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Grassland mowing detection for agricultural subsidy checks with Sentinel-1 and Sentinel-2

EstIIS ESA project

Kaupo Voormansik and Kalev Koppel

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Outline

1. Who is KappaZeta?
2. What does KappaZeta mean?
3. Our research heritage.
4. Our EstIIS ESA project.

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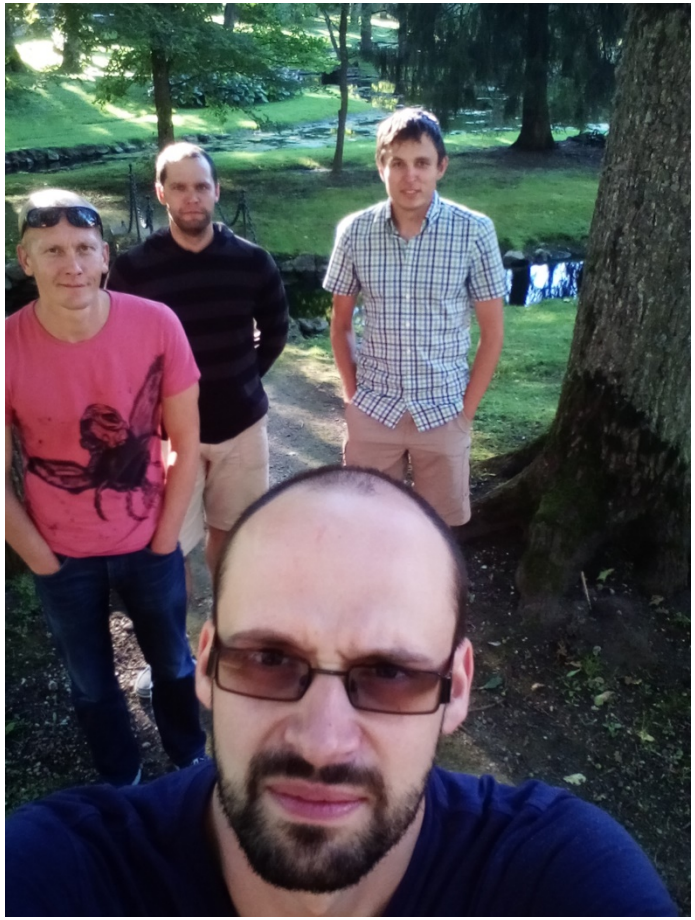
Who is KappaZeta?

- EO applications company.
- Tartu Observatory *spin-off*,
  grown out from the SAR research group.
- Concentrating on agricultural applications and radar technology.
- First product is mowing detection engine for European paying agencies.

Who is KappaZeta?

- Established in 2015 by Kalev Koppel, Tanel Tamm, Kaupo Voormansik and Karlis Zalite.
- Tartu Observatory, University of Tartu and Regio/Reach-U background people.
- EO, GIS and ICT expertise.



What does KappaZeta mean?

- What is κ_z in SAR interferometry?
- Can somebody give the definition of κ_z?

$$k_z = \frac{2\pi\Delta\theta_i}{\lambda \sin\theta_i} \approx \frac{2B_n}{R \sin\theta_i}$$

$$HoA = \frac{\lambda R \sin\theta_i}{2B_n} = \frac{2\pi}{k_z}$$

- What does it show?

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Mowing detection, why?

- Common Agricultural Policy.
- One of the requirements to get subsidies is mowing.
- Potential to greatly reduce manual labour and improve checks quality with automated EO infosystems.

Research heritage in radar remote sensing of grassland

- Applied research since 2011.
- In cooperation with Estonian Agricultural Registers and Information Board – exceptional user partner!

REPUBLIC OF ESTONIA
AGRICULTURAL REGISTERS AND INFORMATION BOARD

Research heritage in radar remote sensing of grassland

What we have done so far?

- 4 main field survey campaigns: (2011 Matsalu, 2013 – Rannu, 2015 – Rannu and 2016 – Rannu).
- 4 research journal articles (+ several conference papers).
- 2 doctoral theses in University of Tartu, 1 more to come.

