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Adaptive Watershed Management of the Southern Athabasca Oil Sands (in-situ) area of Alberta

Presented by: *Margaret Scott, M.A.Sc., E.I.T.*

Co-presenters: *Jos Beckers, Ph.D, P. Geo. (BC), P. Geoph. (AB)*

Jon Fennell, Ph.D, P. Geo. (BC), P. Geol. (AB)

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Overview

- The Journey
- Management Approach
- Modelling Tool Development
- Next Steps

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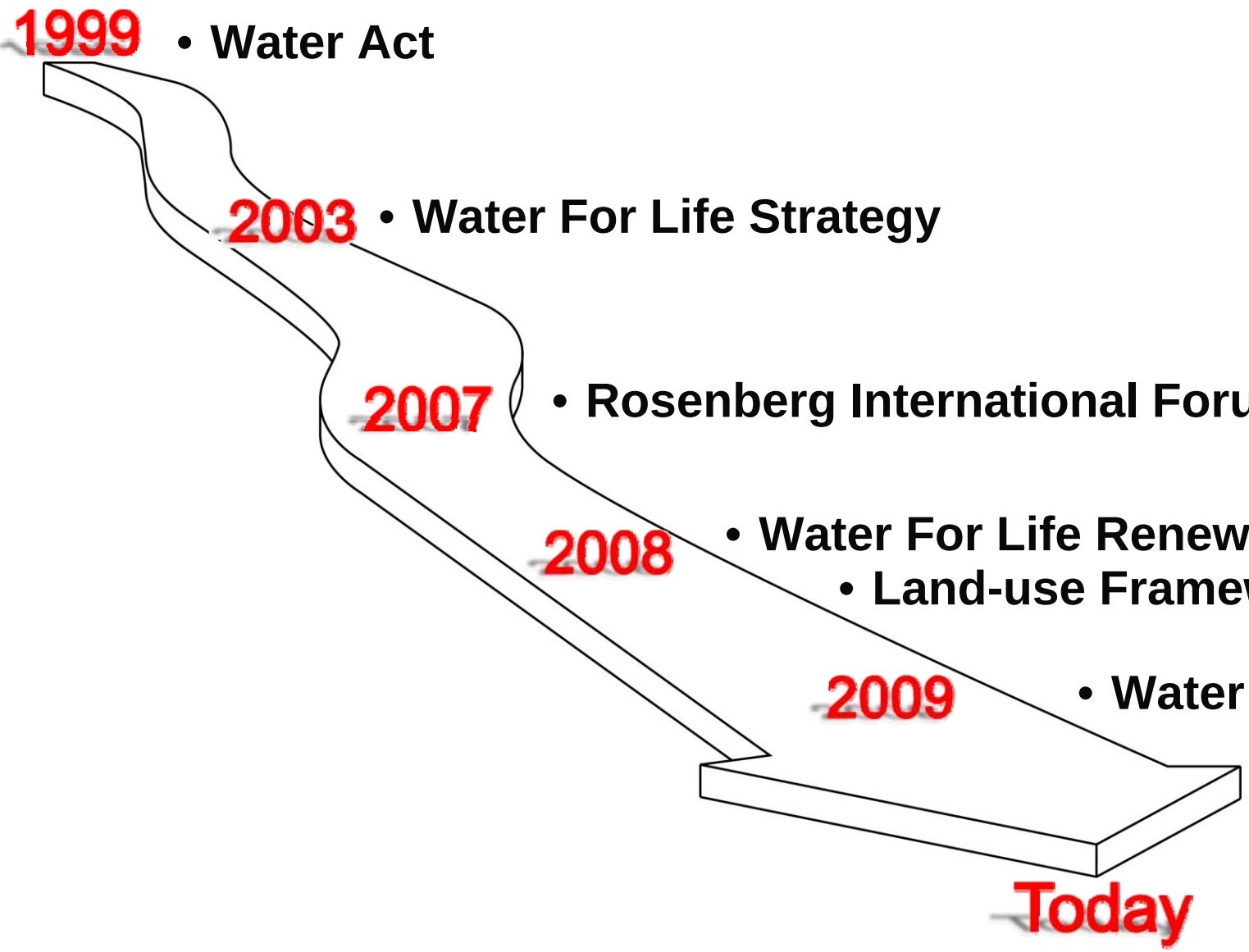
The Journey



Addressing key actions within the context of the Land-use Framework

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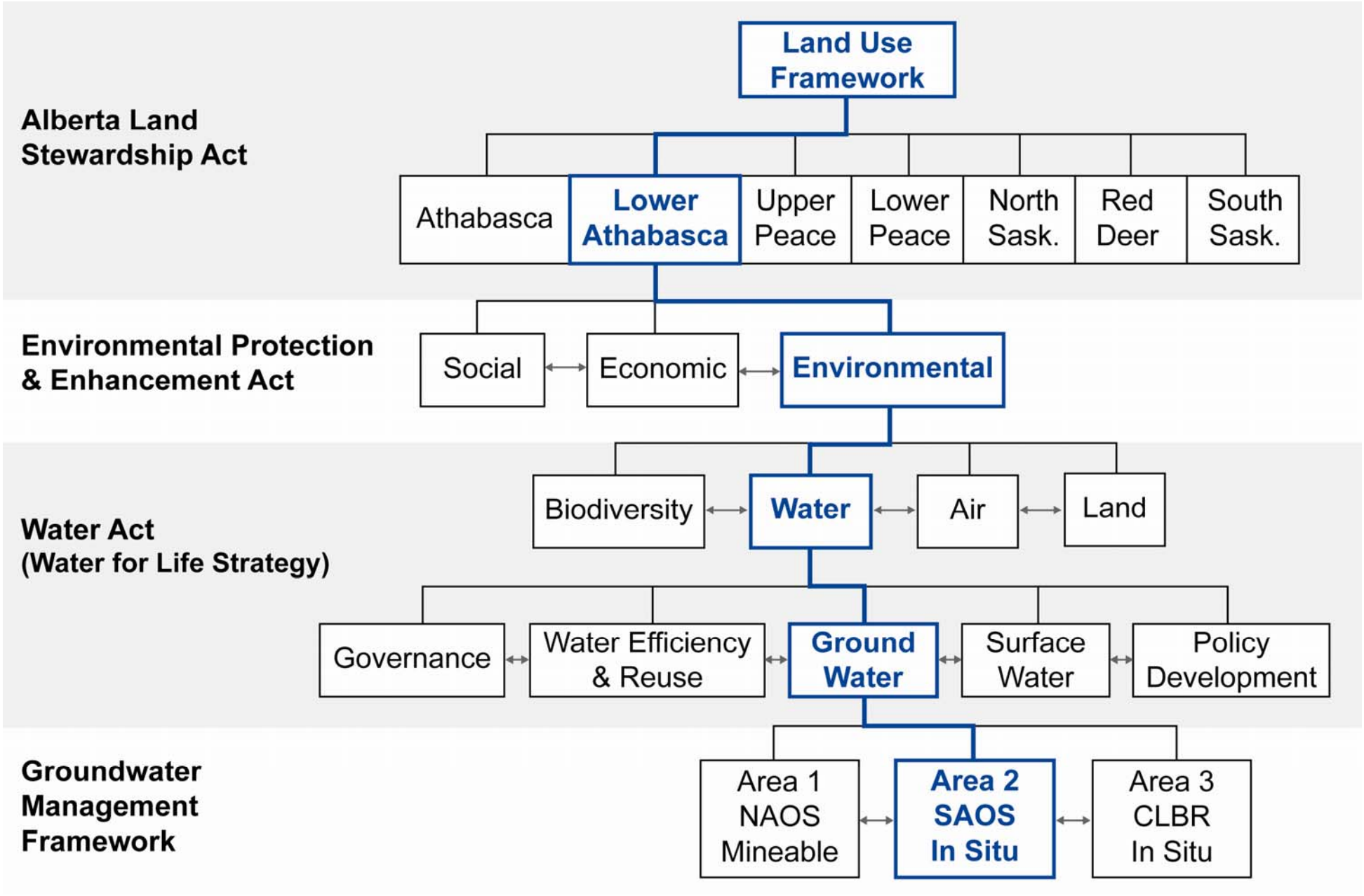
Governing Process



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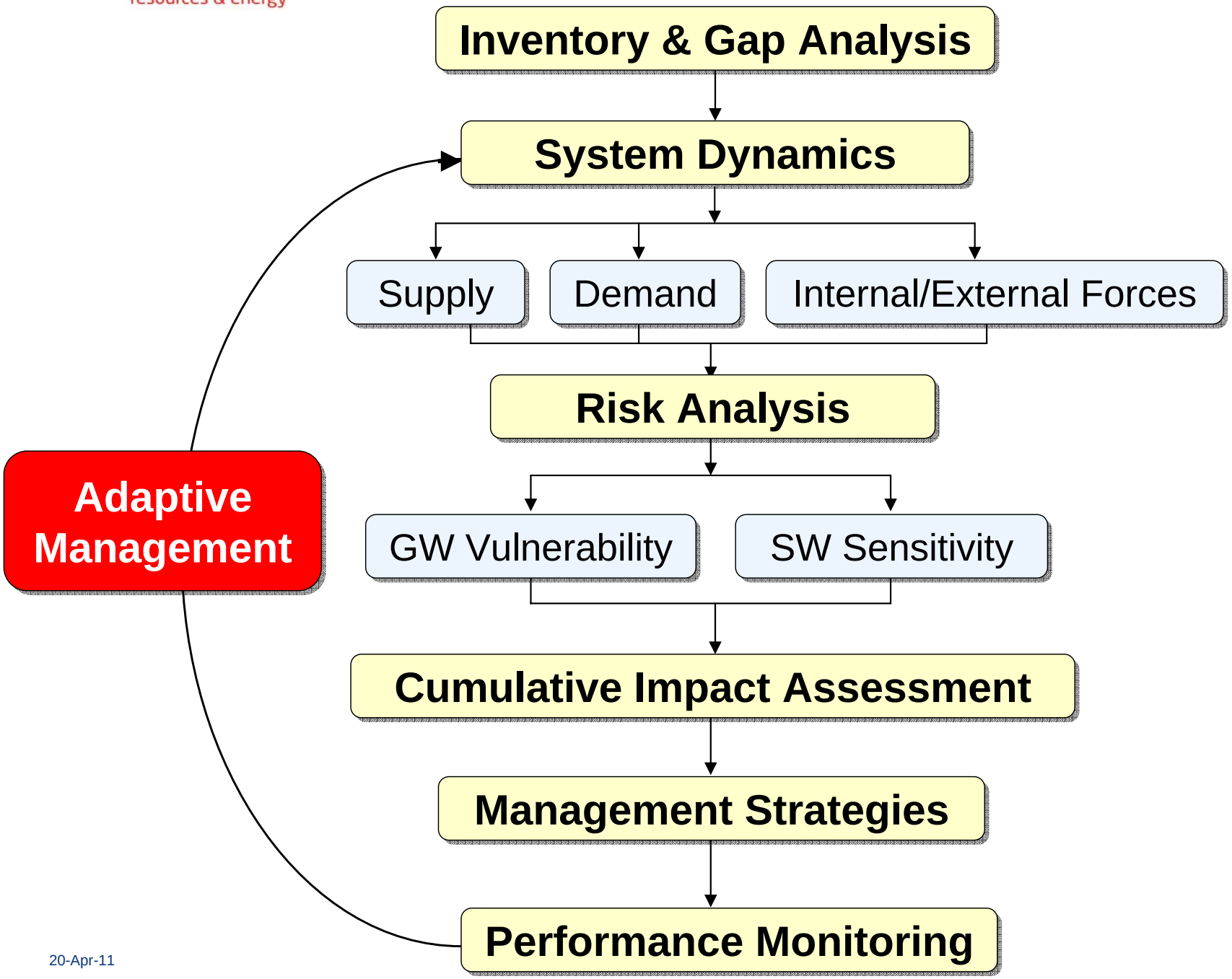
Assessment Approach



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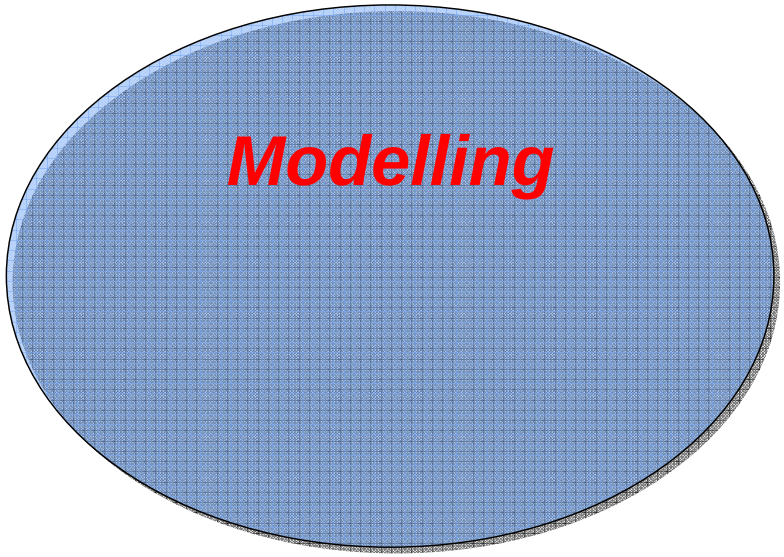
Assessment Tools



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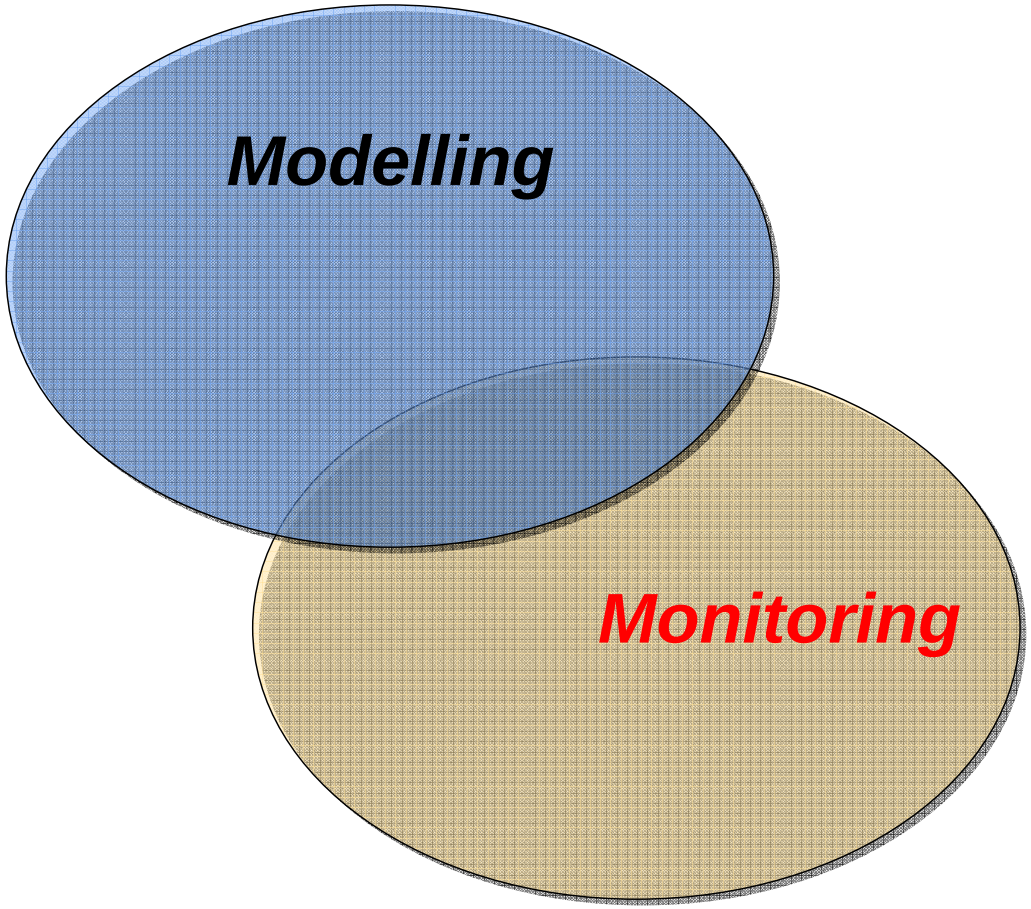
Assessment Tools



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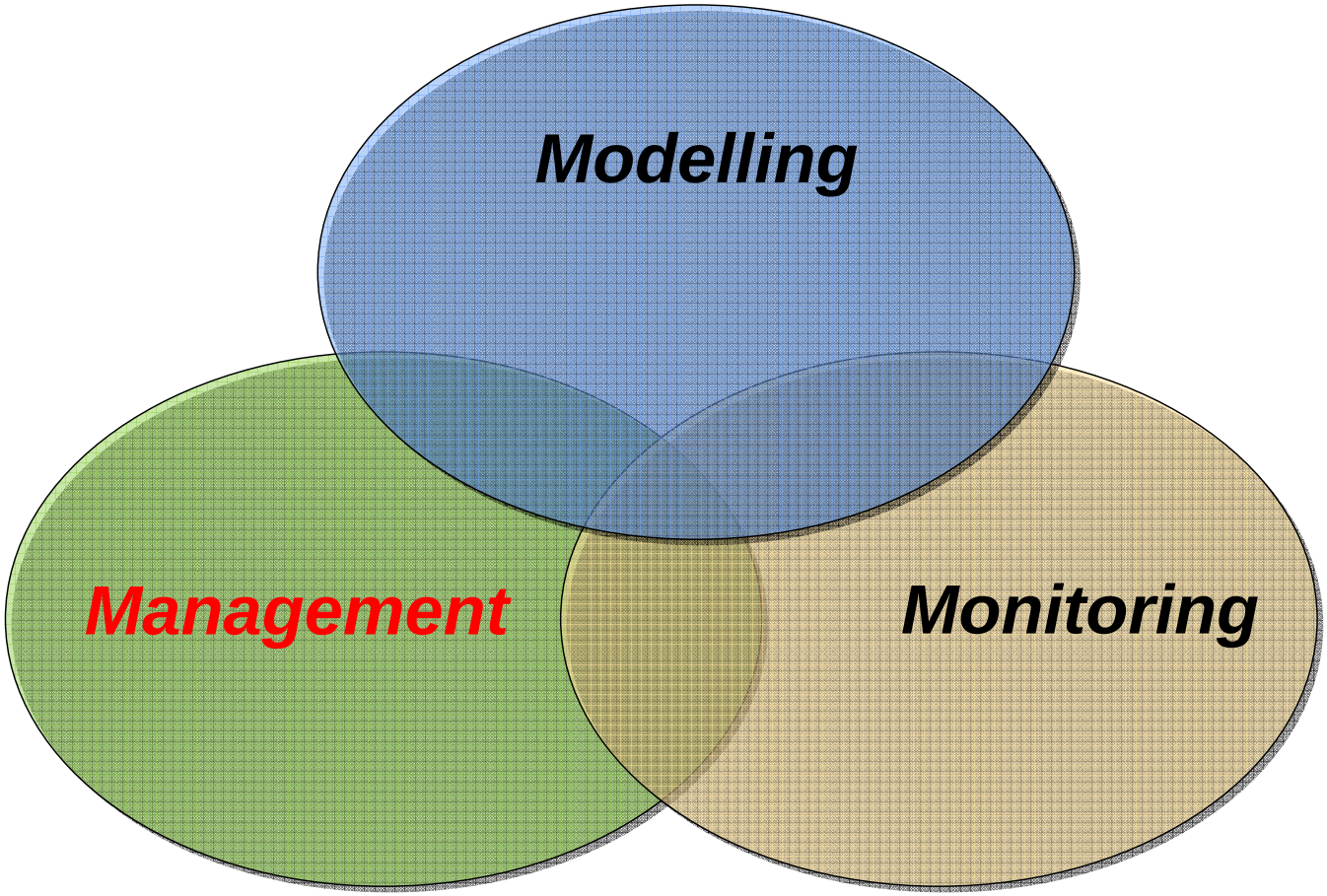
Assessment Tools



