Integrated Models for SEA and other land-use decision-making.

Ruth Waldick
Environment Canada, Ottawa, Canada
Ruth.Waldick@ec.gc.ca

This paper presents the proceedings from a workshop on the development and use of landscape planning models we recently held in Ottawa, Canada. The event's purpose was to ask modelers and snr policy developers, private sector representatives and a suite of academic experts, whether or not modeling tools would be beneficial for policy decision making, planning, SEAs, EAs, etc. The response was an unequivicol YES.

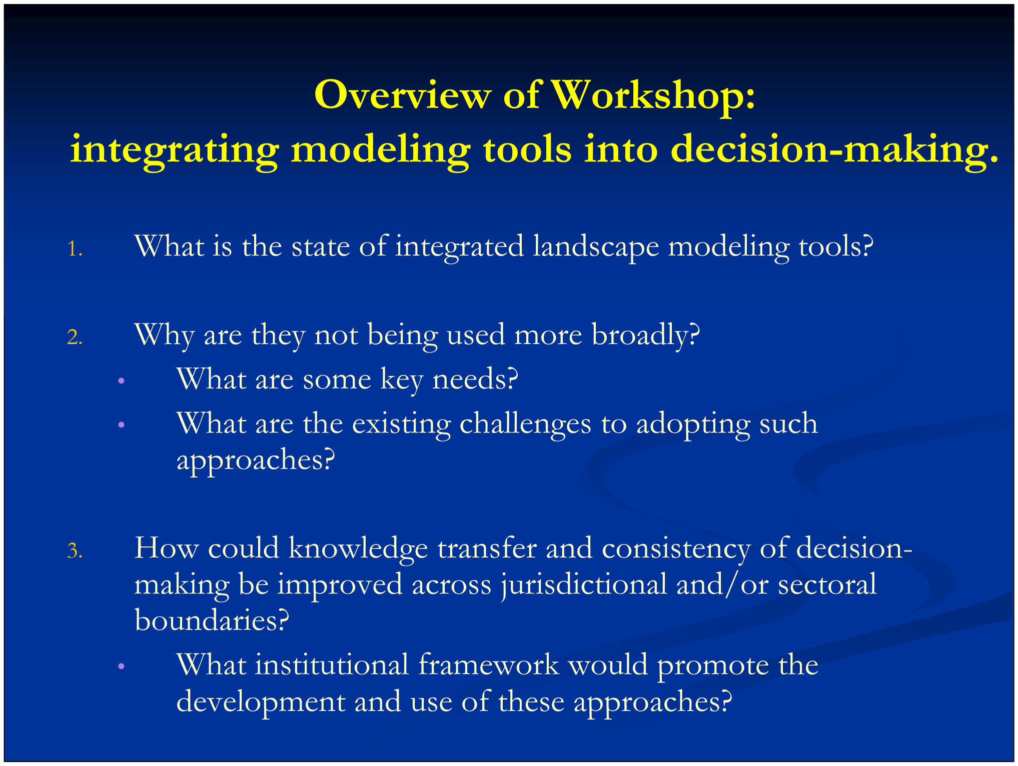
As such, the focus on our workshop was not about the nature of modeling tools, but focused rather in asking

(1) What is the state of application of modeling tools for SEA/EA/planning?

(2) Why are they not being used more?

(3) What would be required to facilitate their development and further use?

Although the workshop consisted primarily of US and Cdn government policy people, modelers and academics, the discussion identified challenges **derived from characteristics of western governance systems and, therefore, the conclusions reached extend beyond North America in the relevance.**



My talk is divided into three parts,

(1) First, a brief review of the current state of integrated modeling tools for policy and land use decision making. I will begin by providing a few examples of the ways in which landscape planning tools are being used (in Canada).

(2) I will then present an overview of some of the key challenges to the implementation of these tools that were identified during our expert workshop (HANDOUT reference)

(3) I will finish then with part 3, which will present the conclusions reached by participants regarding the way in which these challenges could be overcome so that landscape planning tools could be incorporated into the policy decision-making process.

*A need has clearly been identified by the WSSD for the need for new tools for SEA and EAs, specifically tools that apply scientifically-based approaches to strategic planning and decision making.

*In 2004, Canada's Commissioner on the Environment and Sustainable Development reviewed the state of SEAs in Canada and identified challenges that must be better addressed to successfully achieve SD objectives. The Commissioner also noted that in addition to the existence of implementation gaps, there is a problem in that existing policy tools were not being used fully.

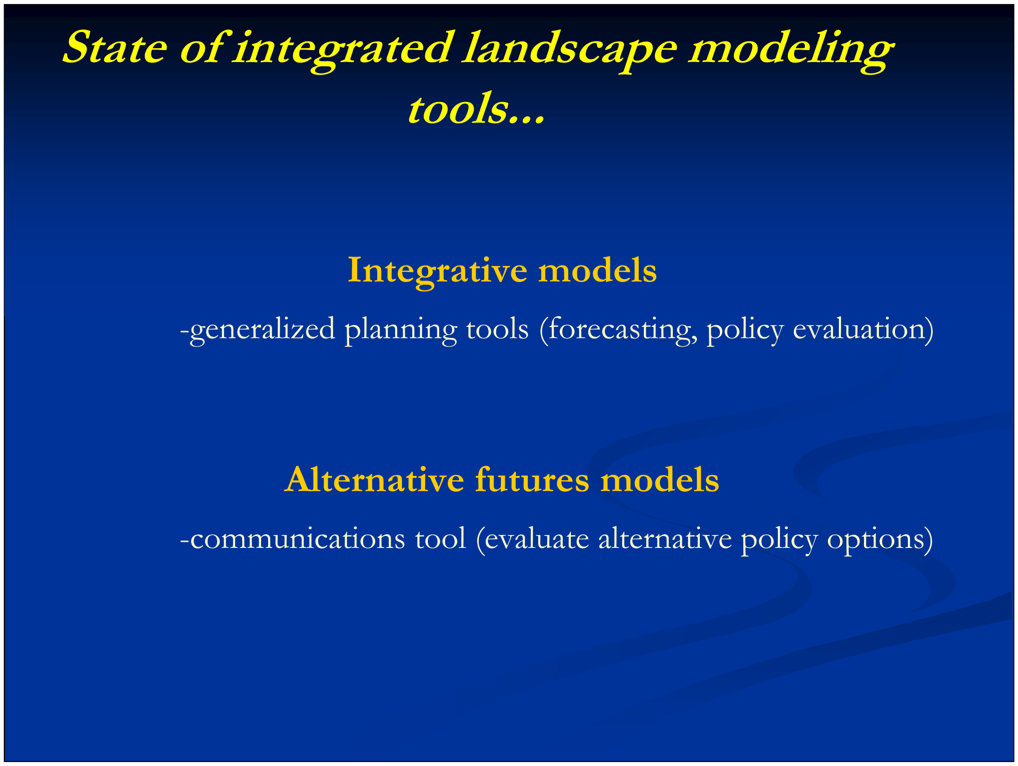
*These characteristics apply equally well to both SEAs and EAs, in that both are lacking in the application of appropriate strategic planning approaches. At present, there are no quantitative assessments of the relative risks or uncertainties between different policy outcomes, including the complex interactions that may take place between seemingly isolated decisions.

