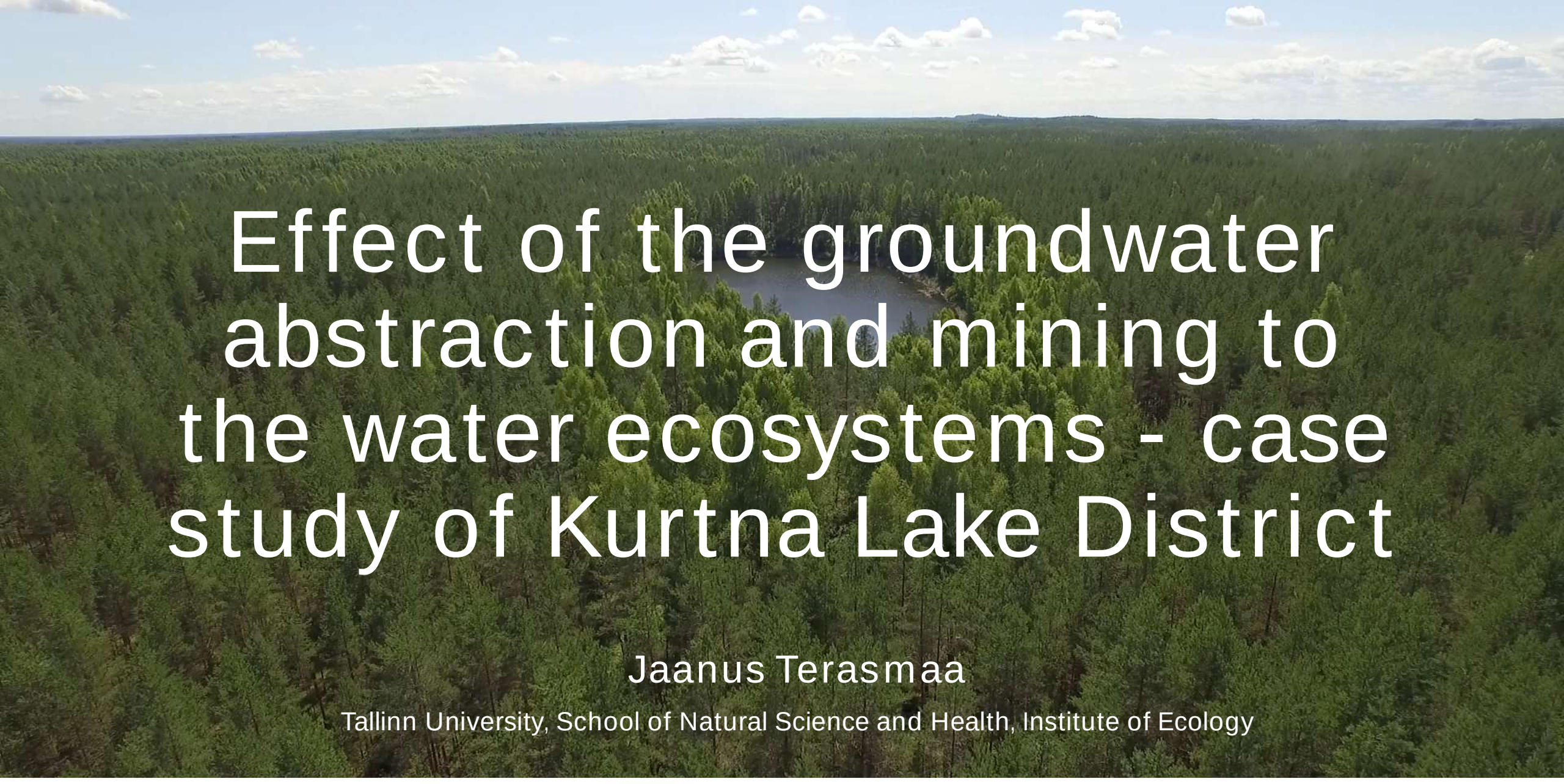

Effect of the groundwater abstraction and mining to the water ecosystems - case study of Kurtna Lake District

