TACKLING WICKED PROBLEMS THROUGH INTEGRATED ASSESSMENT

A Guide for Decision Makers, Project Leaders and Scientists

Bringing together knowledge of ecosystems, people and policy to improve decision making.

Sea Grant Michigan

Graham Environmental Sustainability Institute

University of Michigan

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Michigan Sea Grant, a cooperative program of the University of Michigan and Michigan State University, supports understanding and stewardship of the Great Lakes through research, outreach and education. www.miseagrant.umich.edu

The Graham Environmental Sustainability Institute is a collaborative partnership of nine University of Michigan schools and colleges. The Graham Institute fosters cross-disciplinary collaboration to create and disseminate knowledge and to offer solutions related to complex environmental sustainability issues. www.graham.umich.edu

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Tackling Wicked Problems Through Integrated Assessment:
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EXECUTIVE SUMMARY

Integrated Assessment (IA) is a way of bringing together knowledge of ecosystems, people, and policy in order to find solutions for particularly challenging or "wicked" problems. Integrated Assessment has been used widely in Europe to develop environmental forecasts and summarize scientific knowledge for policy makers, but use of the approach is relatively new in the United States. ***Section III*** of this guide describes the potential benefits of IA, including providing scientific information that is relevant to policy, building scientific consensus and public support around an issue, and developing creative solutions to a problem. ***Section IV*** outlines eight stages of an Integrated Assessment, beginning with a structured dialogue with decision makers and ending with peer review and public comment of the final report. The technical assessment team, with input from stakeholders, provides a useful analysis of the causes, consequences and possible solutions to an environmental or sustainability problem. ***Section V*** explains that an influential assessment must be carefully designed and implemented to ensure technical credibility, relevance to decision making, and a fair representation of different perspectives. Evaluations indicate that the most effective assessments utilize a combination of analytical techniques, such as computer modeling, and participatory techniques, such as stakeholder workshops, to analyze the environmental problem and evaluate possible solutions. ***Section VI*** describes how modeling and stakeholder participation can contribute to an assessment and ***Section VII*** offers strategies for successfully engaging stakeholders. Finally, ***Section VIII*** provides guidance for preparing the final report and actively sharing the results with relevant decision makers and citizens.

I. INTRODUCTION

This paper is a joint effort of Michigan Sea Grant and the Graham Environmental Sustainability Institute. Both programs use Integrated Assessment to promote collaboration among scientists, decision makers, and other stakeholders around challenging or "wicked" environmental issues. Michigan Sea Grant has been partnering with state and federal agencies to fund Integrated Assessments within Michigan around a diverse range of environmental issues, including stormwater management, watershed-based river regulation, and fish consumption advisories. The Graham Institute develops, supports, and manages Integrated Assessments that address complex sustainability issues on local to global scales.

Through this work, both programs have recognized the need to provide a practical explanation of Integrated Assessment for researchers, policy makers, practitioners and outreach professionals who may become involved in a project. We hope this overview helps clarify the goals, range of approaches, and key strategies for planning and executing a successful Integrated Assessment (IA). To date, much of the research regarding IA methodology has focused on national and international projects that use a modeling-intensive approach. This report aims to synthesize the Integrated Assessment literature, emphasizing how the methodology can be used at multiple scales, including smaller scale assessments involving state and local decision making. Many of the examples and approaches described herein come from the perspective of Western cultures and developed countries. As such, some of the recommended approaches may need to be modified to adapt to different cultures and practices of stakeholders around the world.

Defining Integrated Assessment

The goal of Integrated Assessment (IA) is to bring together knowledge of ecosystems, people and policy to develop tools and information that policy makers can use (Figure 1). Integrated Assessments summarize scientific knowledge to build consensus and guide decision making around a particular resource management, environmental or sustainability issue (Figure 2). These projects are *assessments* in that they involve a review and analysis of existing information. Rather than running additional experiments, experts synthesize what is known and go a step beyond the pure facts to offer an assessment or an evaluation of those facts. IA projects are *integrated* in at least four ways.

- IA integrates decision-maker input, to clarify the policy context and frame the assessment in a way that can best guide decisions.
- IA integrates stakeholder perspectives, to incorporate diverse views about the issue and potential solutions.
- IA integrates knowledge from several disciplines, typically physical, biological, technological, and social sciences.
- IA, in contrast with other types of assessment, integrates both an analysis of the causes and consequences of an issue and an analysis of the possible solutions.

