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We are grateful to the researchers and personnel from the ILM project sites analyzed for their cooperation in providing additional information. Thanks also to Charles Thrift of International Institute of Sustainable Development for completing the Pathway project assessment and thanks to the reviewers for their helpful comments. We are also grateful to GeoConnections for providing support for this case study.

Published by the International Institute for Sustainable Development

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Executive Summary

Many of the social and environmental problems faced by industrial societies will not be solved without a fundamental review of how we explore the interlinked concerns of humans and nature. The aim is to develop ecologically informed planning so that we can, "appreciate and better understand the intricate web of interactions between human and natural processes" (Tippett et al., 2007; and Ndubisi, 2002). To be effective in tackling the complexity of human and natural interactions, Integrated Landscape Management (ILM) has emerged as a promising approach to systematically and practically assist in managing trade-offs and identifying win-win situations among environmental, economic and social conditions considered over time, space and across jurisdictions (Imagine Canada, 2008).

The 10 ILM projects analyzed were:

1. participatory Integrated Assessment of Water Management and Climate Change in the Okanagan Basin, British Columbia (PIA – Okanagan);
2. Georgia Basin Futures Project (GBFP);
3. from the Corn Belt to the Gulf: Societal and Environmental Implications of Alternative Agricultural Futures (Corn Belt);
4. Willamette Valley–Puget Trough–Georgia Basin–Ecoregional assessment (EvoLand);
5. Coast Information Team (CIT) program;
6. Integrated Grid-Based Ecological and Economic (INGRID) landscape model;
7. Sustainability Impact Assessment: Tools for Environmental, Social and Economic Effects of Multifunctional Land Use in European Regions (SENSOR);
8. Lake Balaton Integrated Vulnerability Assessment and Adaptation Strategies (Balaton);
9. Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM) ; and
10. Pathway – A visions for Tahoe's Future (PATHWAYS).

In this report, we evaluate ILM approaches, encountered challenges and lessons learned in 10 ILM projects in order to inform pilot projects in Canada that are currently being conducted within the Imagine Canada program.

Most of the analyzed ILM projects aimed to address growing concerns about sustainability of the use of local and regional resources, and conservation issues that are under threat due to development pressures that create cumulative impacts on water, soil, land, forests, biodiversity and habitat. In practice, most of these projects focused on the issues of environment, land-use, nature and biodiversity far more extensively then on the issues of human development including population growth, equity, infrastructure development (energy and transportation), employment and changes in economic performance.

Despite the fact that most ILM projects tend to be place-based, deal with specific local and regional issues, and address specific policies and planning priorities, each reveals common characteristics. The general framework for an ILM project includes the following steps:

- Assessing past and current conditions and trends of the systems, including landscapes and seascapes, to create a baseline scenario (often based on past data) for strategic planning.
- Envisioning or forecasting potential future pathways and desired conditions for the analyzed land or seascape.
- Establishing plans and objectives to attain/respect these desired conditions in a collaborative interjurisdictional context. When appropriate, these plans set thresholds for future development and account for cumulative effects of existing development (the baseline).
- Monitoring actual changes on the landscape through the use of monitoring indicators and reporting, and adapting plans and actions to ensure desired future conditions are attained.

In all the 10 ILM projects, assessing the current state of the analyzed system formed a significant part of the ILM study project. The projects applied a range of methodological approaches, including: indicator system development, Geographic Information Systems (GIS) tools, vulnerability analysis, policy effects and effectiveness analysis, physically-based models (spatial and non-spatial), systems mapping, multi-criteria assessment and integrated models (for example, EvoLand, Alberta Landscape Cumulative Effects Simulator (ALCES), Polestar, among others). From these methods, most of the analyzed studies developed indicator sets that formed a basis that feeds into the integrated model and creates a baseline for the future scenarios without presenting the indicators set and its analyses to the stakeholders. Only a few projects specifically aimed to create an actual set of indicators describing the current system that could be used in the future to monitor the trends and impacts of local development decisions. Most of them saw the indicators as inputs for the modeling.

An essential aspect of many of the 10 ILM projects was to help illuminate potential future scenarios and pathways that could help make win-win policy and development choices and minimize trade-offs. We observed that diverse methods were applied, including multi-stakeholder consultation, consensus building, scenario development and analysis, multi-criteria assessment, strategic assessment, outcome mapping and logical framework analysis. Nearly all of the projects applied some type of scenario development technique including extrapolatory forecasting methodologies to try to envision the future scenario based on current conditions and choices. Instead of predicting the most likely future, some of the projects applied a backcasting approach, which works backwards from future to present; the scenarios are defined in terms of their desirability as a preferred vision of the future development.

The outcomes of the 10 ILM projects had no regulatory authority; they could be seen as guides used to address pressing local issues, and to some extent, to influence decision making across the involved regions. Most of the developed models and tools were made available for policy-makers and could also be downloaded from the projects' website. However, most of the analyzed projects considered it important to contribute to increasing awareness among regional managers, planners, political leaders and media. Policy-makers also had opportunities to use the developed scenarios to envision policies that could improve the local and regional sustainability. The developed models also allowed flexibility in patterns and practices of the created scenarios so that they could be recombined in different ways to achieve varying policy aims.

In this case study, we also focused on analyzing a series of challenges that were encountered during the 10 ILM projects' development including data gathering and management, integrating information/policy/data, managing complexity and the interdisciplinary nature of the projects, uncertainty and risk analysis, and level of collaboration/commitment. Based on the gathered information on encountered challenges, we make the following recommendations for future ILM projects:

Review currently collected data sets and monitored indicators to assess their suitability to reflect on changing socio-economic and environmental conditions and their usefulness in envisioning and monitoring future scenarios and policies.

Experiences from the analyzed studies suggest establishing an independent board to design and manage the information and assessment parts of the study project. The board should consist of respected members of the various "knowledge communities," striving for a balance among the knowledge communities—science, humanities, technical/practitioner, and local—and within each community (CIT Review, 2005; and Tippett et al., 2007).

Experience shows that the effective integration of data and models representing environmental, economic and social domains at the local level would require attention in the early stages of the project development. To enhance this process, it would be beneficial to review the accessible inputs, desirable outputs and products, and the planned model structure when the actual modelling framework is being developed.

Experience in the 10 analyzed projects showed that the involved policy-makers welcome greater links between scientists and policy processes. For all the analyzed ILM projects, it was considered important to design targeted scientific documents and outputs. The main suggestions for such outputs were the following (Nassauer et al., 2007; Bolte et al., 2006; and Robinson et al., 2006):

- highlight the main results, provide recommendations for policy-making and follow-up questions (relevant for decision makers) raised by the research;
- provide visual information that is immediately clear by means of graphs or diagrams;
- provide links to further references in case policy-makers and other stakeholders need

detailed information on the topic;

- involve specific organizations, such as networks and umbrella organizations, to ensure the effective dissemination of the results; and
- collaborate in developing capacity-building events with potential users, including policy-makers so that they could actually learn how to use the model, how to create scenarios, what are the uncertainties, among others.

Finally, ILM projects seem to help in overcoming the gaps between narrowly-focused sectoral assessments and the required integration of social, economic and environmental issues that are able to capture cumulative effects and promote a balanced view of future development on the basis of sustainability. It seems that despite these benefits, ILM projects are strongly driven by scientists aspiring for new innovative approaches when describing and envisioning local and regional systems. During these projects, the research community often seeks the support of local practitioners in order to get data, consult and validate model results, make locally-relevant recommendations and help with transforming project outcomes into policies and measures. However, we would like to emphasize that there are more opportunities for making policy-relevant contributions to ILM models by strengthening the collaboration with policy-makers, increasing transferability of the scenarios and results, and by addressing implementation and monitoring challenges when creating the outcomes of ILM projects.

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1.0 Introduction

Many of the social and environmental problems faced by industrial societies will not be solved without a fundamental review of how we explore the interlinked concerns of humans and nature. We also need to help in developing ecologically-informed planning so that we can "appreciate and better understand the intricate web of interactions between human and natural processes (Tippett et al., 2007; and Ndubisi, 2002). To be effective in tackling the complexity of human and natural interactions, ILM, operating on both spatial and non-spatial scales, different temporal scales and at different levels of governance, has emerged as a promising approach to systematically and practically assist in managing trade-offs and identifying win-win situations among environmental, economic and social conditions considered over time, space and across jurisdictions (Imagine Canada, 2008). ILM can be thought of as one or a series of approaches to managing diverse human activities at regional or larger scales that have developed in the last 50 years or more. It follows in a tradition that includes multiple use, integrated resource management, integrated watershed management, comprehensive regional land use planning, and ecosystem-based management, among others (Hanna and Slocombe, 2007).

The ultimate objective for ILM projects is to help improve management of local resources and decisions on the ground. For ILM projects to assist in creating better decisions, they need to be linked to decision making to provide results that could feed into the policy processes. It is import to develop outputs and recommendations that are relevant to policy-makers and stakeholders who call for new strategies that improve the science-policy interface and build on the effective bi-directional information flows between scientists and decision makers (Sarewitz and Pielke, 2007). It is essential that all participants are engaged in actively producing knowledge and defining the research outcomes. Robinson and Tansey (2006) suggest involving the participating decision makers and stakeholders as partners with whom the research team collaborates in the co-production of knowledge.

This case study paper presents 10 ILM projects to explore new and more effective ways to create usable knowledge for decision makers that could promote implementation of policies and lead to actions when addressing complexity, human-environment interaction and participatory processes in ILM projects. Specifically, this paper offers a comparative review of major ILM projects with a focus on applied methodological approaches, and on means of participation and challenges, including dealing with complexity, interdisciplinarity and uncertainty. Finally, we also explore cooperation with decision makers, characteristics of the projects' outputs and their integration into the decision making processes.

This report is part of a series of activities within the Imagine Canada network, funded by Natural Resource Canada's GeoConnections program with technical support provided by IISD.

2.0 Ten ILM Projects – Methods and Descriptions

The overall aim of this assessment is to explore the use of ILM approaches in different projects to inform pilot projects in Canada that are currently being conducted. In this assessment, 10 projects have been evaluated. The research was based on a variety of data sources and analysis techniques, including practitioner and academic literature reviews and interviews with key members of the analyzed projects' teams. Below, we provide an overview of major research steps and the list of analyzed ILM projects.

The stages of the research were the following:

1. in-depth theoretical exploration of published challenges and lessons learned about diverse methodological approaches and collaboration techniques within ILM projects;
2. developing an analysis framework for assessing the ILM projects based on the challenges identified through the literature review;
3. selecting projects that are appropriate for our assessment;
4. .evaluating the 10 ILM projects based on the analysis framework; and
5. developing the syntheses and conclusions of the issues shared among the analyzed studies—and lessons learned from their experiences—to inform the current pilot projects of the Imagine Canada network.

The 10 ILM projects investigated were:

1. Participatory Integrated Assessment of Water Management and Climate Change in the Okanagan Basin, British Columbia (PIA – Okanagan);
2. Georgia Basin Futures Project (GBFP);
3. From the Corn Belt to the Gulf: Societal and Environmental Implications of Alternative Agricultural Futures (Corn Belt);
4. Willamette Valley–Puget Trough–Georgia Basin – Eco-regional assessment (EvoLand)
5. Coast Information Team (CIT) program;
6. Integrated Grid-Based Ecological and Economic (INGRID) landscape model;
7. Sustainability Impact Assessment: Tools for Environmental, Social and Economic Effects of Multifunctional Land Use in European Regions (SENSOR);
8. Lake Balaton Integrated Vulnerability Assessment, Early Warning and Adaptation Strategies (Balaton);
9. Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM); and
10. Pathway - A visions for Tahoe's Future (Pathway).

Most of the analyzed final reports, research papers and other publications published by the 10 ILM project teams were strongly focused on presenting project results and consequently less focus was placed on describing the processes including the interactions with policy-makers and the challenges encountered during project development. Many of the studied documents were produced **immediately** following completion of the projects so the authors had very limited access and evidence of potentially adopted policies and measures based on the findings. Therefore, some of the findings presented in this paper should be read with caution, keeping in mind that outcomes of participatory and collaborative projects could occur many years after their completion and they are also hard to document.

Overview of the 10 Analyzed ILM Projects (for details see Appendix)

PIA – Okanagan: A collaborative, interdisciplinary effort involving universities, government agencies and many local partners. Building on previous projects in the region since 1997, the goal of this project was to expand the dialogue on adaptation choices for water management to include domestic and agriculture uses and in-stream conservation flows for the basin as a whole as well as for particular sub-regions.

GBFP: A five-year participatory integrated assessment focused explicitly on the co-production of knowledge, whereby "expert" knowledge was combined with partner knowledge to help illuminate sustainability options at a regional scale. Key goals are to increase public involvement in the discourse about sustainability issues, to explore pathways to sustainability in the region, and to create a database of public preferences and values that can be analyzed to better understand challenges in the transition to sustainability.

Corn Belt: This project provides an innovative, integrated assessment of the agricultural and ecological systems in the Mississippi River Basin along with studies of local Iowa agricultural watersheds. Contributors from multiple disciplines discussed how agricultural policies have contributed to current environmental conditions, and developed alternative futures for agricultural landscapes and new policy that can help achieve more beneficial patterns.

EvoLand: This project applies a new modeling tool in the areas of spatial data management and analysis, multi-criteria decision making, which uses an actor-based approach to conduct alternative futures analyses in the Willamette Basin, Oregon.

CIT: CIT was established to provide independent information for the central and north coasts of British Columbia and Haida Gwaii/Queen Charlotte Islands using the best available scientific, technical, traditional and local knowledge. CIT information and analyses are intended to assist First Nations and sub-regional planning processes to make decisions that will achieve ecosystem-based management.

INGRID: The aim of the project is to simulate the ecological effects of management schemes for dry grasslands and to calculate costs in order to serve as a decision tool for nature conservation agencies. The project aims to help in predicting local and regional risks to plants and animals with respect to different management scenarios/disturbance regimes. It also integrates abiotic and biotic state variables, processes and complex interactions in a spatially explicit way.

SENSOR: SENSOR is an integrated project in the 6th Framework Research Programme of the European Commission. Thirty-nine research partners from 15 European countries, China, Brazil, Argentina and Uruguay develop science-based forecasting instruments to support decision making on policies related to land use in European regions.

Balaton: This project has been focused on improving the understanding of the social, economic and environmental forces of change that are shaping the Lake Balaton region of Hungary. The system of quantitative indicators, reflecting the priorities of both the expert community and key stakeholders, was developed, followed by an integrated model development linking local adaptation actions and policy options that can be introduced to build resilience at different scales in the face of global climate change and associated risks to the natural ecosystem.

ATEAM: The objective was to assess the vulnerability of human sectors relying on ecosystem services with respect to global change. Multiple, internally consistent scenarios of potential impacts and vulnerabilities of the agriculture, forestry, carbon storage, water, nature conservation and mountain tourism sectors were mapped for Europe at a regional scale for four time slices (1990, 2020, 2050 and 2080).

Pathway 2007: There have been actions through a range of programs and projects to improve the environment surrounding Lake Tahoe. At present, the major agencies are working together to create a long-term plan for the basin, which recommends the use of a coordinated adaptive management approach among the agencies (each with their own jurisdictions and projects).

Most of the 10 ILM projects in this case study paper were aimed at addressing growing concerns about the sustainable use of local and regional resources and also conservation issues that are under threat due to the cumulative impacts of development on water, soil, land, forests, biodiversity and habitat. Most of the projects addressed common themes such as agriculture and forestry, economic performance and nature and biodiversity.

Most of the 10 ILM projects focused on local and regional ecosystems, their functioning and dynamics in relation to human activity to provide scientific information that can be used to promote better awareness of potential environmental change impacts and local development decisions. The ILM projects also focused on improved management of the ecosystems often analyzed in a specially-explicit manner. The actual triggers for the ILM projects, however, were the negative impacts that were already being experienced, including water shortages, rapid population growth, increasing demands on scarce resources, impacts of environmental quality on local economy, health and wellbeing and a further anticipation of the negative impact of climate change and future development choices on regional and local resources. These triggers represent diverse issues of human and environmental interactions. However, most of the projects ended up focusing on the issues of environment, land use, nature and biodiversity more then on the issues of human development and its elements including population growth, equity, infrastructure development (energy and transportation), employment and changes in the economic performance.

Most of the ILM projects were initiated by researchers that collaborated with local stakeholders and policy-makers to help identify local objectives, data, local knowledge and potential linkages to the policy process. This collaboration was executed in different ways, ranging from participation at each step of the assessment to consultations to discuss results at the final stages of each ILM project. Most of the projects aimed to inform the policy process and policy-makers, however, policy questions were typically not the direct triggers for an ILM project.

