though often only moderate) levels of familiarity with the regional flora. This is a well-known source of pseudo-turnover, even if the researchers have a lot of experience in their own region, as shown already in 1972 by Tüxen (quoted in Klimeš et al. 2001).

Photo 15. *Plant determination, preparation of herbarium specimens, data correction and data entry during the EDGG Field Workshop in Serbia, 2016 (Photo: J. Dengler).*

Photo 16. *Collection of reference specimens for comparison during the EDGG Research Expedition in Khakassia, Russia, 2013 (Photo: J. Dengler).*

We consider that the quality of data obtained from the EDGG filed pulses is superior to that obtained in typical phytosociological studies for the following reasons: (a) we use clearly delimited plots and spend much more time on these than phytosociologists usually do; (b) at least two people jointly sample each plot; (c) the composition of sampling teams varies, while all participants sample all subtypes of grasslands in a region, (d) the participants of the field pulses always include several local organisers who are deeply familiar with the flora of the study region, as well as very experienced field botanists from many countries, with good knowledge also of vegetative traits of grassland plants, and they often participate on a regular basis, and (e) every evening the results of the determination of "critical" specimens, as well as the handling of taxonomically problematic taxa, are discussed among the groups, including a display of such specimens (***Photos 15−16***). These measures reduce errors of incomplete or erroneous species records (but cannot exclude them) and they effectively avoid systematic biases between grassland types or among study regions because the remaining errors should be distributed randomly. Since, however, we are so far not able to quantify how big these estimation errors are, we are planning a pilot project for the field pulse 2017 (Filibeck et al. 2016) to introduce some simple quality assessment (QA) procedures, i.e. to obtain estimates of the average pseudo-turnover in the dataset and include the results of this in the subsequent publications. Although thorough QA procedures may be very time-consuming, a reasonable trade-off could be double-sampling 10% of the 10-m^2 plots (cf. Kercher et al. 2003; Morrison 2016). The problem is more complex, however, for the smaller plots, where double-sampling procedures are faced with practical issues connected with trampling and specimen collection. In addition, the sampling protocol might be refined with some strategies (see e.g. Archaux et al. 2009; Burg et al. 2015; Morrison 2016) to reduce the potential for observer-related error, such as devoting the first day(s) to a thorough floristic training and "calibration" of the participants, with simulated plots; requiring that all plots > 1 m^2 have to be sampled by at least three observers; recording the time spent on each plot; frequently changing the composition of survey teams or reducing the number of plots studied per day to reduce the effects of fatigue.

Advantages of the EDGG sampling methodology

The major strength of the methodology is that it provides high-quality data for a multitude of different analytical procedures, namely vegetation classification (Dengler et al. 2012a; Pedashenko et al. 2013; Kuzemko et al. 2014), diversity-environment relationships (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016) and species-area relationships (Dengler & Boch 2008; Turtureanu et al. 2014). Other obvious options that have not been explored yet include relationships between species diversity, phylogenetic diversity and functional diversity, studies on assembly rules (environmental filtering vs. limiting similarity) or ecological niches, plus the multitude of possibilities that arise from joint analyses of the various consistent regional datasets across large biogeographic gradients. While the time needed for sampling (typically 1−6 hours for a team of 4−6 people for complete recording of an EDGG Biodiversity Plot) is significantly higher than for normal phytosociological sampling, our experience is that this investment pays off in higher data quality and a much wider range of analytical options.

The methodology can be used to study both the overall diversity of dry grasslands or of all grasslands of a region or to focus on specific environmental gradients. For example, Baumann et al. (2016) used it to study an elevational gradient in the Italian Alps, while two Bachelor students under the supervision of J.D. are currently analysing semi-natural grasslands along the full hydrological gradient with this approach.

