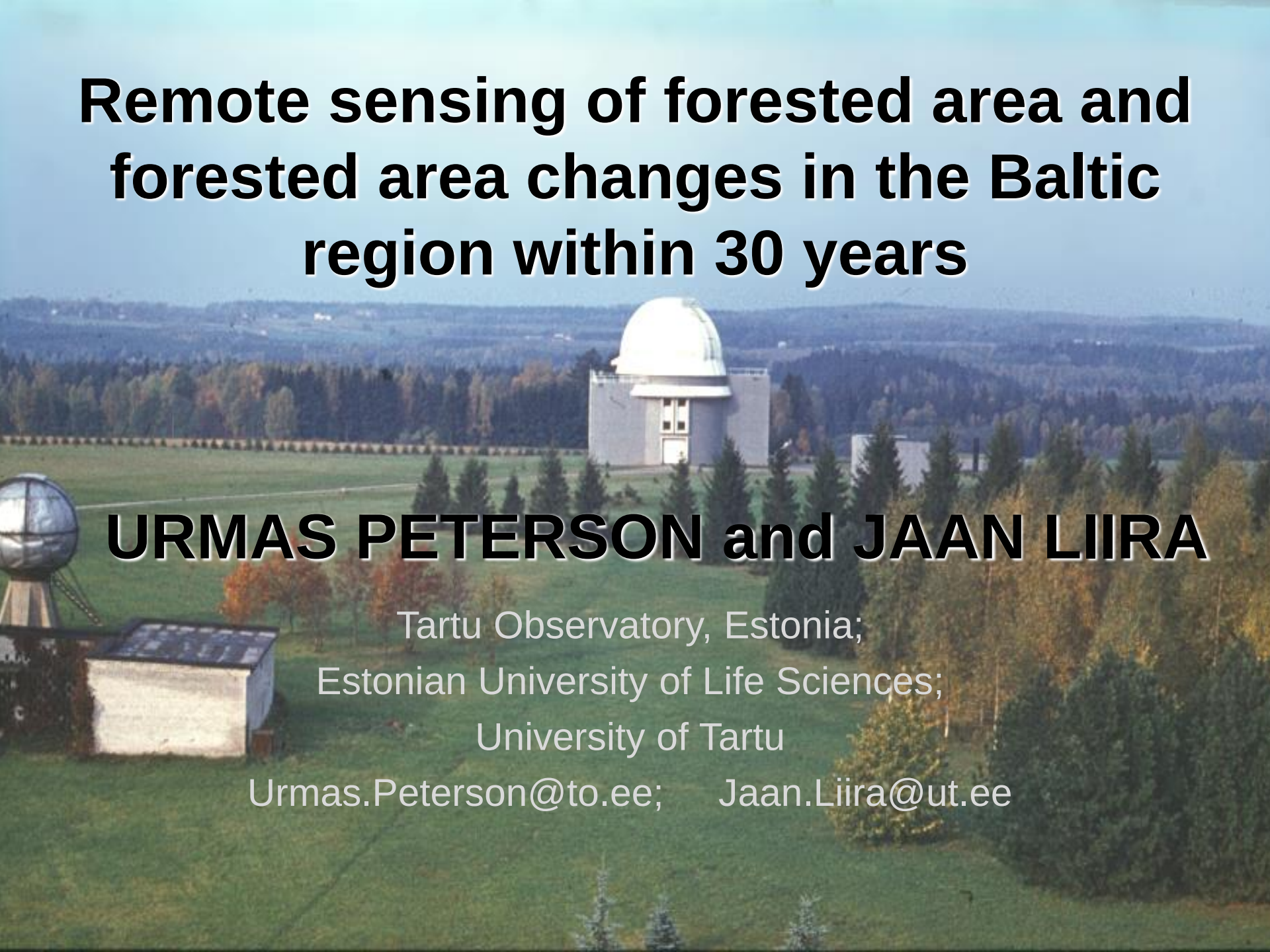
Remote sensing of forested area and forested area changes in the Baltic region within 30 years



