Supplementary Materials: Classification and Monitoring of Reed Belts Using Dual-Polarimetric TerraSAR-X Time Series

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Heading 1. Illustration of the RF classifications of the single parameter layer on 22 November 2014.

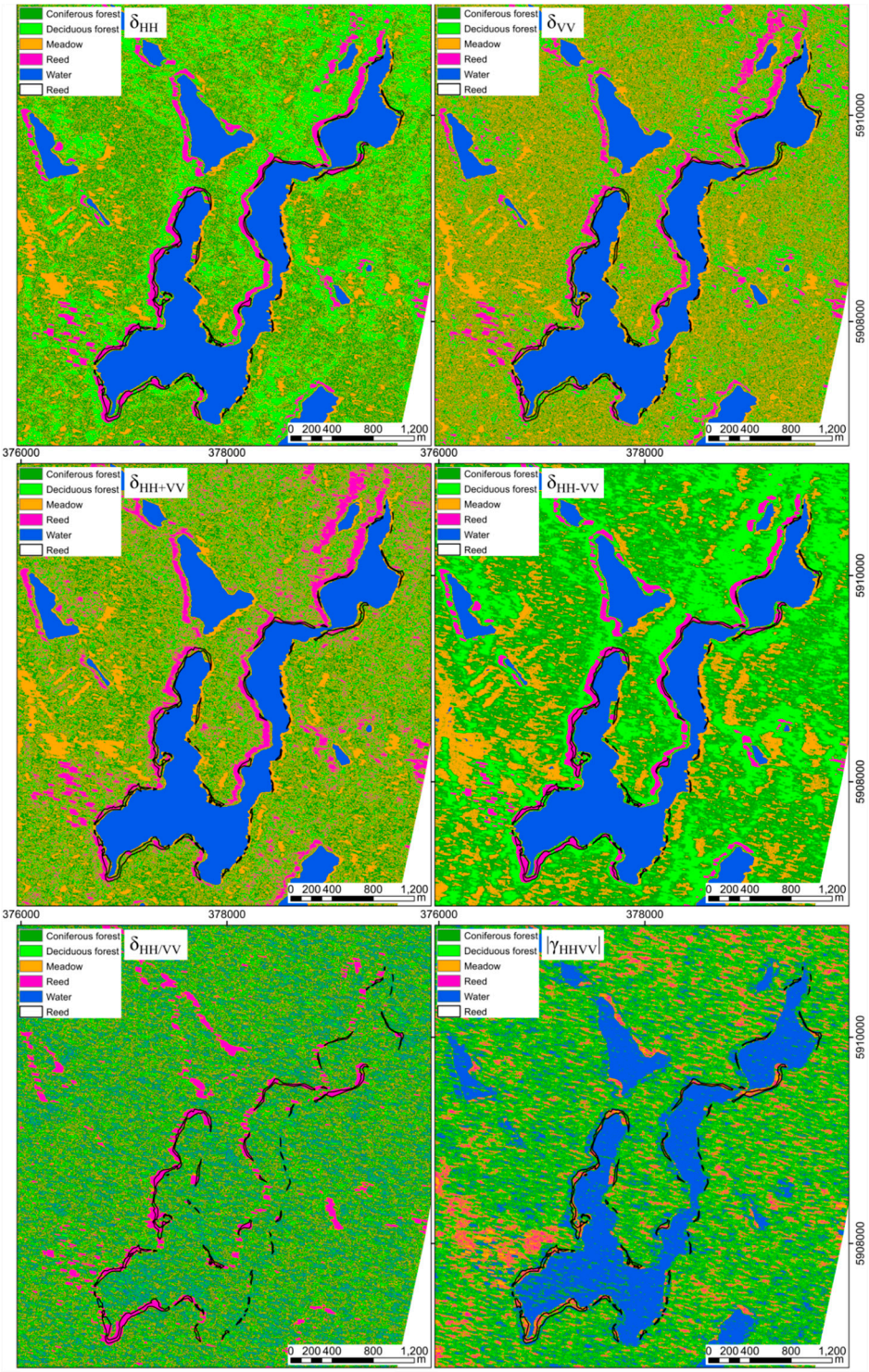

Figure S1. *Cont.*

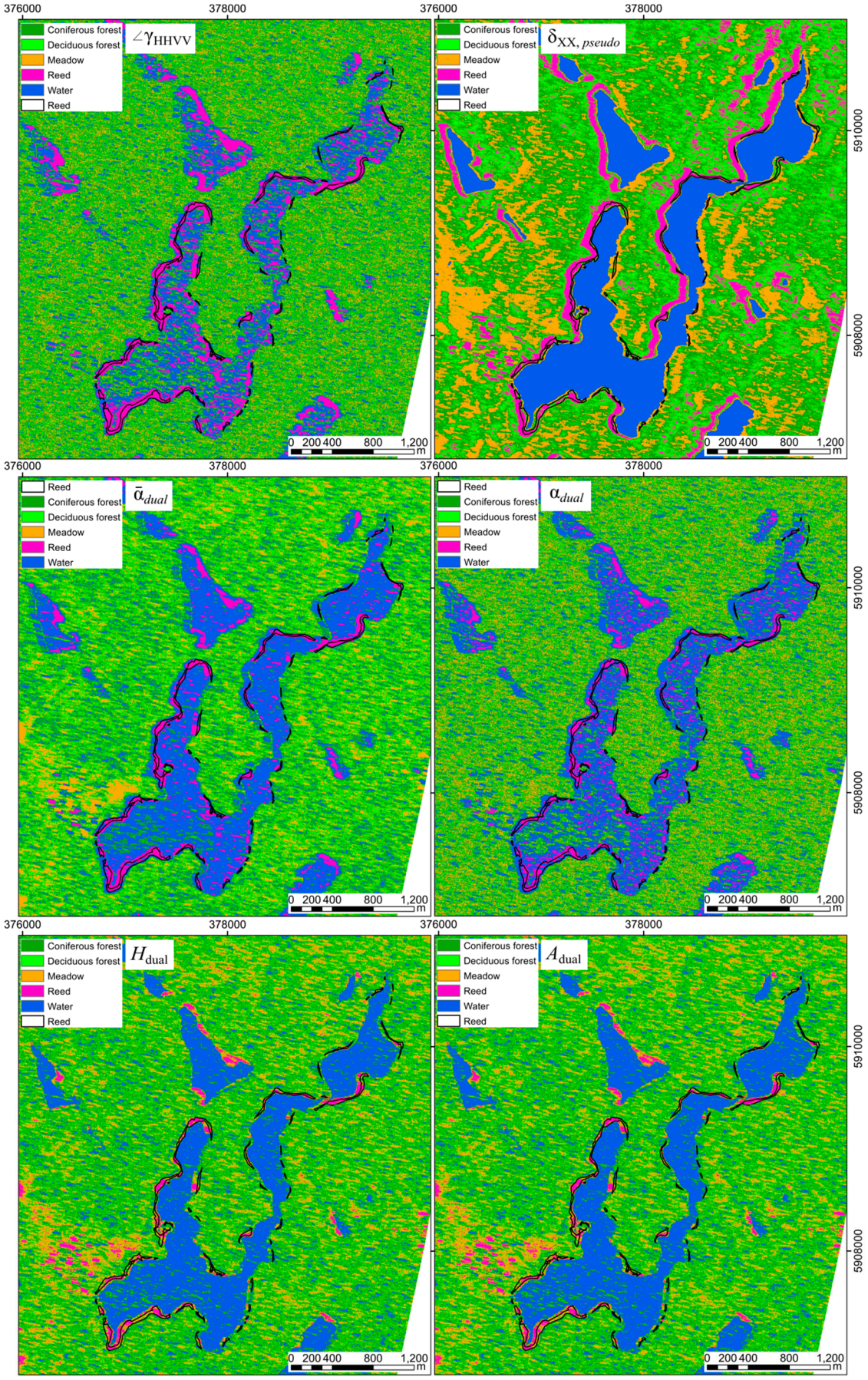

Figure S1. *Cont.*

