STØTTET AF
Promilleafgiftsfonden for landbrug

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Validation of S1/S2 surface water detection

Identifying areas with surface water can be helpful for farmers when planning drainage improvements activities or may serve as input in models for precision fertilizer applications. SEGES has in cooperation with GeoVille, a company providing remote sensing services, investigated an approach for surface water detection, combining Sentinel-1 radar data and Sentinel-2 optical data.

GeoVille has based on a combination of Sentinel-1 radar data and Sentinel-2 optical L2A data produced a map of calculated areas with surface water during March 2019.

The selected area is in Northern Denmark and has often problems with surface water in periods with heavy rainfall as the terrain is flat and the soil is dense.

SEGES investigated the validity of the map. The validation process consisted of two steps.

Removal of known objects from dataset
First, based on existing GIS-data, buildings, lakes and other known water bodies were removed from the dataset. That was about 10 % of the total calculations (table 1). Figure 1 shows the locations of buildings and water bodies and water in the fields.

Table 1	**Number of occurrences**
Buildings	32
Waterhole	12
Watersheed	13
Water in the field	470
Total amount	527

Answers from farmers
Secondly, SEGES asked selected farmers in the area for further validation.

38 farmers were estimated to have fields with surface water. 8 farmers, covering 75 % of the total amount of areas with calculated surface water, were selected for the validation.

By E-mail and mail, each of the 8 farmers received images of their fields with the location of the calculated wet areas. In total 36 images of 74 fields were sent.

The 8 farmers were asked about the following:

- Did they recognize the wet areas in their fields?
- Is the extent of wet areas correctly estimated?
- How frequent is the area wet?

Figure 1: Location of buildings, waterholes and watersheds and calculated surface water areas.

Five farmers responded and gave information on 109 calculated wet areas. They confirmed 21 wet areas as correctly identified and disconfirmed 88. The reasons for the improperly identification of areas with surface water were wheel ruts, potato piles, roads, ditches, and variation in crop growth within the field (figure 2).

According to the farmers, the 21 confirmed areas are typically wet after heavy rainfalls, and the water is often several days to infiltrate. Usually the areas have problems with surface water the entire non-growing season (late September to April).

The extent of the 11 confirmed wet areas was, according to the farmers, correctly estimated. For the other 10 confirmed wet areas the extent was grossly underestimated, failing to identify up to 80 % of the actual extent.

Three of the five farmers informed that the satellites failed to identify wet areas in their fields (for examples see figure 3 and 4). Areas that – to the farmers knowledge – were wet in March 2019.

With 88 areas or 80 % wrongly calculated, it seems the satellite data tend to overestimate the number of areas with calculated water. When using radar-data, the satellite images are classified into water and non-water areas based on the differences in surface roughness of water and land. Objects that have smooth surfaces such as roads, wheel ruts, roof tops, solar panels, etc. may be wrongfully perceived as surface water. One way to overcome overestimation is to apply a threshold to the water detection algorithms. Based on the validation data, by setting the threshold at value 0.05 instead of 0.0 the accuracy of the map would increase from 16 % to 53 %. Based on the current validation analysis it is not possible to set a suitable threshold. It would need extensively further validation.

From this investigation it is clear, that a precise and operational method for surface water detection in fields is still in under development and is not yet ready for application.

