# LOCAL COMPONENT VERIFICATION REPORT: GREEN LINEAR ELEMENTS 2012 STATUS LAYER

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**I. Metadata**

| **DATASET** | ***Green Linear Elements 2012 Status Layer*** |
|---|---|
| **Country** | *Finland* |
| **Institution carrying out the work** | *Finnish Environment Institute* |
| **Data preparation** | *Iida Autio, iida.autio@ymparisto.fi* |
| **Visual inspection of samples** | *Iida Autio, iida.autio@ymparisto.fi* |
| **Evaluation** | *Iida Autio, iida.autio@ymparisto.fi* |
| **Reference data provided centrally** | IMAGE2012 VHR satellite image mosaic |
| | GoogleEarth Imagery |
| **In situ data used** | **National Ortho photo database/The National Land Survey**<br>Natural color/black and white ortho photos<br>Resolution: 0.25-0.5m<br>Reference years: 2010-2015 (partial coverages) |
| | **National high resolution Corine Land Cover 2012**<br>National Corine raster dataset<br>Resolution 20x20m |
| | **National Corine Land Cover change layers 2000-2006 and 2006-2012**<br>Resolution 0.5ha |
| | **Laser Scanned Tree Height Data and Tree Cover Density**<br>Resolution 2x2m<br>Raster Data<br>Reference year: 2008-2016 |
| **Software used for verification** | LACO-WIKI, (+ GoogleEarth, QGIS 2.18.10 ), ArcMap 10.5.1 |
| **Internal quality control done by** | Pekka Härmä, pekka.harma@ymparisto.fi; Minna Kallio, minna.kallio@ymparisto.fi |
| **Date and place of writing the report** | 19.04.2018. Helsinki |