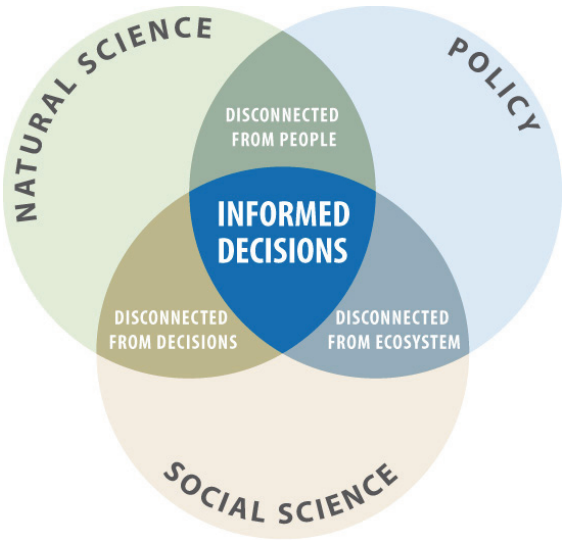

Figure 1. Integrated Assessment brings together knowledge of ecosystems, people and policy to improve decision making.

Integrated Assessment (IA) Definitions:

"Integrated Assessment is a collective, deliberative process by which experts review, analyze, and synthesize scientific knowledge in response to user's information needs relevant to key questions, uncertainties or decisions." *(NRC 2007)*

"Integrated assessment is policy motivated research to develop an understanding of the issue, not based on disciplinary boundaries, based on boundaries defined by the problem."
(Rotmans and Dowlatabadi 1998)

Figure 2. Definitions of Integrated Assessment.

II. TYPES OF ENVIRONMENTAL ASSESSMENT

A wide range of methods have been used to study complex environmental problems, including, process, impact, and response assessments. It is worth reviewing these alternatives because Integrated Assessment combines elements of each, as summarized by the National Research Council (2007).

Process Assessments evaluate the status, trends, and causes of an environmental problem. Their primary purpose is to describe an environmental process, such as ozone depletion or acid rain. A process assessment can evaluate the severity of the problem and isolate its causes, which is often a first step in addressing the issue. For example, Working Group I of the IPCC climate change assessment evaluated the evidence for global warming and the evidence that anthropogenic emissions were to blame.

Impact Assessments or Risk Assessments focus on potential consequences or impacts of an environmental problem for people, economic systems, or ecosystems. This approach is typically most effective when applied at a regional level. For example, after the IPCC assessment validated the climate change process, the National Assessment of Climate Change Impacts examined five sectors (e.g., water, agriculture) in nine regions of the United States to address the specific risks in each area.

Response Assessments or Option Assessments seek to identify and evaluate possible responses to an environmental problem. The scale and mandate of the assessment often shape the potential options being considered. Options may include technological solutions, economic incentives, or local actions that reduce the area's vulnerability to the problem. For example, the IPCC Working Group III modeled change in atmospheric CO_2 under various policy scenarios to identify targets for emission reductions.

Integrated Assessment – the focus of this document – integrates the goals of the previous three types of assessments and therefore, aims to describe the causes, impacts, and possible responses to an environmental problem. State and local assessments with a limited budget may need to address all three goals simultaneously, with emphasis placed on the part that is most relevant or most contested within the policy context. For example, the causes of a problem may be well characterized or may be beyond the control of local decision makers (e.g., climate change) and the assessment can focus on the local implications and the response options. Thus, it is crucial to

understand the type of knowledge needed by decisions makers before designing an effective Integrated Assessment.

Integrated Assessment emerged as a unique methodology in the 1980s as scientists and policy makers struggled to synthesize and integrate disciplinary knowledge related to climate change in a way that could guide decision making (Toth and Hizsniyik 1998). The approach continues to be most useful for addressing "wicked" problems where "facts are uncertain, values in conflict, stakes are high, decisions are urgent, and an extended peer community is required for the resolution of the relevant issues"(Gough et al. 1998). The IA approach has been widely used in Europe and its role in environmental policy making has been well studied (e.g., Rotmans 1998). In the U.S., the most well studied IAs have been national and international in scope, including the assessment for the Intergovernmental Task Force on Hypoxia in the Gulf of Mexico (Nassauer et al. 2007b) and the series of climate assessments mandated by the Global Change Research Act (NRC 2007).