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Interreg Estonia-Latvia

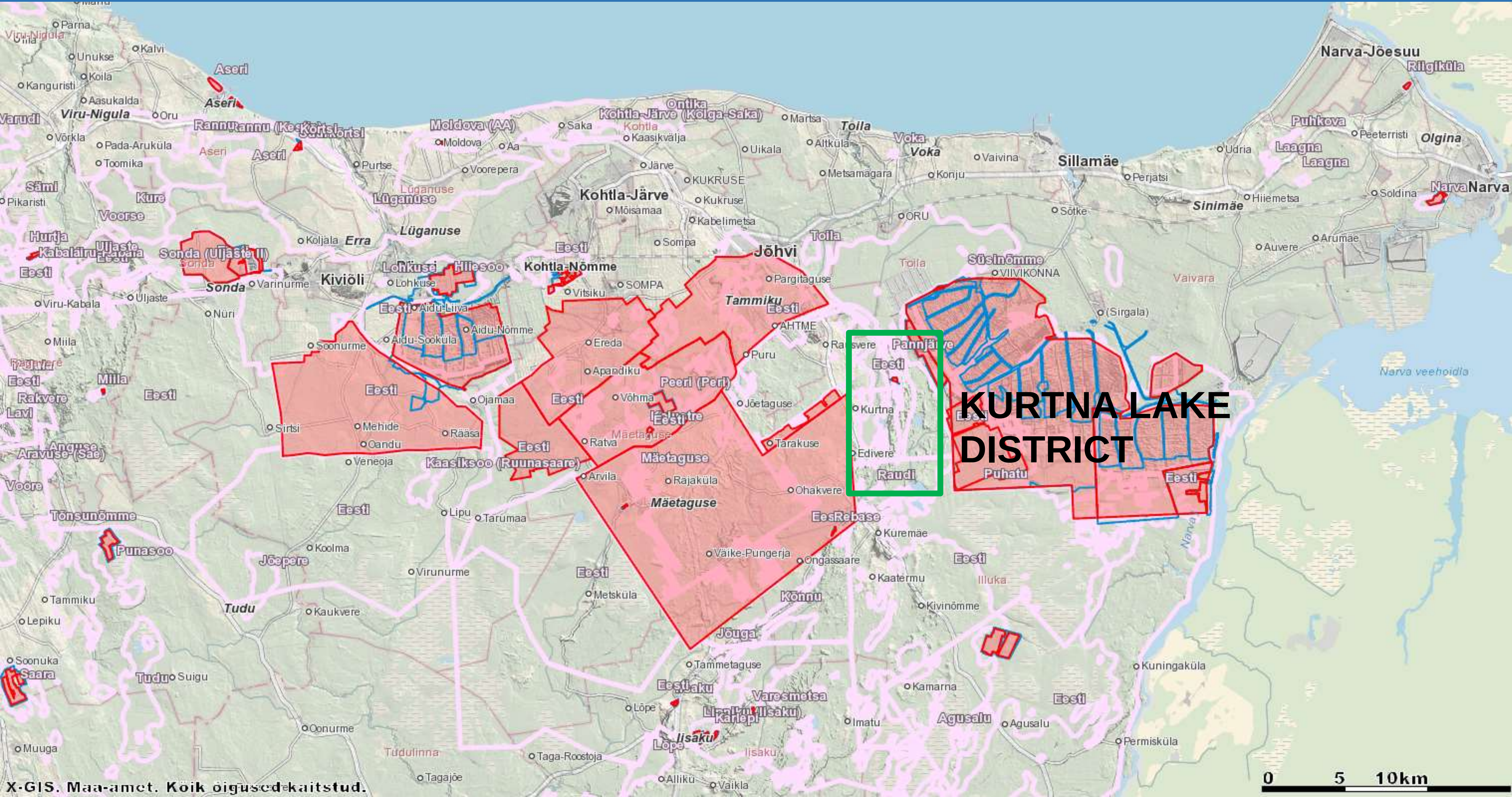
European Regional Development Fund

EUROPEAN UNION

INSTITUTE OF ECOLOGY

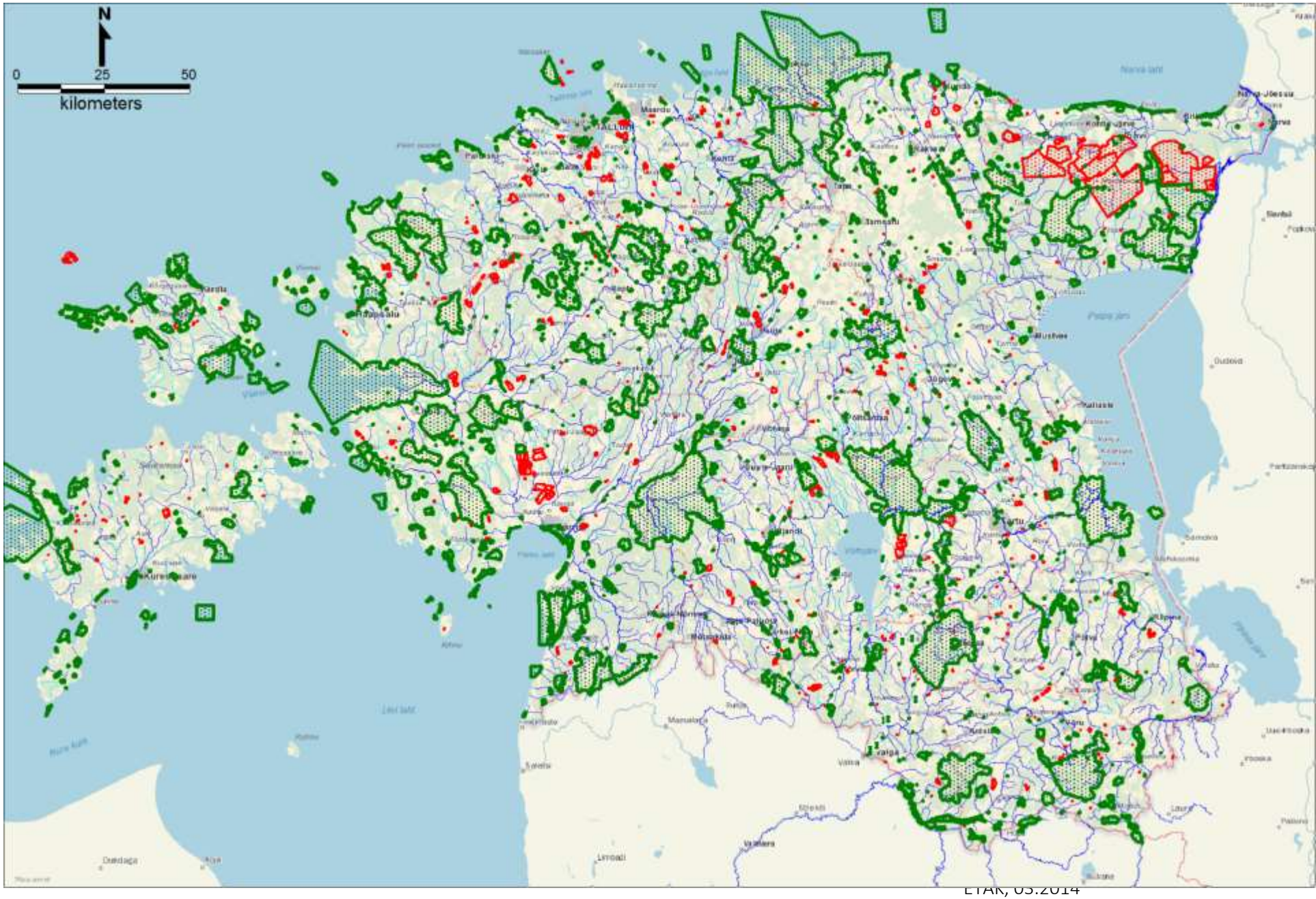
TALLINN UNIVERSITY

Location


KURTNA LAKE DISTRICT
Narva-Jõesuu
Sillamäe
Kohtla-Järve
Jõhvi
Kiviõli
Narva
Toila
Voka
Aseri
Lüganuse
Sonda
Kohtla-Nõmme
Mäetaguse
Tammiku
Pannjärve
Kurtna
Edivere
Raudi
Puhatu
Kuremäe
Tudu
Narva veehoidla
0 5 10km
X-GIS. Maa-amet. Kõik õigused kaitstud.

Nature protection VS mining

- Estonia has 5 national parks, 138 nature reserves, 151 landscape conservation areas.
- In total, 18.1% of Estonia territori is protected.
- Oil Shale is Estonia's prime mineral resource.
- Oil shale is deposited in a layer with thickness of 2,5 to 3 meters in depth of 7 to 100 meters in area of 2700 km^2.
- Production in Estonia makes 70 percent of world's oil shale production.
- Mining started in 1916, peaked in 1980 and is expected to end in next ~30-50 years.



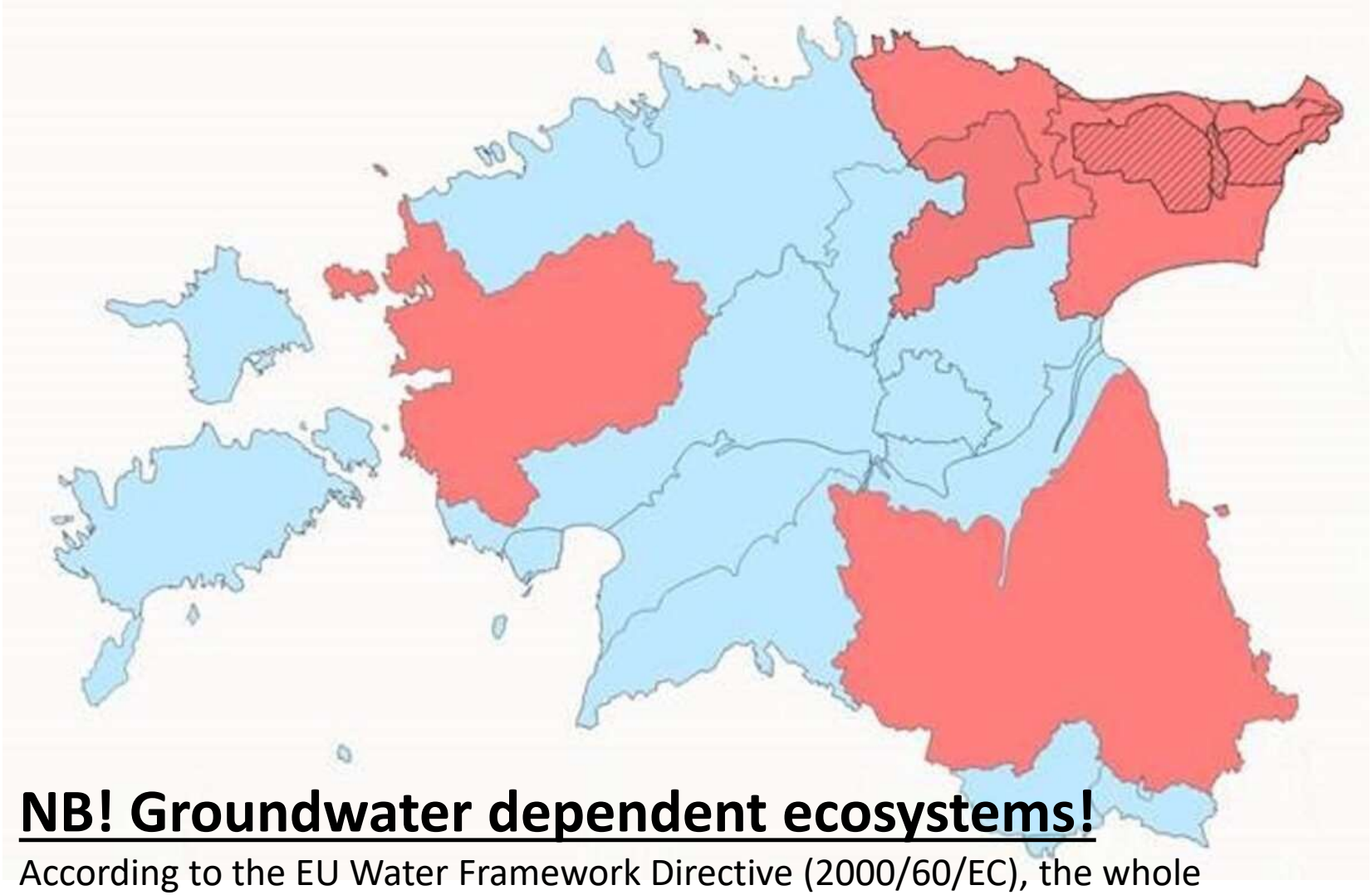
Groundwater status

Groundwater bodies in bad status (8):

- Ordoviitsiumi Ida-Viru,
- Ordoviitsiumi Ida-Viru põlevkivibasseini,
- Kvaternaari Vasavere,
- Siluri-Ordoviitsiumi Pandivere Ida-Eesti,
- Siluri-Ordoviitsiumi Adavere-Põltsamaa,
- Kvaternaari Meltsiveski,
- Kvaternaari Männiku-Pelguranna,
- Kvaternaari Võru põhjaveekogum

Reasons for the bad status:

- NO_3, phenole, benzene, pesticides,
- Mining – lowering of the groundwater level.

