Estimating the Site Index using tree heights measured by Satellite

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Abstract

Since there are repeated (Year 2000 and 2020) tree heights on a resolution of about 30x30 m globally available those could be used to estimate forest productivity. The Site Index (Height of dominant trees at a specific age) is a common way to express productivity. If the growth pattern is known, the site index can be estimated by using height and height increment. With this method the heights need to be measured with high precision. Here I try to extract the top height on points where there was no height change during 20 Years and compare them with the Site Index given by a Site driven local model.

Potapov u. a. (2022) give maps of tree heights for the years 2000 and 2020 in meters (Glad). From those maps heights where extracted which did not change during those 20 years and are higher than 3 m. Those points are compared with the estimated site index (dominant height at age 100) using Kindermann (2021) (3WME).

Figure 1 shows a scatter plot of those two heights which have a correlation of 0.27. It can bee seen, that there are a couple of points where bots estimate high trees and also many points where bots estimate small trees. But there are also many points where Glad is giving low heights but 3WME is giving a high site index.

One cause of this difference could be the forest density. Figure 2 shows that there is a trend between the tree cover from Hansen u. a. (2013) and the difference between Glad and 3WME. A reason for this could be, that tree species react with their height growth according to the stand density. Also the management of the forests, especially between thinning regimes which remove dominating trees compared to those removing suppressed trees will influence forest height. From the side of measurement it will be hard to detect the tip of the trees if there are only few and when those have a crown shape of a peaky triangle.

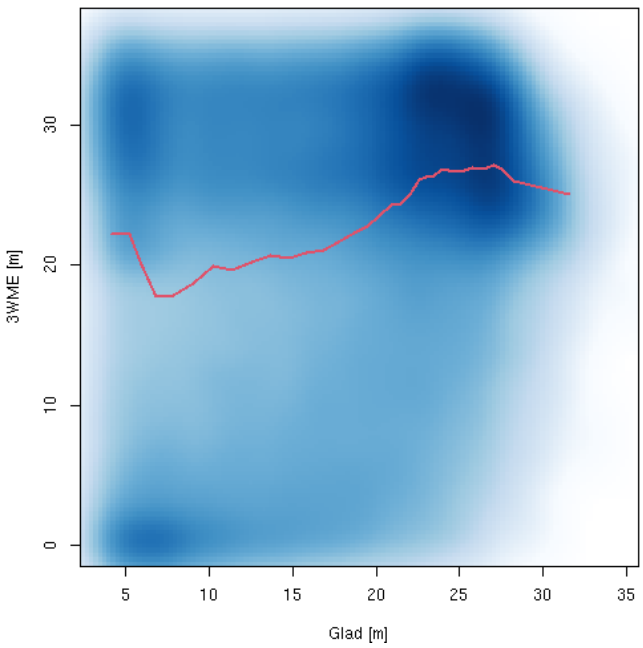

Figure 1: Top Heights from Glad and Site Index from 3WME

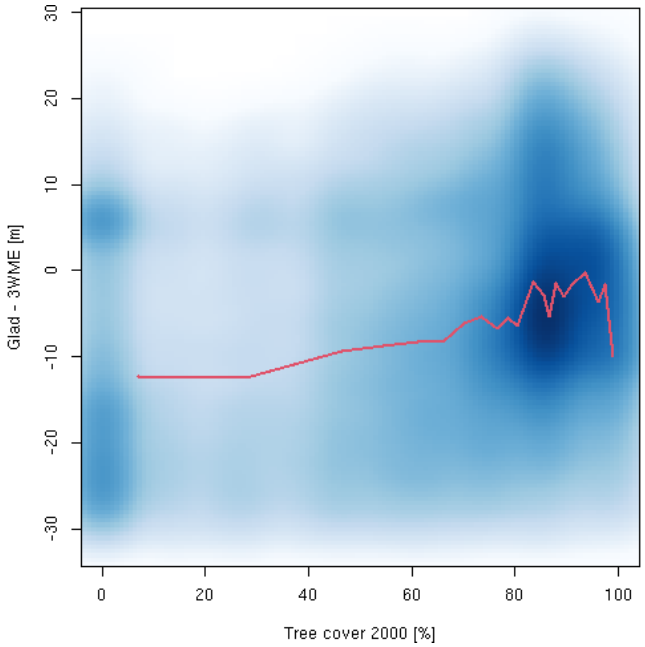

Figure 2: Relation Tree cover and difference between Glad and 3WME

Figure 3 shows that there is a trend over altitude, Fig. 4 over slope and Fig. 5 over aspect. Reasons for those trends could be that high productive forests have a shorter rotation time than low productive ones that those will have an age lower the others higher than 100 years. With this also the probability to detect a high productive forest with a height increment below 1 m in 20 years will be low compared to a low productive. In addition to the influence of the productivity the slope also will influence harvesting ages. On steep slopes it is harder to manage forests and so the rotation times are typical longer than on easy terrain.

