Treefall gap mapping with Sentinel-2A images

Ivan Barton[1], Géza Király[1], Kornél Czimber[1], Markus Hollaus[2]

[1] Deptartment of Surveying and Remote Sensing, Institute of Geomatics and Civil Engineering, Faculty of Forestry, University of Sopron , Sopron 9400, Hungary;
[2] Department of Geodesy and Geoinformation, Faculty of Mathematics and Geoinformation, Technische Universität Wien, Wien 1040, Austria;
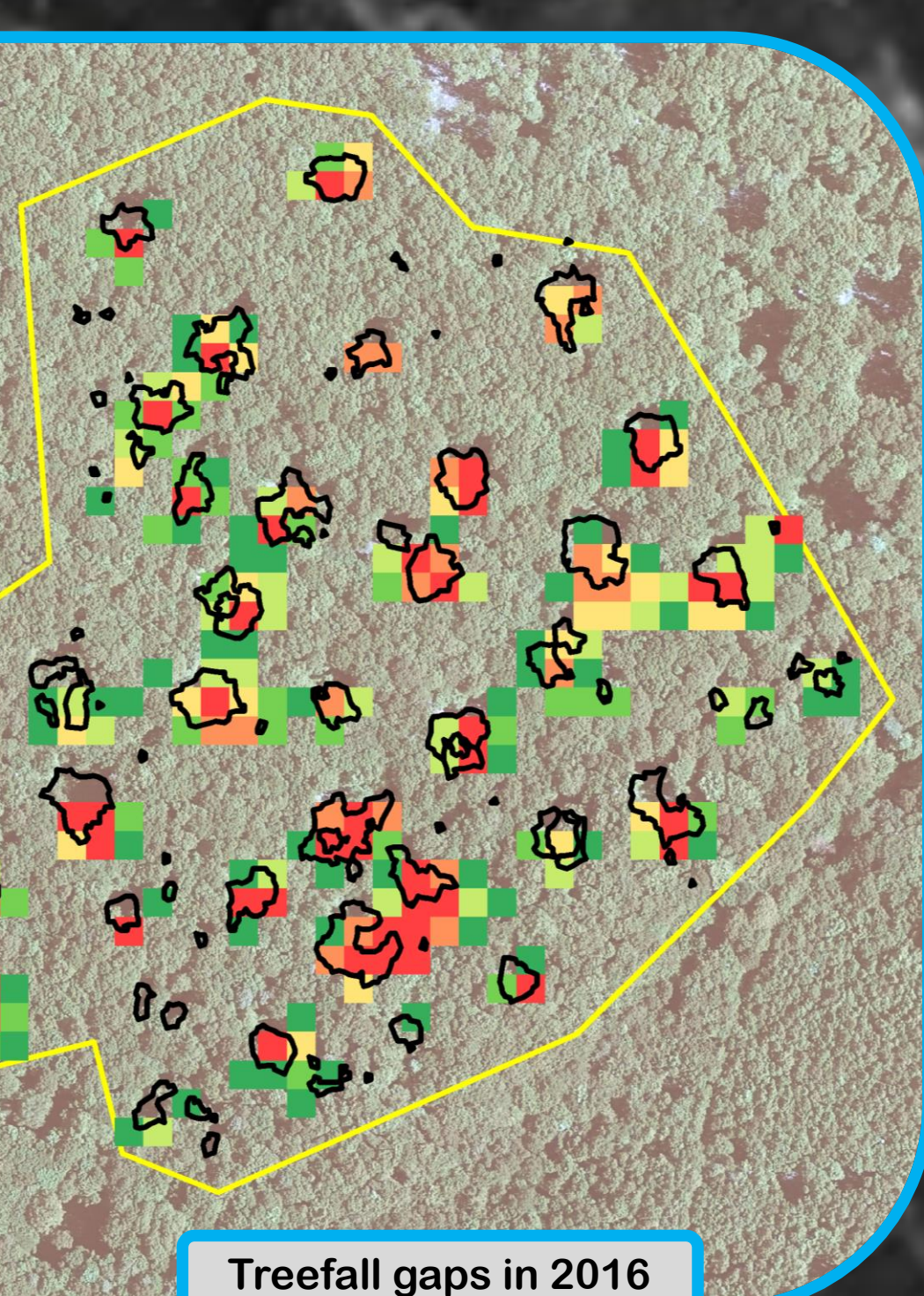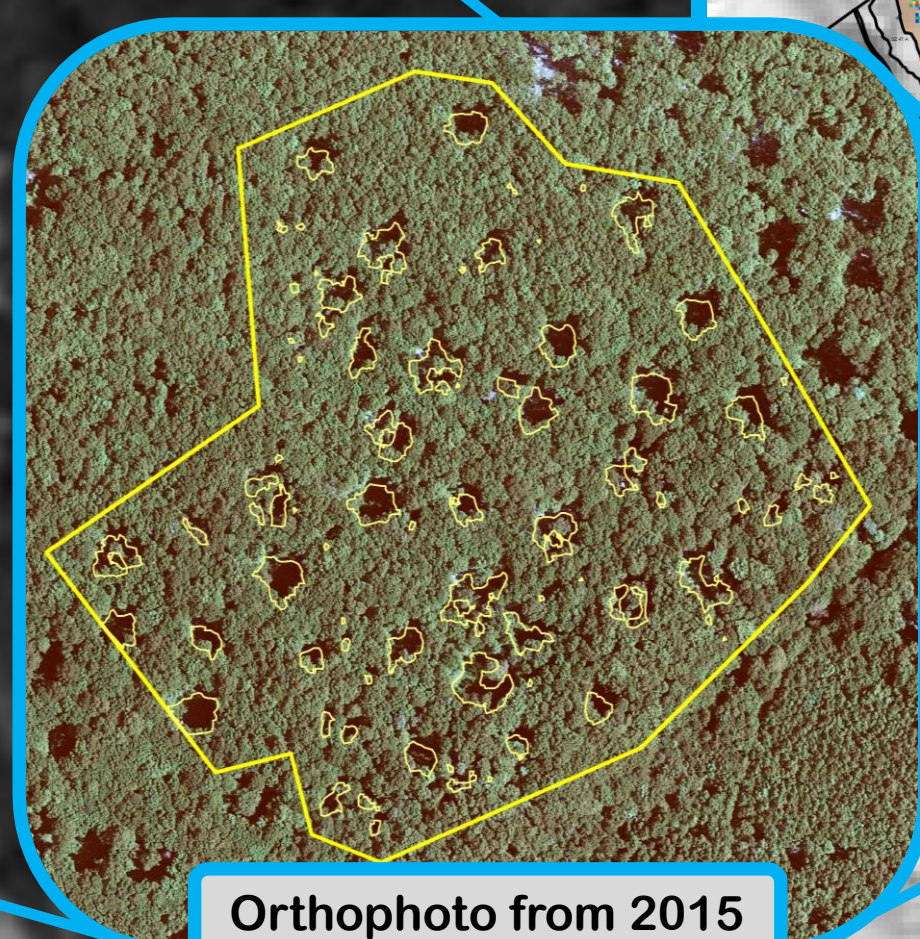Contact: ivan.barton@gastudent.nyme.hu

