Canada

BIODIVERSITY MONITORING FROM SPACE

Forestry

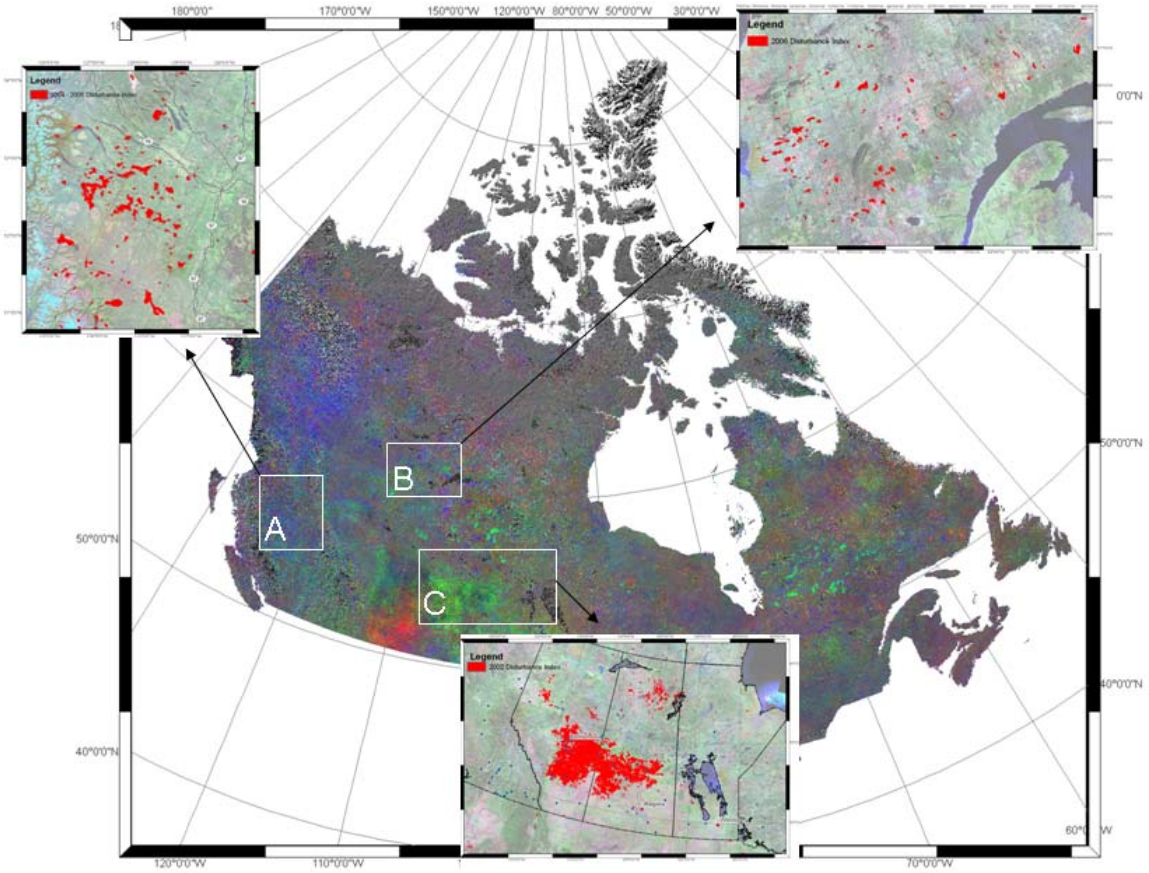
B I O S P A C E

Vegetation is inherently dynamic, changing constantly over a range of spatial and temporal scales. One way to monitor terrestrial disturbance is to detect significant changes in the vegetation cover and condition over annual periods to highlight variations which may be indicative of disruption of ecosystem structure and function. These changes can be both reductions in vegetation cover such as a wildfire or increases due to re-forestation or irrigation.

Using *remote sensing technology* we can monitor these changes. A reduction in vegetation cover typically results in a decrease in overall greenness, and an increase in land surface temperature, due to increased soil exposure. Conversely, positive disturbances result in increasing vegetation density, increase in landscape greenness and a general decrease in land surface temperature.

As part of the BIOSPACE project, we have implemented a DISTURBANCE INDEX to detect disturbance at a continental scale.

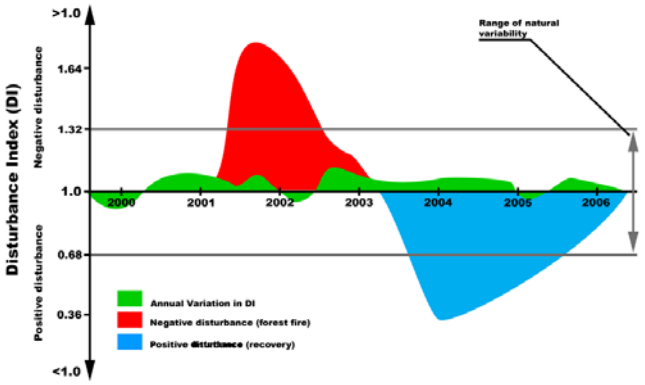
The index, is based on monitoring significant departures from the long term greenness and surface temperature of the landscape. The index is derived solely from satellite data which can be provided by MODIS, SPOT VEGETATION, or MERIS.