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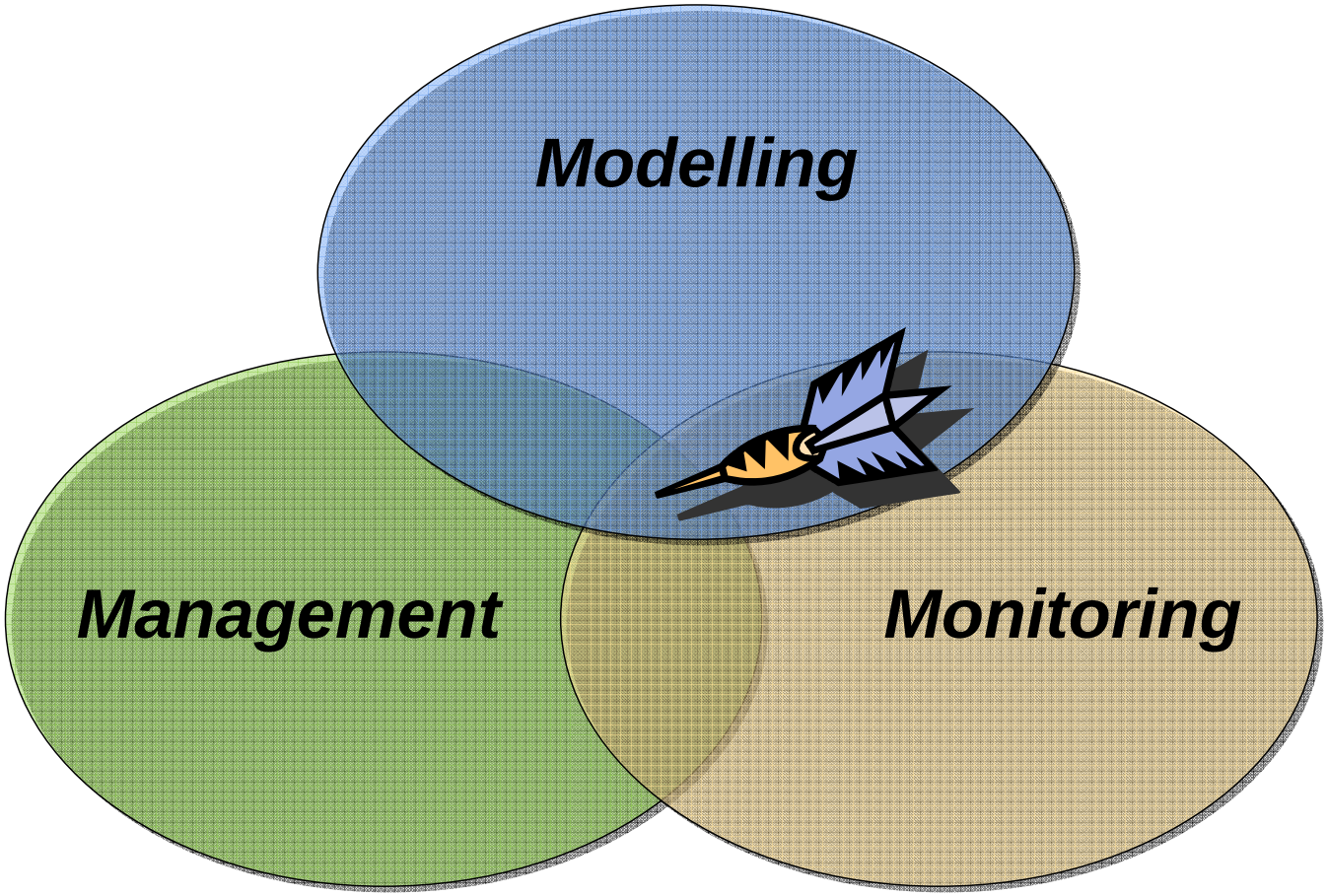
Integrate



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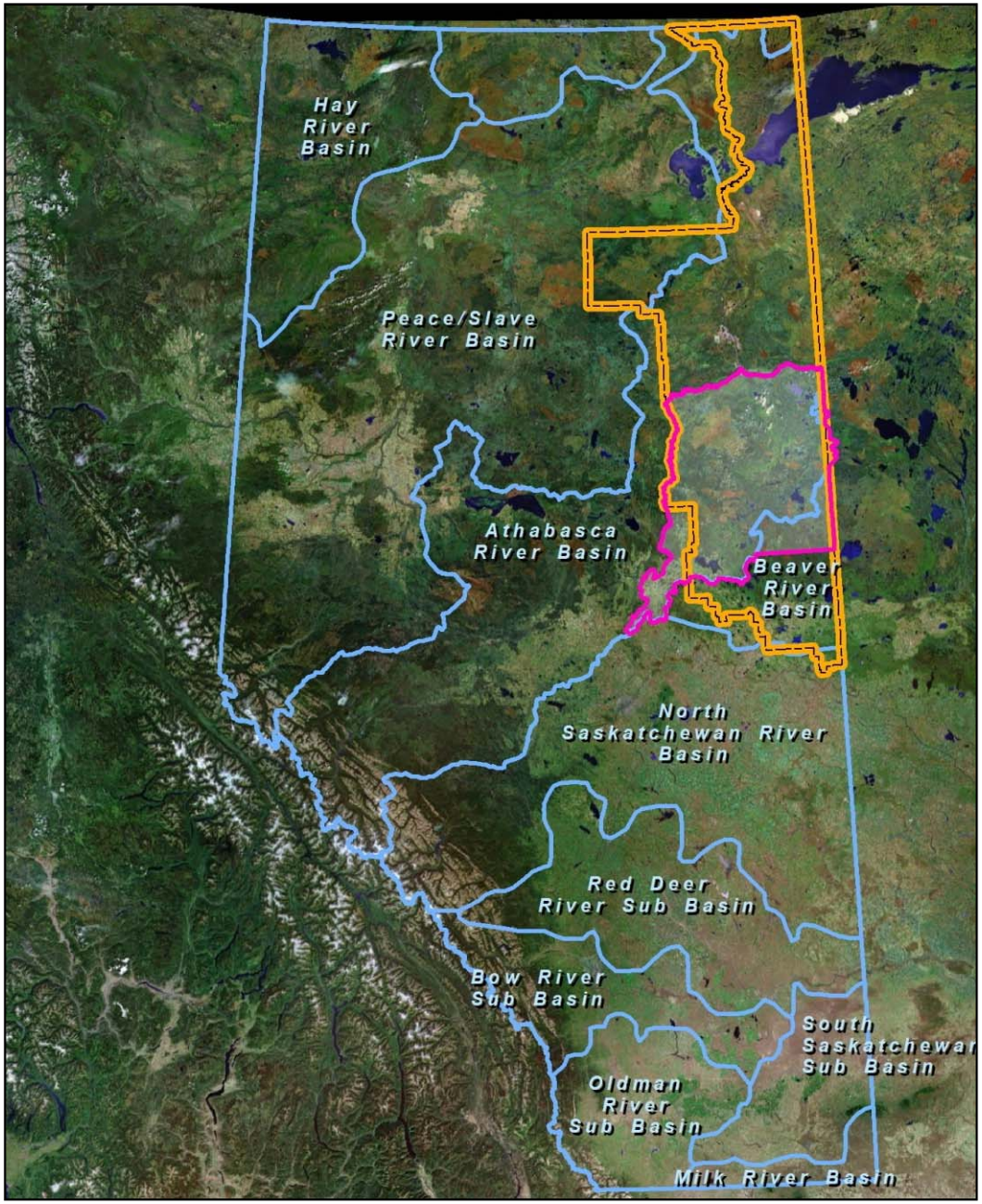
Study Area

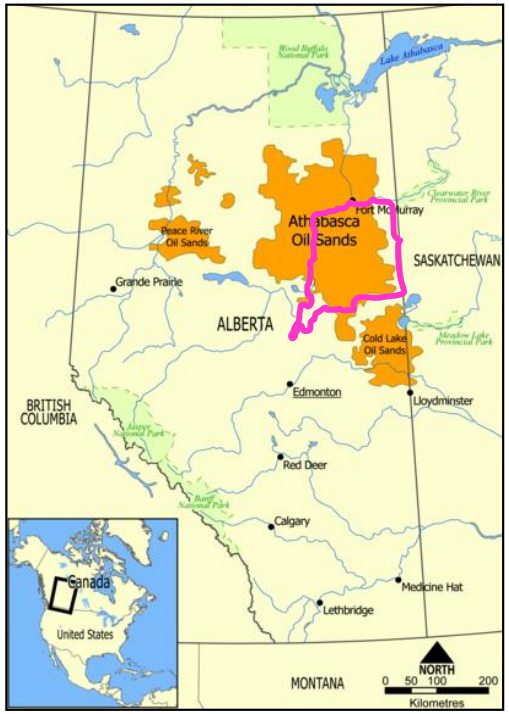


Lower Athabasca Regional Planning Area

SAOS Study Area

Alberta River Basins

~35,000 km²



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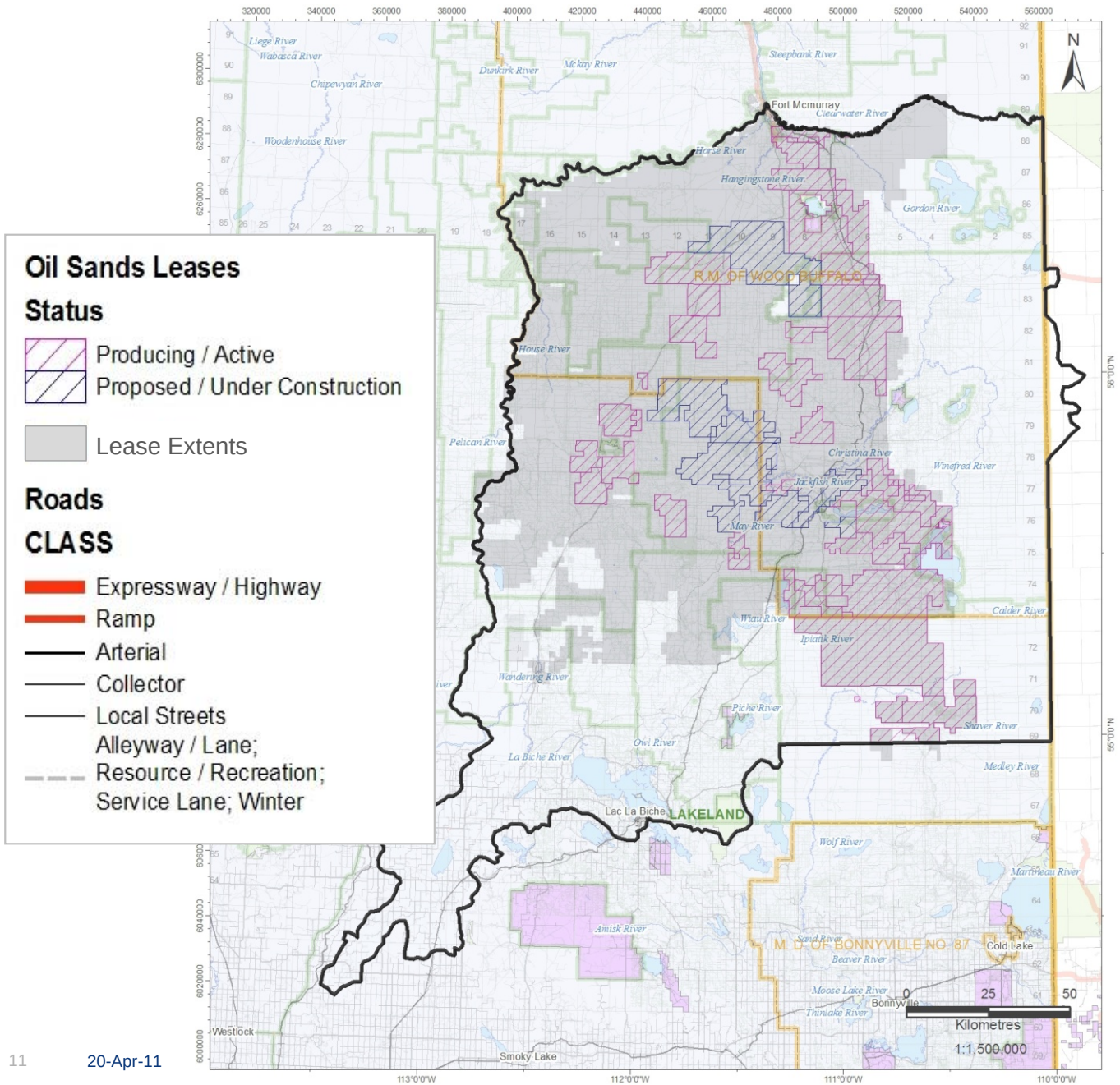
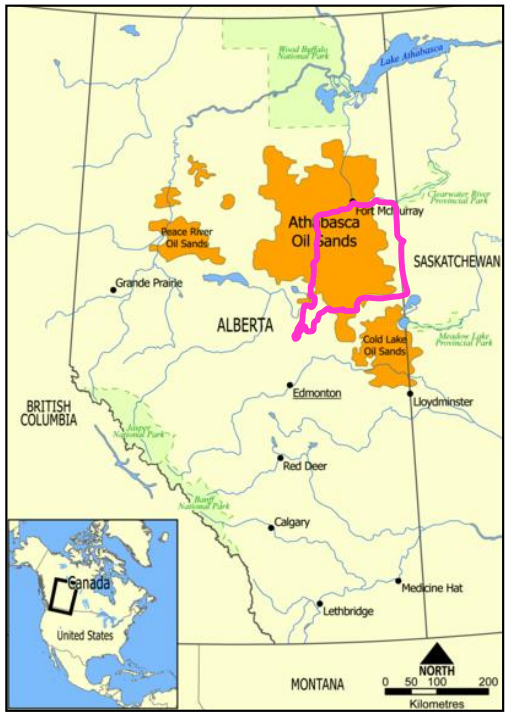
Posted Leases & Active Operations





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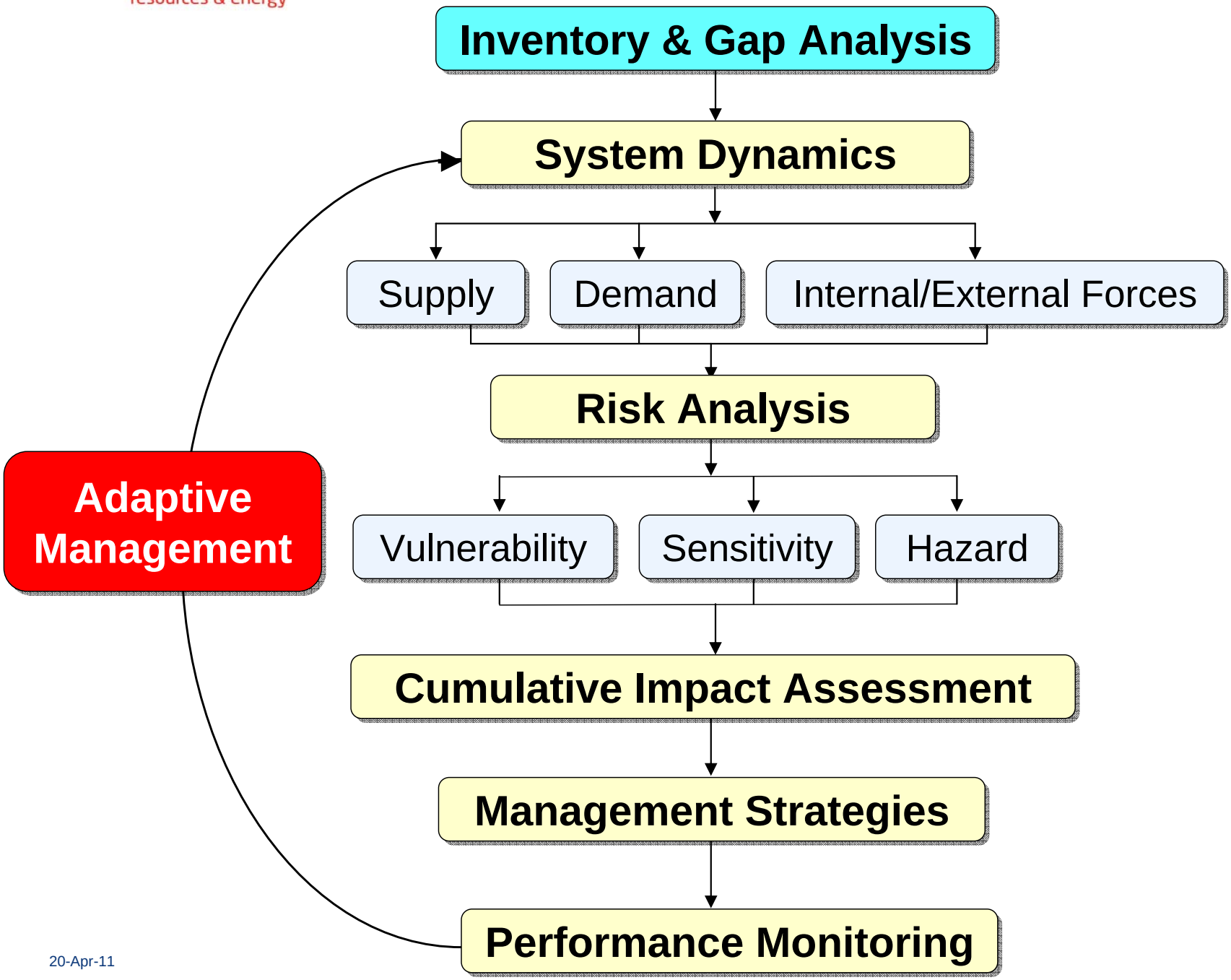
Inventory & Gap Analysis
System Dynamics
Supply
Demand
Internal/External Forces
Risk Analysis
Vulnerability
Sensitivity
Hazard
Cumulative Impact Assessment
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Performance Monitoring
Adaptive Management

