REPUBLIC OF ESTONIA
AGRICULTURAL REGISTERS AND INFORMATION BOARD

European Union
European Regional Development Fund

Investing in your future

ESTONIA

Satellite based grassland mowing detection

Ahti Bleive

Estonian Agricultural Registers and Information Board

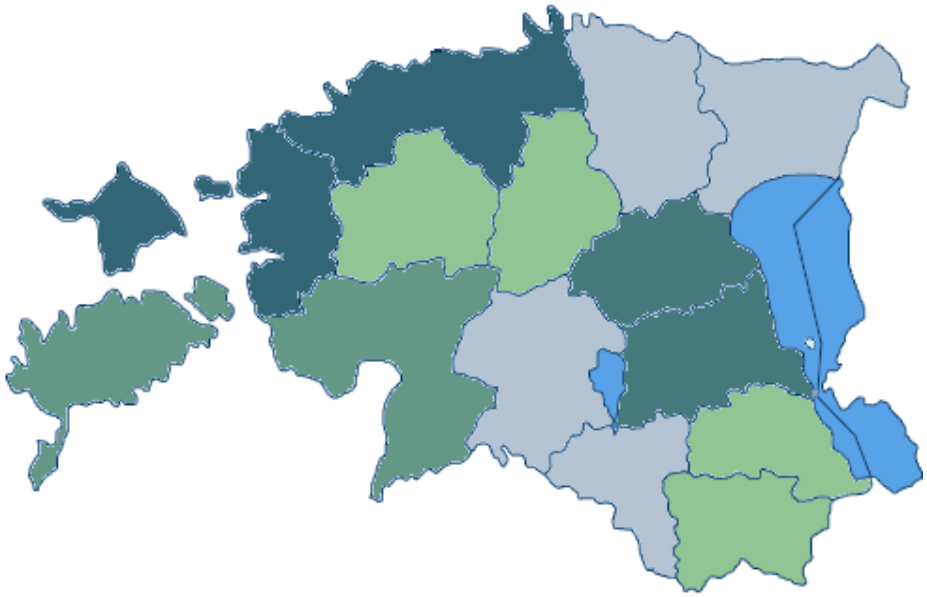
Kaupo Voormansik

KappaZeta Ltd.

Agricultural Registers and Information Board (ARIB)

- State authority in the area of the Ministry of Rural Affairs.
- Established in the summer of 2000 in Tartu.
- Main duties:
  - Maintenance of agricultural registers
  - Administration of agricultural, fishery and rural development support schemes
  - Implementation of EU agricultural market regulation measures

Agricultural Registers and Information Board (ARIB)



- Central Office is in Tartu
- 7 regional bureaus
- 15 offices – 1 in every county
- 345 employees
- 2/3 of them in central office
- Ca 48 000 clients (farmers, en animal owners etc.).
- Ca 300 million euros of support payments annualy.
- ARIB spends ca 3,5-5 € (total expenditure incl. investments), for paying 100€ of support
- Need to be efficient.

ARIB is a paying agency (PA)

Common Agricultural Policy Funds

National budget

REPUBLIC OF ESTONIA
MINISTRY OF RURAL AFFAIRS

REPUBLIC OF ESTONIA
AGRICULTURAL REGISTERS AND INFORMATION BOARD

- Land Parcel register (LPIS)
- Animals register
- Clients register

Requirements (!)

BACKGROUND - PROBLEM

- Mowing or grazing of grassland by certain date is one of the most common requirements for all area based supports in Estonia.
- Mowing requirement is quite often violated. This is keeping error rate high.
- On the spot checks are done only for 5-6 % of applicants.
- Cost of on the spot checks is rising every year.
- There is a need to reduce number of on the spot checks and to have better targeted field inspections.
- Preventing errors is better than sanctioning.

Project: ‘Automated satellite based mowing detection’

- **Goal**: an integrated system that uses Sentinel 1 and 2 images (timeseries) to make country level mowing controls and reports the mowing detection results (mowing dates) to the farmers and paying agency officials.
- **Scope**:
  - Additional functionality to existing systems (IACS, e-ARIB, GIS)
  - A new system SATIKAS
- Development period: 06.2016 - 01.2018
- Fully operational starting from 2018.

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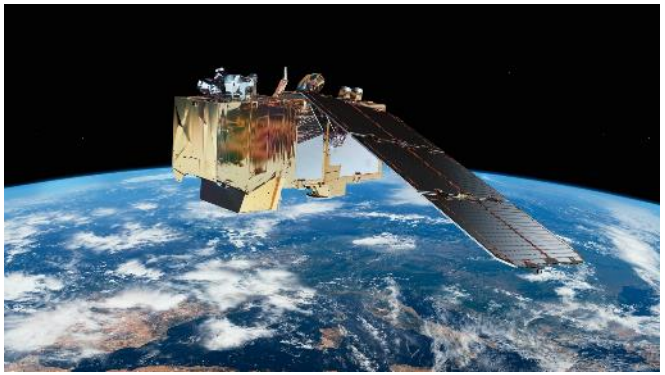
Development of EO technology

Development of EO technology

- Why satellite based monitoring now?
- Research background and scientific basis.
- Design of SATIKAS infosystem.
- Accuracy as of 2018-05.
- Frontrunner pain and gain – challenges.
- Possibilities for extensions and future developments.

Why satellite based monitoring now?



- Copernicus programme and Sentinels' satellite data.
- Free and open data policy.
- Unprecedented temporal data density and truly global coverage.

Why satellite based monitoring now?

- Taking EO from research and limited area studies phase into operational services era.
- Sentinel-1 and -2 full data production capacity reached only in Q3/2017 -> the services data uptake and impact is yet to come.

Temporal resolution at Estonian latitude

About each geographical point:

- Sentinel-1 – new image in every 1.5 days – 243 images per year.

- Sentinel-2 – new image in every 2.5 days – 146 images per year.