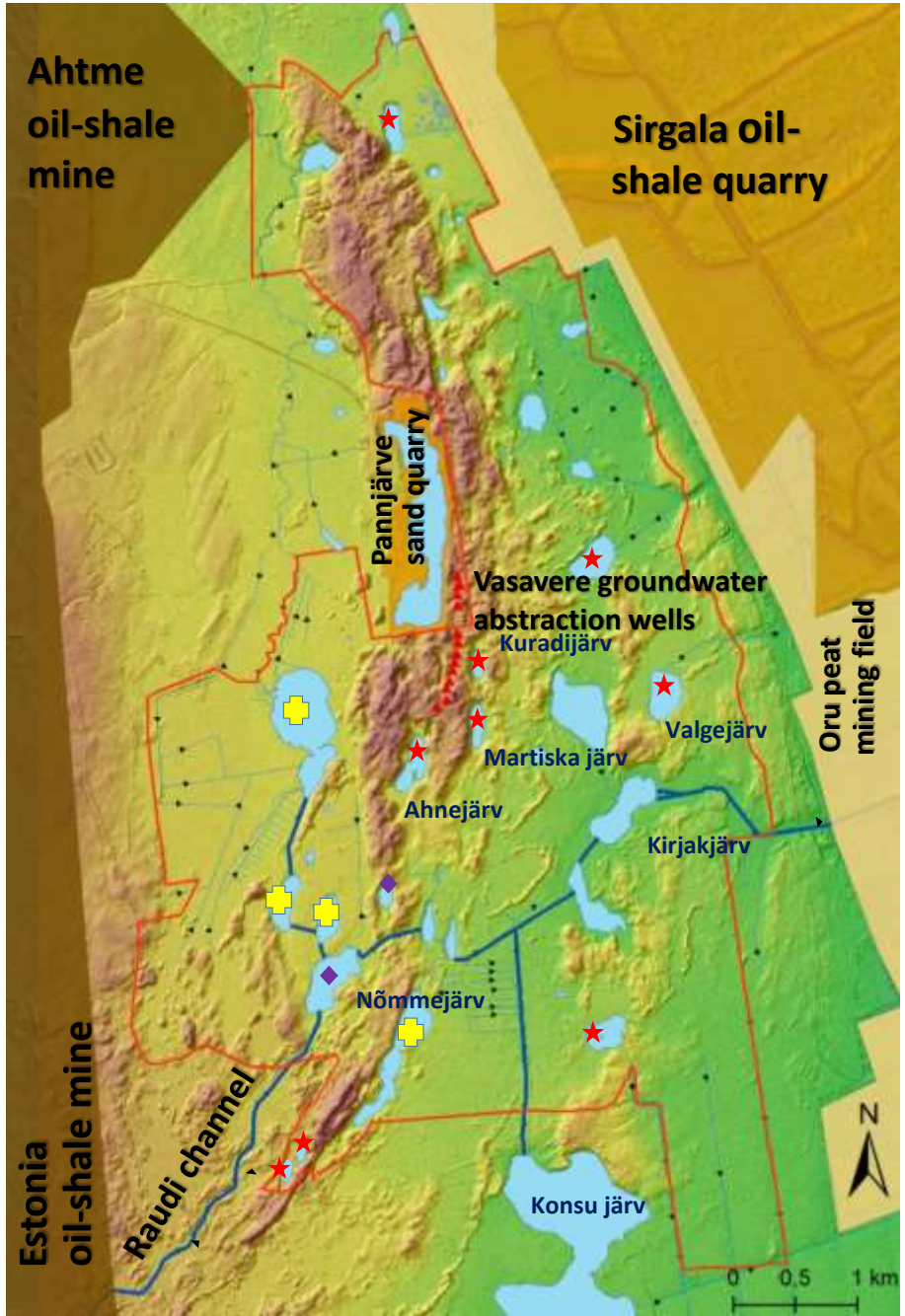


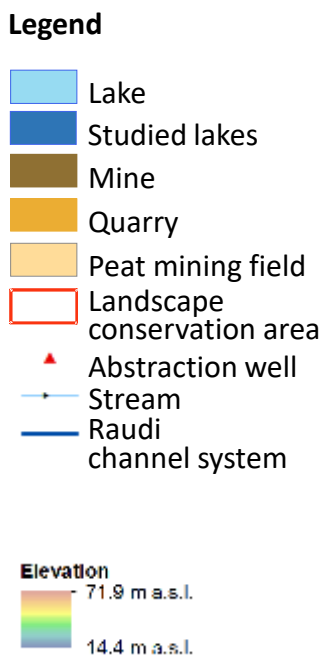
NB! Groundwater dependent ecosystems!

According to the EU Water Framework Directive (2000/60/EC), the whole groundwater body is considered in poor status if anthropogenic pressure on groundwater causes significant damage to groundwater dependent ecosystem.

Aun, M (2015) Põhjaveekogumite seisund
https://kaur.maps.arcgis.com/apps/MapSeries/index.html?appid=fd27acd277084f2b97eee82891873c41

Kurtna Lake District and Landscape Conservation Area (National Park)



