Projecting impacts of climate change on reclaimed forest in the mineable oil sands

Shifting reclamation targets?

Hedvig Nenzén, David Price, Brad Pinno, Elizabeth Campbell, Dominic Cyr, Yan Boulanger, Anthony Taylor
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Area currently and potentially disturbed

Canada: 3rd largest oil reserves worldwide
Oil Sands surface mining

Tailings = by-product with high concentrations of sodium, sulfate, chloride, and hydrocarbons (naphthenic acids, benzene)

Luna and Naeth 2014
Aerial view of CNRL Oil Sand mine
Vegetation: initial and planned after mining

Reclamation – areas of ‘equivalent capability’ remain almost constant
Project objectives

- Operators are legally required to reclaim to ‘equivalent capability’
- With climate change, are pre-disturbance ecosystems feasible?
- Identify a baseline with future vegetation in CNRL in absence of mining

Audet et al. 2015,
Rooney et al. 2015
Project objectives

• Operators are legally required to reclaim to ‘equivalent capability’
• With climate change, are pre-disturbance ecosystems feasible?
• Identify a baseline with future vegetation in CNRL in absence of mining
• Oil Sands landscape impact?
• Identify possible climate-suitable reclamation

Audet et al. 2015, Rooney et al. 2015
Method: Link two vegetation models

1. **Picus**: assess how climate and soil conditions affect tree growth and establishment probabilities

2. **Landis-II**: multi-species succession, dispersal in the entire landscape with natural disturbances

Lexer and Hönninger 2001, Scheller and Mladenoff 2004
Oil Sands future climate:

- Temperature
- Precipitation
- Climate Moisture Index (CMI, Hogg 1997) = precipitation – potential evapotranspiration

- 3 General Circulation Models (GCM)
- 3 Representative Concentration Pathways (RCPs)
Disturbances: Drought

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- Adjusted slope by: = drought tolerance (other species) / drought tolerance (aspen)

Disturbances: Fire and Harvesting

• Fire probabilities
  – Canadian Homogeneous Fires Regimes
  – Annual area burnt increases from 0.2% to 1.6% under severe climate change

• Harvesting
  – Within Alpac (Alberta-Pacific Forest Industries) FMA
  – 2 % / 10 years
Landis-II vegetation model

- Species
- Initial distribution
  - Alberta Vegetation Inventory with most common species
- % sand and clay -> Water holding capacity and pH in each soil
- 20 m resolution
  - 20 x 18 km, 1.8 million grid cells
- Simulate 2000-2300
  - Combinations of disturbances and climate change

AOSERP 1979, Digitized by CFS
Results – final average biomass declines under severe climate change scenarios

GCMs produce generally similar projections
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GCMs produce generally similar projections

Disturbances produce similar projections
Results: deciduous forest dominates under severe climate change
Comparison to National Forest Inventory data in Oil Sands

Low-biomass stands not predicted – because no wetlands in model

High-biomass aspen stands not predicted – because too long fire-return interval?
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Conclusions

- Conifers replaced by deciduous, disturbance-adapted species under climate change
  - Grasses and wetlands?
- Decline of boreal forest also projected by other models
  - Detailed soils maps, Multiple GCMs, Drought
- Baseline simulation results can inform reclamation plans
  - Plant drought-tolerant species

Next steps: Include Mining and Reclamation

- Model vegetation growth on disturbed and reclaimed areas
- Identify possible climate-suitable reclamation
Oil sands reclamation practices

AEW, 2002

Brad Pinno, at CNRL

AEW, 2002

Suncor, tailings pond
Oil sands reclamation – future land forms
Oil sands reclamation – modelling soil substrates

Reclamation substrates are different from natural soils
- Overburden: Mixed, no root regeneration, different nutrients
- Tailings: fewer data

Use model and experimental data
- Physiological & biogeochemical vegetation model
- Past reclamation on tailings

NST = Non-Segregated Tailings
CNRL EIA 2002
Next steps: extend to whole Oil Sands region:

- Landscape-scale projections of vegetation
  - Disturbance and reclamation
  - In-situ mining
  - Combined with climate change impacts

Thank you!
References