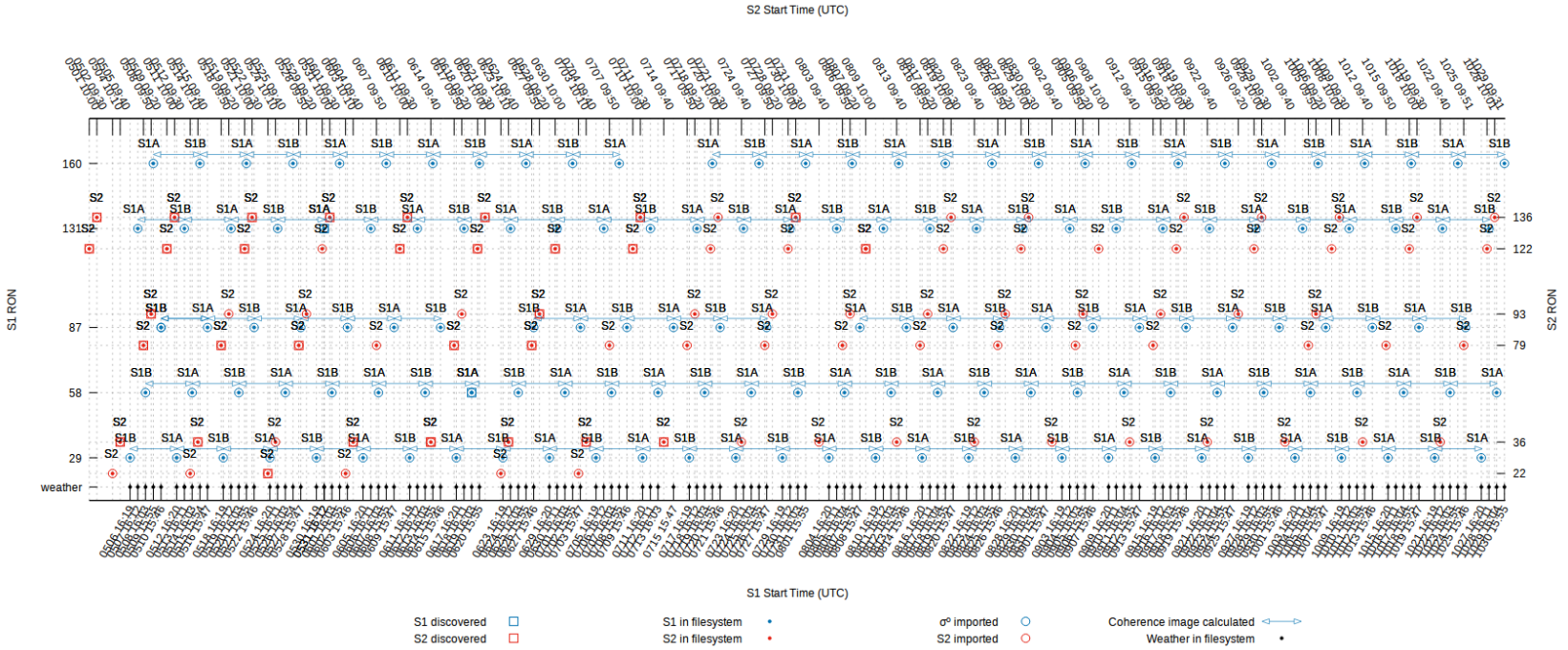
MAY 2018 – Sentinel-1 images at Estonian latitude

1 S1A (L)	2	3	4 S1A (T)	5 S1B (T)	6 S1A (L)	7 S1B (L)
8	9	10 S1B (T)	11 S1A (T)	12 S1B (L)	13 S1A (L)	14
15	16 S1A (T)	17 S1B (T)	18 S1A (L)	19 S1B (L)	20	21
22 S1B (T)	23 S1A (T)	24 S1B (L)	25 S1A (L)	26	27	28 S1A (T)
29 S1B (T)	30 S1A (L)	31 S1B (L)	1	2	3	4
5	6	7	8	9	10	11

MAY 2018 – Sentinel-2 images at Estonian latitude

1 	2	3 	4	5	6 S2B	7
8 S2A	9	10	11 	12	13 	14
15	16 S2B	17	18 	19	20	21 
22	23 	24	25	26 	27	28 S2A
29	30	31 S2A	1	2	3	4
5	6	7	8	9	10	11