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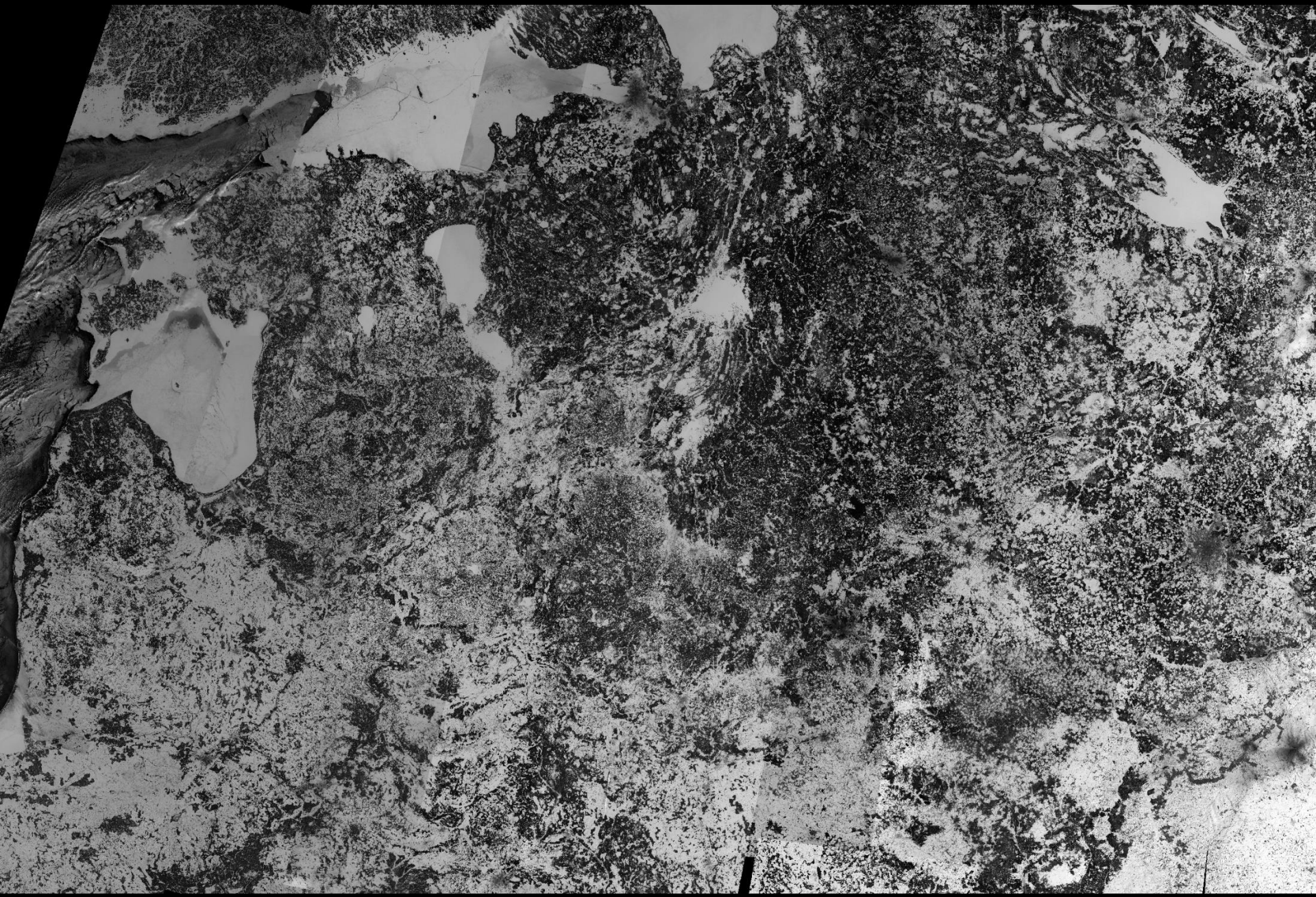
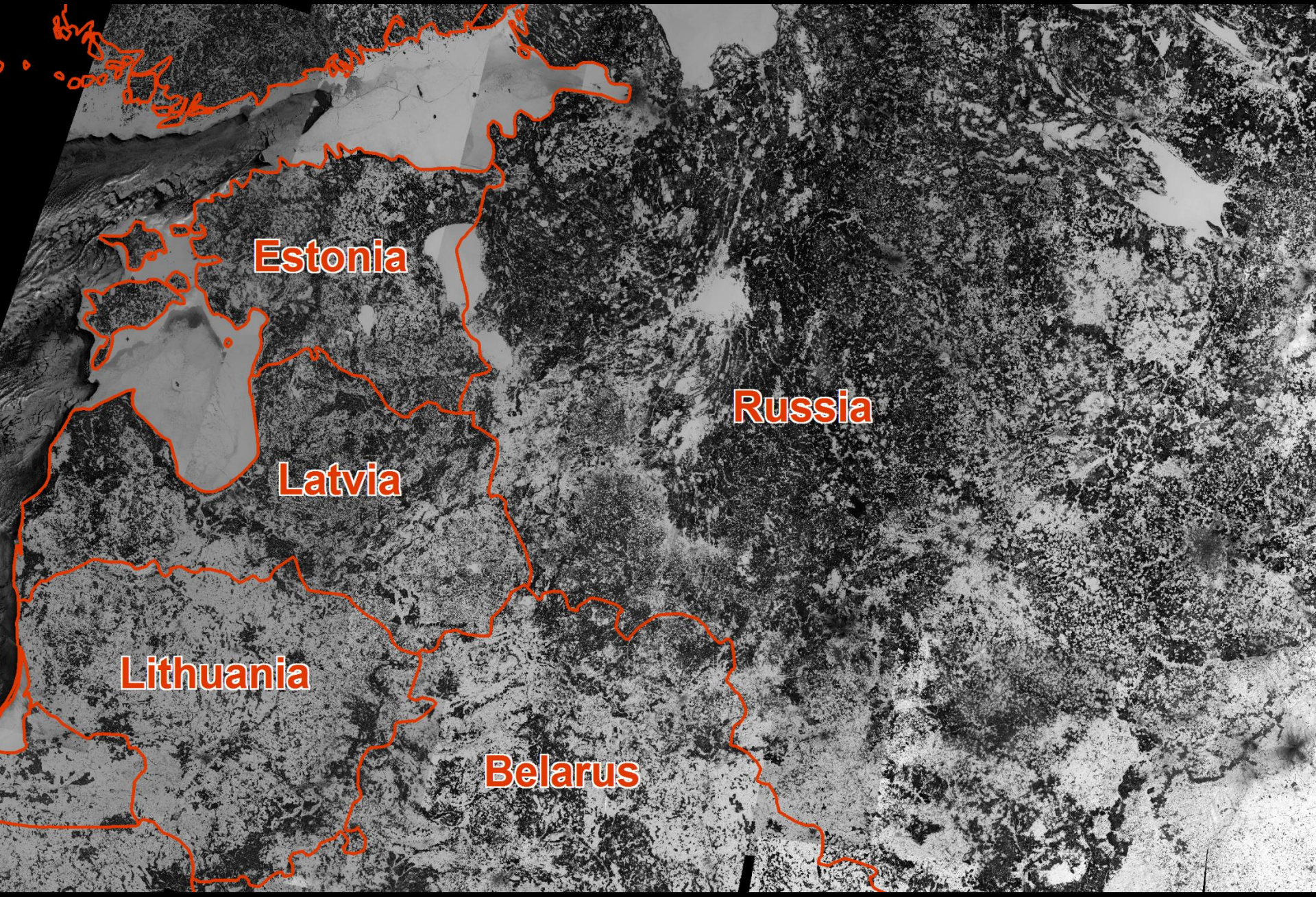
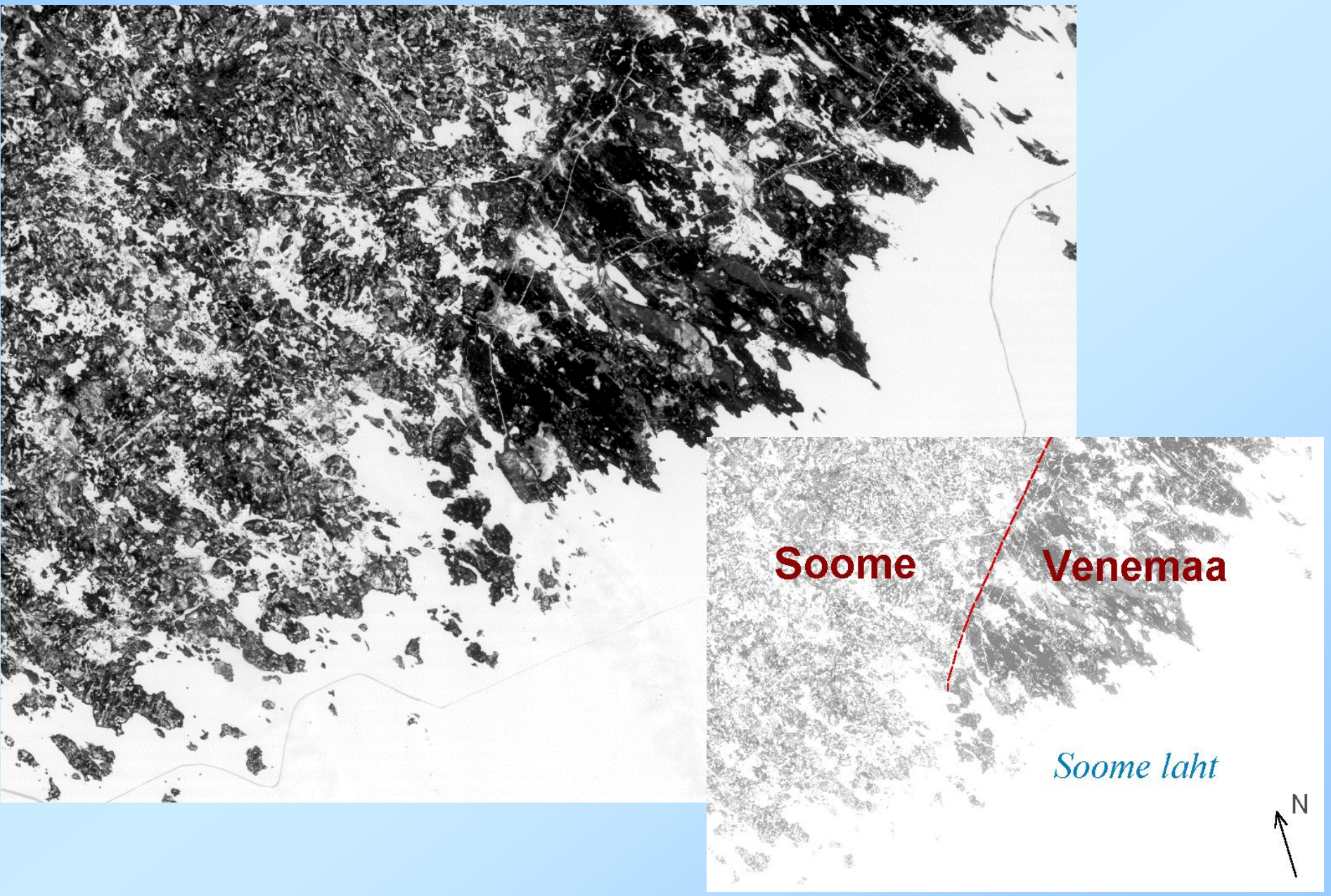
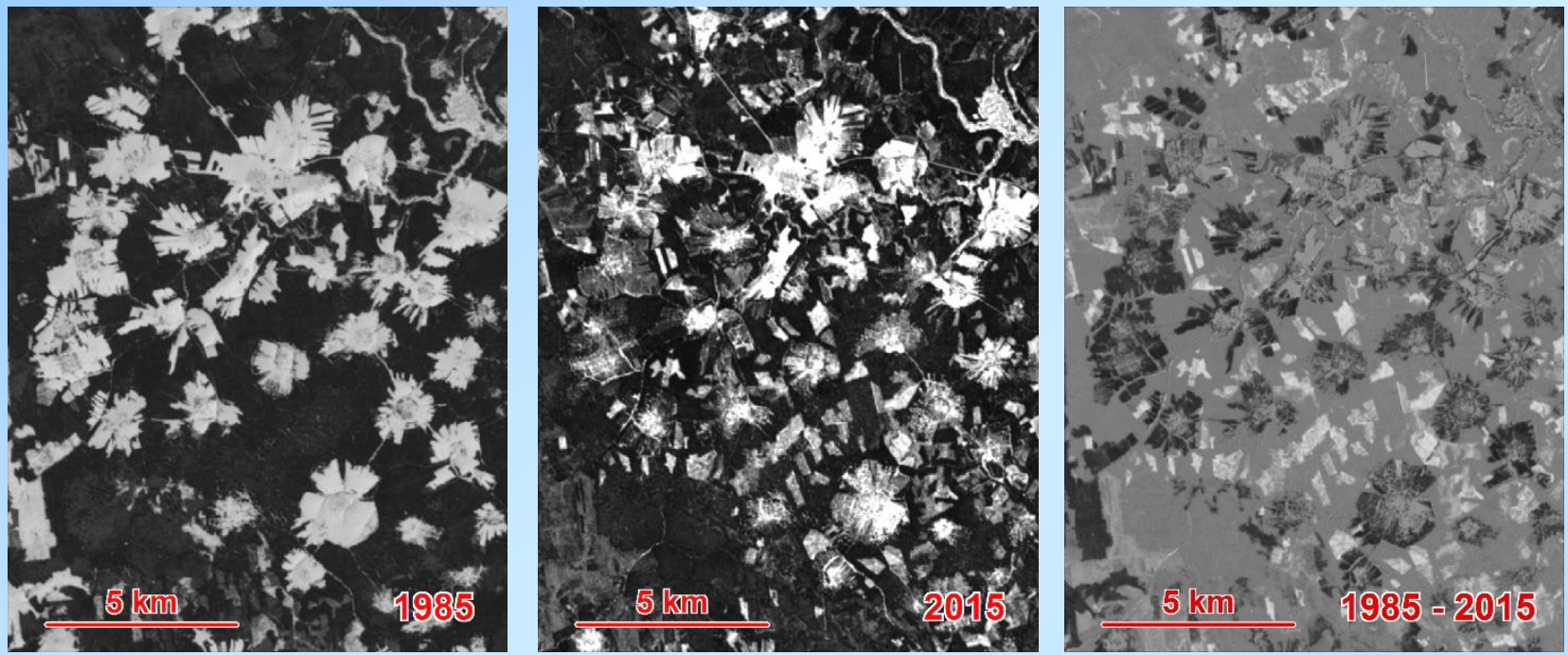
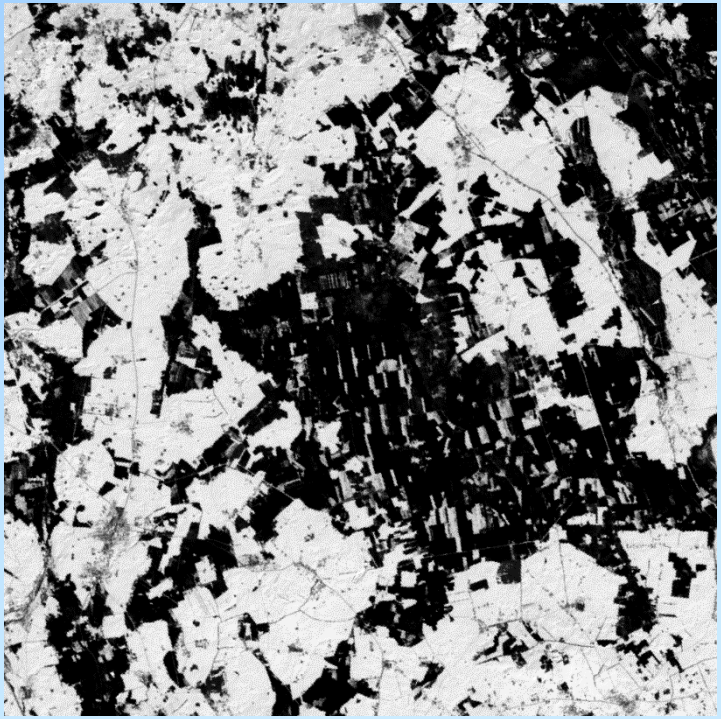