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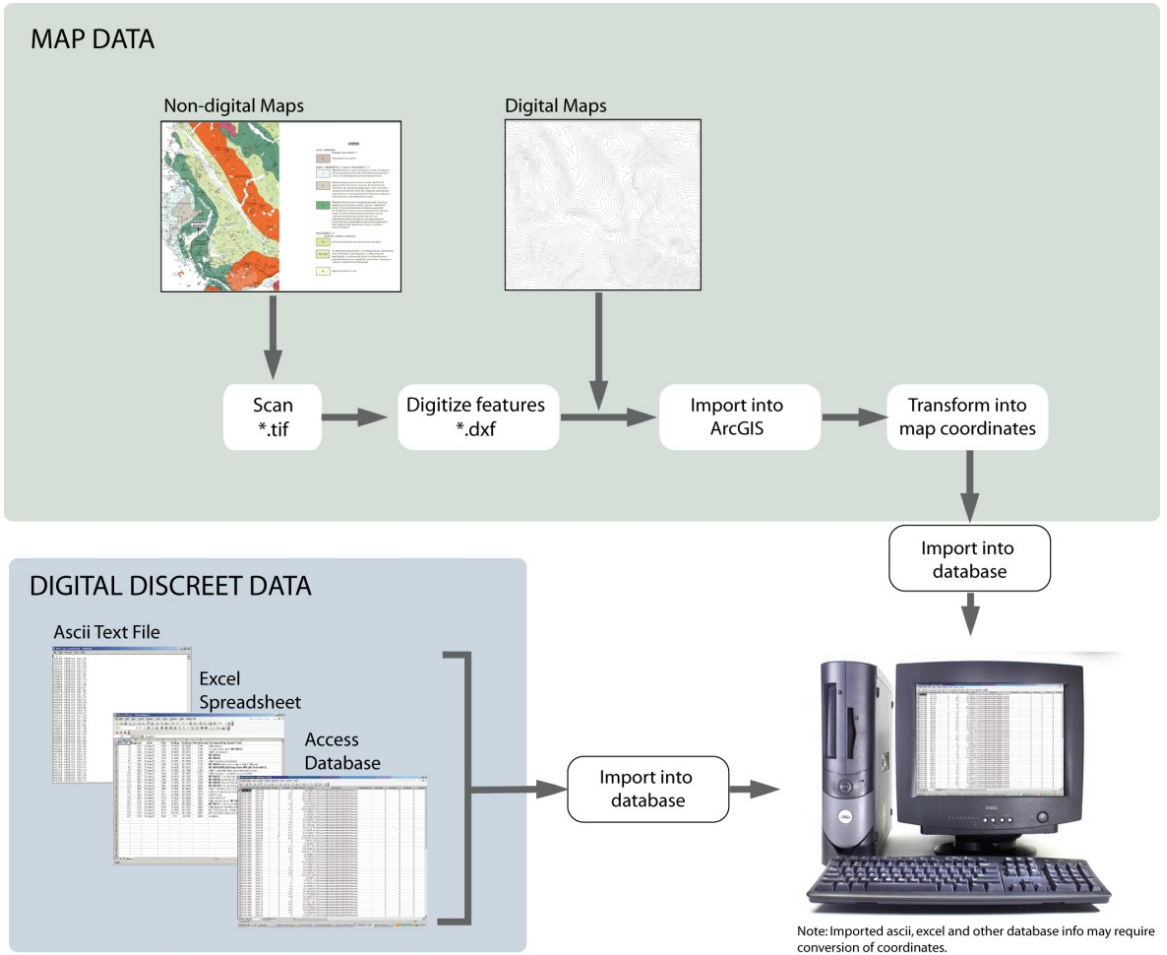
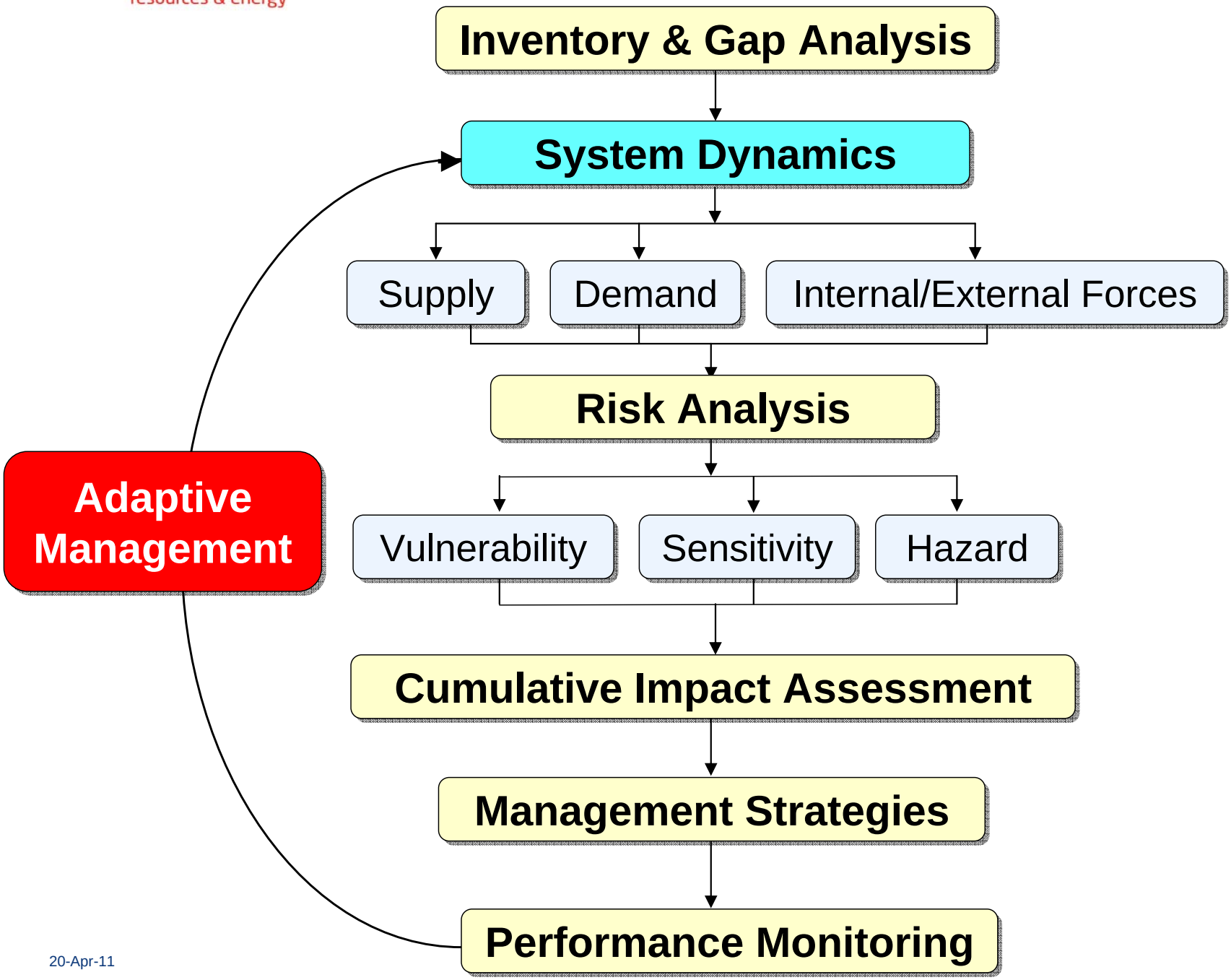
Inventory & Gap Analysis

- Geology & Hydrogeology
  - AENV, Sask WA, IHS, Operators, AGS, & ERCB
- Hydrology & Meteorology
  - AENV, Sask WA, & Env.Can
- Land Use
  - AENV, ERCB, SRD, PFRA
- Oil & Gas Production
  - AENV, ERCB, & Operators

Participating Operators:

Nexen	Suncor
Devon	Husky
ConocoPhillips	MEG
Cenovus	Statoil
Petrobank	JACOS
CNRL	EnerPlus

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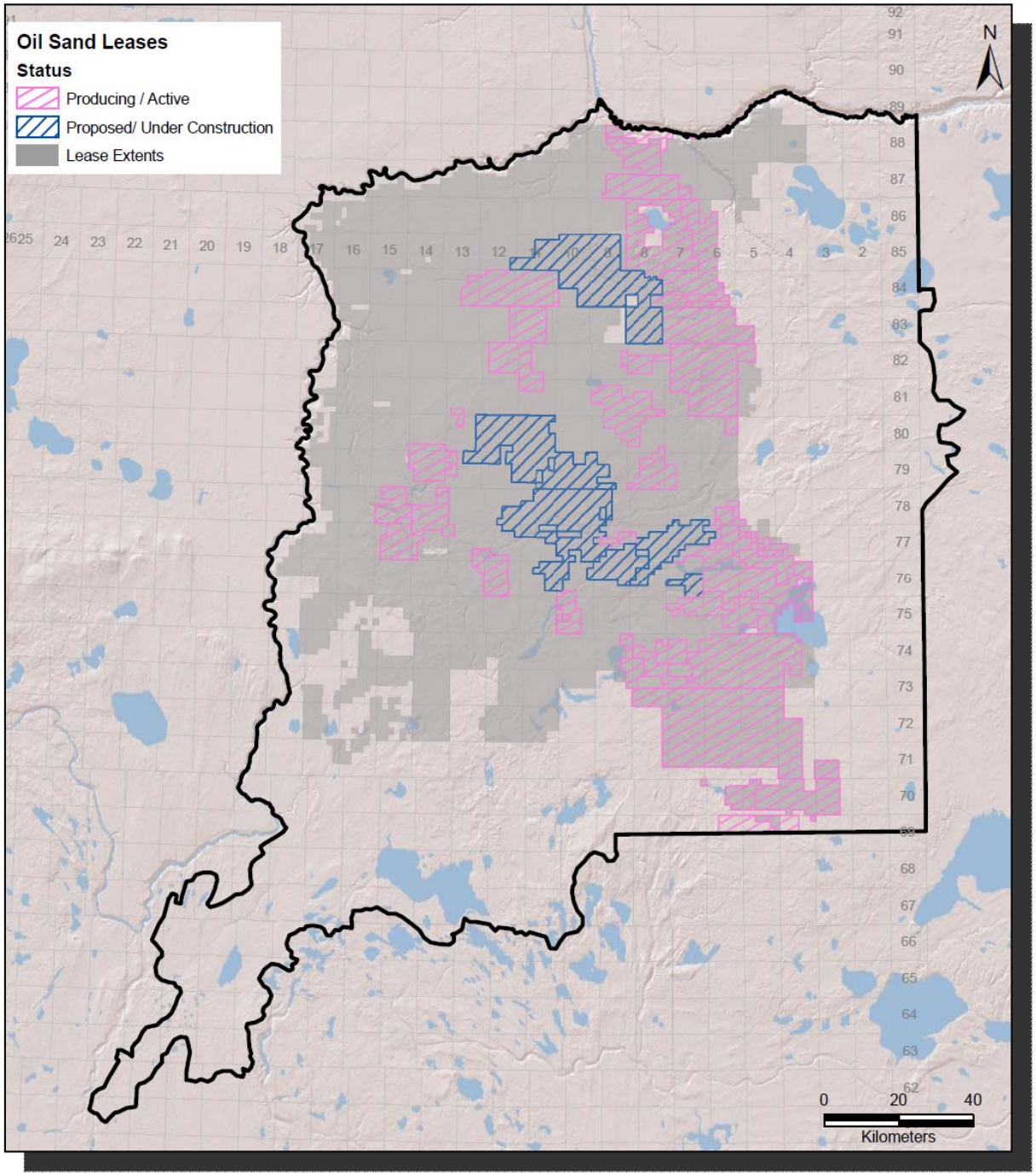
System Dynamics



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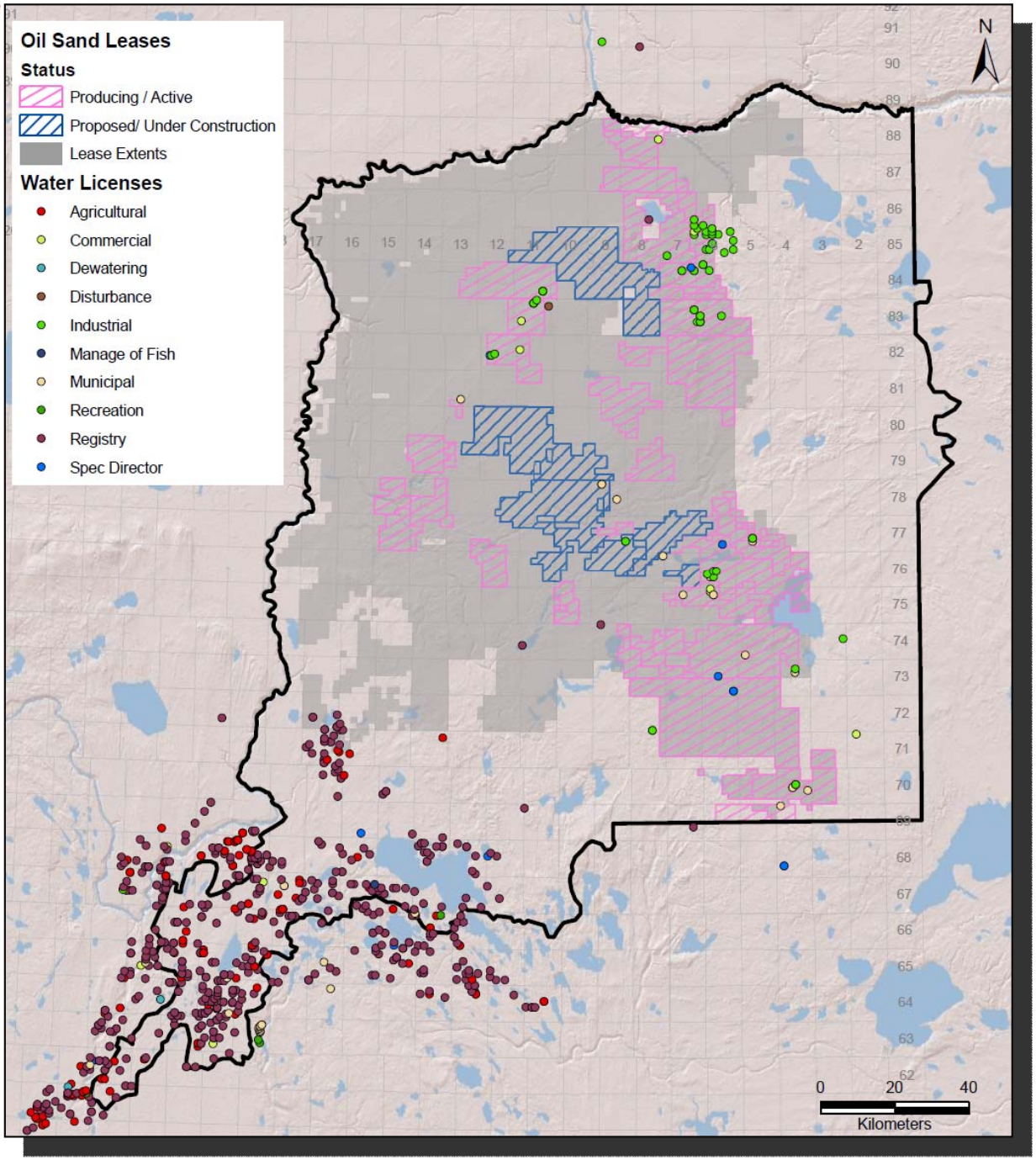
System Dynamics



