LiDAR as a valuable information source for habitat mapping

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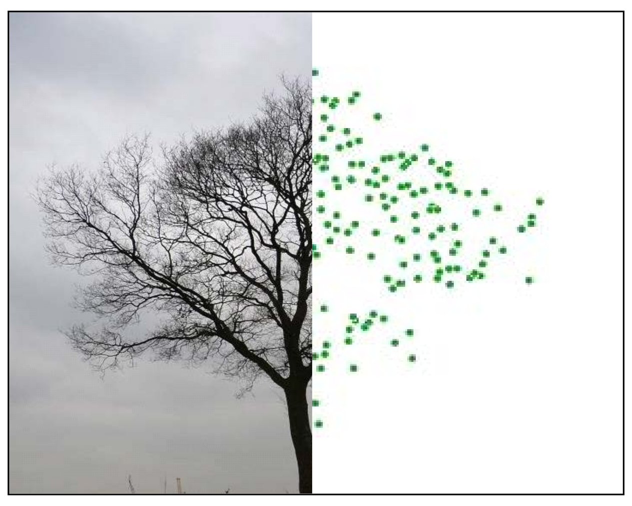
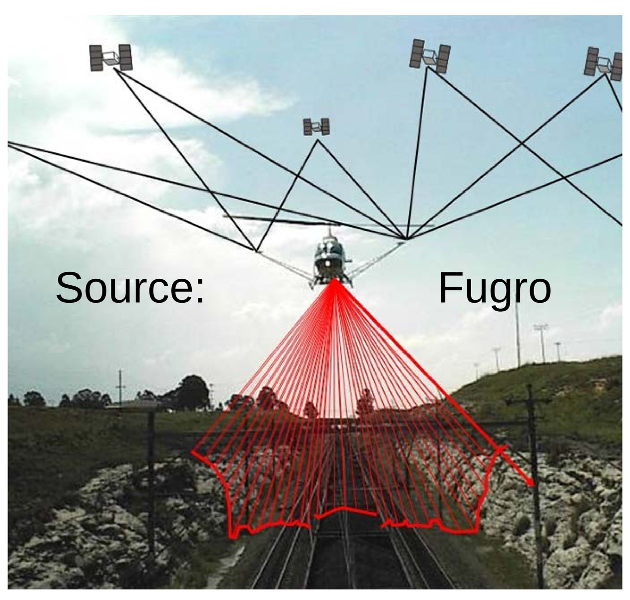
Introduction



Key is the challenge to develop a biodiversity observation system that is transmissible and cost effective. Measuring and reliable reporting of trends and changes in biodiversity requires that data and indicators are collected and analysed in a standard and comparable way.

LiDAR (LIght Detection And Ranging or Laser Imaging Detection And Ranging) is an alternative remote sensing technology that allows to increase the accuracy of biophysical measurements and to extend spatial analysis into the third dimension. The BIO_SOS project develops alternatives to measure habitat diversity as a proxy for biodiversity on the basis of plant life forms. The objective of our study is to assess to what extent LiDAR can be used to map and monitor plant life forms and associated General Habitat Categories (GHCs).

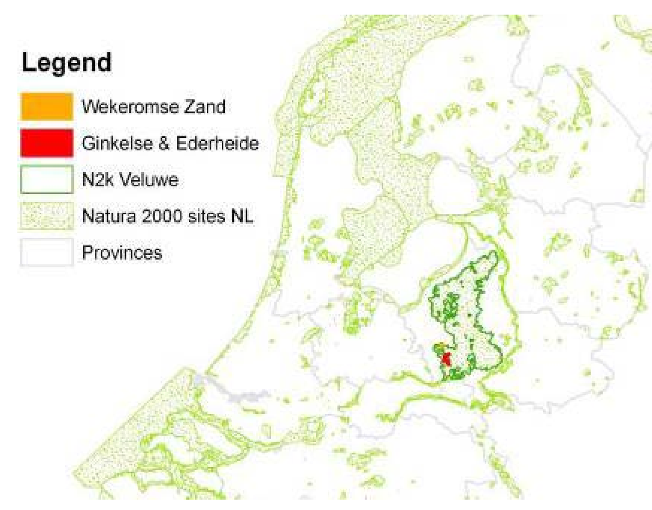
LiDAR



LiDAR is an active remote sensing technique suitable to measure properties of 3D objects. The height accuracy is usually better than 0.2 m. Thus, LiDAR, in contrast to optical remote sensing, can provide fine-grained information about the 3-D physical structure of terrestrial ecosystems. For habitat monitoring, the repeatability and high absolute "xyz" accuracy is advantageous since small changes in vegetation structure can be detected at sub-meter scales.

The BIO_SOS project uses LiDAR as a valuable information source to collect information on the vegetation height as an addition to the optical information from Very High Resolution (VHR) satellite imagery (<= 2 m resolution), such as Worldview-2.

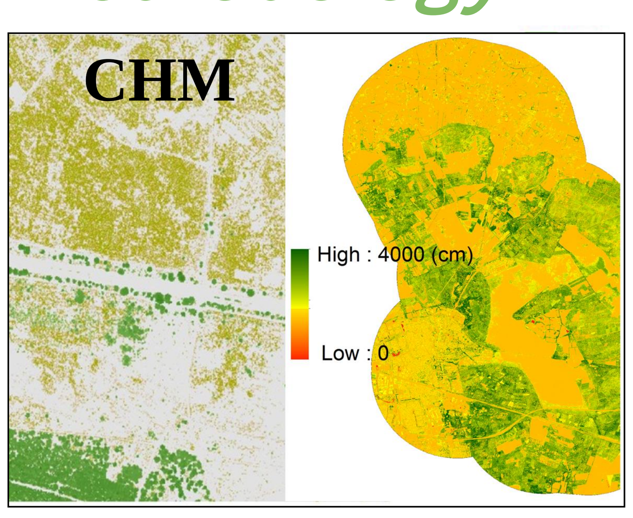
Study area & material



One of the BIO_SOS study areas, is called Ederheide and Ginkelse heide & Wekeromse Zand, and is located within the Dutch Natura 2000 site "Veluwe" in the Province of Gelderland. The Ederheide and Ginkelse heide is dominated by heathland, while the Wekoromse Zand is dominated by inland sand dunes..