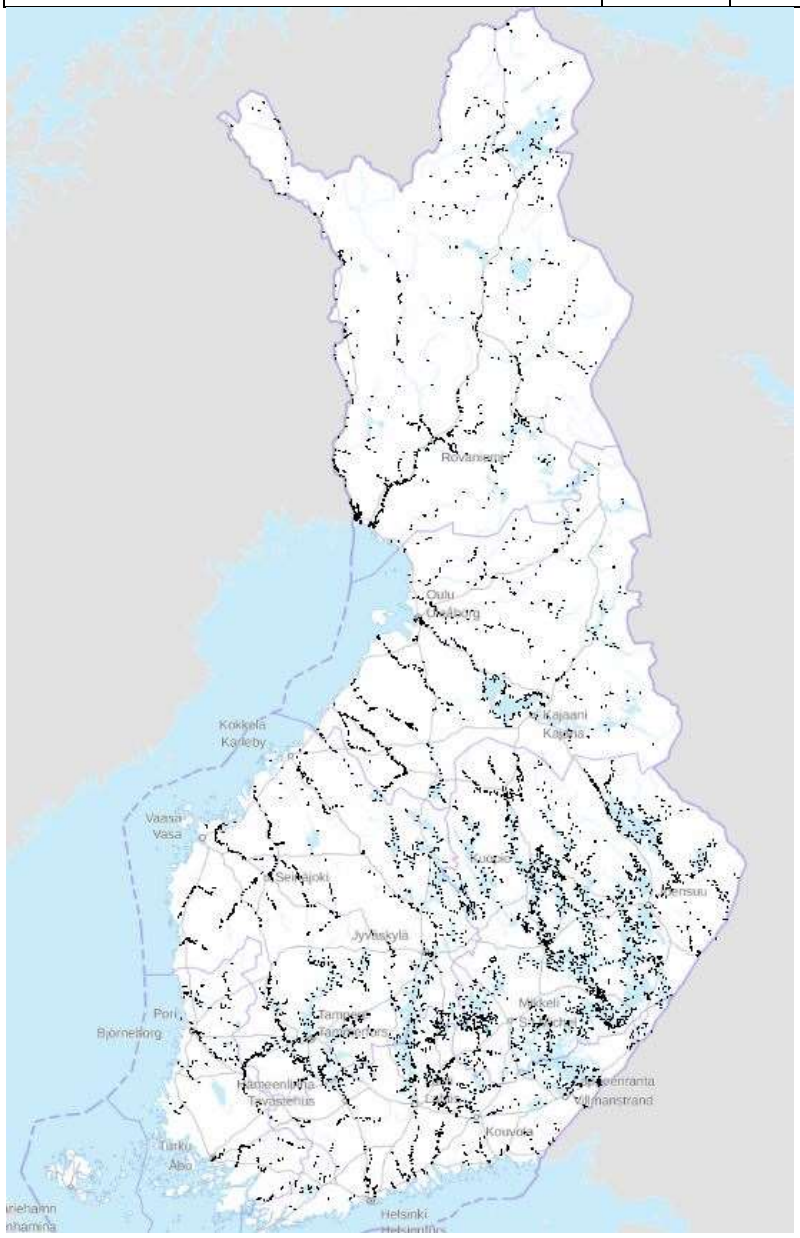
**SUMMARY STATISTICS OF GREEN LINEAR ELEMENTS 2012 STATUS LAYER**

| **GLE Class** | **Number of polygons** | **Area (ha)** | **%** |
|---|---|---|---|
| 1.1 Trees - Linear structures | 4323 | 518 | 4,89 % |
| 1.2 Trees - Patches | 67370 | 9840 | 92,97 % |
| 2.1 Hedgerows and scrub - Linear structures | 1124 | 95 | 0,89 % |
| 2.2 Hedgerows and scrub - Patches | 1053 | 132 | 1,25 % |
| **SUM** | **73870** | **10585** | **100,00 %** |

**II. LACO-Wiki -validation**

**a. Overall characterization of the dataset**

| DATASET | GLE | Green Linear Elements 2012 Status Layer Finland |
|---|---|---|
| **Area covered within country** | 0,03% | 10 580 hectares |
| **Number of valid classes appearing in the country** | 4 | |
| **Number of samples selected** | 100 | 25 samples/class |
| **CORRECTNESS OF LC/LU CODE** | | |
| **Number of correctly interpreted samples** | 78 | |
| **Overall Accuracy** | 98,52 % | |
| **Overall Accuracy (CI)** | ± 0,0069 | |
| **CORRECTNESS OF DELINEATION** | | |
| **Detail of delineation** | 95,00 % | Correct: 95; Too coarse: 5; Too detailed: 0 |
| **Correctness of delineated area** | 35,00 % | Correct: 35; Unnecessary parts included: 27; Missing parts: 35; Both missing parts and unnecessary parts included: 3 |
| **Positional accuracy** | 43,00 % | Correct: 43; Shifted: 57 |
| **OVERVIEW FIGURE OF GLE 2012 STATUS LAYER** | | |



**II.LACO-Wiki -validation**
**b. Characterization of the dataset by LC/LU class**

| DATASET | GLE | Geen Linear Elements 2012 Status Layer Finland |
|---|---|---|
| **LC/LU CLASS** | 1.1 | Trees - Linear structures |
| **Number of samples selected for the class** | 25 | |
| **CORRECTNESS OF LC/LU CODE** | | |
| **Number of correctly interpreted samples** | 22 | |
| **Class user's accuracy** | 88,00 % | |
| **Class user's accuracy (CI)** | ± 0,1300 | |
| **Class producer's accuracy** | 99,18 % | |
| **Class producer's accuracy (CI)** | ± 0,0160 | |
| **CORRECTNESS OF DELINEATION** | | |
| **Detail of delineation** | 100,00 % | Correct: 25; Too coarse: 0; Too detailed: 0 |
| **Correctness of delineated area** | 32,00 % | Correct: 8; Unnecessary parts included: 13; Missing parts: 0; Both missing parts and unnecessary parts included: 1 |
| **Positional accuracy** | 40,00 % | Correct: 10; Shifted: 15 |
| **CHARACTERIZATION OF THE CLASS** | | |
| **Typical mistakes (misclassification, wrong delineation, etc.) describe in detail** | The class polygons are often missing areas in the ends. They are also often a part of a larger forested area and delineating a separate linear structure is not reasonable. Polygons are mostly shifted. | |
| **Typical reference information used / minimum required for decision** | VHR ortho imagery close to year 2012; National high resolution Corine Land Cover 2012; Corine Land Cover change layers 2000-2006 and 2006-2012; Laser Scanned Tree Height Data | |
| **Typical appearance of the class in samples (habitats, cultivation type, land use etc)** | Typical appearance of the class are linear forest patches bordering a field or a water system. | |
| **EXAMPLE (typical mistakes / typical appearance):** | | |