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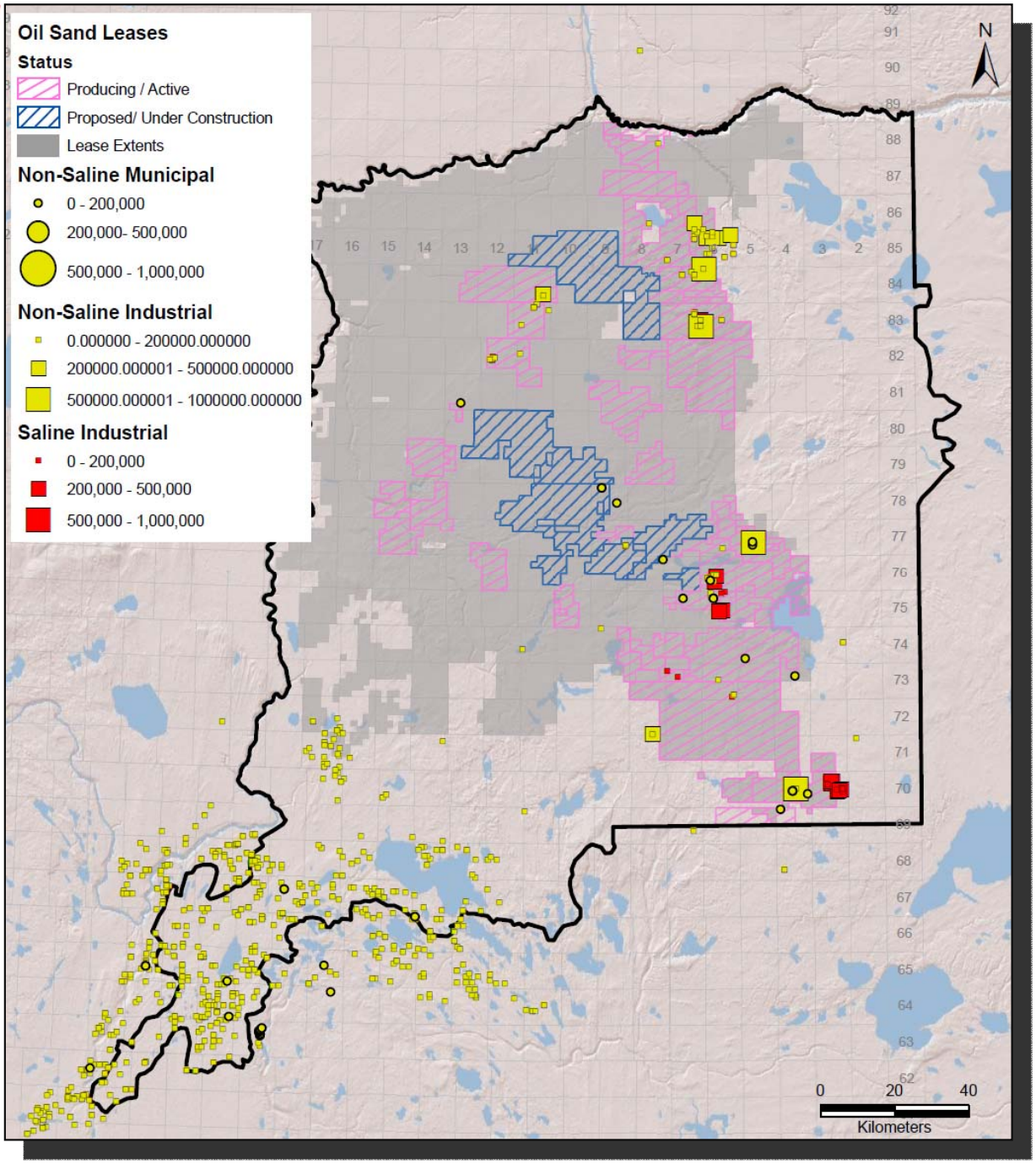
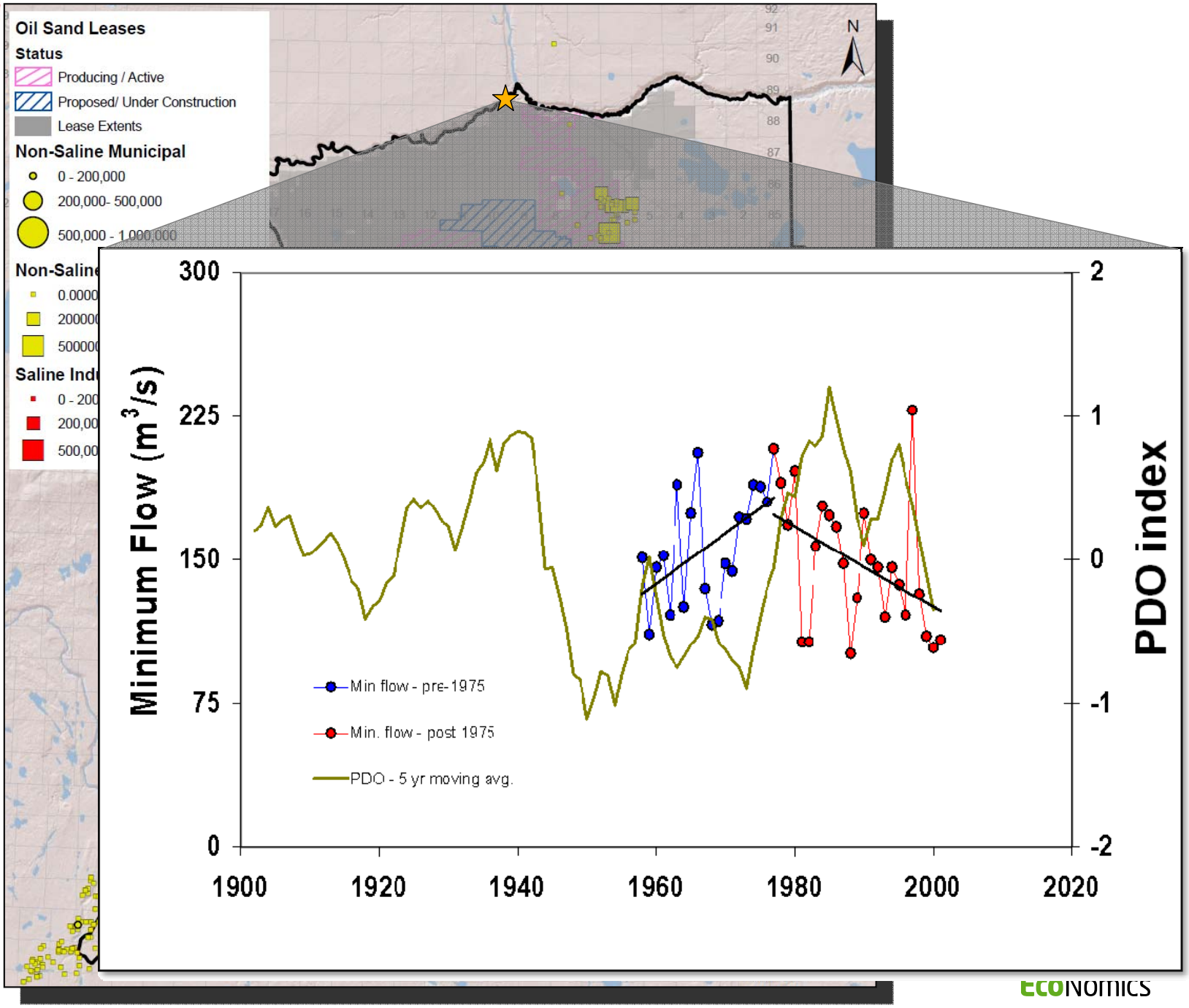


System Dynamics



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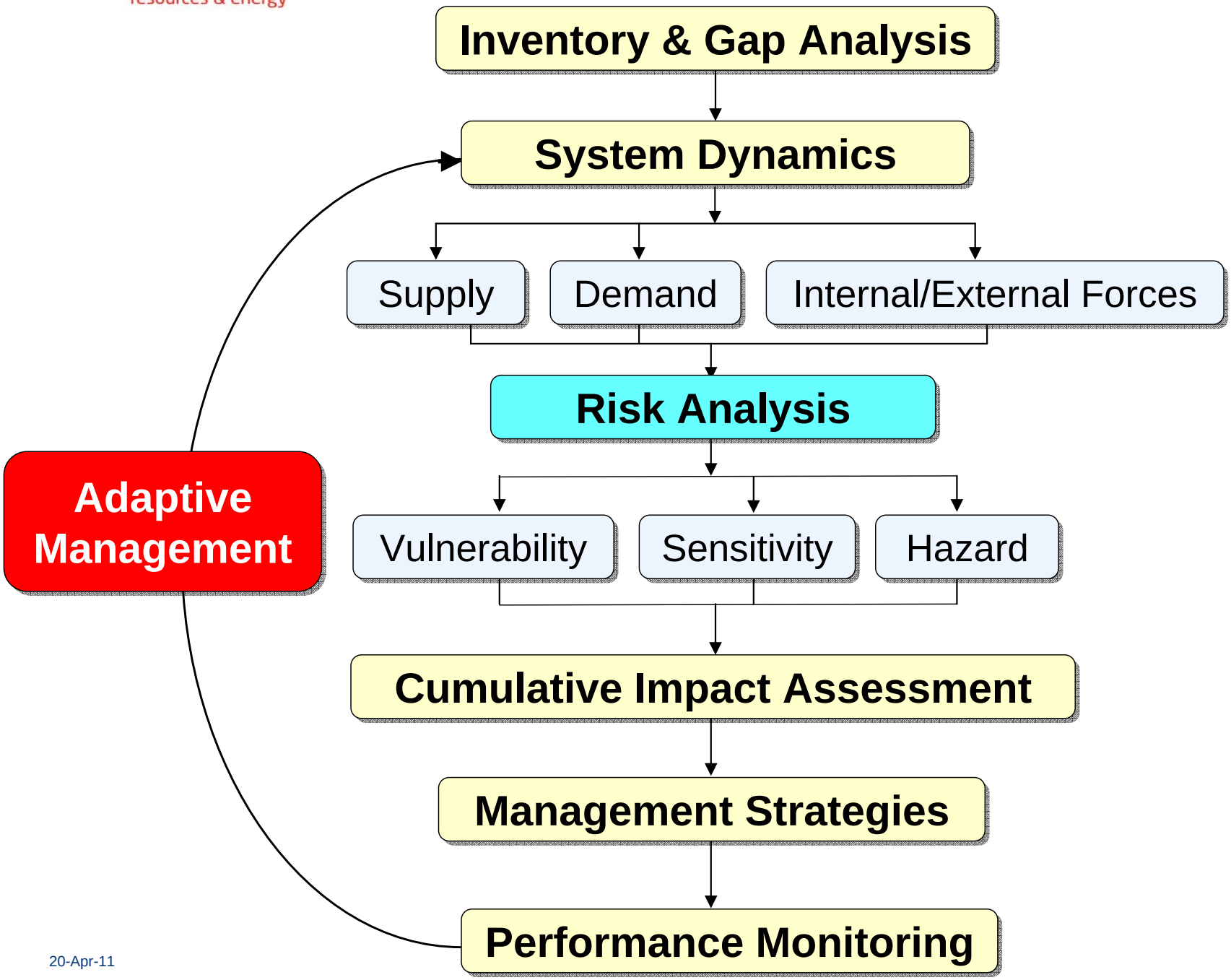
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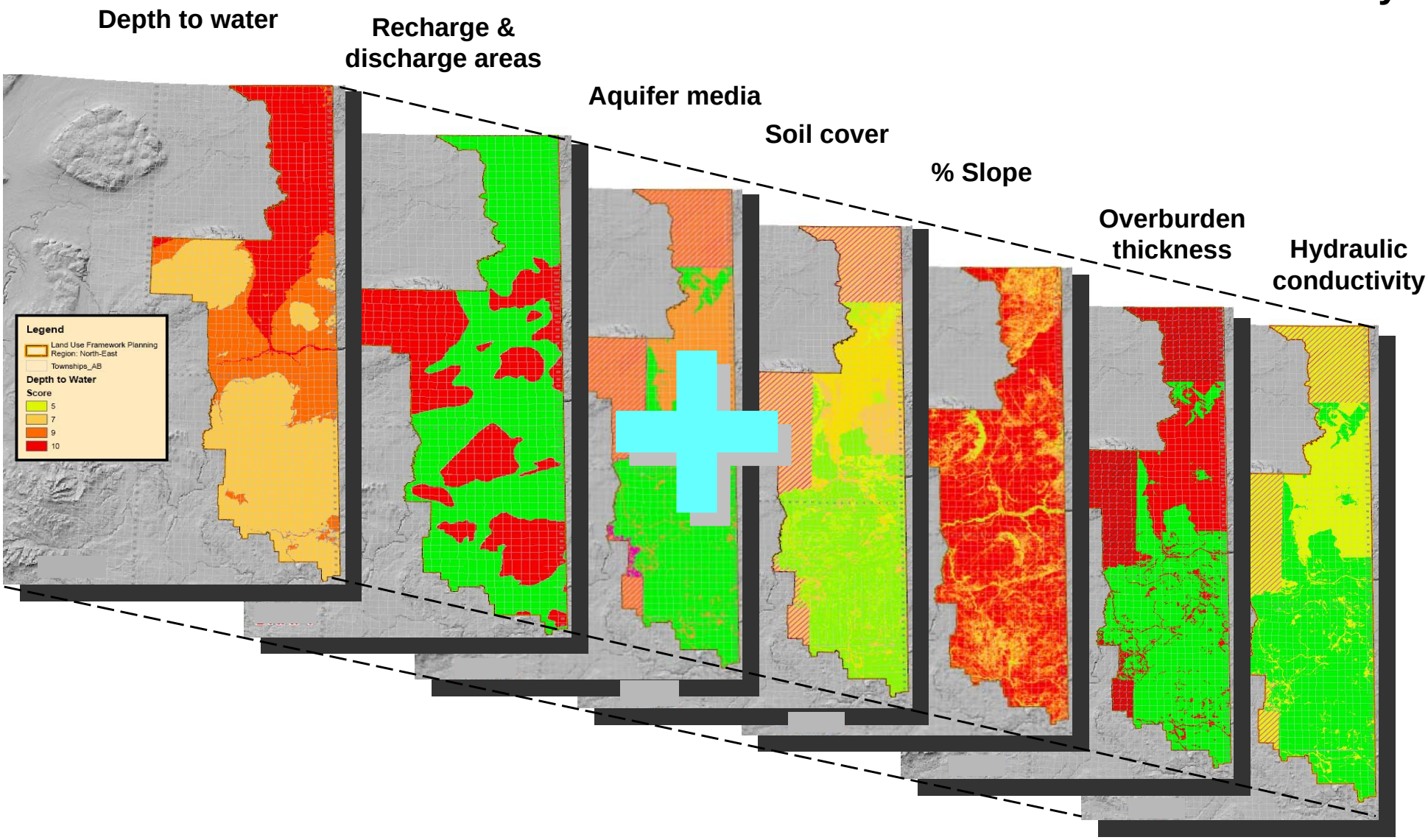
Risk Analysis

Intrinsic Vulnerability



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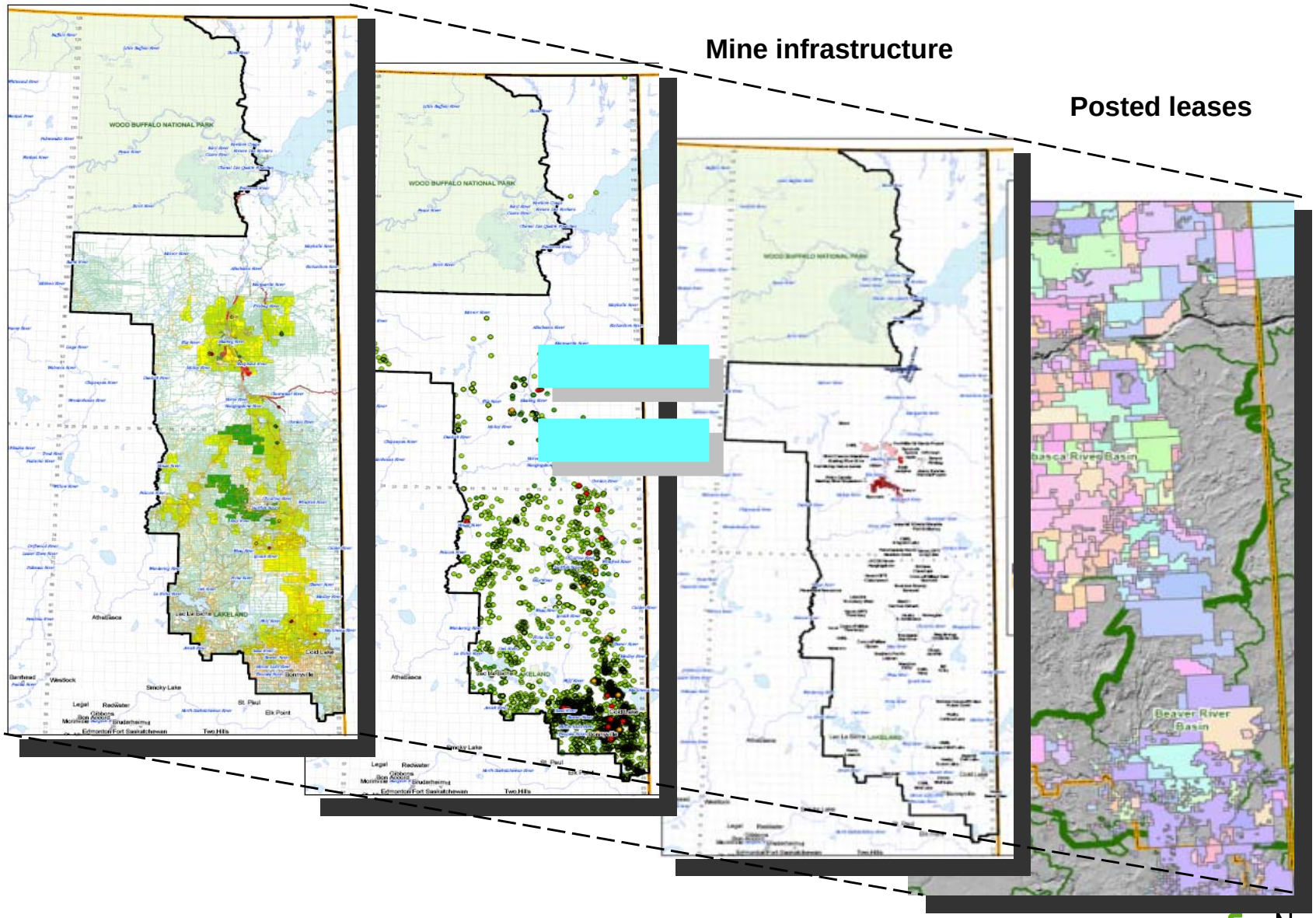
Risk Analysis

Development



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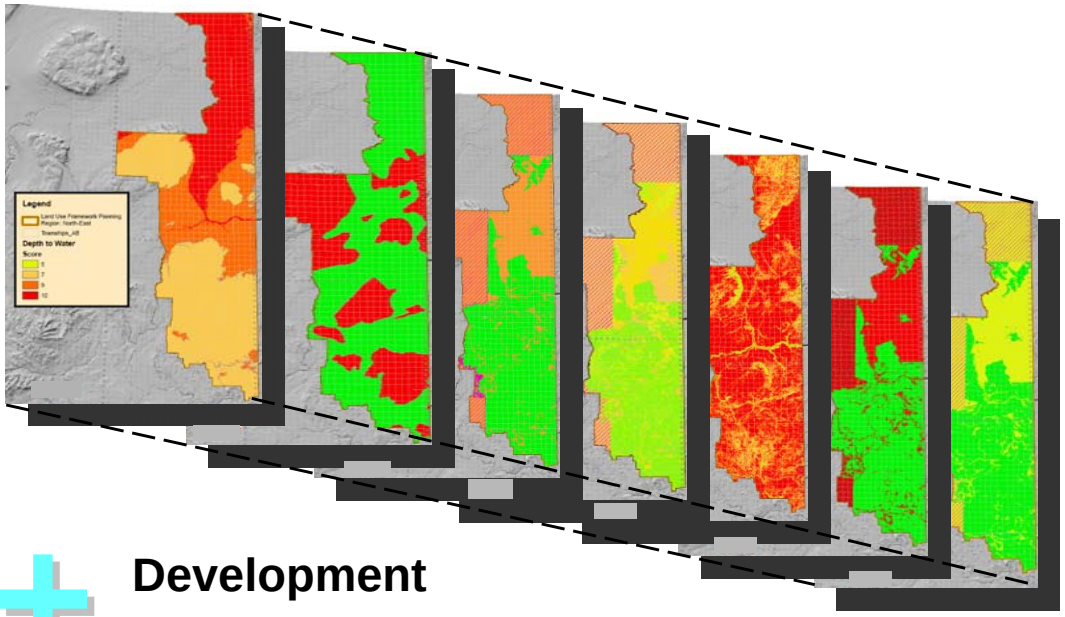
Risk Analysis