*The gap is further exacerbated by the tendancy of SEAs and EAs to focus on specific issues or problems within politically bounded areas which rarely correspond to geographically meaningful boundaries – such as watersheds or ecological districts.

*Policies bounded within sectoral or political constructs preclude any possibility of identifying potential negative interactions or cumulative effects within relevant geographic scales/areas.

**Modeling tools offer an opportunity to assess interactions at appropriate scales using quantitative approaches, and provide a way of evaluating multiple options simultaneously. Landscape planning tools would be useful for SEAs and EAs to mitigate risk and identify potential conflict…

***Consequently, the focus of our workshop was to determine the feasibility of using these approaches… the first question we asked was "Are modeling tools available in a form capable of providing information or insights into these issues?" i.e., **Are landscape modeling tools at a point where they could be used to inform decision making?**



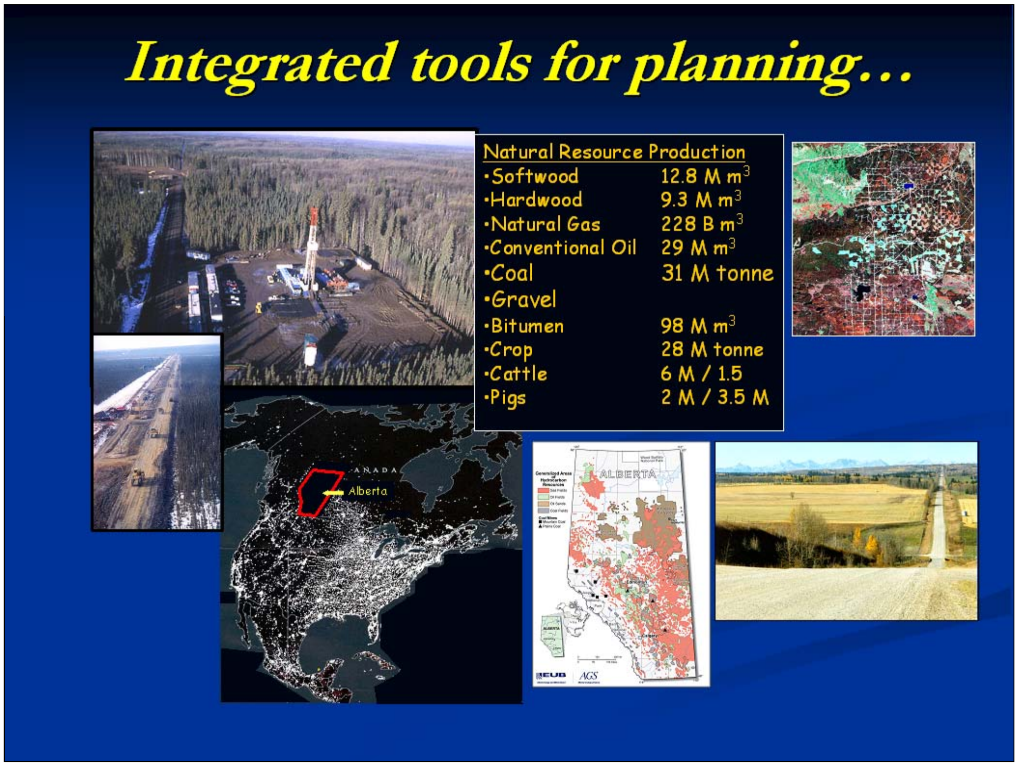
Advances in analytical methods and technology, notably the growth in the use of geographic information systems, have contributed significantly to the evolution of increasingly complex, integrative models. Several basic forms of models have evolved for simulation modeling, each of which uses quantitative data to provide statistical estimates of the outcomes of different possible management scenarios to differing degrees of resolution. Models may range in scale and complexity of detail according to the questions of interest to managers, ranging from engineering and population planning, to ecosystem and habitat conservation.

However, for the purposes of this paper, I will be referring only to those computer-based simulation models designed to project outcomes of various policy and development activities that integrate social, economic, and multiple environmental objectives. As such, when I refer to Integrated Landscape Management Models, I refer to landscape tools that consider policies across sectoral or disciplinary divisions. These can broadly defined as being either

(1) Tools that project or forecast outcomes and interactions among factors or indicators of interest under different management or policy options,

(2) Tools that facilitate communication and policy discussions among stakeholders – to evaluate alternative strategies and consider possible outcomes of choices by simulating generalized patterns of behaviour (rather than making specific predictions).

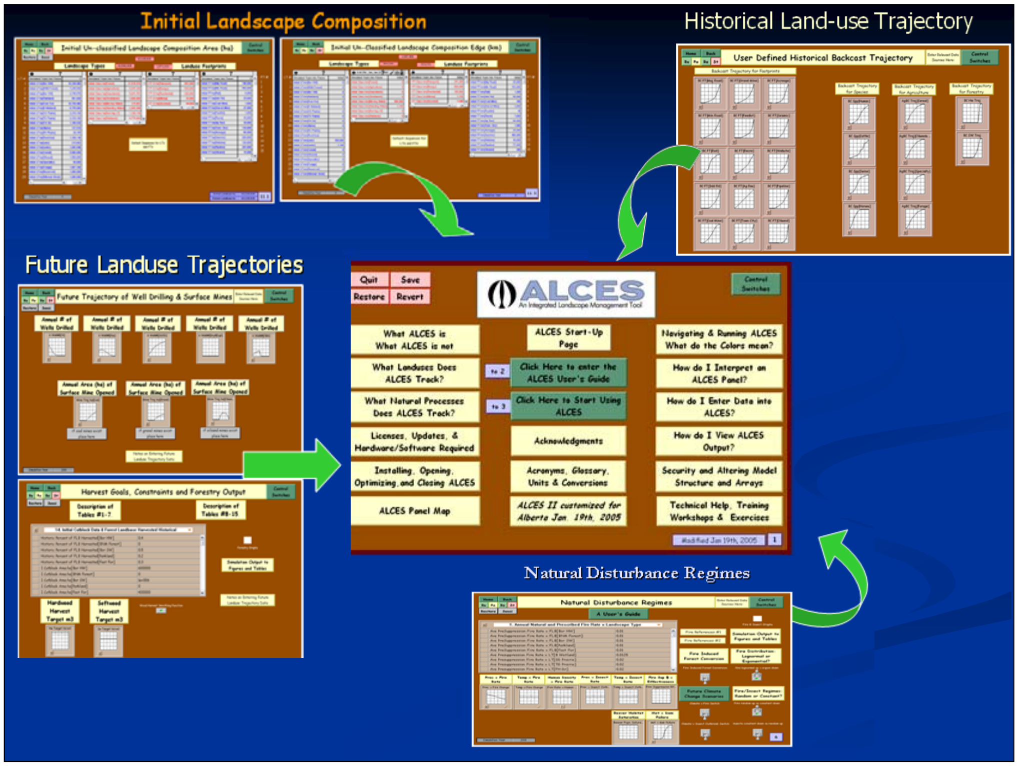
An example of each type of modeling approach follows:



***Integrative models**, are those modeling tools that incorporate specific data on a suite of indicators of importance, ranging from economic indicators such as Natural Gas production to environmental data, such as species diversity per unit area or ground water quality.*