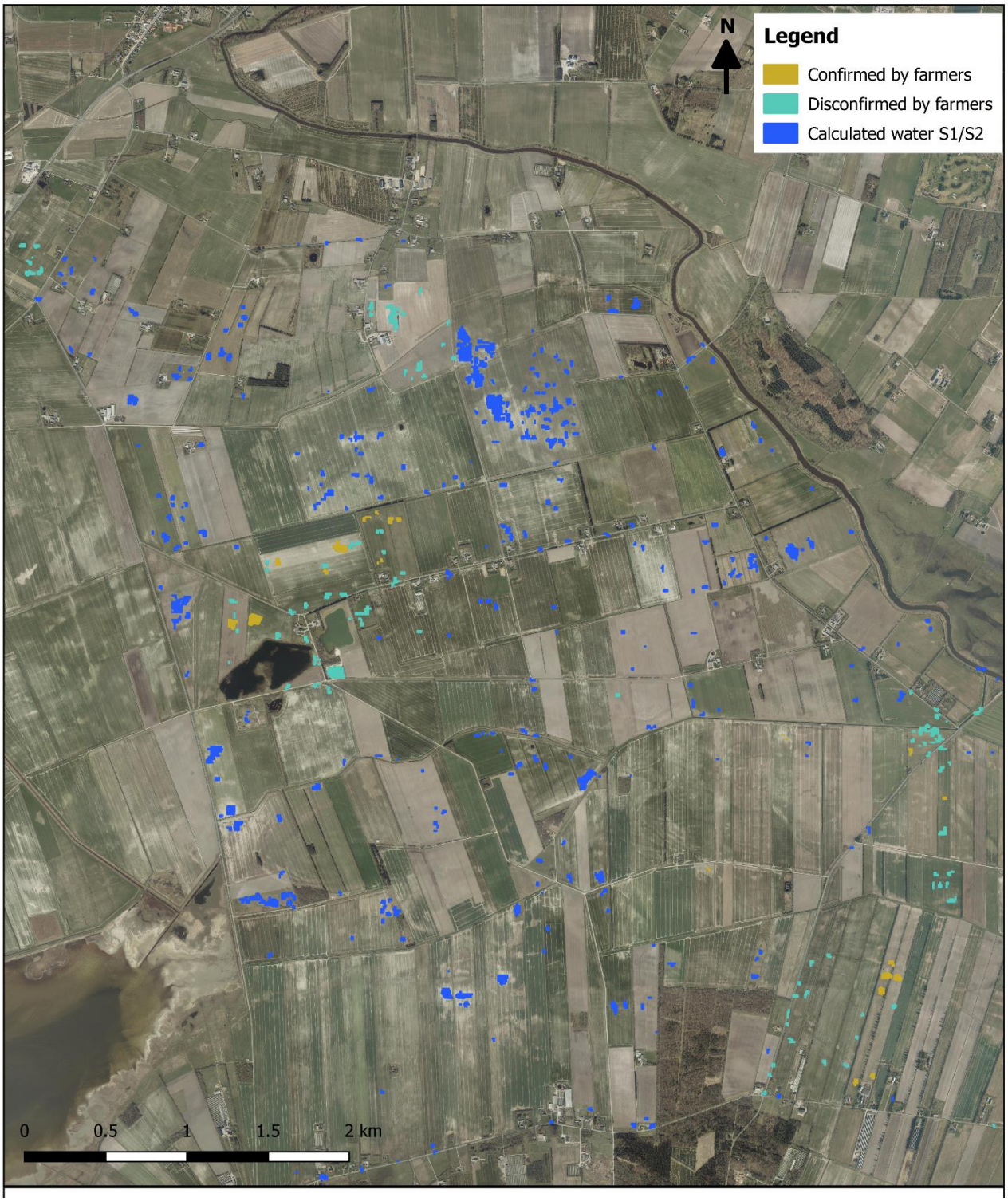

Figure 2: Responses from farmers. Buildings and known water bodies are removed from the data set. The blue areas have not been validated.