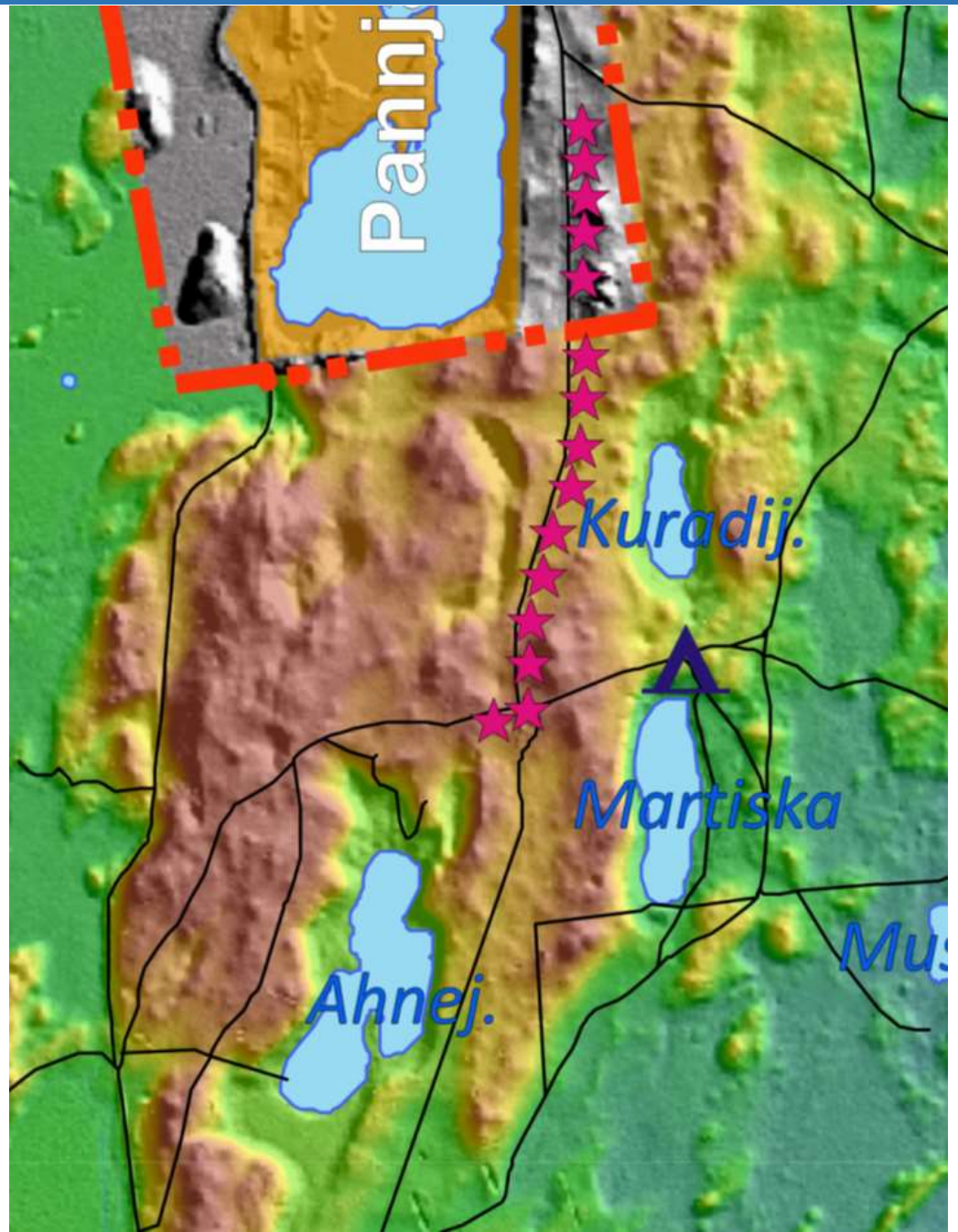


- Lays on the ancient Vasavere valley filled with sandy sediments (depth 50-60 m).
- Total area is 2805 ha, of which 74% is forest.
- 38 natural lakes per 30 sq. km
- 18 lakes are in EU's Natura 2000 network:
  - ★ *Habitat type 3110 (Oligotrophic waters containing very few minerals of sandy plains)*;
  - ◆ *Habitat type 3130 (Oligotrophic to mesotrophic standing waters)*;
  - ✚ *Habitat type 3140 (Hard oligo-mesotrophic waters)*.
- 76 protected species. Water lobelia (*Lobelia dortmanna)* and lake quillwort *(Isoëtes lacustris)*

Main human influences:

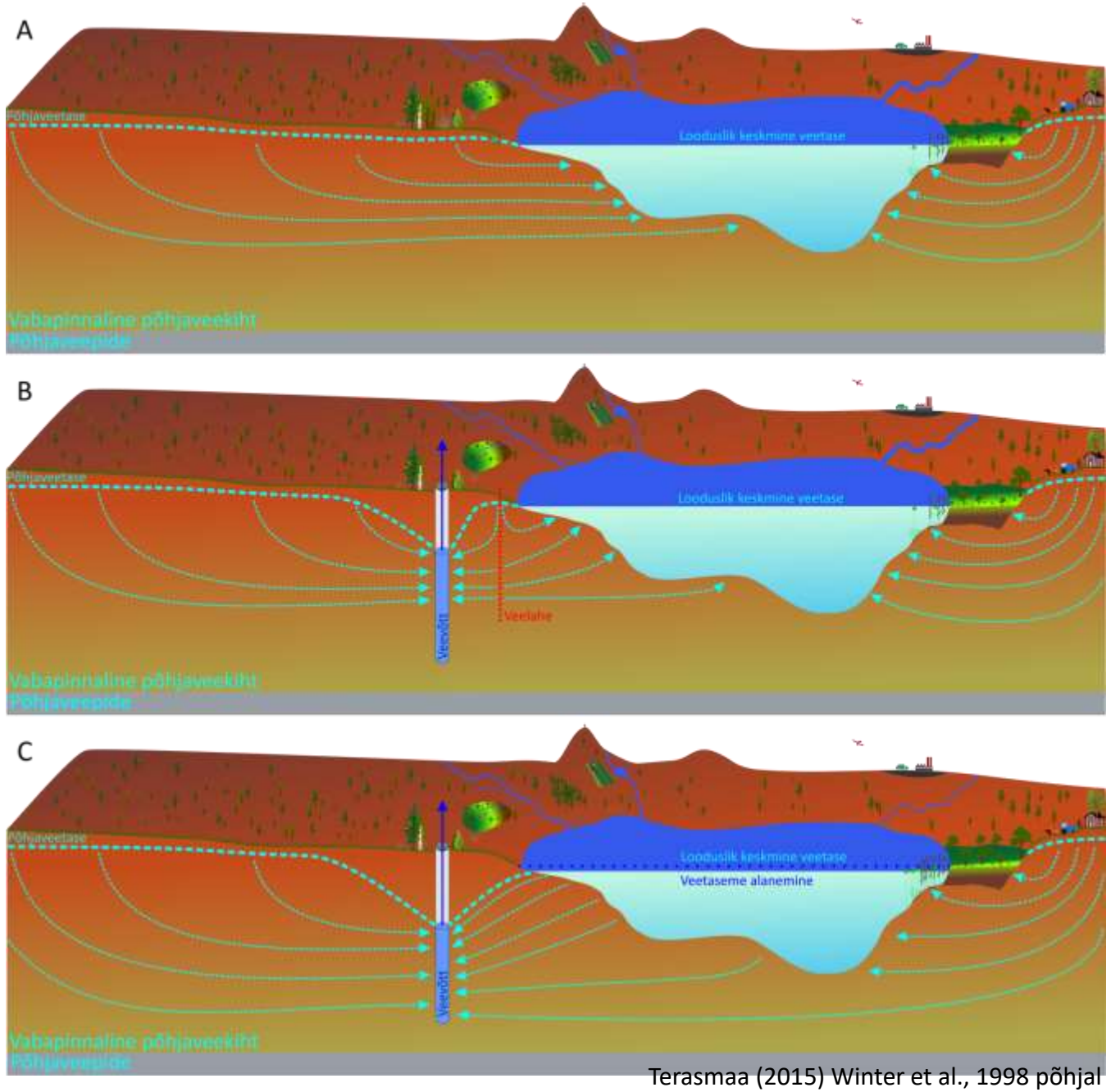
- Oil-shale mines
- Oil-shale and sand quarries
- Groundwater abstraction
- Melioration
- Peat fields
- Recreation, fishing, littering

Kurtna-Vasavere groundwater abstraction system



- Before 1900 – redirection of Raudi creek to the Lake Nõmmejärv
- 1950 – expansion of the oil-shale industry
- Drinking water pumping from Quaternary aquifer started 1972.
- 14 wells, impact area ~7km^2.
- Planned absraction rate: <22 500 m^3/d
- Officially not over 8 000-10 000 m^3/d.
- Until 2035 allowed to take <8 000 m^3/d.
- Wells and pipelines were renovated in 2012. Water intake before that ~4500 m^3/d, after >6000 m^3/d