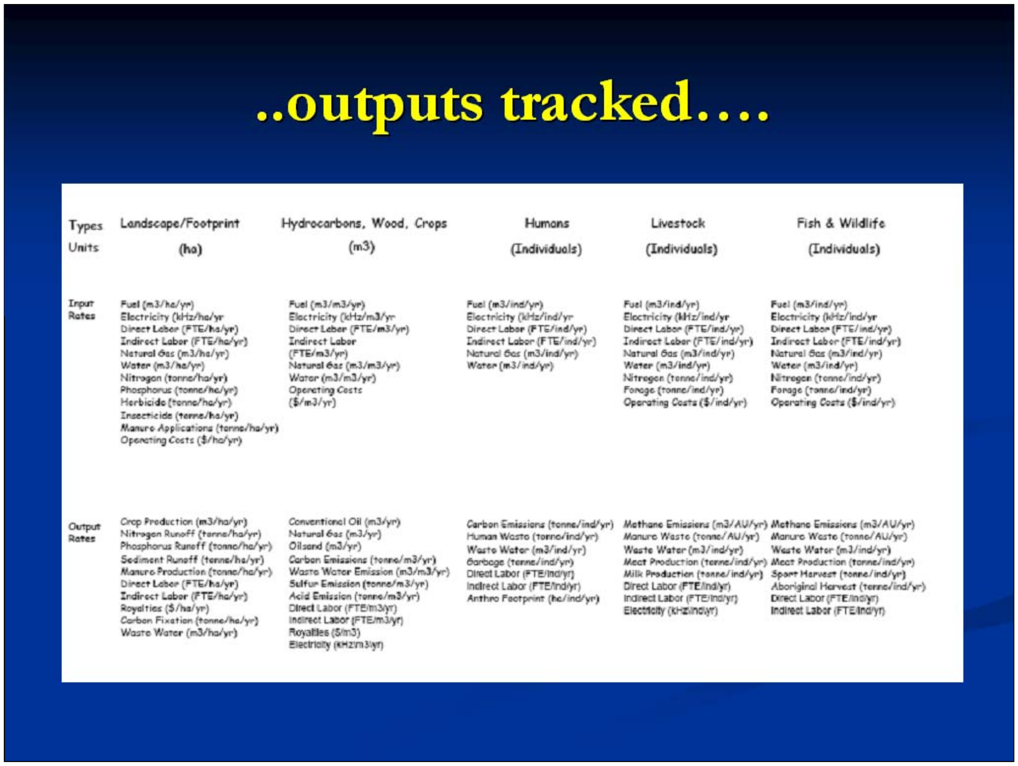
In Canada, such integrative modeling tools are used to project interactions between different sectoral activities and to identify potential cumulative effects of different policy and management choices. An example of the application of such a tools is that of ALCES, a STELLA-based modeling tool that is being applied extensively in Alberta to deal with the broad and varied nature of resource extraction and land use activities that compete across this landscape.

Alberta is a province in central-western Canada with an extremely high level of diverse land use activities taking place. These range from ranching and small scale agriculture to large-scale tree harvesting and oil exploration. The hydrocarbon stores are particularly relevant in Alberta at the present time, with high oil prices driving energetically costly extraction processes, notably that associated with Alberta's tar sands deposit, the second largest store of hydrocarbons in the world. Since these areas underlie heavily agricultural landscapes to the south, and active logging areas and conservation areas in the north, competition for energy, water, etc., create a high potential of conflict. The landscape is also increasingly fragmented by road construction and other forms of land changes. As such, conflicts frequently occur in association with access to water, roads, and the impacts of pollution, among other things. ALCES was developed through a private-public collaboration in order to mitigate such effects, and to reduce conflict and cumulative impacts associated with different sectoral activities/interest groups.



ALCES is capable of evaluating the state of the landscape in question under current, historic, and future conditions, using known or feasible rates of transformation, succession, or development. Interactions between all variables are tracked simultaneously, so that the spin off or cumulative effects of any single policy or land use change can be tracked across all relevant variables. Because of the complex environment in which ALCES evolved, it is capable of tracking and reporting on 1000s of different variables, including interactions and cumulative effects, over different spatial and temporal scales. As such, ALCES is truly integrative in that it is capable of considering a broad range of activities simultaneously and projecting interactive outcomes and cumulative effects for a multitude of activities across a landscape of interest. It can also do so under natural disturbance regimes, climate change scenarios, or other stochastic events.

Because of the complexity of the interactions tracked, ALCES is able to provide insights into the interactions between seemingly independent sectoral activities, including hydrocarbon extraction, urban development, and wildlife conservation. ALCES is currently used to evaluate the potential interactions, conflicts, and outcomes of different land use and policy changes (ie., used to project future effects and relative outcomes of different decisions). ALCES is a fast running program, but it is worth noting that, as with all models, the biggest time consumer is acquiring and inputting the data into the system.



Types Units	Landscape/Footprint (ha)	Hydrocarbons, Wood, Crops (m3)	Humans (Individuals)	Livestock (Individuals)	Fish & Wildlife (Individuals)
Input Rates	Fuel (m3/ha/yr) Electricity (kHz/ha/yr Direct Labor (FTE/ha/yr) Indirect Labor (FTE/ha/yr) Natural Gas (m3/ha/yr) Water (m3/ha/yr) Nitrogen (tonne/ha/yr) Phosphorus (tonne/ha/yr) Herbicide (tonne/ha/yr) Insecticide (tonne/ha/yr) Manure Applications (tonne/ha/yr) Operating Costs ($/ha/yr)	Fuel (m3/m3/yr) Electricity (kHz/m3/yr Direct Labor (FTE/m3/yr) Indirect Labor (FTE/m3/yr) Natural Gas (m3/m3/yr) Water (m3/m3/yr) Operating Costs ($/m3/yr)	Fuel (m3/ind/yr) Electricity (kHz/ind/yr Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr) Natural Gas (m3/ind/yr) Water (m3/ind/yr)	Fuel (m3/ind/yr) Electricity (kHz/ind/yr Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr) Natural Gas (m3/ind/yr) Water (m3/ind/yr) Nitrogen (tonne/ind/yr) Forage (tonne/ind/yr) Operating Costs ($/ind/yr)	Fuel (m3/ind/yr) Electricity (kHz/ind/yr Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr) Natural Gas (m3/ind/yr) Water (m3/ind/yr) Nitrogen (tonne/ind/yr) Forage (tonne/ind/yr) Operating Costs ($/ind/yr)
Output Rates	Crop Production (m3/ha/yr) Nitrogen Runoff (tonne/ha/yr) Phosphorus Runoff (tonne/ha/yr) Sediment Runoff (tonne/ha/yr) Manure Production (tonne/ha/yr) Direct Labor (FTE/ha/yr) Indirect Labor (FTE/ha/yr) Royalties ($/ha/yr) Carbon Fixation (tonne/ha/yr) Waste Water (m3/ha/yr)	Conventional Oil (m3/yr) Natural Gas (m3/yr) Oilsand (m3/yr) Carbon Emissions (tonne/m3/yr) Waste Water Emission (m3/m3/yr) Sulfur Emission (tonne/m3/yr) Acid Emission (tonne/m3/yr) Direct Labor (FTE/m3/yr) Indirect Labor (FTE/m3/yr) Royalties ($/m3) Electricity (kHz/m3/yr)	Carbon Emissions (tonne/ind/yr) Human Waste (tonne/ind/yr) Waste Water (m3/ind/yr) Garbage (tonne/ind/yr) Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr) Anthro Footprint (ha/ind/yr)	Methane Emissions (m3/AU/yr) Manure Waste (tonne/AU/yr) Waste Water (m3/ind/yr) Meat Production (tonne/ind/yr) Milk Production (tonne/ind/yr) Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr) Electricity (kHz/ind/yr)	Methane Emissions (m3/AU/yr) Manure Waste (tonne/AU/yr) Waste Water (m3/ind/yr) Meat Production (tonne/ind/yr) Sport Harvest (tonne/ind/yr) Aboriginal Harvest (tonne/ind/yr) Direct Labor (FTE/ind/yr) Indirect Labor (FTE/ind/yr)