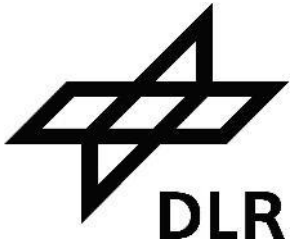
S1 and S2 dataset of summer 2017



By Tarvi Verro, 2017

Applied research since 2011

Republic of Estonia
Agricultural Registers
and Information Board



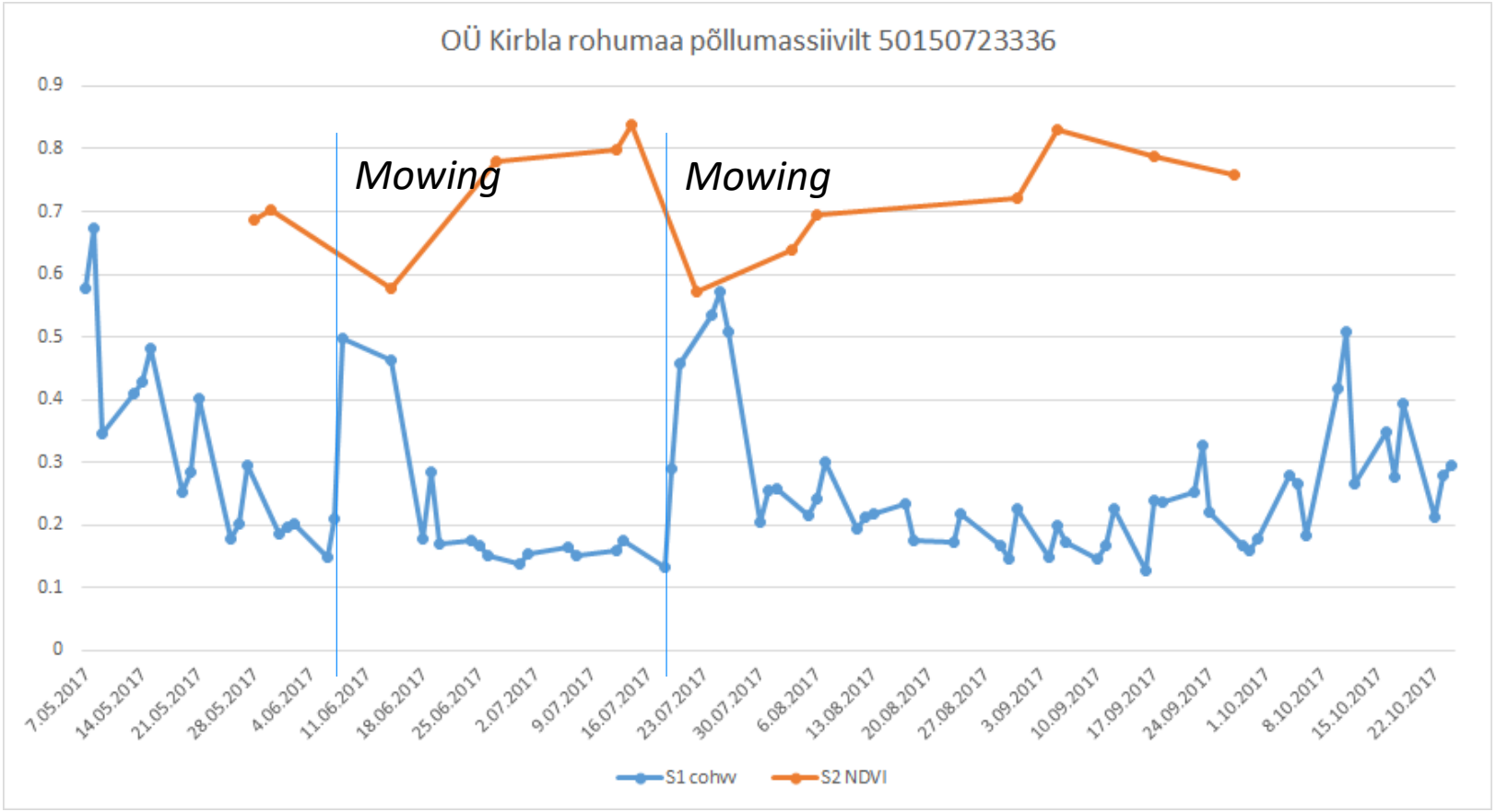
TARTU OBSERVATORY
space research centre

- 4 larger field survey campaigns (2011, 2013, 2015, 2016).
- Radar remote sensing training in DLR, Germany (2011-12 and 2014).
- 5 scientific articles published.
- 2 PhD theses defended in the University of Tartu.

Pilot studies with Estonian paying agency

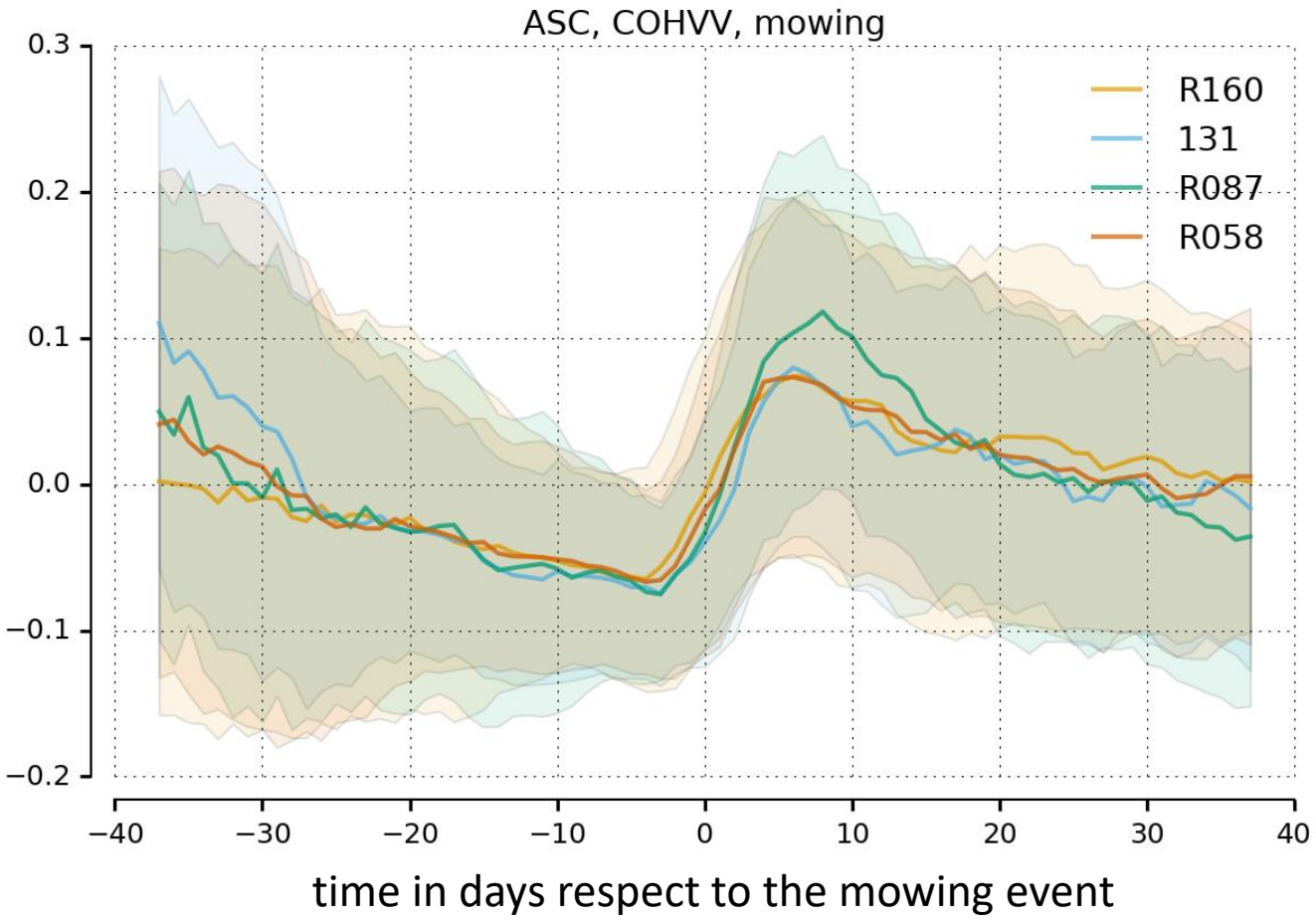
- 3 experiments with radar data: 2011, 2013 and 2015, using TerraSAR-X, RADARSAT-2, COSMO SkyMED and Sentinel-1.
- 2 experiments with optical data: 2012 and 2013, using WorldView-2, QuickBird and Spot-5.
- Encouraging satellite based results, in line with field inspection results.