Impact of the water abstraction to the groundwater dependent lake



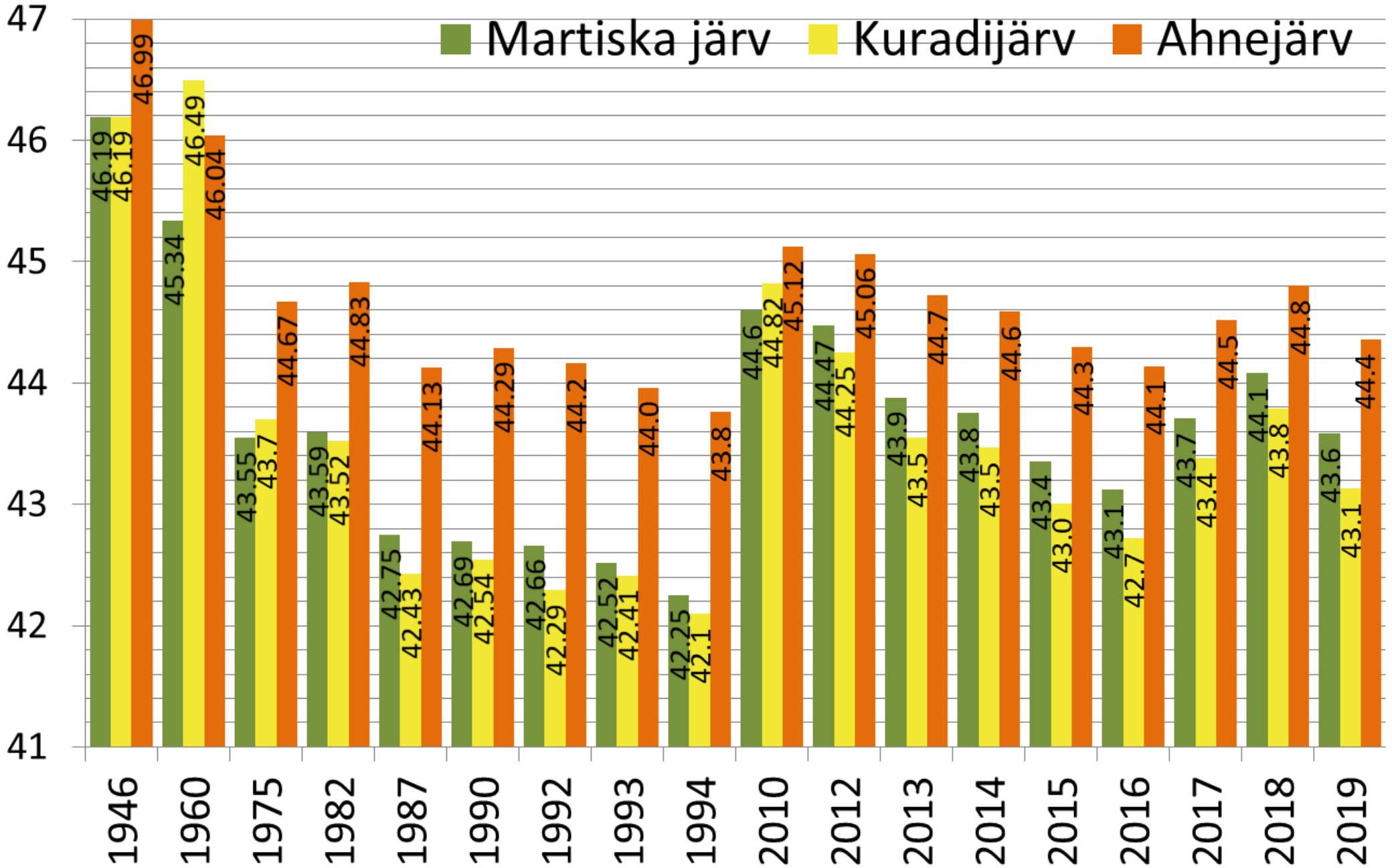
Natural conditions

Start of water abstraction

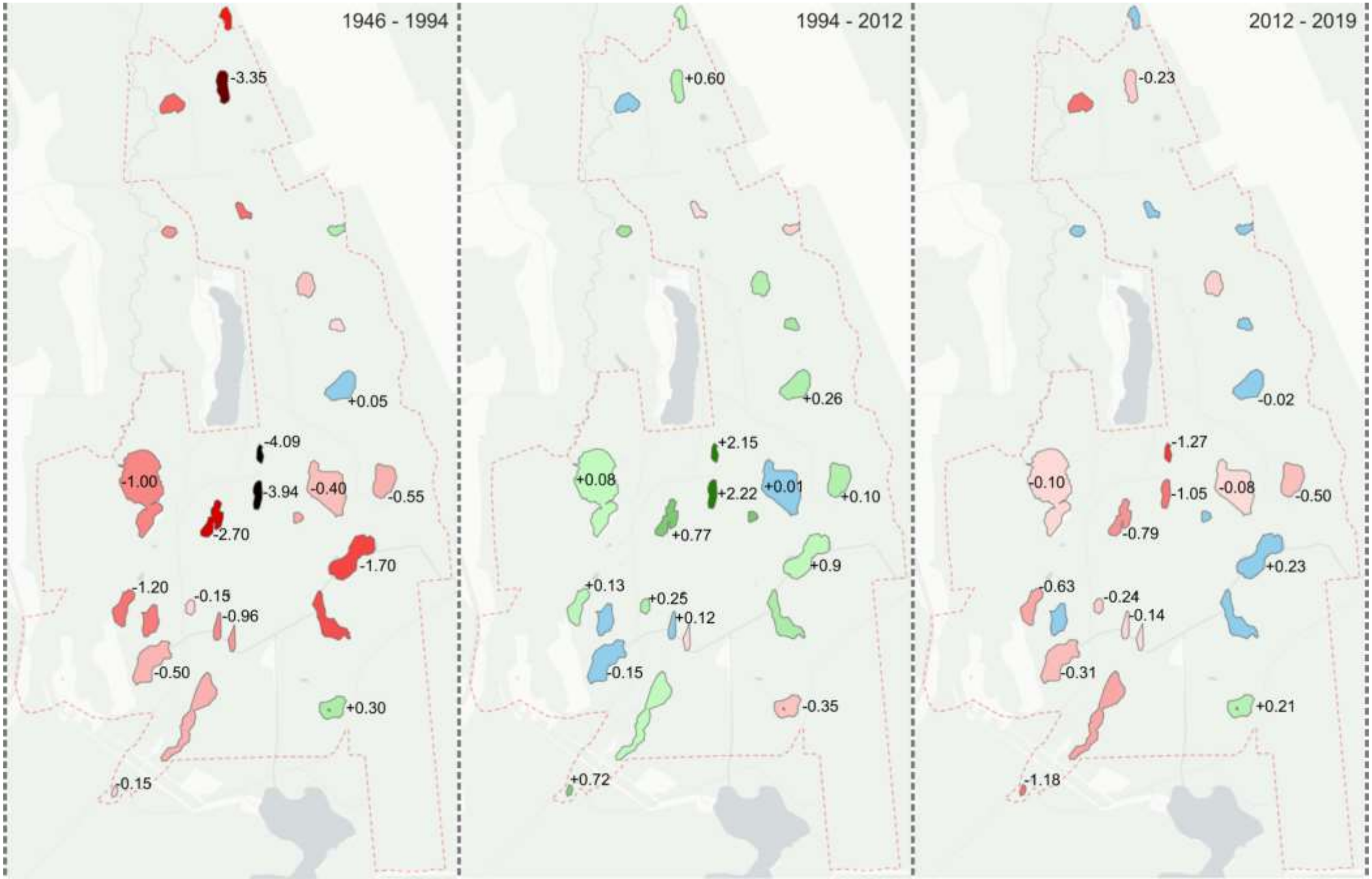
Long-term water abstraction

Terasmaa (2015) Winter et al., 1998 põhjal

Lake-level changes



Water level changes (gis.ee/kurtna)

