Image Processing

Data

Data used for the remote sensing project was from USGS Landsat Program. Data was ordered from National Land Archive Production System. Two data sets were acquired; Landsat 1 MSS and Landsat 5 TM. All data was provided as a level-1G product internally radiometrically corrected and geo-oriented as a map north product and resample using a nearest neighborhood routine. Data was downloaded via FTP site in HDF format with an associated metadata.

Atmospheric Correction

Raw images were provided as calibrated Digital Numbers (DN) scaled at 8-bits TM and MSS was 6-bit range. Gain and offset values were available and can be applied to convert to absolute radiance. For MSS data radiance units are mW cm^{-2} μm^{-1} st^{-1} and TM is Wm^{-2} μm st^{-1} once the gain and offsets are applied. Images were converted from calibrated Digital Numbers (DN) to at-surface reflectance using a numerical atmospheric model program Modtran 4 version 2. Modtran 4 was develop by US Air Force Research Lab as a radiative transfer code program and has been enabled within Canada Centre of Remote Sensing ISDAS processing environment. The program converts DN to radiance to at-surface reflectance using input parameters to account for atmospheric attenuation. Response curves ISDAS processing for TM images were taken from Modtran parameter files and MSS were used from 6S model. At-surface reflectance was derived as a scaled integer to preserve decimal precision by a factor 0.01.

To minimize residual atmospheric effects a normalized process using pseudo invariant features was applied to Landsat TM images only. The process included the selection of features that were considered physical/radiometrically stable over the 16-year period. Nine targets were selected and a cross calibration was applied to adjust images to base reference using a regression analysis. The summer 2003 image was used as the base.

Geocorrection

An image-to-image registration was applied to all images to rectify the image to reference image. The reference image used was an orthorectified Landsat 7 image acquired August 27, 2000 provided by NRCan Geomatics Canada. Horizontal positional accuracy of the reference image was 23 m. The number of control points used to tie the images together ranged from 35 – 44. The control points were uniformly distributed across both the images. The goal was to achieve an

RMSE of 0.5 of pixel between images. Images were then rectified using 2nd order polynomial routine.

Registration could not address data offsets due to orbital path differences in satellite orientation, which resulted in slight differences in geographic overlap of Landsat TM data and a more significant difference associated with Landat MSS. All ROI were within a common overlap area.

Masks

Geographic areas in the image were to be removed from the analysis by applying a mask. This included areas which were void of data as a result of the geocorrection process orientating the image in a north – south direction and water bodies. Water bodies were masked based on spectral signatures.

Land Cover Classes

The land classification used for the 40 and 19 classes are listed below.

40 Classes Unsupervised Classification

Class #	Description
1	Water
2	Shoreline Communities
3	Wetlands - Fen / Marsh
4	Wetlands - Fen / Marsh
5	Wetlands - Fen / Marsh / Open Water
6	Wetlands - Fen / Marsh
7	Wetlands - Fen / Marsh
8	Wetlands - Fen / Marsh
9	Dense White Birch Transition Forest
10	Wetlands - Shrub Thickets
11	Lowland Deciduous
12	Mixed Forest - Conifer
13	Mixed Forest - Sparse Deciduous
14	Wetlands - Fen / Marsh
15	Mixed Forest - Lowland
16	Mixed Forest - Conifer
17	Mixed Forest - Dense
18	Mixed Forest - Sparse Conifer
19	Mixed Forest - Conifer
20	Mixed Forest - Large Crown Deciduous
21	Mixed Forest - Deciduous
22	Mixed Forest - Dense
23	Dense White Birch Transition
24	Barren / Bedrock
25	Mixed Forest - Sparse Deciduous
26	Barren / Bedrock
27	Mixed Forest - Deciduous
28	Sparse White Birch / Bedrock Outcrop
29	Dense White Birch Transition Forest
30	Wetlands - Fen / Marsh
31	Mixed Forest - Deciduous
32	Mixed Forest - Deciduous
33	Dense White Birch Transition
34	Wetlands - Fen / Marsh
35	Field / Grass Surfaces
36	Aggregate / Sand / Mine Waste
37	Industrial / Non-Productive Surfaces
38	Industrial / Non-Productive Surfaces
39	Industrial / Non-Productive Surfaces
40	Field / Grass Surfaces

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