Scientific basis – everything is extremely simple

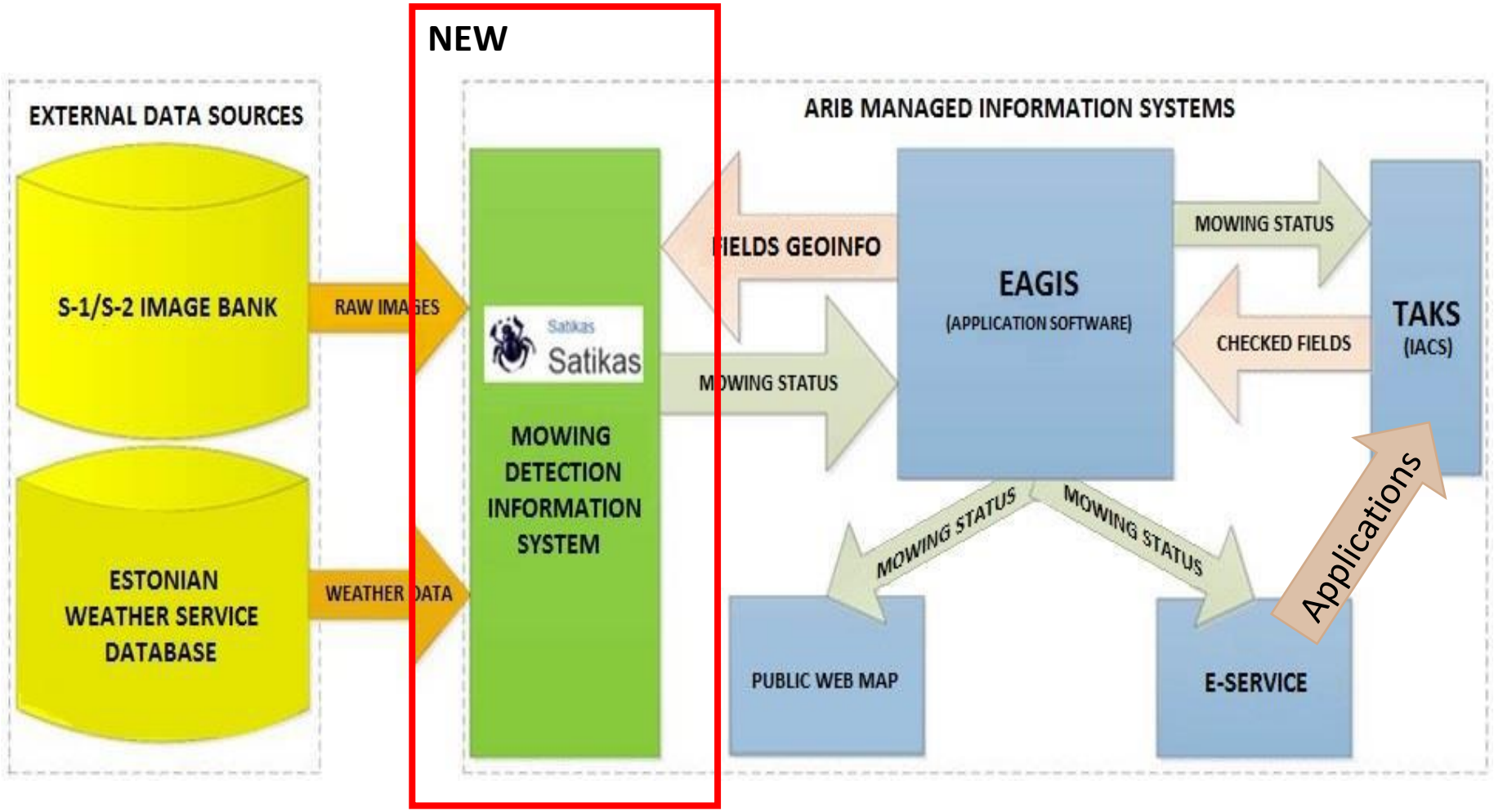


Mowing is characterized by coherence increase and NDVI decrease

Scientific basis – aggregated zero-normalized coherence pattern



General system architecture



System design

- Close to physics rigorous pre-processing of satellite data.
- Modern DeepLearning technologies on top of that.
- Free and open software components: ESA SNAP, PostgreSQL, Keras/TensorFlow and Python.

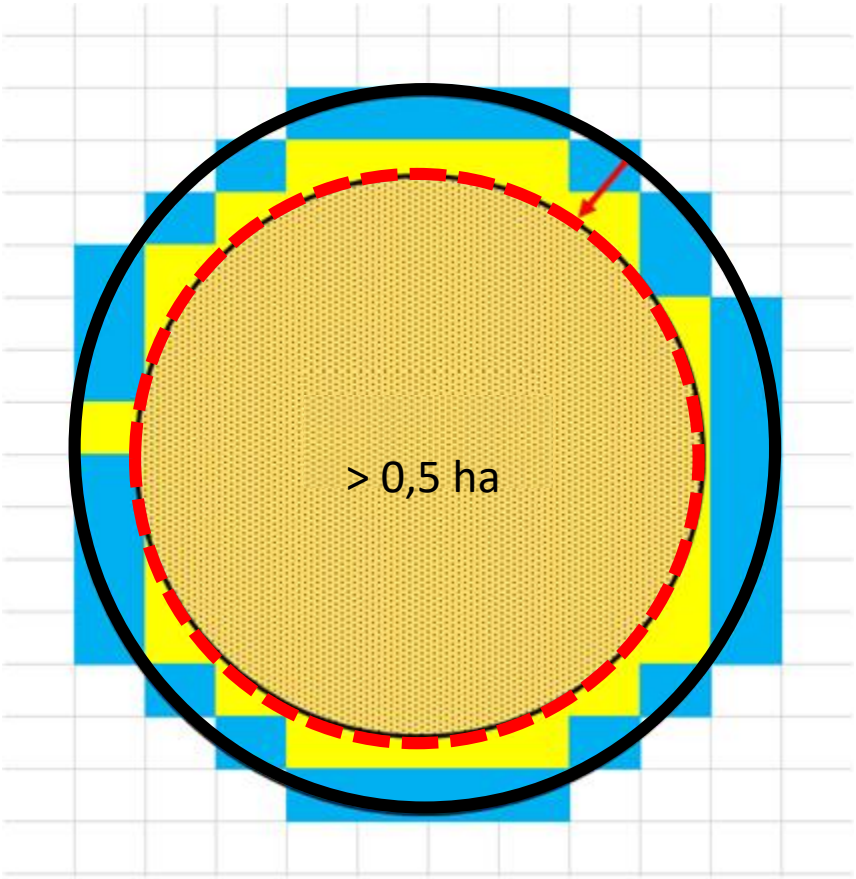
New system “SATIKAS“

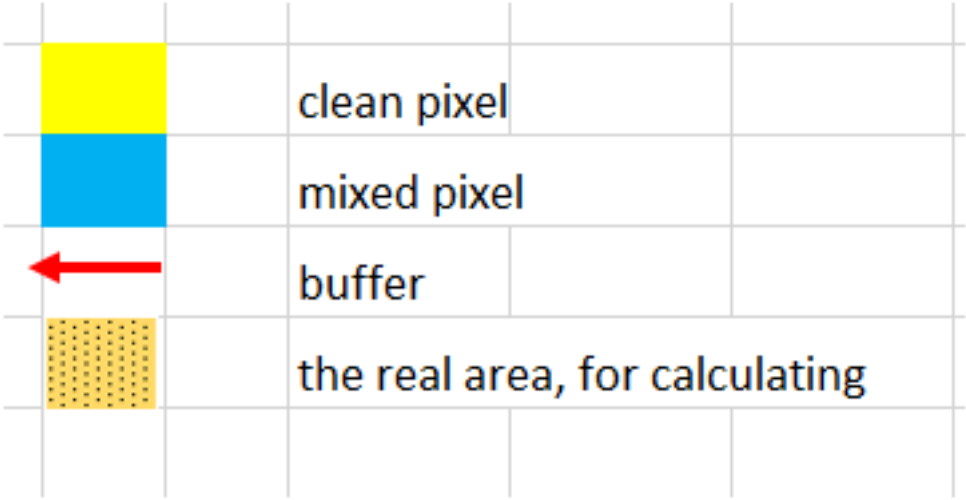
- General name: SATellIidi andmete KAsutamise Süsteem - ‘*A system that uses satellite data*’. Mowing detection is the first task.
- System uses as input data:
  - Agricultural parcel (grasslands) geometries from aid applications (E-ARIB/IACS/GIS)
  - Sentinel-1 and Sentinel-2 time series (ESA scihub)
  - Meteorological (rainfall) data (Estonian Weather service)
- Stand alone system with user interface (UI) for administrator and API for exchanging data.