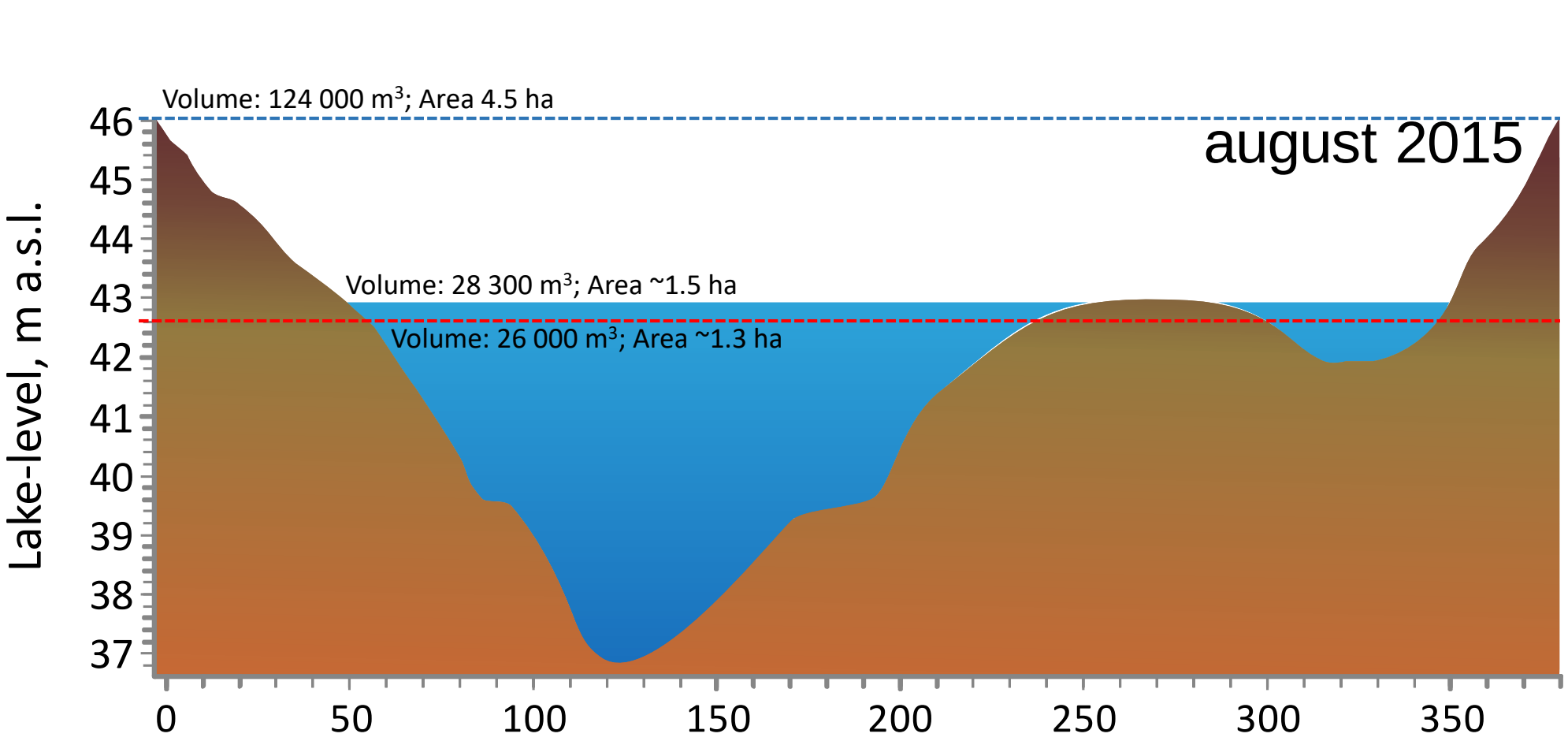


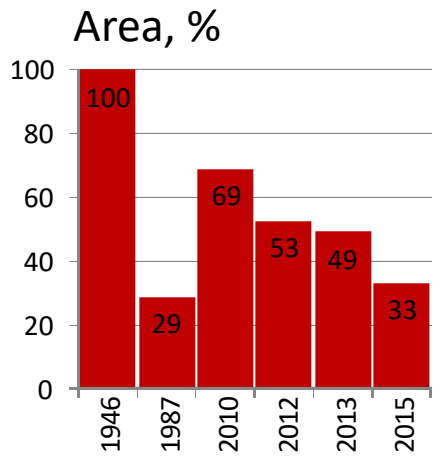
Lake Martiska

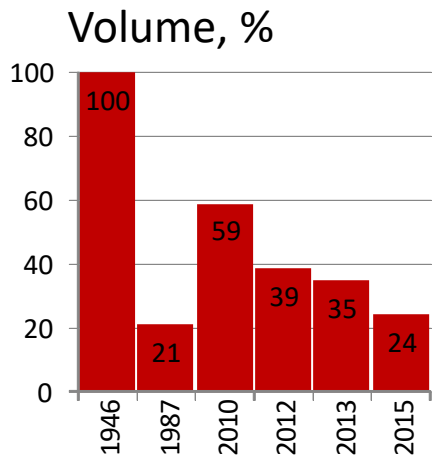
08.09.2015

08.05.2012

Volume and area changes in Lake Martiska

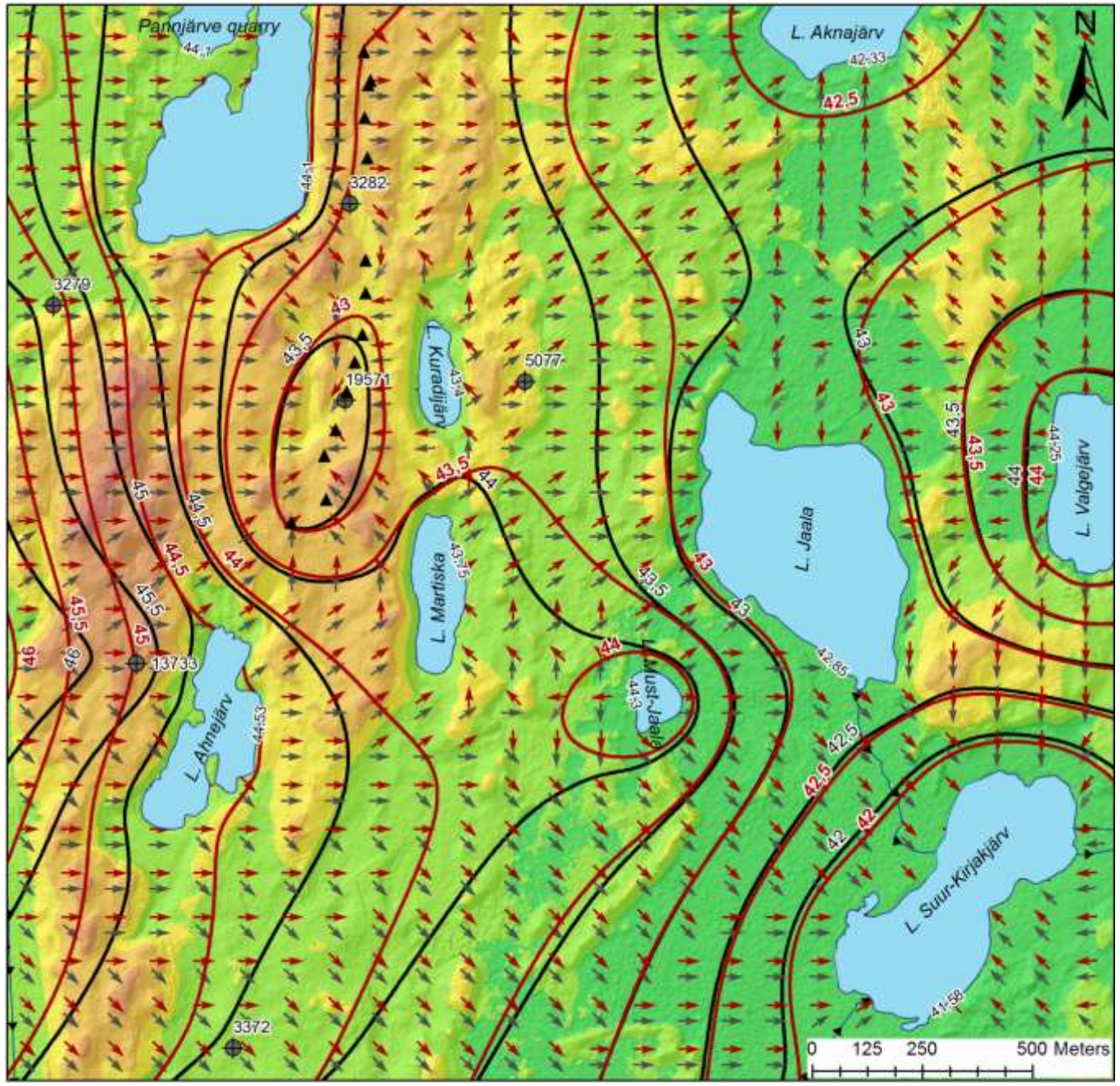






Changes in groundwater level and flow directions 2012 and 2013

- Groundwater level around the water intake dropped up to 0.8 m from June 2012 to June 2013;
- Flow directions did not change significantly.