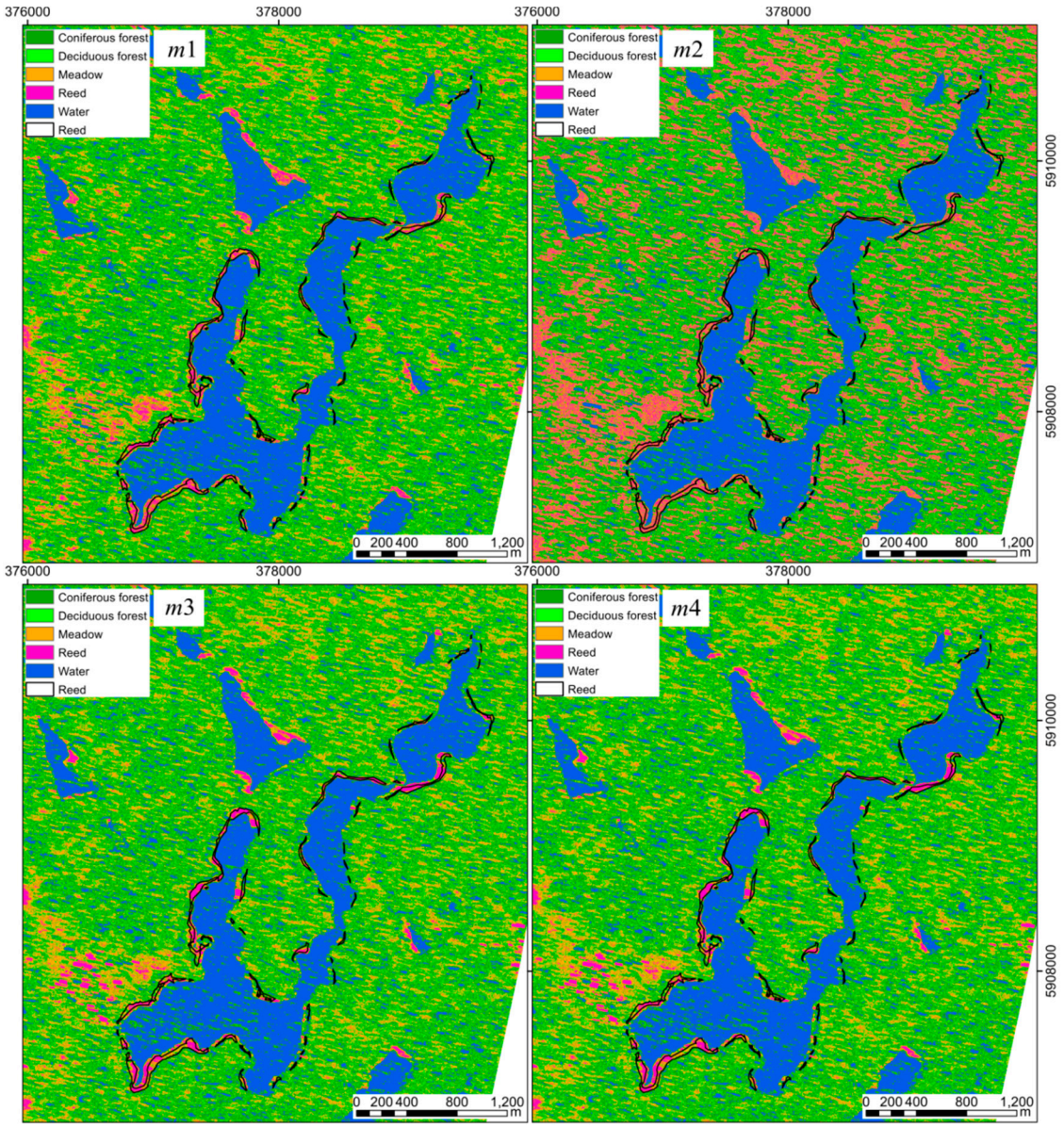

Figure S1. The 16 maps show the classification results of the RF classifier based on the single parameter layers on 22 November 2014. Black outline is the validation reed area.

