Darius Görgen, Mohammed Ahmed Muhammed, Dennis Salwiczek, Alexandros Tsimtsiliakos , Michael Wagner
Github-Gruppe: AxMiDeDa
Dozent: Dr. Christoph Reudenbach
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Master Physische Geographie WS18/19
Geographic Information Systems

Philipps Universität Marburg

Introduction

Geographical Information Systems (GIS) allows researchers and users to retrieve spatially comprehensive and accurate data about various indicators associated with biodiversity, forest management and monitoring of natural resources. Their uses are widely recognized also outside academia, especially with practitioners as well as with decision makers. Digital data changes the way we perceive and manage our environment. However, the usefulness of GIS is subject mainly to three factors. These are the quality and accuracy of the spatial data incorporated in a GIS, the abilities of the people generating information from data and the way results are communicated to a specific audience. Here, we present our findings on a structural analysis of the University Forest Caldern which are based on RGB images and LiDAR data as well as the associated workflows to create insights into the structure of a forest ecosystem.

Tree Segmentation based on Forest Tools Package in R

The Forest Tools package in R takes a Canopy Height Model and applies a search function for a pixel to start a watershed-growing algorithm. Here, we used a simple linear equitation of the form $W = m * x + b$. In order to optimize the segmentation a search pattern for the parameters over structurally distinct forest areas was implemented.

Tab.1: Ratios for calculated parameters

Index	m = 0.155			m = 0.05			m =0.085			m = 0.1		
b = 1.2	hit	over	under	hit	over	under	hit	over	under	hit	over	under
Val1	0.58	0.21	0.20	0.40	0.58	0.02	0.60	0.38	0.02	0.48	0.47	0.04
Val2	0.50	0.31	0.19	0.68	0.26	0.07	0.47	0.14	0.39	0.38	0.19	0.44
Val3	0.65	0.25	0.10	0.005	0.13	0.42	0.50	0.45	0.05	0.45	0.13	0.42