Figure 6 shows the estimated Site Index for Austria. Figure 7 shows the heights in 2020 given by Glad. Figure 8 shows the heights given by Glad which did not change between 2000 and 2020. Figure 9 shows the differences between figure 6 and figure 8. It can be seen that static heights from Glad gives lower values than the site index in flat land and higher values in mountainous regions (fig. 10).

When zooming in (fig. 11–16) it could be seen, that the pattern of low to high productive sites is shown by the static heights of Glad. But the ages of the low productive sites will be higher than 100 Years and their heights higher than the estimated site index.

Static heights of Glad can be used to identify the productivity of forests but are not linear related to a site index. Due to forest management and height detection a possible trend over tree heights, stand density, altitude and slope might be considered.

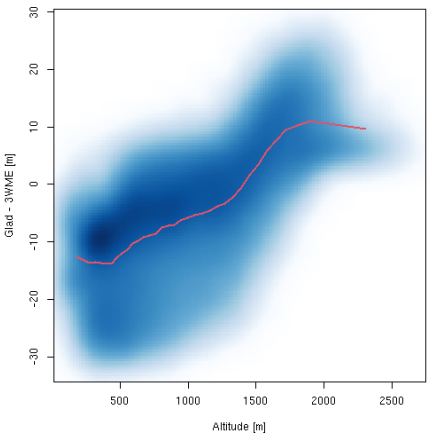

Figure 3: Relation Altitude and difference between Glad and 3WME