One aspect that turned out to be particularly beneficial, albeit at first glance it looks like an inconsistency, is the combination of the EDGG Biodiversity Plots with additional 10 m² normal plots. This allows for a much higher replication at one particularly relevant grain size, resulting in the inclusion of rarer vegetation types and greater statistical power. While one might assume that in a combined analysis of 10 m² plots one should include only one of the two corners of the EDGG Biodiversity Plots, due to the risk of pseudo-replication, this was actually not the case in any of the analyses of biodiversity patterns we have carried out so far (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016). While the richness values of the two corners obviously showed spatial autocorrelation, no significant autocorrelation was present in the residuals of the regression models any more, allowing to use both corners in the final models. This means that if one samples, for example, 30 EDGG Biodiversity Plots and 40 normal plots, 100 10-m² plots with full environmental information become available for analysis.

Starting the sampling always with the smallest grain sizes, forces the researchers to see the grassland from the plant's perspective and to familiarize themselves with tiny and vegetative specimens, which also should improve the reliability and completeness of species records at larger grain sizes (***Photos 17−20***). This factor together with the option to analyse the data in many different directions makes this sampling design also particularly suitable for student courses at the Bachelor and Masters levels (***Photos 21−22***). For example, the first author regularly employs this method with his Bachelor classes in "Plant ecology" to study and compare grasslands of three different management/disturbance regimes on the campus of the University of Bayreuth. These classes last only 3.5 working days in total, spread over one week. After having developed hypotheses regarding the outcomes they expect, the students typically sample 18 EDGG Biodiversity Plots plus additional trait data, and prepare and analyse them. While they perform the sampling jointly, the analyses are carried out in four groups of four students: (a) scale-dependent species richness and SARs; (b) functional composition (fractions of life forms, community-weighted means of metric traits) vs. disturbance regime; (c) diagnostic species of management types, Ellenberg indicator values and vegetation classification; and (d) intraspecific trait variability between the management regimes (not directly related to the EDGG sampling approach, but sampled on the same plots). At the end of the week, the students present the results of their group's work to the other groups and discuss them. Overall, the students who at the beginning of the week often hardly knew any of the common grass and forb species, could not only distinguish them with and without flowers, but got deep insights into some of the core methods and theories of plant community ecology.

Limitations of the EDGG sampling methodology

As is true for any other sampling approach, there are always options to improve certain steps, but this usually comes with significant additional effort and might compromise other aspects of the sampling. One always has to weigh the potential benefits of a modification against the "costs". For example, adding 1000 m² or an increasing replication towards smaller scales would be highly desirable from our perspective (see above), but the additional effort necessary has so far precluded the adoption of these during the field pulses, because otherwise the dataset that could be sampled within the limited duration with a limited team of observers available would get too small for meaningful analyses. The unavoidable "imprecision" of shoot presence sampling has led others to opt for the precise rooted presence sampling (e.g. Peet et al. 1998), but at the cost that SAR analyses become problematic (see Dengler 2008). Methodologically, the biggest limitation is that we sample abiotic parameters only at one spatial scale (10 m²) and use this as a proxy for the abiotic conditions within the smaller grain sizes. This is a reasonable approximation, but still problematic if one of the aims is to explore the varying drivers of biodiversity across spatial scales. This fact might partly also explain why the explanatory power of our diversity-environment relationships strongly decreases towards the smallest scales (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016). However, the sampling of e.g. soil data separately for each grain size would create a prohibitive effort and is practically impossible for the smallest grain sizes. Lastly, one major limitation arises from the fact that during the EDGG Field Workshops we can visit the plots only once, meaning that certain data can only be approximated (e.g. land-use or diversities of the majority of animal taxa), not measured at all (e.g. the important factor: soil moisture regime), or are essentially only comparable within a dataset but not between datasets (e.g. biomass).