Aggregate Risk

Intrinsic Vulnerability



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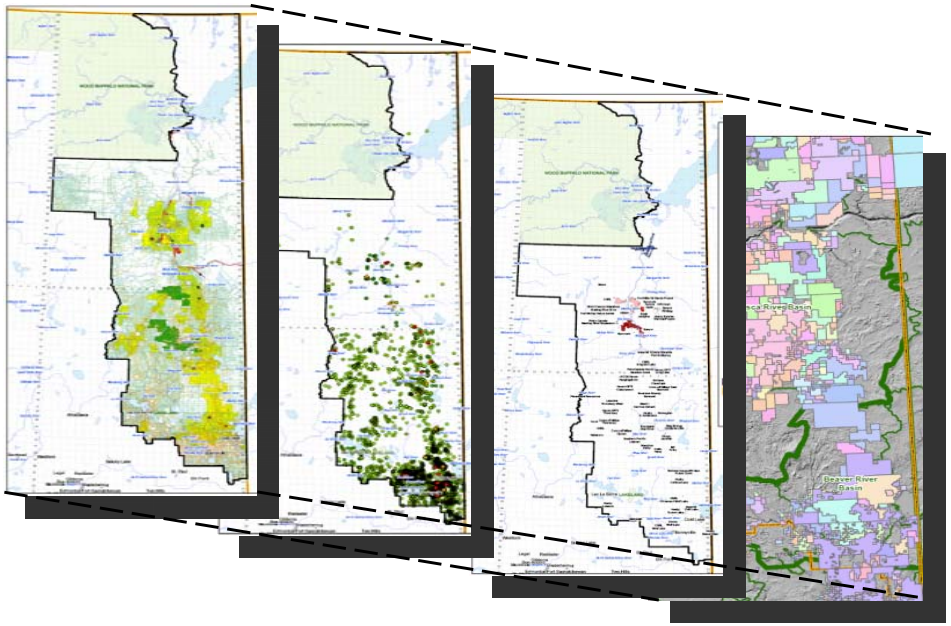
Development



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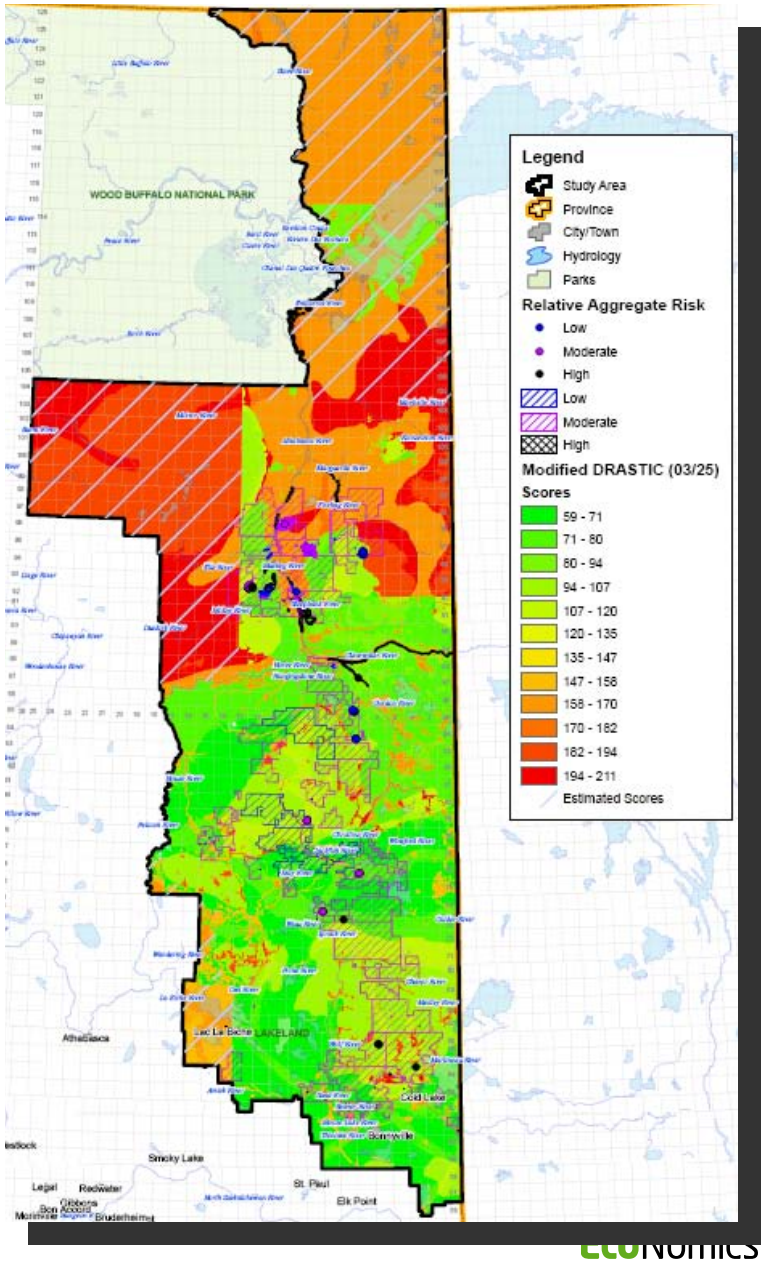

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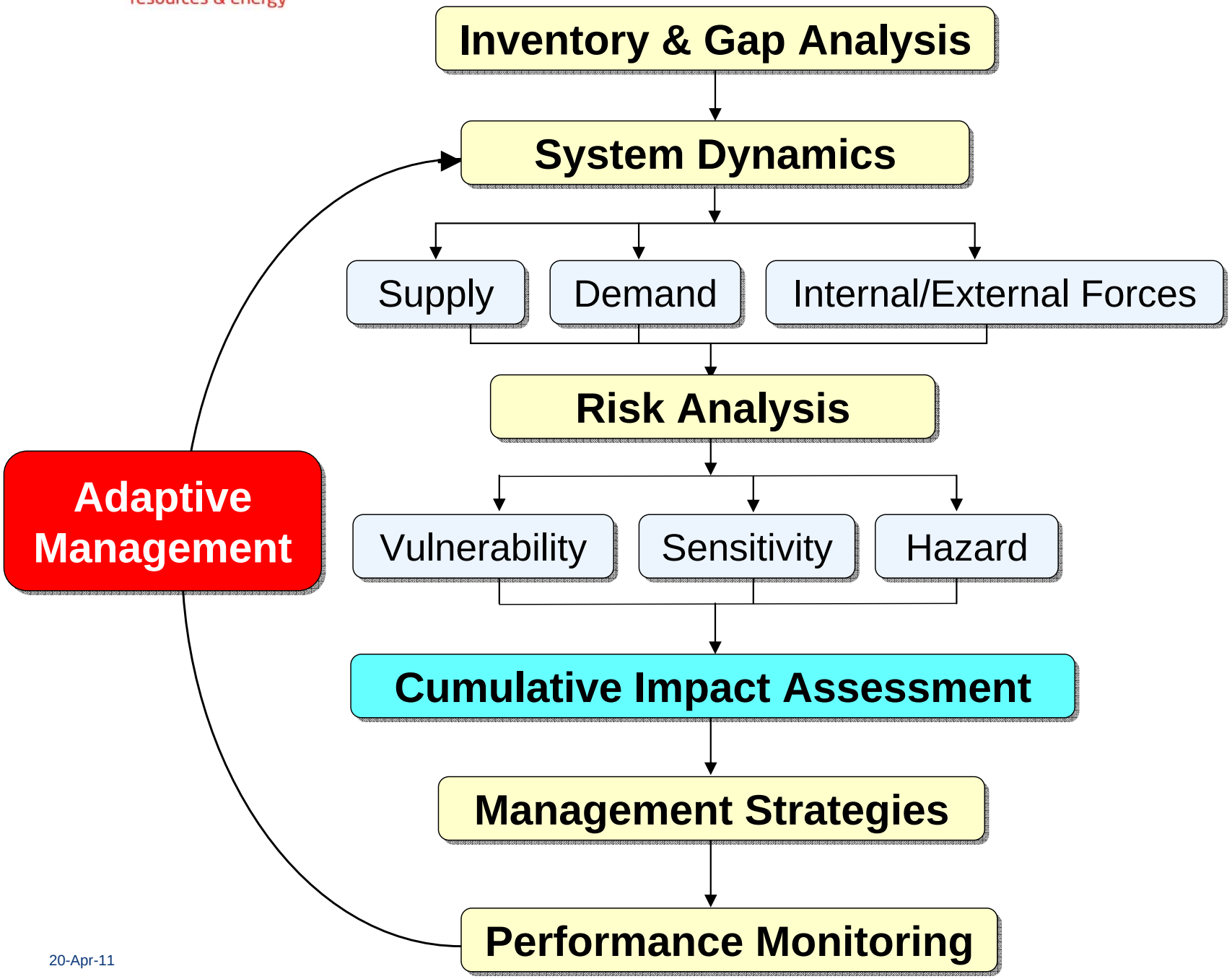
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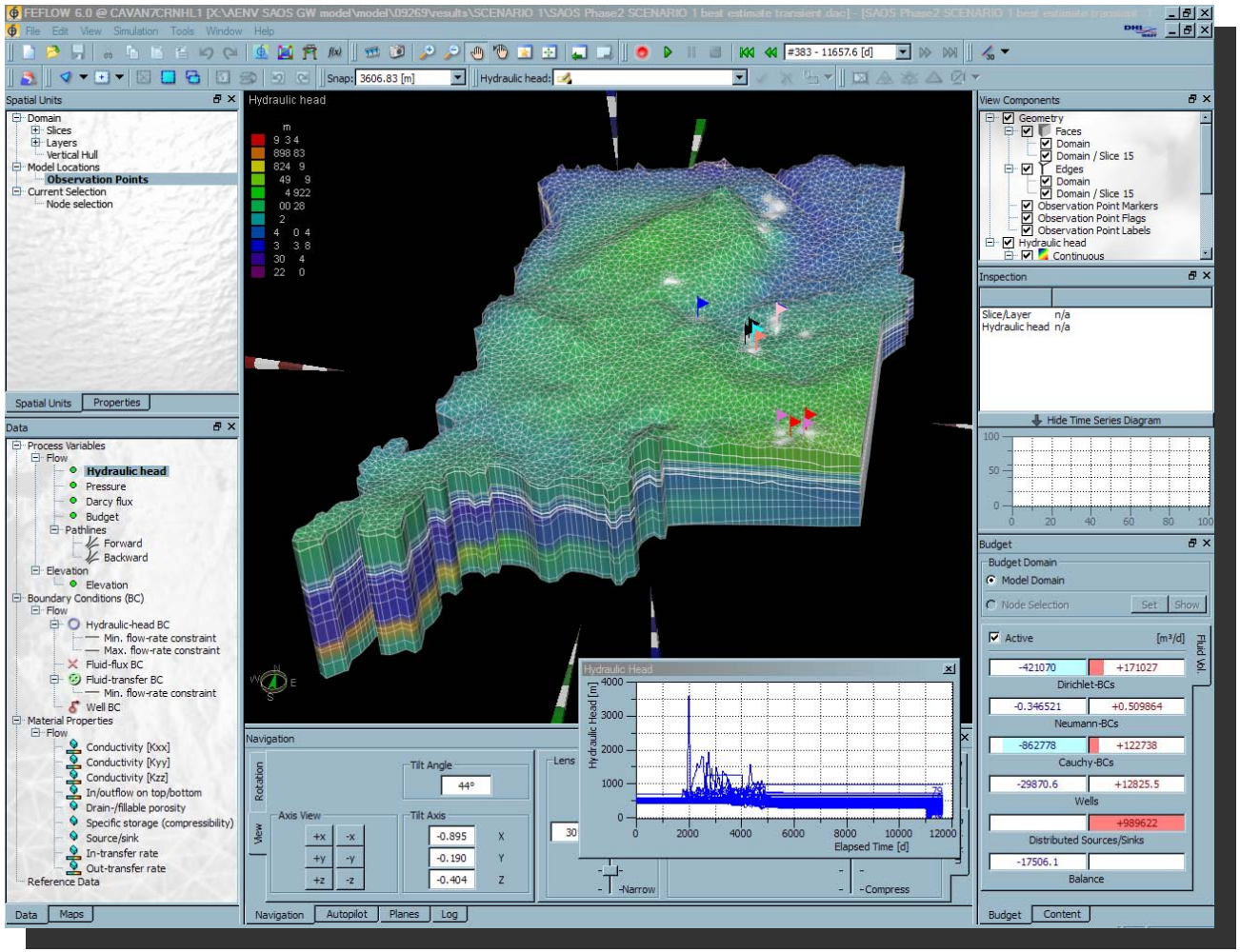
Cumulative Impact Assessment

- Develop numerical modelling tools
  - Quantify cumulative impacts from regional oil sand development
  - Support Groundwater Management Framework



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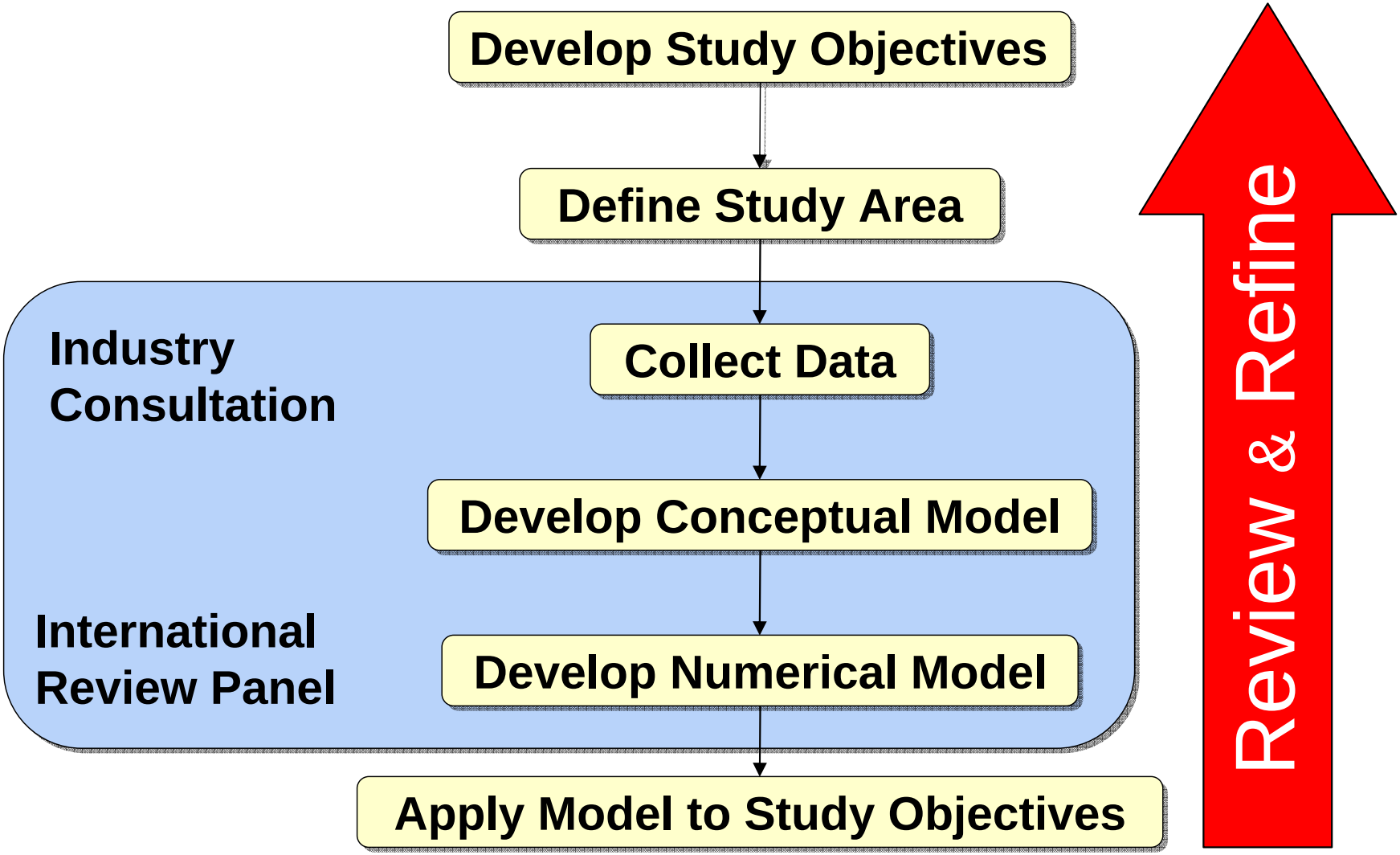
Modelling Tool Development