Heading 2. Intersection of ascending and descending classification result.

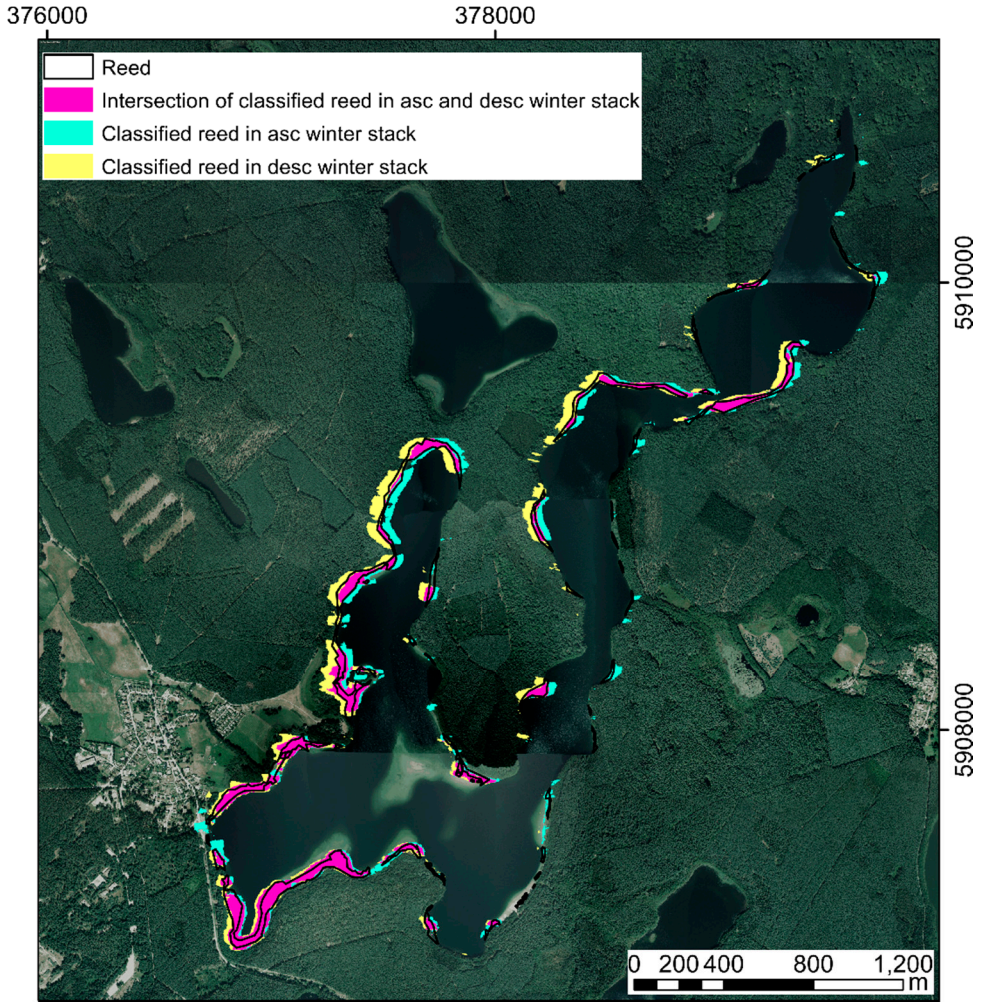

Figure S2. Comparison of the classification results of reed asc and desc winter image stacks (without-ice images). The light blue areas are only classified as reed in the asc stack, the yellow areas only in desc stack. The pink area is the intersection of the reed areas of the classified asc and desc image stacks. Overestimations of the reed area in comparison to the validation reed area (black polygons) appear generally in the look direction of the sensor (range direction).