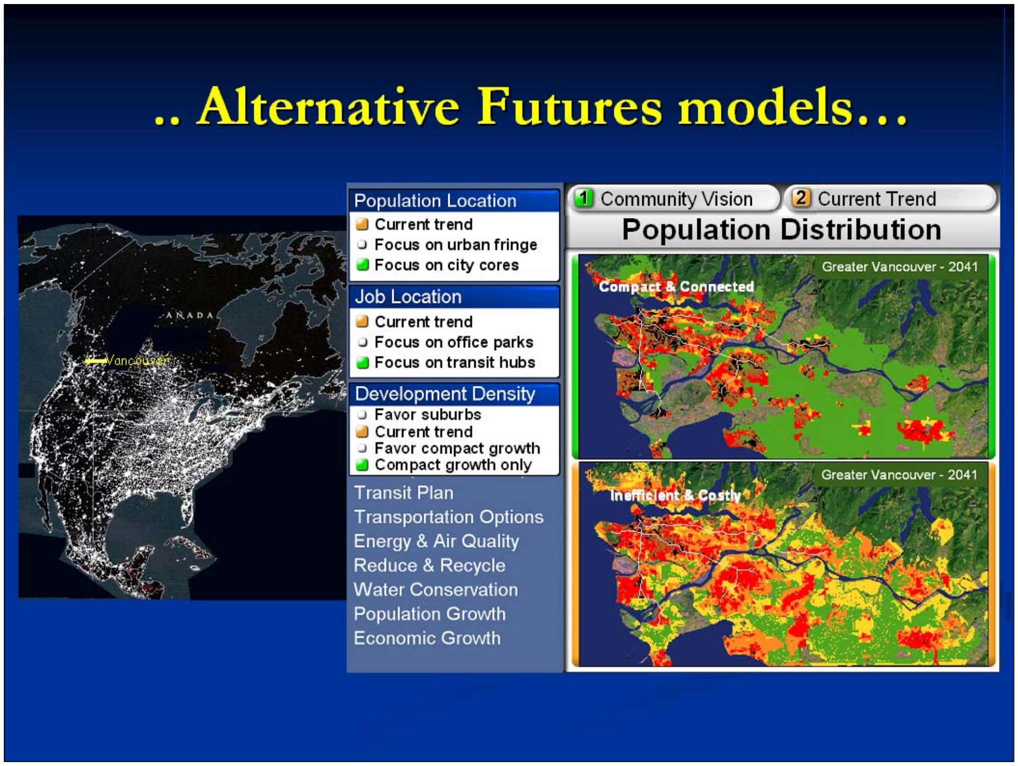
Features of system:

* model runs quickly (the biggest time consumer is acquiring and inputting the data into the system)

* data on current and historic conditions can be used to identify the extent of changes in indicators of interest over time

* evaluates how changes in land-use policies/plans will affect environmental and socioeconomic indicators (cumulative effects and INTERACTIVE effects are tracked)

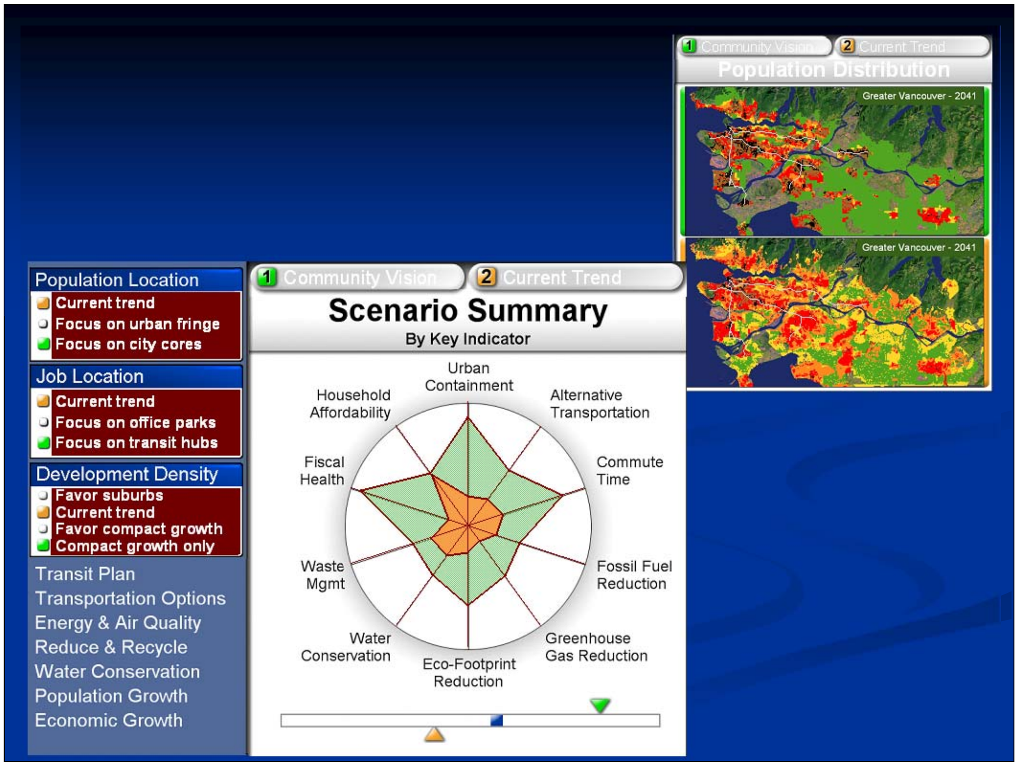
- **Can also consider interactions and compound effects of natural disturbance, and global warming**



The second type is that of an *Alternative Futures* approach, which are designed to compare relative outcomes of different policy outcomes in order to generate and facilitate discussion/communication among stakeholders about the benefits and trade-offs associated with different land-use choices. The example shown is from QUEST, a system developed through academic-government-private contributions during a period of over 10 years. This model differs from ALCES in that it does not track interactions or cumulative impacts, but rather maps policy options and their effects on an area of interest, and evaluates the effects of alternative policy options. It was initially developed in the Georgia Basin, the basin within which the city of Vancouver is located, to facilitate planning through dialogue among stakeholder groups about priorities and trade offs (still ongoing as Georgia Basins Quest).