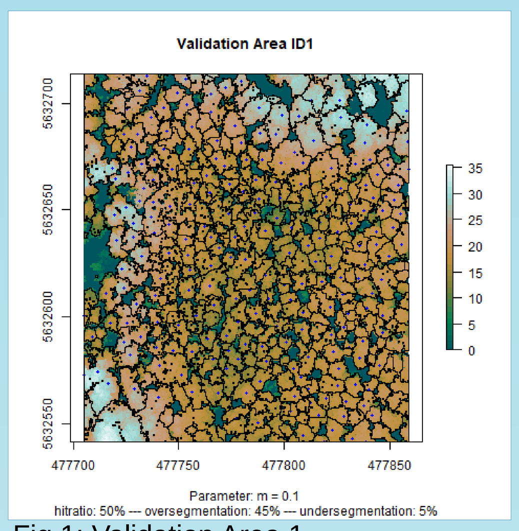


Fig.1: Validation Area 1

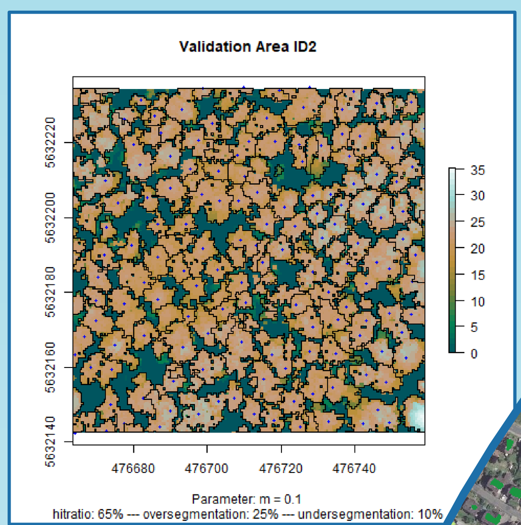


Fig.2: Validation Area 2