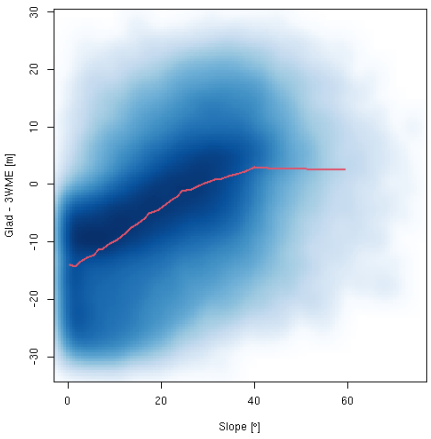

Figure 4: Relation Slope and difference between Glad and 3WME

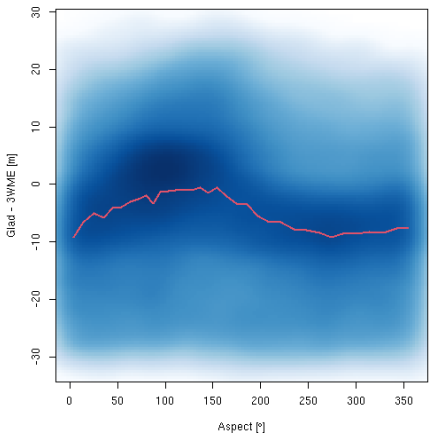

Figure 5: Relation Aspect and difference between Glad and 3WME

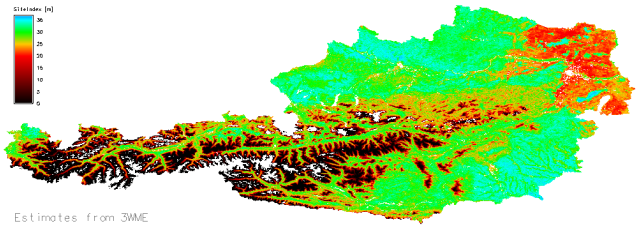

Figure 6: Estimated Site index using 3WME

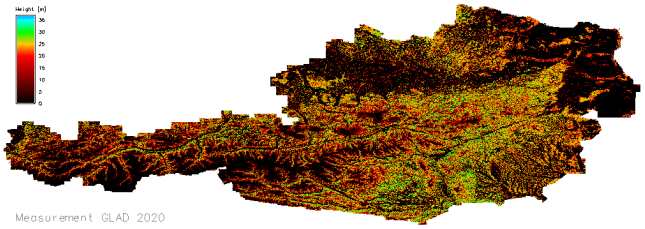

Figure 7: Heights in 2020 given by Glad

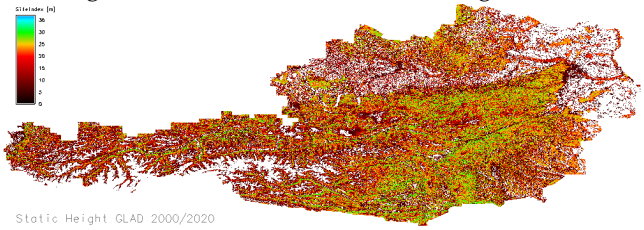

Figure 8: Glad heights of fests with no height increment between 2000 and 2020

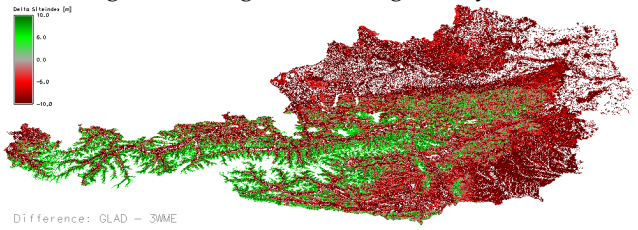

Figure 9: Height difference between static Glad heights and 3WME

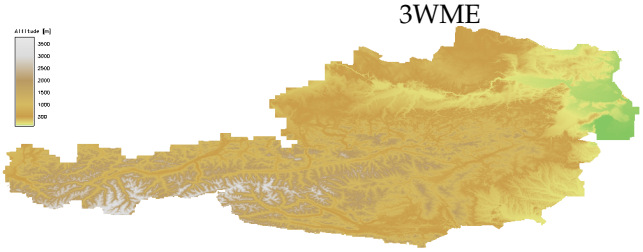

Figure 10: Altitude

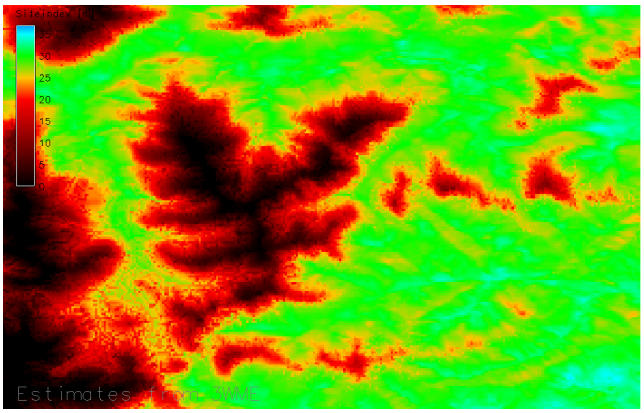

Figure 11: Estimated Site index using 3WME

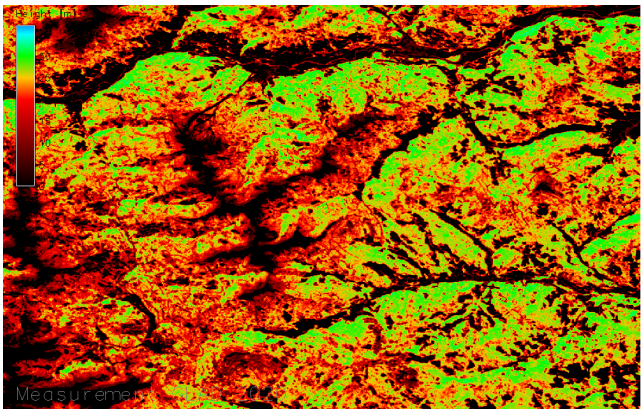

Figure 12: Heights in 2020 given by Glad

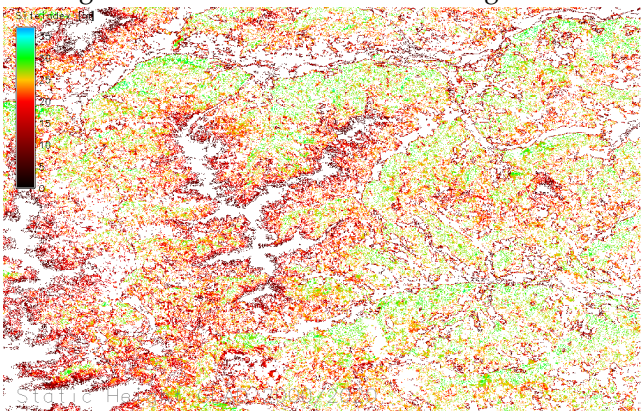

Figure 13: Glad heights of fests with no height increment between 2000 and 2020

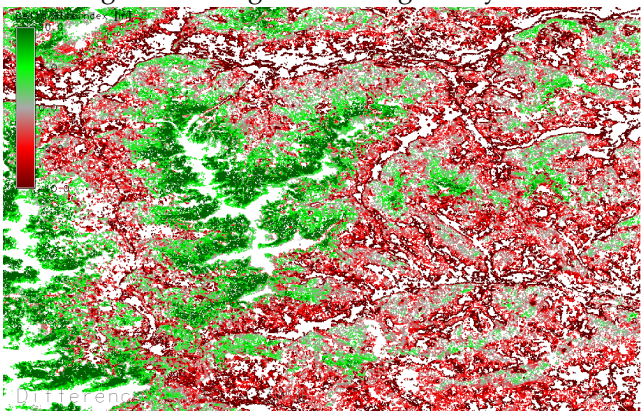

Figure 14: Height difference between static Glad heights and 3WME