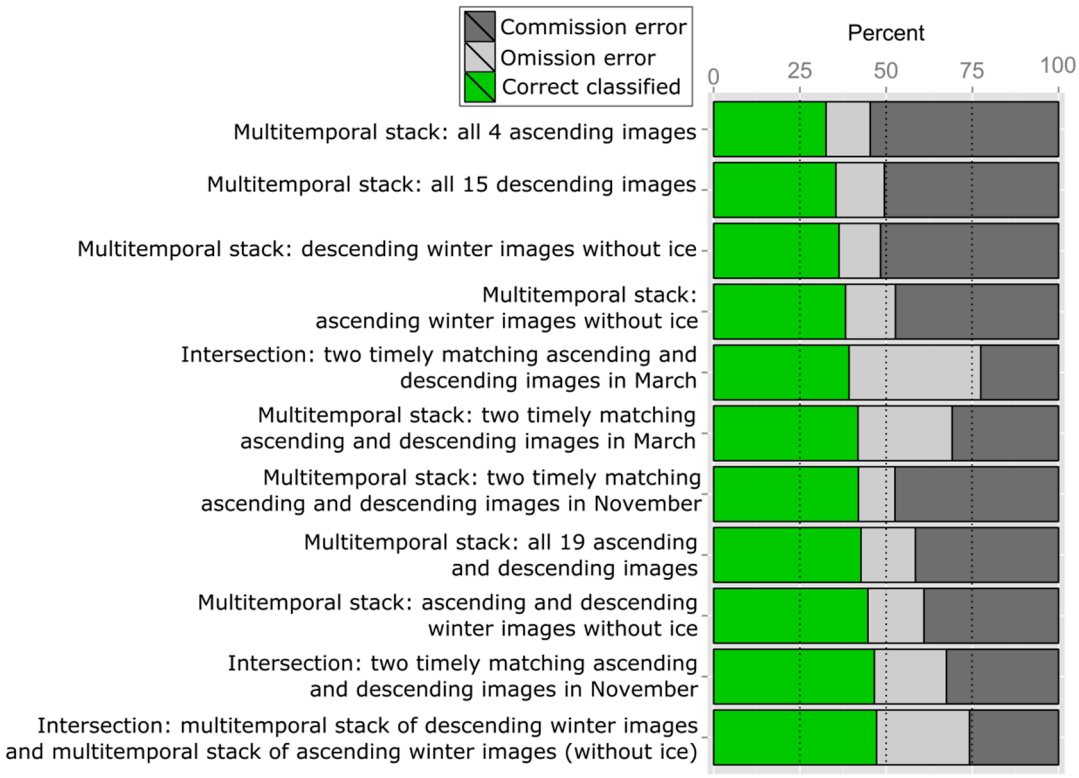

Figure S3. Classification accuracies (in percent) of multi-temporal stacks and intersections of asc and desc classification results. The multi-temporal classification results are based on stacks combining all parameters of different dates. For the intersections of asc and desc images, multi-temporal stacks were classified first and then the intersecting reed area of both looking directions was selected and evaluated. For the evaluation, the classification result was clipped to the area of Lake Fürstenseer + 50 m buffer. The correct classified proportion is illustrated in green, the commission error (false positive) in dark grey and the omission error (false negative) in light grey.

Heading 3. K-Means Clustering

To show the independence of the classification algorithm, we segmented the multi-temporal stack "asc and desc winter images excluding dates with ice coverage" with the five most important parameters in wintertime, according to RF classification (δ_{HH-VV}, $\overline{\alpha}_{dual}$, $\delta_{HH/VV}$, δ_{HH}, and $\angle\gamma_{HHVV}$), a second time using k-means clustering. Water and reed are reclassified afterwards. The stacks were masked with a rectangular polygon to exclude NA values before segmentation.