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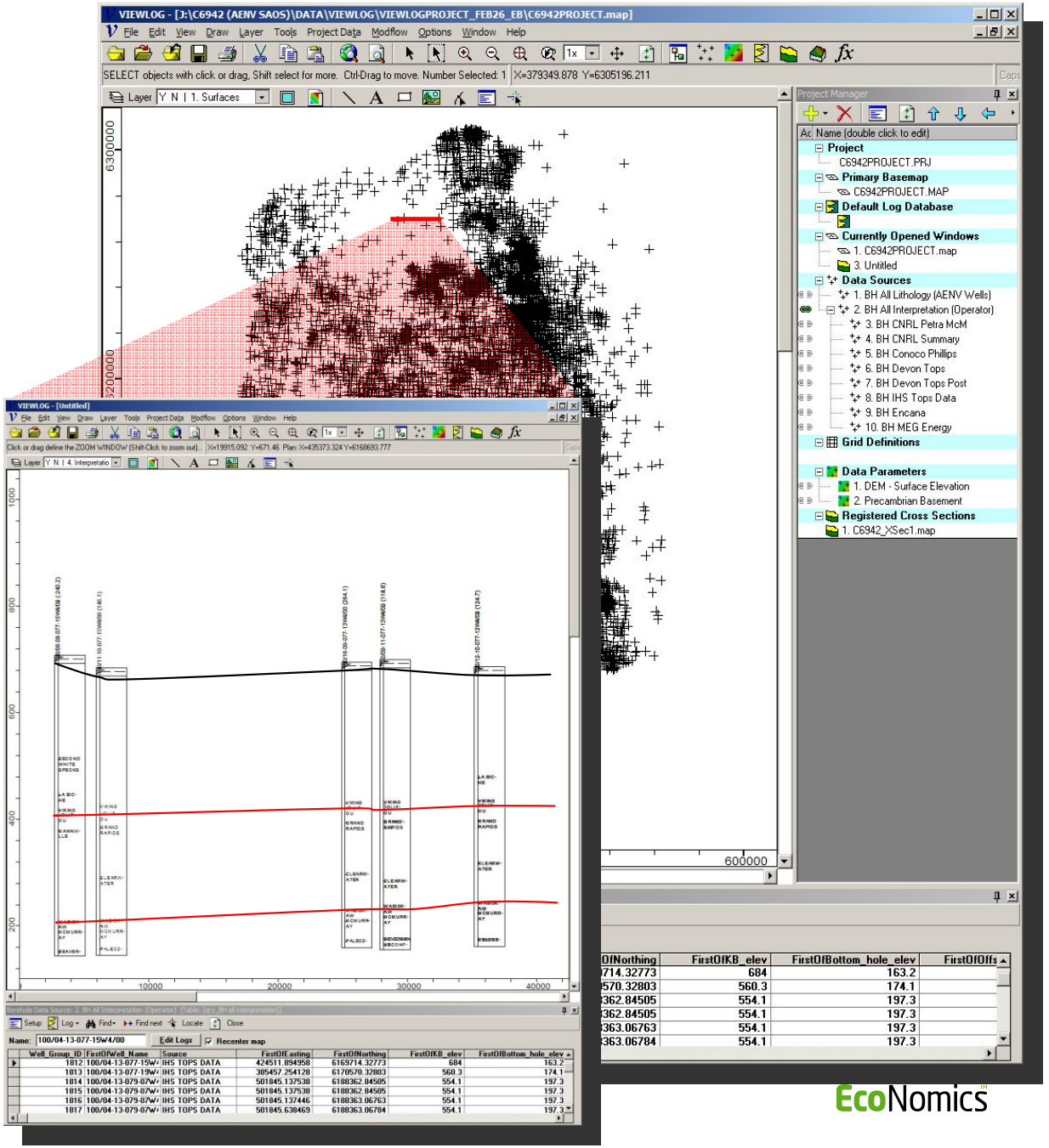
Data Collection & Management

- Data compiled in relational databases
- Developed database tools to QA/QC data
- Linked databases to visualization software



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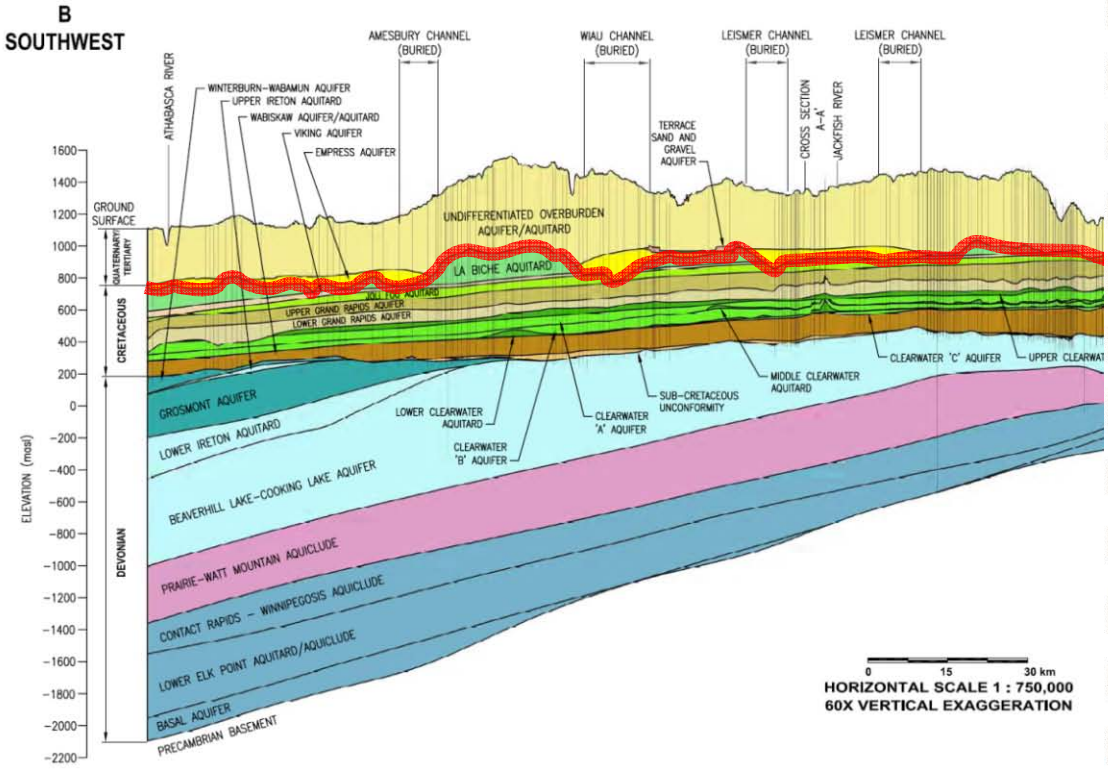
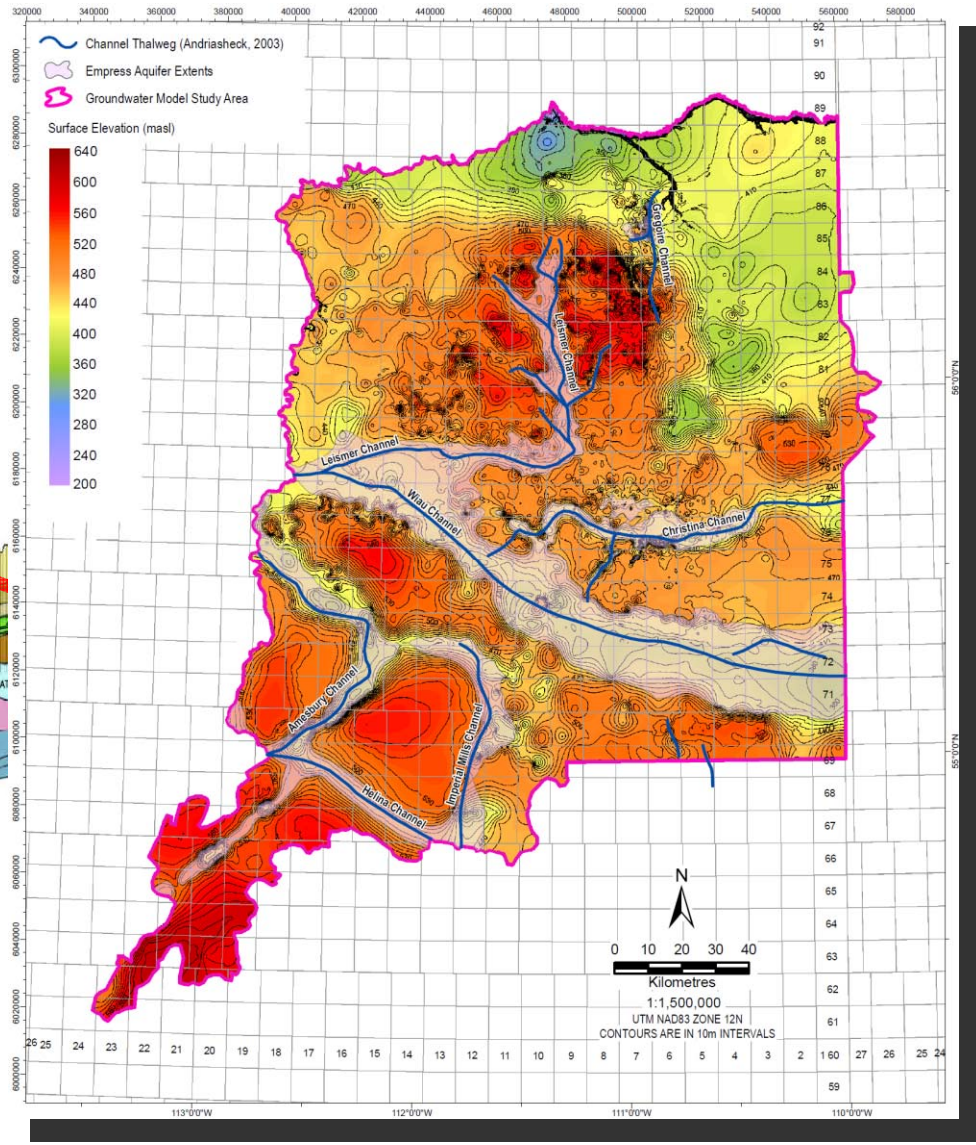
Conceptualization

- 25 regionally significant hydogeologic units
- Buried bedrock channels add complexity





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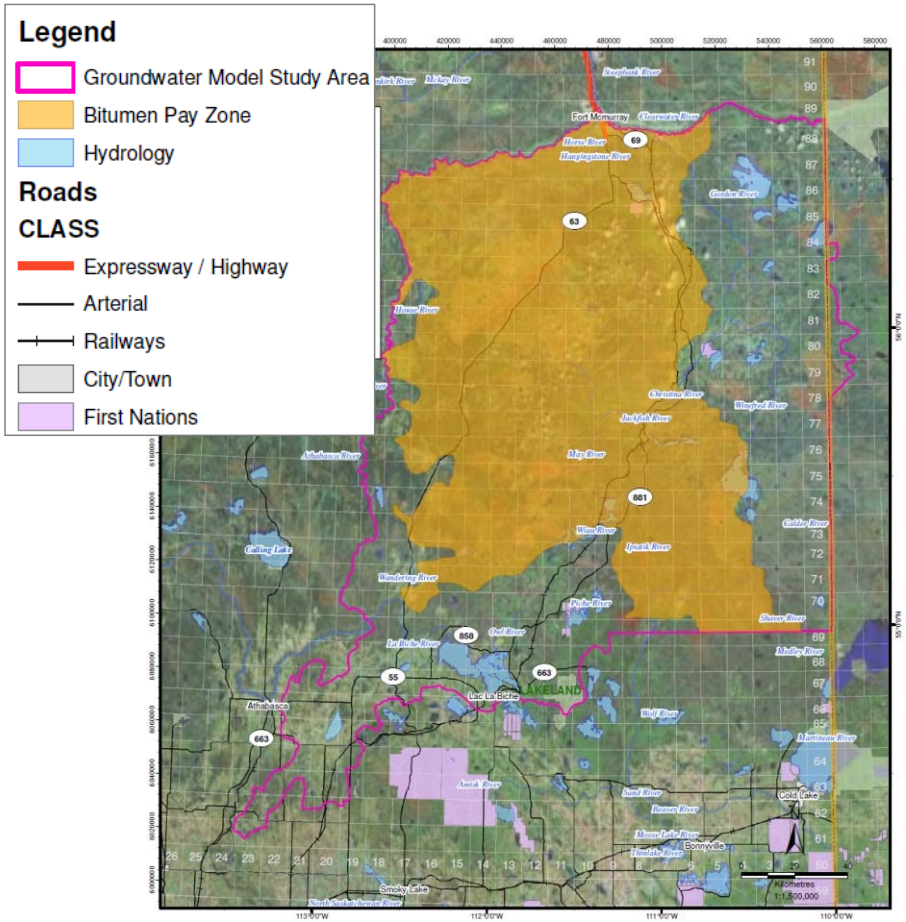
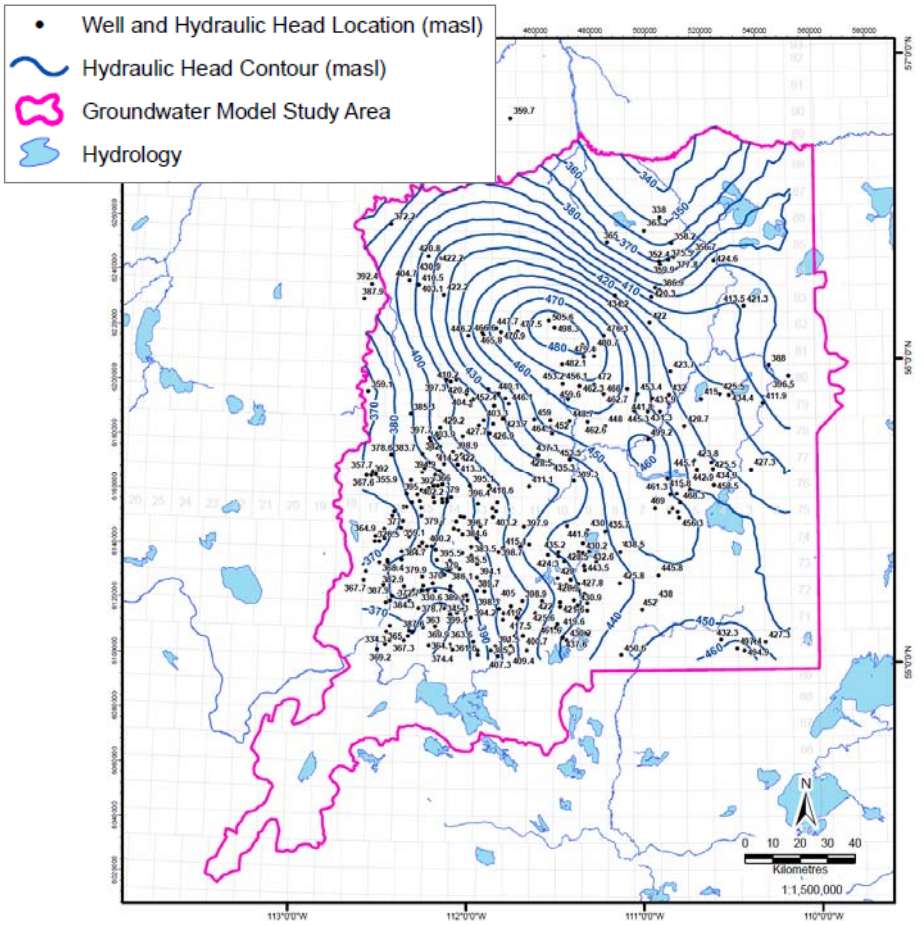
Conceptualization

- Map regionally significant oil and gas deposits



- Compile production water use from government databases



- Map aquifer freshwater head distributions.
- Estimate recharge distribution and rates from literature, vulnerability mapping, and baseflow estimates.

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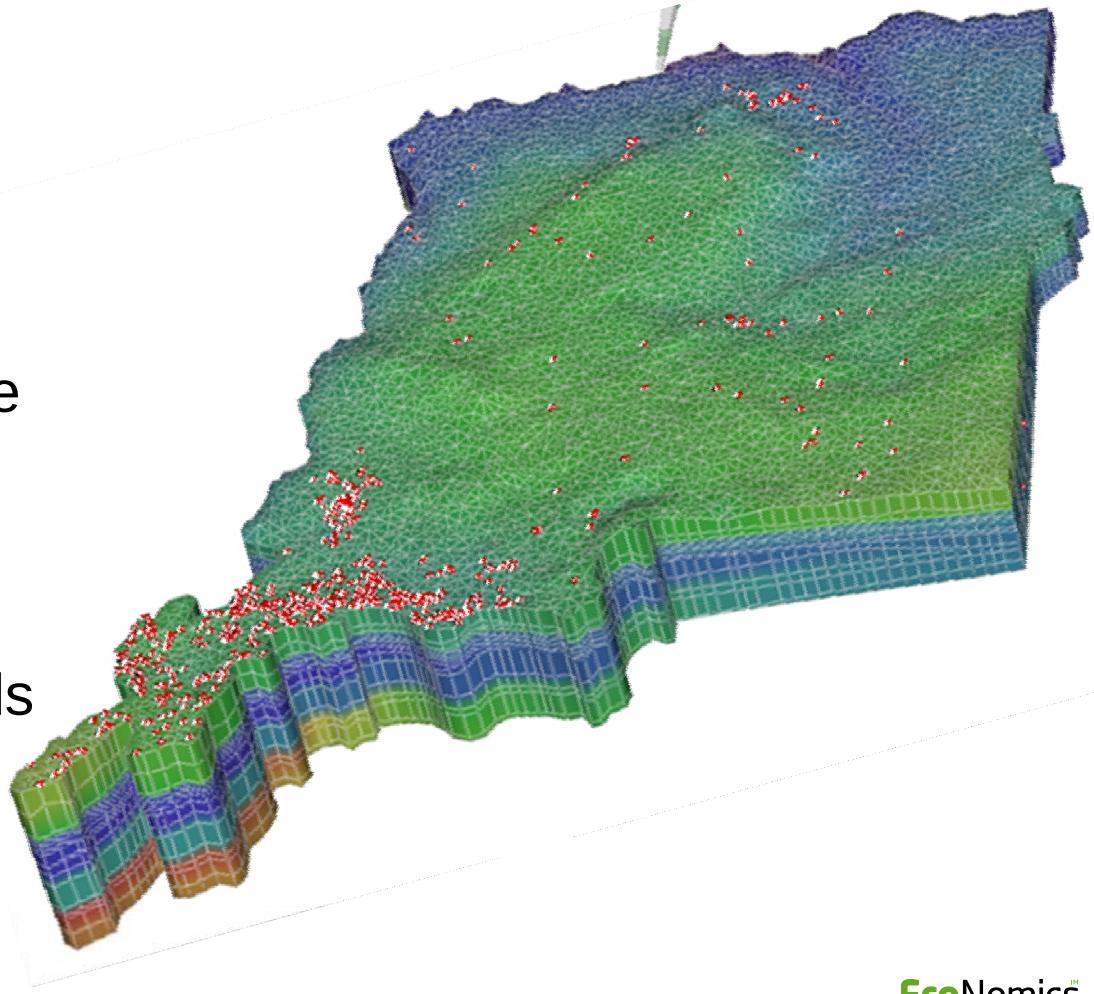
Model Design

25 layer FEFLOW model (292,075 elements)

1. Three model versions to assess prediction confidence
   - Best Estimate Model
   - Min Impact Model
   - Max Impact Model
2. Calibration
   - Initial manual steady state calibration
   - Automated (PEST) to optimize parameters and assess confidence bounds
   - Transient calibration to historic groundwater use/injection in region