Polygon is next to a large forest area.

| DATASET | GLE | Geen Linear Elements 2012 Status Layer Finland |
|---|---|---|
| **LC/LU CLASS** | 1.2 | Trees - Patches |
| **Number of samples selected for the class** | 25 | |
| **CORRECTNESS OF LC/LU CODE** | | |
| **Number of correctly interpreted samples** | 25 | |
| **Class user's accuracy** | 100,00 % | |
| **Class user's accuracy (CI)** | ± 0,0000 | |
| **Class producer's accuracy** | 98,68 % | |
| **Class producer's accuracy (CI)** | ± 0,0062 | |
| **CORRECTNESS OF DELINEATION** | | |
| **Detail of delineation** | 84,00 % | Correct: 21; Too coarse: 4; Too detailed: 0 |
| **Correctness of delineated area** | 32,00 % | Correct: 8; Unnecessary parts included: 0; Missing parts: 17; Both missing parts and unnecessary parts included: 0 |
| **Positional accuracy** | 40,00 % | Correct: 10; Shifted: 15 |
| **CHARACTERIZATION OF THE CLASS** | | |
| **Typical mistakes (misclassification, wrong delineation, etc.) describe in detail** | The class polygons are mostly a part of a larger forested area and delineating a separate forest patch is not reasonable. They are also often shifted.<br>Islands are overrepresented in the samples which is questionable as they don't necessarily act as dispersion vectors of biodiversity. | |
| **Typical reference information used / minimum required for decision** | VHR ortho imagery close to year 2012; National high resolution Corine Land Cover 2012; Corine Land Cover change layers 2000-2006 and 2006-2012; Laser Scanned Tree Height Data | |
| **Typical appearance of the class in samples (habitats, cultivation type, land use etc)** | Most abundant class in the dataset. | |
| **EXAMPLE (typical mistakes / typical appearance):** | | |

Not a separate patch but part of a larger forested area.

| DATASET | GLE | Geen Linear Elements 2012 Status Layer Finland |
|---|---|---|
| **LC/LU CLASS** | 2.1 | Hedgerows and scrub - Linear structures |
| **Number of samples selected for the class** | 25 | |
| **CORRECTNESS OF LC/LU CODE** | | |
| **Number of correctly interpreted samples** | 21 | |
| **Class user's accuracy** | 84,00 % | |
| **Class user's accuracy (CI)** | ± 0,1467 | |
| **Class producer's accuracy** | 79,32 % | |
| **Class producer's accuracy (CI)** | ± 0,3228 | |
| **CORRECTNESS OF DELINEATION** | | |
| **Detail of delineation** | 96,00 % | Correct: 24; Too coarse: 1; Too detailed: 0 |
| **Correctness of delineated area** | 60,00 % | Correct: 15; Unnecessary parts included: 8; Missing parts: 2; Both missing parts and unnecessary parts included: 0 |
| **Positional accuracy** | 44,00 % | Correct: 11; Shifted: 14 |
| **CHARACTERIZATION OF THE CLASS** | | |
| **Typical mistakes (misclassification, wrong delineation, etc.) describe in detail** | In most cases there are not enough reference data to confirm the occurrence of hedgerows in the polygon: vegetation cannot be seen in ortho photos and the laser scanned tree height data hasn't detected any vegetation. | |
| **Typical reference information used / minimum required for decision** | VHR ortho imagery close to year 2012; National high resolution Corine Land Cover 2012; Corine Land Cover change layers 2000-2006 and 2006-2012; Laser Scanned Tree Height Data | |
| **Typical appearance of the class in samples (habitats, cultivation type, land use etc)** | Potential appearance of the class is bushy vegetation bordering ditches in fields. | |
| **EXAMPLE (typical mistakes / typical appearance):** | | |

Hedgerow vegetation cannot be detected in the data.