New system “SATIKAS“

- Cloudy weather independence thanks to Sentinel-1 radar data.
- Input data temporal density: new S1 or S2 image every 2 days.
- Update of “mowing layer“ at least every week.
- Due to input (Sentinel) data resolution constraints, system covers fields greater than ~1 ha (90% of parcels by area, 60% by count).

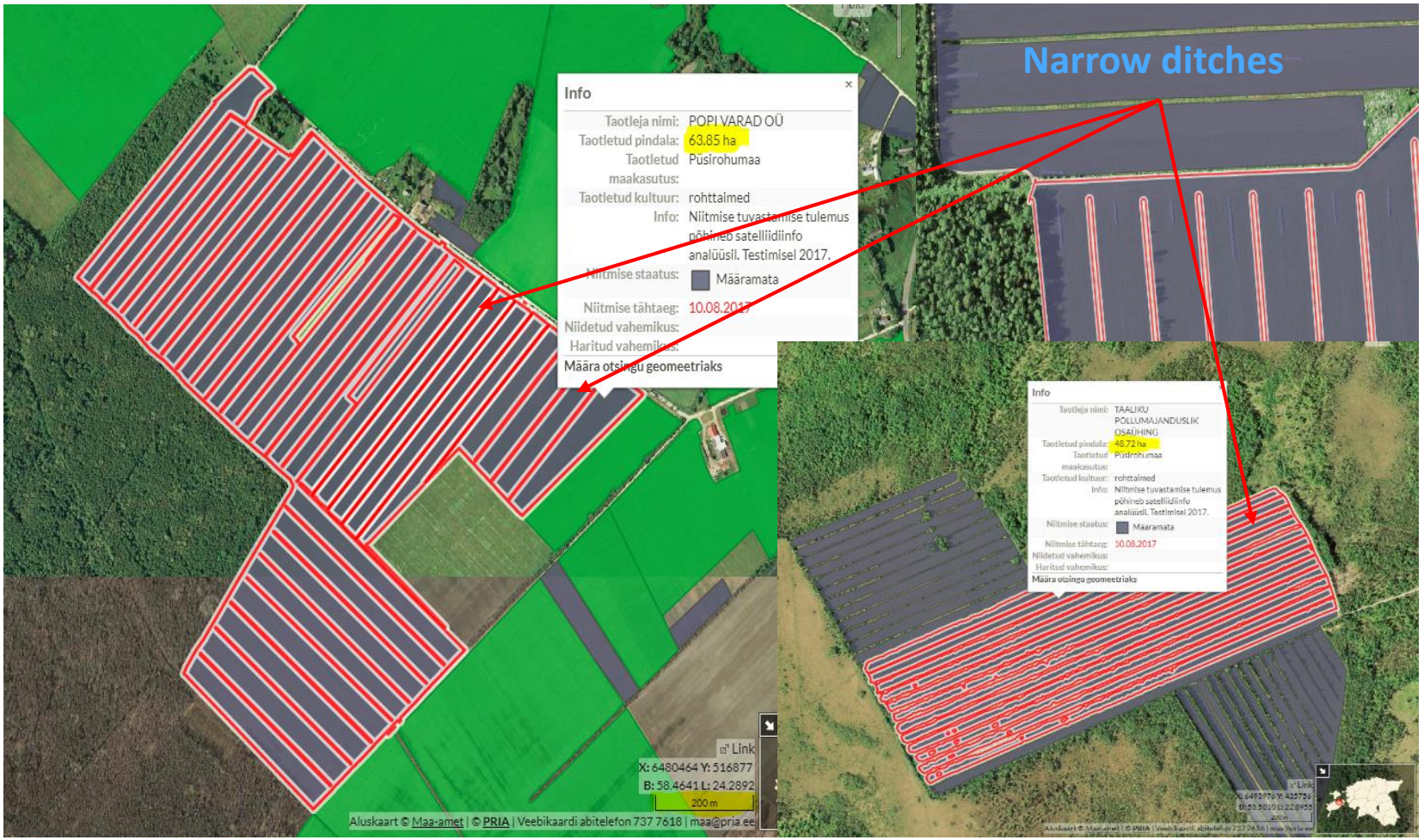
20 m S1 data spatial resolution limitations





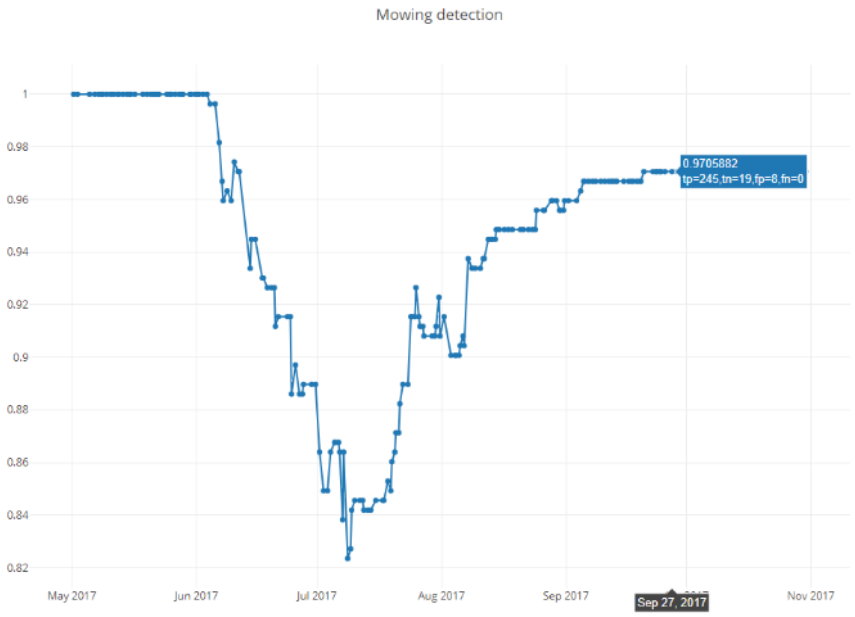
Buffer area (mixed pixels) 15 m
Min 140 ‘clean’ pixels needed
Min area for calculating ~0,5 ha
(ideal circular shape parcel).

Examples of skipped parcels



Accuracy as of 2018-05

- 98% true positive rate (mowing detected and the parcel was really mown).
- 70% true negative rate (mowing was not detected and the parcel wasn’t really mown).
- Overall accuracy 97%.
- Accuracy varies during the season.



