Mapping indicators to monitor the state of forests with remote sensing in Abitibi-Témiscamingue and Nord-du-Québec regions

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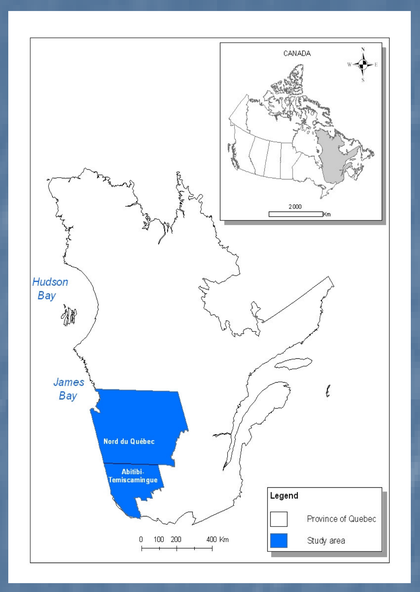
Context

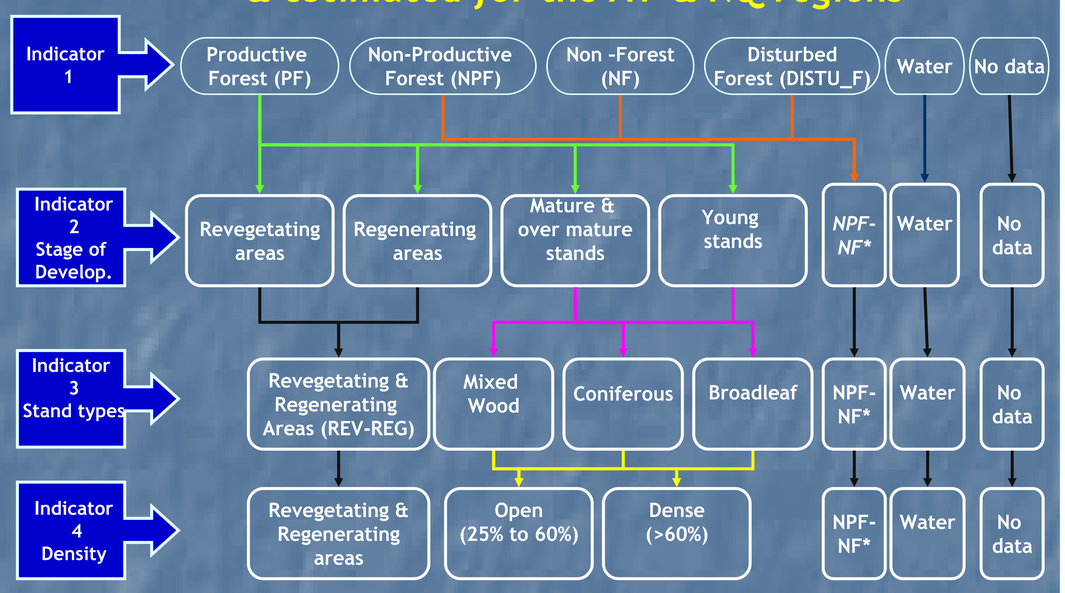
- One of the most important gaps raised by the Coulombe Commission's report* is the absence of an updated portray of the forest in Quebec
- Ministère des ressources naturelles et de la faune du Québec provides updated forest inventories only every 10 years.
- In this context, this research project uses remotely sensed data to portray the general state of forests in Abitibi-Témiscamingue (AT) and Nord du Quebec (NQ) regions as well as how they are changing over time, through the use of 4 forest state indicators.

Objectives

- To develop geomatic operational tools to monitor the state of the forest in AT and NQ using four indicators extracted from Landsat satellite imagery.
- To quantify the multi-temporal evolution of these indicators on a 5 to 10 year cycle for a period of 20 years (1985 to 2005).
- To produce final report on the sate of forest in AT-NQ and establish mechanisms for the follow-up.



4 remotely sensed key indicators were established & estimated for the AT & NQ regions



* Non productive Forest or non Forest

METHODS

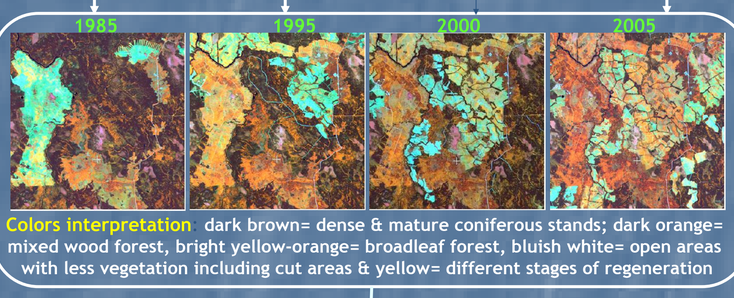
Image processing

- 9 Landsat TM and ETM images were used for each period (1985, 1995, 2000 & 2005). These images represent the best imagery in the archives for the months of July and August.
- Each single scene was radiometrically & atmospherically corrected, then spatially orthorectified to a UTM NAD 83 projection using an image-to-image registration, a 30 m DEM and a minimum of a 20 ground control points with a resulting RMSE of less than 0.5 pixel.
- The images from each period were then normalized and mosaicked together.
- The three spectral bands 4, 5 & 3 of the resulting 4 mosaics (85, 95, 00 & 05) were enhanced the same way in order to emphasize discrimination of forest classes.