| DATASET | GLE | Geen Linear Elements 2012 Status Layer Finland |
|---|---|---|
| **LC/LU CLASS** | 2.2 | Hedgerows and scrub - Patches |
| **Number of samples selected for the class** | 25 | |
| **CORRECTNESS OF LC/LU CODE** | | |
| **Number of correctly interpreted samples** | 10 | |
| **Class user's accuracy** | 40,00 % | |
| **Class user's accuracy (CI)** | ± 0,1960 | |
| **Class producer's accuracy** | 100,00 % | |
| **Class producer's accuracy (CI)** | ± 0,0000 | |
| **CORRECTNESS OF DELINEATION** | | |
| **Detail of delineation** | 100,00 % | Correct: 25; Too coarse: 0; Too detailed: 0 |
| **Correctness of delineated area** | 16,00 % | Correct: 4; Unnecessary parts included: 13; Missing parts: 3; Both missing parts and unnecessary parts included: 2 |
| **Positional accuracy** | 48,00 % | Correct: 12; Shifted: 13 |
| **CHARACTERIZATION OF THE CLASS** | | |
| **Typical mistakes (misclassification, wrong delineation, etc.) describe in detail** | Misclassifications with tree patches as vegetation is often > 5m. | |
| **Typical reference information used / minimum required for decision** | VHR ortho imagery close to year 2012; National high resolution Corine Land Cover 2012; Corine Land Cover change layers 2000-2006 and 2006-2012; Laser Scanned Tree Height Data | |
| **Typical appearance of the class in samples (habitats, cultivation type, land use etc)** | | |
| **EXAMPLE (typical mistakes / typical appearance):** | | |

Wrong class: these are trees and polygon is not a separate patch.

**IV. Cross-tabulation validation**

According to visual inspection it was noticed that only an arbitrary subset of small scale forests were detected in GLE data. In order to examine this observation quantitatively and estimate the omission error, GLE polygons were compared with Laser scanning data using cross-tabulation method. This was performed for a subset of the RZ/GLE-data covering an area of 31 299 ha in south-western Finland (Figure 1.)
The primary source of in situ data in this verification task was very high resolution canopy height model, which was retrieved using point clouds measured using airborne laser scanning. Canopy height was produced as continuous variable from point cloud in raster format with ground resolution of 2 meters. These data covered the whole area of sampling area (Figure 1.) The accuracy of canopy (tree) height information derived using Lidar is very high i.e. RMSE < 1 meter in Finland (Kaartinen, H. & al 2012.) and corresponds to the accuracy of ground measurements. Point cloud was scanned between years 2008 and 2015 i.e. 3-4 years around the nominal reference year of GLE.

Preparation of in situ data used in the verification task included:

