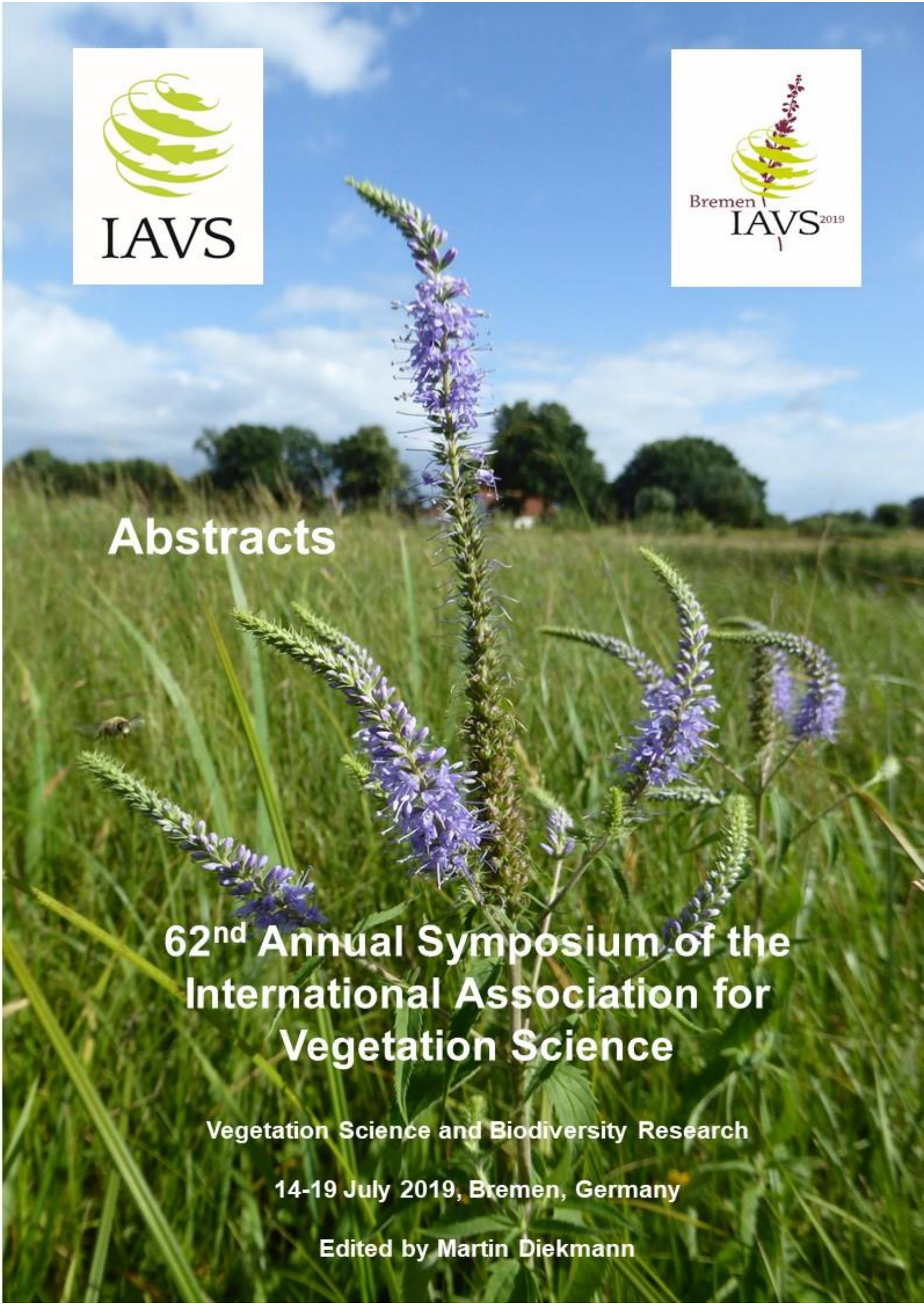

Abstracts

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Forest biodiversity estimated from optical and LiDAR data: testing the Spectral Variation Hypothesis and the Height Variation Hypothesis through the Rao's Q index

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Forests cover about 30 percent of the earth surface, they are among the most biodiverse terrestrial ecosystems and they are at the base of many ecological processes and services. The loss of forest biodiversity makes in risk the benefits that the humans derived from them. The assessment of biodiversity is therefore an important and essential goal to achieve, that, however, can be difficult, time consuming and expensive if estimated through field data. Earth observation can be a unique source for consistent and standardized data to support these mapping efforts.

One of the methods to estimate species diversity from optical remote sensing data is applying the Spectral Variation Hypothesis (SVH), which states that, the higher the spectral variation of an image, the higher the environmental heterogeneity and the species diversity of that area. The SVH has been tested using different indices and measures; recently in literature, the Rao's Q index, applied to remote sensing data has been tested as a new and innovative spectral variation measure.

In the first part of this this study, we tested the SVH, evaluating the performance of the Rao's Q, comparing it with another index, the Coefficient of Variation (used as a benchmark). We validate them against values of Shannon's H (used as species diversity index) derived from in-situ collected data. Twenty forest plots (1 ha each), mainly covered by conifer, located in South Tyrol (North of Italy) have been used for this purpose. The SVH has been tested using an NDVI data-set derived from Sentinel-2 and Landsat 8 for the year 2016 and 2017. This has been done to test the effect of the spatial grain of different sensors and to understand the seasonality of the SVH.

The second part of this research is focused on the use of the LiDAR data to understand the relation between the height variation of the forest trees and their species diversity. A new concept called Height Variation Hypothesis (HVH) has been devised and developed, stating that, the higher the variation of the height of the trees (Canopy Height Model -CHM-) derived from LiDAR data is, the more complex is the overall structure of the forest and the higher is the species diversity of that area. In this case, the concept of HVH has been tested with LiDAR data at different CHM resolutions, through the Rao's Q index and correlated with data of tree species diversity (through Shannon's H) collected in the mentioned 20 forest plots and in other 100 plots in a temperate forest in Traunstein (S of Germany).

The results showed that the SVH is season- and sensor-dependent. For both years and satellites, the relation between Rao's Q and field data reached the highest R^2 for the Sentinel-2 satellite, between June and July decreasing towards winter and spring similarly to the NDVI time-series.
The HVH showed also good results in both the considered forests: the correlation with field data reached excellent values of R^2, especially when the CHM resolution was of 2.5 m.