This report augments the literature on larger-scale IA with experience on smaller scale assessments that support state and local decision making. The discussion draws upon existing definitions of Integrated Assessment (Figure 2) and provides practical examples and lessons from Michigan Sea Grant and the Graham Environmental Sustainability Institute.

III. THE PURPOSE OF INTEGRATED ASSESSMENT

Benefits of Integrated Assessment

Benefits to the policy making process

Integrated Assessment synthesizes natural, social, and technological scientific information within the context of a specific policy or management issue to promote informed decision making (Figure 1). In many cases a governing body will request a scientific assessment related to a particular issue. For example, in 1990 Congress passed the Global Change Research Act, which mandated that an assessment about global change be conducted every four years. Some assessments, notably the series of Stratospheric Ozone Assessments, have influenced the development of successful international policies. Michigan Sea Grant has funded a series of Integrated Assessments around topics identified by government or agency partners as being particularly relevant to upcoming funding or policy initiatives - such as brownfield redevelopment or coastal wind power development. The Graham Institute is launching its IA program with two local projects focused on University of Michigan campus sustainability and policy options for a sustainable metropolitan Detroit, with plans for international assessments.

Assessments can be designed to fulfill one or more distinct purposes within the policy context. The assessment can be used to establish the importance of an issue; build consensus among government, industry, and university scientists; evaluate different policy actions; provide technical solutions; identify new research needs; or evaluate impact of an existing policy (NRC 2007). Scientists often hesitate in making predictions with limited information, even though such projections are often what policy makers need. IA provides an opportunity for scientists to come together and, as a group, make the best consensus judgment and projections possible.

Smaller scale assessments, such as those conducted within a state or within a few counties, often encourage broad participation in the hopes that the assessment process can also help build consensus among disparate stakeholders, create a common knowledge base, and increase public support for policies (Ridder and Pahl-Wostl 2005, Dennison et al. 2007). Addressing environmental problems within a state involves engaging different types of decision makers, many of whom are only loosely organized (e.g., business owners) and/or are responsive to public opinion (e.g., locally elected officials). For many issues, decisions of businesses and individuals are part of the problem and these stakeholders could be part of an innovative and effective solution. Integrated Assessment can also be used to bring community leaders, resource managers, and researchers together to define a common set of social or environmental goals and coordinate a variety of potential responses in the public and private sectors. For example Integrated Assessment can be used to support a regional planning process where outcomes might include business investment, non-profit initiatives, government incentives, and planning/zoning changes.

Promoting participation

Environmental and sustainability managers are increasingly seeking public feedback in the hopes of enhancing the effectiveness and legitimacy of their policies (Ridder and Pahl-Wostl 2005, Reed 2008). Collaborative management approaches, such as when regulatory responsibility is shared among government and fishing groups, have been used successfully in many countries to manage fisheries (Jentoft and McCay 1995, Sen and Nielsen 1996). Integrated Assessment is not intended to create permanent governance structures, but through stakeholder engagement, IA can promote transparency, participation, and public support around a particular issue and may, as a secondary benefit, lead to more inclusive governance structures as groups become more comfortable with one another (Figure 3).

Benefits for researchers

Collaboration beyond traditional disciplinary boundaries allows researchers to tackle more complex issues and better incorporate human dimensions of environmental problems. Integrated Assessment advances science by creating consensus around a particular issue and identifying additional research needs, as evidenced by the IPCC climate change assessments. Perhaps most importantly, Integrated Assessment expands the scope and impact of scientific knowledge. By engaging stakeholders and policy makers, scientists increase the utility of their work and build broader support for their research agenda.

Potential Benefits of Public Participation in Environmental Decision Making:

- Produce better outcomes or decisions
- Garner public support for agencies and their decisions
- Bring to light important local knowledge about natural resources
- Increase public understanding of natural resource issues or management decisions
- Reduce or resolve conflicts between stakeholders
- Ensure implementation of new programs or policies
- Increase compliance with natural resource laws and regulations
- Help agencies understand flaws in existing management strategies
- Create new relationships among stakeholders

(Introduction to Stakeholder Participation, NOAA 2007)

Figure 3. Benefits of Stakeholder Participation

Participants in Integrated Assessment

A clarification of the roles and responsibilities associated with the different types of people engaged in an IA provides context for a discussion of the IA process.