Classification procedure

We used The Enhancement-Classification Method (ECM) (Beaubien et al. 1999) for each of our 4 mosaics. ECM consists of 4 steps:

1- Digital contrast enhancement of the image bands4,5,3 (displayed in RGB respectively) to maximize visual discrimination among classes



Colors interpretation: dark brown= dense & mature coniferous stands; dark orange= mixed wood forest, bright yellow-orange= broadleaf forest, bluish white= open areas with less vegetation including cut areas & yellow= different stages of regeneration

2- Unsupervised classification of the enhanced mosaics through a minimum distance function (150 classes were specified)

3- Re-classification of the enhanced image on the basis of selected signatures (~ 90 to100 classes)

4- Agglomeration of the resulting spectral clusters into thematic 48 classes → Agglomeration of the 48 resulting thematic classes to 4 indicators

Validation & accuracy assessment

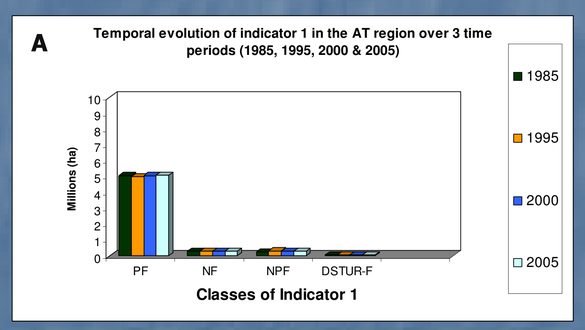
- A validation protocol was implemented in order to determine the number and spatial location of aerial digital photo samples to be used for accuracy assessment;
- More than 40000 geo-referenced aerial digital photos were acquired in September 2005 by *GEO-3D* (www.geo-3d.com) for the purpose of the validation process. Example of theses photos:
- Contingency tables (confusion matrix) between classified images and the reference photo data were built up for each municipal administrative unit (MRC) in our study area;
- Accuracy metrics (overall accuracy; omission & commission errors) were calculated for each period and each MRC.

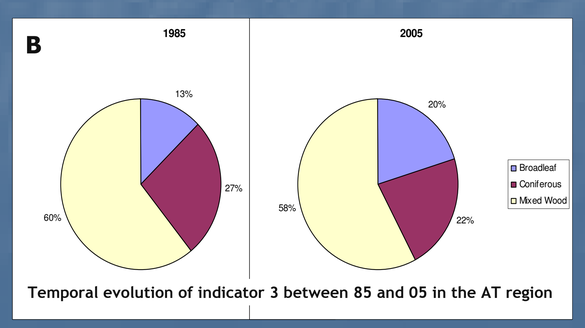
RESULTS

Analysis of the preliminary results

- Thematic indicator maps of the AT and NQ regions as well as for each MRC (i.e. Fig. c) have been realized. However at this stage we present only results summarizing the evolution of 2 indicators (1 & 3).
- By comparing the productive territory forest of 2005 with that of 1985, the results of this study, based on our definition of productive forest, show that what is lost in term of forest surfaces is being compensated by the regeneration of equivalent surfaces (diagrams A).
- Graphic B, reveal that during the period ranging between 1985 and 2005, the whole area knew loss of a coniferous and mixed cover of about 5% and 2% respectively compared to 1985.

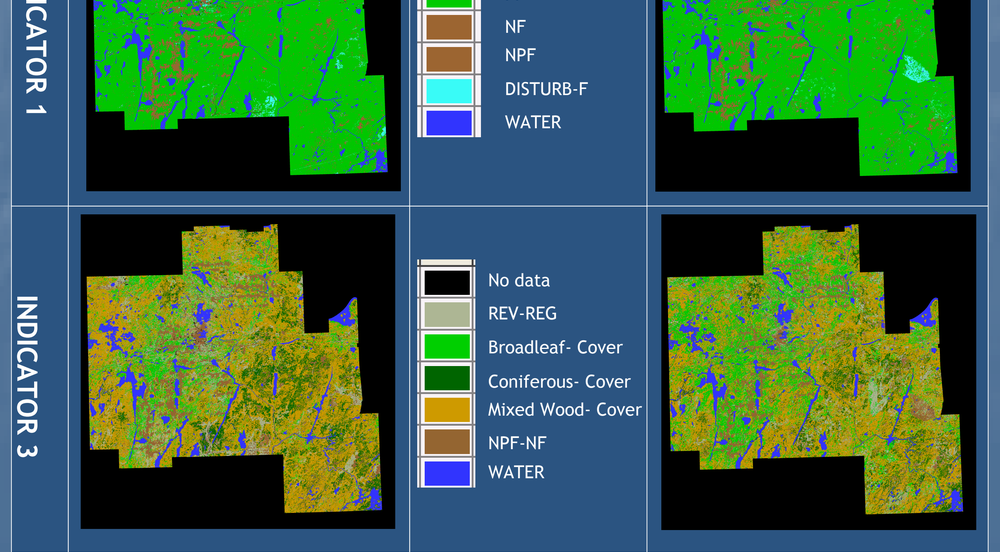
Conclusion : Overall, our preliminary results showed that Landsat imagery used in this study is a powerful tool to monitor the state of boreal forest at the lanscape level, through 4 indicators for which accuracy assessment was calculated for the whole region and is being analysed.





Temporal evolution of indicator 3 between 85 and 05 in the AT region

Figure C. Thematic indicator maps of the MRC of Rouyn-Noranda



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