ABSTRACT

Ecosystem structure, particularly the vertical structure of vegetation, is one of the six essential biodiversity variables, constituting an important aspect of habitat heterogeneity that influences species distribution and diversity. However, until relatively recently, measuring vegetation structure was extremely laborious and collecting such data was virtually impossible for large areas. However, this changed fundamentally with the advent of laser altimetry in the mid-1990s. In particular, airborne laser altimetry has seen an unprecedented boom in the last twenty years. As a result, we now have unique detailed data on vegetation structure in many countries around the world, particularly in Europe and North America. However, such data are lacking in the less developed countries, where most of the world's species diversity is found. Fortunately, recent years have favoured satellite-based laser altimeters that can fill in the gaps. Specifically, two devices were launched into Earth orbit in 2018: the Advanced Topographic Laser Altimeter System (ATLAS) onboard the ICESat-2 satellite and the Global Ecosystem Dynamics Investigation (GEDI) on the International Space Station. These devices provide, among other things, data on vegetation structure on a global scale, which can be used to improve our understanding of the distribution of species diversity on Earth.

This dissertation focuses on monitoring terrain and vegetation structure by laser altimetry and on using these data to model the diversity and distribution of animals. The airborne laser scanning data were used to model the diversity and rarity of birds on the Radovesická spoil heap in northern Bohemia. The study showed a strong positive effect of vegetation structure on both bird diversity and rarity. The next two studies have focused on satellite laser altimetry data, and airborne laser scanning data was used only as a reference to evaluate acquisition and environmental characteristics that may affect the quality of satellite altimeter data. While the first of those two studies focused on ICESat-2 data, the other analyzed GEDI data. Both studies identified several characteristics that affect the accuracy of vegetation and terrain height measurements and made key recommendations regarding data filtering for subsequent analyses. The last study examined the accuracy of recently published high-resolution global vegetation height maps derived from GEDI and Sentinel/Landsat data. The results of this study showed the limitations in the accuracy of the global vegetation height maps. Typically, the height of low vegetation was overestimated and that of high vegetation was underestimated. Thus, their usefulness for modelling species diversity and distribution proved limited, distorting the true relationships between species diversity and environmental characteristics.