Estonia
Russia
Latvia
Lithuania
Belarus

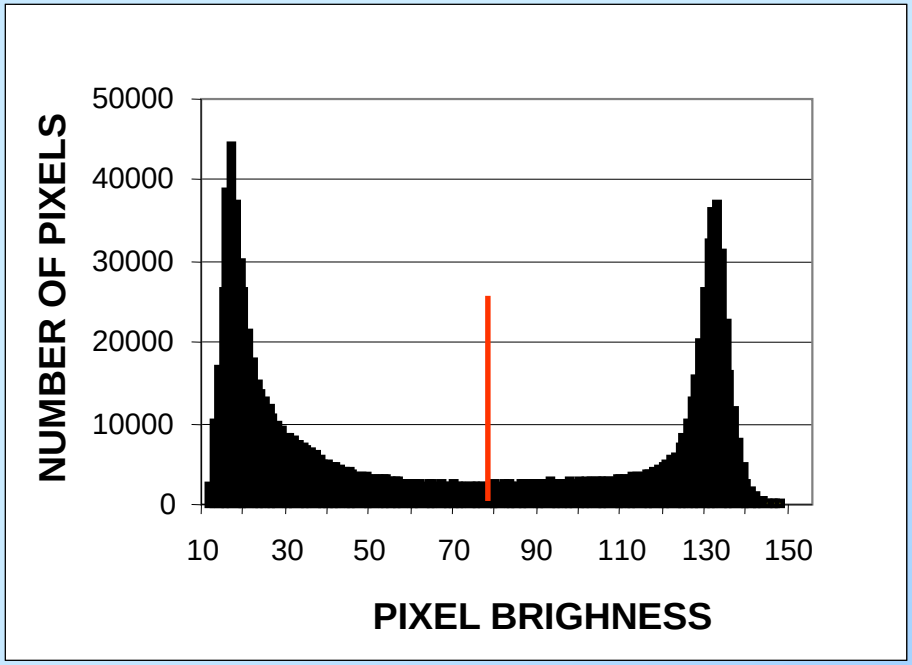

Soome
Venemaa
Soome laht
N



An example of forest change. Bright patches are agricultural openings, typically 1.5 to 2 km wide, in forested background. This pattern of patches is common in several regions in European Russia, here at 58. 6° N 43.3° E (*and is common also in Moscow region*). Agricultural activities in the openings, have ceased since mid-1980s, the openings are closing from the perimeter towards their central areas.

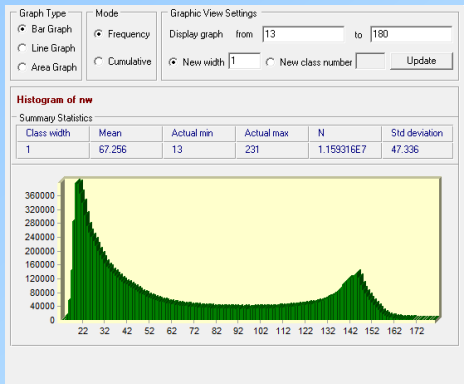


Remotely sensed image (Landsat) in March, ground is covred with snow.

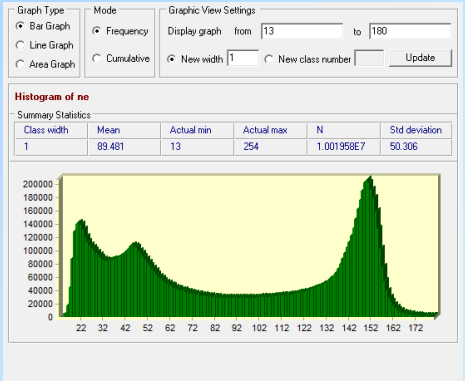


Frequency distribution of pixel brightness values.

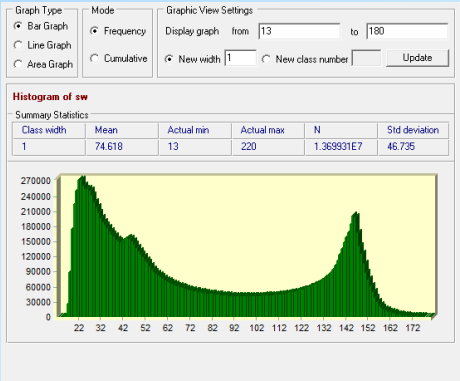
NW


Graph Type
Bar Graph
Line Graph
Area Graph
Mode
Frequency
Cumulative
Graphic View Settings
Display graph from 13 to 180
New width 1
New class number
Update
Histogram of nw
Summary Statistics
Class width | Mean | Actual min | Actual max | N | Std deviation
1 | 67.256 | 13 | 231 | 1.159316E7 | 47.336
360000 320000 280000 240000 200000 160000 120000 80000 40000 0
22 32 42 52 62 72 82 92 102 112 122 132 142 152 162 172