Introduction

The fundamentals of forest management are the proper knowledge about resources. Remote sensing is a powerful tool for determining the actual forest coverage. The Earth observation satellite, Sentinel-2A was set to orbit as part of the Copernicus programme. With the 10-meter resolution bands it is possible to observe smaller scale forestry operations like treefall gaps. The spatial extension of these gaps are often less than 200m^2, thus their detection could be done on sub-pixel level. Due to the higher temporal resolution of the satellite, multiple observations are available in a year, therefore time series evaluation is possible. During the research, we developed a method which could handle images captured at different conditions for mapping.

Input data

Sentinel-2 time series

Forest management and inventory data

VHR DSM

Intermediate product

Gap fraction in 10x10 m resolution for each date

Material & Methods

The study area was located in the Börzsöny mountains, Hungary. Eleven Sentinel-2A images were used form 2015 and 2016. The investigated forest are managed by the Ipoly Erdo Zrt. The continuous forest cover is maintained by artificial treefall gaps & using close to nature methods. The gap mapping was done by spectral mixture analyze on individual images. The method was boosted with illumination condition modelling on a DSM. The gap mapping was carried out on a 10x10 meter resolution grid over the forested area. From the stack of gap fractions the probability and the area could be calculated. 2340 hectares of forested areas were evaluated for gap mapping.