Conclusions and outlook

The EDGG sampling methodology was devised to be an effective multi-purpose sampling strategy. Since its first application during the Research Expedition in Transylvania (Dengler et al. 2009, 2012a) it has proven to fulfil this expectation quite well. The experiences of many of the researchers in-

Photo 17. ***One of the richest 0.1-m² subplots of an EDGG Biodiversity Plot during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

Photo 18. ***Learning to know the species in one of the first EDGG Biodiversity Plots during the EDGG Research Expedition in Khakassia, Russia, 2013 (Photo: J. Dengler).***

Photo 19. ***Detailed searching for plants in an 1-m² subplot of an EDGG Biodiversity Plot during the EDGG Field Workshop in Serbia, 2016 (Photo: J. Dengler).***

Photo 20. ***Thorough search for tiny plants in and EDGG Biodiversity Plot during the EDGG Field Workshop in Navarre, Spain, 2014 (Photo: J. Dengler).***

Photo 21. ***Sampling of an EDGG Biodiversity Plot with a Bachelor-level practical course in plant ecology on the lawns of the University of Bayreuth, Germany, 2016 (Photo: J. Dengler).***

volved, both in the field and during data analysis over the years, led to numerous small modifications and additions, while leaving the overall approach untouched. It has been shown to provide high-quality data for a wide range of different research questions at the regional scale, while at the same time accumulating a highly consistent dataset across the Palaearctic biogeographic realm (Dengler et al. 2016) that promises exciting macroecological studies that are yet to be done.

While most of us have a strong phytosociological background, we have to admit that the phytosociological tradition contains many methodological aspects that are not optimal from our present-day knowledge, yet are rarely questioned (e.g. using varying plot sizes, not precisely delimiting the plots, Braun-Blanquet scale instead of direct estimation of percentage cover, etc.). Re-evaluating these, but avoiding throwing the baby out with the bath water, led to our current approach, which in nearly every tiny detail deviates from standard phytosociological practices (e.g. Dierschke 1994). Still our data are perfectly suited for phytosociological classifications (Dengler et al. 2012a, Pedashenko et al. 2013, Kuzemko et al. 2014), but at the same time also for many other questions, such as vegetation-environment relationships, scaling laws in ecology, relationships between different facets of biodiversity, and many more. The time effort is certainly higher than for classical phytosociological sampling (Mucina et al. 2000; Dengler et al. 2008), but the additional time pays off, in our experience, which is corroborated by the fact that people outside the EDGG are applying it (e.g. Mardari & Tănase 2016; unpublished studies of A.C.'s group).

One of the major strengths of the approach is certainly its modularity. There is a core set of well-justified elements that can be reduced, augmented or modified, depending on the specific needs and resources, while still keeping full comparability to an increasing body of reference data and published studies (see Dengler et al. 2016). We hope that many readers will feel inspired to apply the EDGG sampling methodology, and inform us of their experiences, as well as suggestions for further improvements, and possibly contribute their data to our collaborative database for cross-site studies.

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Author contributions

J.D. proposed the general idea of the sampling in 2008, "invented" the EDGG Field Workshops in 2009 and since then

Photo 22. ***A group of "grassland managers" showing some interest in an EDGG Biodiversity Plot during a Master-level field course in NE Brandenburg, Germany, 2016 (Photo: J. Dengler).***

has coordinated them, supported by I.B. as EDGG Deputy Field Workshop Coordinator. C.M. had the idea for this article, the writing of which was led by J.D. S.B. and G.F. contributed significant parts to the manuscript, B.H. and N.Y.P. the information on zoological sampling, while all others made smaller contributions of text and illustrative material and helped revise the text.

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Forum

Short communication

Here we present a recently published paper that highlights important conflicts between existing European policies to mitigate climate change by increasing carbon sequestration on the one hand, and grassland biodiversity conservation on the other. This issue is extremely important for conservationists and policy makers, and we believe it is also of high interest to grassland ecologists.

Burrascano, S., Chytrý, M., Kuemmerle, T., Giarrizzo, E., Luyssaert, S., Sabatini, F.M. & Blasi, C. 2016. **Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity.** Biological Conservation, 201: 370-376.