Frontrunner pain and gain – challenges

- Facing all the errors and troubles first, everything cannot be foreseen as we are among the first in this path.

- When you learn to solve the problems you get some glory and can teach the others.

Frontrunner pain and gain – challenges

- Copernicus Sentinels data supply is like a brand new Formula 1 engine.
- Immense capacity, but crashes frequently and quite often weird things happen.
- Yet to become reliable and run smoothly in all conditions.

Image source: Wikipedia

Challenges

- IT development and science has to be done simultaneously.
- From 30 field test-area studies to country-wide system (100 000 fields) – facing a lot of new special cases.
- Local Sentinel data distribution centre (EstHUB) is not there yet.

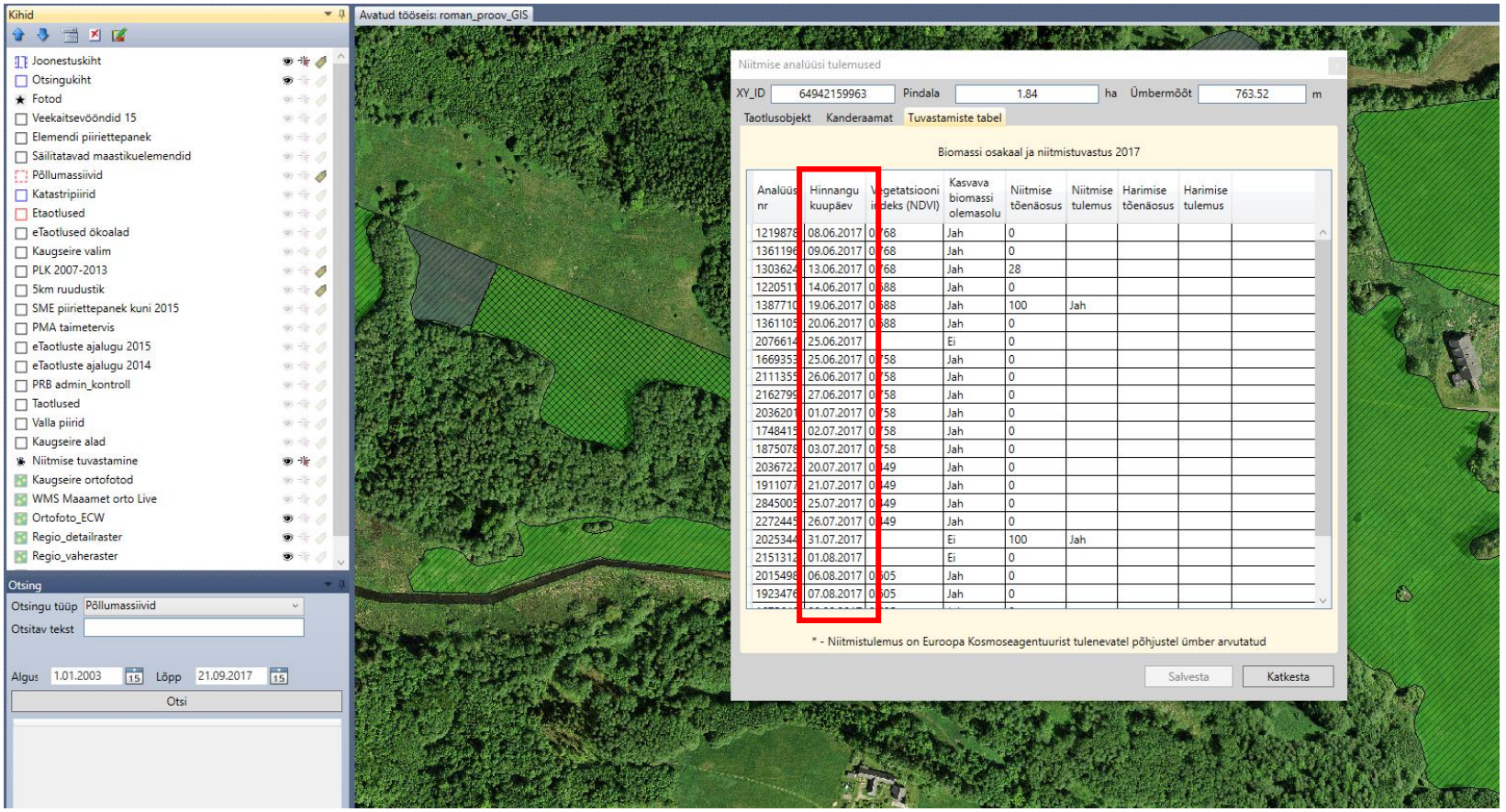
Frontrunner pain and gain – challenges

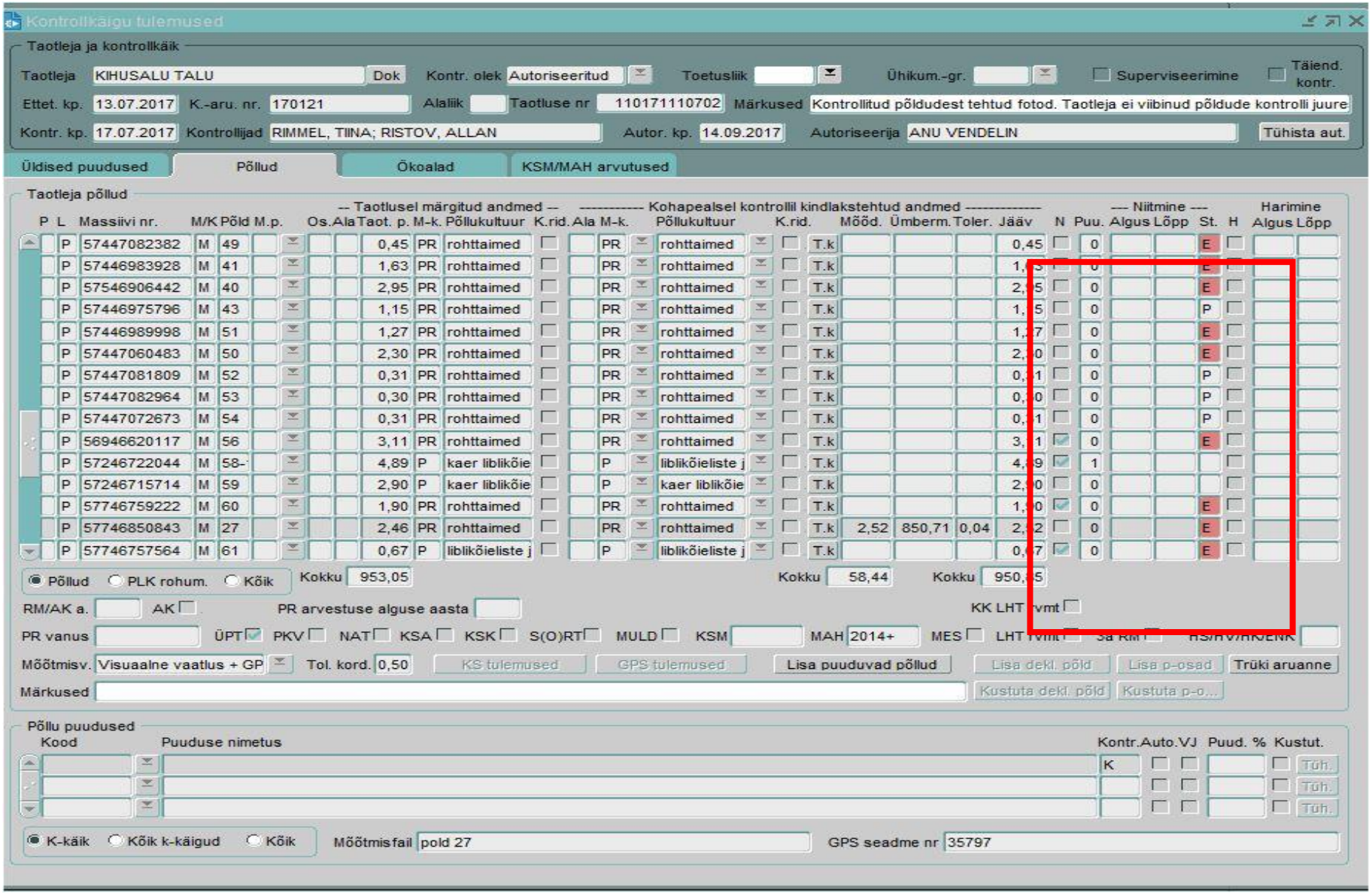
- Large data quantities (15 TB per season) have to be processed in short time – performance is a key factor.
- Every single step of the process is time consuming -> testing takes a lot of time.