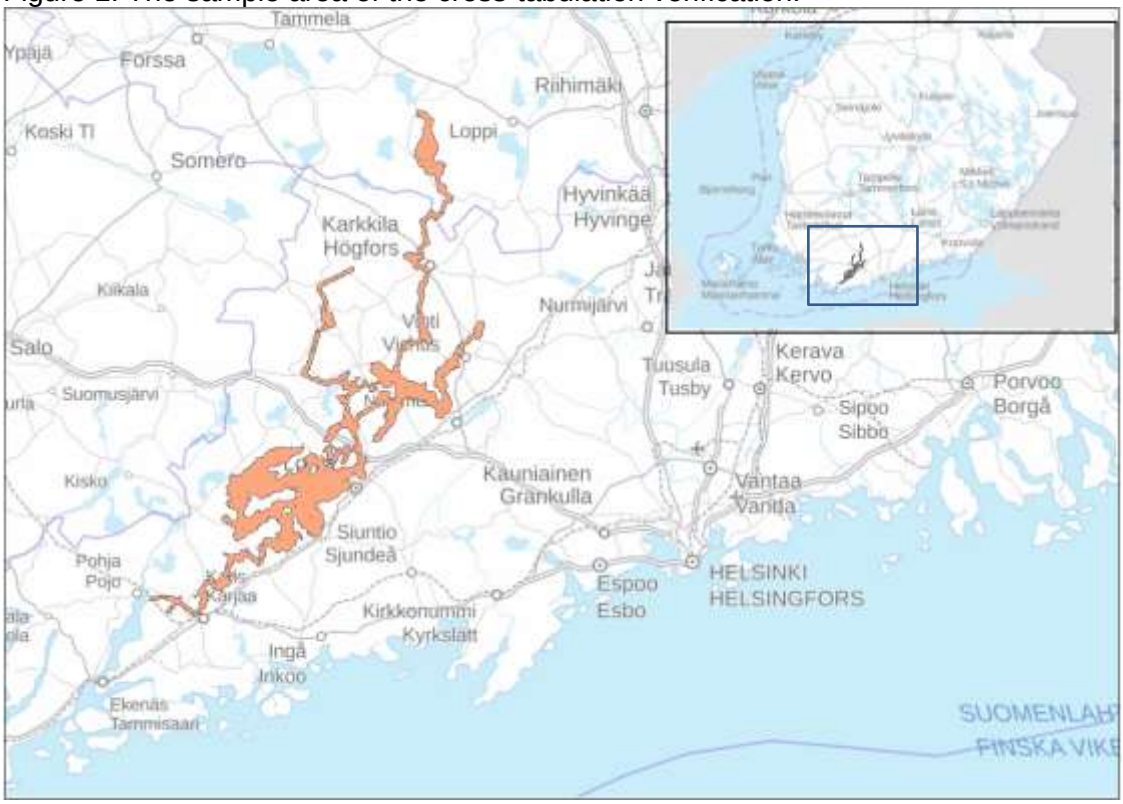
- Masking out the Riparian Zones forest classes (3000). This was done to demonstrate the area in which RZ data indicates to be no trees/forest.
- Reclassifying the canopy height raster data into 2 classes: no vegetation (vegetation height 0-0,5m) and hedgerows and trees (vegetation height >0,5m).

Preparation of Green Linear Elements/RZ dataset in the sample area

- Rasterizing of the data into the same grid with in-situ data.

Verification was completed by cross-tabulation of the sample area with reclassified in-situ data in raster format with ground resolution of 2 meters. Accuracy metrics were calculated using an error matrix.

Figure 1. The sample area of the cross-tabulation verification.



| DATASET | GLE | Green Linear Elements 2012 |
|---|---|---|
| **Classification accuracy according to error matrix (2*2 m cells)** | | |
| **Overall Accuracy** | 92,2% | |
| **Omission error** | 98,1 % | |
| **Commission error** | 0,0 % | |
| **User's accuracy** | 71,3 % | |

Table 1. Results of the cross-tabulation

The omission error (98,1 %) is very high (Table 1). This indicates that only a fraction of forested areas outside forest polygons in Riparian zone status layer is present in the GLE data. It must be noticed that only the forest classes (3000) of the Riparian Zones status layer were masked out in this analysis in order to define areas outside continuous forests. In reality, several RZ-classes such as Green urban areas (1411) and Sports and leisure facilities (1421) might include trees. Also the fact that the entire Lidar-data point cloud is not scanned in the reference year of 2012 (2008-2015) can cause bias in the analysis. The low commission error (0,0%) show that the GLE polygons are correctly located in areas with trees and hedgerows.
Figures 2 and 3 demonstrate these results. They also confirm that in many cases GLE polygons are located in larger forested areas and thus their delineation as separate patches and linear elements is not reasonable.

Figure 2. Riparian Zone (grey), Green Linear Elements (red), tree and hedgerow covered areas from Lidar (green), forest polygons of the Riparian Zone status layer (black stripes).