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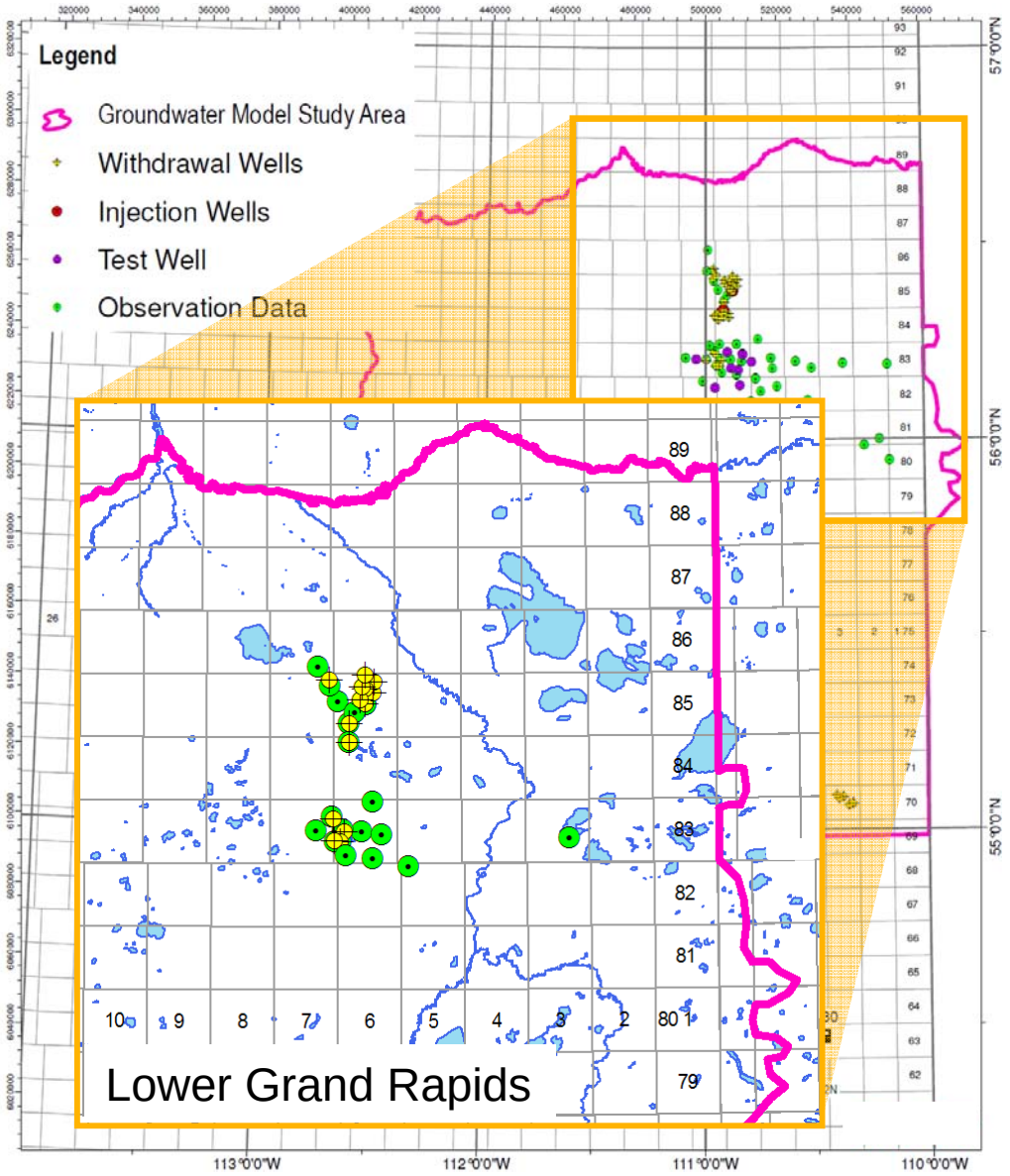
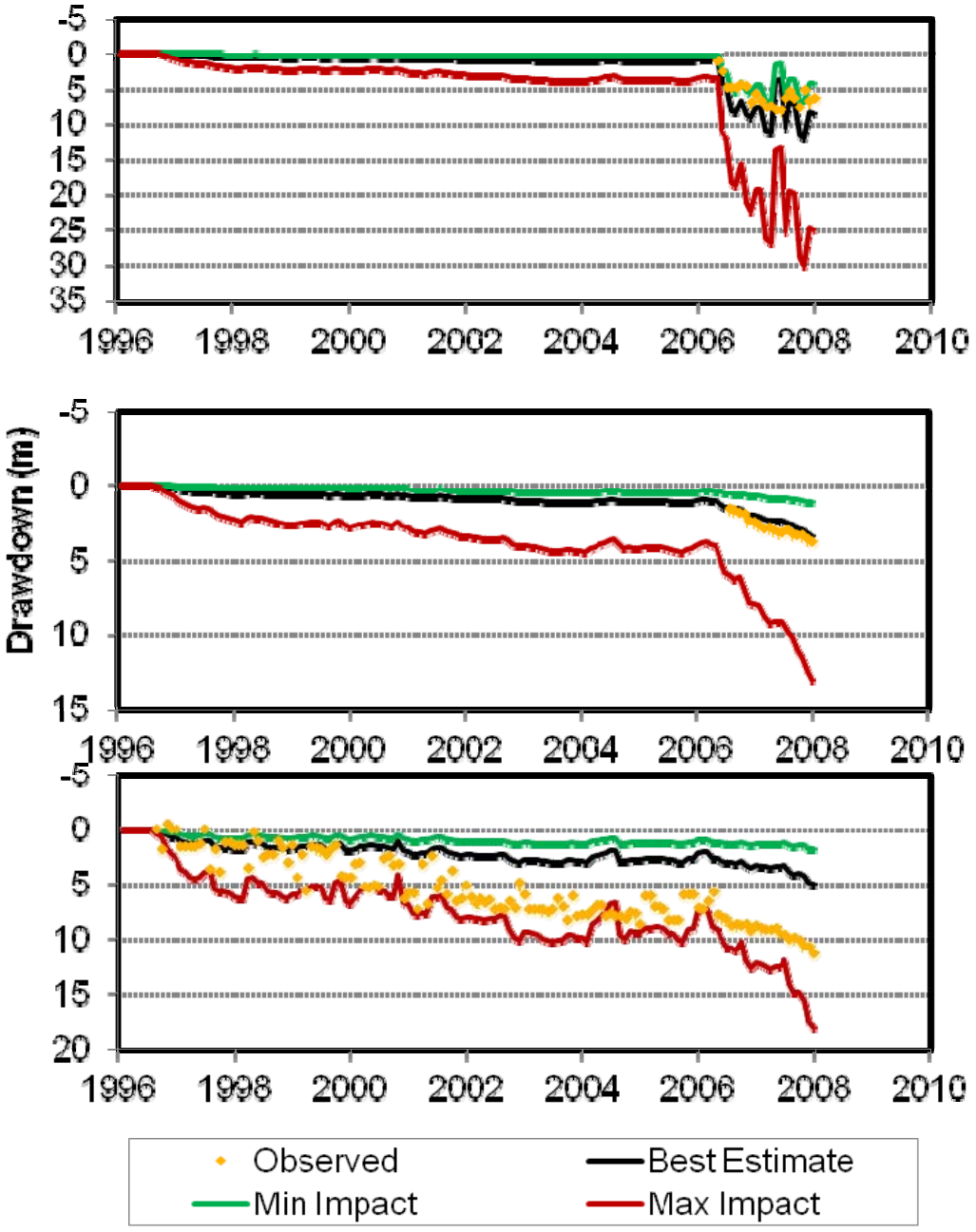
Transient Model Calibration

Lower Grand Rapids Aquifer





Calibrated to 27 monitoring locations

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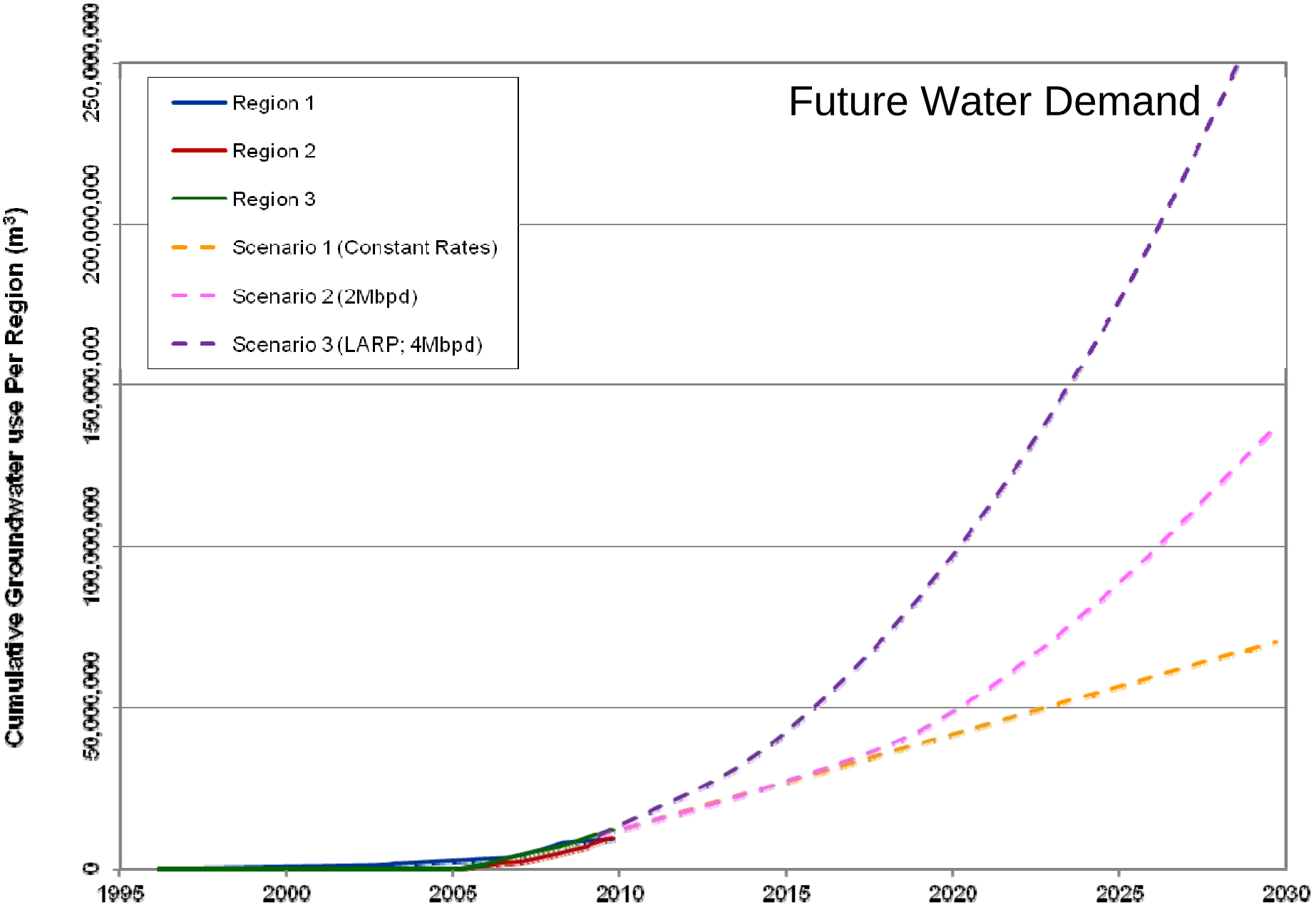
Predictive Scenarios



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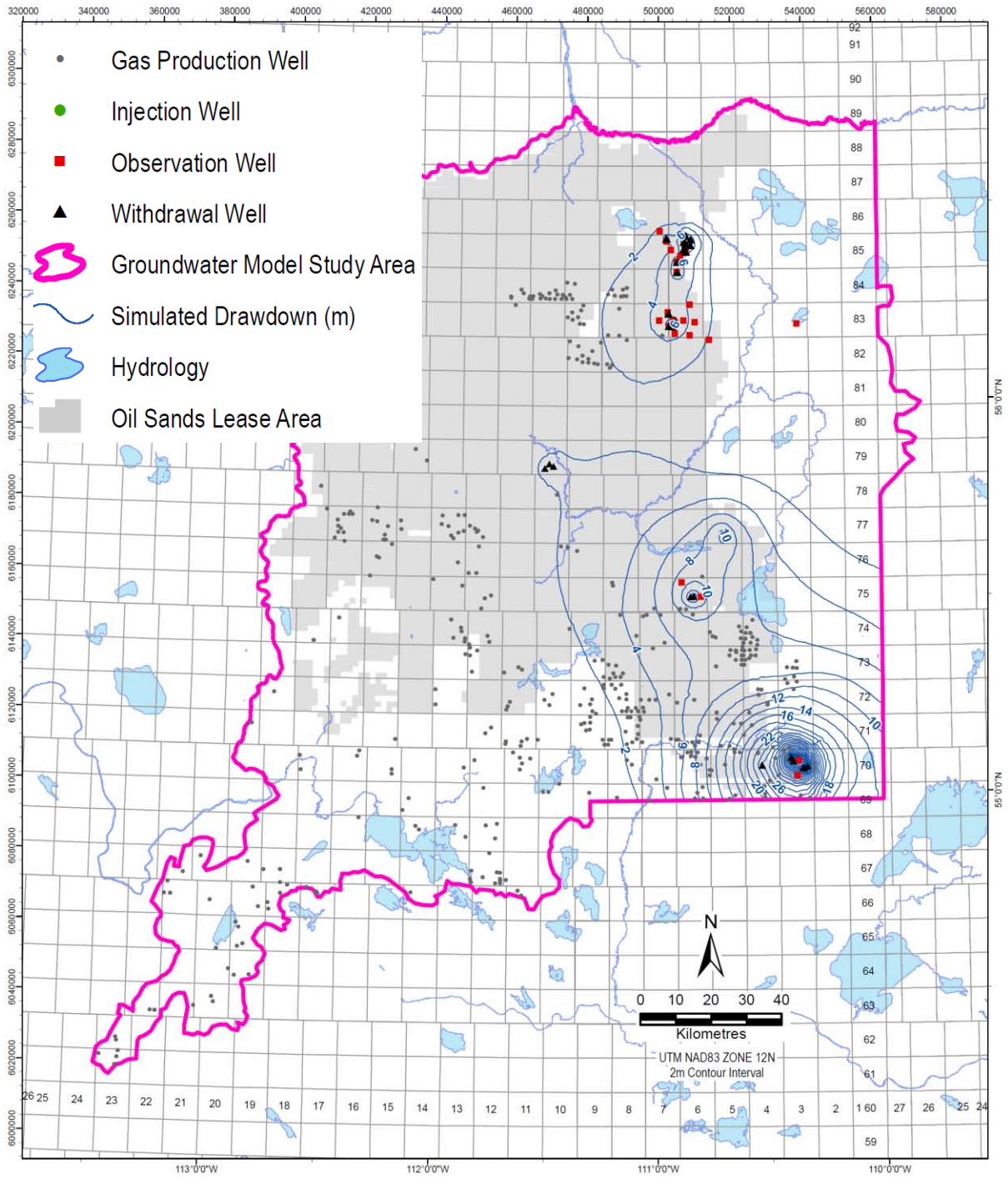
Scenario 1 Results

Drawdown in Lower Grand Rapids Aquifer

Scenario results can be used to :

- ►Quantify regional cumulative impacts
- ►Recommendations for monitoring network development
- ►Assess projected drawdown at proposed MWs (targets)
- ►Assess effectiveness of existing guidelines



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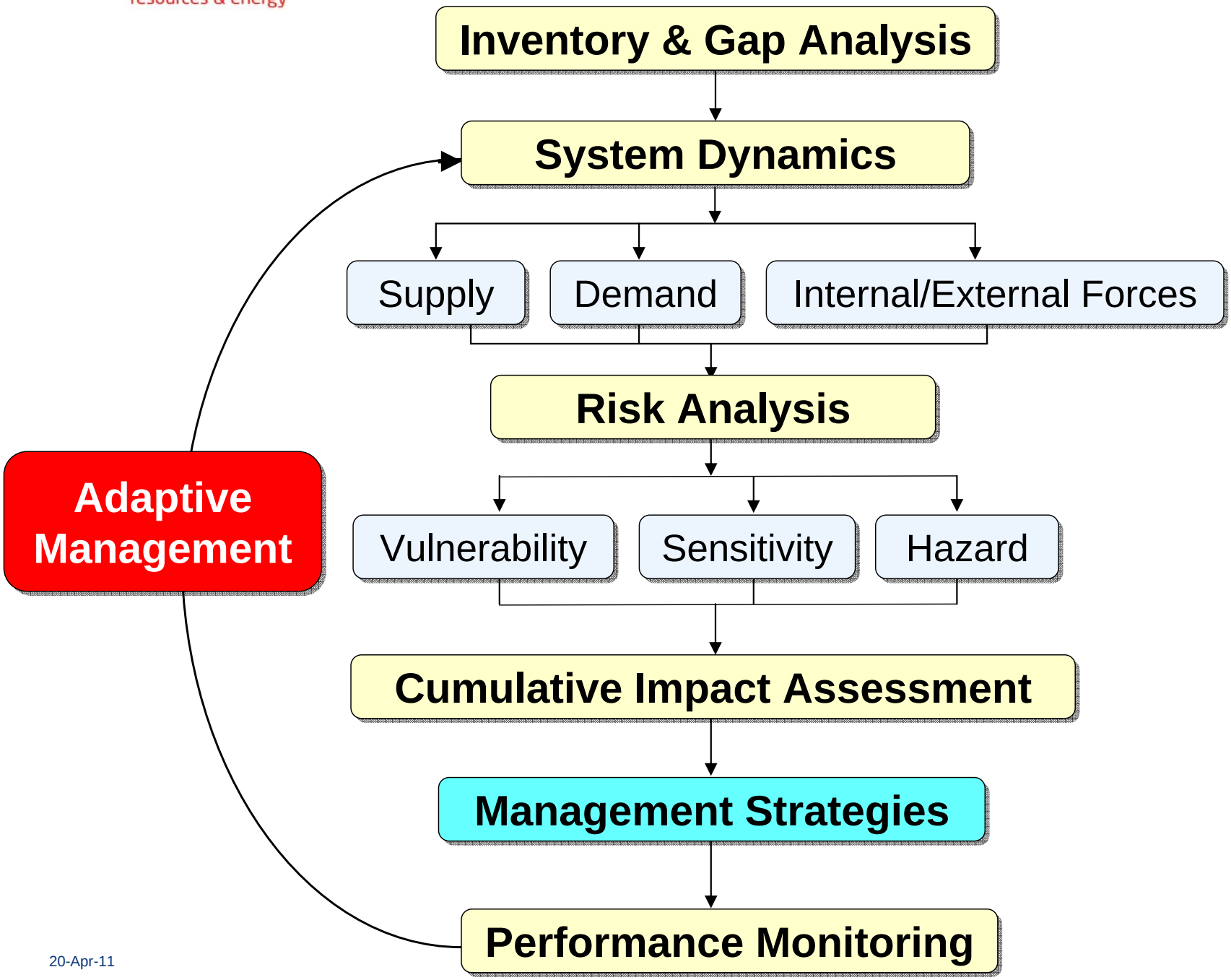
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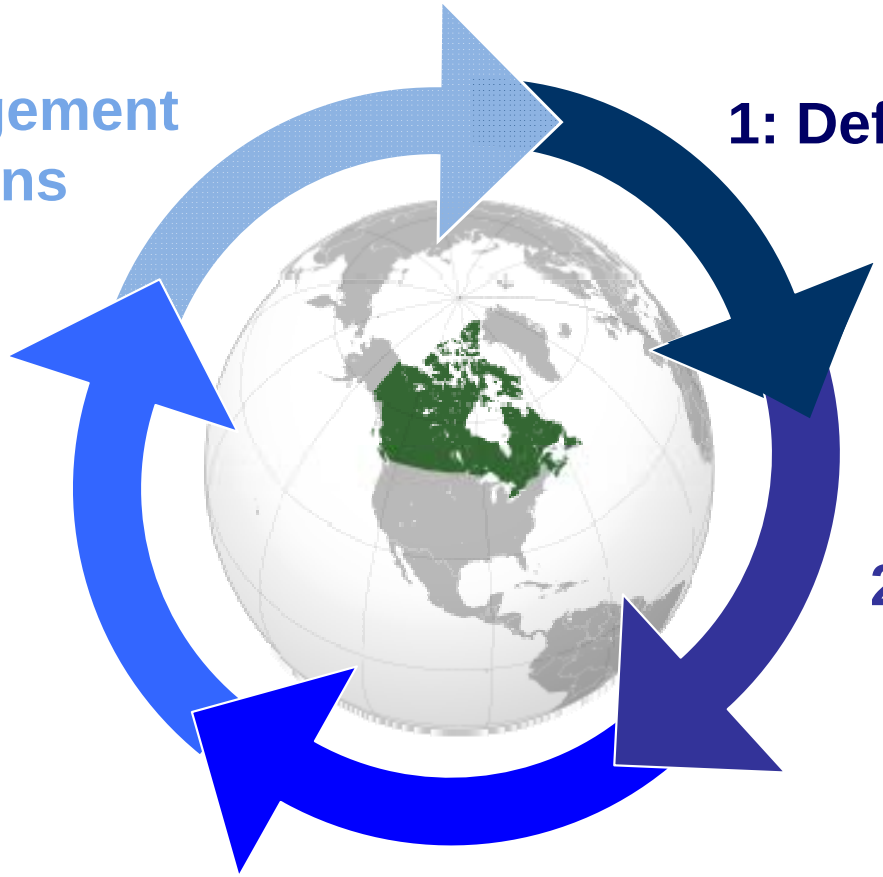
Management Strategies