The focus of QUEST is on compiling appropriate stakeholder groups and allowing them to compare several alternative futures – to evaluate the outcomes of these alternatives on indicators of interest (eg., quality of life, water), and to facilitate dialogue and stakeholder discussions about options. The goal of these participatory stages is to run through enough scenarios to inform stakeholders and assist in their arriving at the *most desireable* option. This system considers broad environment, economic, and social considerations. The benefit of using QUEST is that it allows stakeholders to compare several futures side by side, identify their relative impacts, and evaluate their effects using a suite of indicators of interest.

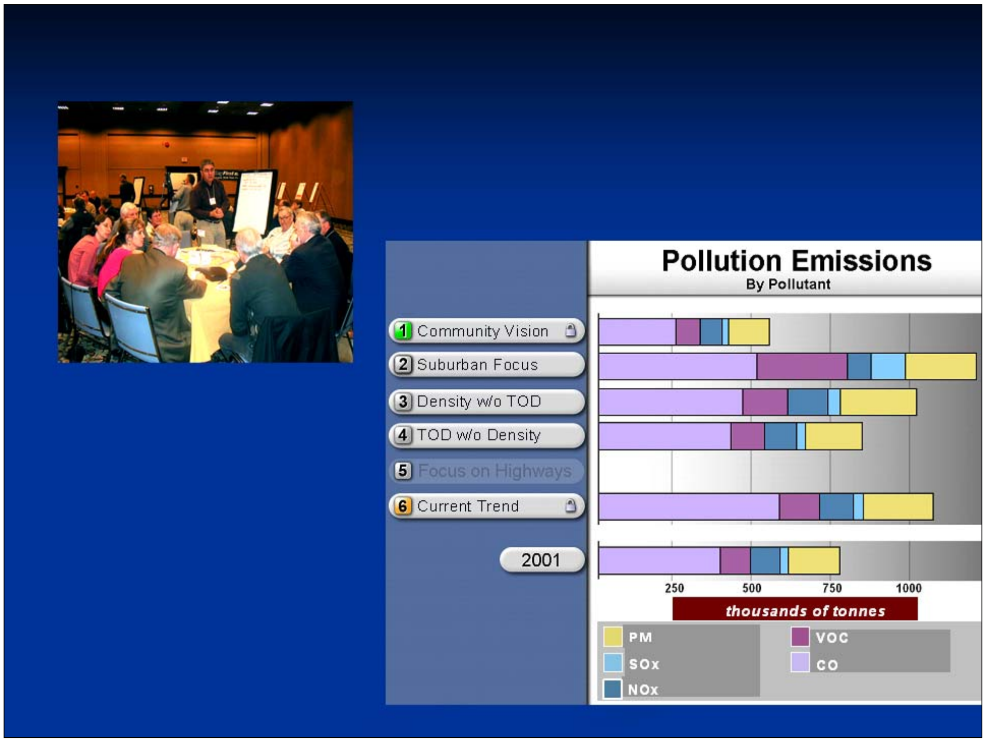
In a workshop, stakeholders can create several scenarios. This display shows the list of scenarios created and saved in a workshop (on the left), and allows you to see the results of each of these scenarios side-by-side. This model is also data dependent, although unlike the integrative model types, focuses on demonstrating or tracking the compounded effects of policy outcomes rather than projecting interactions or cumulative effects.



On the top right, you see an example of two alternative futures visions for the georgia basin area (2041). The population has doubled in this time. In the community vision (top), policies have been established to regulate industrial development and land use, as such, agricultural areas persist and the city has been developed to support high densities of people around transportation corridors. In the lower screen, you see the projections under the current policy and development trends.

What you see at the lower left is a screen capture of one of the reporting or tracking screens from several scenario runs. This summary shows values for a series of indicators that were selected initially by the stakeholders, and demonstrates where the differences lie with regard to the community vision scenario (in green) and the current trend scenario (in orange).

These indicators serve as information to facilitate dialogue among stakeholders regarding the consequences of different policy choices. It is worth noting that in this example, the community vision was the preferred vision by all stakeholder groups, which focused on regulated **industrial and urban growth, retention of agricultural lands, and a focus on efficient transportation.**



Although QUEST does not track cumulative effects, it does track the impacts of individual policies. Consequently, changes in urban density, industrial development, and transportation patterns will produce emission output data on emissions such as those in the lower right of the screen.

Here you see a comparison of five different alternative futures, and the relative impacts on pollutants – each of which can be tracked back to individual policy choices. As a result, even though Quest does not track cumulative effects, it provides information on the relative costs and impacts of individual policy choices.

Emphasis of Alternative Futures approach is less on prediction or projection, but more on:

-Engage stakeholders in scenario planning

-Foster dialog on values and priorities

-Educate on the costs & benefits of options

-Gather feedback on desired futures & acceptable tradeoffs

-Reinforce the plan and its benefits during implementation

*This model is more time consuming than the previous due to the emphasis on stakeholder engagement and communication throughout the planning process

The desireable policy options are ultimately identified by eliminating undesireable future scenarios one by one.

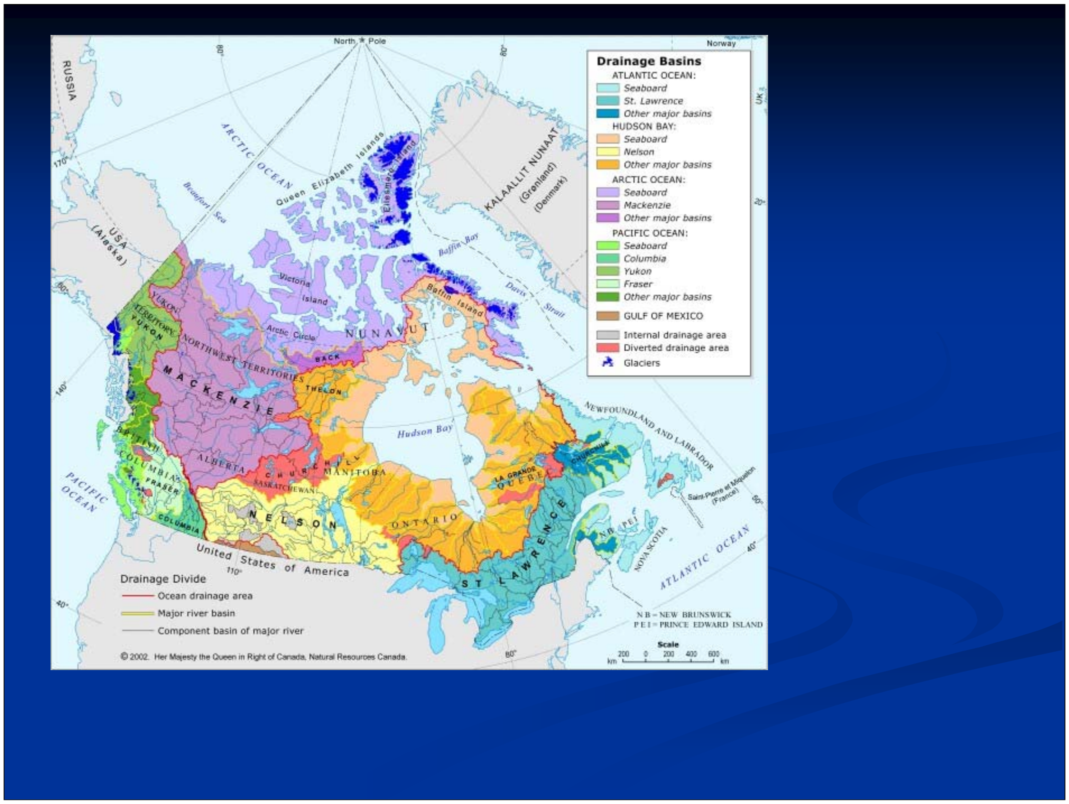
NOTE: Although Quest was originally developed within a physically delineated area, the Georgia Basin, the system has recently undergone changes to reduce its scope. Current versions of Quest, now known as MetroQuest, are applied within politically bounded urban centres, with an emphasis on development and transportation over environmental health. This streamlining has increased the market for this planning tool, which is now being applied in six urban centres across Canada. However, these changes have required that the tool become more generalized, and the breadth of variables considered and scope of indicators tracked have been significantly reduced. In effect, the more expansive and integrative system is now in the form of a more generalized urban planning tool.

