

Session 'Describing biodiversity patterns' / ORAL

CALCULATING GENERALIZED ENTROPY AS A MEASURE OF LANDSCAPE DIVERSITY IN AN OPEN SOURCE SPACE

Duccio Rocchini^{1,*}, Luca Delucchi¹, Giovanni Bacaro², Paolo Cavallini³, Hannes Feilhauer⁴, Giles M. Foody⁵, Kate S. He⁶, Harini Nagendra^{7,8}, Claudio Porta^{9,10}, Carlo Ricotta¹¹, Sebastian Schmidtlein⁴, Lucio Davide Spano^{9,10}, Martin Wegmann¹², Markus Neteler¹

¹ Fondazione Edmund Mach, Research and Innovation Centre, Department of Biodiversity and Molecular Ecology, GIS and Remote Sensing Unit, Via E. Mach 1, 38010 S. Michele all'Adige (TN), Italy, ² BIOCONNET, Biodiversity and Conservation Network, Department of Environmental Science "G. Sarfatti", University of Siena, Via P.A. Mattioli 4, 53100 Siena, Italy, ³ Faunalia, Piazza Garibaldi 5 - 56025 Pontedera (PI), Italy, ⁴ Department of Geography, University of Bonn, Meckenheimer Allee 166, DE-53115 Bonn, Germany, ⁵ School of Geography, University of Nottingham, University Park, Nottingham NG7 2RD, UK, ⁶ Department of Biological Sciences, Murray State University, Murray, Kentucky 42071, USA, ⁷ Ashoka Trust for Research in Ecology and the Environment, 659 5th A Main Hebbal, Bangalore 560024, India, ⁸ Center for the Study of Institutions, Population, and Environmental Change, Indiana University, 408 N. Indiana Avenue, Bloomington, IN 47408, USA, ⁹ ISTI-CNR, HIIS Lab, Via Moruzzi 1, 56124 Pisa, Italy, ¹⁰ Università degli Studi di Pisa, Dipartimento di Informatica, Largo B. Pontecorvo, 3, I-56127 Pisa Italy, ¹¹ Department of Plant Biology, University of Rome "La Sapienza", Piazzale Aldo Moro 5, 00185 Rome, Italy, ¹² University of Würzburg, Institute of Geography, Department of Remote Sensing, Remote Sensing and Biodiversity Research, Am Hubland, 97074 Würzburg, Germany
(corresponding author: duccio.rocchini@iasma.it, ducciorocchini@gmail.com)

Keywords: biodiversity, Free and Open Source Software, landscape heterogeneity, remote sensing, Rényi generalized entropy

Landscape diversity generally relates to species diversity at a range of ecological levels, such as species community diversity and genetic diversity. Species-based measures of diversity such as species richness or species turnover are the most commonly used metrics for quantifying the diversity of an area.

Nonetheless, the assessment of species diversity in relatively large areas has always been a challenging task for ecologists, mainly because of the intrinsic difficulty in judging the completeness of species' lists and in quantifying the sampling effort. Since the variability in the remotely sensed signal is expected to be related to landscape diversity, it could be used as a good proxy of diversity at the species level.

However, free and open source tools (tools that allow access to the source code) for assessing landscape heterogeneity at different spatial scales are still lacking today. In this study, we aim to achieve the following: i) provide a theoretical background of the most commonly used diversity indices stemming from information theory that are commonly applied to quantify landscape heterogeneity from remotely sensed data and ii) propose a free and robust Open Source tool (*r.diversity*) consisting of source code (running in GRASS GIS) for calculating diversity indices. In particular, we will focus on Rényi generalized entropy as a continuum of diversity measures. While traditional metrics supply point descriptions of diversity, in Rényi's framework, there is a continuum of potential diversity measures, which differ in their sensitivity to rare and abundant.

As far as we know, this is the first example in which Rényi entropy is provided in an open source framework. Hence, *r.diversity*'s code is available from the GRASS GIS source code repository (<http://svn.osgeo.org/grass/grass-addons/raster/r.diversity/>) for further modifications and for potential re-use in the development of new indices based on new or underused mathematical theory.

We expect that the theme proposed in this study will stimulate discussions regarding the opportunities offered by free and open source Software to calculate landscape diversity.

Session 'Describing biodiversity patterns' / ORAL

ROOT SEQUENCING DOUBLES SMALL-SCALE PLANT RICHNESS MEASURES AND ALTERS DIVERSITY PATTERNS

Inga Hiiesalu¹, Maarja Öpik¹, Madis Metsis², John Davison¹, Martti Vasar¹, Mari Moora¹, Martin Zobel¹, Scott D. Wilson³, Meelis Pärtel¹

¹ University of Tartu, Department of Botany, Tartu, Estonia; ² Tallinn Technical University, Centre for Biology of Integrated Systems, Tallinn, Estonia; ³ University of Regina, Department of Biology, Regina, Canada. (corresponding author: Inga Hiiesalu, Email: Inga.Hiiesalu@ut.ee)

Keywords: 454 sequencing, belowground, grassland, root community, species coexistence

Plant species richness data exclusively describes aboveground vegetation; roots and rhizomes have never been included in richness measurements of natural plant communities. We measured the total number of coexisting plant species as well as the aboveground richness and the number of species additionally identified belowground. We made direct comparisons between above- and belowground richness of vascular plants in identical volumes (0.1 x 0.1 x 0.1 m) above and below the soil surface, using conventional species identification to measure aboveground richness and 454 sequencing of the chloroplast *trnL*(UAA) intron to measure additional belowground richness. Taxa detected using DNA-based identification of roots increased total small-scale plant richness up to two times that of aboveground richness alone. Newly-detected belowground richness increased strongly with soil fertility, a result contrary to the negative productivity-diversity relationships that are widely reported for aboveground vegetation. Our results indicate that conventional approaches to plant diversity measurements may overlook many species coexisting at a small scale. We also show that belowground diversity becomes relatively more important in conditions where aboveground diversity decreases. Measuring plant belowground diversity will profoundly alter perceptions of biodiversity and its response to both natural and anthropogenic factors.