Possibilities for extensions and future developments

- Relatively easy to extend the functionality to other farming events detection (grazing, ploughing, harvesting, detection of emerging vegetation), needed for catch-crop subsidy checks etc.
- Paying agency (PA) will have an objective and fresh view of what is happening in the fields of the country.
- Our developments are well in line with the new “Monitoring approach” of the Common Agricultural policy.
- Estonian PA is well prepared for the changes to come.

RESULTS IN EAGIS (LPIS)




Kontrollkäigu tulemused
Taotleja ja kontrollkäik
Taotleja KIHUSALU TALU Dok Kontr. olek Autoriseeritud Toetusliik Ühikum.-gr. Superviseerimine Täiend. kontr.
Ettet. kp. 13.07.2017 K.-aru. nr. 170121 Alaliik Taotluse nr 110171110702 Märkused Kontrollitud põldudest tehtud fotod. Taotleja ei viibinud põldude kontrolli juure
Kontr. kp. 17.07.2017 Kontrollijad RIMMEL, TIINA; RISTOV, ALLAN Autor. kp. 14.09.2017 Autoriseerija ANU VENDELIN Tühista aut.
Üldised puudused
Põllud
Ökoalad
KSM/MAH arvutused
Taotleja põllud
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P L 57446975796 M 43 1,15 PR rohttaimed PR rohttaimed T.k 0 P
P L 57446989998 M 51 1,27 PR rohttaimed PR rohttaimed T.k 0 E
P L 57447060483 M 50 2,30 PR rohttaimed PR rohttaimed T.k 0 E
P L 57447081809 M 52 0,31 PR rohttaimed PR rohttaimed T.k 0 P
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P L 56946620117 M 56 3,11 PR rohttaimed PR rohttaimed T.k 0 E
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P L 57746757564 M 61 0,67 P liblikõieliste j P liblikõieliste j T.k 0 E
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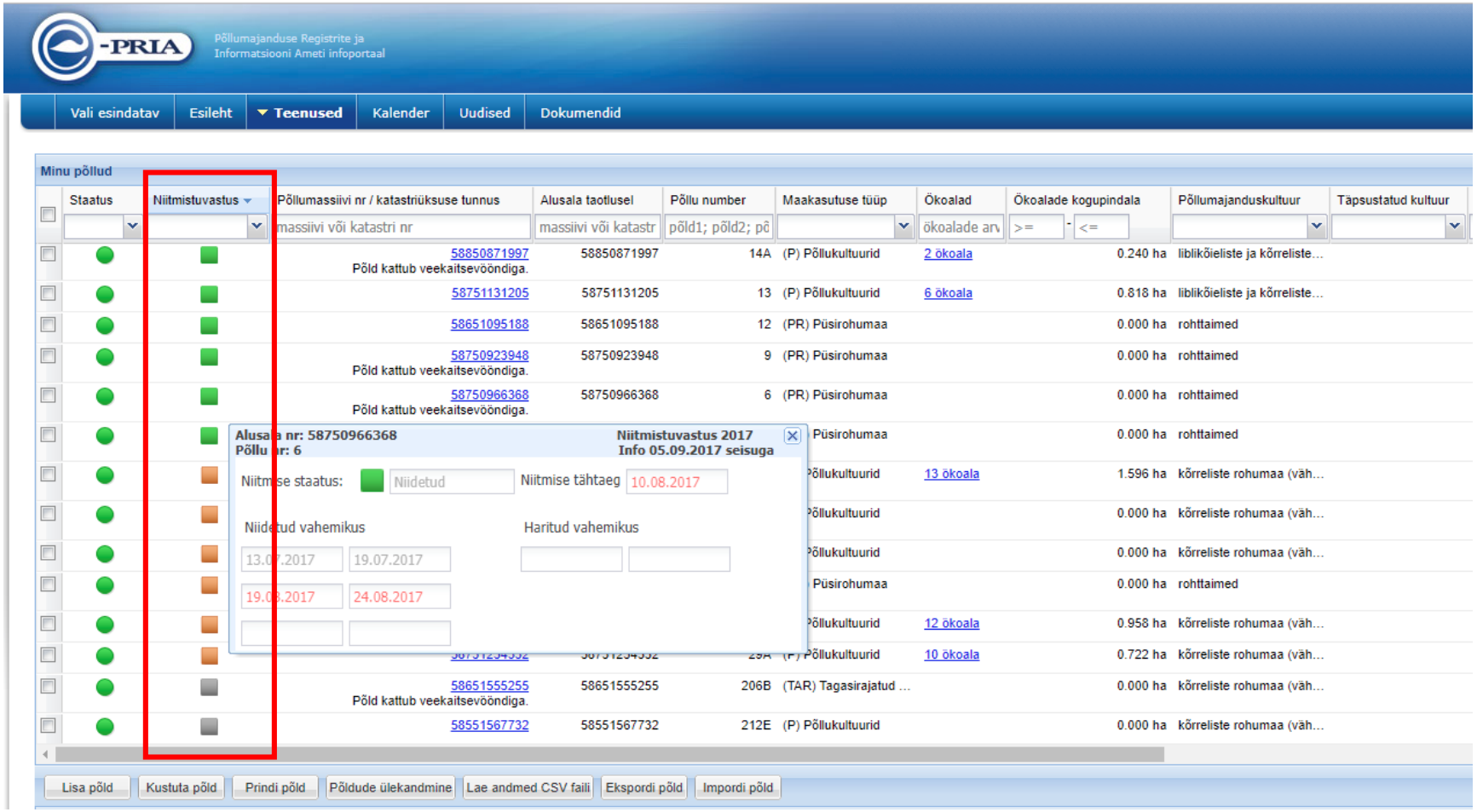
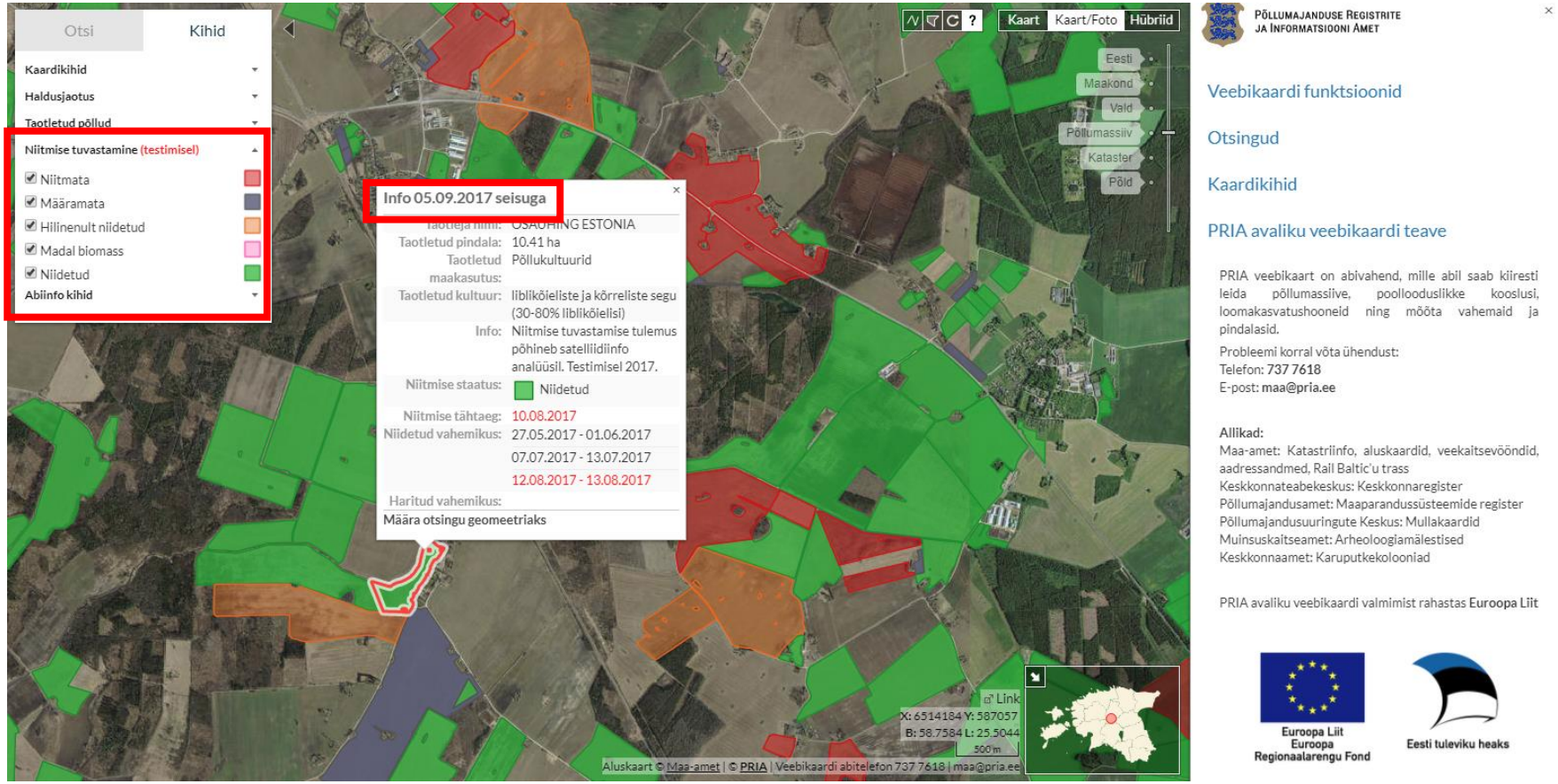
RESULTS IN FARMERS PORTAL (e-ARIB)



RESULTS ON PUBLIC WEBMAP
https://kls.pria.ee/kaart/