Clearly a variety of different types of integrated planning tools are available to address different types of land-use planning and policy questions.

However, both examples demonstrate that such approaches, even when applied, tend to be applied with limited scope. Alces is almost exclusively used in Alberta, and is highly politically bounded, while Quest has gone from a broader evaluation tool to a more restricted, politically bounded tool that focuses within urban centres. Both are jurisdictionally bounded which limits their scope.

This indicates that these quantitative approaches are highly informative but are subject to the same problems/challenges that are currently limiting the scope of SEAs – in other words, that their ability to be integrative/strategic is limited by the narrow scale and breadth of their application (i.e., geographical, ecological, and disciplinary).

Why are they not being applied more routinely? What are the key challenges that limit the use of these approaches?



The principle challenge identified can be summed up as a lack of institutional capacity or a formalized mechanism to coordinate policies and reduce conflict across jurisdictional and sectoral boundaries.

This is illustrated in this example of the distribution of drainage basins across Canada. These basins span across multiple political (provincial) boundaries, thereby creating a situation where decisions made within one political jurisdiction, in this case a province or territory, will have ramifications for neighbouring regions.

Existing governance structures do not correspond with these basins, nor with other biophysical areas, such as ecoregions. These political divisions limit the scale at which modeling tools can be applied, however, they are exacerbated by the structure of government agencies along sectoral lines (eg., agriculture, transportation, fisheries, etc). As such, water issues are dealt with individually within sector-specific agencies.

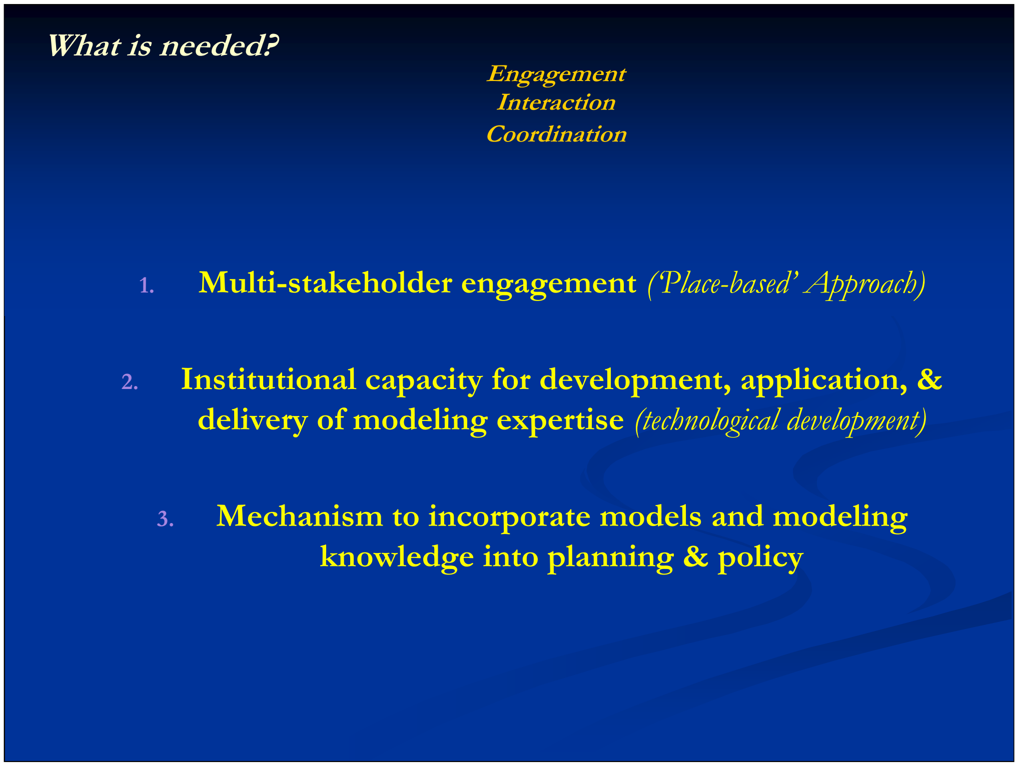
Another challenge is the reality that land-use decisions and resource policies are made at local levels, by provincial and municipal governments. This further limits the scope of model application, since the decision-making scales do not correspond to the scales at which environmental processes occur. In the absence of overarching government agencies, strategic and integrative planning across disciplines is unlikely to occur.

Integration across agencies or disciplinary divisions is further limited by the presence of multiple levels of decision-making bodies, at local, regional, and federal levels. In Canada, for instance, each of the 10 provinces and three territories have multiple departments responsible for land-use planning, in addition to the more than 20 additional federal departments and agencies run both centrally and regionally.

In many countries, no single department or sector is currently capable or mandated to initiate this level of coordination. As such, integration across political boundaries (or at bio-physical scales) must fall within the domain of federal or national governments. The main problem with integration across sectors (which affects SEA, EA, and modeling initiatives) is the lack of any formalized process to facilitate the transfer of information across hierarchical and sectoral divisions.

