Sentinel-1 data of agricultural fields in the Netherlands (Twente)

1. Introduction
Local users (e.g., regional water managers and farmers) would benefit from fine resolution soil moisture products. With Synthetic Aperture Radar (SAR) a fine resolution soil moisture product can be obtained, which would complement the currently available coarse resolution soil moisture products. Sentinel-1 is a new satellite mission that provides images with a high spatial-temporal resolution, a high radiometric accuracy and dual polarization data. Sensitivity to soil moisture changes is essential to retrieve soil moisture states from the Sentinel-1 data.

Objective: Investigate the sensitivity of Sentinel-1 backscatter to surface soil moisture content and vegetation conditions.

2. Methodology
A. Pre-processing and sensitivity analysis
The Sentinel-1 data characteristics are summarized in Table 1.

Table 1: Characteristics of the Sentinel-1 Interferometric Wide Swath level 1B High resolution ready (Sentinel-1, 2013)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>C-band (5.405 GHz)</td>
</tr>
<tr>
<td>Pixel spacing</td>
<td>10 m × 10 m</td>
</tr>
<tr>
<td>Maximum Noise Equivalent</td>
<td>-22 dB</td>
</tr>
<tr>
<td>Backscatter</td>
<td>0.03 0.46</td>
</tr>
<tr>
<td>Soil moisture states</td>
<td>0.08 0.46</td>
</tr>
<tr>
<td>Vegetation products</td>
<td>0.01 0.46</td>
</tr>
</tbody>
</table>

Figure 1 presents the pre-processing and sensitivity analysis procedure. Backscatter is plotted against soil moisture and vegetation conditions for one hydrological year and bare/low vegetation conditions for one hydrological year is plotted against soil moisture and vegetation conditions from the Sentinel-1 data.

B. Study area and ancillary vegetation data
In-situ soil moisture measurements at 5 cm depth collected from the Twente soil moisture monitoring network in the Netherlands (Figure 2) are used as reference. The Twente area is almost flat and has a heterogeneous landscape, including agricultural lands (Figure 2) of the regression lines in Figure 5 & Table 2: Sensitivity of backscatter to NDVI. The slopes and coefficients of determination of the regression lines are presented in Table 2.

3. Results

4. Conclusions and outlook
The results provide insight into the potential of Sentinel-1 data to quantify vegetation and soil moisture states. The sensitivity of backscatter to soil moisture is noticeable but weak, because the effects of vegetation dynamics, surface roughness and standing water are not considered yet. The research should be extended to other crop types, especially corn and potatoes. The research is continued with the testing of three promising methods, namely a data-driven algorithm, a radiative transfer model and a downsampling algorithm.

The objective of the research is to develop an operationally applicable method to estimate surface soil moisture from Sentinel-1 data over the dominant agricultural crop types in the Netherlands.

The research is part of the OWAIS project (Optimizing Water Availability with Sentinel 1 Satellites). The OWAIS project stands for integration of the freely available global Sentinel-1 data and local knowledge on soil physical processes to optimize water management of regional water systems and to develop value-added products for agriculture.

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References

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