Table 1. Focal Issues of the 10 ILM Projects Analyzed

	PIA – Okanagan	GBFP	Corn Belt	EvoLand	CIT	INGRID	SENSOR	Balaton	ATEAM	Pathway
Air quality		■		■		■				■
Agriculture and forestry	■	■	■	■	■	■	■	■	■	
Climate change	■							■		
Economic performance	■	■	■	■	■	■	■	■		■
Education		■								■
Employment		■			■			■		■
Energy		■	■			■	■	■		
Freshwater	■	■	■	■						
Governance		■	■	■	■	■			■	
Housing	■	■								
Land use	■	■	■	■	■	■	■	■	■	■
Nature and biodiversity		■	■	■	■	■	■	■	■	■
Population	■	■						■		
Seas, oceans and coasts		■	■	■	■				■	
Social issues and equity		■			■					
Transportation		■								■
Waste		■								■
Groundwater	■		■							■
Water quality	■	■	■	■		■	■	■		■
Wetlands				■		■	■	■	■	

3.0 Observed ILM Tools and Processes

The ILM processes undertaken by these 10 projects seem to have many common characteristics, despite the fact that most of the projects were place-based, dealt with specific local and regional development issues, and addressed specific policies and planning priorities. A general framework for ILM projects typically includes the following steps:

- assessing the status and trends of the system—including landscapes and seascapes—creating a baseline scenario for planning;
- envisioning or forecasting potential future pathways and desired conditions for a land or seascape;
- establishing plans and objectives to attain/respect these desired conditions in a collaborative interjurisdictional context–when appropriate, these plans set thresholds for policy changes and future development, and account for the cumulative effects of existing development (baseline); and
- monitoring actual changes to the landscape through the use of indicators and adapting plans and actions to ensure desired future conditions are attained.

In the following section, we present in detail how the 10 ILM projects dealt with each step, the major focus and what methods they used.

3.1 Assessing current conditions and trends

In all 10 ILM projects, assessing the current state of the analyzed system formed a significant part of each ILM project. The projects applied a range of methodological approaches, including: indicator system development, GIS tools, vulnerability analysis, policy effects and effectiveness analysis, physically-based models (spatial and non-spatial), systems mapping, multi-criteria assessment and integrated models (for example, EvoLand, ALCES, Polestar, among others). Some of the projects, including CIT, EvoLand, SENSOR and Balaton, specifically aimed to create an actual set of indicators describing the current system that could be used in the future to monitor the trends and impacts of local development decisions. In the SENSOR project, a system of "40 impact indicators" was developed to help assess the effects of land-use changes on social, economic and environmental land-use functions. Most of the analyzed studies used the indicator set as a basis that feeds into the integrated model and creates a baseline for the future scenarios without presenting the indicators set and its analyses to the stakeholders. Such approaches were used in GBFP, PIA – Okanagan, INGIRD and ATEAM projects. In some of these projects, the indicator and data collection were completed as part of other initiatives prior the actual ILM project.

Most of the 10 ILM projects started the assessment with developing physically-based models addressing changes in land-cover, habitat, ecosystems, water resources, climate and biodiversity.

These assessments were often spatially explicit using GIS applications allowing the results to be presented in map form. The models then incorporated the physically-based model with socio-economic data in an integrated modelling framework. Most of the projects developed their specific integrated model describing their local systems, which makes transferability of the model and their applications for other locations very challenging. Most of these models were developed by an interdisciplinary team of researchers involving stakeholders for consultations on issues such as the relevance of the results and recommendations. A different approach was taken by the PIA – Okanagan project. The integrated model itself was developed in collaboration with local stakeholders and policy-makers, including validating the model and providing data.

The primary focus of these models was to help to describe the targeted system and to develop future scenarios of system changes. Beyond developing future scenarios, the developed models were used to assess conditions relevant for current policy questions (Corn Belt), the economic cost of achieving current policy targets (INGRID), the cumulative and indirect impacts created by current fragmented policies on the system (PIA – Okanagan) and to estimate the pathway [what is needed to reach current policy targets (GBFP)].

Table 2. Tools Observed in the 10 ILM Projects for Assessing the Current System

	PIA – Okanagan	GBFP	Corn Belt	EvoLand	CIT	INGRID	SENSOR	Balaton	ATEAM	Pathway
Indicator system				■	■	■	■	■	■	■
GIS tools		■		■		■	■	■	■	
Vulnerability analysis								■	■	
Policy effects and effectiveness analysis			■			■				■
Physically-based models (spatial and non spatial)	■			■	■	■	■	■	■	■
Systems mapping							■			■
Multi-criteria assessment						■				
Integrated model (for example, EvoLand, ALCES, Polestar, among others)	■	■	■	■	■		■		■	

3.2 Envisioning potential future pathways

An essential aspect of many of the 10 ILM projects was to help illuminate potential future scenarios and pathways that could help make win-win policy and development choices and minimize trade-offs. We observed that diverse methods were applied, including multi-stakeholder consultation, consensus building, scenario development and analysis, multi-criteria assessment, strategic assessment, outcome mapping and logical framework analysis. Nearly all of the projects applied some type of scenario development technique, which represented an opportunity to begin an exploration of different futures. The scenarios were built using the integrated model developed in the previous stage of each ILM project, but often without developing performance measures to analyse the impacts of each scenario.

In general, there is a growing interest in the use of scenarios as heuristic tools that make mental maps more explicit (Berkhout et al., 2002) as:

- aids to social and organizational learning (Chermack and van der Merwe, 2003);
- tools for scanning the future in a rigorous, creative and policy-relevant way that explicitly incorporates normative elements (Swart et al., 2004); and
- as a means by which we may explore the effects of an alternative course of action for future problems involving multiple actors, risk and uncertainty (Mayer et al., 2004).

The three most commonly used scenarios are:

- **exploratory**, which posit a range of underlying socio-economic conditions upon which alternative futures may be constructed;
- **extrapolatory**, which provide forecasts based on baseline trends; and
- normative scenarios or **backcasting**, which are built on positive and negative visions of the future, and explore pathways of change that might lead to them (Berkhout et al., 2002).

Except for the GBFP and Corn Belt, all studies used extrapolatory forecasting methodologies to try to envision the future scenario based on current conditions and current choices. The GBFP and Corn Belt projects, instead of predicting the most likely future, applied a backcasting approach, which works backwards from future to present. The scenarios are defined in terms of their desirability as a preferred vision of the future development, and their feasibility and consequences framed by the local and regional biogeophysical systems (Robinson, 2003). These projects were focused on building normative scenarios that are not predictions of the future from current trends, but tried to emphasize the plausible prospects of what might be a desirable outcome. The outputs of the scenarios were future landscapes presented by spatially explicit representations of land cover patterns and land management practices (Nassauer et al., 2007).

In the 10 ILM projects, stakeholders were involved during the assessment and/or the development of the scenarios. The scenarios were developed with different levels of participation. In the PIA – Okanagan, the scenario-generating model was developed in the participatory bases as well as the scenarios. The scenarios were developed by the stakeholders in the GBFP, Balaton and EvoLand projects. In the rest of the projects, scenarios were consulted with stakeholders on specific local challenges and drivers in future development and these collaborations provided an important "reality check" for the research team's developed scenarios. This included commenting on the relevance of the scenarios for the local and regional community, but also it could address potential impacts of the future global development at the local scenarios if the applied integrated model doesn't account for changes at the global level.

The extent to which the developed local and regional scenarios account for future global changes differed considerably. When developing local and regional scenarios, local possibilities and consequences often depend critically on large-scale phenomena, including world markets, global policies, climate change and other large-scale issues. Projects such as GBFP, PIA – Okanagan, ATEAM, SENSOR and Balaton included a dual-scale spatial capability, which allows one to consider how global forces affect local outcomes. At the global scale, a number of scenarios are available to predict the future development including the International Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (Nakicenovic and Swart, 2000), Global Environmental Outlook scenarios (GEO) and others. Each global scenario gives rise to different regional implications, such as population growth, regional trade, demands on local resources and land-use change. The integrated models in some of the projects allowed the created local scenarios to be informed by global scenarios and trends. These models also treated the local and regional system as self-contained, which means that the process and the local scale don't alter the process and the global scale. The rest of the studies involved stakeholders and consultation with experts to help identify potential impacts of global trends at the local level.

Table 3. Tools Applied in the 10 ILM Projects to Envision Future Development

	PIA – Okanagan	GBFP	Corn Belt	EvoLand	CIT	INGRID	SENSOR	Balaton	ATEAM	Pathway
Multi-stakeholder consultation, consensus building	■	■	■	■	■	■	■	■	■	■
Scenario development and analysis	■	■	■	■		■	■	■	■	
Multi-criteria assessment							■		■	■
Strategic assessment*				■	■					
Outcome mapping				■						
Logical framework analysis					■					
Performance measure development										

* Strategic environmental assessment, strategic sustainability assessment, integrated policy appraisal

Another important aspect of the scenario development is the chosen temporal scale. Current studies (for example, UK CIP, 2001) concluded that longer timeframes (up to 2050), allow stakeholders to keep their distance from current situations and think creatively about future development options. It also gives enough time to address impacts of global processes, such as climate change, and also provides opportunities for thinking about changes, policies and to see their results in new urban forms, infrastructure, transportation and natural resources. Most of the 10 ILM projects aim for longer timeframes (up to 2080), dividing it up into short and medium timeframes, such as 2025 and 2050 (Balaton, PIA – Okanagan, ATEAM). GBFP applied backcasting in the medium term (up to 2040), reflecting on the regional sustainable development planning document. Similarly, the SENSOR project was focused on the short term (up to 2025), to focus on creating policy scenarios.

Most of the projects did not aim directly for scenarios that can be easily translated into policies. Direct policy relevance was achieved in the SENSOR project by the specific policy scenarios that were developed. These scenarios also linked to future global projections and they are based on narratives of global economic and societal trends for the target year 2025, and optional policy decisions on land use and rural development that are formulated and analyzed with respect to their implications on land-use sectors. Most of the projects see the scenarios as learning and capacity-building opportunities, as tools for policy-makers to help them better understand linkages within the local systems and to illuminate potential future system changes.

3.3 Establishing plans and objectives and monitoring actions

Since science and policy serve different purposes (Lee, 1993) and scientists and decision makers typically maintain different values, interests, concerns and perspectives, and, more importantly, tend to lack a mutual understanding of each other's knowledge systems, transforming results from the 10 ILM projects to actual policies is a challenging task (Sarewitz and Pielke, 2007). While scientists often complain that their voices have been ignored by policy-makers, the latter have also expressed dissatisfaction that critical information required for decision making is often not readily available or accessible, or not presented in a usable form (for example, Jacobs, 2002; and Sarewitz and Pielke, 2007).

All 10 ILM projects use language and design of project outputs in a way that is understandable for the policy-makers. The following specific approaches were applied to make the project outputs relevant for policy-makers (Nassauer et al., 2007; Bolte et al., 2006; and Robinson et al., 2006):

- highlighting the main results and recommendations for policy-making and present follow-up questions raised by the research that are relevant for decision makers (ATEAM, EvoLand and others);
- providing visual information that can be acquired immediately by means of graphs or diagrams (Balaton, GBFP and others);
- providing links to further references in case policy-makers and other stakeholders need detailed information on the topic (suggested by ATEAM);
- involving specific organizations, such as networks and umbrella organizations to ensure effective dissemination of the results (most of the 10 ILM projects); and
- conducting capacity-building events with potential users, including policy-makers, so that they could actually learn how to use the model to generate scenarios and get a better picture of the uncertainties–among others). (Nassauer et al., 2007; Bolte et al., 2006; and Robinson et al., 2006).

Table 4. Tools Applied in the 10 ILM Projects to Assess the Current System

	PIA – Okanagan	GBFP	Corn Belt	EvoLand	CIT	INGRID	SENSOR	Balaton	ATEAM	Pathway
Supporting Implementation of the Outcomes										
Capacity building	■	■		■			■	■	■	
Local policy development						■	■			■
Improving the planning process	■					■				■
Recommendations to policy- makers*	■	■	■	■	■	■	■	■	■	■
Monitoring and Assessing Progress										
Regular data collection					■			■		
Recommendations for policy development	■			■						■
Review of implemented actions					■					
Meetings with key stakeholders	■	■	■		■	■		■		■

* Recommendations to regional, provincial and national policy-makers.

The outcomes of the 10 ILM projects had no regulatory authority; they could be seen as guides used to address pressing local issues, and to some extent, to inform decision makers across the involved regions. Most of the developed models and tools were made available for policy-makers and could also be downloaded from the projects' website. However, most of the analyzed projects considered it important to contribute to increasing awareness among regional managers, planners, political leaders and media. They used the developed scenarios to envision policies that could improve the local and regional sustainability. They also allowed flexibility in patterns and practices of the created scenarios so they could be recombined in different ways to achieve varying policy aims (for example, in the Corn Belt study in Nassauer et al., 2007). In terms of creating actual policy-relevant outcomes, the analyzed projects applied the following approaches (also see Table 3):

- capacity building for policy-makers–mostly focused on helping them to learn how the use the integrated model, how to create and interpret scenarios and deal with uncertainties involved in the model;
- assistance in local policy development was mostly centred on providing inputs for land-use planning, local management plans and zoning;
- improving planning processes by helping involved policy-makers to understand linkages between environment and human decision within the integrated model; and
- making recommendations for policy-making based on the developed scenarios and

models–this is included in all 10 ILM projects. Some of the analyzed projects supplemented the concluded recommendations for the policies with capacity building for the local and regional policy-makers on how to use the models and to develop scenarios.

In general, the involved policy-makers welcomed initiatives that develop greater links between scientists and the policy process. However, we have very limited information about the actual policy changes and direct local actions taken to improve the local issues and to manage challenges. We suspect that many of the projects' impacts, including those in the policy arena, occurred after the completion of the projects and often without knowledge of team members. Few of the documented changes were gathered for the PIA – Okanagan and the GBFP projects. In the PIA – Okanagan project, the suggested policy responses and model outputs from the project were directly incorporated into local water management plans (Cohen et al., 2006). For GBFP, more than 10 Canadian municipalities supported a development of their integrated model development similar to GBFP to help them better understand their challenges toward sustainability and improve their long-term planning.

4.0 Key Challenges Observed from the 10 ILM Projects

4.1 Data gathering and management

For most of the projects, the project teams had to overcome significant challenges in data gathering that impacted the applied tools and results. Basic challenges in the 10 ILM projects included general lack of data (or at least non-accessibility in the reasonable timeframe) for certain indicators, data on inappropriate temporal and spatial scale for modeling, diverse frequency of collected data within and in between social, economic and environmental domains and finally some data were only available for purchase. This led to changes in the used indicators and data sets. For example, the Balaton project team decided to limit the number of indicators because of the difficulties in collecting data of sufficient quality (Pinter et al., 2008). Similarly, the Pathway project team struggled with limited funding for collecting data for all indicators so they decided to focus only on the set of priority indicators. To overcome local data gaps, the analyzed projects used the following approaches:

- available regional data were downscaled to the local level (GBFP and INGRID) to make them appropriate for the locally-focused model;
- additional data collection by project team members (INGRID, Balaton) was conducted;
- data that were feasible to collect were used, even though they were not necessarily the most representative figures for the addressed issues as recognized by stakeholders (ATEAM);
- experts' judgments to cover data gaps were necessary to minimize misinterpretation of data describing ecological and human systems;
- additional data collected by local policy-makers (often limited, but relevant datasets) and stakeholders were included in the models;
- additional consultations, including interviews for additional (mostly qualitative) data collection were conducted (Corn Belt, Balaton, CIT and Okanagan)
- most of the project teams decided to limit the use of data and indicators to data sets that were available. However, using regularly monitored data, based on past and current situations, are often not able to reflect on the new policies, management and actions that are the expected outcomes of the 10 ILM projects. Therefore, most of the 10 ILM projects recommended changes in data collection and monitoring

Experiences from the analyzed projects (for example, Balaton and CIT) suggest establishing an independent board to design and manage the information and assessment parts of the project. The board should consist of respected members of the various "knowledge communities," striving for a balance among them—sciences, humanities, technical/practitioners and local—and within each community (for example, biophysical sciences and socioeconomic sciences, traditional knowledge), and should encourage methods of research and validation appropriate to each knowledge community. This is necessary because scientific research follows scientific procedures and is reviewed by scientists. Other forms of investigation require different procedures and involve a different set of peers (CIT, Review Report, 2005; and Tippett et al., 2007). Finally, building each ILM project on data and databases collected in previous projects in the region helped in targeted model development based on the knowledge of what is feasible with a good knowledge of available data.

4.2 Integration of information/policy/data

Integrating diverse data representing economic, social and biophysical systems in a way that it could be included in the scenario development and lead to recommendations for the policy process seems to be a considerable challenge encountered by most of the 10 projects. Applied conceptual frameworks in most of the projects aimed for integration across the environmental, social and economic domains, which is inevitable in order to address local challenges and cumulative effects. In most of the projects, the actual integration of these domains was done by a research team that had good knowledge of the project site or area (often from previous work). However, the integration still remained challenging. For example, in the PIA – Okanagan study, the project team tried to link different models that were developed for the region, but only a few of them turned out to be compatible and feasibly linked within a reasonable timeframe (Neilsen, et al., 2006). Similarly, integration was a huge challenge during the Balaton project, partly because this project tried to look at socio-economic vulnerabilities to climate change, rather than assess only the state of the local environment, water management and climate change. When the project team tried to link the outputs of hydrological and climate models with socio-economic data, it was not successful, mostly because of the lack of socio-economic data over longer timeframes.