Gaps in Oak type forests

The artificial treefall gaps in the Oak type forest are generally compact shaped objects. Their average diameter is about one tree height, which is around 20-25 m. When the satellite captures the image only projected shadow and shades could be seen on the image due to the lower sun elevation. By assuming a high canopy closure outside the treefall gaps, the delineated shades are representing the gaps on the satellite image. Two Oak type forest were selected for validation, using orthophotos and DSMs.
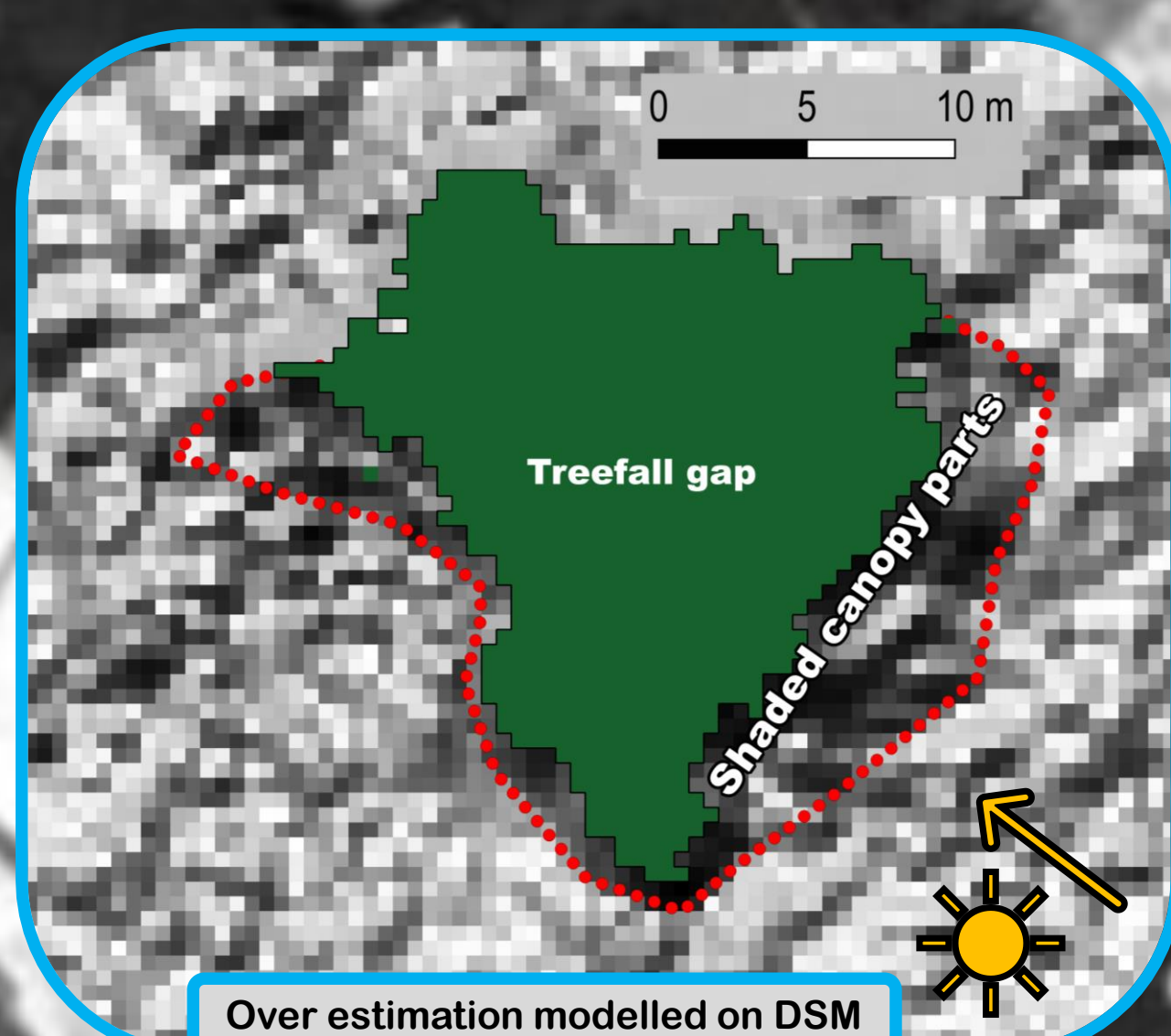
Gaps in Beech type forests