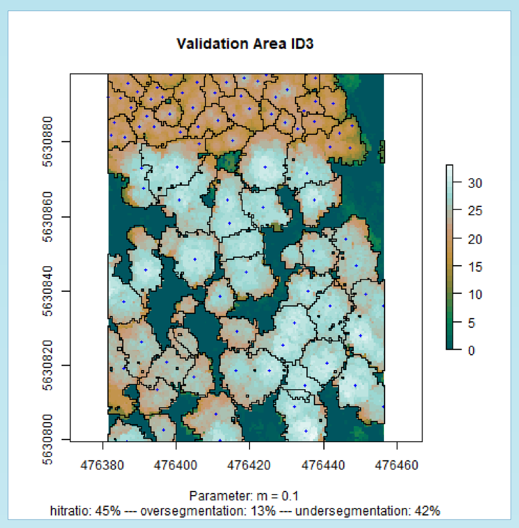
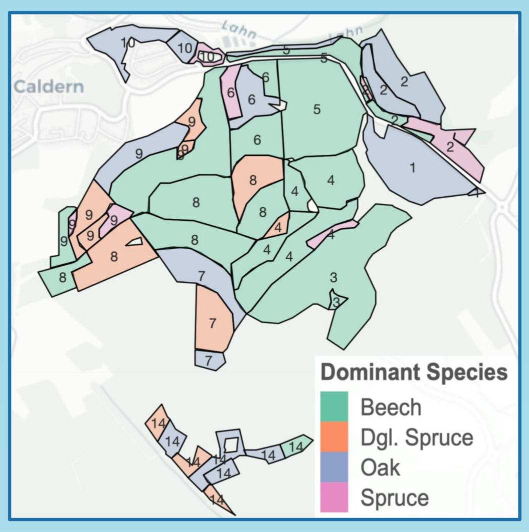
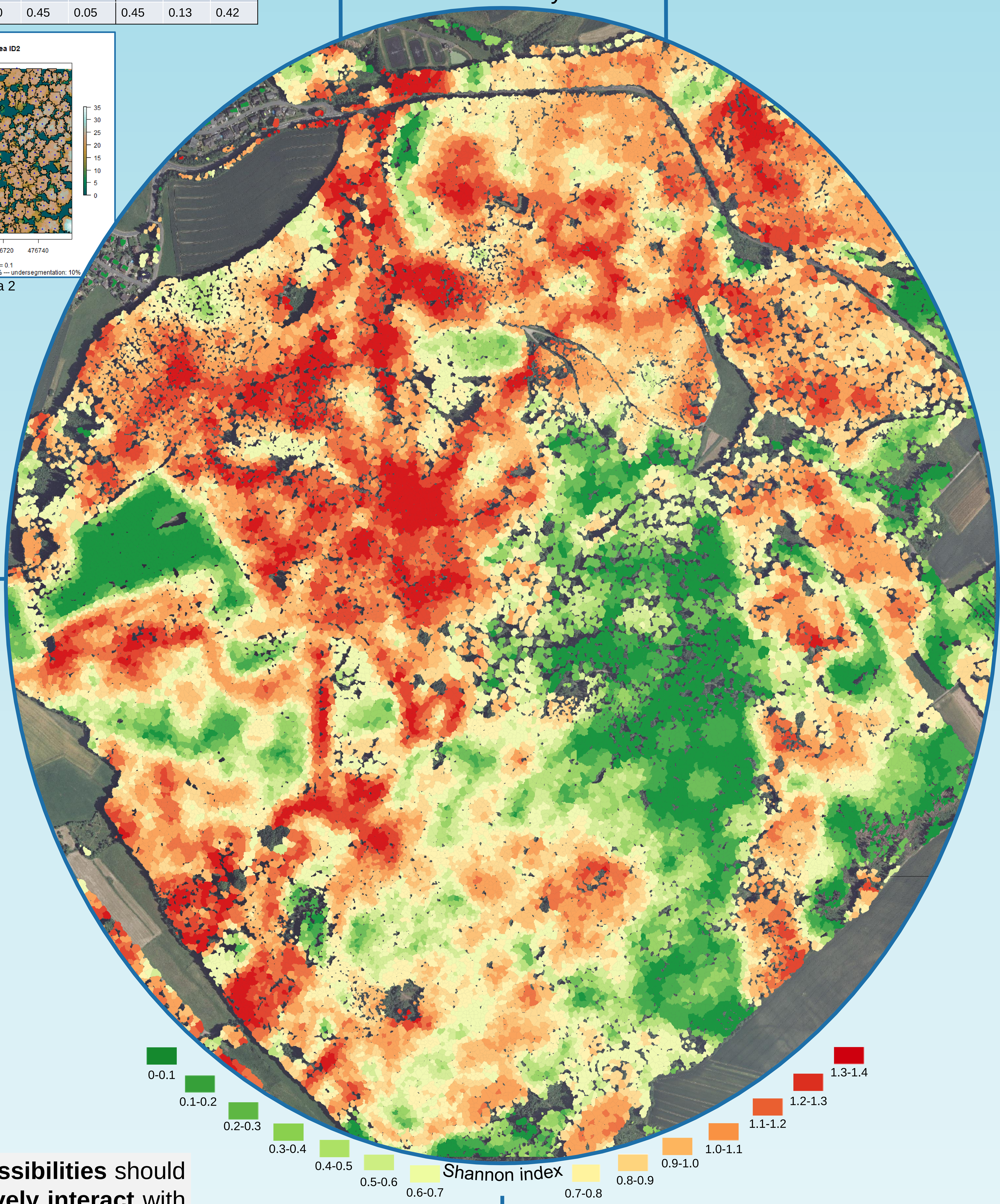