Very often, climate change mitigation policies support the expansion of forest area as a tool to offset CO_2 emissions from deforestation and combustion of fossil fuels and this increase is also perceived as creating benefits for biodiversity conservation. However, the gain in biodiversity is strongly context-dependent, and in Europe, the increase in forest extent is frequently at the expense of low-intensity managed grasslands, which have a great relevance for biodiversity conservation.

Forests and grasslands are strictly linked through both spatial and dynamic relations and the expansion of forests to semi-natural grasslands can be due to either the grassland abandonment followed by spontaneous succession towards woody vegetation or deliberate afforestation programmes promoted by the carbon-centered policies of the European Union or individual member states. For instance, between 1990 and 2015, EU-27 forests underwent a 12.9 million hectare (Mha) expansion on abandoned agricultural land, of which > 1.5 Mha were deliberately afforested, including large areas of semi-natural grasslands. Both deliberate afforestation and natural expansion of forest may support forest-dwelling species and carbon storage, but especially afforestation often has negative outcomes in terms of both soil carbon storage and biodiversity when it happens in semi-natural grasslands.

In our research, we found a striking ambivalence between European policies and funding schemes addressing grassland conservation on the one hand (e.g. Habitats Directive, green payments within the Common Agricultural Policy) and those supporting afforestation on the other (e.g. rural development funds). Since the current land-use trends are still towards the abandonment of marginal farmland with the consequent increase in forest area, carbon-centered measures that further promote and allocate funding to afforestation may only marginally contribute to the international commitments to mitigate climate change. At the same time, they can result in a substantial decline in biodiversity and fewer ecosystem services.

We therefore advocate a better harmonization of the EU policies that target forest and grassland ecosystems, and propose three measures that could contribute to more effective policy making: (1) promoting the alignment of the decisions taken across different policy sectors; (2) focusing on the whole range of ecosystem services and biodiversity issues rather than on carbon management only; (3) appraising low-intensity managed systems for their multifunctionality.

Eleonora Giarrizzo

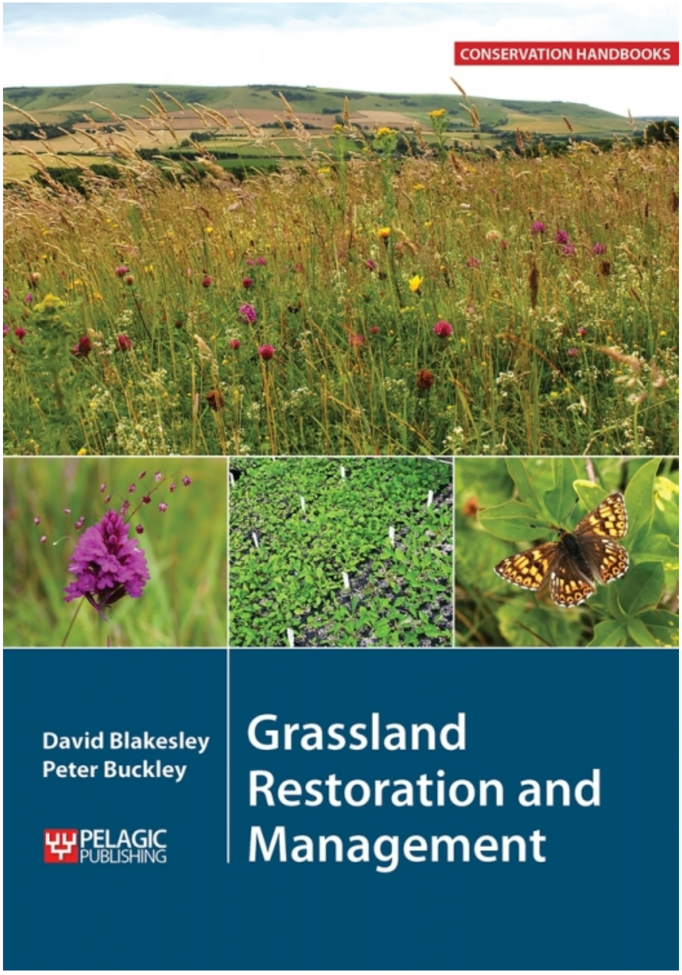
Contact details:
eleonora.giarrizzo@uniroma1.it