Experience shows that effective integration would require attention in the early stages of the project development. Unless the integration of different domains and data is built into the project when the analyses are well advanced, it is too late to change outputs, scenarios and indicator sets to accommodate integration (CIT, 2005). To enhance this process, it would be beneficial to review the accessible inputs, desirable outputs and model structure when the actual modelling framework is being developed, to avoid surprises such as major components of the framework that do not fit together at the operational level because of the data structure, availability and quality (Cohen et al., 2006).

4.3 Managing complexity and the interdisciplinary nature of the projects

The complexity inherent in the systems addressed in the 10 ILM projects challenged the modelling community to provide tools that sufficiently captured the richness of human and ecosystem processes, and interactions in ways that are computationally tractable and understandable to the users including policy-makers. The 10 ILM projects were developed mostly by researchers experienced in interdisciplinary projects with a high degree of complexity. However. this approach was fairly new to most of the stakeholders (experience from ATEAM project; and Schoeter et al., 2004). The biggest challenge for many project teams was to help the stakeholders understand the ILM approach and the trade-off between being detail-oriented and using fewer data sets to try to understand the human-environment interactions that are often hard to express in measurements and data, and require modelling in much coarser scale (Robinson and Tansey, 2000; and Schoeter et al., 2004).

Within most of the projects, considerable effort has been made to address complexity in the framework and in the actual assessment. When discussed with stakeholders, the recurring theme during the dialogue was just how complex human-environment interactions are in the context of global, national and regional policies and under socio-economic constraints (Cohen and Neale, 2006; Robinson et al., 2006; and Schoeter et al., 2004). Most of the projects were focused on local and regional issues, as regional models are able to handle greater detail than is feasible when considering the complexity of global systems. By focusing on the local and regional levels, the models treat the chosen geography as self-contained, with no feedback to the global scale, implying that regional processes are relatively autonomous without feedbacks to the global processes (Robinson, 2003; and Tansey et al., 2002). However, this doesn't mean that the models ignored the complexity of global processes; they used different global future scenarios to update the regional models (for details see section 3.2).

Focusing on local and regional models that try to describe the complexity of human and environment interactions and often also predict potential future pathways makes these models highly specific to the locality, leading to lower transferability to other places and systems. This naturally relates not only to the different data sets for each region, but also different types of system components and their interactions. However, we are aware that there are tools describing the types of ecosystems and management options creating a shell that, with local data and adjustments, can be applied in different places (such tools as ALCES, MARXAN and others). From the project that we analyzed, the INGRID project aims for this type of transferability, focusing on grassland management and options, and related costs of these actions.

It is critical to develop creative and innovative ways to communicate the complexity (as well as uncertainty) associated with global change and its regional and local implications. These complexities were discussed during stakeholder interactions and explored especially in the context of the applied project framework. This helped the ATEAM, Balaton, Pathway, GBFP and PIA – Okanagan projects to create an assessment that was both valuable and useful for stakeholders and scientifically relevant in showing how to handle complex human-environmental interactions.

Generally, if stakeholders are to benefit from scientific insight, scientific results should not be over-simplified, but they should be understandable. For example, to practically ease the use of the ATEAM, SENSOR, INGRID and CIT mapping tools, stakeholders suggested limiting the number of indicators per sector displayed on maps and other visuals. The accompanying information on the results and their interpretation was to be found important as well (detailed user manuals in PIA – Okanagan in Cohen and Neale, 2006; guided workshop to help users to use the model, Robinson et al., 2006; capacity building session to help model users in Balaton). However, stakeholders also suggested that most of the results would benefit from further processing, documentation and synthesizing to be used to their full potential, especially when they are trying to address complex issues and relationships. This could include commentary from local policy-makers, examples from local newspapers about local issues and past events experienced by the local communities to ground sophisticated research outputs and to promote better interaction with stakeholders.

4.4 Linking the case study project and its results to decision-making processes

Ensuring that the case study project results and products feed directly into decision-making processes is a considerable challenge. Most of the 10 ILM projects address this challenge using four main tools:

- modelling currently applied policies in the project area;
- illuminating diverse future policy scenarios for the locality;
- providing recommendations for future policy-making based on the scenarios; and
- involving stakeholders, including policy-makers, in developing, commenting on and providing "a reality check" for the policy scenarios and recommendations.

For example, in the Corn Belt and EvoLand studies, analyzing different future policy alternatives was a project goal from its early stages. The integrated models and the scenarios were built in a way to answer policy questions at the regional scale, including addressing cumulative effects that are not always easily accessible for the local policy-makers. However, the aim was to inform the policy process with future scenarios and their impacts; it is not directly focused on being policy-prescriptive for current policy-making (Nassauer et al., 2007; and Bolte et al., 2006).

In some of the projects, such as ATEAM, PIA – Okanagan, GBFP, Balaton and CIT, the policy-makers expressed concerns that the model outputs are difficult to use in practice. For example, policy-makers who await predictions or detailed quantified outputs to guide their decision-making will be disappointed by the lack of "answers," such as those proposed by decision-support and expert systems. As such, there seems to be a broad consensus that any state-of-the-art assessment would not in and of itself be sufficient to significantly influence behaviour (Schroter et al., 2004; and

Rudner et al., 2007). To help overcome some of these barriers, in the Balaton and PIA – Okanagan projects, there were workshops organized to discuss the implementation feasibility, enabling institutional arrangements to achieve the future scenarios and to develop policy recommendations. None of the analyzed projects, however, devised strategies that could actually guide the policy implementation process; however, some projects identified such needs.

In most of the 10 ILM projects, the decision-makers were involved to some extent from the early stages of each project's development. It is important to help create a realistic expectation among the decision makers about what is feasible to model and what kind of outputs they could expect (often also under what constraints and levels of uncertainty). It would be important to communicate to decision-makers the added value of ILM, especially in helping to grasp complexity, interaction between humans and environment, and cumulative effects. To make this communication effective, it would be beneficial to create a communication strategy that will outline the consultation process with stakeholders in advance that could alert the stakeholders for the up-coming consultations and meetings, manage expectations and also provide benefits for the researchers by getting information about when and how to best plug project outcomes into the policy process. This could include windows of opportunities such as council meetings, policy and development plan reviews and up-dates of standards, among others.

4.5 Uncertainty and risk analysis

When analyzing, envisioning and planning for policies that link environmental issues with human activities at the local level, we often introduce uncertainties into developed models, scenarios, recommended policies, and consequently into the decisions-making processes. Although uncertainty analyses are possible within individual modelling systems, weak connections between different models, scenario development techniques and data operating at different scales make it difficult to achieve systematic testing of the integrated system. It should be stressed that current models, particularly those addressing alternative futures, are difficult to verify in any traditional way and new approaches and tools are needed for validating them. This will be a key challenge to allow more widespread acceptance of these models for real-world applications (Bizikova et al., 2009; Floberg et al., 2004; CIT, 2005; and Schroter et al., 2004).

Collaboration with local decision-makers, however, can be used to validate model outputs, test the scenarios and, in this way, establish credibility for project outputs among stakeholders and decision-makers. Rich local knowledge compensates in part for the fallibility of models, and participants in most of the 10 ILM projects became comfortable with the idea of working with ILM models in the development of the future scenarios (Bizikova et al., 2009). For example, for PIA – Okanagan, outputs of the project showed that it is necessary to include specific development pressures and challenges in a comprehensive way to create results that reflect the local reality. If we do not do so, then the risk of creating scenarios that are not relevant for the region is very high. However, by adding these components, new uncertainties were introduced (Cohen and Neale, 2006). Similarly, in the case of other projects (such as Corn Belt, ATEAM, INGRID and SENSOR), the integrated models and the scenarios were tested by involved stakeholders to assess the relevance of the projections. Outputs were also tested by experts to ensure that the data used were high quality, and peer-reviewed to ensure that project' outputs were adequate, despite the uncertainties.

Specifically, to minimize uncertainty, it would be useful for future modelling assessments to explicitly address specific policy- and management-orientated questions at higher spatial resolution, in close consultation with interested stakeholders. Smaller, dedicated models, expert systems and decision support tools, which consider national and sub-national scales, could be useful media to develop for this purpose; better data sets available at the large scale could help in reducing uncertainty (Robinson, 2003; Tansey et al., 2002; and ATEAM).

However, to effectively deal with uncertainties, stakeholders need to understand the roles and limits of scientific enquiry and modelling performances. Scientists cannot provide an exact prediction of future changes, impacts and vulnerabilities, and stakeholders should not expect that such a task be feasible, as uncertainty is unavoidable since society is continuously shaping its future in a complex unpredictable manner (Manning et al., 2006). The dialogue between scientists and stakeholders is itself an important step to communicate about the challenges of the scientific inquiry and the feasibility of transforming results into adaptive policies that could handle uncertainty during the course of implementation. This would probably require presenting the uncertainty and its level in relation to potential policies maybe in a form of critical threshold instead of continuity and also outlining information gaps that could help for policy-making and future integrated modeling efforts.

4.6 Level of collaboration/commitment

Participation and local expertise is becoming essential for ILM projects because it helps in:

- providing excess data, and information on priorities for and assumptions about critical driving forces for scenario development;
- reviewing developed projects' outputs; and
- helping in overcoming significant uncertainty and fostering policy development and actions.

For most of the 10 ILM projects, the models were developed by an interdisciplinary group of researchers. Stakeholders consulted on model characteristics, potential scenarios and their elements, and policy relevance. For example, in the case of the PIA – Okanagan, SENSOR, Pathway and Balaton projects, stakeholder involvement was very high. It included involvement in the actual integrated model development through five workshops (PIA – Okanagan), a series of indicator and scenario development stakeholders' workshops (Balaton and SENSOR) and regular workshops throughout the project (ATEAM). PIA – Okanagan went further and involved local stakeholders and policy-makers in the actual integrated model development and its validation.

Finally, lessons learned show that support of local practitioners in the region is absolutely crucial for ILM projects to get data, consult and validate model results, make locally-relevant recommendations and to consult after a project is complete to help with implementation. Consulting with local stakeholders—even before a project proposal submission—on how much they are willing to cooperate would help in designing the appropriate methodology and completing a project. Management and steering committees that oversee a project should have both research and stakeholder community representatives and help facilitate effective collaboration during and after a project.

During our assessment, we did not come across direct information on sharing information and lessons learned between each project group. We assume that most of the researches were aware of on-going ILM work by their peers through articles and books, conference participations and involvement in scientific societies.

5.0 Conclusions and Recommendations

This case study analysis of the 10 ILM projects aimed to grasp the complexity behind pressing local and regional issues, to illuminate diverse scenarios of future development and to develop recommendations for policies. Most of the 10 ILM projects developed integrated models linking the environmental, social and economic dimensions of the analysed issues. These models were often physically based and spatially explicit using GIS applications, allowing the results to be presented as maps. The models then integrated the physically-based model with socio-economic data in an integrated modelling framework. Most of the projects developed a specific integrated model describing the local systems, which makes transferability of the model and their applications for other location very challenging.

An essential aspect of many of the 10 ILM projects was to help illuminate potential future scenarios and pathways that could help make win-win policy and development choices, and minimize trade-offs. We observed that nearly all of the projects applied some type of scenario development technique, which represented an opportunity to begin an exploration of different futures. The scenarios were built by using the integrated model developed in the previous stage of each ILM project, but often without developing performance measures to analyse the impacts of each scenario. Most of the projects did not aim directly for scenarios that can be easily translated into policies. Most of the projects see the scenarios rather as learning and capacity-building opportunities and tools for policy-makers to help them better understand linkages within the local systems, cumulative effects and to illuminate potential future changes to the system.

Most of the 10 ILM projects were developed by researchers working in an interdisciplinary team and having experiences with the ILM type of assessment with high degrees of complexity. However, this approach was fairly new to most of the stakeholders. The studies emphasized the importance of the bi-directional communication between the researchers and stakeholders to facilitate learning opportunities for both communities, to help integrate local knowledge into the assessments and to make the developed tools, scenarios and recommendations most relevant for the local and regional community. In some of the 10 ILM projects, the significant challenge was to help the stakeholders understand the ILM approach and the trade-off between being detail-oriented and using fewer data sets to try to understand the human-environmental interactions that are often hard to express in measurements and data, and require modelling in much coarser scale (Schroeter et al., 2004; and Robinson et al., 2006).

In this case study, we also focused on analyzing a series of challenges that were encountered during the development of the 10 ILM projects including:

- data gathering and management;
- integrating information, policy and data;
- managing complexity and the interdisciplinary nature of the projects; and
- uncertainty and risk analysis and level of collaboration/commitment.

Based on the gathered information on encountered challenges, we offer the following recommendations for future ILM projects:

- Review currently collected data sets and monitored indicators to assess their suitability to reflect on changing socio-economic and environmental conditions and their usefulness in envisioning and monitoring future scenarios and policies.
- Experiences from the analyzed studies suggest establishing an independent board to design and manage the information and assessment parts of the project. The board should consist of respected members of the various "knowledge communities," striving for a balance among the knowledge communities—science, humanities, technical/practitioner and local—and within each community (CIT Review, 2005; and Tippett et al., 2007).
- Experience shows that the effective integration of data and models representing environmental, economic and social domains at the local level would require attention in the early stages of project development. To enhance this process, it would be beneficial to review the accessible inputs, desirable outputs and products, and the planned model structure when the actual modelling framework is being developed.
- The 10 ILM projects illustrate that the involved policy-makers welcome greater links between scientists and policy processes. All 10 ILM projects considered important to designing targeted scientific documents and outputs, the main suggestions for such outputs were the following (Nassauer et al., 2007; Bolte et al., 2006; and Robinson et al., 2006):
    - highlight the main results, recommendations for policy-making and follow-up questions relevant for decision-makers raised by the research;
    - provide visual information that is immediately clear by means of graphs or diagrams;
    - provide links to further references in case policy-makers and other stakeholders need detailed information on the topic;
    - involve specific organizations, such as networks and umbrella organizations, to ensure the effective dissemination of the results;
    - collaborate in developing capacity-building events with potential users, including policy-makers so that they could actually learn how to use the model, how to create scenarios and what are the uncertainties, among others.

Finally, lessons learned from the 10 ILM projects show that ILM approaches could provide significant benefits for local and regional decision-makers by helping them understand the linkages between environment and humans, and by providing opportunities to explore potential future development pathways and future policies. It seems that despite these benefits, ILM projects are strongly driven by scientists aspiring for new, innovative approaches when describing and envisioning local and regional systems. During these projects, the research community often seeks the support of local practitioners in order to get data, to consult and validate model results, make locally-relevant recommendations, and help with transforming project outcomes into policies and measures. However, we would like to emphasize that there are more opportunities for making policy-relevant contribution with ILM models by strengthening the collaboration with policy-makers, increasing transferability of the scenarios and results, and by addressing implementation and monitoring challenges when creating the outcomes of ILM projects.

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7.0 Appendix –Ten ILM Projects

7.1 Participatory Integrated Assessment of Water Management and Climate Change in the Okanagan Basin, British Columbia

1. **Who is the lead organization in the project?**
   Adaptation and Impacts Research Division, Environment Canada
   Institute for Resources Environment and Sustainability, University of British Columbia

2. **Who is the contact person for the project?**
   Tina Neale and Stewart Cohen

3. **Contact email:**
   tinan@interchange.ubc.ca

4. **What triggered the project?**

   Self- initiated to address an issue
   The rapid population growth in the Okanagan that exceeded even the highest local predictions has led to significant changes in water demand and land use, including loss of farmland. Furthermore, because of the local climatic conditions, water is a scarce resource in the region. Summer irrigation of agricultural land, residential outdoor and indoor water use, tourism, sensitive habitat areas and biodiversity are all demanding water—most of them at an increasing rate (Cohen and Neale, 2006).

   The main triggers of the project were: already experienced water shortages, growing water demand and population and an anticipation of negative impact of climate change on water availability in the region.

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed and forest zone, among others)?**
   The focus was on the Okanagan Valley, which is located in the southern interior of British Columbia, situated around Okanagan Lake. The valley is approximately 160 km in length and encompasses approximately 8,200 km^2 of land surrounding Okanagan Lake and Okanagan River. In the project, the valley was divided into three sub-regions (Cohen et al., 2004).

   Project goals

1. Explore case study experiences on climate change and water resource management in the Okanagan

1.1. Investigate how the potential changes in water balance (supply-demand) will influence water availability for activities and nature conservation in the region

1.2. Investigate experiences with adaptation to water shortages and assess effectiveness and costs of potential future adaptation options.

2. Synthesize the outcomes of the climate change impacts assessment on local water resources, expected development in the region and effectiveness of potential adaptation options in a way that it will help in moving towards strategic approach to adaptation design

6. What are the major issues that the project is focused on?

Agriculture
Climate change
Economic performance
Freshwater
Housing
Land – use
Population
Water quality

B. Major activities in the ILM project

7. What methods and tools were utilized to assess current trends addressed in the ILM project?

Physically-based models - *Okanagan Fish Water Management Tool was linked with ongoing groundwater studies*

Integrated STELA model developed by the research group

8. What were the key challenges faced in completing the assessment within the ILM project and how were they addressed?

Since 1997, there has been a growing amount of research exploring water resources in the Okanagan. Previous research on climate change and Okanagan water resources provided information about supply and demand trends and identified a need for an integrated assessment model that would be developed in close collaboration with local practitioners. This project addressed this need and a participatory integrated assessment model (PIA – Okanagan) of the Okanagan water system's response to climate change was developed.