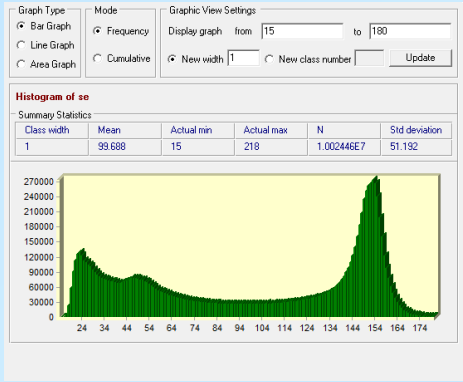
NE

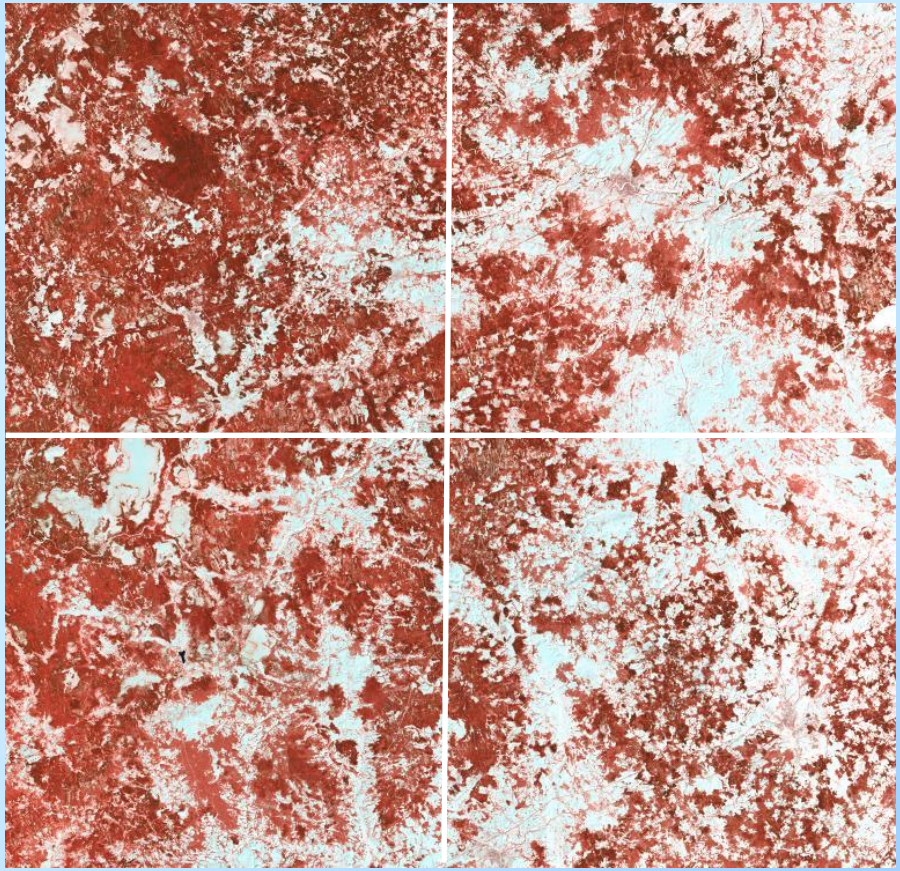

Graph Type
Bar Graph
Line Graph
Area Graph
Mode
Frequency
Cumulative
Graphic View Settings
Display graph from 13 to 180
New width 1
New class number
Update
Histogram of ne
Summary Statistics
Class width | Mean | Actual min | Actual max | N | Std deviation
1 | 89.481 | 13 | 254 | 1.001958E7 | 50.306
200000 180000 160000 140000 120000 100000 80000 60000 40000 20000 0
22 32 42 52 62 72 82 92 102 112 122 132 142 152 162 172

SW


Graph Type
Bar Graph
Line Graph
Area Graph
Mode
Frequency
Cumulative
Graphic View Settings
Display graph from 13 to 180
New width 1
New class number
Update
Histogram of sw
Summary Statistics
Class width | Mean | Actual min | Actual max | N | Std deviation
1 | 74.618 | 13 | 220 | 1.369931E7 | 46.735
270000 240000 210000 180000 150000 120000 90000 60000 30000 0
22 32 42 52 62 72 82 92 102 112 122 132 142 152 162 172

SE


Graph Type
Bar Graph
Line Graph
Area Graph
Mode
Frequency
Cumulative
Graphic View Settings
Display graph from 15 to 180
New width 1
New class number
Update
Histogram of se
Summary Statistics
Class width | Mean | Actual min | Actual max | N | Std deviation
1 | 99.688 | 15 | 218 | 1.002446E7 | 51.192
270000 240000 210000 180000 150000 120000 90000 60000 30000 0
24 34 44 54 64 74 84 94 104 114 124 134 144 154 164 174

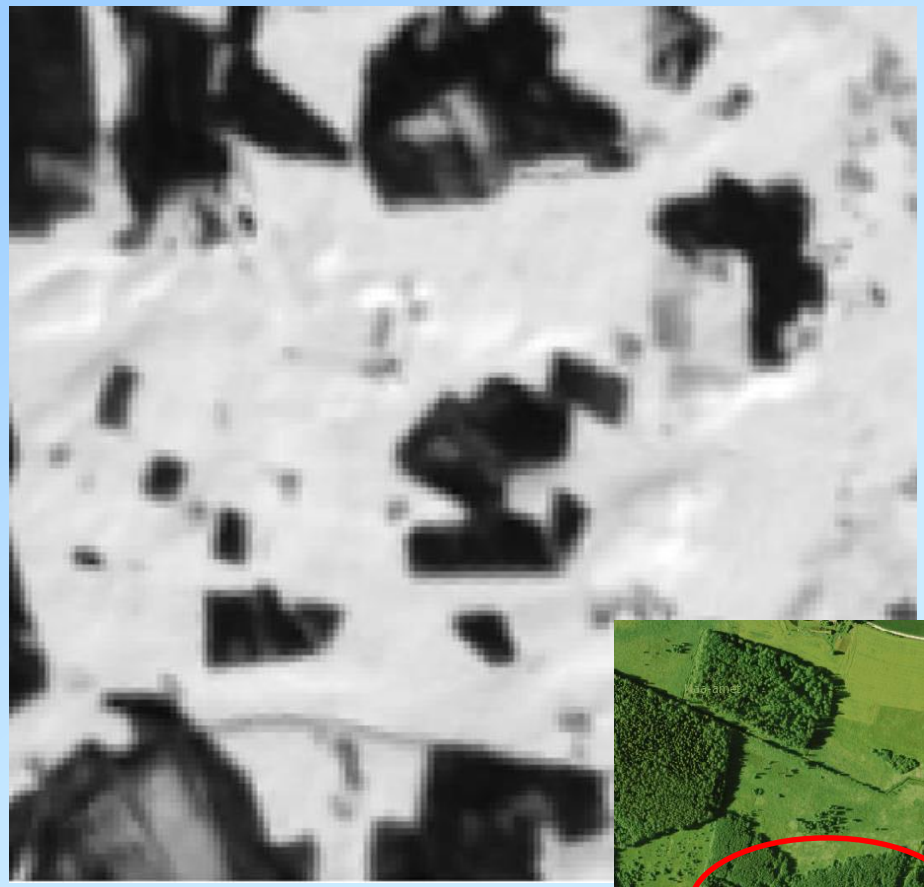


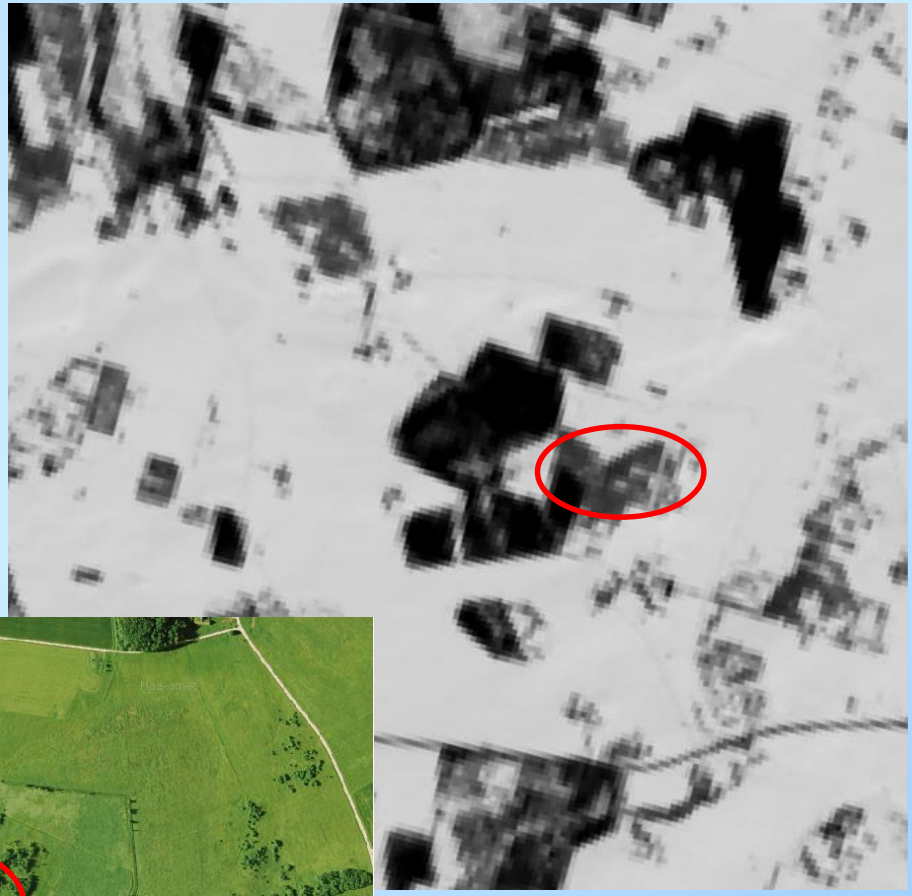
Horizontal reference panel with movable cover 10 m by 10 m at Järvselja, Estonia, buil in 2010, material: concrete.