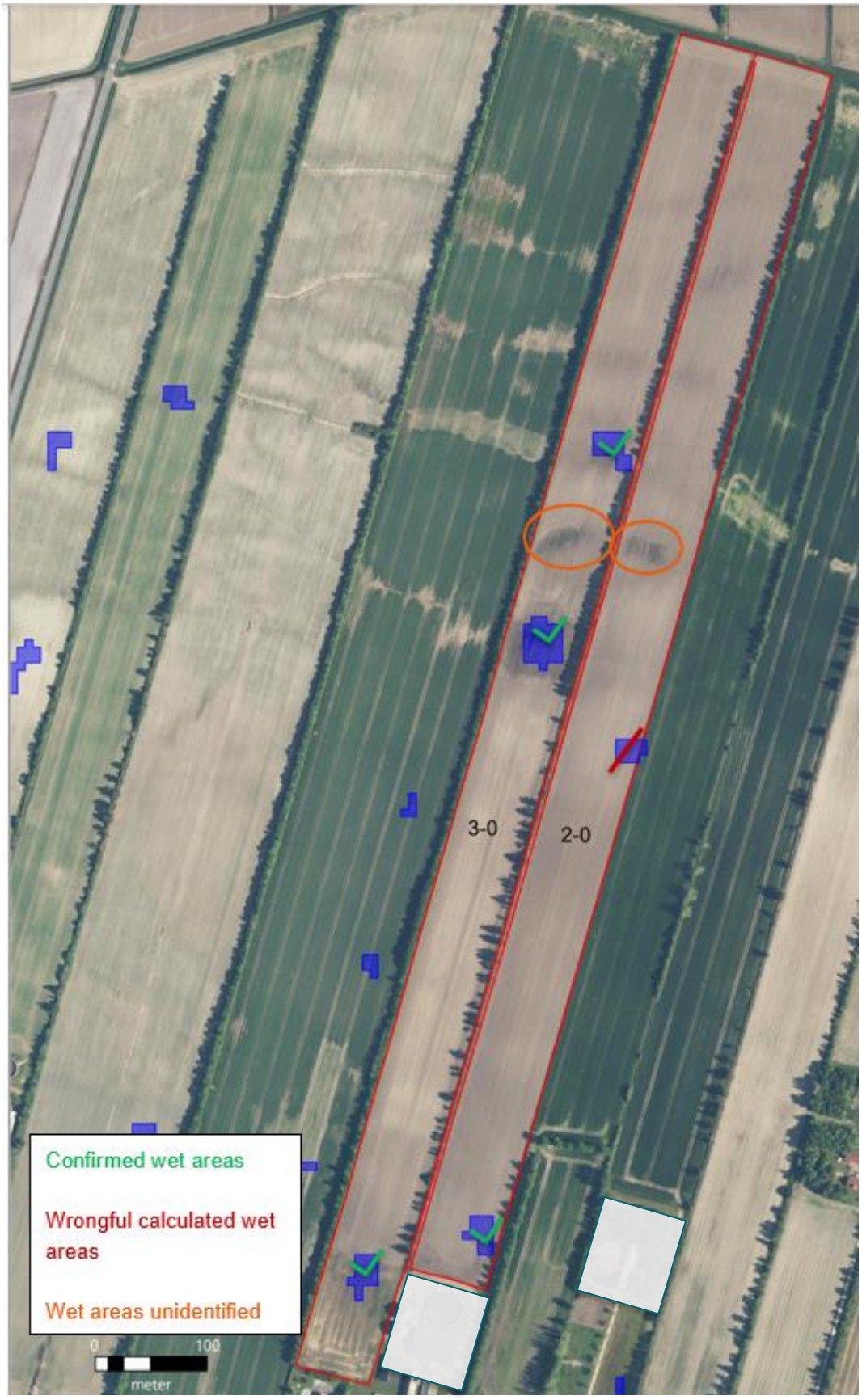

Figure 3: The orange circles mark the locations where the farmer has problems with surface water.

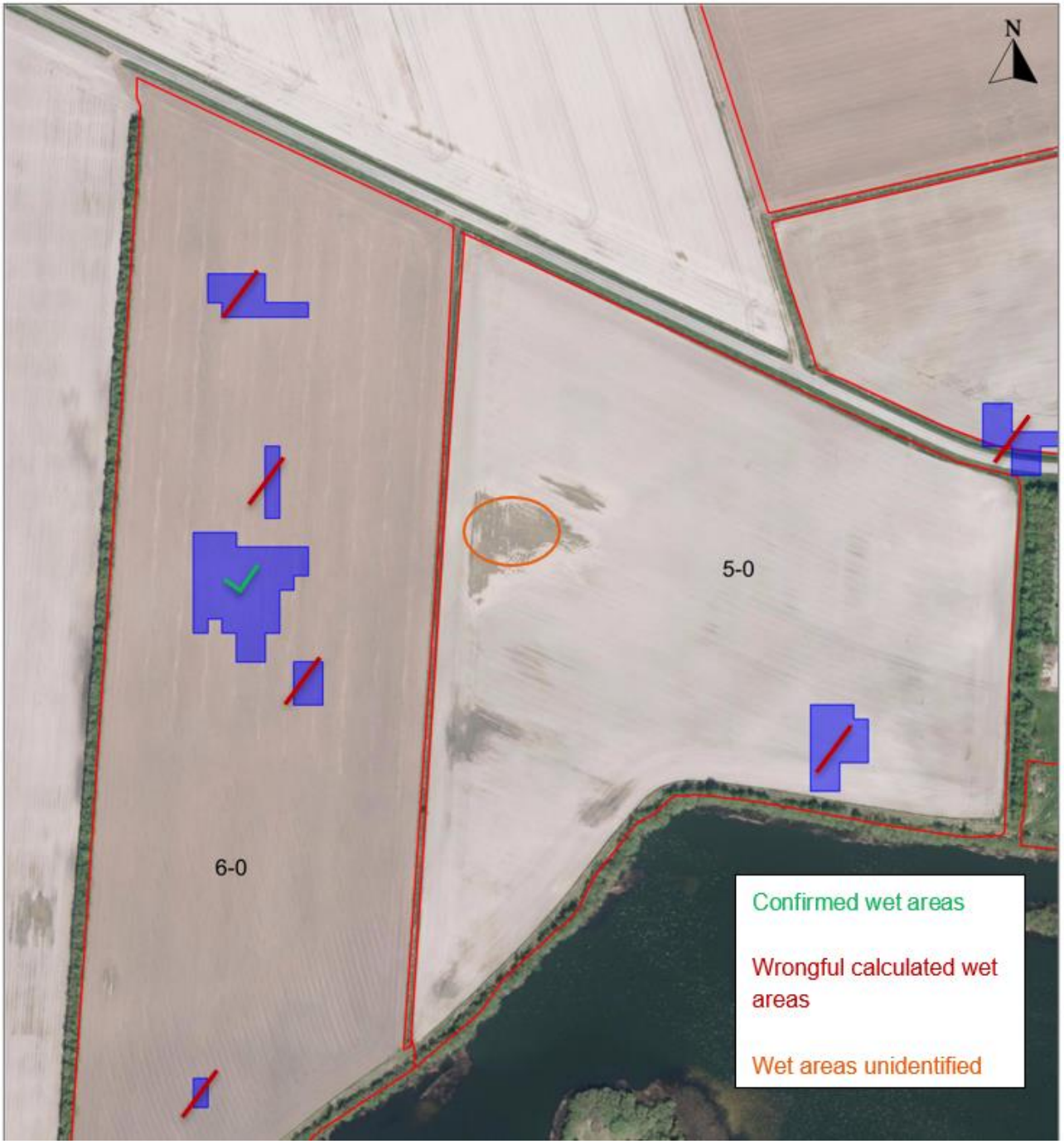

Figure 4: The orange circle marks the location where the farmer has problems with surface water.