Legend

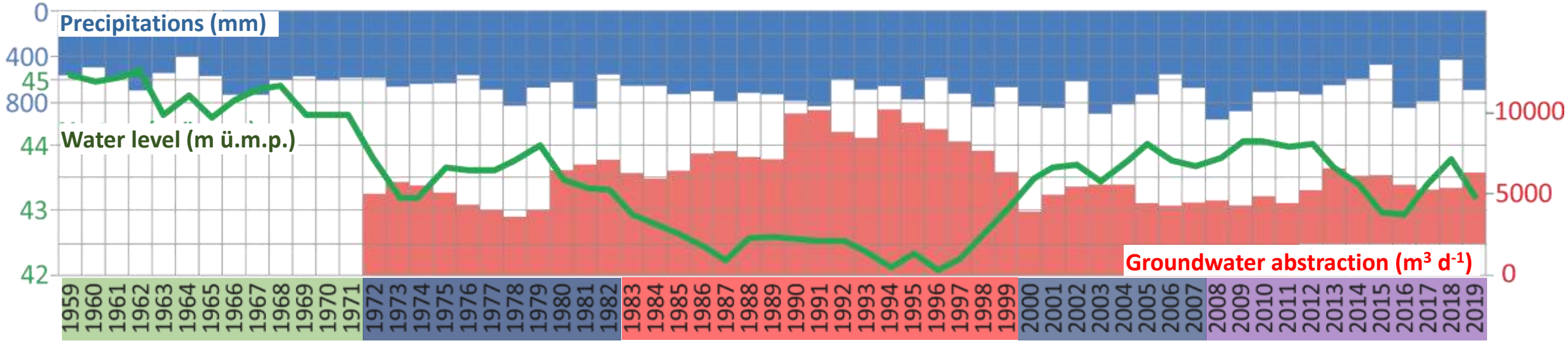
- Abstraction well
- Monitoring well
- Groundwater flow direction in 2012
- Groundwater flow direction in 2013
- Water-table contour in 2012 (m a.s.l.)
- Water-table contour in 2013 (m a.s.l.)
- Stream
- Lake (m a.s.l. in 2013)

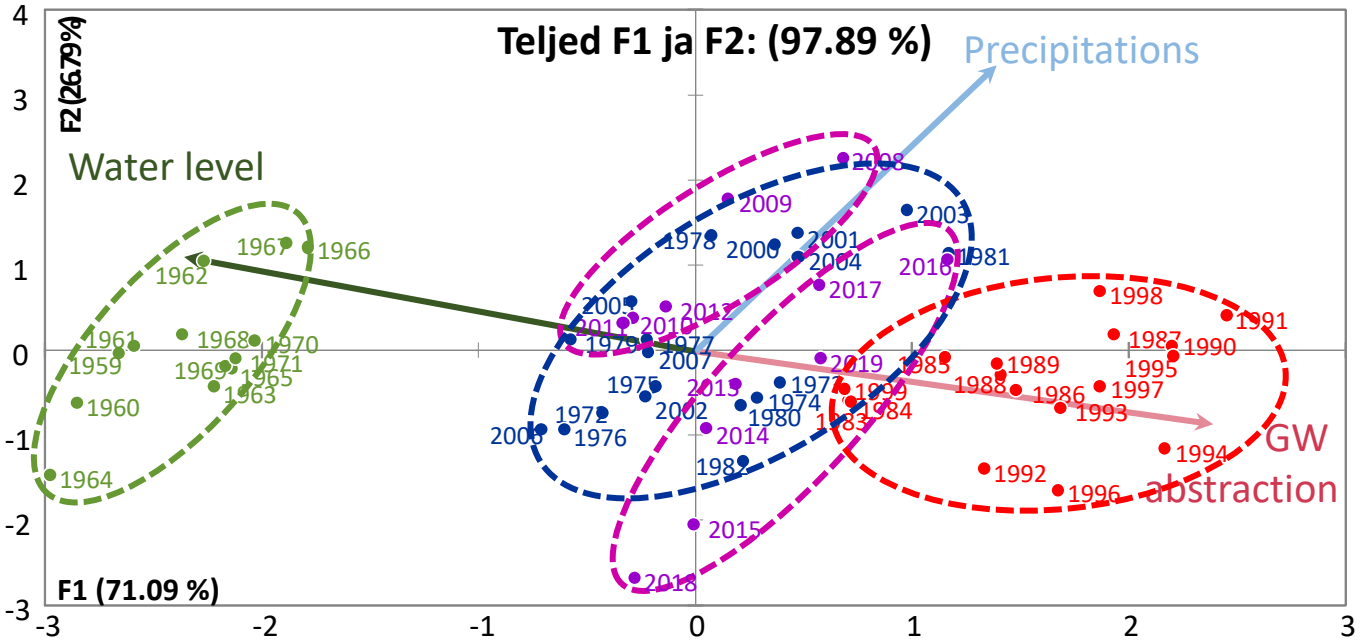
Elevation (m a.s.l.)

40.1 - 45
45.1 - 50
50.1 - 55
55.1 - 60
60.1 - 65
65.1 - 70

(Vainu et al. 2014, Vainu & Terasmaa, 2016)

Groundwater abstraction, water level ja precipitations 1959-2019





- Pre-abstraction period (1959-1971).
- Slow start of the GW abstraction up to 1980ies, water level minimum in the middle of 1990ies. Decline of the water abstraction and rise of the water level (2000-2012).
- Reconstruction of the water intake and rising water abstraction (2012-2019).

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Ecological status of the studied lakes in Kurtna

	FYKE	FYPLA	MAFY	ZOPLA	HYMO	ÖSE
Valgejärv	kesine	hea	hea	hea	hea	hea
Martiska järv	kesine	hea	kesine	kesine	hea	kesine
Kuradijärv	kesine	kesine	kesine	kesine	hea	kesine
Liivjärv	kesine	hea	halb	kesine	hea	halb
Saarejärv	kesine	hea	hea	hea	väga hea	hea

High status	Good status	Moderate status	Poor status	Bad status

Indicators:

FYKE – physico-chemical, FYPLA – phytoplankton, MAFY – macrophytes, ZOPLA – zooplankton, HYMO – hydromorphology

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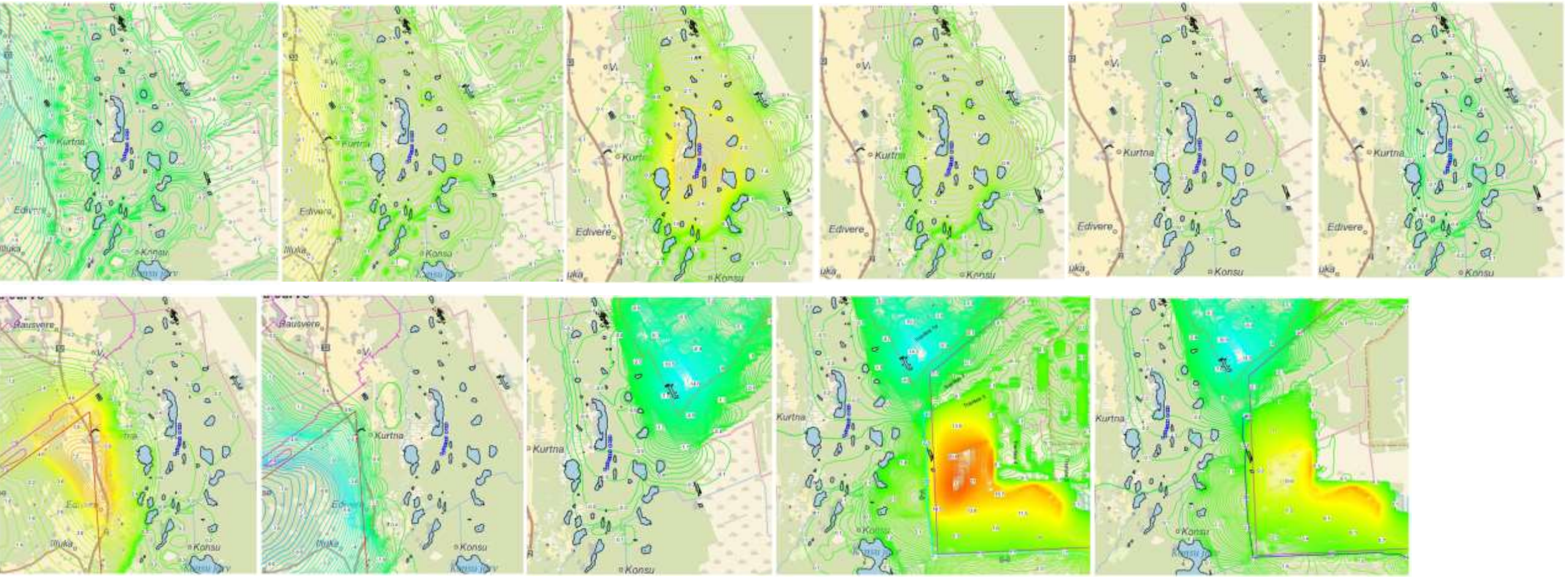
Future? Result of the hydrogeological modelling