First image

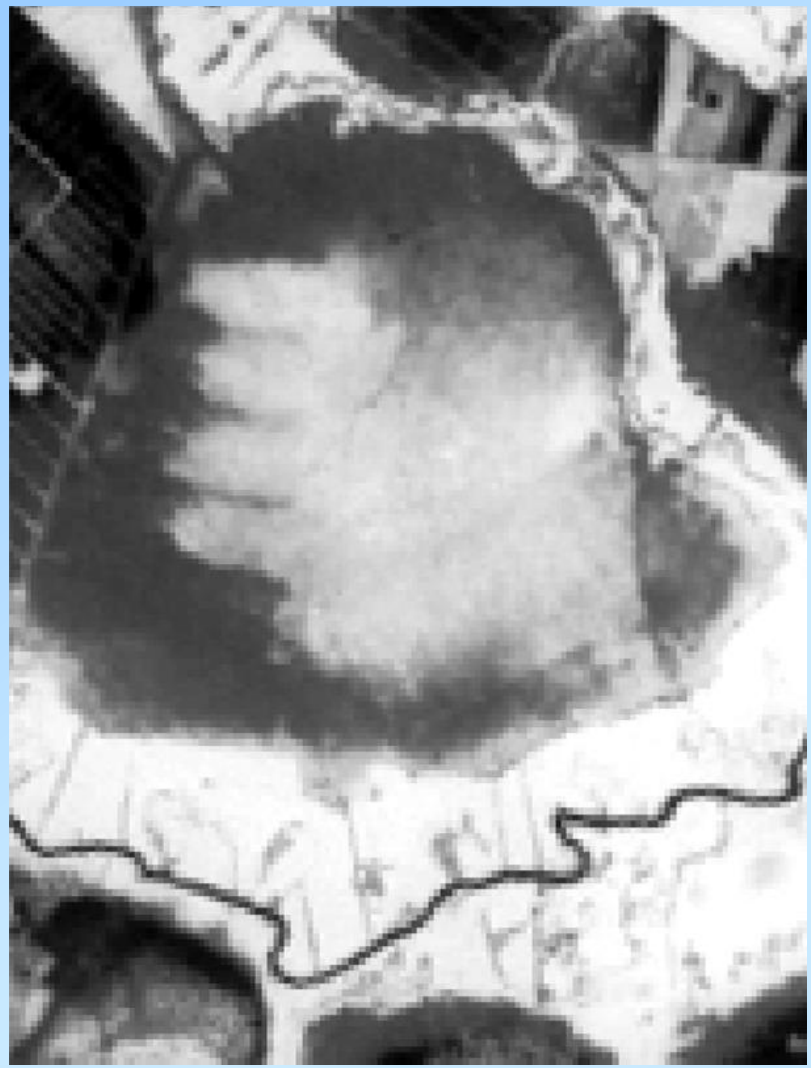
Second image

Difference image – cleaercuts classified

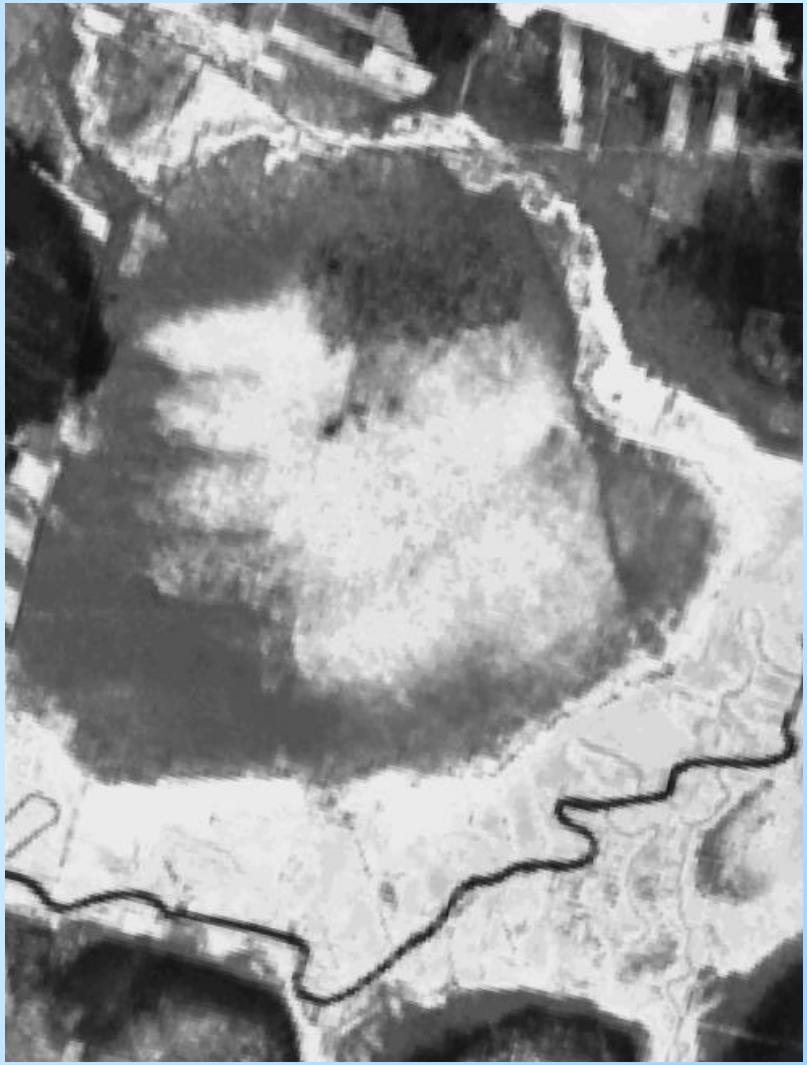




1996.a. märts, *Landsa* ärts *SPOT HRV*



March 1987, *Landsat TM*



March 2011, *SPOT HRV*

Alam-Pedja Protected Area, Karisto Nature Reserve

IKONOS, pixel 1 m

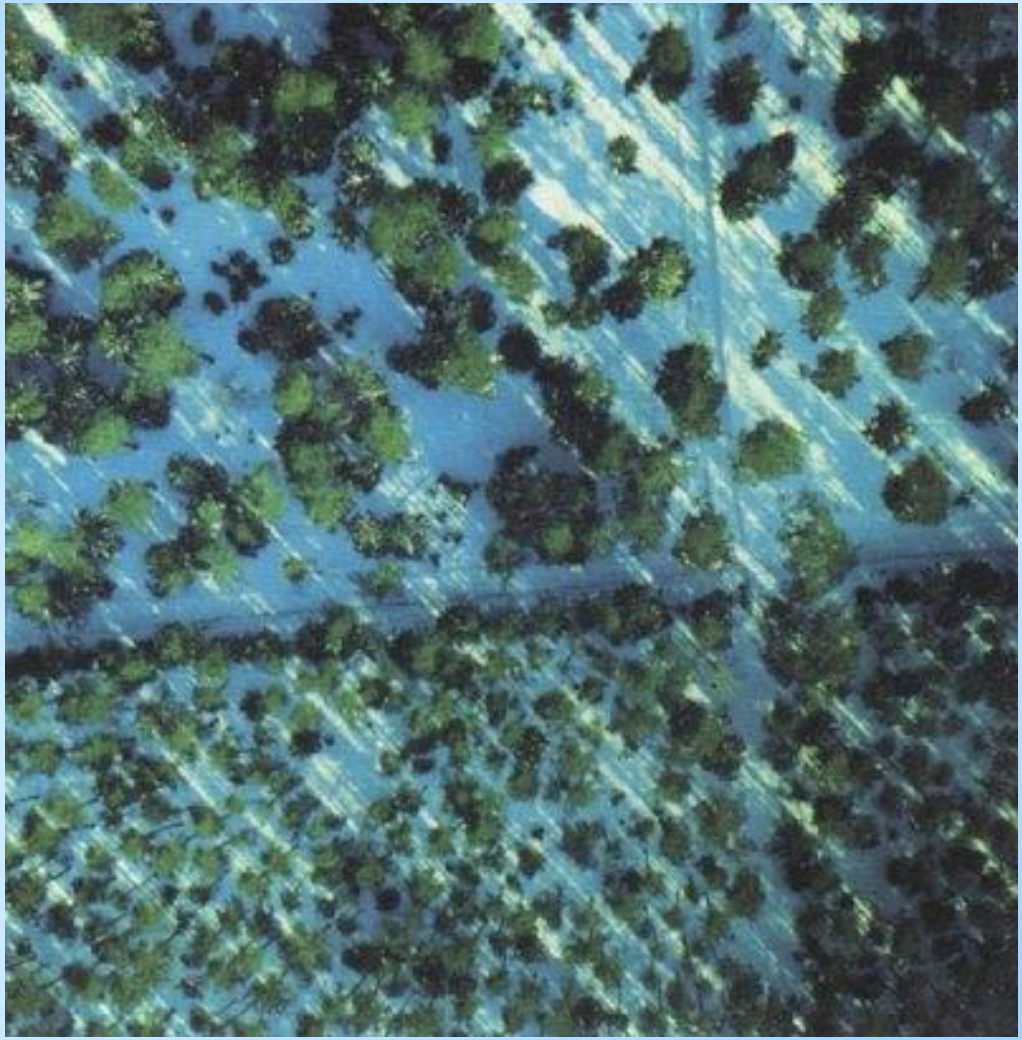
ASTER, pixel 15 m

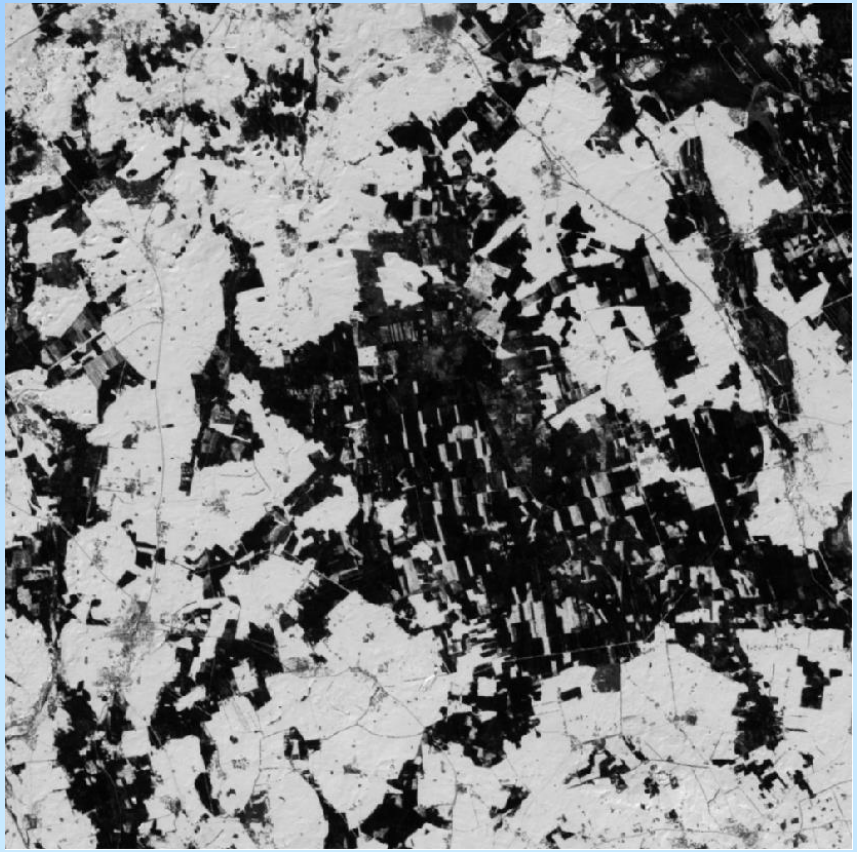
Landsat TM, pixel 30 m

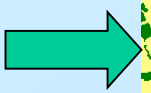