Sabina Burrascano:
sabina.burrascano@uniroma1.it

Colonization by shrubs in a semi-natural grassland in the Apennines (Central Italy), a situation that can happen when the management of grasslands come to an end (Photo: S. Burrascano).

Book Review

Here we present recently published books that might be relevant for grassland scientists and conservationists, both specific grassland titles and faunas, floras or general books on ecology and conservation biology. If you (as an author, editor or publisher) would like to propose a certain title for review, or if you (as an EDGG member) would like to write a certain review (or reviews in general), please contact the Book Review Editor (anya_meadow@i.ua).



Blakesley, D. & Buckley, P. 2016. Grassland Restoration and Managemant. - 272 pp., Pelagic Publishing, Exeter. ISBN: 978-1-78427-078-0. 34.99£

This book is a new and interesting addition to the "Conservation Handbook Series" by Pelagic Publishing. In this book, dry grassland conservation and restoration perspectives are in the spotlight, thus it can be a useful and interesting reference for all the members of the Eurasian Dry Grassland Group. The topic is in line with the themes of the EDGG, which is well reflected in recent EDGG-edited special features on the importance, conservation and restoration of steppes and semi-natural grasslands (Dengler et al. 2014; Becker et al. 2016; Török et al. 2016; Valkó et al. 2016; Wesche et al. 2016).

The book is pioneering in many ways, as it provides a comprehensive overview of the conservation status, threats and nature conservation and restoration perspectives of dry grasslands in the United Kingdom. There is an urgent need for such books on grassland restoration and management in many regions. This publication is a nice example to follow, and hopefully similar syntheses will be published in other countries as well.

The book guides us to the field of grassland restoration and management through seven chapters totalling 191 pages. Initially, the authors give a comprehensive overview of grassland types in the United Kingdom based on the National Vegetation Classification (Rodwell 1992), with links to the Natura 2000 habitat types as well. The chapter about grassland wildlife identifies species of special conservation interest in the UK and also those habitat features, which are important for these species. Authors also provide guidelines for biodiversity assessment, including habitat and wildlife surveys, with references to several protocols and guidelines. After these introductory parts, chapters 3-7 deal with the management and restoration of grasslands. First, management methods, such as grazing, mowing, shrub control and herbicide application, are discussed. Probably the most interesting part is about grazing, with detailed guidelines for stocking rates, timing and duration of grazing and challenges for animal husbandry. Chapters 4 and 5 give a comprehensive overview of the threats, challenges and opportunities for grassland restoration. Chapter 6 discusses questions on the plant material used in restoration, such as the origin, species composition and ecological traits of the species used and the methods of their introduction into the restoration sites. Finally, chapter 7 deals with determining the success of grassland restoration, in terms of monitoring short and long-term restoration success and cost-effectiveness analyses.

The focus of the book is clearly on the United Kingdom, but reference is made to several international researches. I am sure that the findings are important and informative for readers outside the United Kingdom as well. One minor criticism is that species are mentioned in their English common names and Latin names are only given in the Species index, which is rather challenging for readers whose mother tongue is not English. But to sum up, this is a comprehensive and practice-oriented book, which can be recommended for conservationists, site managers and also for scientists who are concerned with the conservation and restoration of grassland habitats.

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Török, P., Ambarlı, D., Kamp, J., Wesche, K. & Dengler, J. 2016. Step(pe) up! Raising the profile of the Palaearctic natural grasslands. *Biodiversity and Conservation* 25: 2187-2195.