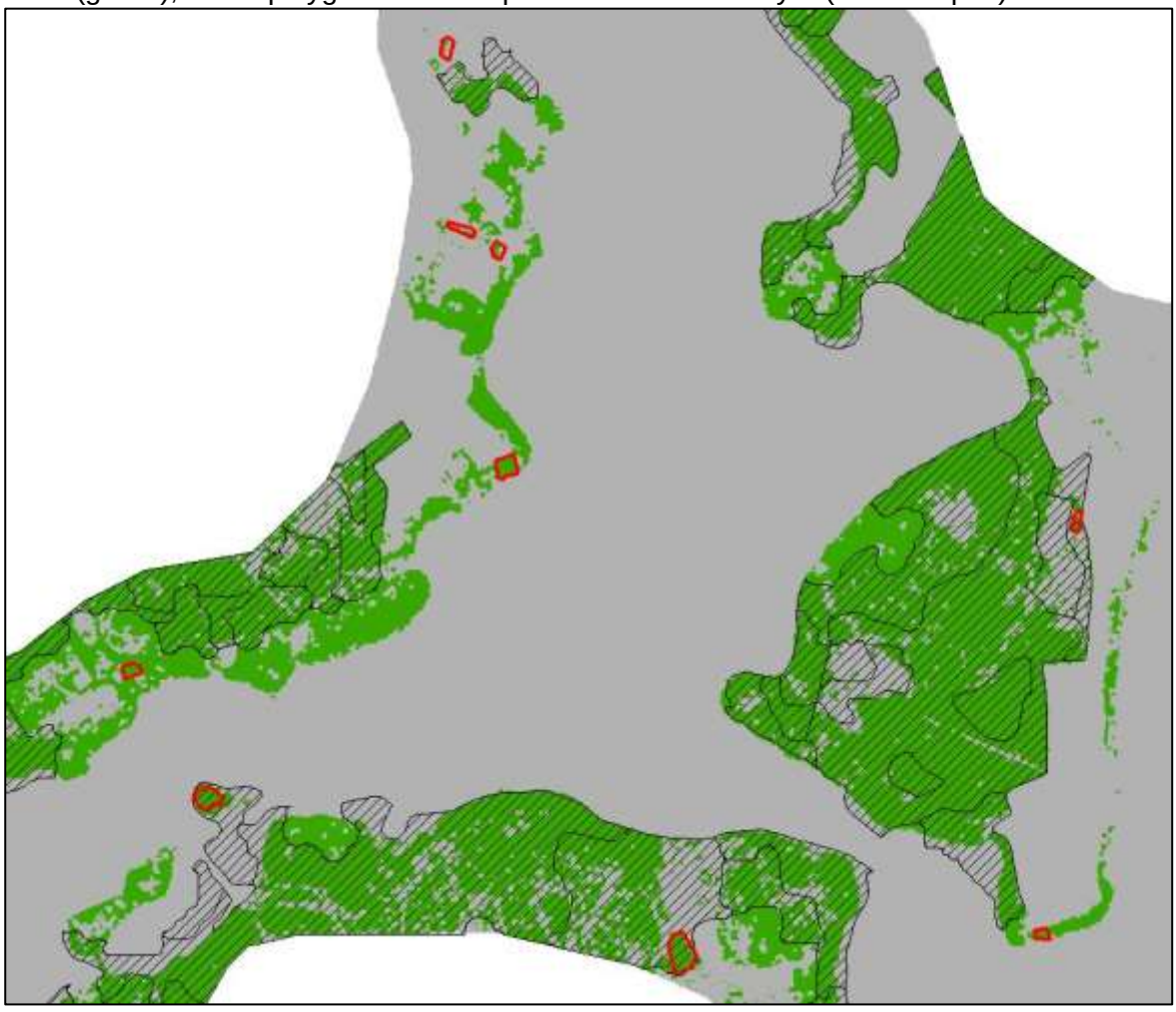
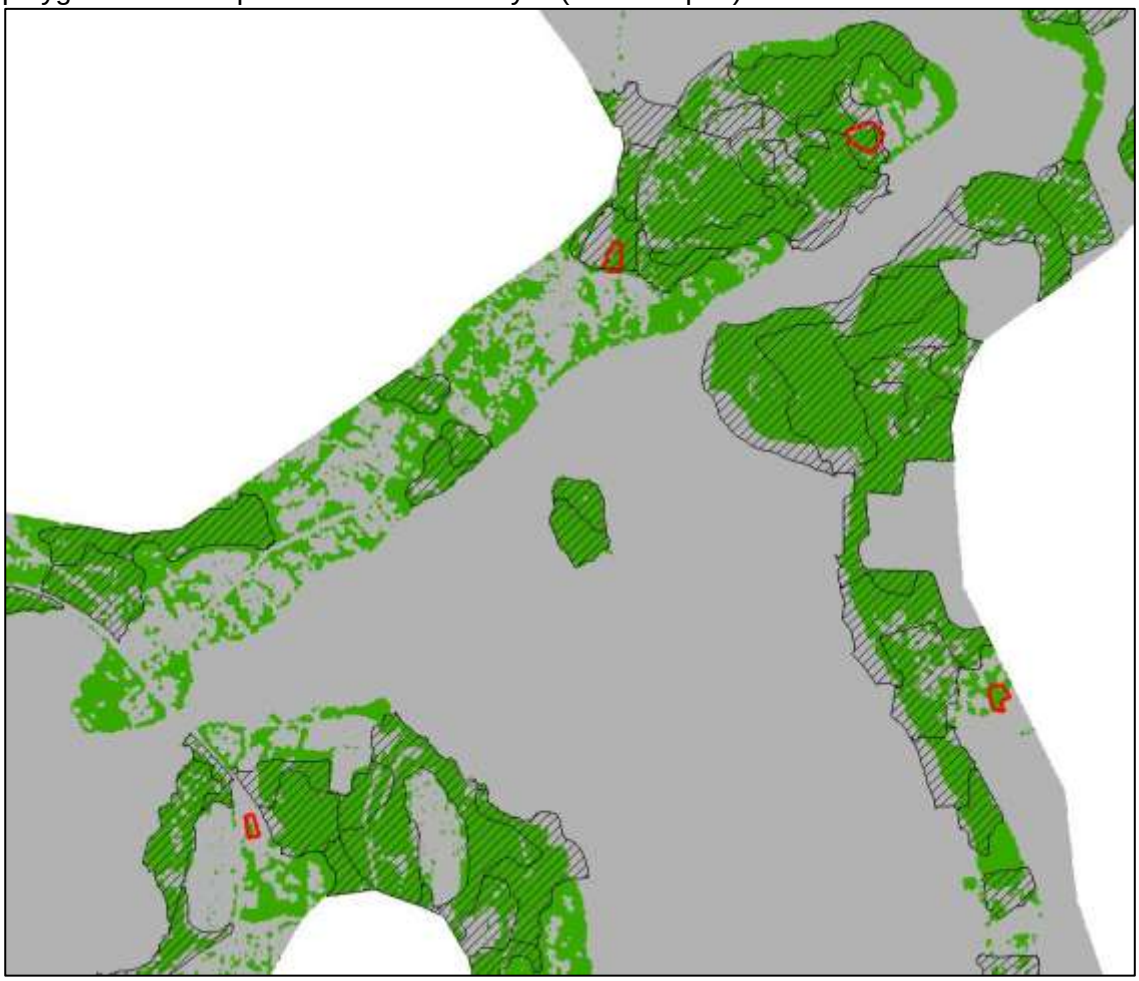