Central Estonia, Kabala on satellite images of different spatial resolution.
Winter, ground is covered with **snow**.

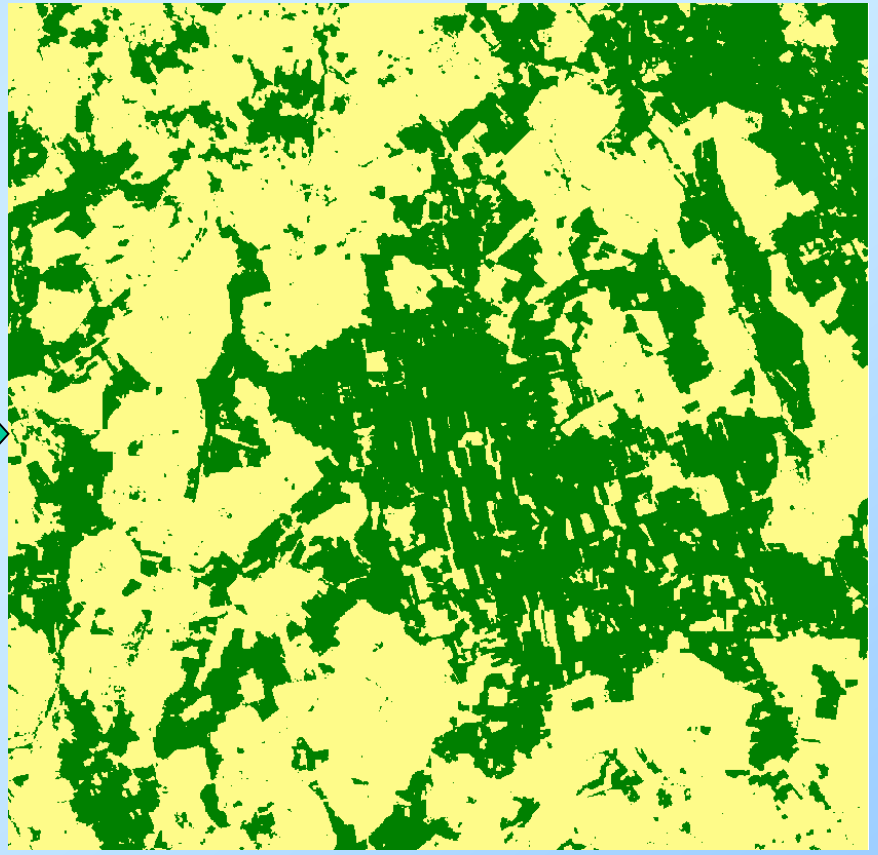
High resolution images are for maps in scale 1 : 10 000 to 1: 25 000
Moderate resolution Landsat TM images are for maps in scale 1: 100 000.

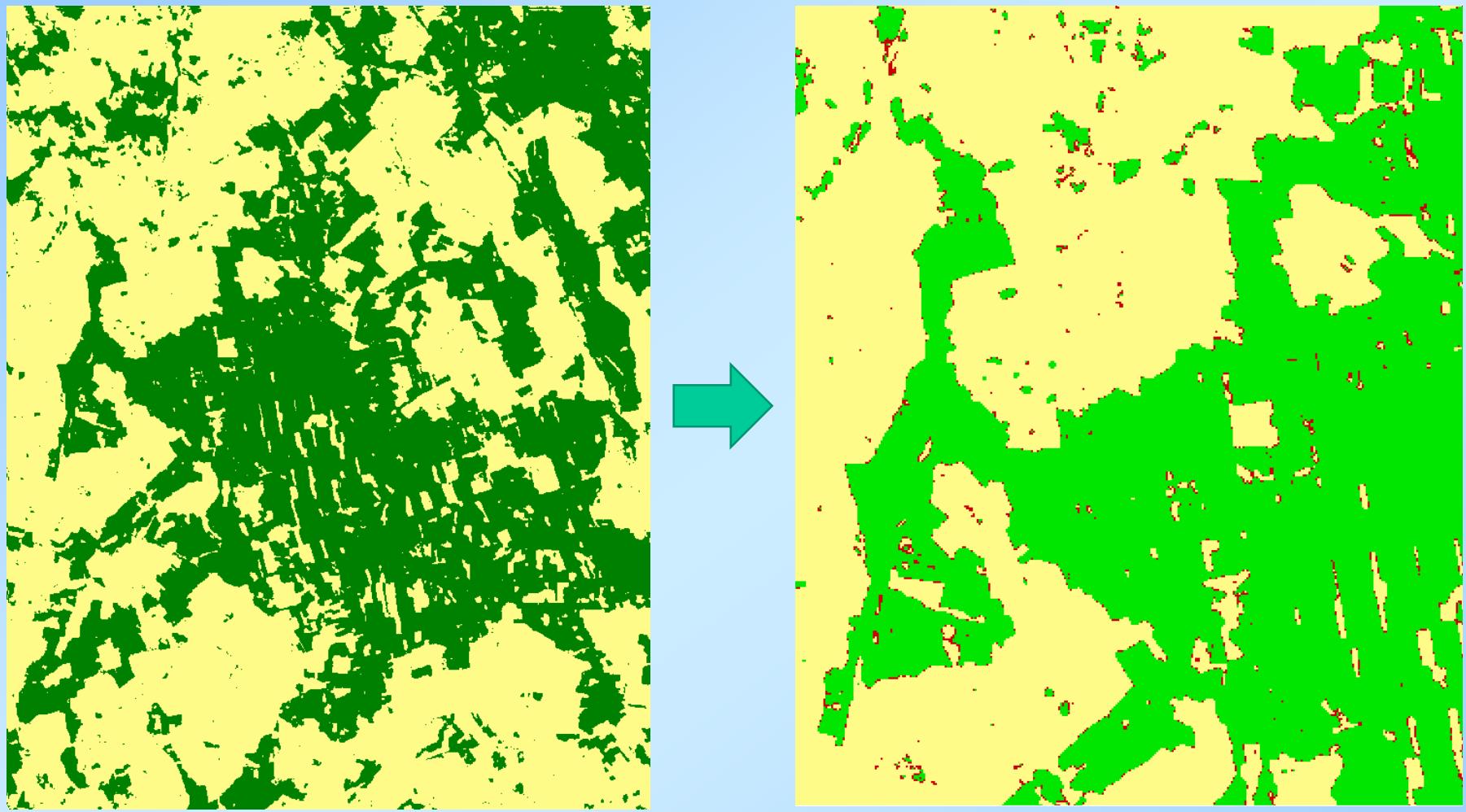
If resolution is too high unwanted details will appear and classification accuracy would decrease if common classification methods are used.