Fig.3: Validation Area 3

Area of Interest Dominant Species



Biodiversity



Biodiversity and Stand Density

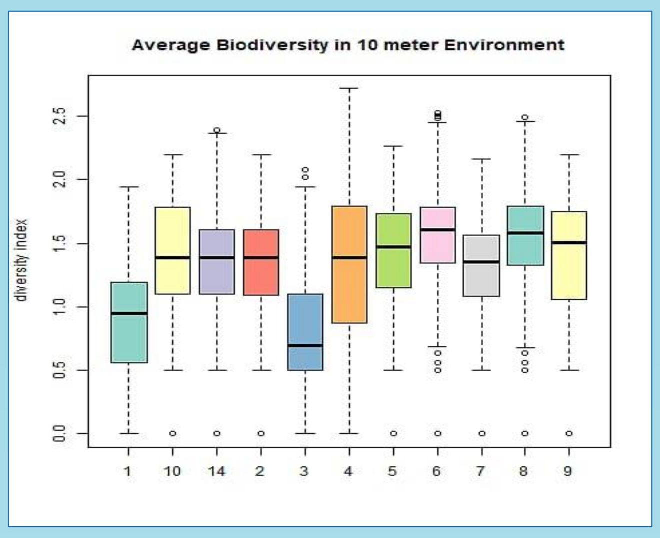


Fig.4: Average Biodiversity in 10m

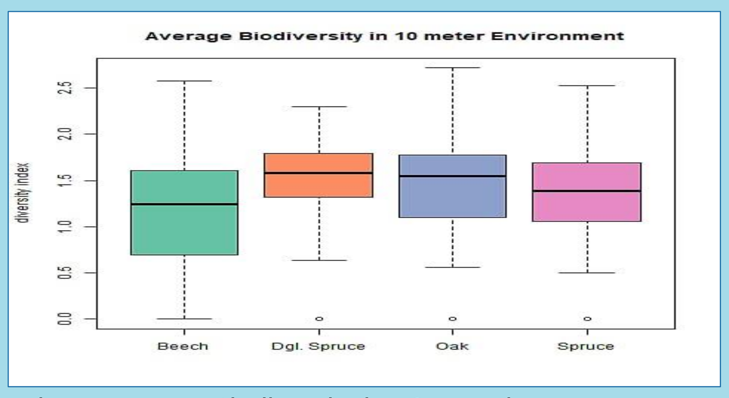


Fig.5: Average Biodiversity in 10m Environment by Species

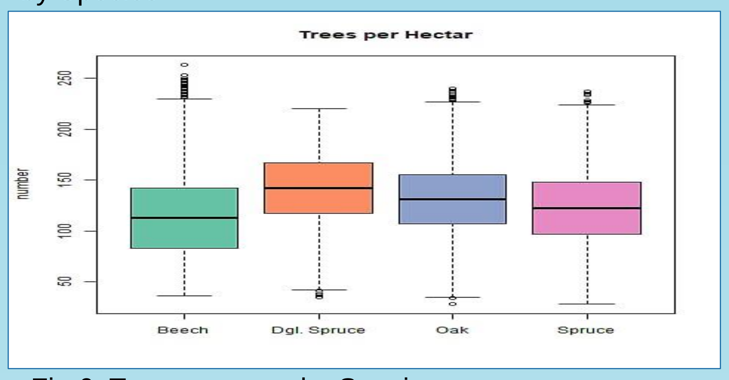


Fig.6: Trees per acre by Species

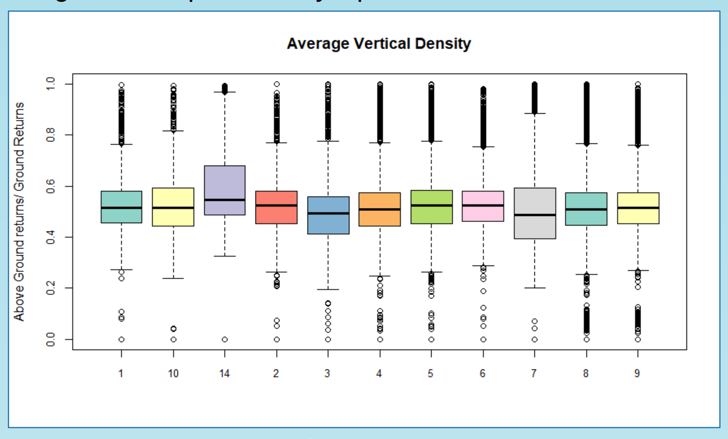


Fig.7: Average Vertical Density

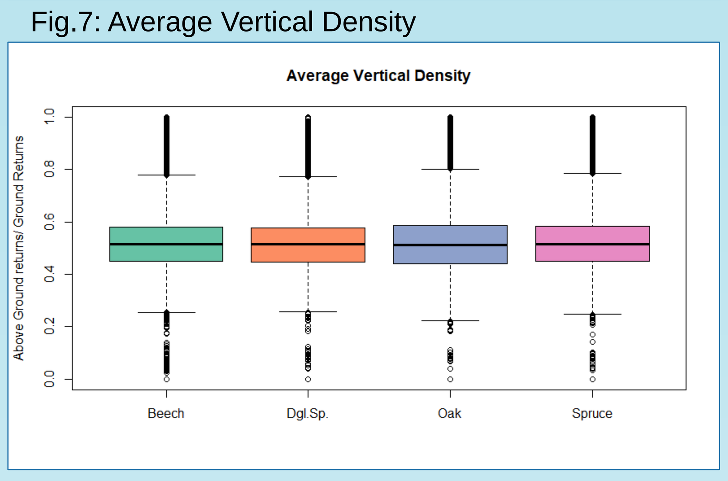


Fig.8: Average vertical Density by Species

Interactive Exploration of Geographic Data

We believe that today's **digital possibilities** should be used to allow people to **intuitively interact** with data to generate more useful information. This process needs to be based on a great level of **transparency** about the data and the methods used to generate scientific results. In order to achieve this we decided to create a website that allows users to interact with our results as well as with our code. This brings the double benefit of offering transparency to a possibly broad audience at comparatively **low costs** and therefore enable developers and users to **engage in a dialog** with the researcher who created a workflow to use GIS in a specific problem setting. In order to access our webpage your are invited to scan the QR-Code above, which will lead you to a GitHub-Repository containing our results.

Discussion

- Segmentation:
  - Reserved segmentation of the Canopy Height Model to reduce oversegmentation tendency
  - Possibly real number of trees slightly higher, but good performance in dense areas with relatively small trees
  - Performance is worse areas with more extensive crowns
  - Limitation of the segmentation error through omitting trees smaller 10m² and bigger 350m²
- Biodiversity
  - when accurate species data is present the use of GIS allows for spatially comprehensive analysis on different scales ranging from considering individuals up to analyzing large-scale patterns of biodiversity in forest areas
- Density
  - LiDAR data allows to analyze vertical vegetation density at spatially high resolution without in-situ measurement
  - Still the acquisition and processing of LiDAR data is expensive and needs a elaborated skill-set in GI data management

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