Figure 3. Green Linear Elements (red), tree and hedgerow covered areas from Lidar (green), forest polygons of the Riparian Zone status layer (black stripes).



**IV. Conclusions**

Patches of trees is the most abundant class of the GLE status layer. These polygons are in most cases part of a larger forested area and their delineation as separate polygons is not reasonable. Hedgerows are often difficult to validate as the vegetation is not detectable in the reference data. Also in many cases, vegetation in hedgerow polygons is higher than 5m. High user's accuracy detected in the LACO-Wiki validation is not an indication of the good quality of the data. This is because many samples that were actually part of a bigger forest area were regarded as correctly classified.

Both the LACO-Wiki and cross-tabulation validations point out that the quality of the Green Linear Elements 2012 status layer is not acceptable in Finland. Large areas of trees and hedgerows are missing from the dataset and the delineation of the GLE-polygons doesn't make sense as they're often located in a forest. The purpose and usability of this dataset is very questionable in Finland and is probably more relevant in e.g. central Europe where forests are less abundant.

**References**

Harri Kaartinen, Juha Hyyppä, Xiaowei Yu, Mikko Vastaranta, Hannu Hyyppä, Antero Kooko, Markus Holopainen, Christian Heipke, Manuela Hirschmugl, Felix Morsdorf, Erik Naesset, Juho Pitkänen, Sorin Popescu, Svein Solberg, Bernd Michael Wolf, Jee-Cheng Wu. An Internationnal Comparison of Individual Tree Detection and Extraction Using Airborne Laser Scanning. Remote Sensing. 2012, 4, 950-974