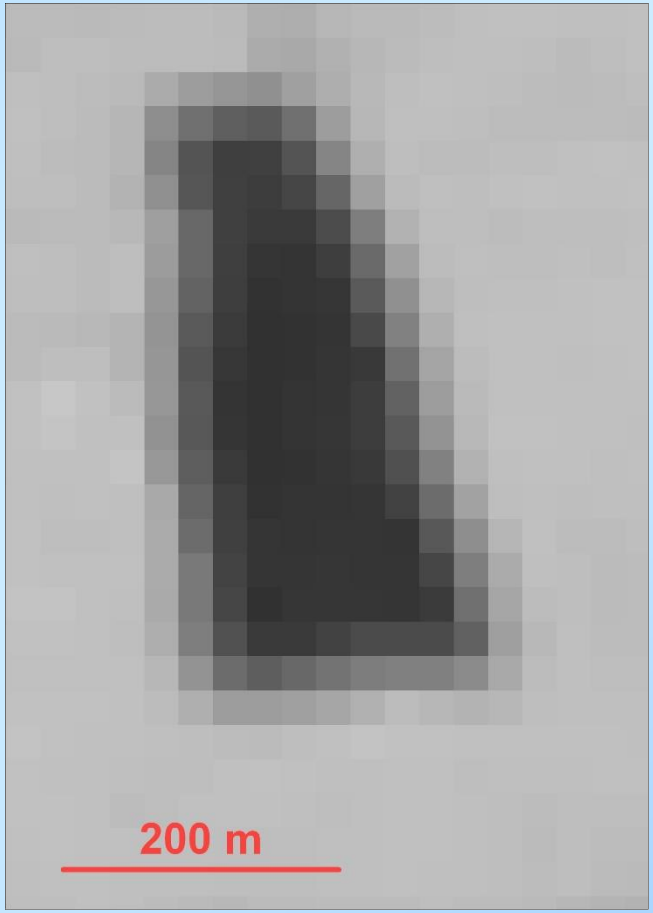








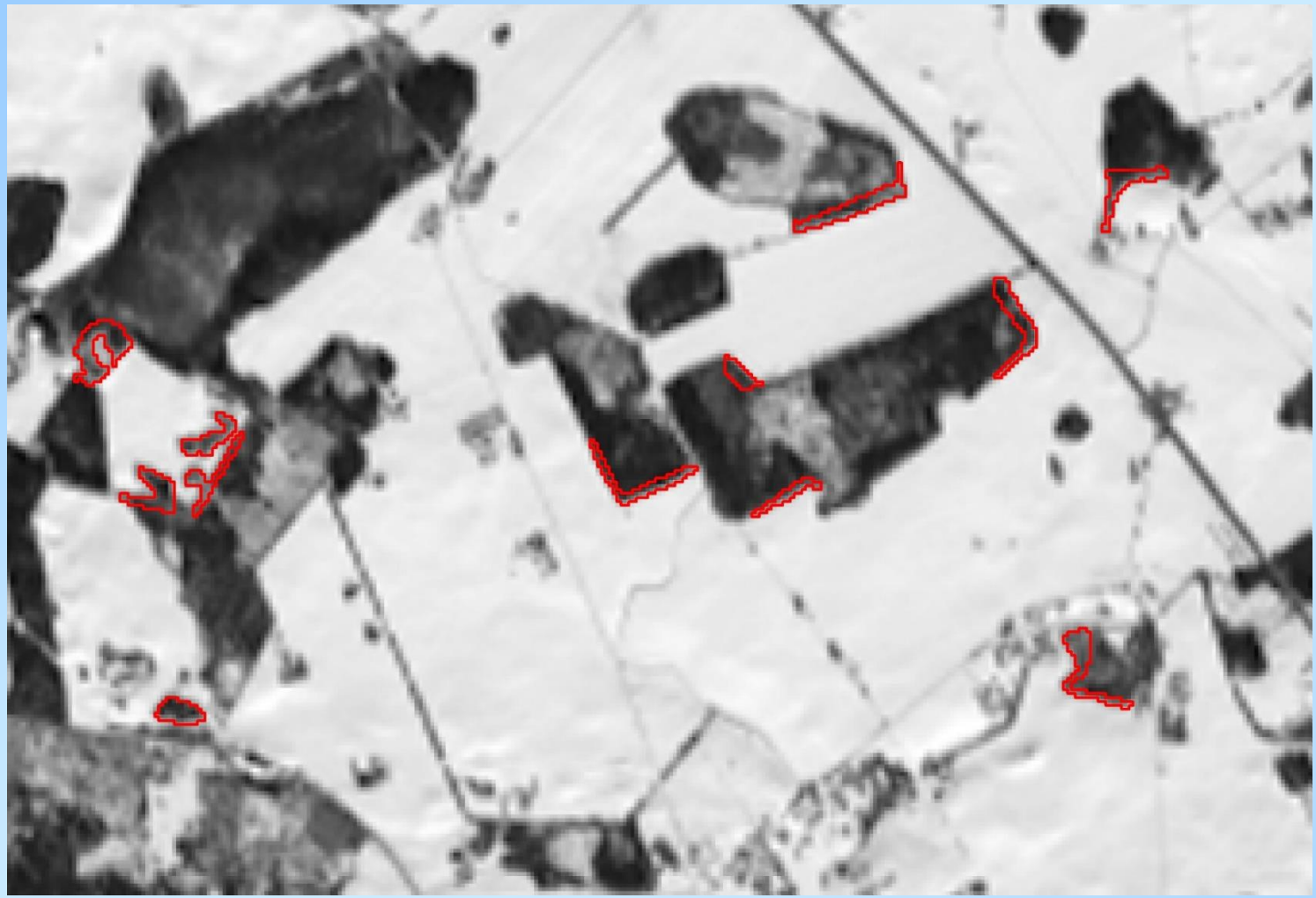
National Basic MapOrthophoto



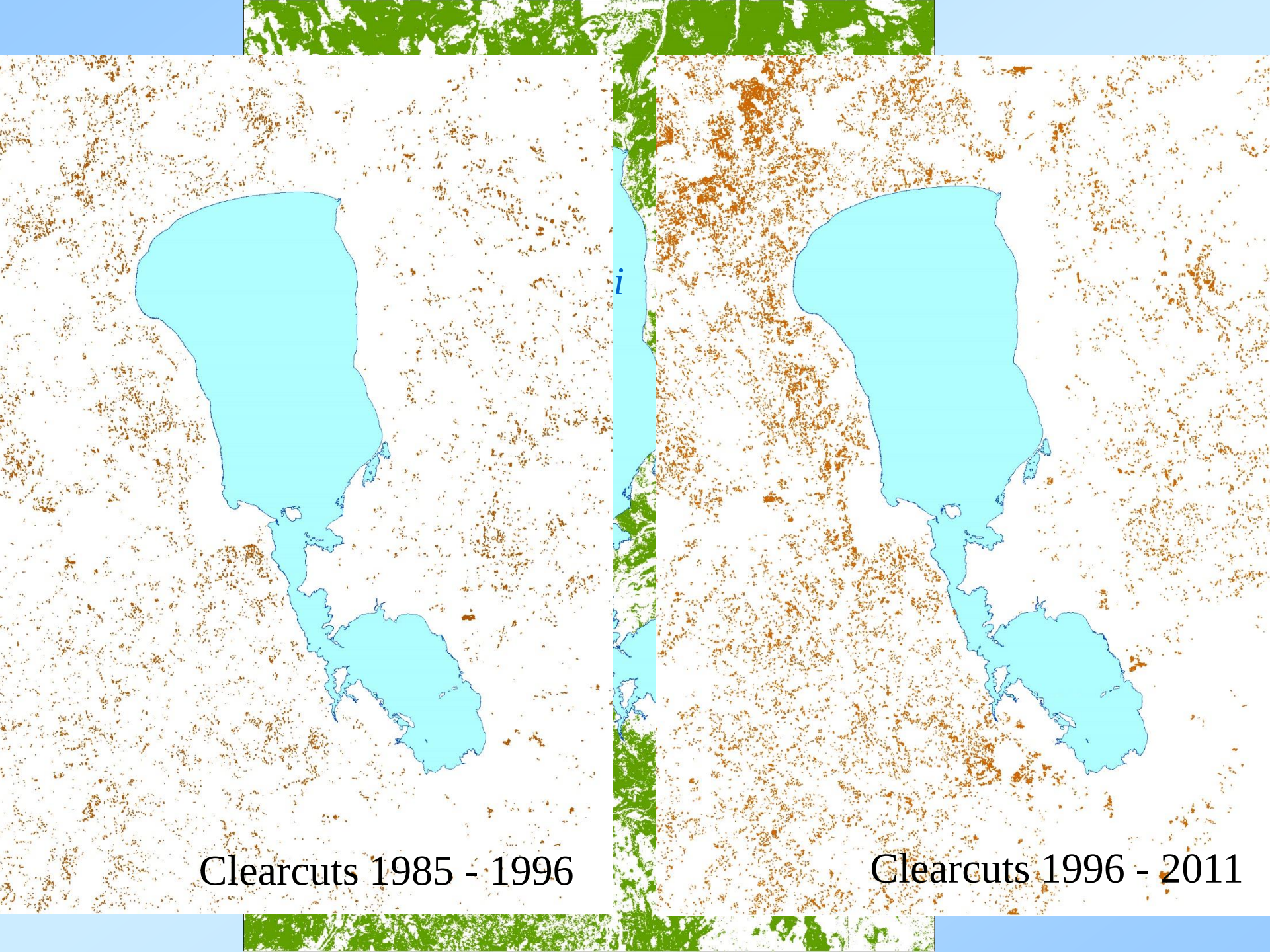
Same forest patch in a Landsat image, nominal pixel size 30 m.