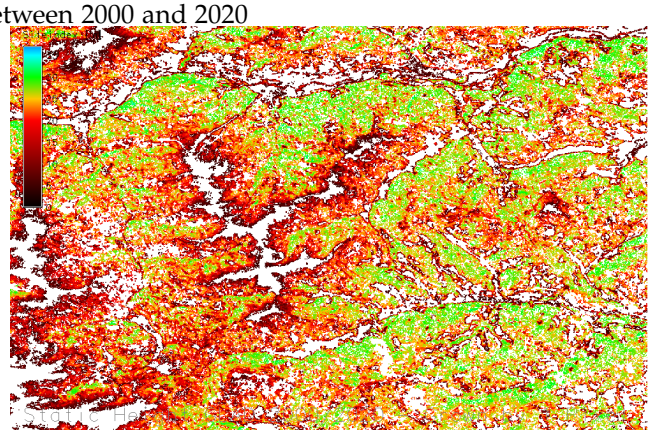

Figure 15: Glad heights of fests with no height increment between 2000 and 2020, Pixels grown by 1

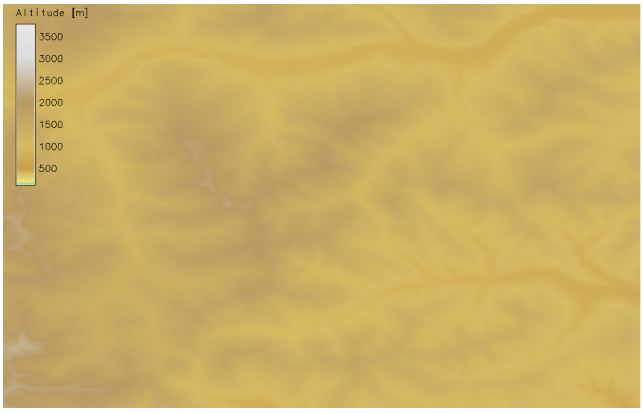

Figure 16: Altitude

Zoom to region around 47N 14E

References

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[Kindermann 2021] Kindermann, Georg: Funktionen und Koeffizienten des Waldwachstumssimulators 3WME. (2021). http://dx.doi.org/10.13140/RG.2.2.27649.17767. – DOI 10.13140/RG.2.2.27649.17767

[Potapov u. a. 2022] Potapov, Peter ; Hansen, Matthew C. ; Pickens, Amy ; Hernandez-Serna, Andres ; Tyukavina, Alexandra ; Turubanova, Svetlana ; Zalles, Viviana ; Li, Xinyuan ; Khan, Ahmad ; Stolle, Fred ; Harris, Nancy ; Song, Xiao-Peng ; Baggett, Antoine ; Kommareddy, Indrani ; Kommareddy, Anil: The Global 2000-2020 Land Cover and Land Use Change Dataset Derived From the Landsat Archive: First Results. In: *Frontiers in Remote Sensing* 3 (2022), April. http://dx.doi.org/10.3389/frsen.2022.856903. – DOI 10.3389/frsen.2022.856903