Valkó, O., Zmihorski, M., Biurrun, I., Loos, J., Labadessa, R. & Venn, S. 2016. Ecology and conservation of steppes and semi-natural grasslands. *Hacquetia* 15: 5-14.

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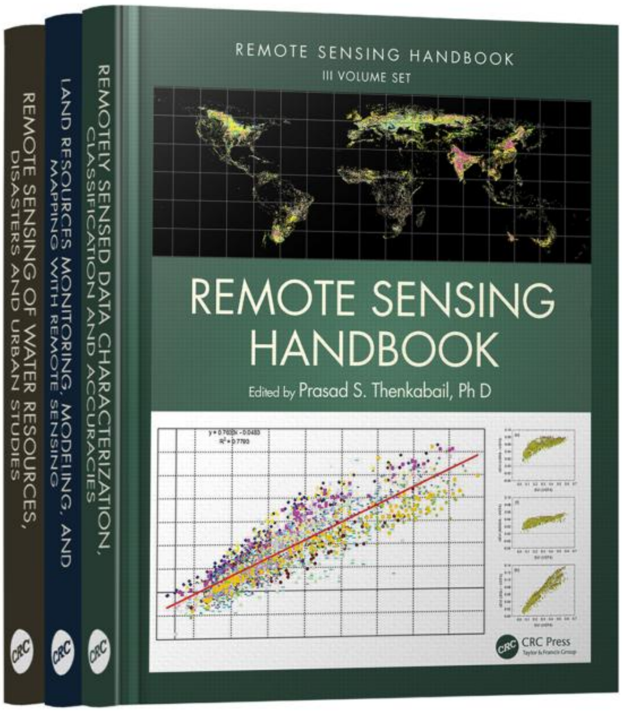
Orsolya Valkó , Debrecen, Hungary

valkoorsi@gmail.com

Specific biodiversity-friendly management in the Csik Mts.—the site of post-conference excursion of the EGC. (Photo: M. Janišová).

Book Review



Thenkabail, P.S. (Ed.) 2015. Remote Sensing Handbook - Three Volume Set. - 2200 pp., CRC Press, Taylor & Francis, Boca Raton, Florida. ISBN: 9781482218015. 409.00£ (Hardback).

GIS and remote-sensing form an integral part of our life these days. Beside everyday applications, such as navigation, smart phone applications relying on GIS technology, browsing the images provided by Google Earth or just checking the weather forecast, it is becoming more and more widely available for practical and scientific purposes, such as nature conservation and ecological uses. The substantial improvements regarding the technology and methodology of data acquisition and classification has resulted in an enormous amount of knowledge on remote sensing in the past decades. Given the fact that remote-sensing is getting to be widely used in nature conservation in recent years, exciting reviews have been published on the application possibilities of remote-sensing in habitat-mapping and monitoring (Vanden Borre et al. 2011; Nagendra et al. 2013). However there has been an urgent need for a synthesis of the most up-to-date developments and application possibilities in remote-sensing. The *Remote Sensing Handbook* can definitely fill this gap. The 82 chapters and 2200 pages, written by an international team of renowned leading experts in the field, provides a fully comprehensive reference material on the topic, from theory to practice. The book contains 942 colour and 321 black-and-white illustrations to support the readers in the visualisation of the methodology, the applied workflow and the results. This gigantic work has been coordinated and edited by Prasad S. Thenkabail (United States Geological Survey), an internationally acknowledged expert in the field of remote-sensing.

The three-volume *Remote Sensing Handbook* summarises the scientific and methodological evolution in remote-sensing during the past 50 years, and gives an overview on the state-of-the-art fundamental and practical knowledge on the topic.

