An Overview of Twenty Years of Research on Fuel Moisture Estimation Using Remote Sensing over Boreal Forests at the University of New Brunswick, Canada

* Brigitte LEBLON[1], L. GALLANT[1], G. STRICKLAND[1], S. OLDFORD[1], K. ABBOTT[1], L. BOURGEAU-CHAVEZ[2], J. R. BUCKLEY[3], G. STAPLES[4], M.E. ALEXANDER[5], M. FLANNIGAN[6]

1. Faculty of Forestry and Environmental Management, University of New Brunswick, 28 Dineen, Fredericton (NB), E3B 5A3, Canada, bleblon@unb.ca

2. Michigan Tech Research Institute - Michigan Technological University, 3600 Green Ct., Ste. 100, Ann Arbor, MI 48105, USA

3. Royal Military College, 13 General Crerar Crescent, Kingston, ON, Canada, K7K 7B4

4. MacDonald, Dettwiler and Associates (MDA) Ltd. 13800 Commerce Parkway, Richmond, B.C., Canada, V6V 2J3

5. Northern Forestry Centre, Canadian Forest Service, 5320-122nd Street, Edmonton, AB, Canada, T6H 3S5

6. Department of Renewable Resources, University of Alberta, 751 General Services Building, Edmonton, AB, Canada T6G 2H1

* **Corresponding Author**

ABSTRACT

This paper presents an overview of 20 years of research at the Faculty of Forestry and Environmental Management, University of New Brunswick, Canada, on fuel moisture estimation using optical, thermal infrared and radar remote sensing in the boreal forests of Alberta, the Northwest Territories, and Alaska. In collaboration with Canadian Forest Service (CFS), the first studies tested the use of NOAA-AVHRR NDVI and surface temperature images over the boreal forests of the Northwest Territories and Alberta. Over the boreal forests in the Northwest Territories, we observed that mean surface temperature values increased as ignition dates approached and high fire weather index (FWI) areas corresponded to high surface temperature values (Oldford *et al.* 2003). A modelling approach showed that FWI was related to the ratio between actual and potential evapotranspirations estimated from NOAA-AVHRR images (Strickland et al. 2001). Over boreal forests in Alberta, significant relationships were established between the drought code (DC) and NOAA-AVHRR NDVI and surface temperature images, Satellite-based DC estimations were more reliable than weather station-based DC in the detection of fire starts (Oldford et al. 2006). More recently, SAR images from ERS-1 C-VV (Leblon et al. 2002) and RADSARSAT-1 C-HH (Abbott et al. 2007) were tested over forests in the Northwest Territories for the estimation of fuel moisture codes such as DC and FWI. Relationships with foliar moisture content (FMC) were also established. These studies also showed that biomass and canopy had an influence on the moisture code or FMC estimation. Finally, over a chronosequence of Alaskan boreal black spruce ecosystems (recent burns, regenerating forests dominated by shrubs, open canopied and moderately dense forest cover), RADARSAT-2 and ALOS-PALSAR polarimetric images were tested to assess DC variations (Bourgeau-Chavez et al. 2013a). Several polarimetric variables from a multi-date RADARSAT-2 C-band image sequence that were acquired across a range of soil moisture conditions were used to develop empirical algorithms to estimate volumetric soil moisture maps over the Alaskan boreal test area (Bourgeau-Chavez et al. 2013b). A mean error of 6.7 % between observed and estimated values was achieved through a regression model that used the C-VH backscatter intensity, the maximum of degree of polarization (d_{max}) and the maximum of the completely unpolarised component ($Unpol_{max}$) as independent variables. The model also showed improvement from 27% to 33% in the accuracy of the soil volumetric moisture content retrieval by comparison with a model that used only single polarized C-HH data. By providing information on surface roughness and/or biomass, d_{max} appeared to be helpful for extracting surface soil moisture from SAR data. So far, only empirical relationships have been established and a more deterministic approach still needs to be developed. The various studies were funded by NSERC. ERS-1/2 images were provided by the European Space Agency, RADARSAT-1 and-2 images were provided by the Canadian Space Agency. ALOS-PALSAR images were provided by the Japanese Space Agency.