Decision maker
Effective Integrated Assessments are endorsed by one or several managers or policy makers who plan to use the results of the assessment. This endorsement and involvement is particularly important in shaping the early stages of an assessment. The decision maker provides an official or unofficial mandate for the project and can help identify the policy relevant question, the geographic focus, and key stakeholders.

Technical assessment team
Natural, social, and technology scientists comprise an inter-disciplinary team, which gathers and analyzes relevant data and information for the assessment.

Stakeholders
Stakeholders are broadly defined as anyone affected by or interested in the issue. In addition to the targeted decision makers, IA stakeholders typically include community, business, and government leaders and representatives from different user groups or citizen organizations (Figure 4).

Facilitator/Outreach coordinator
Facilitating the assessment team and identifying, engaging, and maintaining contact with stakeholders often requires the time and skills of a facilitator or outreach coordinator.

Stakeholders are defined as anyone who is affected by or who has an interest or stake in a particular issue.

Stakeholders may include:

1) Key decision makers from local, state, federal or tribal governing bodies or government agencies
2) Business leaders and industry representatives.
3) Representatives from non-profit groups or other citizen organizations
4) Individuals from loosely defined user groups, such as local residents, recreational boaters, or farm owners.
5) Any other individual with an interest in the issue.

Figure 4. Definition of Stakeholders

IV. THE INTEGRATED ASSESSMENT PROCESS

The methods employed in Integrated Assessment vary widely depending on the geographic scope, budget, type of issue, and range of decision makers. Hisschemoller and colleagues (2001) described a generic IA process as: 1) Defining the question/problem and establishing goals; 2) Analyzing the options; 3) Identifying strategies for action; and 4) Communicating results (Hisschemoller et al. 2001). Here we describe eight elements of an Integrated Assessment process (Figure 5) following the model laid out by Scavia and Nassauer (2007) and used by IA projects supported by Michigan Sea Grant and the Graham Institute. In our experience, these eight stages help ensure that the IA is relevant to stakeholders and credible scientifically. IA proposals and final reports are often organized around the six elements starred in Figure 5 because these involve substantial analysis and provide essential information for stakeholders about the scope, causes and solutions of the problem.

The focus and thus the design of every IA will be unique. The eight elements outlined here are best seen as a flexible framework; different stages might be emphasized within an assessment, depending on the policy context and the scientific and public understanding of the issue. For example, the status and trends of some issues may be well documented, allowing researchers to focus on analyzing the response options. In the following sections (VI and VII) we discuss different approaches and specific tools for conducting Integrated Assessment.

Key Elements of an Integrated Assessment Process

1) Define the policy-relevant question **
2) Document the status and trends **
3) Describe the causes and consequences **
4) Identify desired outcomes and policy options
5) Evaluate various policy options **
6) Provide technical guidance for implementation **
7) Assess uncertainty **
8) Submit findings for peer review and public comment

** *IA proposals and final reports are often organized around these elements.*

Figure 5. The Integrated Assessment Process.

Stage 1: Define the Policy-relevant Question

Define the Focus

Integrated assessment begins with a structured dialogue among scientists, policy makers, and other stakeholders to establish the key question around which the assessment will be developed. This is an essential step, one that distinguishes IA from more general scientific syntheses or state-of-the art reviews. The assessment is designed to gather natural and social science information with the specific purpose of supporting decision making on a specific policy question. Thus, researchers need to understand stakeholder concerns, the policy context, and how and when the assessment process will support decision making (Lee 2006).

By involving relevant decision makers and key stakeholders, these early conversations serve to secure buy-in, build trust, and expose different perspectives. Perhaps most importantly, this dialogue ensures that the scientific assessment is framed in a way that is most useful to the policy making process. Assessments can be seen as "science with a mandate," which requires a lot of communication early on and throughout the assessment to clarify the mandate. In a review of environmental assessments over a 30 year period, the Social Learning Group (2001) found that assessments were much more likely to influence decisions if the decision maker was engaged in negotiating its design. A relevant example is Germany's Enquete Kommission, which is a committee of equal numbers of scientists and policy makers who worked together to assess the importance of issues such as climate change for Germany. The close collaboration allowed the assessment to be modified based on the policy making needs, thus ensuring a high level of salience and influence (NRC 2007). Suggestions for engaging stakeholders and facilitating this process are discussed in section VII.