The "*Remotely Sensed Data Characterization, Classification, and Accuracies*" volume introduces the existing remote-sensing platforms and sensors, as well as advances in data calibration, normalization, harmonization and synthesis. The chapters about image-processing methods and approaches, together with the detailed review on vegetation indices, can be particularly useful for phytosociological and ecological studies. Furthermore the volume provides theoretical and practical information on object-based image analysis and geo-spatial data integration; change detection techniques; geo-processing, GIS, and GIScience; GNSS applications; crowd-sourcing and cloud computing; Google Earth for Earth Sciences; map accuracies and up-to-date information on remote -sensing law and space law.

Maybe the "*Land Resources Monitoring, Modeling, and Mapping with Remote Sensing*" volume, dealing with several biodiversity, ecology and land-use related topics, is the most exciting for ecologists. Several chapters provide precise methodological descriptions and case studies about habitat mapping and monitoring, above ground biomass measurements and modelling, biodiversity detection, habitat quality measurements using remotely-sensed data. The chapter "Ecological characterisation of vegetation using multisensor remote sensing in the solar reflective spectrum" provides a brief history of key optical sensors applied in vegetation mapping and application possibilities of optical sensors in the detection of vegetation structure and function. The reader can find further information on land-use and land-cover mapping; application of remote-sensing in agricultural systems, food security analysis, soil studies and measuring photosynthesis from space.

The "*Remote Sensing of Water Resources, Disasters, and Urban Studies*" volume provides a fully comprehensive overview of the application of remote-sensing in the field of hydrology, water resources, floods, water use and water productivity; wetland modelling, mapping, and characterization; snow and ice studies; drought and dryland monitoring and mapping; volcanoes, coal fires, and greenhouse gas emissions; urban remote-sensing for disaster risk management and remote-sensing for the design of smart cities.

Actually, after reading this book I had the impression that the title of the book might be changed to "All you wanted to know about remote-sensing– a handbook for experts and practitioners". Given its breadth, depth, carefully constructed structure and easily readable style, the handbook is an indispensable reference for a wide audience interested in remote-sensing. On the one hand it provides very detailed and up-to-date information for professionals who would like to have an in-depth view of the present state-of-the-art of remote-sensing science and technology development. On the other hand, the self-contained thematic chapters of the handbook provide an essential reference for practitioners who would like to focus on a specific topic, about which they would like to find a basic theoretical knowledge and guidance on application possibilities. And last but not least, the volumes of the book can effectively be used for education purposes given the wide range of topics covered by the chapters and its clear and readable style. All volumes contain several chapters focusing on ecological problems, such as vegetation mapping, estimation of biomass and biodiversity, habitat quality assessment, habitat modelling and many other related topics. Advanced image-based algorithms and their applications described in the book have the potential to extend the spatial and temporal limits and resolution of ecological studies.

The applicability of remote-sensing to grassland ecosystems was demonstrated by several case studies from Pannonian alkali grasslands. Alkaline grasslands being one of the most complex grassland habitats in Europe, with a fine-scale mosaic of several plant associations, are suitable objects for testing remote-sensing applications (Török et al. 2012; Valkó et al. 2014). In their studies, Deák et al. (2014) differentiated eight typical alkali plant associations solely based on their vertical position along an elevation gradient in an alkaline landscape using digital terrain models derived from airborne laser-scanned (ALS) data. Another approach for vegetation mapping in grasslands characterised by elevation differences is to apply topographical indices, such as Topographic Wetness Index (TWI) and Topographic Position Indices (TPI), derived from ALS data (see Alexander et al. 2016). Multi-temporal full waveform ALS data has a high potential not only for mapping grassland habitats, but for mapping their nature conservation status even in a landscape level (Zlinszky et al. 2015). Beside ALS data, which provides fine resolution structural data from the studied area (such as plant height, elevation, vegetation cover and patterns), hyperspectral remote-sensing can also be a feasible tool for vegetation classification and mapping. Spectral attributes of the environment and the vegetation can be effectively used for differentiating vegetation groups with different photosynthetic activity and biomass (Burai et al. 2015).