In the higher region of the mountains natural disturbances like wind or ice damage often take place at the Beech type forests. Therefore, their structure are more diverse. The size of these gaps are larger compared to the Oak type. Beside the shade detection the young and old trees are also separated in the spectra. On the selected validation site in late 2014 there was a ice damage. The regeneration of partial crown damages could be observed on the maps.

Study area with S-2 footprints

Orthophoto from 2015

Treefall gaps in 2016

Regeneration map from 2015 to 2016
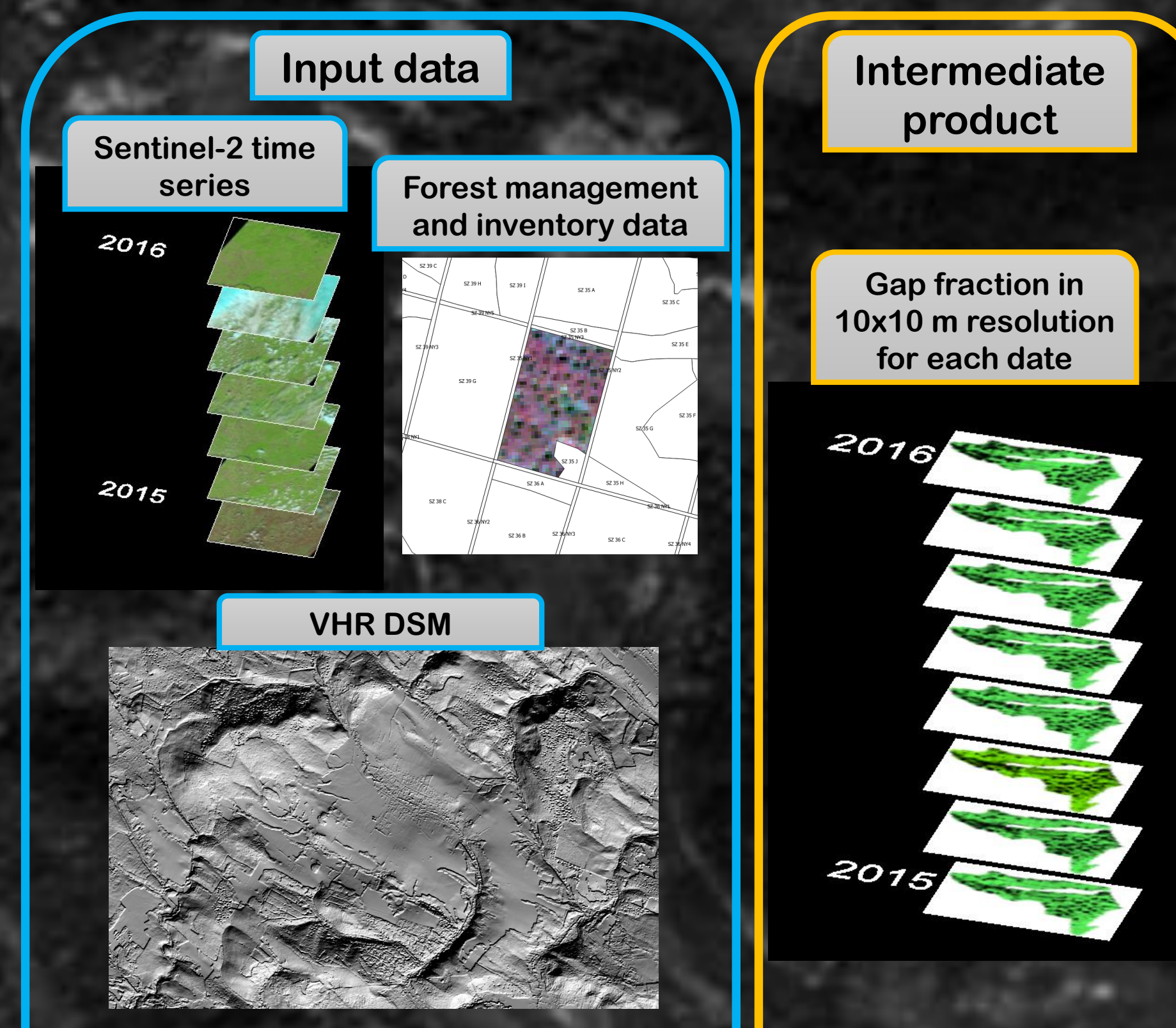