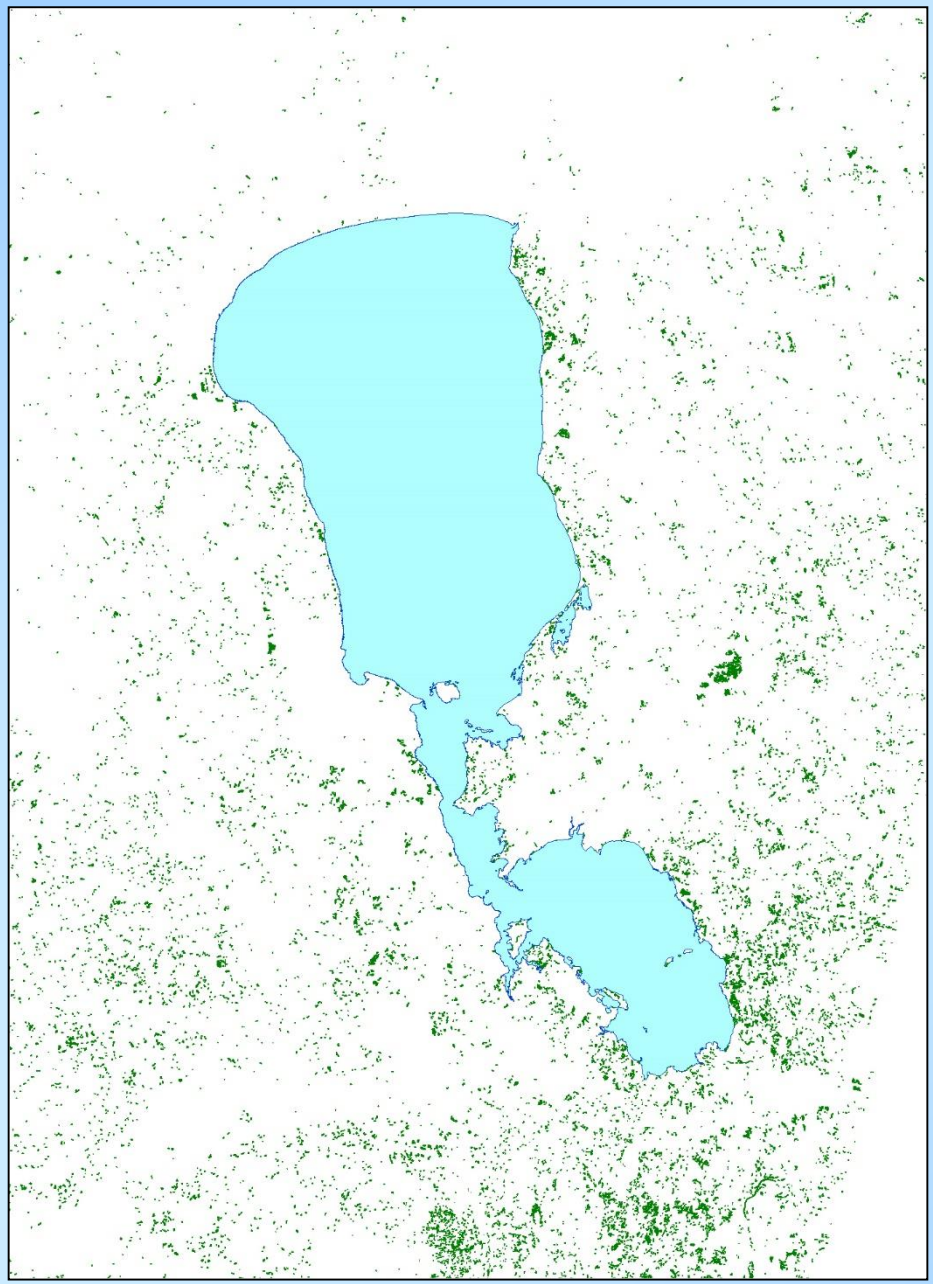
Greyscale image represents the result of the division operation. Shortwave blue image is divided by near infrared image. The shadow areas at forest edges have high pixel values on this image and are visible as bright white patches on greyscale images.

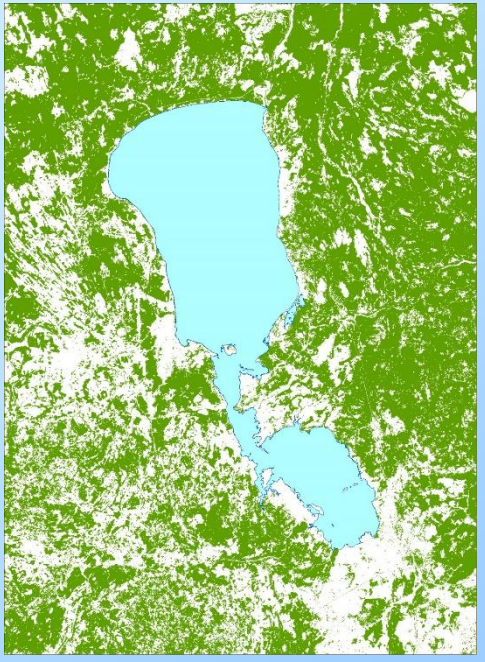
A common way of growth of forest patches in agricultural landscapes is forest patch extension to agricultural lands. Strips of younger trees some metres to some tens of metres wide have accrued to older established patches (see the different texture of tree canopies in patch interior and at edge areas on the orthophoto above). A ground photo shows the changed land use habits that have brought with forest patch expansion.



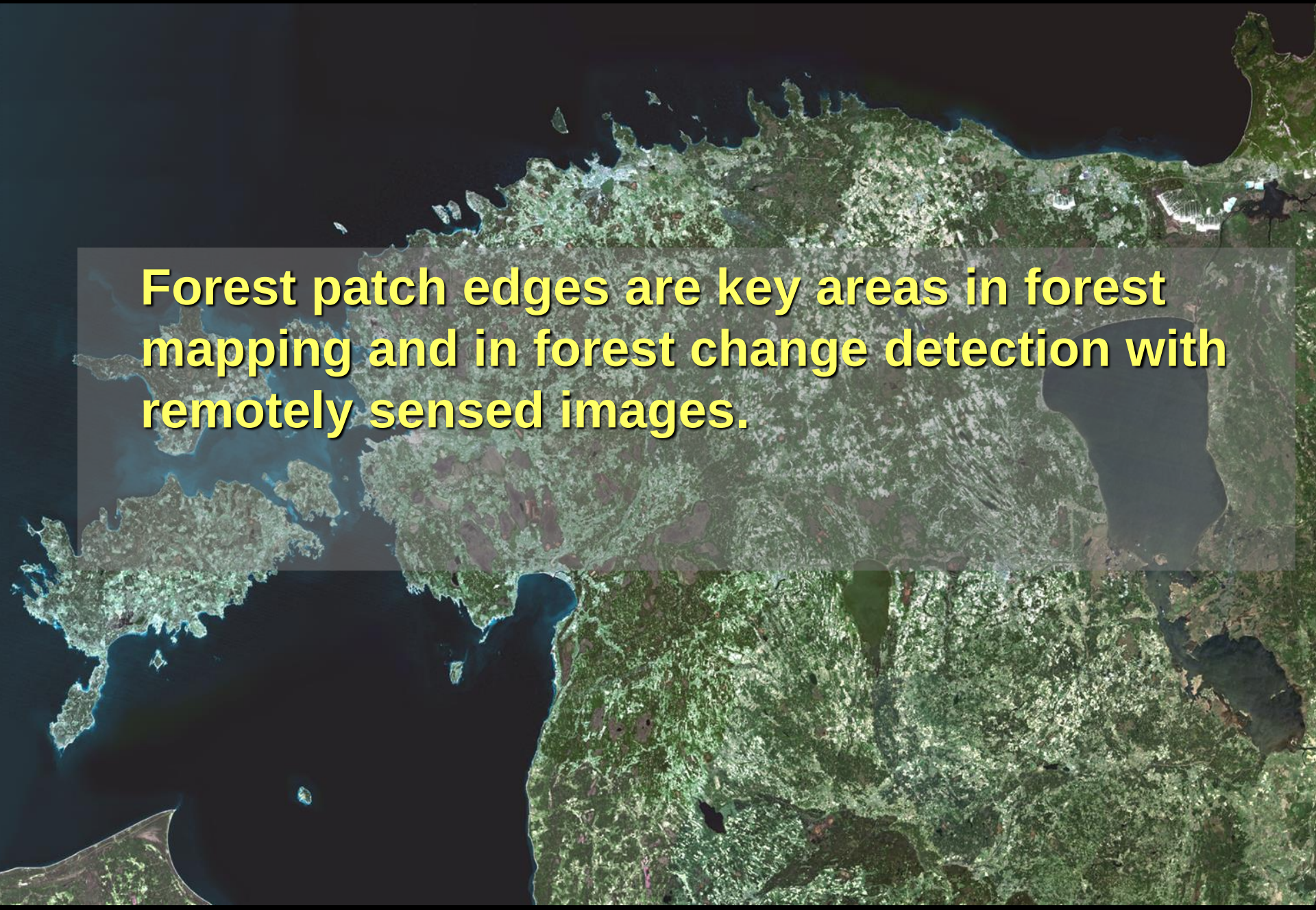
Expansion of forest patches to agricultural land on a winter image. This change is typical in agricultural landscapes in Eastern Europe. The change in forested patch dimensions, compared to an earlier situation several years before, is very likely as a strip of one or some pixels wide on a moderate resolution satellite image. Changes areas are shown as red vector overlay.


Clearcuts 1985 - 1996
Clearcuts 1996 - 2011





Afforestation of formerly non-forested land from 1987 to 2011.


Forest patch edges are key areas in forest mapping and in forest change detection with remotely sensed images.