An important advantage of the application of remotely sensed data is that it allows testing conventional hypotheses in a much broader scale and it also supports the testing of novel hypotheses related to e.g. changes in plant leaf traits or primary production on a regional level, which would not be possible without this technique. Besides that the chapters introduce a number of cutting-edge methodologies, this book also provides up-to-date examples of case studies, which can further contribute to the in-depth understanding of the work-flow, and support planning and implementation of one's own projects.

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Balázs Deak, Debrecen, Hungary

debalazs@gmail.com

Forthcoming events

8th Planta Europa conference "Save Plants for Earth's Future"

22-26 May , 2017, Kyiv, Ukraine

Host organisations will be the O.V. Fomin Botanical Garden of the Taras Shevchenko National University of Kyiv, M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine and M.M. Gryshko National Botanical Garden of the National Academy of Sciences of Ukraine.

The conference webpage http://8peconference.in.ua

10th EDGG Field Workshop

3–11 June 2017, Central Apennine Mts., Italy,

For more information see Bulletin 31

60th Symposium of the International Association for Vegetation Science (IAVS)

20-25 June 2017, Palermo, Italy

The meeting webpage is not yet available.

The theme will be "Vegetation patterns in natural and cultural landscapes". The pre-symposium excursion will be from June 11–18 (Sunday–Sunday). The focus will be on coastal landscapes of Sicily: Along the Sicilian coast, from Capo San Vito (NW Sicily) to Capo Passero (SE Sicily), including two days on the Island of Marettimo (max 30 participants). The post-symposium excursion will be from June 25–July 1 (Sunday–Sunday) and will visit the Sicilian Mountains (for well-trained hikers): Etna, Nebrodi, Madonie (max 30 participants). The symposium venue will be the Palermo Botanical Garden.

14th Eurasian Grassland Conference

4-9 July 2017, Latvia/Lithuania

The meeting webpage is not yet available.

More information at the pages 10-11

37th Eastern Alpine and Dinaric Society for Vegetation Ecology Meeting

13-16 July 2017, Prizren, Kosovo

The symposium is organised by the Eastern Alpine and Dinaric Society in collaboration with: University "Haxhi Zeka" of Peja, Republic of Kosovo (http://unhz.eu/) University "Ukshin Hoti" of Prizren, Prizren, Republic of Kosovo (http://uni-prizren.com/)

The meeting webpage http://www.eadsve.org/

26th European Vegetation Survey Meeting

13-16 September 2017, Bilbao, Spain

The meeting will be hosted by the University of the Basque Country (Javier Loidi and colleagues).

The meeting webpage is not yet available.

Second Interdisciplinary Symposium 'Biogeography of the Carpathians'

27-30 September 2017, Cluj-Napoca, Romania.

The symposium webpage is not yet available

ComEc -the First Conference on Community Ecology

28-29 September 2017, Budapest, Hungary

The First Conference on Community Ecology is the opening of a conference series accompanying the journal Community Ecology. The scientific focus is quite wide, presenting all aspects of community ecology and its connections to landscape ecology, multivariate statistics, systems ecology, vegetation science, macroecology and many other fields.

The conference webpage https://e-conf.com/comec2017/registration/

27th European Vegetation Survey Meeting

spring 2018, Wrocław, Poland

The meeting will be hosted by University of Wrocław (Zygmunt Kącki and colleagues).

61th Symposium of the International Association for Vegetation Science (IAVS)

23-27 July 2018, Bozeman (Montana), U.S.A.

The meeting webpage is not yet available.

Photos: J. Dengler

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Important dates: The deadline for Bulletin 33 is 15 November 2016

Bulletin 33 to appear: December 2016

EDGG on the web: **http://www.edgg.org**

EDGG in Facebook: **https://www.facebook.com/groups/938367279561202**

Spialia orbifer* *(Photo: D. Ambarlı)