Nitrogen deposition from intensive agriculture is one of the major threats for the Natura 2000 habitats, causing moss, grass, shrub and tree encroachment.. The acquired LiDAR cloudpoints (March 2010) have an height precision of a few cm and a density of approximately 15 points per m². The multiple return LiDAR data used in this study is generated by the FLI-MAP 400 laser scanner, developed by Fugro Aerial Mapping (NL).

Methodology



The Canopy Heigth Model (CHM), crucial in our approach for habitat mapping and monitoring, is derived from the LiDAR data using the MCC-LiDAR software and LAStools. The CHM is calculated in two steps:

- The Z component of the lidar points is made relative to the ground so that it represents the object height
- The lidar file is rasterized into a grid, the maximum Z value within one grid cell of 1 by 1 meter being the object height

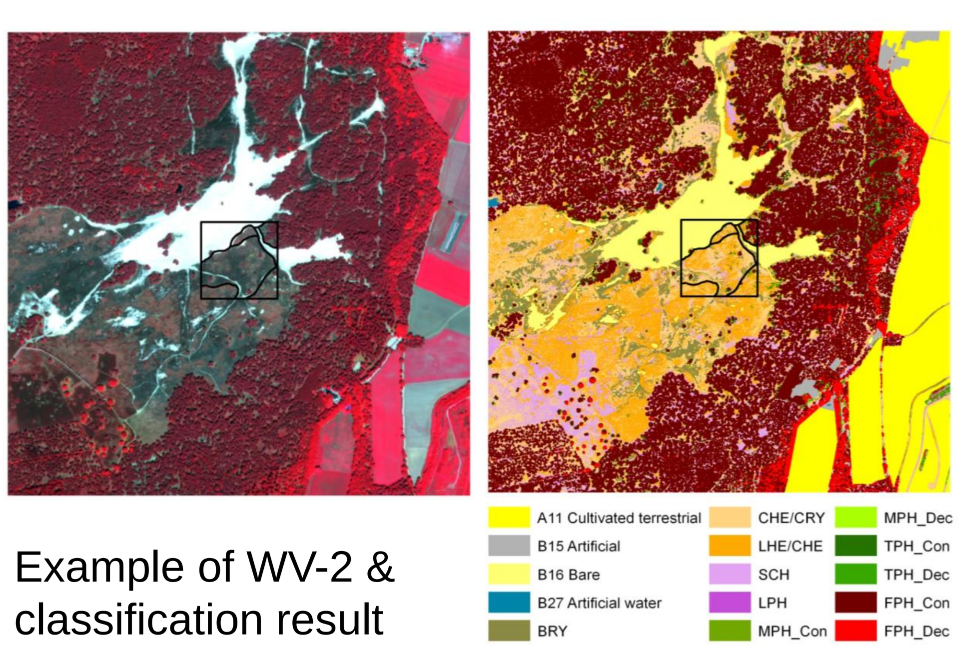
Plant life forms, are the basis for our habitat mapping and monitoring (BUNCE et al. 2008; 2011) which aims at delineating the General Habitat Categories (GHC). The latter being the dominant life form for a given mapping unit of at least 400 m² . Since the woody life forms on which the majority of GHCs are based have crisp height definitions they can be easily translated from the CHM.

BIO_SOS has developed new and automated methods that are beyond current state-of-the-art in Europe. We use High and VHR remote sensing data to identify and map the land cover types described by the FAO Land Cover Classification System (LCCS). These are translated subsequently with contextual and semantic information to GHC and finally Annex I habitat types. In both LCCS and GHC, height information of the canopy is essential. This procedures will sit within an ecological modelling framework for automated provision of habitat maps and biodiversity indicators useful for a deeper understanding of the impacts of human induced pressures.

Real height

Normalized height (DSM-DTM)

Results and conclusion



Example of WV-2 & classification result

The result obtained from LiDAR multiple return data is a CHM with a spatial resolution of 1 by 1 meter and vegetation height indicated in cm. The segmentation and classification process integrates several VHR Worldview-2 imagery in the peak-flush, post-flush and pre-flush growing period in combination with LIDAR and topographic data. Knowledge rules were defined for all occurring LCCS land cover and GHC habitat classes.

Validation for the Dutch case study (based on 12 stratified random sample sites)	
Overall classification accuracy	Regression analysis of the percentage coverage of a specific life forms of individual habitat mapping units
GHC habitats = 70%	R^2 for FPH (Forest Phanerophytes) = 0.96,
LCCS level3 land cover classes = 74%	R^2 for CHE and LHE (herbaceous vegetation) = 0.70
	R^2 for SCH = 0.40.

Validation on basis of fieldwork showed that LiDAR provides accurate height measurements on shrubs and trees, even in early spring when no leaves are present. Combining CHM as derived from LiDAR with VHR satellite imagery is a step forward to provide higher accuracies in habitat mapping.

The BIO_SOS project is showing that this combination is a powerful tool for habitat mapping & monitoring

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