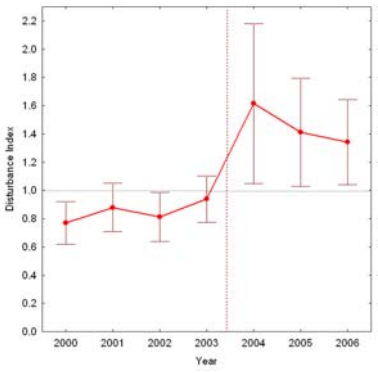
The disturbance index for 2000, 2003, and 2006. Areas of grey are indicative no change, bright red indicates major disturbance in 2000, Green indicates disturbance in 2003 and blue in 2006. Insert A shows pixels detected due to mountain pine beetle damage in Western Canada in 2004-05. Insert B shows the index detecting wildfire in the boreal forests, and Insert C the index response to drought in the agricultural production zone of the Prairies.

D E T E C T I N G D I S T U R B A N C E

The disturbance index is based on Mildrexler [*Mildrexler, D. J., M. S. Zhao, F. A. Heinsch, and S. W. Running. 2007. A new satellite-based methodology for continental-scale disturbance detection. Ecological Applications 17:235-250*] who proposed a continental disturbance index to serve as an automated, economical, systematic disturbance detection index using Land Surface Temperature (LST) and Enhanced Vegetation Index (EVI) data. Pixels are detected as containing a disturbed landscape if they depart significantly from the long term mean EVI/LST ratio.

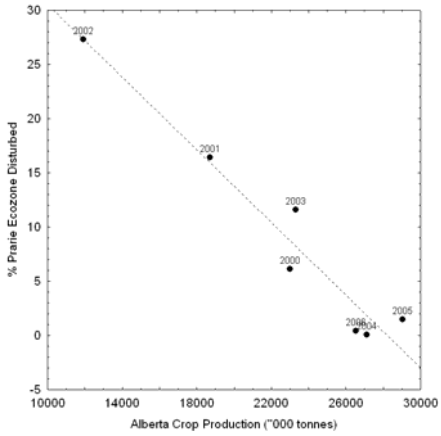


We applied and validated the disturbance index over Canada from 2000 – 2006 allowing seven years of disturbance to be detected and compared to a series of auxiliary datasets to verify both the temporal and spatial resolution robustness of the predictions.



Tracking recovery of disturbed areas is important for understanding the state and rate of recovery, and if recovery to the pre-disturbance range of natural variability is occurring. The mean and range of the DI for pixels burnt in 2003 is shown (left) and is relatively stable prior to the fire, within the natural variation of the landscape. After the fire in 2003 the index increases above the threshold. In addition, the variability of the index within the fire cells also increases. Post fire, the index remains above the threshold for 2005, gradually declining to values within the natural variability.

Changes in condition are also detected in agricultural zones principally due to drought. The index (right) shows the proportion of the Prairies flagged as disturbed, compared to the agricultural production of the region. This relationship confirms the link between production, and the deviation of pixels away from the long term mean, with large numbers of pixels associated with a reduction in production. This coarse spatial resolution (1-km) application of the index provides cost-effective coverage, and has a critical role to play as a 'first pass' filter to identify regions of major change. These areas would then be targeted for more detailed investigation using finer spatial resolution imagery or field surveys.



Systematic disturbance monitoring of large areas enables both the potentially most vulnerable biotic (vegetation) and abiotic (soil) components of the terrestrial ecosystem to disturbance to be monitored. The capture of these elements, both in terms of positive and negative changes, provides a powerful tool for national level monitoring in Canada.

This research has been described in detail in:

Coops, N.C., Wulder, M.A., Iwanicka, D. (2008) Large area monitoring with a satellite-based disturbance index sensitive to annual and seasonal variations. Ecological Applications (07-2015) (in review)

Coops, N.C, Duro, D.C., Wulder, M.A., Han, T (2007). Estimating Afternoon MODIS Land Surface Temperatures (LST) Based On Morning MODIS Overpass, Location, And Elevation Information. International Journal of Remote Sensing. 28: pp 2391-2396.

Image of TERRA provided by: www.spacetoday.org/Satellites/TerraAqua/TerraStory.html

BIOSPACE is a collaboration between the Canadian Forest Service (CFS) of Natural Resources Canada (NRCan), Canadian Space Agency (CSA) and the University of British Columbia (UBC) with a number of co-operators across-governmental and non-governmental agencies. Funding provided by the CSA GRIP Program 2006 – 2008. Project Manager: Dr Mike Wulder (CFS).

IRSS INTEGRATED REMOTE SENSING STUDIO

CSA ASC

CFS CANADIAN FOREST SERVICE
SCF SERVICE CANADIEN DES FORÊTS

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