- 12 scenrios with different settings (precipitation, inflitration, groundwater abstraction, oil-shale mines extent etc) (A. Jõeleht)



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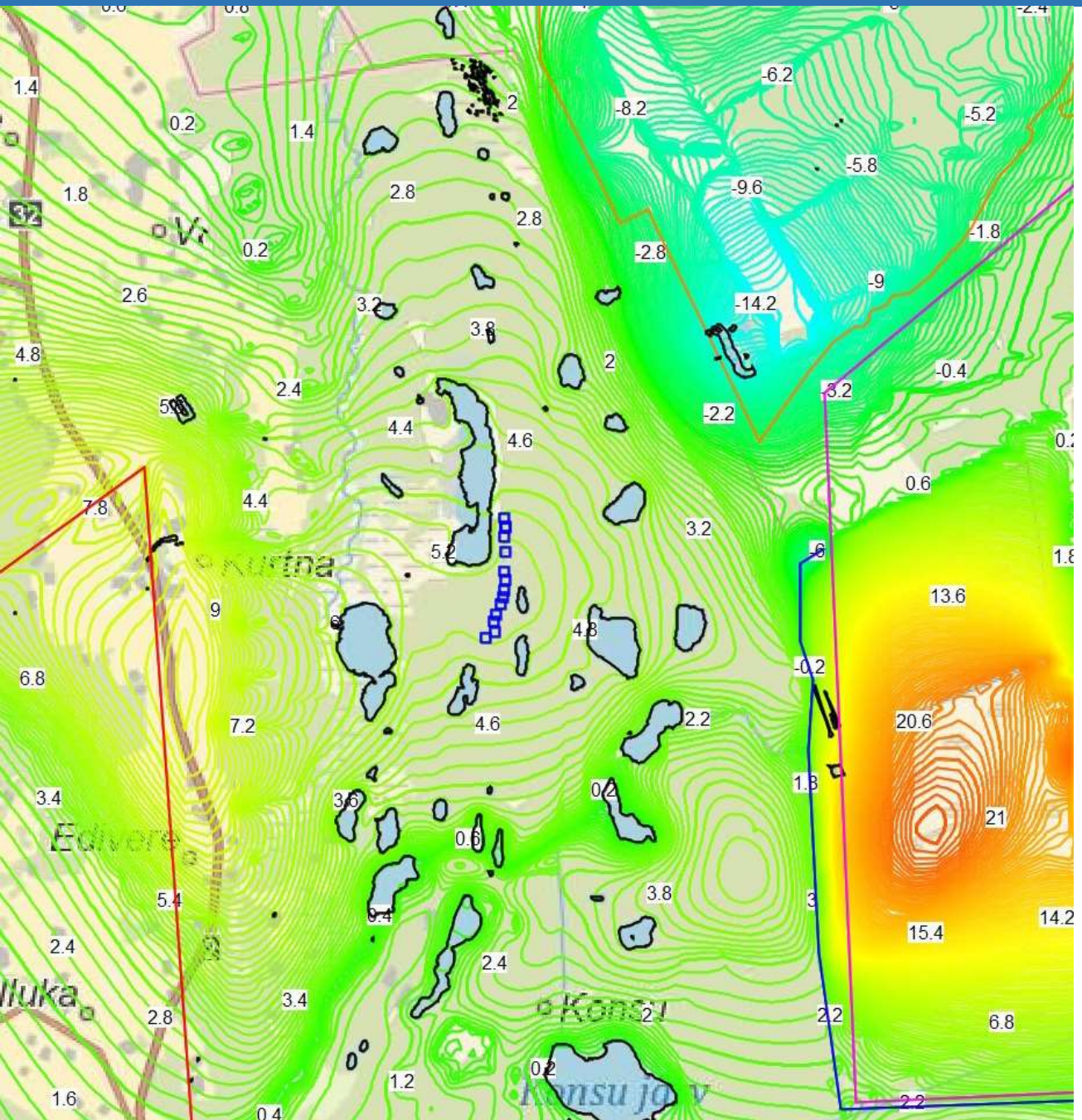
Future? Result of the hydrogeological modelling



Hypothetical scenario #12. Isohypses describe the possible groundwater level drop in meters.

Scenario will occur when all possible negative impacts (20% less precipitation, water abstraction 10 000 m^3/d, maximum reach of oil-shale mines without mitigation measures) emerge at the same time. (A. Jõeleht)

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Lakes potential to reach optimal water level and good ecological status

	2017	sts1[1]	sts2[2]	sts3[3]	sts4[4]	sts5[5]	sts6[6]	sts7[7]	sts8[8]	sts9[9]	sts10[10]	sts11[11]	sts12[12]
Valgejärv													
44,2–44,7	0	0,8	-1,3	-1,7	-0,9	-0,1	0,5	-0,2	0	0,5	-0,4	-0,2	-3,9
43,7–44,2	44,1	44,9	42,8	42,4	43,2	44,0	44,6	43,9	44,1	44,6	43,7	43,9	40,2
<43,7 >44,7													
Martiska													
44,4–44,9	0	0,8	-1,1	-3,1	-1,6	-0,3	0,8	-0,4	0	0,3	0	0,2	-5,2
43,9–44,4	43,8	44,6	42,7	40,7	42,2	43,5	44,6	43,4	43,8	44,1	43,8	44,0	38,6
<43,9													
Kuradijärv													
44,2–44,7	0	0,8	-1,1	-3,4	-1,8	-0,3	0,9	-0,4	0	0,4	0,1	0,2	-5,5
43,7–44,2	43,5	44,3	42,4	40,1	41,7	43,2	44,4	43,1	43,5	43,9	43,6	43,7	38,0
<43,7													
Liivjärv													
44,1–44,6	0	0,6	-0,8	-1,1	-0,6	-0,1	0,3	-0,1	0	0,4	0,3	0,3	-2,3
43,6–44,1	42,9	43,5	42,1	41,7	42,3	42,8	43,2	42,8	42,9	43,3	43,2	43,2	40,6
<43,6													
Saarejärv													
44,3–44,8	0	0,5	-0,6	-0,5	-0,3	-0,1	0,1	-0,2	0	0,1	-1,6	-0,9	-3,5
43,8–44,3	44,6	45,1	44,0	44,1	44,3	44,5	44,7	44,4	44,4	44,7	43,0	43,7	41,1
<43,8 >44,8													

Green – optimal water level
Pink - temporarily acceptable water level
Red - undesirably low water level

Scenario 6 – groundwater abstraction is up to 4000 m^3 per day.

Currently it over 6000 m^3 per day.

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Take home message

- Groundwater dependent ecosystems really are groundwater dependent!
- The water levels around Vasavere water intake are most strongly affected by groundwater abstraction and then by changes in precipitation.
- Not only closeness to the lakes but also compactness of the water intake is a problem - all water is taken from a 1.1 km long section.
- Ecosystem will react and deteriorate rapidly, when groundwater input is not stable.
- Stabel lake-level is almost as important as high lake-level.
- If current direction of human activities in the vicinity of the Lake District continues, there are not many changes to achieve needed optimal water levels for lake ecosystems to reach good status.
- Deterioration of lake ecosystems will continue and there is a high risk that protected species and habitats will disappear in the not too distant future.

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Thank You!
Questions and suggestions: jaanus.terasmaa@tlu.ee