The development of the integrated model was focused on expanding the dialogue about the implications of adaptation choices for water management to include residential and agricultural users and in-stream conservation flows, for the basin as a whole as well as for particular sub-regions. This work strongly depended on the collaboration with local stakeholders, their active participation and provision of data. The project team needed to gather a fairly significant amount of data and link them with already developed regional models. This turned out be a considerable challenge because each model was developed for a different scale and time frame, and used different data.

In the model development, the project team tried to follow established policies regulating water usage in the region. Translating policies that often provide very generic guidelines into specific data and water levels needed for the models was a challenging task.

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
   - **Multi-stakeholder consultation, consensus building**
     - Core group of six to 12 local stakeholders met six times to:
     - Discuss major changes in the region's water resources during the past nearly 100 years
     - Identify major components of and relationships of a regional water management model
     - Provide local data that could be included into the model
     - Validate the model and conduct sensitivity analyses
     - Develop a series of region scenarios
     - Capacity-building session with more local stakeholders to teach them how to use the model and how to create scenarios
   - **Scenario development and analysis – STELLA decision support model developed thought participation with local stakeholders**

10. **What were the key challenge(s) faced in completing the envisioning and planning activities within the ILM project and how were they addressed?**
    The study may have originated as an assessment of climate change impacts on water resources, but as the project progressed impacts on water supply and demand in the context of local development became the centre of the project (Merritt et al., 2006). In addition, this is not a one-way street. Development choices will also affect the water supply and demand balance. Some development choices could exacerbate climate-related water problems, while others could ameliorate them. For future research, development constraints and challenges of development choices should be indentified and addressed at the early stages of a project.

11. **What information, products were generated as the outcome of the project? Did/will**

the project lead to implementation of new policies, program objectives, agreements or other products (lease specify)?
STELA Based Decision-Support tool allows selection of different population scenarios and different climate scenarios, and allows you to select different adaptation options and their combinations

12. **What methods, tools and actions were utilized during implementation within the ILM project?**

- **capacity-building;**
- **improving planning process; and**
- **recommendation to regional, provincial and national policy-making.**

13. **What were the key challenge(s) faced during implementation of the ILM project?**
To implement the project results basin-wide, implementation, integration of envisioning and planning with local growth strategies is absolutely crucial to provide relevant results. During the whole envisioning and planning process, close collaboration with local practitioners is necessary to create a sense of 'ownership' of the outputs, and in this way create a sense that the project belongs to 'the basin'(Shepherd et al., 2006).

Finally, the visioning and the planning process need to address institutional challenges, because many of the great ideas and scenarios just won't be implemented if there is no clearly defined mandate to manage water quantity and nearly no integration between land use plans with long term water management needs. This would also require collaborating with policy-makers at different scale not only at the local level.

14. **What methods, tools and actions were utilized to monitor and assess progress during the ILM project?**

- **review of implemented actions (limited);**
- **meetings with key stakeholders; and**
- **recommendation for policy development.**

The climate change adaptation dialogue has started, but still it is in its early stages. The project created an increased awareness among regional water managers, planners, political leaders and media. The project provided recommendations for water demand management as first priority, along with supply augmentation, by 2050 if no climate change is assumed, and by 2020 if climate change is assumed. Finally, implications of climate change impacts on water availability based on the project outcomes were incorporated into Trepanier Landscape Unit Water Management Plan (Cohen et al., 2006).

15. What were the key challenges faced in monitoring and assessing the ILM project and how were they addressed?

Larger scale implementation actions would require considerable effort from a number of local policy-makers operating in different areas of the Okanagan Valley. Also many of the recommendations of this study would require changes in the competencies of local policy-makers and in the system of water licenses and these are outside of the scope and influence for the project team.

Even though the project was developed on a participatory basis, involving local decision-makers at the each step of the project, the project team and the participating local -decision-makers perceived this project more as a learning tool than an initiative with direct policy implications that would be implemented (Cohen and Neale, 2006).

16. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

Most of the data were already collected during previous projects in the region.

B. Linking the project and its results to decision making processes

Researchers have also learned that for this type of project, the support of local practitioners in the region is absolutely crucial in order to get data, consult model results, validate model results, make locally-relevant recommendations and consult after the project completion to help with implementation (if needed). Consulting with local stakeholders even before the project proposal submission on what and how much they are willing to cooperate would help to design the methodology and complete the project (Cohen et al., 2006).

C. Integration of information/policy/data

The project team tried to link different models that were developed for the region. However, only a few of them turned out to be compatible and feasible to be linked within a reasonable time horizon (Neilsen, et al., 2006). For the next project, the project team suggested the input, output and model structure be reviewed when the actual modelling framework is being developed to avoid surprises, such as major components of the framework that simply do not fit together at the operational level because of the data structure and availability (Cohen et al., 2006).

D. Handling the interdisciplinary nature of the project

The research team had a lot of experience in interdisciplinary projects and more than half of the team members were interdisciplinary researchers.

E. Managing complexity of tasks and issues

Most of the issues were discussed with the local participants

F. Uncertainty and risk analysis

Finally, the output of the study showed that it is necessary to include development pressures and challenges in a comprehensive way to create results that reflect the local reality. If we do not, then the risk of creating scenarios that are not relevant for the region is very high. The next project in the region should build on past and ongoing research, but with the goal of extending this to the exploration of alternative development paths already being considered within the region (Cohen and Neale, 2006).

G. Level of collaboration/commitment

At least twelve stakeholders, mostly local policymakers, participated in the model development each time. The team had five workshops in total. The project team managed to gather a fairly committed group of stakeholders, but only few of the participating stakeholders attended in more than two events.

H. Costs and time constraints

We had a budget for two years of approx. $135, 000, but some of the money was going to other issues not directly to the decision-support tool.

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7.2 Georgia Basin Futures Project

1. Who is the lead organization in the project?

Institute for Resources, Environment and Sustainability (IRES, UBC)

2. Who is the contact person for the project?

John Robinson

3. Contact email:

johnr@ires.ubc.ca

4. What triggered the project?

Addressing local and regional planning challenges to promote sustainability

5. What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?

The Georgia Basin bioregion - watershed.

The Georgia Basin Futures Project (GBFP) is a five-year interdisciplinary research project to explore regional sustainability in the bioregion that surrounds Vancouver, British Columbia. The Georgia Basin bioregion is defined by the watershed surrounding the cities of Vancouver and Victoria, on the west coast of Canada. The Georgia Basin is rich in natural and human resources, has an environment far less degraded than most highly populated areas, and enjoys one of the highest "human development" indices in the world. The region has experienced significant population growth in the past 30 years as well as structural and ethnic diversification. The structural transition has involved the expansion of the service sector in the region and a detailed portrait is provided elsewhere (Robinson et al., 2003).

6. What are the major issues that the project is focused on?

Air quality
Agriculture
Economic performance
Education
Employment
Energy
Freshwater
Governance
Housing
Land use

Nature and biodiversity
Population
Sea, oceans and coasts
Social issues and equity
Transportation
Waste
Wastewater
Water quality

A. **Major activities in the ILM project**

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? What existing approach or newly developed model was used for these purposes? Is the developed tool available for use?**
    - Integrated modeling – QUEST model
    - GIS tools – QUEST model is spatially explicit

    PROJECT GOALS:

    The goals of the project, as defined in the original proposal are:

    Goal 1: Through scenario analysis, to better understand the interrelated dynamics of the ecological, economic and social systems in the Georgia Basin, and to identify policy interventions which could enhance human well being, while reducing the adverse environmental effects of human activities.

    Goal 2: To evaluate the role of game-like simulation tools in enhancing public understanding of these dynamics, and of the complex trade-offs involved in sustainability.

8. **What were the key challenge(s) faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**

    GB-Quest seeks to achieve some degree of ambivergence by combing the regional modelling approach with the rich global scenarios of the Global Scenarios Group (Raskin et al., 1998), which are being interpreted and modified to relate to this geographic region. This approach recognizes that even relatively autonomous socio-economic and biophysical regional processes may be influenced by exogenous global factors. For instance, the regional agricultural sector is dependent on international trade, even though domestic markets and policies may have a more significant impact. Ambivergence will result from the development of regional scenarios in the context of different global conditions; the project will explicitly examine the implications of these regional responses for the global context (Robinson et al., 2006).

9. What methods and tools were utilized during the envisioning and planning activities within the ILM project?

- multi-stakeholder consultation, consensus building; and
- scenario development and analysis – using backcasting.

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and the availability of key stakeholders, dealing with uncertainty etc.

Many forecasting methodologies, particularly those where the focus is upon the interactions between institutionalized social practices and biogeophysical systems, base these predictions on past experiences, since these efforts must make assumptions about the form these social practices will take in the future. The backcasting approach, used in this project, takes the inevitable moral dimensions to modelling as the starting point and seeks to make the process of defining what is desirable or undesirable an explicit and intentional part of scenario development. Rather than embedding normative assumptions about human behaviour within the complex architecture of the model, backcasting requires that these be made explicit in the computer-aided design of future scenarios. Instead of predicting the most likely future, the approach works backwards from scenarios defined in terms of their desirability to assess their consequences in terms of biogeophysical systems (Robinson, 2003).

The design approach in this project is based on backcasting and we may distinguish between the machine space, which contains the physical processes and interrelationships within the model, and the actor space, describing the interface that allows the user to develop scenarios as well as the social processes within which the model is used.

11. What information, products were generated as the outcome of the project? Did/will the project lead to the implementation of new policies, program objectives, agreements or other products? Please specify.

The backcasting model for the Georgian Basin bioregion was developed: Much of the modelling research effort was dedicated to the characterization of the physical transformation processes, which underlie the systems being modelled. The model itself describes the transformation of energy, labour, land-use and materials, given user-supplied assumptions. This approach shares with systems dynamics a focus on stocks and flows and the physical representation of process (Tansey et al., 2002). This implies a similar treatment of data and a similar attitude toward model validation. Design approach models, like system dynamics models are also dynamic. However, like input/output models, and unlike system dynamics models, the design approach implies a very disaggregated treatment process, and the externalization of all behavioural relationships. This implies a fundamentally open modelling system (Robinson, 2003; Carmichael, 2005).

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

It has been recognized that the model can be used in a number of distinct social contexts. The most important from a research and policy planning perspectives are:

- Stakeholder forums, involving a range of different constellations of actors from within the region and including elected officials, government officers and staff from the non-governmental sectors.
- 'Laboratory' style studies, where the purpose is to experiment with different processes and ways of presenting data, user choices and model outputs. This context will allow for more intensive and detailed studies of the social learning process the tool creates.
- Individual uses of the model, where users 'play' iteratively with Quest to explore the consequences of their choices.
- Educational applications from high schools to further education, where the tool will be used as a learning aid (Tansey et al., 2002).

13. What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.

The model did not directly aim for implementations; however some of the implementations are outlined above. The research group was also focused on testing the educational implications of the model, in particular, the influence of the model on attitudinal change. This is being currently explored in the more controlled laboratory context in order to ensure that the validity of the data and that the effects observed are real. This will also include an important exploration of the role of the model in the processes of social learning and in the development of adaptive strategies, particularly in the face of climate change.

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

The model developed into a spin-off company called Envision and was applied to other regions in BC, including Vancouver, Richmond, Bowen Island, and many other cities (approx. 10 or even more) in Canada. It was also turned into a learning tool helping in planning for sustainability by using average census data for Canada called "Riverside QUEST."

15. **What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?**
    The spin-off process (being for profit) was successful, though at the beginning it was challenging to find communities who were interested in investing in the model and its adjustment for the community with actual community data. The model is still free for educational purposes at University of British Columbia.

16. **What lessons were learned (from questions 11, 13 and 15) and what improvements and/or adaptations are recommended for the next application of future projects (as related to the following issues, if relevant for your project):**

    A. Data gathering and management
    Gathering data at the local level is always a challenge; some of the data were developed for the local level by using regional proxies, because pollution data, waste production and water quality are monitored only in the higher level, and in some cases, local data such as time spent within transportation to work.

    B. Linking the project and its results to decision making processes
    See point below

    C. Integration of information/policy/data
    The central ethos of GBFP is that policy relevance can be improved by interacting with a much wider array of agents on a regional scale. This implies that power is not concentrated in the formal organizations of government; it is diffused among the wide array of institutions of which society is composed. The actual model was developed by the research team (see also the answer to point H below), but tested with number of communities in BC and later applied to even more communities (Robinson et al., 2006).

    D. Handling the interdisciplinary nature of project
    The project was developed by an interdisciplinary team from its early stages.

    E. Managing a complexity of tasks and issues
    This recognizes that regional models are able to handle greater detail than is feasible when considering the complexity of global systems. Local regionalism treats the chosen geography as self-contained, with no feedback to the global scale, implying that regional

processes are relatively autonomous. Finally, ambivergent regionalism implies that flows of information in one direction are as important as in the other. The global and local scales are co-determinant to some degree (Robinson, 2003; Tansey et al., 2002).

F. Uncertainty and risk analysis

The treatment of uncertainty regarding human behaviour is an innovative feature of the project and the issues are quite different to projects where the goal of the model is to represent behaviour through the use of genetic algorithms (Janssen, 1995 in Tansey et al., 2002). Since the backcasting approach asks users to define what constitutes a desirable future, the critical concern about whether the representation of human agents is accurate is to a large degree by-passed. Once the user makes the choices they consider desirable, the model projects them cross the region in order to represent the consequences. Thus, the user's choice is principally deterministic and this may be unrealistic in the way it represents society. The advantage is that it allows researchers to discover with a relatively high degree of certainty, what is considered a desirable future, what trade-offs are acceptable, what individuals and groups are able to learn about the future and what the relationship is between the knowledge of some of the issues the region faces and actual behaviour (Tansey et al., 2006).

G. Level of collaboration/commitment

There was collaboration with a number users of the model; it was a participatory model development and later the model was used in numerous participatory workshops and events.

H. Costs and time constraints

The comparable initiative in Canada is the Georgia Basin Environment Initiative, a co-operative initiative between Environment Canada (Federal), Department of Fisheries and Ocean (Federal) Ministry of Environment, Lands and Parks (Provincial) and Ministry of Municipal Affairs (Provincial). This initiative identified the Georgia Basin Bioregion as the watershed that drains into the Straits of Georgia, between Vancouver and Victoria.

I. Please add comments

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7.3 From the Corn Belt to the Gulf: Societal and Environmental Implications of Alternative Agricultural Futures

1. **Who is the lead organization in the project?**
   University of Michigan and University of Oregon

2. **Who is the contact person for the project?**
   Joan Iverson Nassauer

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4. **What triggered the project?**
   Self-initiated to address an issue
   Meeting a government legislative or policy requirement

   Agriculture at the Mississippi River Basin has been identified as the leading cause of depleted oxygen in the 'dead zone' of the Gulf of Mexico. The generation of American agricultural policy could ameliorate this problem along with many environmental and societal impacts in the Basin. Negotiations with trade partners, challenges for policy-makers about how to design future policies, increasing societal attention to costs and the environmental effects of agricultural policies, and emerging opportunities including ethanol production created a momentum to explore alternative policy directions.

   Specific issues:
   The hypoxic area is very large. It has doubled since 1993 and significant fishery resources are at risk. Scientific Assessment is therefore needed to address the river N load as the main long-term driver of hypoxia (N load is > 3X that of 1950s) and most N sources are agricultural non-point (90 per cent of nitrate inputs from non-point sources and 56 per cent of nitrate enters system north of Ohio River)

   The interest was to see if it is possible to reduce loads by 40 per cent and also investigate economic and spatial choices to give flexibility for policy

5. **What is the geographic boundary of the project (using a country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   The Corn Belt region in the Middle and Upper Mississippi sub-basin of the Mississippi

River Basin

6. **What are the major issues that the project is focused on?**
   Agriculture
   Economic performance
   Energy
   Freshwater
   Groundwater
   Land – use
   Nature and biodiversity
   Sea, oceans and coasts
   Species at risk
   Water quality

A. Major activities in the ILM project

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? What existing approach or newly developed model was used for these purposes? Is the developed tool available for use?**
   - Integrated model
   - GIS tools

Two scales of Integrated Assessment were completed in this project. Both IAs used science as a means of assessing multiple environmental conditions and share the following common characteristics:

- Assess conditions that are relevant to policy questions
- Use empirical data that describe past and current landscape conditions to develop descriptions of future landscape conditions
- Describe policy-relevant characteristics of future landscape conditions
- Quantitatively compare the function of future conditions on numerous policy-relevant dimensions
- Integrate multiple assessments to result in a whole picture, allowing comparisons among different future conditions (Nausser et al., 2007)

8. **What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**
   Linking local scale actions with regional and even state policies required dealing with an extensive scale. This approach helped to show that policies and programs that influence

local practices and landscapes have also enormous cumulative effects downstream. These linkages would not be exploitable without creating the integrated model.