Our main research findings

- TerraSAR-X HH/VV polarimetric coherence works as a mowing events indicator.
- Optical satellite imagery based NDVI works as a mowing events indicator.
- COSMO SkyMED 1 day repeat pass InSAR pairs could even give us grass height estimates up to 30 cm (after that quick saturation).
- Most important: Sentinel-1 12 day repeat pass interferometric coherence works as a mowing events indicator
  – read our paper (Tamm *et al*, 2016). ☺

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List of published papers by our team

- *K. Voormansik, T. Jagdhuber, A. Olesk, I. Hajnsek and K. P. Papahtanassiou, "Towards a detection of grassland cutting practices with dual polarimetric TerraSAR-X data," International Journal of Remote Sensing, vol. 34, no. 22, pp. 8081-8103, 2013.*
- *K. Voormansik, T. Jagdhuber, I. Hajnsek and K. P. Papathanassiou, "Improving Semi-natural Grassland Administration with TerraSAR-X," in Proceedings of the 17th GeoCAP Annual Conference, edited by: D. Fasbender, K. Taşdemir, Ph. Loudjani, V. Angileri, C. Lucau, P. Milenov, W. Devos, R. De Kok, S. Lemajic, A. Tarko and P. Pizziol, pp. 26-32, Tallinn, 2011.*
- *K. Zalite, O. Antropov, J. Praks, K. Voormansik and M. Noorma, "Towards detecting mowing of agricultural grasslands from multi-temporal COSMO-SkyMed data," 2014 IEEE International Geoscience and Remote Sensing Symposium (IGARSS), pp. 5076–5079, 2014.*
- *K. Voormansik, T. Jagdhuber, K. Zalite, M. Noorma and I. Hajnsek, „Obervations of Cutting Practices in Agricultural Grasslands using Polarimetric SAR", IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2016.*
- *K. Zalite, O. Antropov, J. Praks, K. Voormansik and M. Noorma „X-band Repeat-Pass Interferometry for Monitoring of Grasslands," IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 2016.*
- *T. Tamm, K. Zalite, K. Voormansik and L. Talgre "Relating Sentinel-1 Interferometric Coherence to Mowing Events on Grasslands," Remote Sensing, 2016.*

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The “Grassland mowing detection for agricultural subsidy checks with Sentinel-1 and Sentinel-2” EstIIS ESA project

Objectives:

- Provide reliable full scale and near real-time grassland management events monitoring for European paying agencies and farmers.
  ... for that build a scalable remote sensing based software solution that is validated in Northern Europe (Denmark, Sweden).
- Reach to 30% market share (12 countries) in Europe.
- ... for that develop viable business model to provide a high-quality service for target customer segments.

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The Grasslands EstIIS ESA project

- In brief: (i) mowing detection engine development, (ii) technical and business feasibility analysis and (iii) user trials with Danish and Swedish paying agencies (PAs).
- Danish and Swedish PAs as the pilot users of the service.
- Also Finnish, Latvian and Lithuanian paying agencies have expressed their interest about the project outcomes.

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The Grasslands EstIIS ESA project impact

- From *in situ* inspector checks covering 5% of the subsidy applications.

- To almost country-wide coverage.

