AUTOMATED SYSTEM FOR ACCURATE SHELTERBELT INVENTORY AND REMOVAL DETECTION

AGGP-Agroforestry

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Two main objectives were addressed as follows: (1) evaluating the capability of Sentinel-2A Multispectral Instrument (MSI) and Sentinel-1B Synthetic Aperture Radar (SAR) imagery in delineating shelterbelt tree rows on managed agricultural land in Saskatchewan, and (2) detecting shelterbelt removal during the period 2008-2016. Because landowners are actively managing the shelterbelt agroforestry systems on their land bases, by planting new shelterbelts or removing existing shelterbelts, up-to-date inventories are a necessity. Therefore, new approaches are needed for national carbon inventories which utilize automated data processing of annually collected datasets for agricultural landscapes. Although SAR data offer the opportunity to map shelterbelts, the capability of using freely available, but coarser spatial resolution data, such as the Sentinel imagery (10 m), have not been evaluated for shelterbelt mapping.

AUTOMATED SHELTERBELT INVENTORY SYSTEM

The workflow of the new method consisted of five major steps (Fig. 1):
(1) data collection and pre-processing to standardize image data and create new image layers, (2) collecting the training and validation data, (3) image classification using threshold and Random Forest (RF) classifiers, (4) map evaluation using an accuracy assessment matrix table for three land-cover classes, Tree, No-tree, and Mixed; and (5) identification of shelterbelt removal along with an accuracy assessment matrix table using ground-truth data. The classification process was conducted in the eCognition Developer software (excluding road, developed areas, and water bodies).

Briefly, contrast split segmentation for the Normalized Difference Vegetation Index (NDVI) and Gaussian filter (line filter) datasets from SAR were used to delineate feature borders. Several feature variables from the spectral bands of MSI were used as inputs for an object-based classification using the Random Forest classifier. A resulting land cover map, including the linear features of existing shelterbelts, was created.

Finally, a shelterbelt change detection analysis using the land cover map (2016) and a legacy shelterbelt inventory map (2008) was used to detect removals across the Province (Fig. 1).

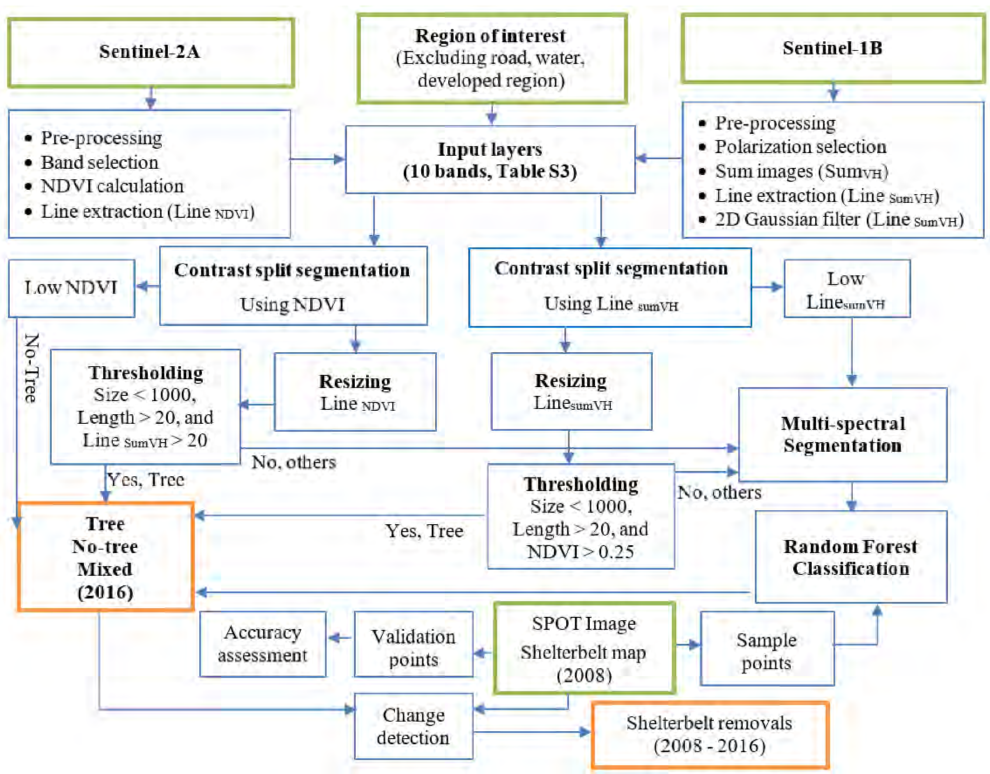

Figure 1. Workflow of mapping three major land cover classes (Tree, including shelterbelt; No-tree, and Mixed) using an object-based classification approach on Sentinel satellite imagery data.