9. What methods and tools were utilized during the envisioning and planning activities within the ILM project?

- multi-stakeholder consultation, consensus building; and
- Scenario development and analysis.

As the scenario developed, the focus was on building normative scenarios that are not predictions of the future based on current trends. Instead, the normative scenarios try to emphasize the plausible prospects of what might be a desirable outcome. The outputs of the scenarios were future landscapes presented by a spatially explicit representation of land cover patterns and land management practices. The models used a menu of patterns and practices to describe a set of characteristic land covers for each scenario. Then the location and pattern characteristics of the land covers were operationalized into a set of precise, replicable, decision-making rules for landscape change. The rules used existing GIS data to construct GIS models of the alternative future landscapes. Each of the scenarios was tested for the stakeholder response, economic return, and ecological and hydrological performance of landscapes that could plausibly emerge from the new policies. These tests included simulation along with statistical and other explanatory models and analyses (Nausser et al., 2007; Naussuer, 2008).

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty etc.

The scenarios contribute greatly to envisioning aim for policy as they would affect local landscapes. Many of the patterns and practices can be recombined in different ways to achieve varying policy aims. This approach also allows a site-specific examination of trade-offs and multiple benefits when landscapes are changed to maintain agricultural productivity, water quality and biodiversity. However, these scenarios are not intended to provide detailed roadmaps on how to reach the desired future outcomes.

11. What information, products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify

Integrated assessment model for the Mississippi River Basin

Set of thee major future scenarios and baseline

12. **What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?**

Recommendation to regional, provincial and national policy-making

Changes in Corn Belt farming could dramatically reduce the 5,000 square mile "dead zone" in the Gulf of Mexico. Agricultural policies could help to achieve these changes including:

- More complete adoption of traditional and innovative conservation practices
- Precision farming
- Upland and wetland habitat restoration
- Perennial crops –properly managed for conservation value

13. **What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.**

This project didn't directly aim for policy implementation. It tried to show alternative and innovative ways of agricultural policy-making analyzed for different conditions, including biodiversity, water quality and farmers revenues analyzed at diverse spatial area.

14. **What methods, tools and actions were utilized to monitor and assess progress during the ILM project?**

Meetings with key stakeholders

15. **What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?**

Information about monitoring was collected

16. **What lessons were learned (from questions 11, 13 and 15) or what improvements and/or adaptations are recommended for the next application of future projects (as they relate to the following issues, if relevant to your project):**

A. **Data gathering and management**

Data were gathered by the project team member. Data about farmers' practices were gathered through interviews with farmers.

B. **Linking the project and its results to decision-making processes**

Analyzing different policy alternatives was a direct aim of this project from its early stages. The integrated models and the scenarios were built to address policy questions. However, the aim was to inform the policy process about future scenarios and their impacts; it is directly focused on being policy-prescriptive for current policy-making.

C. Integration of information/policy/data

Most of the integration was done by the research team, who had worked before on similar projects. They aimed to inform policy process and use current policies to inform the models and scenarios, but no deeper integration was done.

D. Handling the interdisciplinary nature of project

No information available

E. Managing complexity of tasks and issues

No information available

F. Uncertainty and risk analysis

The integrated models and the scenarios involved farmers in assessing the projections. The involved data were high quality and the outputs were peer-reviewed to ensure that the project outputs were adequate despite uncertainties.

G. Level of collaboration/commitment

No information available

H. Costs and time constraints

No information available

I. Please add comments

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7.4 Willamette Valley–Puget Trough–Georgia Basin Eco-regional Assessment

1. **Who is the lead organization in the project?**
   Department of Biological and Ecological Engineering, Oregon State University

2. **Who is the contact person for the project?**
   John Bolte

3. **Contact email:**
   boltej@ engr.orst.edu

4. **What triggered the project?**
   Self-initiated to address an issue

5. **What is the geographic boundary of the project (country and place-based descriptors such as eco-zone, watershed, forest zone, etc.)?**
   The Willamette Valley-Puget Trough-Georgia Basin ecoregion is a long ribbon of broad valley lowlands and inland sea flanked by the rugged Cascade and coastal mountain ranges of British Columbia, Washington, and Oregon. It encompasses some 5,550,000 ha (13,715,581 ac or 21,431 square miles) of Pacific inlet, coastal lowlands, islands, and intermontane lowland, and extends from the Sunshine Coast and eastern lowland of Vancouver Island along Georgia Strait, south through Puget Sound and the extensive plains and river floodplains in the Willamette Valley. The ecoregion contains over 10,000 miles of streams and rivers, including the middle reaches of a number of major (third order or larger) rivers whose headwaters lie in the mountains of adjacent ecoregions.

6. **What are the major issues that the project is focused on?**
   Agriculture
   Economic performance
   Fisheries
   Forestry
   Freshwater
   Governance
   Land – use

Nature and biodiversity
Sea, oceans and coasts
Species at risk
Water quality
Wetlands

A. Major activities in the ILM project

7. What methods and tools were utilized to assess current trends addressed in the ILM project? Existing approach was used or new developed model was for these purposes? Is the developed tool available for use?

- Indicator development and reporting (spatial and non-spatial).
- Integrated modeling
- GIS tools
- Physically-based models

A deeper, more site-specific **analysis of the key impacts** to biodiversity is needed to inform impact-abatement strategies. The impact analyses conducted in this assessment (i.e., the use of suitability indices to gauge some of the impacts that may determine the success of biodiversity conservation at each site, and the cataloguing of a checklist of impacts believed to operate at each site) allowed for crude estimates of the relative prevalence, severity and urgency of impacts, but did not address the complex interactions among impacts or break complex impacts (e.g., invasive species) down sufficiently. This deeper impact analysis and strategy development work may be inappropriate for inclusion in ecoregional assessments, and more suited to planning conducted by users of the assessment (Bolte et al., 2006; Floberg et al., 2004).

8. What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?

The chief challenge is the imbalance of biodiversity data among environments. Terrestrial species and habitats are more fully documented than either marine or freshwater biodiversity in terms of their identification, location and relative condition. A major limitation on the marine assessment, for example, was the lack of comprehensive data for benthic habitats and other physical parameters in the offshore environment. This limited the marine analyses to the nearshore and a few shoal areas away from the coast for which data were available. Within the nearshore, data on fine filter (e.g., species) target occurrences and on habitat condition is lacking when compared to the terrestrial analysis. The resulting marine portfolio should be regarded as a representative sample of nearshore and shoreline habitats that provide a good starting point for field verification of habitat condition and other attributes that will determine which sites are higher priorities for conservation. The freshwater analysis, meanwhile, faced similar limitations on species-level data outside of salmonids. In addition, the freshwater analysis could not be conducted within the boundaries of the terrestrially derived Willamette Valley-Puget Trough-Georgia Basin ecoregion; freshwater biodiversity is better represented within watersheds. It required analysis of the six watershed-based ecological drainage units (Floberg et al., 2004).

9. What methods and tools were utilized during the envisioning and planning activities within the ILM project?

- Multi-stakeholder consultation, consensus building
- Scenario development and analysis
- Multi-criteria assessment
- Strategic assessment (strategic environmental assessment, strategic sustainability assessment, integrated policy appraisal)

EvoLand (for Evolving Landscapes) is an example of a modelling tool that supports the development of spatially explicit, actor-based approaches to landscape change and alternative futures analysis. EvoLand provides a framework for representing:

1. a landscape consisting of a set of spatial containers, or integrated decision units (IDU's), modelled as a set of polygon-based geographic information system (GIS) coverages containing spatially-explicit depictions of landscape attributes and patterns;
2. a set of actors operating on a landscape, defined in terms of a value system that couples actor behaviour to global and local production metrics and in part determine policies the actor will select for decision making;
3. a set of policies that constrain actor behaviour and whose selection and application results in a set of outcomes modifying landscape attributes;
4. a set of autonomous process descriptions that model non-policy driven landscape change; and
5. a set of landscape evaluators modelling responses of various landscape production metrics to landscape attribute changes resulting from actor decision-making.

EvoLand provides a general-purpose architecture for representing landscape change within a general paradigm incorporating actors, policies, spatially explicit landscape depictions, landscape feedback, and adaptation; application-specific components are "plugged in" to EvoLand as required to model particular processes (Bolte et al., 2006; Floberg et al., 2004).

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include difficulties with interdepartmental relations, needed resources, availability of key stakeholders, dealing with uncertainty, etc.

The analytical tool used in this assessment requires goals. We also recognize the importance of attempting to set goals in order to answer the question of how much is enough in order to maintain species, communities and systems. However, these goals were primarily a device for assembling an efficient conservation portfolio, and should not be interpreted as guaranteeing the necessary and sufficient conditions for long-term survival of plant communities and ecological systems. Ideally, when setting goals, we are attempting to capture ecological and genomic variation across the ecoregion and ensure species persistence by spreading the risk of extirpation. However, the science of setting goals is young and evolving. The project team had no scientifically established method for setting goals for coarse filter targets. Hence, we relied on the best professional judgment of ecologists from the technical team and state Natural Heritage Programs. For each ecological system, the project team estimated percentage loss or decline of the system from 1850 to the present in ten percent intervals using current land use/land cover data and, where available, pre-settlement land cover reconstructions, for systems where the loss was greater than 75 per cent, and therefore less than 30 per cent of its historic existence is remaining, we set a goal of "all extant relatively viable (ecological integrity C or better) occurrences" (Floberg et al., 2004)

11. What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.

The conservation portfolio presented here has two main applications. First, the portfolio is most useful as a guide for habitat protection. The project team encouraged government agencies, donors and NGOs that fund conservation projects or provide financial incentives for habitat protection to use the portfolio as they consider priorities. Conservation projects inside the conservation portfolio should receive special consideration, and projects that can have a range of siting options should be sited to benefit priority conservation areas wherever possible. Biodiversity conservation in the ecoregion will attain its fullest potential if all conservation organizations coordinate their land acquisition, conservation easement and habitat restoration efforts according to the priorities identified by the portfolio. In the process of using this new portfolio tool, the users themselves will discover improvements that should be incorporated in future updates.

With a clear understanding of its strengths and weaknesses, all planners are encouraged to use this assessment and the created scenarios together with other resources to address specific projects. For example, local governments preparing long-term land use plans should find the scenario's portfolio and associated data useful for identifying places that should be given special consideration for their biodiversity value. Likewise, local land trusts can use the outputs to gain a perspective on local biological resource values and to quickly obtain detailed information on the biological value and suitability parameters of local portfolio sites in integration with diverse human activities (Bolte et al., 2006; Floberg et al., 2004).

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

Recommendations to regional, provincial and national policy-making

During the scenario development, policies are characterized by two types of decision variables: (1) those required to be satisfied before the policy can be considered (also known as non-compensatory attributes or constraints); and (2) compensatory factors defining the intention of the policy at addressing specific goals, which can be "traded off" against other objectives in decision-making using a multiobjective decision-making algorithm. Further, policies may optionally be constrained to operating only with selected actor classes (e.g., all home owners, farmers with streams flowing through their property, forest owners with anadromous fish in adjacent streams; Bolte et al., 2006)

13. What were the key challenge(s) faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles etc.

The assessment had no regulatory authority. It was simply a guide to help inform conservation decision-making across the ecoregion. The sites described are approximate, and often large and complex enough to allow (or require) a wide range of resource management approaches. Ultimately, the establishment and management of any priority conservation area will be based on the policies, values, and decisions of the affected landowners, governments, and other community members (Floberg et al., 2004).

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

- Data base development and management
- Review of implemented actions
- Meetings with key stakeholders

15. What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?

The authors will conduct annual reviews of the use of the assessment and feedback received from users to determine the timing and focus of future editions.

This assessment should be treated as a first approximation. It is more complete for some species or ecological systems than for others, more detailed for some land-use activities then others, reflecting the variable state of knowledge of the natural world. Generally speaking, terrestrial biodiversity is more adequately represented than that of freshwater and marine systems (Floberg et al., 2004).

Finally, the current models, particularly those addressing alternative futures analysis, are difficult to verify in any traditional way and new approaches and datasets are needed to validate these models. This will be a key challenge to allow more widespread acceptance of these models for real-world applications. We have yet to develop well-specified operational definitions of key concepts like resilience, vulnerability and adaptation, although current models are beginning to make progress in this area (e.g. Carpenter et al., 1999 in Bolte et al., 2006).

16. What lessons were learned (from questions 11, 13 and 15) or what improvements and/or adaptations are recommended for the next application of future projects (as they relate to the following issues, if relevant to your project):

A. Data gathering and management

See also answerers above

A number of ecological and human systems were potentially misrepresented to varying degrees by our data. Many of the data sets include information on occurrences not collected recently. In a rapidly changing ecoregion such as the WillametteValley-Puget Trough-Georgia Basin, occurrences documented in the past may no longer be in the same condition or even still present at all. For ecological system occurrences generated from remotely sensed data, it is difficult to assess condition or landscape context. Therefore, it is likely that some of the “occurrences” do not meet minimum element occurrence rank specifications for ecological integrity (Floberg et al., 2004)

B. Linking the project and its results to decision making processes

The assessment was conducted at an ecoregional scale. It provides information for decisions and activities that occur at an ecoregional scale, such as establishing regional priorities for conservation action, coordinating programs for species or habitats that cross state, county or other political boundaries, judging the regional importance of any particular site, and measuring progress in protecting biodiversity and their interaction with human actions (Floberg et al., 2004).

C. Integration of information/policy/data

An initial set of policies are crafted based on current operative policies in the study areas as well as policies that are currently being contemplated. The future scenarios focus primarily on land use/land cover change. During the scenario development, trajectories and patterns of change to determine likely development patterns, vulnerability of specific landscape areas to changes in capacity to provide ecological, economic and social productions were projected over next 50 years (Bolte et al., 2006; Floberg et al., 2004).

D. Handling the interdisciplinary nature of project

The process of **integrating terrestrial, freshwater and nearshore marine assessments** needs to be improved. The next step in this regard for this study area is the completion of freshwater portfolios for the six intersecting ecological drainage units. This will allow a more balanced integration that represents freshwater priority conservation areas. Additional needs include building databases that combine information on stream reaches, contributing watersheds and associated estuaries and shoreline to allow better integration of ecological processes in these multi-ecosystem sites.

Climate change was not considered in this assessment. In future editions, the portfolio should be examined to determine its vulnerability to sea-level rise, temperature and moisture gradient shifts, and other predicted changes that may require adjustments in site selection, prioritization and boundaries (Floberg et al., 2004).

E. Managing complexity of tasks and issues

The complexity inherent in this system challenges the modelling community to provide tools that sufficiently capture the richness of human and ecosystem processes and interactions in ways that are computationally tractable and understandable. We examine one such tool, EvoLand, which uses an actor-based approach to conduct alternative futures analyses in the Willamette Basin, Oregon (Bolte et al., 2006).

F. Uncertainty and risk analysis

The purpose of the sensitivity analysis is twofold: (1) to demonstrate how changing our assumptions with regard to goals and the suitability index influences the selection and prioritization of assessment units and (2) to generate additional information to help prioritize among assessment units and the areas selected for the portfolio. The sensitivity analysis was done only for the terrestrial portion of the portfolio because: (1) the terrestrial results have a greater influence on the portfolio than the marine or freshwater results and (2) terrestrial environments and species have been more thoroughly studied, and therefore, the terrestrial results are more robust than the marine or freshwater results (Floberg et al., 2004).

G. Level of collaboration/commitment

Not available

H. Costs and time constraints

Not available

I. Please add comments

References

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7.5 Coast Information Team Program

1. **Who is the lead organization in the project?**
   Coast Information Team, http://www.citbc.org/

2. **Who is the contact person for the project?**
   Melissa Hadley - Cortex Consultants Inc.

3. **Contact email:**
   http://www.citbc.org/

4. **What triggered the project?**
   Meeting a government legislative or policy requirement

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   North and central coastal British Columbia (BC) covers the coastal waters, islands, and watersheds of the Canadian Pacific from the Alaskan border south to the Strait of Georgia and from the summits of the coastal ranges west to the continental slope. It includes Haida Gwaii/Queen Charlotte Islands (QCI) and northern Vancouver Island. The region has a land area of 118,000 square kilometres (CIT, 2004).

6. **What are the major issues that the project is focused on?**
   Economic performance
   Fisheries
   Forestry
   Governance
   Land – use
   Natural resources
   Nature and biodiversity
   Recreation
   Sea, oceans and coasts
   Social issues and equity
   Species at risk

A. Major activities in the ILM project

Project goals

The Coast Information Team (CIT) was established to provide governments, stakeholders and the provincial and First Nations planning processes with independent information on the region using the best available scientific, technical, traditional and local knowledge. The CIT's task was to produce information to help governments and participants in the planning processes reach decisions that achieved ecosystem-based management, and, specifically, to provide:

- An ecosystem-based management (EBM) framework.
- Regional and subregional analyses.
- A hydroriparian decision tool.
- Technical support for pilot projects that investigate local applications of ecosystem-based management.