PÕLLUMAJANDUSE REGISTRITE JA INFORMATSIOONI AMET

Veebikaardi funktsioonid

Otsingud

Kaardikihid

PRIA avaliku veebikaardi teave

PRIA veebikaart on abivahend, mille abil saab kiiresti leida põllumassiive, poollooduslikke kooslusi, loomakasvatushooneid ning mööta vahemaid ja pindalasid.

Probleemi korral võta ühendust:
Telefon: 737 7618
E-post: maa@pria.ee

Allikad:
Maa-amet: Katastriinfo, aluskaardid, veekaitsevööndid, aadressandmed, Rail Baltic'u trass
Keskkonnateabekeskus: Keskkonnaregister
Põllumajandusamet: Maaparandussüsteemide register
Põllumajandusuuringute Keskus: Mullakaardid
Muinsuskaitseamet: Arheoloogiamälestised
Keskkonnaamet: Karuputkekolooniad

PRIA avaliku veebikaardi valmimist rahastas **Euroopa Liit**

Euroopa Liit
Euroopa Regionaalarengu Fond

Eesti tuleviku heaks

FUTURE PLANS for SATIKAS

- 2018. improve the mowing detection algoritm (machine learning)
- Other possible functionalities (and other possible image/data providers) will be assessed:
    1. Crop (crop group) detection
    2. Detection of nitrogen fixing crops
    3. Detection of cultivation of fallow land
    4. Detection of flooded areas
    5. Hints for changes in LPIS.
- Notification of farmers before

deadline of mowing.

- System will be hosted on top of/next

to the EstHUB (at KeMIT)

Conclusions

- The results of automated mowing detection can be used in risk analysis and targeted controls, BUT …
- … 100% mowing control is not possible using only S1 and S2 images (because of the pixel size and error rate of the system)
- Sentinel images can possibly be used in combination with other datasets (LIDAR, VHR, aerial photos, geotagged photos) and methods as alternatives for OTSC.
- A benefit allready achieved: farmers know that PA knows (ie PA is monitoring)

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THANK YOU FOR YOUR ATTENTION!