REGIONAL SCALE SATELLITE MONITORING

Summary

Satellite monitoring enables a cost effective solution to understanding the spatial variation throughout a large NBS site. It provides an effective way of monitoring effects after applying a NBS, and enables better and more precise understanding of the potential of applying a NBS on a regional scale.

The need

In the trans4num Decision Support Tool, we focus on the effects of introducing NBS across an entire region. In the Danish site this region contains more than 40.000 fields. Here a primary focus is on the spatial effect of the NBS, where the effect of decisions is highly affected by a spatial component.

This requires deep understanding of the spatial variation of the arable land in the region. Satellite monitoring provides a crucial input to this understanding, and can help in measuring the actual effect of implementing a NBS across the region.

"We are particularly focused on monitoring crop growth across multiple seasons at the NBS sites, with an emphasis on how effectively crops use available nutrients, especially nitrogen. On a regional scale this can be effectively monitored from multispectral satellite imagery using vegetation indexes like NDVI and NDRE.

In order to understand the context of a large region, it is key to know the crops on individual fields on every growth season, an application where satellite monitoring is a very efficient tool to provide insights on the most important crops.

The benefits

Satellite monitoring is a cost effective tool for the monitoring of agriculture in large areas. Further, since the data has already been collected, it gives access to medium resolution agricultural data covering large regions throughout the past decade.

Manual data collection, like soil sampling, at individual fields is at best sparse, and with varying degree of details across farms. Data collected with drones, enables very precise high resolution data, however the cost of collecting data, makes it very hard to obtain for large regions, especially in a temporal context, where data has to be fetched throughout the growth seasons.

Remote sensing makes the trade-off where precision and spatial resolution is sacrificed for high temporal resolution, and complete spatial coverage. This makes a perfect match for the regional scale at which the trans4num Decision Support Tool operates. Here the focus is not on optimization within a specific field or farm, but at a regional scale. Hence the high resolution from more precise sources like UAV monitoring is of no to little benefit.

The remote sensing satellite data enables timeseries monitoring of crop health at the scale, and provides important inputs on the spatial variation in growth of individual crops, throughout several growth seasons, providing detailed insights throughout the case areas.

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trans4num solution

Aarhus University and Cordulus provides a satellite monitoring pipeline targeted towards the regional scale NBS sites in the trans4num project. The data is directly targeted towards the NBS decision support tool being developed in the project.

Many of the existing work and tools for satellite monitoring are focused on the monitoring of field or farm level variation of fields. In trans4num the focus has been shifted towards monitoring of large regions, which introduces a requirement for a very effective pipeline and processing chain, but which in turn also enables a smaller focus on individual details in the collected data.

The satellite imagery works as a key input to the Decision Support Tool, for it to function effectively. The Decision Support Tool, is capable of describing spatial variation based on tabular values, manually collected field data and low resolution nitrogen leaching maps, however a more detailed spatial effect of introducing NBS solutions can be extracted through the use of satellite imagery.

We utilize Deep Learning models to classify the individual crops, over previous and current growth seasons, since this context is a requirement for the model to work. For the primary crops this can be done with very high precision using multispectral satellite imagery.

We further monitor the variation in growth across the entire region using indexes like NDVI and NDRE, in order to rectify the errors in the tabular values, which is otherwise the best available input for the Decision Support Tool.

Further we believe that we can monitor the crops ability to utilise the available nitrogen, through the growth of crops and especially cover crops in the area, giving a much more refined understanding of the leaching effect of the individual crops throughout the region.

What were the challenges / limitations in the implementation process?

The access to large quantities of ground truth data is required in order to generate effective monitoring algorithms. This is due to the fact that we monitor large regions, and have large quantities of low resolution input data available, but data driven models also require a lot of targets in order to generalize.

The noise in satellite imagery primarily from clouds introduce significant challenges for automated analysis.

What kind of resources do you need to implement the proposed solution?

An effective compute environment capable of storring and processing large amounts of data.

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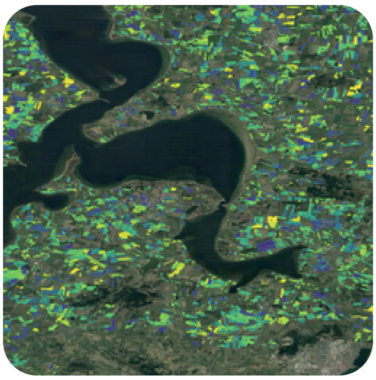
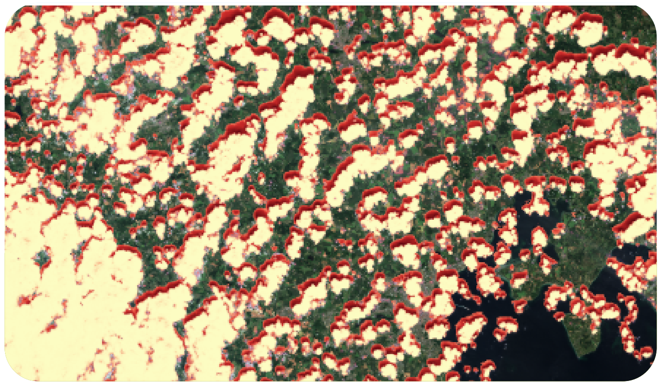
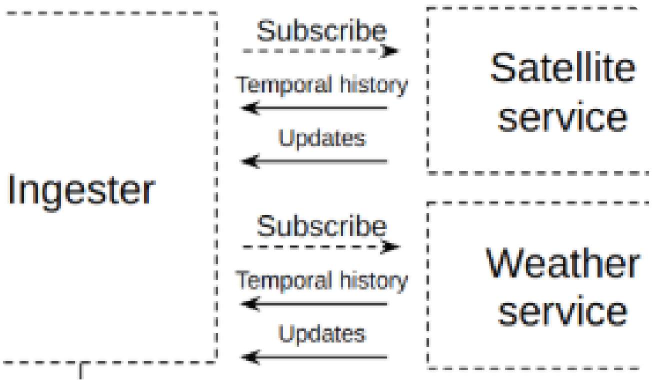
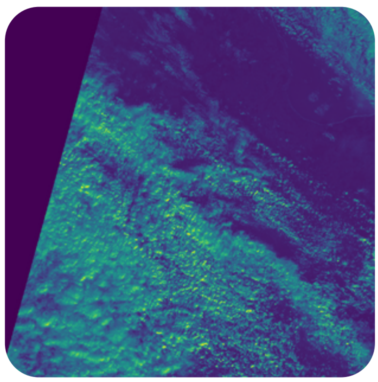
More information

- Nyborg, J., Pelletier, C., & Assent, I. (2022). Generalized classification of satellite image time series with thermal positional encoding. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 1392-1402).
- Nyborg, J., Pelletier, C., Lefèvre, S., & Assent, I. (2022). TimeMatch: Unsupervised cross-region adaptation by temporal shift estimation. ISPRS Journal of Photogrammetry and Remote Sensing, 188, 301-313.









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