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? What existing approach or newly developed model was used for these purposes? Is the developed tool available for use?**

- Indicator development and reporting (spatial and non-spatial).
- Integrated modelling
- GIS tools
- Physically-based models

The team adopted a dynamic framework, integrating ecosystem integrity and human well-being with their linking elements, such as ecosystem services, human impacts, human interactions and drivers of change. We organized the information/assessment program according to the following steps: (i) adopt the framework; (ii) develop a set of goals, objectives, indicators, and targets; (iii) define the data requirements for scenarios that explore alternative ways of achieving the goals, objectives and targets; (iv) develop and implement projects to provide the data; (v) develop the scenarios; (vi) develop a strategy with the assessment users to achieve the preferred scenario (CIT Review report, 2005).

8. **What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**

Lack of information prevented a detailed assessment of First Nations sites. Major gaps in coverage of traditional territories make it likely that many places important to First Nations have not been recorded. Prepared by a sociologist and anthropologist from data provided by First Nations or—in the case of other communities—gathered by individuals or small teams were used to cover some of these gaps.

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
    - Multi-stakeholder consultation, consensus building
    - Scenario development and analysis

10. **What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.**

    The least complete and integrated part of the CIT's work is the strategy. Strategy development was outside the CIT's mandate; the CIT was unable to develop the scenarios that would have guided the strategy; and the regional and subregional analyses that would have provided the building blocks for the strategy were not completed in time. Nonetheless, an integrated strategy is still needed. The following recommendations are specific to the north and central coast of BC (including Haida Gwaii/QCI, CIT Review report, 2005).

11. **What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.**

    The CIT program produced four ecosystem-based management (EBM) guides and six regional and subregional analyses (CIT Review report, 2005):

EBM guides

Ecosystem-Based Management Framework. Defines EBM, sets out principles to guide EBM, defines goals and objectives of EBM, and outlines key elements of EBM planning and implementation.

Ecosystem-Based Management Planning Handbook. Describes key concepts of conservation planning, socioe-conomic planning, and their integration, including management direction, risk management, human vulnerability mapping, monitoring, knowledge and information management and collaboration.

Hydroriparian Planning Guide. The hydroriparian decision tool called for in the CIT mandate (section 1.3.1). Supplements the *EBM Planning Handbook* by providing more detailed advice on how to maintain the functions of aquatic and riparian ecosystems, especially at the watershed level. Prepared by a team of hydrologists, ecologists and practitioners.

The Scientific Basis of Ecosystem-Based Management. Provides the rationale and scientific background to the ecological aspects of the CIT's approach to EBM.

Regional and subregional analyses

Ecosystem Spatial Analysis. Identifies priority areas for biodiversity conservation and provides an information base and decision support for subsequent planning and management efforts

Central Coast Coarse Filter Ecosystem Trends Risk Assessment—Base Case. Uses the abundance and extent of old forest (older than 250 years), by ecosystem type, to indicate the probability of maintaining coarse filter biodiversity, ecosystem function, and ultimately ecological integrity in the Central Coast.

Cultural Spatial Analysis. Identifies important places for sustaining the cultural values of First Nations and other communities, including sustenance, heritage, spiritual and recreational values.

Economic Gain Spatial Analysis. Reports on timber and tourism—prepared by small teams led by an economist specializing in the sector concerned—identify areas with the highest potential for timber harvesting and tourism respectively, estimating the potential economic gain in terms of direct employment within and outside the region (jobs, full-time equivalents per year, and annual employment income), revenue to the Crown and profit to enterprises (total revenues minus expenses).

Wellbeing Assessment. Measures current environmental and human conditions in each of the eight subregions of North and Central Coastal British Columbia to provide a context for decision-making, a test of options and scenarios and a baseline for monitoring implementation of plans and progress toward EBM and sustainability.

Policy and Institutional Analysis. Identifies the main features of EBM that require institutional support. Discusses the design of institutions, institutional constraints and opportunities, and the design of policy instruments (regulatory, economic, legal, and voluntary), drawing lessons from three projects. Examines policy and institutional issues relating to aboriginal title and rights, adaptive co-management, and local benefits from land use and resource extraction.

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

- Local policy development
- Improving planning process
- Recommendation to regional, provincial and national policy-making
- Changes in legislation /regulations ?

13. What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.

Unexpectedly, the mandate to provide independent information conflicted with the mandate to use knowledge from diverse sources—technical and traditional, as well as scientific (see next section). Partly, this was because independence was loosely (and naively) equated with "scientific," although scientists are human and have their points of view and biases. Partly, it was because technical and practitioner knowledge seemed too close to the corporations and other interest groups from whence they came. To provide the most useful information possible for the social choices of planning processes and decision making, assessments should aim for neutrality and independence. At the same time—given that knowledge is value-rich rather than value-free—they should also try to accommodate multiple values (CIT Review report, 2005; CIT, 2005).

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

- Review of implemented actions
- Meetings with key stakeholders
- Strategy development

15. What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?

In general, only limited transformations of knowledge to future strategies occurred in this project for example, the economic development strategy. Supporting information required for this includes: a global review of the characteristics of a sustainable economy (one that maintains ecological integrity while delivering human well-being); analysis of the level of economic activity (e.g., jobs, government revenue, community revenue, nonmarket activity) needed to achieve human well-being; analysis of the economic opportunities and strategies that can be pursued within EBM constraints under evolving market and policy conditions.

The recommendations of the planning processes and the outcomes of government-to-government negotiations between the Province and First Nations should be assessed against the objectives of EBM to see how well they meet the targets. Thereafter, regular monitoring and periodic assessment are required to determine progress toward the objectives and targets and to make any necessary course corrections.

16. What lessons were learned (from questions 11, 13 and 15) or what improvements and/or adaptations are recommended for the next application of future projects (as they relate to the following issues, if relevant to your project):

A. Data gathering and management

For future projects, we suggest to establish an independent board to design and manage the information/assessment program. The board should consist of respected members of the various "knowledge communities," striving for a balance among the knowledge communities—science, humanities, technical/practitioner, and local—and within each community (e.g., biophysical sciences and socioeconomic sciences, aboriginal and non-aboriginal). Use methods of research and validation appropriate to each knowledge community. (Scientific research follows scientific procedures and is reviewed by scientists; other forms of investigation require different procedures and involve a different set of peers.) This implies at least one assessment by each knowledge community (CIT Review report, 2005).

B. Linking the project and its results to decision making processes

We experienced significant delays in establishing the proposed decision-making bodies and regional science body. As well as moving forward with EBM planning, monitoring and research, these bodies should address the other governance recommendations of the Policy and Institutional Analysis and Wellbeing Assessment (CIT, 2004).

C. Integration of information/policy/data

The major reason for the lack (very limited amount) of integration was that integration was not built into the program. The EBM guides, Wellbeing Assessment and spatial analyses were initiated and developed separately. Scenarios were not deeply considered until the analyses were well advanced, by which time it was too late to change them. With hindsight, it is clear that the second step (after the adoption of a single dynamic framework) should have been to develop the set of objectives, indicators and targets—as a combined exercise rather than the separate initiatives of the EBM Planning Handbook, Hydroriparian Planning Guide, and Wellbeing Assessment. The crucial role of objectives, indicators and targets is that by elaborating the goals they clearly define what it is we want to achieve (CIT, 2004 and 2005).

D. Handling the interdisciplinary nature of project

See above.

E. Managing complexity of tasks and issues

The management committee interpreted the CIT's mandate, determined and oversaw the program and budget, decided the specifications of each project and the composition of the project teams, and assured the CIT's independence. The secretariat included an executive director, a project manager and other part-time staff. It was responsible for advising the management committee on the program, administering the projects and liaising with the planning processes. Consultations with stakeholders (the communities and sectors involved in the planning processes) were organized by the planning processes concerned. Data were stored by the Ministry of Sustainable Resource Management, which also assisted with data processing and analysis (CIT, Review report, 2005).

F. Uncertainty and risk analysis

We suggest going ahead with the program only when those requirements are assured. "Risk management" (i.e., starting without such assurance and trying to gain the time or resources while undertaking the program) does not work. If either the time or the resources is uncertain, consider a less ambitious program or none at all. In addition, a research program is needed to fill major knowledge gaps and reduce uncertainty. The CIT report on the Scientific-Basis of Ecosystem-Based Management notes the lack of empirical studies of ecological thresholds in the region; the great uncertainty about the risk of loss of ecological integrity between very high and very low levels of disturbance; and the absence of information on ecological differences (especially at regional and sub-regional scales) between old forest and selectively harvested forest (CIT Review report, 2005; CIT, 2005).

G. Level of collaboration/commitment

The CIT was set up by the Provincial Government of British Columbia, First Nations of the region, environmental groups and forest products companies. It consisted of independent scientists and practitioners and traditional and local experts, overseen by a management committee and supported by a secretariat. The CIT became operational in mid-January 2002 and concluded its work at the end of March 2004. Its CA$3.3 million budget was funded by the Province (58%), environmental groups (18%), forest products companies (18%) and the Federal Government of Canada (6%). The five-person management committee consisted of representatives of the founding partners (Provincial Government, First Nations, environmental NGOs, forest products companies) and the community at large, and was co-chaired by Provincial Government and First Nations representatives (CIT, Review report, 2005).

H. Costs and time constraints

Determine the time and resources required to engage aboriginal and non-aboriginal knowledge communities and budget the required time and resources; use expert-based approaches to accommodate information from different knowledge communities. For example, local experts and practitioners, as well as scientists, can provide estimates of the status and trend of ecosystems and species and their contributions to human wellbeing (CIT, 2005).

For information costs see answer above

References

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CIT (2005) *CIT Experience: Recommendations on processes and structures for success*, retrieved January 18, 2009 from: CIT Experience: Recommendations on processes and structures for success

CIT (2004) *Ecosystem-based Management Framework*, retrieved January 18, 2009 from: http://www.citbc.org/c-proc-recommend-31Dec04.pdf

7.6 Integrated Grid Based Ecological and Economic Landscape Model

1. **Who is the lead organization in the project?**
   Landscape Ecology Group, Institute of Biology and Environmental Sciences, University of Oldenburg, 26111 Oldenburg, Germany

2. **Who is the contact person for the project?**
   Robert Biedermann

3. **Contact email:**
   robert.biedermann@uni-oldenburg.de

4. **What triggered the project?**
   Self initiated to address an issue

   Economic pressure on Central European agricultural systems causes a loss of species-rich ecosystems. Traditional and extensive practice to preserve open landscapes, expensive management measures like annual mowing are currently applied; however it is uncertain how long these practices could be sustained. Many abandoned grassland sites became nature reserves with the need to remove standing biomass and to extract nutrients. Consequently, it would be generally desirable to shift from these static, costly conservation measures to dynamic, more cost-effective management regimes (Rudner et al., 2007).

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   Data and parameters necessary for reliable modelling were determined empirically in a study site in southern Germany. Subsystems of the overall model are empirically parameterized and validated by means of extensive field surveys. The INGRID landscape model is still in development to allow customization to diverse regions around Central Europe that share similar practices, administrative units, biophysical conditions and socio-economic conditions.

6. **What are the major issues that the project is focused on?**
   Agriculture
   Economic performance
   Energy
   Forestry
   Governance
   Land – use

Natural resources
Nature and biodiversity
Species at risk
Water quality
Wetlands

A. Major activities in the ILM project

7. What methods and tools were utilized to assess current trends addressed in the ILM project? What existing approach or newly developed model was used for these purposes? Is the developed tool available for use?

- Integrated modeling – spatial - INGRID
- Policy effects and effectiveness analysis
- GIS tools
- Physically-based models
- Multi-criteria analyses

The Integrated Grid Based Ecological and Economic (INGRID) landscape model offers the possibility to predict ecological benefits as well as economic costs depending on a selected management scenario in a spatially explicit way.

8. What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?

The INGRID landscape model was implemented in Borland Delphi and integrates several abiotic and biotic modules, coupled on the basis of a simple grid-based Geographic Information System (GIS). An interface to ESRI ArcView enables the import and export of digital maps. However, because each module was empirically parameterized and validated, extensive field surveys were required, which limits the validity of the model for only similar locations, mostly in central Europe (Rudner et al., 2004 and 2007):

Combining the modules the landscape model allows:

(i) scaling and regionalization, i.e. extrapolating surveys and predicted probabilities of occurrence from plot scale to landscape scale (but again the plots need to be relevant for the study area)

(ii) spatially explicit modelling of processes and interactions between different abiotic and biotic features, and assessing ecological values (nature conservation evaluation) as well as economic costs (costs of conservation measures) of any of the management scenarios. It seems that the economic assessment is a bit more universal, not necessarily linked to only central Europe. So, if some other group or decision-makers would like to apply this model the economic module is directly transferrable.

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
    - Multi-stakeholder consultation, consensus building
    - Scenario development and analysis

The model includes a 'scenario wizard.' The scenario wizard allows a guided interactive definition of management scenarios following different paths. Areas with predefined conservation measures can be linked to diverse scenarios. The management type may be assigned to single areas by habitat type or by setting up proportions of different types. In the next step, the time schedule is fixed for each area. Furthermore, a set of options concerning the simulation has to be specified. In the last step, the habitat models have to be specified and assigned to the selected simulation run. Then, the scenario wizard serves also to modify scenarios. When the modellers developed the wizard, they used stakeholder consultations to come up with predefined as well as potential scenarios (Rudner et al., 2007).

10. **What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.**

Comparison of different scenarios leads to management regimes that combine low management costs with acceptable environmental consequences. The model includes five different conservation measures. However, it is very likely that in reality, the management systems will result in a mosaic of habitat qualities for plant and animal species shifting in space and time and changing management practices.

The model also works on different scales and levels of hierarchy to assess the risk of extinction of plant and animal species. This requires integrating static and dynamic modules regarding abiotic and biotic state variables, processes and interactions into a spatially explicit landscape model. This is based on literature reviews mostly from forest ecology and management.

The management scenarios for each area are interactively assembled by selecting time schedule and type of management. Based on these scenarios, a time series of several years may be simulated yielding three types of result:

- species frequencies and distributions,
- these transferred to conservation values,
- absolute and relative costs of each conservation measure.

Modification of scenarios, for example, by changing proportion or spatial location of conservation measures, will lead to different simulation results. By comparing several simulation results, the user is able to quantify the trade-off between ecological and economic aspects and may so optimize the management scenario. However, this will also depend on the quality of the data that is used to calibrate the model to different locations. If the input data are not satisfactory then the results are only illustrative guidance to the potential trade-offs (Rudner et al., 2004 and 2007).

11. **What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.**
    - **Maps**: static input maps of elevation, slope, and aspect, as well as more complex topographic parameters like plan and profile curvature, potential insolation and topographic wetness index;
    - **Abiotic model:** calculates the dynamics of potential and actual evaporation, as well as plant-available water, and, via the crop coefficients, these values depend on the management regime chosen.
    - **Habitat model:** Statistical habitat models predict the shifting mosaic of habitat qualities for plant and animal species as well as the spatial distribution of the species; logistic regression was used to estimate habitat models for 52 plant species and five insect species (Rudner al., 2007).

12. **What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?**
    - Improving planning process

    The model outputs are available to decision-makers to be applied to their regions and be used in the policy-planning process.

13. **What were the key challenges faced during implementation of the ILM project? These may include for example financial resources, program capacity and mandate, decision-making cycles, etc.**

    The management regimes comprise frequency, spatial extent and temporal sequence of conservation measures. These parameters determine if the selected management options within the created scenario work in practice and be considered a cost-effective alternative for the conservation of open dry grasslands that helps to preserve biodiversity.

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

- Review of implemented actions (see below)

15. What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?

During the model testing and calibration, the research team applied the model for the region in Germany and during this process some of its policy options were evaluated. But no further monitoring of the use and implementation of the model are collected.

Furthermore, the landscape model may be useful for the prediction of future development within environmental planning processes (e.g. impact assessment). However, further developments of the INGRID landscape model, like integration of population dynamic models or economic models for pasture management, are necessary in order to achieve more accurate predictions of the biodiversity of plants and animals as well as management costs (Rudner et al., 2004; 2007).

16. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

For the testing of the model, the research groups chose a site that was known to them and therefore they had information about available data. Despite this, much of the data needed to be recollected, because the available information was at higher scale, and therefore not appropriate for the scale of the model to make the GIS application useful.

B. Linking the project and its results to decision making processes

This model allows decision-makers to focus on the areas of the highest concern first and shape the rest of the scenarios in a way that will address these valuable areas. In a first step, an established method will be assigned to the most valuable areas. For the other areas, conservation measures will be chosen either by habitat type or by spatial proportions of different measures. Additionally, the proportions of the conservation measures can be modified step by step (Rudner et al., 2007).

C. Integration of information/policy/data

Unknown

D. Handling the interdisciplinary nature of project

Unknown

E. Managing complexity of tasks and issues

Unknown

F. Uncertainty and risk analysis

To minimize uncertainty of management decisions, model developers integrated habitat models into the landscape model. The aggregation of ecological information in the nature conservation evaluation module corresponds to the multi-criteria analysis. The weighting problem is tackled in the evaluation factors that are assigned to each species in the species database. This leads to transparent evaluation results (Rudner et al., 2007).

