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Automatic detection of pit-mound topography from LiDAR based DEMs

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Pit-and-mound (treethrow, windthrow) topography is a result of tree uprooting caused by the impact of hurricane-speed wind events. Analyzing its location and morphometric features can improve our knowledge about the influence of winds on forest ecosystem dynamics and on changes in the forest floor microrelief. This is important in terms of hillslope denudation and soil evolution.

The occurrence and evolution of pit-mound topography can be studied with the use of high-resolution elevation data. Such data can be obtained from LiDAR (Light Detection and Ranging) surveys. Polish Institute of Geodesy and Cartography carried the LiDAR survey in the years 2010-2015. Point cloud data for the entire area of Poland with the minimal density of 4 points per m^2 is currently available on the Internet.

Under the present project, we have analyzed Digital Elevation Models (DEMs) produced from the above-mentioned LiDAR data in order to develop and test a new method for automatic detection of pit-mound topography. As far as we know, no such method exists at the moment. We generated DEMs with 0.5 m spatial resolution for three study sites with the confirmed occurrence of pit-mound topography, located in Southern Poland. A script with the method was written in the R programming language.

The proposed method is based on contour lines. We found that the detection of pit and mound topography formed on gentle hillslopes is possible when closed contours are delineated. Detected forms can be classified into “pits” and “mounds” by investigating point positions with the highest and the lowest elevation within the closed contour. On the other hand, for steep surfaces pit-mound topography can be detected by calculating distances between contours and selecting slope segments with between-contours distances above a certain threshold value. This leads to the identification of gently-sloped areas within the study site. With a high probability, such areas indicate places, where pit-mound topography was formed. To validate our methods, we performed the on-screen assessment of DEMs for the presence of forms that could be interpreted as pit-mound topography.

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