Mapping Forest Stand Age Using NOAA AVHRR and SPOT VEGETATION Imagery

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We developed a remote sensing algorithm for mapping forest stand age distribution that accounts for harvesting and the dated fires scars. Stand age of a pixel was determined by its SWVI, a vegetation index derived from SPOT VGT imagery, in comparison with the dated fires. A change indicator, that considered interannual changes in the NDVI from sequential AVHRR imagery, was employed to differentiate areas with lower SWVI values due to biophysical constraints. The stand age products were evaluated using Landsat TM imagery.

INTRODUCTION

An average of 2 million hectares have been burned and a total of 1 million hectares of forests are harvested every year in Canada. Fire have been documented and remain the dominant stand-replacing disturbance, and harvesting has increasingly become important in shaping the landscape pattern and affecting carbon budget. Evidence indicates that the northern hemisphere is acting as a sink negating the increase of the atmospheric CO_2, little is known about its spatial distribution. Such knowledge would be of great interest in estimating regional carbon budget. The objective here was to explore the feasibility of using remote sensing techniques to develop stand age distribution.

APPROACHES

There were several steps in the procedure (Fig. 1). The SWVI was calculated using the corrected SPOT VGT imagery.

SWVI = (NIR – SWIR) / (NIR + SWIR)

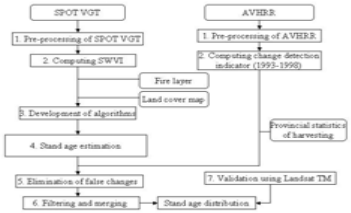

Fig. 1. Flowchart showing the procedure

The relationships between stand age And the SWVI, stratified by ecozone, Were derived from the dated fire scars utilized to determine ages of other pixels,. A change indicator (Fig. 2; Latifovic, 2002),that measured the matching between the seasonal profile of a cluster and the examined pixels, was calculated using the sequential AVHRR imagery (10-day composites from April 11 to October 31, 1993-1998). Provincial harvesting statistics were applied for determining its thresholding. Pixels with little change in the NDVI were concluded as non-forests due to biophysical constraints.

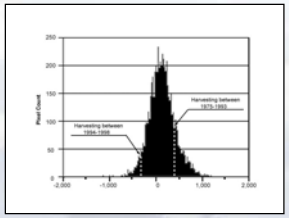

Fig. 2. Histogram of the change indicator

RESULTS

Fig. 3 shows the 1998 stand age distribution accounting for stand-replacing disturbances including fires and harvestings, a landscape composed of forest patches in various successional stage. However, the product is not complete, because the remote sensing algorithm could only retrospectively identify disturbed areas less than 40 years of age. In the procedure, only harvesting areas since 1975 were applied because of the saturation of the SWVI. Also, the fire database covers varying time periods for the provinces and territories.

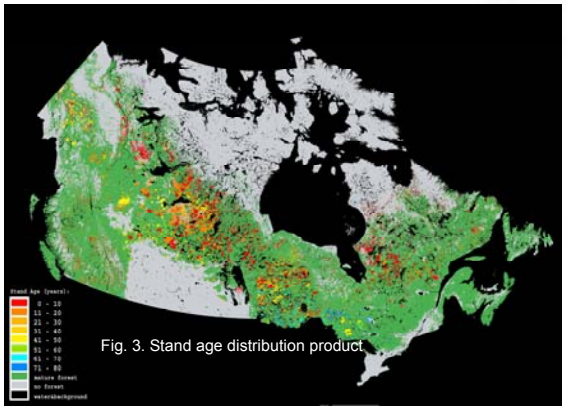

Fig. 3. Stand age distribution product

EVALUATION

The product (Fig. 3) was evaluated using Landsat TM scenes by comparing the difference among the dated fire scars, the detected regenerating forests (i.e., harvesting), and mature forests. Visual examination indicated that both the detected harvestings and the dated fire scars were visible on the Landsat TM imagery (Fig. 4, 5).

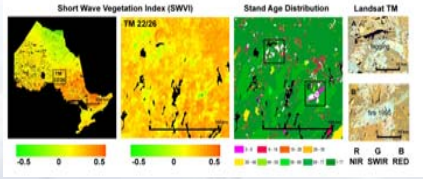

Fig. 4 SWVI, stand age distribution, and Landsat TM scene (22/26) of Ontario.

On average 50% of the detected regenerating forests were classified as disturbed areas, and more than 60% of the pixels were dominated by disturbed areas from the TM interpretation (Fig. 5). The paired-sample t test indicated that there were no significant differences between the detected regenerating forests and the dated fire scars (P>0.20). Histograms of the detected regenerating forests and the dated fire scars from the Landsat TM show similarity: a larger number of the pixels with a high percentage of disturbed areas compared to that of the mature forests.

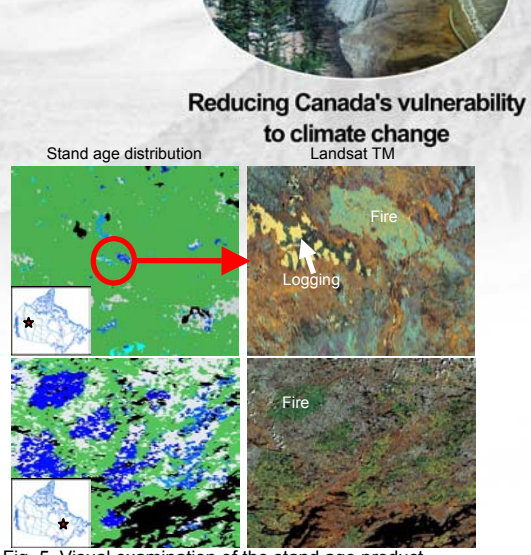

Fig. 5. Visual examination of the stand age product

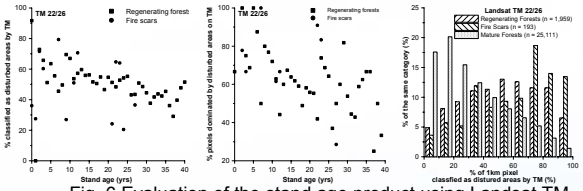

Fig. 6 Evaluation of the stand age product using Landsat TM

PERSPECTIVES

The remote sensing algorithm, i. e., relationships between the SWVI and stand age, can only retrospectively disturbed areas with less than 40 years of age. Thus, incorporation of the conventional forest inventory data is necessary to develop a complete stand age distribution product. The spatial heterogeneity of disturbances and biophysical conditions requires varying strategies for developing the stand age distribution product for different regions. For instance, mapping wildfires is sufficient to determine the forest stand age in the northern region where forests are unproductive. Additionally, fine resolution satellite imagery (e.g., Landsat TM) could be used to address fire intensity and help reduce the large variations of the predictive model (i.e., relationships between the SWVI and stand age).

REFERENCE

Fraser, R. H., & Li, Z. (2002). Estimating fire related parameters in boreal forest using SPOT VEGETATION. *Remote Sensing of Environment, 82,* 95-110.

Latifovic, R. (2002). Assessing cumulative environmental impact of large scale surface mining: Effects on temporal and spatial variability in land cover distribution and vegetation growth in Athabaska Oil Sand Region, Special subject GM62157, Faculte des sciences et de genie, University Laval. Quebec, Canada.