G. Level of collaboration/commitment

The model was mostly developed by a group of scientists from diverse fields. Stakeholder collaboration was only involved in the form of specific consultations to discuss of the model characteristics, potential scenarios and their elements and policy relevance.

H. Costs and time constraints

Unknown

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Rudner, M., Biedermann, R., Schröder, B. and Kleyer, M., (2004) *Assessing management systems for the conservation of open landscapes using an integrated landscape model approach.* In Pahl-Wostl, C., Schmidt, S., Jakeman, T. (eds.), *Complexity and Integrated Resources Management.* Osnabrück: International Environmental Modelling and Software Society.

Rudner M., Biedermann, R., Schröder, B. and Kleyer, M., (2007) Integrated Grid Based Ecological and Economic (INGRID) landscape model e A tool to support landscape management decisions. *Environmental Modelling and Software 22*, pp. 177–187.

7.7 Sustainability Impact Assessment: Tools for Environmental, Social and Economic Effects of Multifunctional Land Use in European Regions

1. **Who is the lead organization in the project?**
   ZALF Leibniz-Centre for Agricultural, Landscape Research, Müncheberg, Germany

2. **Who is the contact person for the project?**
   Dr. Katharina Helming

3. **Contact email:**
   Email: sensor@zalf.de, www.sensor-ip.eu

4. **What triggered the project?**
   Self-initiated to address an issue

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   SENSOR is an Integrated Project in the 6th Framework Research Programme of the European Commission. Thirty-nine research partners from 15 European countries, China, Brazil, Argentina and Uruguay develop science-based forecasting instruments to support decision-making on policies related to land use in European regions.

6. **What are the major issues that the project is focused on?**
   Agriculture
   Economic performance
   Energy
   Forestry
   Land – use
   Nature and biodiversity
   Water resources
   Wetlands

A. Major activities in the ILM project

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? Was the existing approach or a newly developed model used for these purposes? Is the developed tool available for use?**
   - Indicator development and reporting (spatial and non-spatial).

- Integrated modelling
- GIS tools
- Physically-based models
- Systems mapping

SENSOR's main objective is to develop Sustainability Impact Assessment Tools (SIAT). They allow the assessment of land use policy effects on sustainable development at a regional scale for Europe. The research process addresses:

- **Land use models.** Land use changes are simulated at one square kilometre grid resolution to reflect possible driving force changes as expressed in global economic and societal trends and policy scenarios.
- **Impact indicators.** The impacts of land use changes on social, economic and environmental land use functions are assessed by means of around 40 impact indicators.
- **Spatial reference framework.** To analyze land use impacts within a regional context; social, economic and environmental characteristics are integrated towards regional profiles and clusters.
- **Thresholds and targets.** Expert judgements and participatory tools are employed to identify and evaluate sustainability problems, thresholds and targets related to land use impacts.

8. **What were the key challenges faced in completing the assessment within the ILM project; such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**
   Unknown

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
   - Multi-stakeholder consultation, consensus building
   - Scenario development and analysis - **Policy scenarios.** Based on narratives of global economic and societal trends for the target year 2025, optional policy decisions on land use and rural development are formulated and analyzed with respect to their implications for land use sectors

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.

The project was strongly scenario-driven and considered global economic, demographic and policy trends for target year 2025 in order to provide trend-based perspectives for land use changes in Europe. Plausibility of the developed scenarios builds upon stakeholder consultations on concerns about regional sustainability issues and suggested measures to address the concerns.

11. What information and products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.

2006/6 **Common basic pre-processing tools for GIS-based integrated data management**
Author(s): W. Loibl, H.S. Hansen et al.

2006/5 **Risk assessment concepts and regional indicator thresholds**
Author(s): M.L.M. Jones, S. Petit et al.

2006/4 **Spatial Regional Reference Framework (SRRF) - Methodology and Report**
Author(s): Ch. Renetzeder, M. van Eupen et al.

2006/4 **Spatial Regional Reference Framework (SRRF) – Annex 2 (Maps)**
Author(s): Ch. Renetzeder, M. van Eupen et al.

2006/3 **SENSOR Data Management System Overall Design**
Author(s): H.S. Hansen, W. Loibl et al.

2006/2 **Baseline scenario storylines**
Author(s): T. Kuhlmann, P. Le Mouël, C. Wilson

2006/1 **Methods for cross-referencing, consistency check and generalisation of spatial data**
SENSOR Project Deliverable Report 5.1.2 Author(s): H.S. Hansen, L. Grondal

Source: http://www.sensor-ip.eu/

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

- Capacity-building
- Recommendation to regional, provincial and national policy-making

- **Sustainability Impact Assessment Tools.** The above steps from the scenario development are transferred into decision support instruments to analyze the impacts of land use policy options on regional sustainability issues.

- **Transferability test.** European approaches to impact assessment are adapted to regions in China, Brazil, Argentina and Uruguay.
- **Sensitivity analysis.** Critical sustainability issues in sensitive regions such as mountains, coastal zones, islands and post-industrialized areas are identified and analyzed in the light of driving force changes.

13. What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

Data base development and management - **Data and indicator management.** GIS-based, GMES/GEO compatible data and indicator management systems are developed for land use impact analysis at regional scale for EU 25.

15. What were the key challenge(s) faced in monitoring and assessment of the ILM project and how were they addressed?

16. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

See question no. 9

B. Linking the project and its results to decision-making processes

Decision makers were involved in this project from the beginning. Still it was a challenge to ensure that the results are integrated into the decision-making. The most tangible outputs of this process were the recommendation for local development strategies that have been developed in the same time as the project.

The only activity directly listed in the project proposal was that the project provides recommendation for local funding distribution to avoid further increase of local vulnerabilities and this goal was accomplished.

C. Integration of information/policy/data

Unknown

D. Handling the interdisciplinary nature of project
Unknown

E. Managing complexity of tasks and issues
See responses above

F. Uncertainty and risk analysis
Major impacts in this category were that the project wanted to rely on output of previous projects that aimed to collect data that turned out to be inaccessible/unavailable.

G. Level of collaboration/commitment
Level of commitments from the stakeholders was very high on the testing site.

H. Costs and time constraints

References

Helming, K, Pérez-Soba, M. and Tabbush, P., (eds) (2008) Sustainability Impact Assessment of Land Use Changes. Springer Verlag, Berlin Heidelberg

7.8 Lake Balaton Integrated Vulnerability Assessment and Adaptation Strategies

1. **Who is the lead organization in the project?**
   LBDCA - Balaton Fejlesztési Tanács, the Lake Balaton Development Coordination Agency (LBDCA), www.balatonregion.hu/public/home.php?m=0

2. **Who is the contact person for the project?**
   Dr. Gábor Molnár,

3. **Contact email:**
   molnarg@balatonregion.hu

4. **What triggered the project?**
   Self-initiated to address an issue

   The municipalities around Lake Balaton formed a separate Lake Balaton Recreational Area (LBRA) focused mostly on the tourist industry. This region represents the highest share of the tourist industry in the country's economy and also has the highest-proportion (approx. 26 per cent) of Hungary's total number of hotels, which are concentrated around the lake. The Balaton region produces over 30 per cent of Hungary's tourism revenue, or 2–4 per cent of total GDP (about €1.5bn/year). There are more than 10 million registered guest nights annually in a region of some 250,000 permanent residents, resulting in a major spike in infrastructure use during the summer season.

   Lake Balaton's natural environment and its watershed have been heavily altered over the last 100 years. The opening of the Sió Canal in 1863 resulted in a major drop in water level to the current average of 3.2 m. Given its large surface area and watershed, this makes Lake Balaton one of the world's shallowest large lakes. Through the rapid expansion of settlements and construction of artificial shorelines, major natural habitats have been lost such that almost the entire south shore is now a 70 kilometre-long village. Given the proximity of houses and infrastructure to the shore on the one hand and the shallow water depth on the other, water levels need to be regulated within a very narrow range. The Balaton region is home to several endemic species, but many of these are being crowded out by exotics or are losing their habitat due to land use change. It is probable that few locals are aware of the fact that the Kis-Balaton wetlands at the

Western end of the lake are designated as wetlands of international biodiversity significance under the Ramsar Agreement.

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   Lake Balaton is located in central Europe, in the western part of Hungary. Lake Balaton, with a surface area of 588.5 km^2 and average depths of only 3.3 m, is predominantly a shallow lake that is highly sensitive to changes in weather patterns, ecological impacts and management decisions. The typical local climate includes moderately wet continental weather, which significantly influences the lake's water level. The years 2000 to 2003 were characterized by lower precipitation levels resulting in lower than normal water levels (Gorlach and Kovacs, 2006). Based on 81 years of records, a long-term precipitation average is about 687 mm/yr; in 2001, on the other hand, the average level of precipitation was approximately 557 mm and in 2002, it was only 445 mm. During these years, higher temperatures resulted in increased evaporation, with a negative impact on water levels (Bouchard, 2005; Puczkó and Rátz, 2000).

6. **What are the major issues that the project is focused on?**
   Agriculture
   Economic performance
   Energy
   Forestry
   Governance
   Land – use
   Nature and biodiversity
   Species at risk
   Water quality
   Wetlands

A. Major activities in the ILM project

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? Was an existing approach or a newly developed model used for these purposes? Is the developed tool available for use?**
   - Indicator development and reporting (spatial and non-spatial).
   - Physically-based models
   - Vulnerability analyses

8. **What were the key challenges faced in completing the assessment within the**

ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?

Lake Balaton has a long history of scientific research and monitoring making it one of the best studied lakes in the world.[1] Although this may be the case, the abundance of scientific data is in stark contrast with the paucity of systematized, regularly updated trend information available to the general public and decision-makers in an easy-to-access format. Information is not only scattered across countless agencies creating ownership of public data, often such data obtained through publicly funded work is available only if one is willing to pay a considerable amount *again* to some agency.

The purpose of creating this indicators system was to create a platform to compare environmental, economic and social trends in an environmentally sensitive area with heavy dependence on tourism. However, compiling cross-cutting datasets presents many problems: there are many data gaps, few consistent time series, and data collected at considerable expense are frequently left to sit in formats that make it useless for anyone except the most dedicated expert. All very much limit comprehensive analyses among economic, social and environmental domains.

When local trends are analyzed, longer time series covering a few decades are crucial for such assessments. Despite numerous discussions with local monitoring and data collection agencies, most of the gathered data are from the early 1990s. It is understandable that some economic and social data become almost incomparable due to transition from the socialist regime, however issues such as the number of tourists, education level, life expectancy and environmental data seem to be less dependent on the societal transitions. Even in these cases, however, the data were only available from the early 1990s.

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
    - Multi-stakeholder consultation, consensus building
    - Scenario development and analysis

- To develop a preferred future scenario for the area around Lake Balaton
- To illuminate preferred trends in selected indicators relevant for the identified local scenario

[1] See for instance Lóczy, 1896.

- To discuss with participants the key measures needed to put the region on a pathway leading to the identified future scenario

Collage technique was used for the scenario development. A collage (from the French: *coller*, to glue) is a work of visual art, made from an assemblage of newspaper articles, pictures and drawings that create a new whole. Participants were divided into four groups of approximately 4–6 per group and had about one hour to develop the scenario. This was followed by a presentation by each group and final discussion to identify short-term measures that could help achieve the preferred local scenario.

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.

To help the participants better understand the current trends, we use an indicator database developed in the previous step of this project. This database covers changes in the region mostly for 1960s, as presented in a draft indicator report (Bizikova et al. 2008). To help participants better understand what the future development might look like, we also introduced four major scenarios describing potential pathways of future development in the region based on the four IPCC scenario families, as outlined in a draft report prepared for the BAP. This part of the workshop was followed by a short discussion about some of the indentified trends, suggestions for new indicators and clarification regarding the IPCC scenarios and then the actual local scenario development. Because, of the general lack of planning and scenario development in the region, the project team felt that there is a need for introduction on what scenarios could mean, therefore they used the IPCC scenarios.

11. What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.

- SWAT model for integrated water management that was transferred to local water management authority
- Local indicators' database, which was developed with a web environment and was transferred to the LBDCA
- Local climate change predictions till 2100
- Recommendation on the local development strategy
- Publications about the project outputs in Hungarian

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

- Capacity-building
- Recommendation to regional, provincial and national policy-making

13. What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles etc.

A capacity-building session was held for the local users of the developed tools, so that they are able to use the tool after the completion of the project. Still, the project team was concerned that in the long-run updates of the software and a significant amount of new data will be needed for which the local participants would probably need more support.

The project team also provided inputs for the local development strategy and other strategic national and local documents, that wouldn't have been possible if this project didn't exist. However, provided inputs to these documents was unforeseen when the project team tried to plan this project.

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

- Regular data collection
- Data base development and management
- Meetings with key stakeholders

15. What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?

The project was just finished (end of 2008). Therefore, the monitoring activities are left with the local participants and agencies and presently the project team is unaware of any experiences on these issues.

16. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

See question no. 9

B. Linking the project and its results to decision making processes

Decision makers were involved in this project from the beginning. Still it was a challenge to ensure that the results are integrated into the decision-making. The most tangible outputs of this process were the recommendation for local development strategies that have been developed at the same time as the project.

The only activity directly listed in the project proposal was that the project provides recommendations for local funding distribution to avoid a further increase in local vulnerabilities and this goal was accomplished.

C. Integration of information/policy/data

Integration was a huge challenge during the project, partly because this project really tries to look at socio-economic vulnerabilities and not simply assess the state of the local environment, water management and climate change. When the project team tried to link the outputs of hydrological and climate models with socio-economic data in the form of the STELLA model, it was not successful, mostly because of the lack of data over longer time series.

To avoid this type of issue, most of the scenario planning and policy recommendation development were done in close collaboration with local stakeholders.

D. Handling the interdisciplinary nature of project

Most of the team members are used to working in the interdisciplinary environment; however this approach was fairly new to the most of the stakeholders. So the biggest challenge was to help the stakeholders understand the approach and the trade-off between being detail-oriented and using lot of data versus trying to understand the human-environment interactions, which are often hard to express in measurements and data and require modelling in a much coarser scale.

E. Managing complexity of tasks and issues

See responses above

F. Uncertainty and risk analysis

Major impacts in this category were that the project wanted to rely on output of previous projects that aimed to collect data. Unfortunately, the project was cancelled halfway through so the anticipated data weren't available and this significantly postponed the first phase of the indicator development.

G. Level of collaboration/commitment

Level of commitments from the stakeholders was very high. We organized approximately 15 stakeholders' workshops in 2007–2008 and we had on average 20 participants each time. It is also important to note that as the project was progressing and more people got information about the project, the number of participants increased.

H. Costs and time constraints

The funding was from the UNDP-GEF and, the project team experienced a delay between the proposal submission and funding award, so it was bit of a challenge to put such a big team together after everybody thought that the project is not happing and also the circumstances in Hungary changed very much since the proposal submission.

I. Please add comments

References

Bizikova, L., Pintér, L. and Kutics, K., (2008) *Investigating Stakeholder Decision Priorities for Adaptation to Climate Change in the Lake Balaton recreational Area of Hungary*. Winnipeg: IISD.

Pintér, L., Bizikova, L., Kutics, K. and Vári, A., (2008) Developing a system of sustainable development indicators for the Lake Balaton. *Tájökológiai Lapok* 6, pp. 271 – 294.

7.9 Advanced Terrestrial Ecosystem Analysis and Modelling

1. **Who is the lead organization in the project?**
   Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

2. **Who is the contact person for the project?**
   Dagmar Schroeter

3. **Contact email:**
   Dagmar.Schroeter@pik-potsdam.de

4. **What triggered the project?**
   Self-initiated to address an issue
   At the heart of ATEAM's research are ecosystems and their functioning and dynamics in relation to human activity. One of the key motivations of this project is to provide scientific information, which can be used by society to promote better awareness about potential global change impacts, improve management of European ecosystems and help to bring about a sustainability transition.

5. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   Europe

6. **What are the major issues that the project is focused on?**
   Agriculture
   Forestry
   Governance
   Land – use
   Natural resources
   Nature and biodiversity
   Species at risk
   Wetlands

A. Major activities in the ILM project

7. **What methods and tools were utilized to assess current trends addressed in the ILM project? Was an existing approach or a newly developed model used for these purposes? Is the developed tool available for use?**
   - Indicator development and reporting (spatial and non-spatial).

- Integrated modelling including physically-based models
- Vulnerability analysis
- GIS tools

8. **What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**

   Not the least from our interactions with stakeholders, the project team concluded that aggregated measures of vulnerability are of limited value. In our integrated assessment they came to serve as a way to alert us to regions or sectors that were then analyzed further by consulting the underlying data. Often information on potential impacts was sufficient for stakeholders to make conclusions about vulnerability, using knowledge about their own adaptive capacity and their individual values.

   More specifically, stakeholders contributed to the work of each modelling team in many ways. In particular, the indicators of ecosystem services that were estimated by the ATEAM modelling framework were chosen together with stakeholders from the list of indicators that the ecosystem model was able to produce. This choice was generally straightforward, for example choosing the indicator "wood production" for the forestry sector, and "run-off quantity and seasonality" for the water sector. However, in some cases we experienced surprises during the stakeholder interaction. For example, many stakeholders from the agricultural sector were less interested in crop yield estimates than they were in estimates of future agricultural areas ("farmer livelihood"). Furthermore, additional indicators were found to satisfy stakeholders' interest in biomass energy production.

9. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**

   - Multi-stakeholder consultation, consensus building
   - Scenario development and analysis

   The variation between scenarios seeks to encompass the range of possible futures as well as the scientific uncertainty about the functioning of the Earth System. To adequately reflect this scientific uncertainty, ATEAM used a range of state-of-the-art models, each of which represented an alternative set of hypotheses of how the Earth System works. The ATEAM scenarios are spatially explicit (10' x 10' - ca. 16 x 16 km grid) and were created for four time slices (i.e.: 1990, 2020, 2050, 2080).

10. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.

Scenario assumptions were produced using extensive literature reviews (e.g. on forest policy and management), expert consultation (e.g. agricultural economists, local authorities, governmental bodies), existing storylines and scenarios (e.g. IPCC SRES) and models (e.g. IMAGE 2.213), as well as stakeholders' feedback during previous ATEAM activities. Assumptions used in the land use scenarios addressed broad generic factors and trends. For example assumptions were made about how technological change might influence generic agricultural yields, as opposed to how specific technologies, such as genetically engineered crops, might affect the yields of a special breeding variety. It was accepted that some of the assumptions were too simplistic (e.g. continuation of current trends), although without appropriate data, or further resources, more refined and realistic assumptions could not be produced. Stakeholders' comments on scenario and model assumptions are an important "reality check," which contributes to significantly improving further scenarios and modelling developments.

11. What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.

ATEAM has produced (Vega-Leinert and Schroter, 2004; Schroter et al., 2004):

- a comprehensive modelling framework for projecting the dynamics of ecosystem services provided by European terrestrial ecosystems at a regional scale,
- a set of multiple, internally consistent socio-economic, climate, land use and nitrogen deposition scenarios at high spatial resolution for Europe,
- a vast array of modelled outputs on ecosystem service provision, adaptive capacity and European vulnerability based on these global change scenarios, and
- a CD-ROM with the interactive ATEAM mapping tool displaying the full range of charts and maps of results with exhaustive documentation and summarized conclusions.

12. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

- Capacity-building
- Recommendation to regional, provincial and national policy-making
- Future collaborative work between researchers and practitioners
- Other, please specify

13. What were the key challenge(s) faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.

Stakeholders welcomed initiatives that develop closer greater links between scientists and decision-makers. It is important to develop a common language and to design especially targeted scientific documents, which: 1) highlight the main results, recommendations and follow-up questions raised by the research, 2) provide visual information that can be acquired straight away by means of graphs or diagrams, and 3) link to further reference in case readers need detailed information on the topic (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

14. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

No information on this

15. What were the key challenges faced in monitoring and assessment of the ILM project and how were they addressed?

Unknown

16. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

Unknown

B. Linking the project and its results to decision-making processes

Stakeholders emphasized that ATEAM results are useful to identify which ecosystem services could be significantly impacted in future and to explore adaptation issues at European, national and regional levels. To them, ATEAM has succeeded in formulating strong messages, which could provide some guidance in policy and decision-making in a range of sectors, including landowners' and farmers' organizations, forestry and biodiversity managers and environmental non-governmental organizations, as well as raising the awareness of the general public on climate change issues (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

C. Integration of information/policy/data

To practically ease the use of the ATEAM mapping tool, stakeholders suggested limiting the number of indicators per sector displayed on the ATEAM atlas. The accompanying information on the results and their interpretation was found to be important. However, stakeholders believed that the results would benefit from further processing, documentation and synthesizing to be used to their full potential. Finally, additional levels of interactivity would be desirable (e.g. the possibility for stakeholder to create their own scenarios [Vega-Leinert and Schroter, 2004; Schroter et al., 2004]).

D. Handling the interdisciplinary nature of project

Initially, the ATEAM project was designed to achieve a state-of-the-art potential impact assessment, using for the first time ever a consistent set of multiple global change drivers and multiple plausible future scenarios of these on a high spatial resolution to drive a framework of state-of-the-art ecosystem models. No ready-made methodologies were available—the discipline of vulnerability assessment is so young that it finds or develops tools as it moves along. However, ATEAMers were determined to move beyond a mere impact assessment, toward an integrated vulnerability assessment of Europe with the tools that were at hand and those that we were able to develop during the project life-time. Therefore, we have expanded our research commitment and have gone two steps further than originally planned (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

E. Managing complexity of tasks and issues

We concluded that our assessment was both valuable and useful for stakeholders and relevant in scientific terms in showing how to handle complex human-environmental interactions. We also conclude that future analysis can be based on our concepts and results and for some sectors should especially target local scales and shorter time scales. Ecosystem modelling should continue to mature into human-environment-system modelling, by accounting for management and decision-making in the socio-economic and policy context of the relevant stakeholders. This can be greatly facilitated by continued stakeholder interaction, making use of as well as advancing the tools and the stakeholder network developed in ATEAM (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

F. Uncertainty and Risk analysis

One way to minimize uncertainty (or at least effectively deal with uncertainty) would be for future modelling assessments to explicitly address specific policy- and management-orientated questions at higher spatial resolution, in close consultation with interested stakeholders. Smaller, dedicated models, expert systems and decision support tools, which consider national and subnational scales, could be useful media to develop for this purpose. The ATEAM analysis would be a relevant broad basis for these. However, stakeholders need to understand the roles and limits of scientific enquiry and modelling performances. Scientists cannot provide an exact prediction of future global change impacts and vulnerability, and stakeholders should not expect that such a task be feasible, as large uncertainty is unavoidable since society is continuously shaping its future in a complex unpredictable manner (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

G. Level of collaboration/commitment

ATEAM modelling partners engaged in a number of stakeholder activities on a sectoral basis (e.g. agriculture/biomass and mountain environments/biodiversity workshops). In September 2002, the second general stakeholders workshop took place. Twenty-two stakeholders and 19 scientists evaluated and discussed the ATEAM land use scenarios and the vulnerability mapping methodology being developed within the project, as well as the usefulness of preliminary model indicators, and future key areas for model improvement. The following year, 2003, was mostly dedicated to implementing the model developments, finalizing the scenarios, developing the integrating interface and the mapping tool, and obtaining near final results in time for the final general stakeholder workshop. In early 2004, preparations were made for this final event. In particular the stakeholder database was broadened— up to 100 stakeholders were invited in writing and by phone, material for presentation to stakeholders was developed and updated (Vega-Leinert and Schroter, 2004; Schroter et al., 2004).

H. Costs and time constraints

I. Please add comments

References

de la Vega-Leinert, A. C. and Schröter, D., (2004) *Vulnerability of European sectors to global changes* The 3rd ATEAM Stakeholder Dialogue Workshop. Potsdam, Germany.

Schröter, D. et al., (2004) *ATEAM Final report.* Detailed report, related to overall project duration Reporting period: 01.01.2001-30.06.2004. Contract n°EVK2-2000-00075. Potsdam, Germany: Potsdam Institute for Climate Impact Research (PIK)

7.10 Pathway 2007 – A visions for Tahoe Basin's Future

A. Basic information about the ILM project

1. What is the name of the ILM project?

There has been action through a range of programs and projects to improve the environment surrounding Lake Tahoe. Some of the programs and organizations have attempted to use adaptive management. At present, the major agencies are working together to create a long-term plan for the basin (entitled "Pathway2007"), which recommends the use of a coordinated adaptive management approach among the agencies (each with their own jurisdictions and projects). The recommendations of the four management bodies involved have been presented in report format. These recommendations will go back to the four agencies, which will then develop and implement their own programs and goals in line with these recommendations. Though a collaborative adaptive management system to coordinate resource management in the basin has been recommended, there is no overarching program to work towards these goals. As the draft Evaluation Report states: "It is important to note that each of the agencies' planning processes are subject to further public input and to adoption by each agencies' respective board, commission or agency official. Changes may be made during those proceedings" (Pathway 2007, 3). This project document covers previous projects, and the current process of managing the Tahoe Basin.

2. Who is the lead organization in the project?

There is no lead organization. The closest there is, is the Tahoe Regional Planning Agency (TRPA). The other organizations in the partnership are the USDA Forest Service Lake Tahoe Basin Management Unit (LTBMU), the Lahontan Regional Water Quality Control Board, and the Nevada Division of Environmental Protection.

3. Who is the contact person for the project?

Shane Romsos

4. Contact email:

sromsos@trpa.org
775-588-4547

5. What triggered the project?

Self-initiated to address an issue: concerns regarding the deteriorating environmental quality (primarily water clarity) of the Lake Tahoe Basin, which is the cornerstone of their recreation-based economy. The recent planning process, "Pathway 2007," was started in 2001 when the four agencies responsible for resource planning in the basin "recognized an opportunity to align their management direction and policies as they began three major resource planning efforts. The Pathway 2007 program was developed as a means to collaborate with one another and with other interested parties to establish a common vision and desired conditions for the resources of the Lake Tahoe Basin for the future" (Pathway 2007, 2007).

6. **What is the geographic boundary of the project (country and place-based descriptor such as eco-zone, watershed, forest zone, etc.)?**
   The Lake Tahoe Basin is split between Nevada (one third of the region) and California (two thirds). The surface of the lake covers 122,200 acres, and the basin covers 207,000 acres.

7. **What are the major issues that the project is focused on?**
   The major issue is the need to balance improvements in lake clarity, water quality, forest health and the quality of life of residents, while maintaining recreational opportunities and decreasing wildfire risks. For the management of the Lake Tahoe Basin, 34 indicators have been developed around the following issue areas:

   Air quality
   Economic performance
   Education
   Employment
   Freshwater
   Groundwater
   Housing
   Human health
   Land – use
   Natural resources
   Nature and biodiversity
   Recreation
   Species at risk
   Transportation
   Wastewater
   Water quality
   Noise management
   Wildfire risk management

B. Major activities in the ILM project

8. **What methods and tools were utilized to assess current trends addressed in the ILM project? Was an existing approach or a newly developed model used for these**

purposes? Is the developed tool available for use?

- Systems mapping (they plan to implement "conceptual models that clarify assumptions about cause and effect in the ecological or social system" [Pathway 2007, 2007a, 1]);
- Policy effects and effectiveness analysis (LTBMU monitoring program includes effectiveness monitoring to gain a "better understanding of how ecosystem components, structures, and processes respond to management activities, and how ecosystem components relate" [LTBMU, 2008]);
- Indicator development, analysis and reporting (36 indicators have been developed, tracked, analyzed, and reported by the TRPA and reported in their Evaluation Reports.; see [Pathway 2007, 2007f);
- GIS tools (not as of 2006, but part of planned "dynamic portal" [Pathway 2007, 2007f]);
- Physically-based models (e.g., Lake Clarity Model, predictive models)

9. **What were the key challenges faced in completing the assessment within the ILM project, such as suitability of the tool, resources needed including time, money, skills and expertise, ability to manage uncertain or missing data? How were these challenges addressed?**
   - Funds are currently insufficient to monitor all indicators, therefore we need to prioritize indicators.
   - Indicators and assumptions related to standards required for attainment of water quality objectives need to be updated.
   - "Resource management agencies have generally found it difficult to implement resource management actions to test hypotheses and improve their understanding of the system" (Pathway 2007, 2007b, p. 5). To deal with this problem, they have (a) created a science-agency working group to facilitate dialogue between scientists and agency resource managers; (b) are identifying areas for further investigation "that agency management understand will reduce uncertainty related to important management decisions" (Pathway 2007, 2007b, p. 5); and (c) are ensuring that the research results "are presented to management in a meaningful context that will inform their near-term management decisions through the development of an annual synthesis of findings related to specific areas of management concern." (Pathway 2007, 2007b, p. 5).

10. **What methods and tools were utilized during the envisioning and planning activities within the ILM project?**
    - Multi-stakeholder consultation, consensus building (as part of the

generalized continual improvement and adaptive management process outlined in Pathway 2007, 2007b, p. vi)

- Multi-criteria assessment (e.g., Nevada Division of Environmental Protection carries out water quality assessments every other year to measure progress on water quality objectives, LTBMU has assessed regularly a wide range of environmental conditions)

11. What were the key challenges faced in completing the envisioning and planning activities within the ILM project and how were they addressed? These challenges may include for example difficulties with interdepartmental relations, needed resources and availability of key stakeholders, dealing with uncertainty, etc.

12. What information or products were generated as the outcome of the project? Did/will the project lead to implementation of new policies, program objectives, agreements or other products? Please specify.

The project has led to updated regional plans and policies that should lead to improved management of the Lake Tahoe Basin. Pathway 2007 has led to an agreed collaborative adaptive management plan for the major agencies responsible for resource management in the basin.

13. What methods, tools and actions were utilized to help in implementing the outcomes and products of the ILM project?

The following were utilized to help in implementing the outcomes and products of management efforts in the LTB:

- Local policy development
- Improving planning process (i.e., Pathway 2007)
- Recommendation to regional, provincial and national policy-making
- Changes in legislation /regulations

14. What were the key challenges faced during implementation of the ILM project? This may include for example financial resources, program capacity and mandate, decision-making cycles, etc.

"Pathway Indicators significantly exceed existing and expected future resource availability. Further, most of the Pathway Indicators require additional development of monitoring plans and supporting documentation. As a result, Pathway agency management will have to invest strategically in Indicators to gain the most information of greatest value to fulfill mandates, address public concerns and inform management decisions." (Pathway 2007, 2007b, p. v [Executive Summary]).

“Leadership will be required to support funding and demand for targeted information to be used in coordinated resource management decisions for the next twenty years” (Pathway 2007, 2007g, p. 6).

“Current funding does not support simultaneous investment in development and monitoring of all of the proposed Pathway Indicators. A management system would provide a foundation to fulfill the immediate need to determine how to most strategically invest available funds” (Pathway 2007, 2007a , p. 1).

15. What methods, tools and actions were utilized to monitor and assess progress during the ILM project?

- Regular data collection (e.g., regular monitoring of ecosystem conditions and management activities by LTBMU)
- Database development and management (e.g., Tahoe Integrated Information Management System)
- Reporting (e.g., LTBMU annual reports, data posted to Tahoe Integrated Information Management System);
- Review of implemented actions (e.g., LTBMU monitors implementation to determine “the degree and extent to which application of standards and guidelines met management direction and intent (what, when, where, and how management direction has been followed)” (LTBMU, 2008, p1);
- Effectiveness assessment (see Figure 1, above).

16. What were the key challenge(s) faced in monitoring and assessment of the ILM project and how were they addressed?

The following (directly quoted from Pathway 2007, 2007a, p1) have been identified as lacking:

- Conceptual models that clarify assumptions about cause and effect in the ecological or social system and facilitate communication with management and stakeholders.
- Explicit objectives and action plans that contain defined targets enabling comparison between planned and actual performance.
- An annual synthesis of findings that brings together both scientific and performance-based findings relevant to informing policy and resource allocation decisions in a timely and understandable format.
- Annual management decisions that drive the timing and focus of the other process

elements and keep staff and management engaged in the development and use of information to inform management decisions.

- An annual audit that engages staff not directly involved in management system operations in a review of the system to inform the program-specific management system coordinator and agency management about the actual operations of the system.
- A basic web site for cataloguing, posting and making documents available that are related to the program-specific management system; this will facilitate communication and increase transparency at minimal cost.

In addition, there is a need to develop methods of aggregating indicator data ("27 of the proposed Pathway Indicators are indices of several parameters and do not currently define how their underlying parameters/data will be aggregated to provide a single determination if the associated desired condition has been achieved" [Pathway 2007, 2007b, p. 61]).

Most or the necessary monitoring documentation is non-existent or incomplete, and "very little of this documentation is assembled into an organized, accessible repository" (Pathway 2007, 2007b, p. 61).

17. What lessons were learned (from questions 11, 13 and 15)? What improvements and/or adaptations are recommended for the next application of future projects?

A. Data gathering and management

- There is a need to evaluate the costs and benefits of indicators—there are many things that ought to be measured, but not enough funds to monitor them all. Therefore, we need some strategic investments.
- Need better data management: therefore develop Integrated Information Management System

B. Linking the project and its results to decision making processes

C. Integration of information/policy/data

- Need an "annual synthesis of findings that brings together both scientific and performance-based findings relevant to informing policy and resource allocation decisions in a timely and understandable format" (Pathway 2007, 2007a, p. 1).
- Need an integrated information system to catalogue, post, and make documents available that are related to the program-specific management system.

D. Handling the interdisciplinary nature of project

E. Managing complexity of tasks and issues

Need detailed objectives and clearly defined targets so as to measure progress.

F. Uncertainty and risk analysis

Need to develop conceptual models that can reduce uncertainty and clarify assumptions about cause and effect.

G. Level of collaboration/commitment

Need better coordination between the major agencies responsible for resource management. This led to the development of a collaborative adaptive management approach.

H. Costs and time constraints

There are major limitations on what can be done. The costs of measuring some indicators, for instance, makes them prohibitive, and investments in indicator monitoring will therefore have to be quite strategic.

I. Please add comments

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