Ecological properties of nature reserve areas can now be analyzed by laser scanning from a plane

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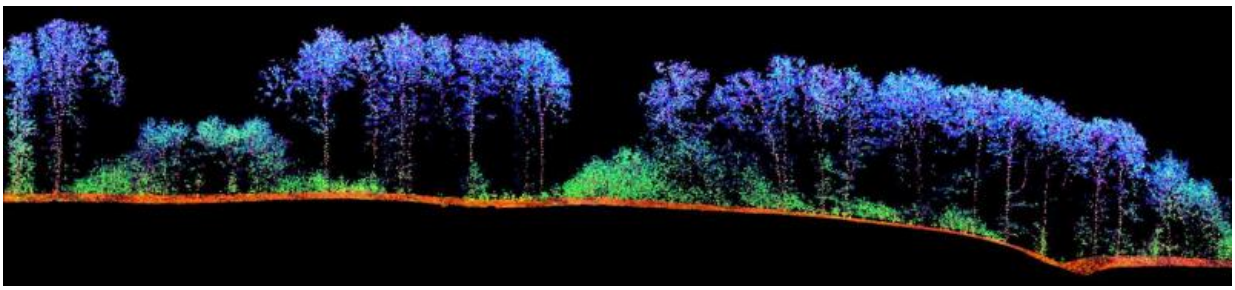

From the laser data, a 3-D structure of a forest can be calculated. Credit: TU WIen

Simply declaring a region as a nature protection area is not enough, regular monitoring of its ecological condition is also necessary. Since Nature protection areas already cover almost one fifth of the surface of the European Union, it is impossible to inspect such a vast area in the traditional way on foot. Therefore, new methods are being developed to monitor Europe's nature protection areas from the air. Short laser pulses are sent to the ground, and information on the status of the habitat can be deduced from the reflected light signals using elaborate computer algorithms.

Laser Scanning from the Air

"The rules of the Natura 2000 network of nature protection areas request the evaluation of the conservation status of protected region at least every six years", says Professor Norbert Pfeifer (Vienna University of Technology). "This can only be achieved with the help of remote sensing."

Planes fly at an altitude of 500 to 2000 metres, scanning a strip 300 to 800 metres wide. About ten points per square meter are sampled using an infrared laser pulsing half a million times a second. The pulses are reflected and return to the plane. From their travel time, the exact distance between the plane and the ground can be calculated, creating a detailed 3D map of the landscape.

Software Identifies Structure

"Our team has developed special classification software which can use this data to distinguish different types of vegetation", says Norbert Pfeifer. Even disturbing factors such as weeds and vehicle tracks can be identified.

The 3D map obtained by the laser pulses contains much more information than a simple aerial photograph. When a forest is scanned, not all the laser light is reflected by the tree tops. The lower layers of the vegetation are surveyed as well. Ecologically healthy woodland does not only consist of various tree and shrub layers, but also of a layer of herbs and grasses. Whether or not these sub-canopy levels exist can be mathematically deduced from the infrared data.

"When people process remote sensing data for ecological monitoring, they usually focus on very specific parameters which are easy to derive", says Norbert Pfeifer. "Our approach is quite different. We use the data to calculate precisely the same parameters as they are collected in a site

inspection by human ecologists." Therefore the data complies with EU regulations and can directly be compared to older data.

Given the power of the new method, it should be possible to go one step further. "We believe that an even better characterization of a region's biodiversity can be obtained when we do not focus on site inspection parameters but rather try to define new parameters which are easier to obtain from above", says Pfeifer.

Agreement Between Humans and Computer

The newly developed computer algorithms were tested in the nature protection area of Ágota-puszta, Püspökladány (Hungary), consisting of an intricate mosaic of salt meadows, loess grasslands and marsh areas. Part of the field data was used to adjust the algorithms. With the rest of the data, the method was validated. "We achieved an agreement of 80 to 90% between our data and on-site observations", says Norbert Pfeifer. "This is a huge success. It is about the same level of agreement that would be expected if two different people assess the same region."

"This study is a major step forward in closing the gap between the remote sensing and conservation ecology communities", says András Zlinszky (Centre for Ecological Research, Hungary). "We have shown that it is possible to monitor Natura 2000 conservation status by remote sensing, exactly following the rules laid out by the local ecology experts."

The research was conducted within the EU funded project ChangeHabitats2, http://www.changehabitats.eu/.The study about the new remote sensing technique has been published in the journal *Remote Sensing*.

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