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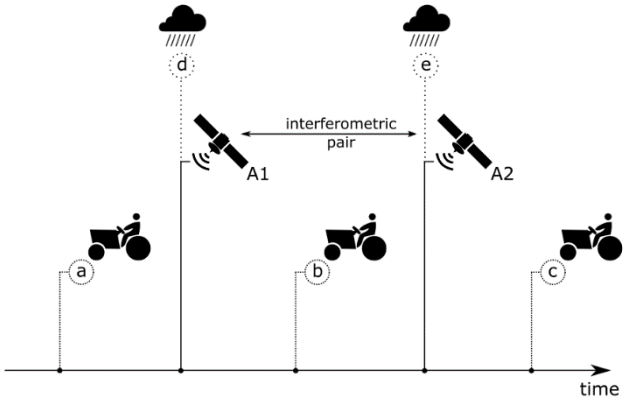
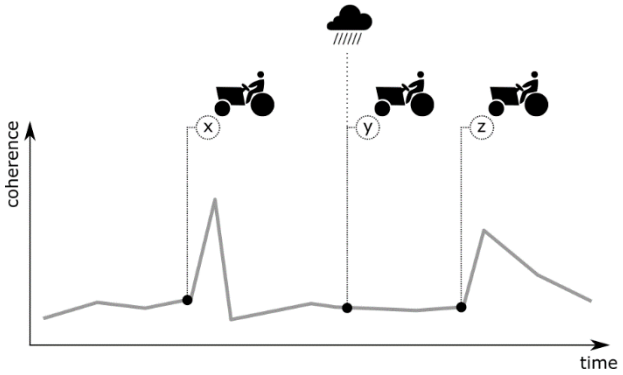
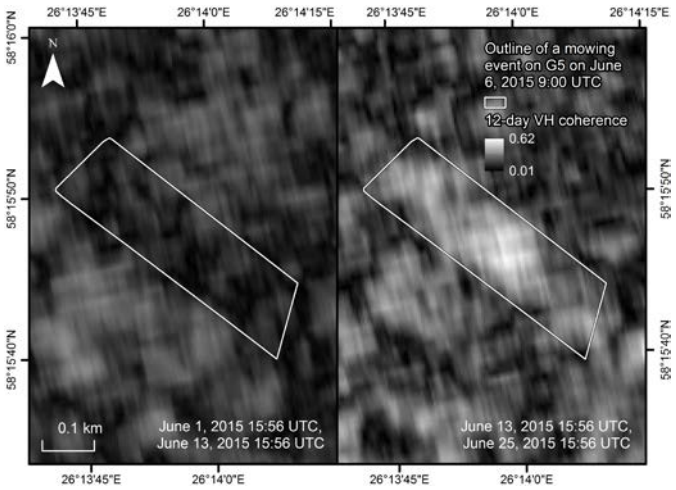
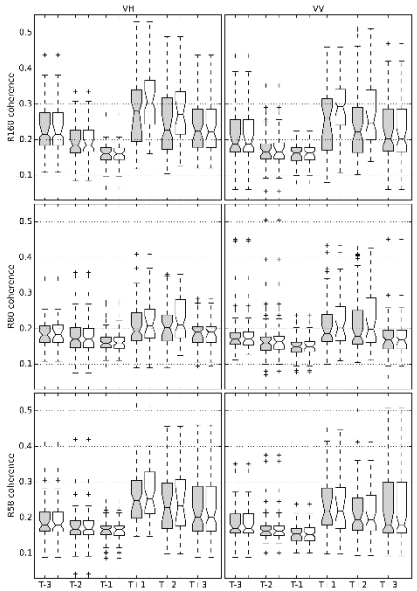
How does it work – key figures









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Overall service architecture