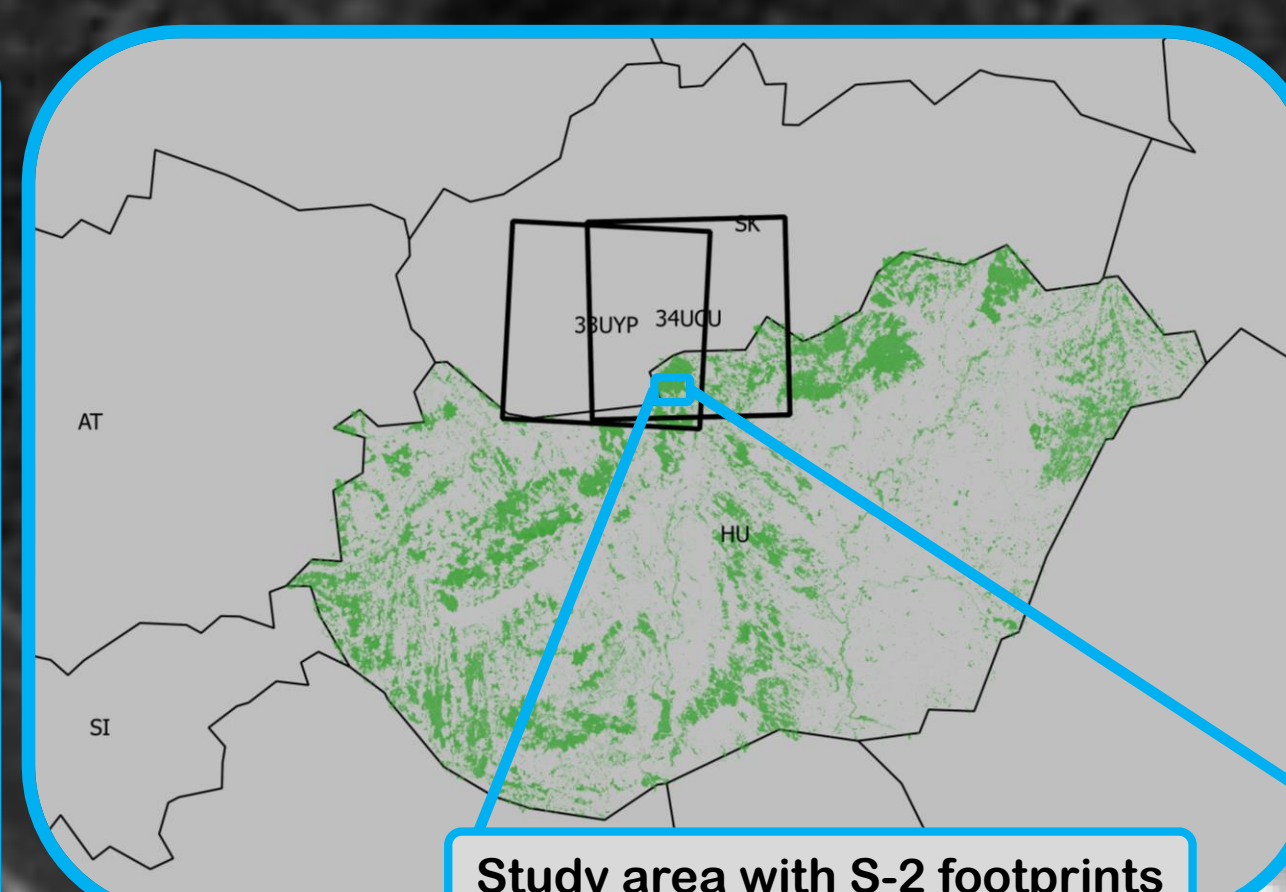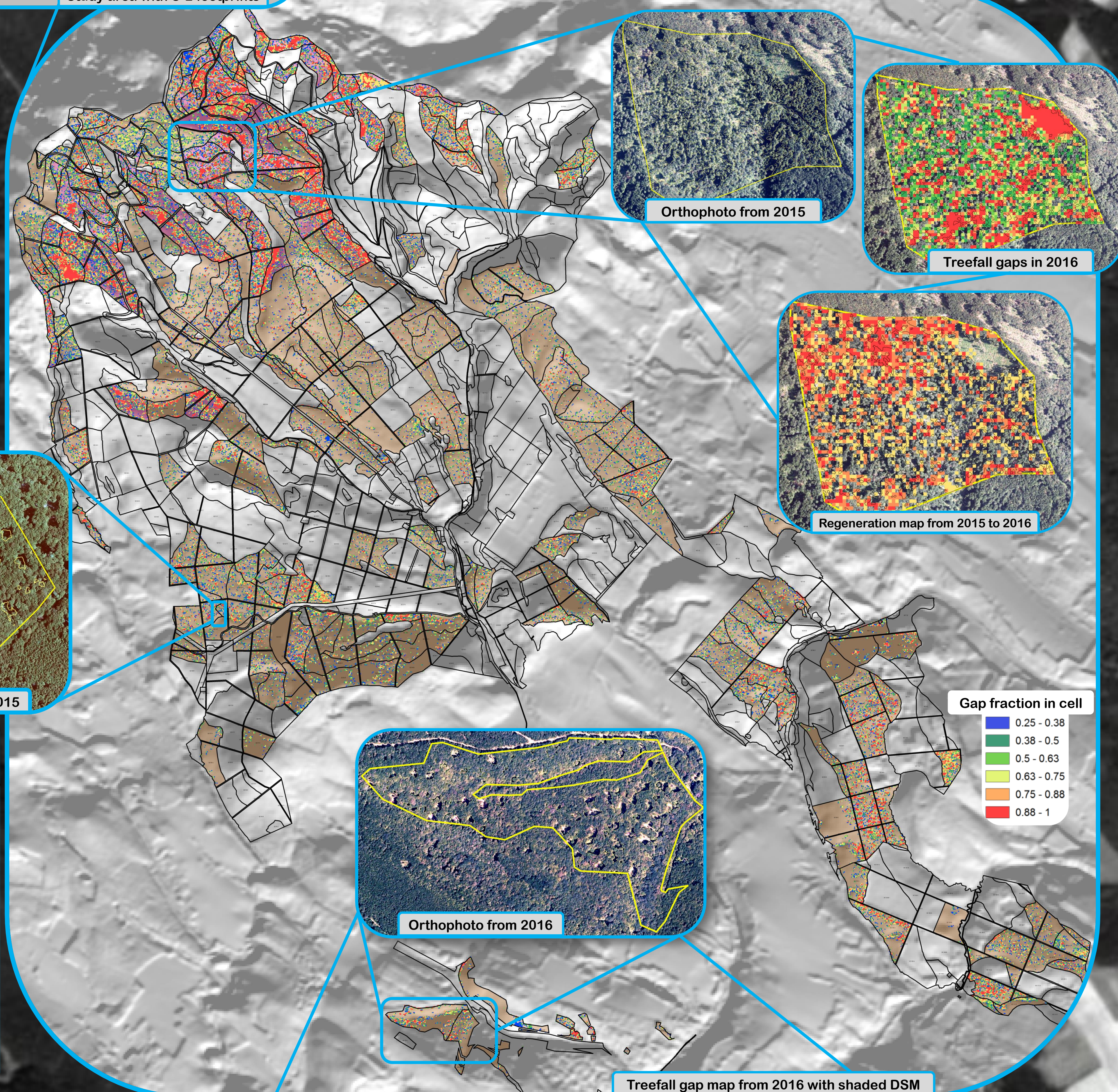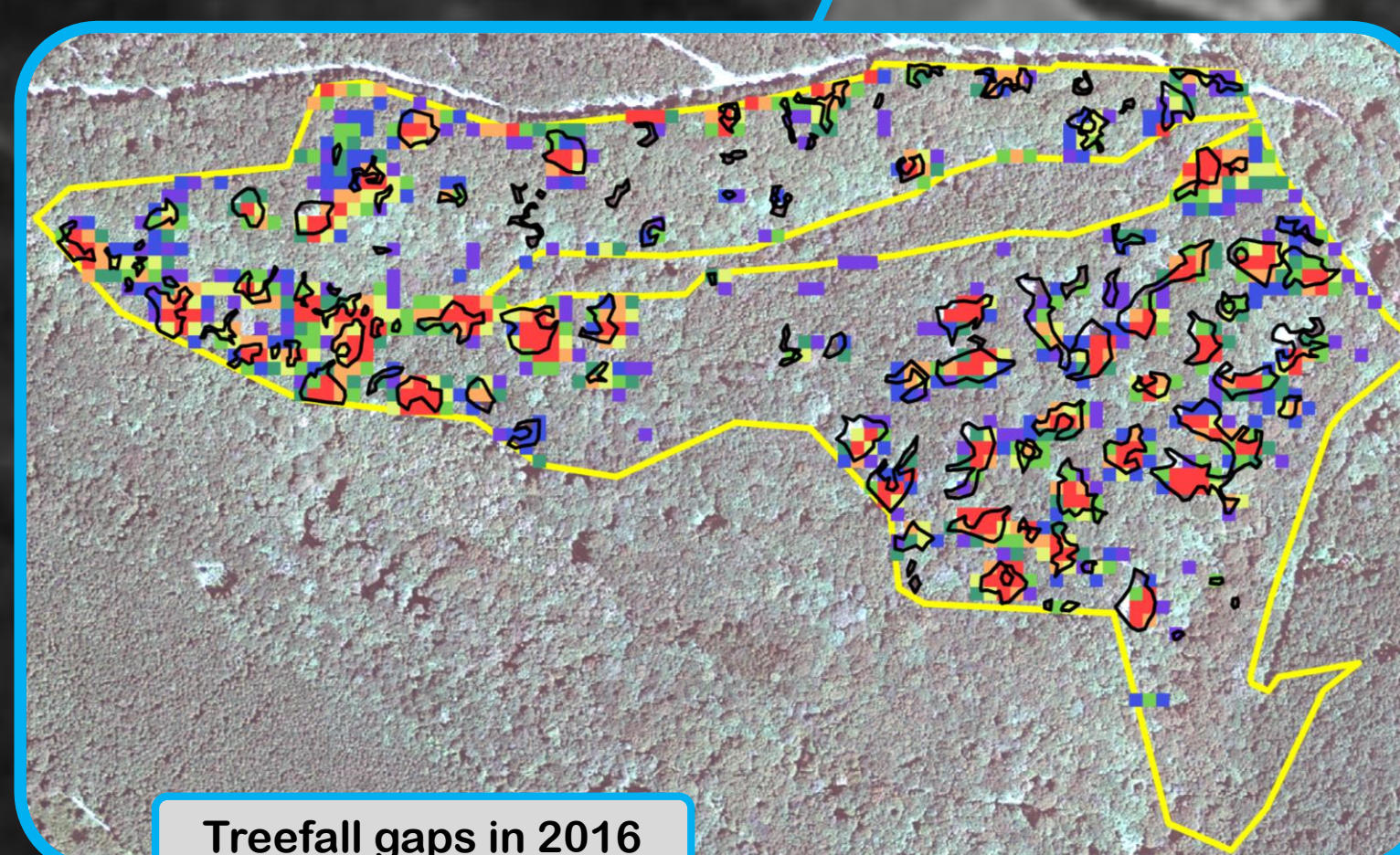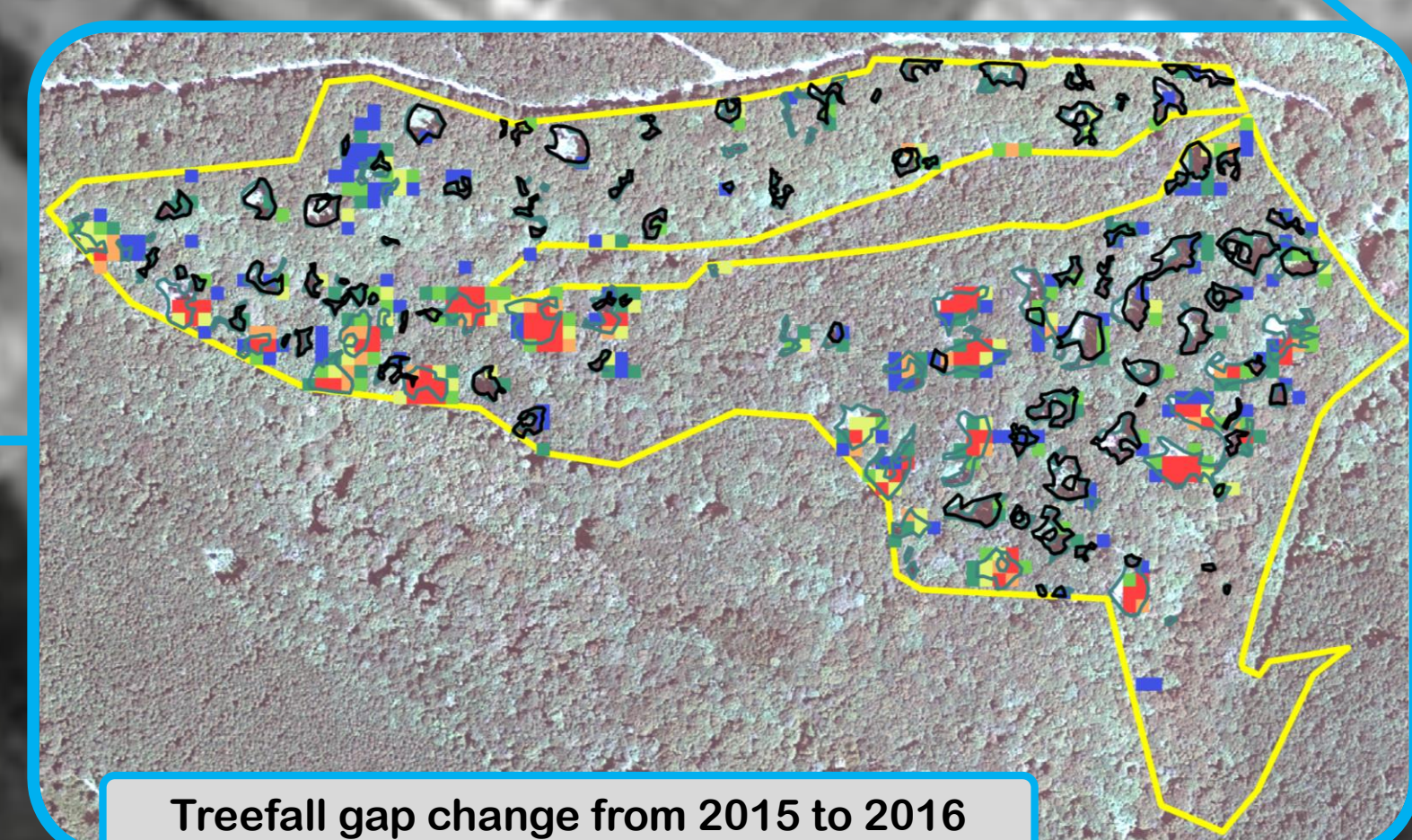

Treefall gaps in 2016

Orthophoto from 2015

Sources of error

Multiple filtering on the results are done during the map creation. In most case it improves the quality of the map. But in some cases when the gap fraction inside the cell is too low, it is also filtered as noise. Therefore, gaps which are significantly smaller than the pixel size or if they have narrow elongated shape, those stay hidden. The overestimation of the gap area could be modelled and correction could be applied for spatial statistics.

Orthophoto from 2016

Gap fraction in cell
- 0.25 - 0.38
- 0.38 - 0.5
- 0.5 - 0.63
- 0.63 - 0.75
- 0.75 - 0.88
- 0.88 - 1

Treefall gap map from 2016 with shaded DSM

Treefall gap
Shaded canopy parts
Over estimation modelled on DSM

Treefall gaps in 2016

Treefall gap change from 2015 to 2016