The k-means algorithm is an unsupervised segmentation method, in which the number of clusters (k) is defined beforehand. The number of clusters is set to five, in accordance with the number of classes in the RF classification. The k-means algorithm aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest cluster mean [1]. Voronoi cells are the result of the segmentation. The k-means clustering algorithm used in this study is based on the k-means algorithm by James MacQueen [1]. The algorithm is implemented in R in the biganalytics package ("bigkmeans") [2].

The result of the k-means segmentation validation has a similar accuracy as the classification using the RF classifier. Using k-means, 42% of the reed area is classified correctly. The omission error is 8% and the commission error amounts to 51%. The influence of the sensor look direction is clearly visible in class 2. The result of the k-means segmentation supports that the five selected parameters are the best choice in winter for reed mapping, independent of the used segmentation/classification method.

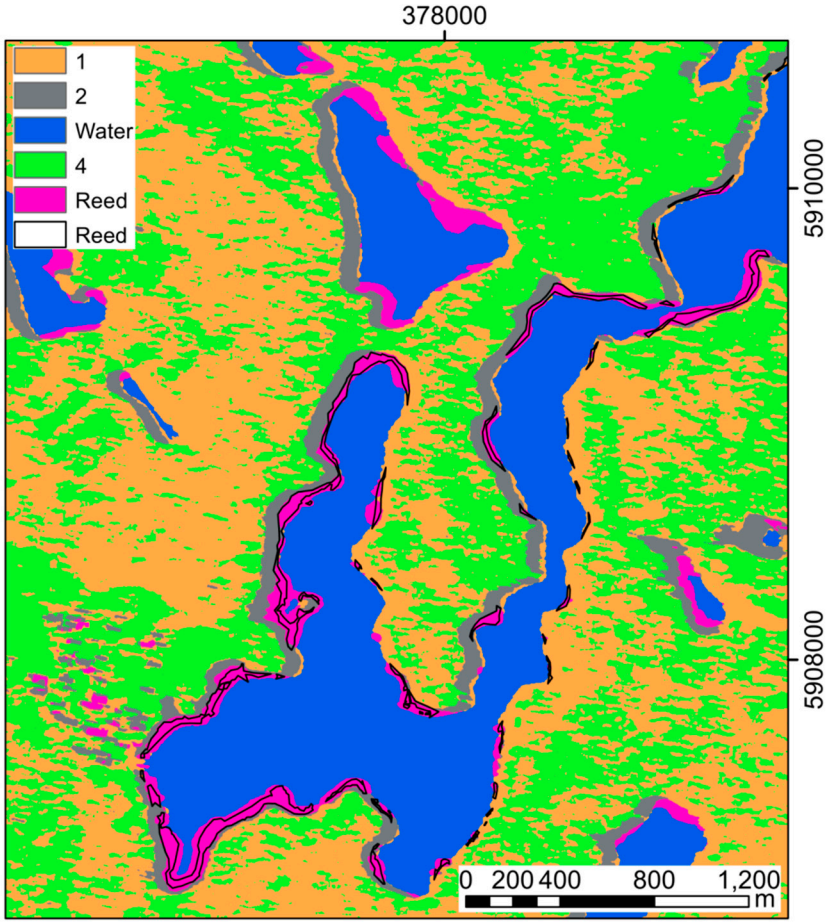

Figure S4. Reclassified result of the k-means clustering with a multi-temporal stack. The stack consist of the five most valuable parameters in winter (δ_{HH-VV}, $\overline{\alpha}_{dual}$, $\delta_{HH/VV}$, δ_{HH}, and $\angle\gamma_{HHVV}$) according to the RF-based ranking of variable importance. The base map is the DOP40 from 2013. Black outlines are the validation reed areas.

References

1. MacQueen, J.B. Some methods for classification and analysis of multivariate observations. In *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*; University of California Press: Berkeley, CA, USA, 1967; Volume 1, pp. 281–297.
2. Emerson, A.J.W.; Kane, M.J. *Package "Biganalytics"*; 2010.