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Method Evaluation and Summary

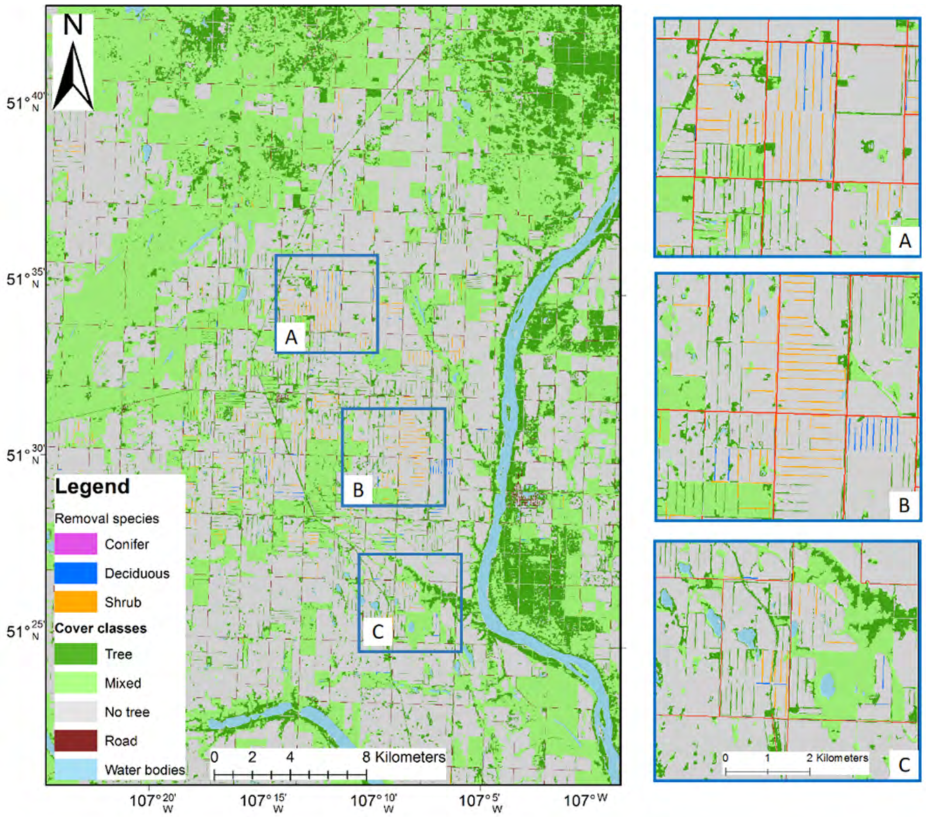

Figure 2. Output map of shelterbelt removals in a study area near Outlook, Saskatchewan classified by shelterbelt species and three subset examples (A–C).

- Training and validation data were collected using a stratified sampling method for the 2008 vector layer of shelterbelts (Tree class) and SPOT 5 imagery (No-tree, and Mixed classes). The training data (N=719) and the validation data (N=900) were acquired independently within the study area.
- The accuracy of the output map was assessed using visually evaluated reference data and the classified map.
- Accuracy assessment matrices were created to examine how the shelterbelt mapping was influenced by species group and width of the planting design (i.e., indicating number of tree rows).
- The overall map accuracy was 80%, which indicated the percent agreement between the classified map and the reference data (Fig. 2).
- The Kappa coefficient, which takes into account the possibility of the agreement occurring by chance, was 0.69.
- The map commission error was highest for the Mixed class (45%). The highest map omission error was for the Tree class (33%) (Fig. 2).
- This method was more suitable for field shelterbelts, characterized as elongated objects, compared to farm yard shelterbelts, which tend to be planted in predominantly L- or square shaped designs.
- The classification accuracy of the output map was highly affected by the coarser spatial resolution of the input Sentinel imagery (10 m pixel size), relative to the smaller width of narrow (1-row) shelterbelts.
- The presented inventory system is efficient and is transferable for mapping existing shelterbelts and detecting removals at larger spatial extents across the province of Saskatchewan, provided there is access to Sentinel imagery.

Further reading: Fact sheets SASK-33 through SASK-38

Contact for more information: SASKAGROFORESTRY.CA/

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