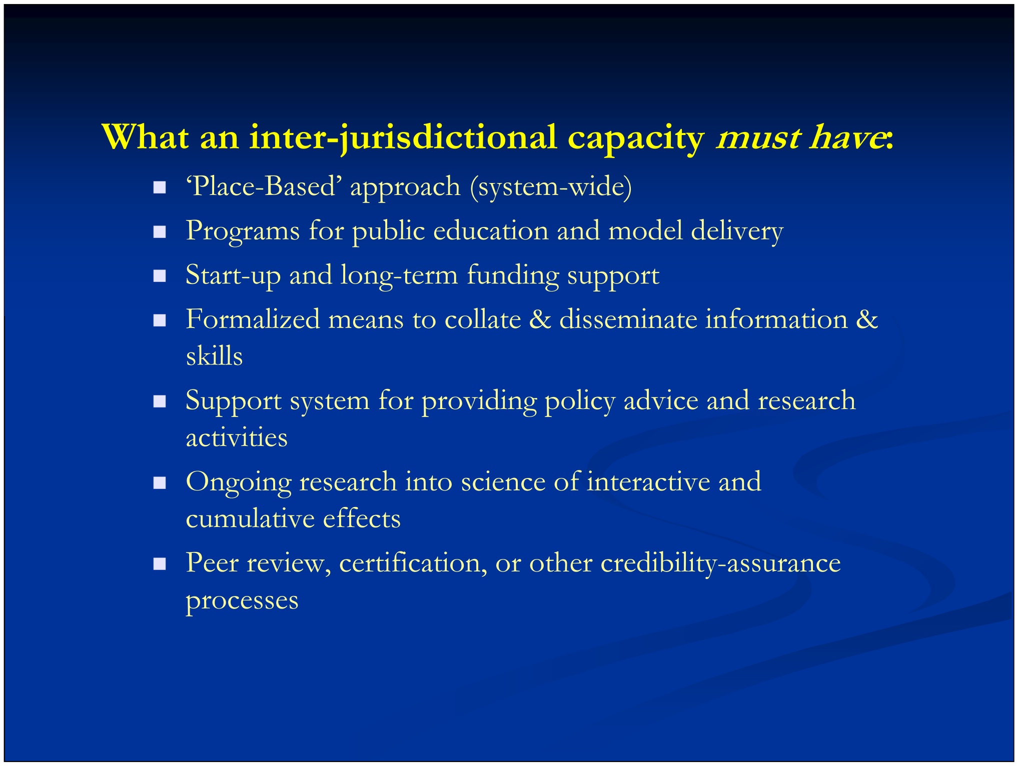
In Canada, many modeling tools have been developed for discipline-specific applications (i.e., different reasons), by a variety of groups (governmental and non-governmental). Most are unaware of the other. In the USA, like Canada, a large number of discipline specific models exist, as do more complex, integrated models. However, these models have been developed on a case-by-case basis through a variety of collaborative efforts, including various levels of government (EPA, USACE, USGS, etc) and private organizations (eg., universities). Although the capacity for interagency work is greater in the US, models are still applied largely to single issues (i.e., not fully integrative).

In both countries, little coordination exists among model developers because models tend to be developed for specific and often local reasons, and because of the complete absence of any central lead agency to facilitate dialogue, knowledge transfer and integration.



The biggest challenges to creating the required inter-jurisdictional capacity are in establishing and maintaining community participation, communication and knowledge sharing, and, in the case of integrated models, in technological development.

For Information on landscape planning tools and decision-making, see:
http://policyresearch.gc.ca/doclib/SD_BN_IntLandscape_E.pdf;



What is needed is a way to:

1. Strengthen existing and new management planning projects/policies
2. Coordinate existing programs and priorities across political and sectoral boundaries (eg., biodiversity conservation, sustainable land use planning..)
3. Promote the development and adoption of standardized/consistent methodologies for cumulative effects assessments, and SEAs
4. Increase coordination of priorities across governments/public
5. Develop formalized mechanisms early in the policy life cycle to identify and mitigate conflict, reduce inconsistencies in priorities and redundancies.
6. Improve knowledge sharing and gap identification through formalized agreements and forums of engagement/exchange.
7. **Improve consistency of approaches to sustainable land use planning and policy development (municipal-regional-national levels)**

Landscape modeling tools are subject to precisely the same problems that are limiting the scope of integration within the SEA process. So, before such quantitative approaches can be applied, it is necessary to deal with issues of capacity.

In the third and final section of this paper, I will briefly provide an overview of some of the key conclusions reached at our workshop with regard to the following questions:

1. **What is needed to address these challenges?**
2. **How can integration within SEA and modeling efforts be increased and applied at** geographically or ecologically meaningful scales?

Please see Workshop Report for more detials:
http://policyresearch.gc.ca/doclib/ILMM_Workshop_Report_e.pdf

As a first step, the features of a facilitation capacity were outlined.

1. A formalized process for knowledge transfer and integration across political and disciplinary lines is required to overcome the limits of existing governance structures. All workshop participants felt there was a strong need for a process, or institution, that would provide strong leadership.

2. The process must directly address knowledge transfers and scale challenges, including:

-identifying appropriate community experts/modelers for the issue at hand

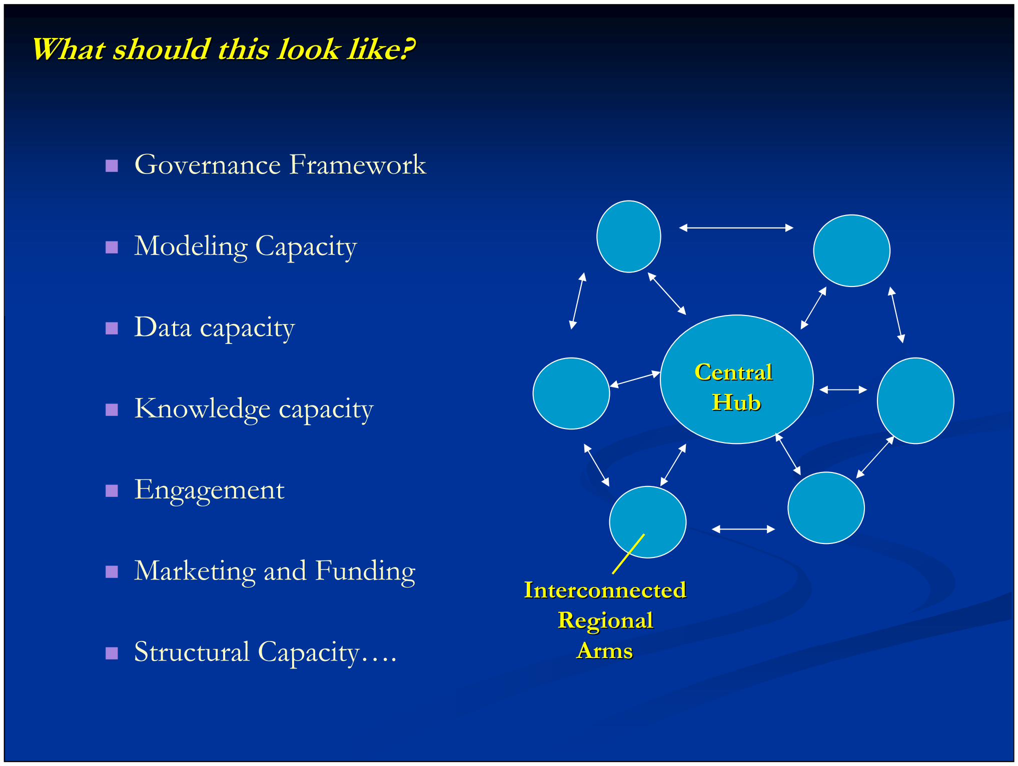
-developing and providing training and tool kits in use and application of modeling tools/approaches

-providing a forum for expert and stakeholder engagement (communication facilitation)