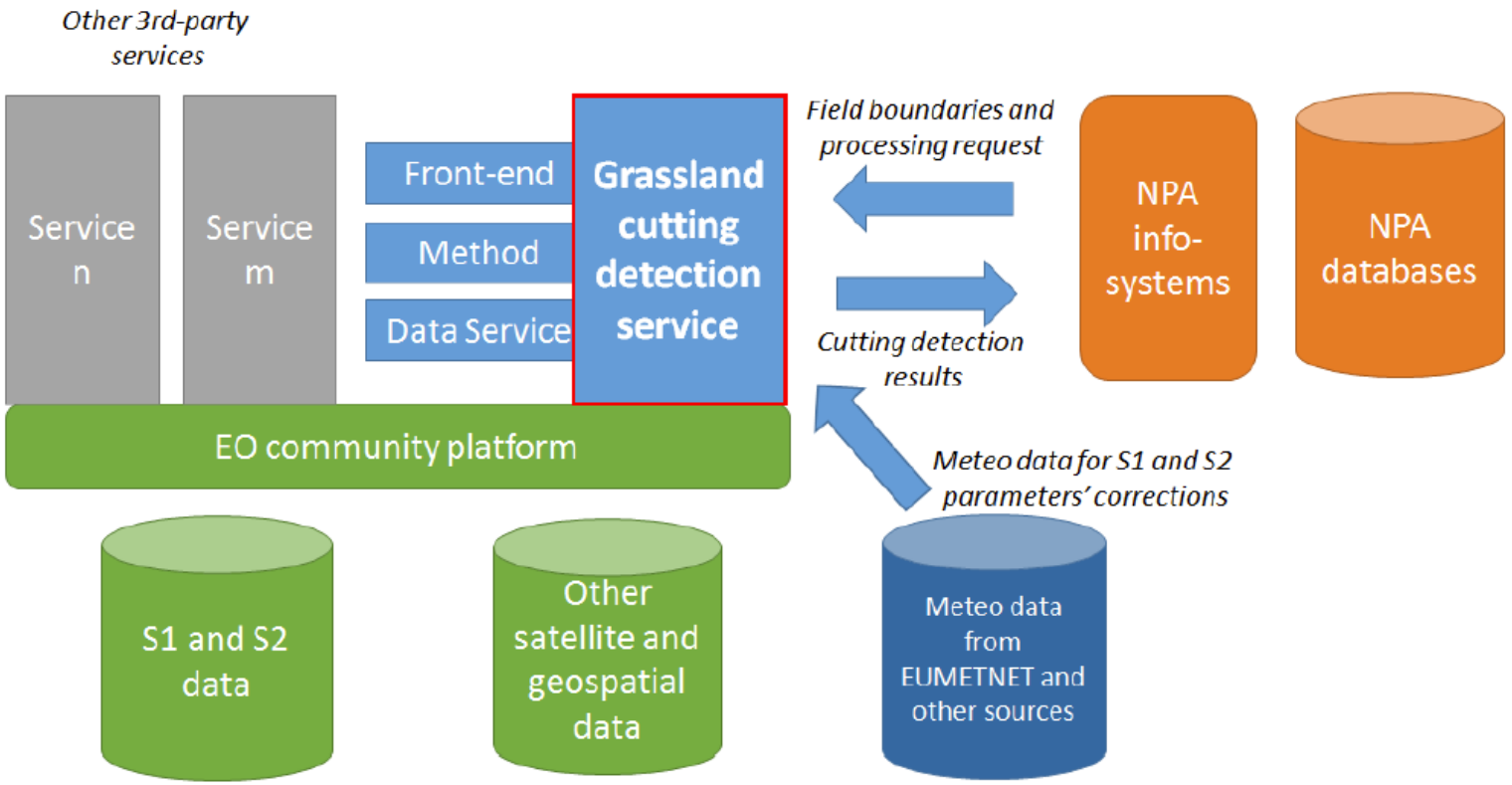
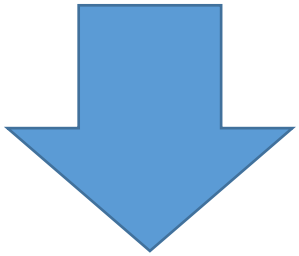


Figure 1 Grassland cutting detection service (light blue box) and its links to EO community platform, NPA information systems and meteorological databases.

Technology Readiness Level info

- From: TRL 4 “Application/service verification in laboratory environment, market segments and customers/users identifies”.



- To: TRL 7 “Trials with customers/users to validate utilisation and business models”.

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The steps of the EstIlS project

- Perform Viability Analysis, including analysis of economic and technical feasibility as well as the development of a business model and a pricing policy.
- Enhance the existing cutting and grazing detection methodology; the method will use Sentinel-1, Sentinel-2, Landsat-8 and meteorological data as input.
- Develop the software product based on the cutting detection and grazing methodology.
- Validate the Service by performing user trials with NPAs and farmers during summer 2017 and summer 2018 in Sweden and Denmark.

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Thank you!

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