Supplementary Materials: Density Estimates as Representations of Agricultural Fields for Remote Sensing-Based Monitoring of Tillage and Vegetation Cover

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This supplement provides details of the satellite data used in the article manuscript of the same name and outlines initial steps for formatting the data as raster inputs to the processing pipeline. Because the identifying and geometric vector shapefile (.shp) data of the field parcel polygons are not publicly available at this time, as explained in the article, the initial steps of the computational pipeline process cannot be duplicated as such by the reader. Instead, we equivalently published an intermediate derived dataset, anonymized and without the geospatial information, packaged in the article codebase and Docker container available at (accessed on 3 December, 2021) https://github.com/luotsi/vegcover-manuscript-12_2021.

S1. Sentinel-1 data

We use Sentinel-1 SAR mean gamma nought intensity mosaics [1] constructed for the area of whole Finland by the Finnish Meteorological Institute (FMI). The mosaics can be retrieved using the following two URL links (online version of this annex):

- s1m_grd_20180411-20180421_mean_VV_R20m.tif
- s1m_grd_20180411-20180421_mean_VH_R20m.tif

To use these images in our processing pipeline, we stacked the bands in the given order to a single .tif file using the GDAL geospatial tool suite [2].

The Finnish Data Hub System (FDHS) is a "web-based system designed to provide EO data users with distributed mirror archives and bulk dissemination capabilities for Copernicus Sentinel data products" [3]. The full mosaic linked above covers the entire area of Finland, but for the region of interest (ROI) in our study the same information can be derived from the following Sentinel-1 Ground Range Detected (GRD) images during the time period between April 11th to 21st 2018, queryable from FDHS:

- S1A_IW_GRDH_1SDV_20180413T050602_20180413T050627_021444_024ECD_BF8D.SAFE
- S1A_IW_GRDH_1SDV_20180415T044946_20180415T045005_021473_024FC5_F3A5.SAFE
- S1A_IW_GRDH_1SDV_20180415T044946_20180415T045005_021473_024FC5_DE5B.SAFE
- S1A_IW_GRDH_1SDV_20180415T160451_20180415T160516_021480_025001_D2A6.SAFE
- S1A_IW_GRDH_1SDV_20180417T043352_20180417T043421_021502_0250B4_2C57.SAFE
- S1A_IW_GRDH_1SDV_20180417T154832_20180417T154857_021509_0250E9_8636.SAFE
- S1A_IW_GRDH_1SDV_20180420T045755_20180420T045814_021546_025214_88B2.SAFE
- S1A_IW_GRDH_1SDV_20180420T045755_20180420T045814_021546_025214_5DA3.SAFE
- S1A_IW_GRDH_1SDV_20180420T045834_20180420T045903_021546_025215_37CF.SAFE
- S1A_IW_GRDH_1SDV_20180420T161303_20180420T161328_021553_02524A_FB61.SAFE
- S1A_IW_GRDH_1SDV_20180420T161328_20180420T161347_021553_02524A_C5A3.SAFE
- S1A_IW_GRDH_1SDV_20180420T161303_20180420T161328_021553_02524A_1EE6.SAFE

S2. Sentinel-2 data

Identifying image product names follows the L2 Sentinel-2 images used in the study. Note that in addition to the two images (T34VEN and T34VFN) falling within the ROI, time (see Sentinel-1 mosaic, April 11th to April 21st) and 10% cloud criteria, we selected an additional third T34VFM tile only two days outside (April 23rd) of the Sentinel-1 mosaic dates. We justify this by having expanded the data fusion dataset by 50% and the added accuracy resulting from the data fusion experiment. The L2 images can be retrieved from the Copernicus Hub (FDHS does not provide L2 versions) using these identifiers:

- S2A_MSIL2A_20180423T095031_N0207_R079_T34VFM_20180423T115044
- S2B_MSIL2A_20180411T100029_N0207_R122_T34VEN_20180411T134414
- S2B_MSIL2A_20180418T095029_N0207_R079_T34VFN_20180418T111406

We first constructed GeoTiff images of each tile using ESA SNAP software, essentially producing NDVI and NDTI bands as band arithmetic, plus snow and cloud confidence values and natural colors for development-time reference. The complete list of bands follows:

- B2 (Band 2 / Blue, for natural-color reference images)
- B3 (Band 3 / Green, for natural-color reference images)
- B4 (Band 4 / Red, for natural-color reference images)
- p_cld (cloud probability)
- p_snw (snow probability)
- NDTI
- NDVI

We then merged the images into a spatial mosaic using the GDAL toolset (gdal_merge.py). To match the SAR dataset and .shp shapefiles, we changed the projection to the TM35Fin coordinate system (EPSG 3067). The resulting raster .tif file is used by the pipeline as the second raster input.

References

1. Finnish Meteorological Institute. Sentinel-1 SAR-image mosaic (S1sar). Available online: https://ckan.ymparisto.fi/dataset/sentinel-1-sar-image-mosaic-s1sar-sentinel-1-sar-kuvamosaiikki-s1sar. (Accessed on 8 February 2021).
2. OSGeo Project. GDAL. Available online: https://gdal.org/. (Accessed on 31 November 2021).
3. Finnish Meteorological Institute. Finnish Data Hub System. Available online: https://finhub.nsdc.fmi.fi/#/home. (Accessed on 8 February 2021).