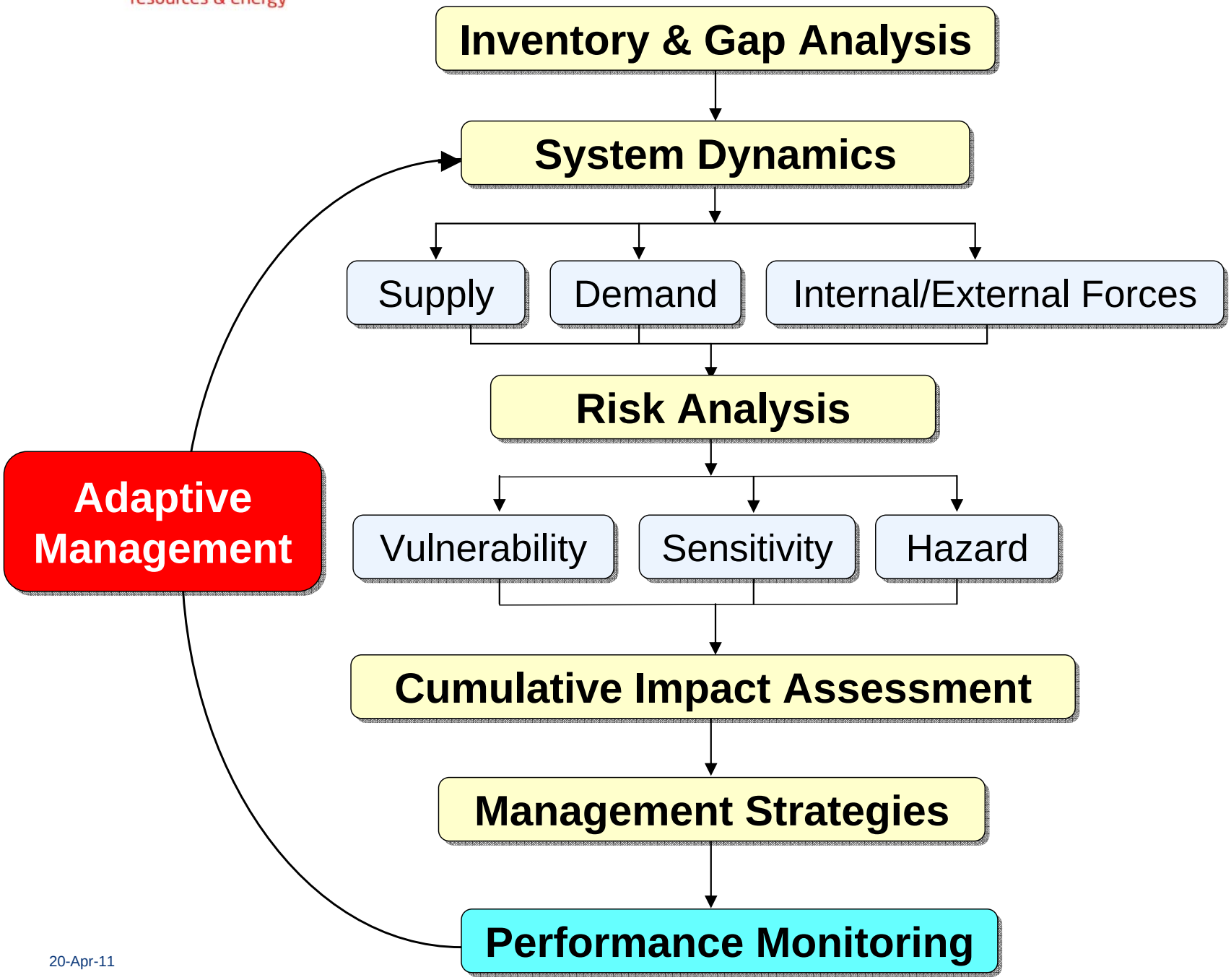
1: Define outcomes

2: Select indicators

3: Monitor indicators

4: Evaluate indicators using targets and thresholds

5: Management actions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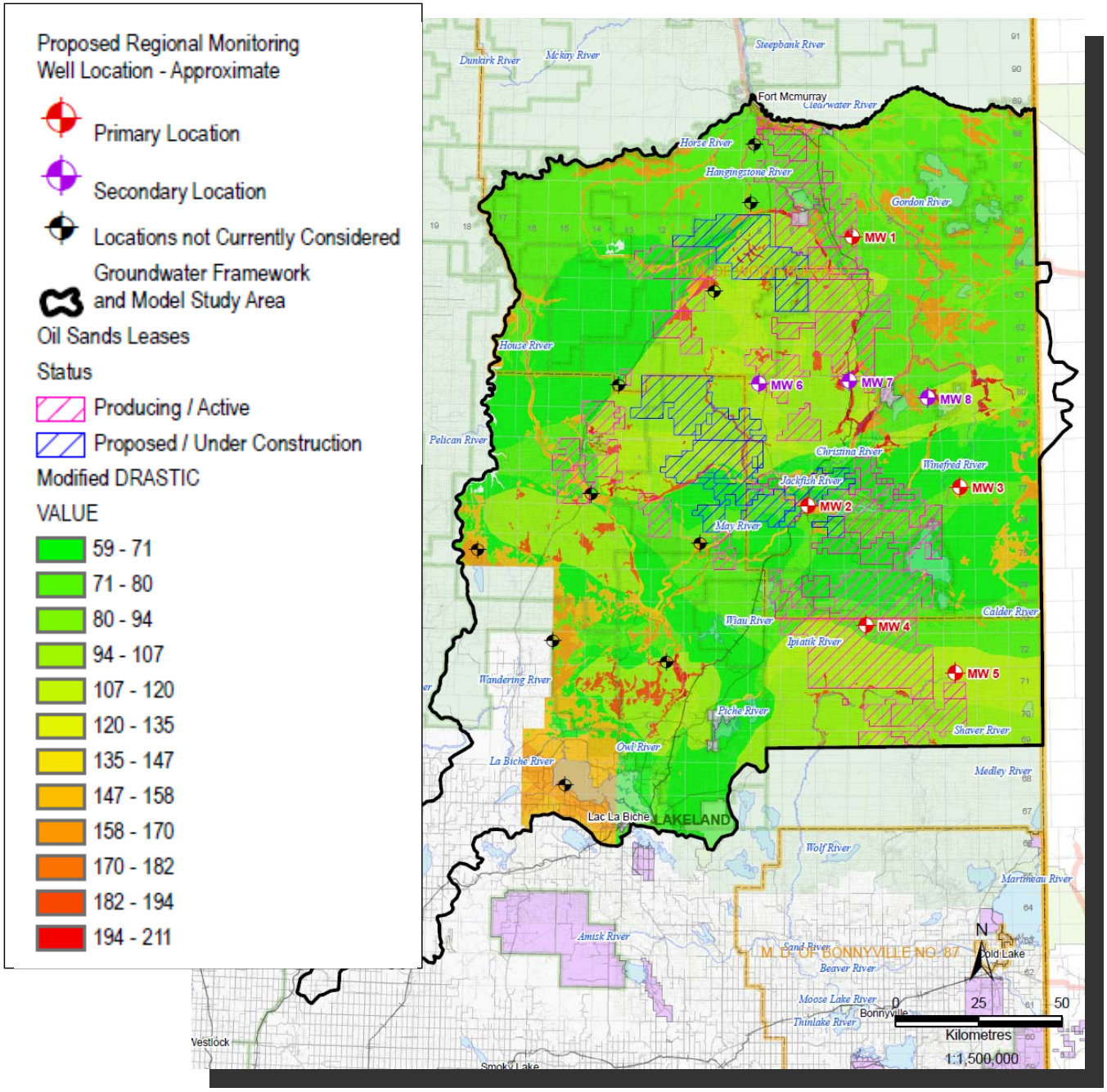
Performance Monitoring



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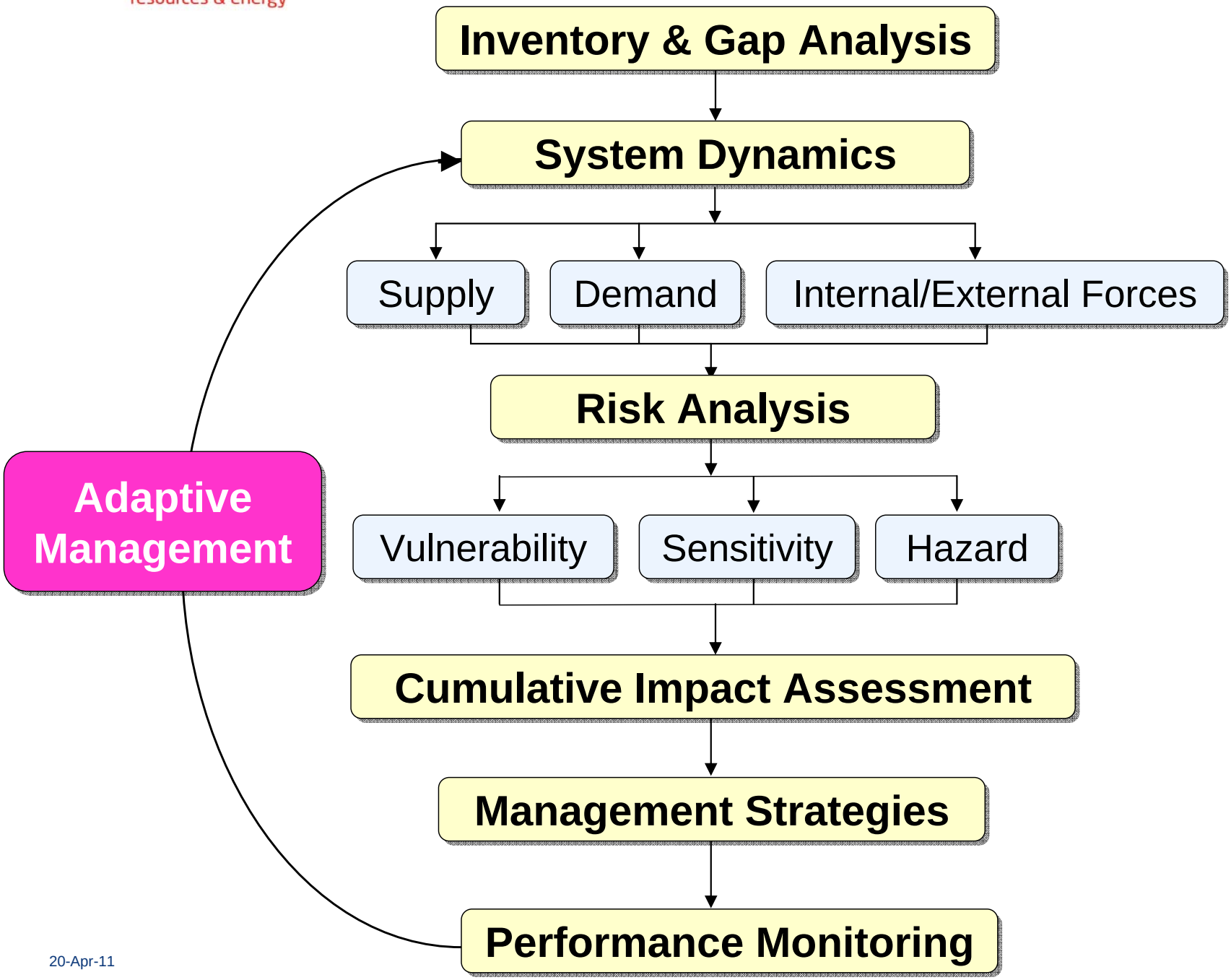
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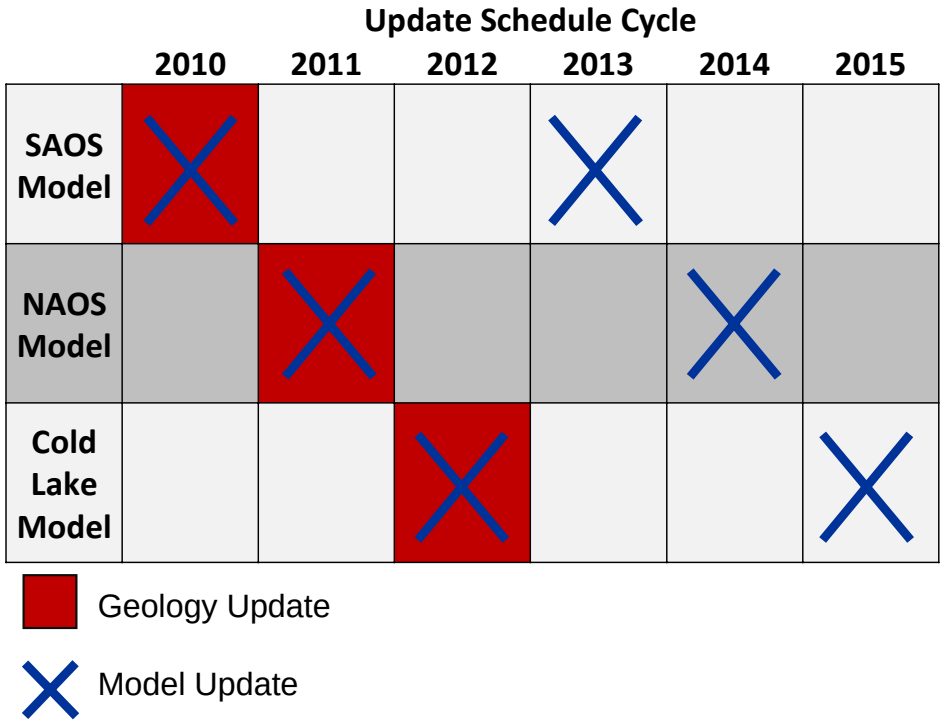
Adaptive Management

- Management tools developed are dynamic, not static
- Develop tools to facilitate updates (templates, database tools, etc.)
- Regular data maintenance required
  - Roles and responsibilities (regulators, operators, stakeholders, consultants)
  - Define update schedule



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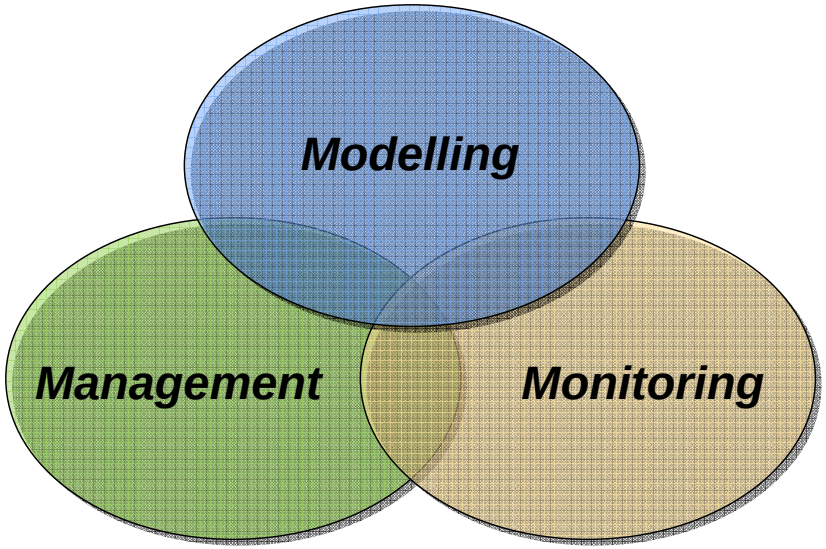
Continued Work

- Assess potential cumulative impacts to assist with sustainable resource planning and strategic management decisions *(Modelling)*
- Design and implement a groundwater monitoring network as per the management strategy *(Monitoring)*
- Implement GW management framework - defined goals, targets & thresholds *(Management)*
- Develop GW working group to administer network & communicate results *(Management)*



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Summary

- A systematic approach is key to addressing complex challenges
  - predicated on risk identification and risk management
- Effective, achievable and pragmatic outcomes required to ensure sustainable development
  - incorporation of engineering & science into water governance
- Integration of tools and approaches will facilitate rigorous assessment, detection of change, and response to challenges identified

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Thank you

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