Search for plots of pure tree species over Hyytiälä, Aarne Hovi 31.1.2012

Description of workflow:

1) A grid (100x100 m) of sample points was created over Hyytiälä 2010 LiDAR DEM (2160 points in total). Polygons defining the DEM's extent, and the area of hyperspectral (HS) imagery (2011) were created.

2) For each grid point, a 100x100 m neighborhood was checked for suitable plots with pure pine, spruce or birch forest. This was done by opening 20-cm resolution, accurately oriented aerial images (2010) centered at the point, and by visually interpreting the image. Grid points outside DEM or the HS images were ignored. If a suitable plot was found, the centre of the plot (treetop) was measured (XYZ) photogrammetrically. Tree species and visual estimation of stand density (1-3) were recorded. Because tree species determination was based on visual interpretation, "degree of certainty" was recorded, and when I was sure, that there were no other tree species in the plot, purity class was 1, otherwise 0.

3) LiDAR estimates of stand dominant height (95th percentile of the height distribution) and stand density (proportion of ground returns, h < 2 m) were calculated, using the 2010 and 2011 LiDAR data separately. Mean and maximum heights of the LiDAR points were also calculated for comparison. Because aerial images were from 2010 and HS data from 2011, it was necessary to exclude plots with harvesting operations after 2010. These were searched by comparing stand height estimates 2010 and 2011. If the stand height was reduced by more than 1 m, the plot was excluded from the data.

4) Finally, the set of plots was checked to determine, which plot is visible in which HS image. This was done by extracting the (HS orthos) image data within a 10 m radius around the plot center. If the data in any of the RGB bands contained no-data values (zeros), the plot was deemed to be invisible to the image in question.

Notes:
- the aerial plot radius was 15 m. If HS image features are extracted from a circle of radius 10 m, we can be quite sure that the sample represents the plot measured. The 5 m extra buffer is to take into account the image orientation inaccuracy (~2m), the fact that there were sometimes trees of some other species near the plot borders, and also the effects of perspective distortion, which depend on the max view zenith angle of the HS sensor and the height of the vegetation.
- the "degree of certainty" signals how sure I was about the tree species. Class 1 means that I was ~100% sure of the species, 0 means that there possibly can be a couple of individual trees with other tree species (for example, the stand is very dense or there are other factors that makes interpretation difficult). Of course we can never be 100% sure when visual interpretation is in question. Ilkka has earlier had 93-97% accuracy at the single tree level.
- when selecting plots, areas with large openings were tried to avoid in order to eliminate effects of radiation reflected from the ground. However, sparse stands can have a large amount of image data coming from ground instead of tree canopies. Also, stands with high amounts of understory trees (eg. pine stands with broadleaved understory) were avoided.
- plot coordinates are provided in EUREF-FIN system, the actual image interpretation was done in a KUVAMITT photogrammetric workstation using KKJ2/N60 system. Conversions between systems (UTM/ellipsoid height vs. KKJ2/N60) were made using local equations for Hyytiälä (used by Ilkka in his earlier studies, these are accurate to 2-3 cm).
- the proportion of ground returns in 2011 LiDAR data can be used as a measure of stand density during HS aquisition, since proportion of ground returns correlates well with visually estimated density (in 2010 data, see excel sheet 'Histograms')

Data in the Excel table:

Sheet 1 – 'All_plots'
-contains all data of the plots

serial	Plot serial nr
x	Plot center X in KKJ2 system
y	Plot center Y in KKJ2 system
z	Plot center Z in N60 system
sp	Plot tree species (1=pine, 2=spruce, 3=broadleaved)
pure	Degree of certainty (1=100% pure, 0=uncertain)
dens	Visual estimate for stand density (1=sparse, 3=dense)
n_points_2011	Number of lidar points, in 2011 data
pgnd_2011	proportion of ground (h > 2 m)returns, in 2011 data
h_max_2011	Maximum height of LiDAR points, in 2011 data
h_mean_2011	Mean height of LiDAR points, in 2011 data
d95_2011	95th decile of the LiDAR point height distribution, in 2011 data
n_points_2010	Number of lidar points, in 2010 data
pgnd_2010	proportion of ground returns (h > 2 m), in 2010 data
h_max_2010	Maximum height of LiDAR points, in 2010 data
h_mean_2010	Mean height of LiDAR points, in 2010 data
d95_2010	95th decile of the LiDAR point height distribution, in 2010 data
X_UTM	Plot center x in EUREF-FIN system
Y_UTM	Plot center y in EUREF-FIN system
d95_diff	Difference between height deciles, 2011 vs. 2010
pgnd_diff	Difference of proportion of ground returns, 2011 vs. 2010
Selected	Plots suitable for the study (1=no fellings after 2010, 0=fellings after 2010)
Visible	1=visible to some of the RGB images, 2=visible to none of the RGB images (either not fully covered by the image, or a duplicate ie. plot measured twice in KUVAMITT)
Columns V to BE, pixel coordinates and visibility for each of the 12 RGB images separately	
visible	1=plot visible to the image, 0=not visible
pix_x	x in pixel coordinates (origin is at the center of upper left corner cell)
pix_y	y in pixel coordinates (origin is at the center of upper left corner cell)

Sheet 2 – 'Histograms'
- histograms of stand height and tree species distributions

Sheet 3 - 'Plots_by_species'
- sam plot information as in sheet 1, sorted by tree species (used for drawing histograms)

Sheet 4 – 'Min_pix_val_per_plot'
- minimum pixels values for the plots, used for finding if there are no data cells within the plot

Sheet 5 – 'Image_corners'
corners of the RGB images, used for calculating the pixel coordinates

Checking of the broadleaved plots based on field checks and personal knowledge, February 2012

The species estimate was based on visual image interpretation, and there is a possibility that the 'birch' plots contained other broadleaved species too. Some of the plots were checked by Antti Uotila (prior knowledge and field visits). In addition, Aarne remembered couple of plots that contained pure birch.

Thus, plots that are known to contain only birch are:

- 97, 106, 119, 136, 170, 171, 173, 176, 177, 179, 192, 199, 253, 266, 267, 273, 284, 364, 384, 388, 398, 399, 413, 427, 433

- 424, 425 and 365

- 275, 294, 295, 307, 374, 380, 365, 122

E-mail correspondence:

2.2.2012, Antti Uotila:

"Hei!

Tutustuin karttaan ja lisäksi autoilin pari tienvarsikoealaa.
Puhtaita koivikoita ovat: 173, 176, 199, 177, 179, 253, 266, 267, 398, 364, 384, 398, 273, 427, 433, 192, 170, 171, 106, 97, 119, 413, 284(seassa visakoivuja), 388, 136.

Muutkin ehdotetut voivat olla, en ainakaan tiedä yhtään joka ei olisi. Sekapuita niissä jonkin verran on ainakin alemmissa latvuskerroksissa. Koealalla 136 rajauksesta riippuen saattaa olla kaksi mäntyä joukossa. 399 oli myös valtapuustoltaan koivikko, mutta kuusialikasvoksessa oli pisimmät lisävaltapuita.

Parin viikon päästä voin lähettää lisätietoja ainakin ladun varressa olevista koealoista. Olen ensi viikon poissa. Tässä on nyt ainakin ensiapua.

Antti"

2.2.2012, Aarne Hovi:

"Hi,

Antti checked the birch plots. Absolutely sure cases that he knows of, or checked in the field, are plots nr 97, 106, 119, 136, 170, 171, 173, 176, 177, 179, 192, 199, 253, 266, 267, 273, 284, 364, 384, 388, 398, 399, 413, 427, and 433.

In plot 399 there is spruce understory, of which largest trees reach the dominant canopy layer. In plot 136 there may be 2 pine trees.

In addition, I know the plots 424, 425 and 365 are birch. This makes
28 birch plots in total.

Aarne"

27.2.2012, Antti Uotila:

" Hei!

Tässä lisää ladun varren koivikoita.

Koealat: 275, 294, 295, 307, 374, 380, 365, 122. Aika moni näistä oli pienialainen, suurinpiirtein koealan kokoinen. Umpihangelle en ole vielä mennyt, mutta voin kyllä käydä, jos on tarvetta lisävarmistuksista.

Antti"