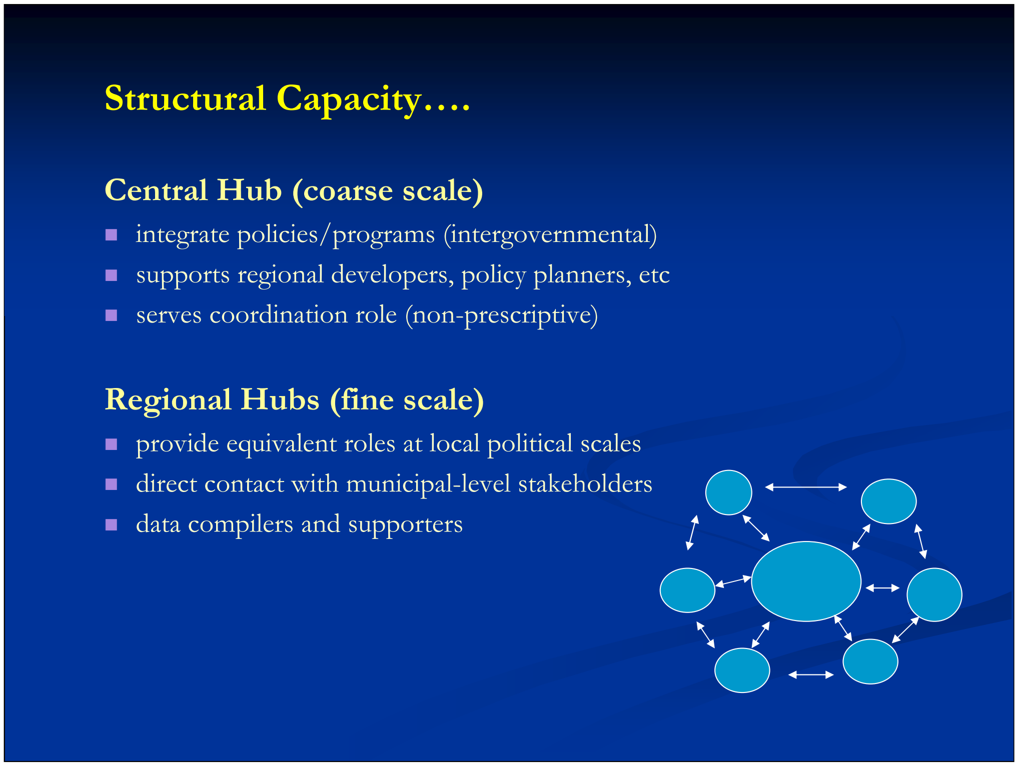
-supporting and facilitating transfers of data, knowledge and modeling approaches.

As such, the overall framework was described.

The components of this capacity were also described in the following document:
http://policyresearch.gc.ca/doclib/ILMM2_Briefing_Note_E.pdf.



- ❖Governance Framework
  - Central Leadership
  - Facilitation and coordination (engagement, policy, research, priorities, etc)
- ❖Modeling Capacity
  - Public domain, open-source
  - Shared knowledge
  - Long-term supported facilities
  - Development by policy and technical collaboration
- ❖Data capacity
  - Centrally stored or managed data or clearinghouse
  - Data sharing facilitation through formal agreements, legislation, or conditional terms
  - Strategic gap identification and management
- ❖Knowledge capacity
  - Training workshops, seminars, forums, etc
  - Connected to broader modeling/policy communities (eg., international)
  - Mechanism for transfer between all stakeholders
- ❖Engagement
  - Participation is easy, cost-free, transparent, user-friendly
  - Active inclusion of stakeholders (demonstrate values of involvement)
  - Includes social considerations of all stakeholders using innovative, flexible information, participation, and other mechanisms
- ❖Marketing and Funding
  - Intergovernmental agreement/participation
  - Build into existing programs/commitments
  - Share knowledge with other governments
  - Establish funding and support through private-public programming
- ❖**Structural Capacity….**



A structure was also described for this capacity, consisting of two parts:

1. Central Hub (coarse scale)

*integrate policies/programs (intergovernmental)

*supports regional developers, policy planners, etc

*serves coordination role (non-prescriptive)

-data clearinghouse, distributor (collate, distribute, standardize approach, reduce redundancy of efforts, etc)

-provides or facilitates exchanges of technical & policy experience

-houses steering committee (establish agreements)

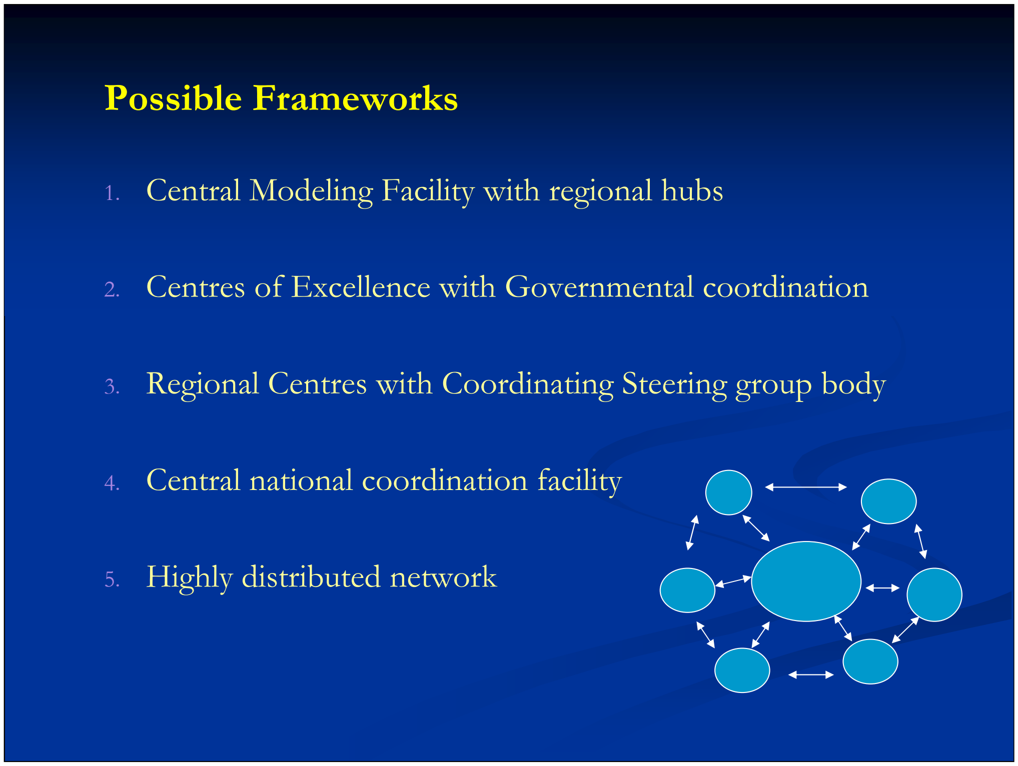
-conducts modeling or policy advice/research on request

2. Regional Hubs (fine scale)

*provide equivalent roles at local political scales

*direct contact with municipal-level stakeholders

*data compilers and supporters



Although a single structure was described, there are a number of different frameworks which could be adopted. Further details of these frameworks can be found in: http://policyresearch.gc.ca/doclib/ILMM2_Briefing_Note_E.pdf.

Conclusions

1. Landscape planning models could significantly add to SEA/EA processes

2. Landscape planning tools are susceptible to the same limitations and challenges as existing SEA/EA approaches

3. New governance structures are required to develop and support the application of these tools across interdisciplinary and interjurisdictional boundaries

Further Information

Reference materials:

Capacity Building

http://policyresearch.gc.ca/doclib/ILMM2_Briefing_Note_E.pdf

Workshop Report

http://policyresearch.gc.ca/doclib/ILMM_Workshop_Report_e.pdf

Review of Modeling Tools

http://policyresearch.gc.ca/doclib/SD_BN_IntLandscape_E.pdf;