In many cases, the focus of the IA is defined by a governing body that requested the assessment. Even when a policy mandate is clear, discussions about the environmental issue can help refine the goals of the assessment. For example, the IAs that Michigan Sea Grant funds often start with the generic question: "What are the causes, consequences, and correctives of <<natural resource problem>> in <<defined geographic location>>". After further discussion with relevant decision makers, projects may adopt a more specific question such as, "What stormwater management alternatives are available to the Village of Spring Lake and Spring Lake Township that allow for

future development and also mitigate the impacts of stormwater and improve the quality of Spring Lake, the Grand River and Lake Michigan?" Iterative conversations help to clarify IA goals and outline the scientific input that is needed by decision makers. Researchers ensure that the project scope is reasonable given available data, tools, and resources, while stakeholders ensure that the response options considered are potentially feasible.

Establish Appropriate Assessment Methods
After defining the policy-relevant question, research teams develop and refine their assessment methods and communicate their plans to stakeholders. Initial discussions should clarify which elements of a typical IA are most important within the policy context and which will require the most effort and precision. The timeline for the IA should be established with an understanding of how the assessment compliments any related planning or policy-development processes.

Many IA teams form technical working groups to focus on different components of the assessment. Working groups may be defined by discipline (e.g., economics, water quality), assessment methods (e.g., focus group analysis team, modeling team), or type of response strategy (e.g., zoning changes, business initiatives). A smaller group can more easily accomplish a series of related tasks throughout the assessment. Workshops or team meetings provide an opportunity to integrate findings of the different assessment teams and solicit feedback from stakeholders.

It may be tempting to push through technical components of an assessment, presenting results (e.g., from model outputs) to stakeholders at the end of the process. However, an assessment will be most effective if stakeholders have a clear role in all stages of the process. Presenting interim results to stakeholders, even if they are not technical experts, allows for the kind of iterative process that builds support for IA results among the stakeholders. At the same time, it allows the assessment team to benefit from the local and/or specialized knowledge of the stakeholder group. Figure 6 offers an example timeline and Sections VI and VII describe ways to integrate both analytical and participatory assessment methods.

Stage 2: Document the Status and Trends

The next stage is to document status and trends of environmental, social, and economic conditions related to the specific question. This is an objective description of current conditions and trends involving a synthesis of existing data and information. This stage is useful for demonstrating the extent of the problem and building support for addressing the issue. In addition, information may be necessary for quantitative modeling and forecasting during the next stage. Even in the absence of a formal modeling effort, this baseline data can help project future conditions if the environmental issue is not addressed – the no-change option.

Stage 3: Describe the Causes and Consequences

To effectively address the issue, decision makers need to understand the probable causes and the environmental, social, and economic consequences of the issue. Gathering and synthesizing this information may involve model simulations, statistical analyses, and other explanatory models and analyses, as well as expert judgment and review of existing information. Although these descriptions are fact-based, they are subject to analysis and interpretation and thus, require more specialized expertise, collaboration among experts, and peer review (see Stage 8 below).

Stage 4: Identify Desired Outcomes and Policy Options

Using the available IA findings, stakeholders should establish goals and specific desired outcomes related to the issue. Based on these goals, the technical assessment team in collaboration with stakeholders, identify possible response options. Stakeholders may need to prioritize these potential actions, allowing subsequent analyses to focus on options that are most politically, socially, and economically feasible. Depending on the issue, response options might be specific legislative or regulatory policies, a more general principle or goal (e.g., 20% reduction in CO_2), or a suite of potential private and public sector actions that fall within a future scenario (e.g., a community development scenario).

Ongoing communication with stakeholders is essential in this stage because perspectives and the overall policy context may evolve throughout the assessment. A variety of methods are available to solicit input. Workshop breakout sessions or focus groups can allow participants to brainstorm and evaluate the feasibility of response options. Surveys of stakeholders can be used to prioritize goals and strategies. Michigan Sea Grant successfully used individual electronic response devises, (e.g., "clickers" by TurningPoint ©) to allow workshop participants to "vote" and collectively rate goals and potential actions. Another assessment organized a three-day field workshop with selected experts and stakeholders to develop three alternative scenarios of future farming practices and land use policies for Iowa (Nassauer et al. 2007a). Regardless of the method or type of options considered, the process of generating response strategies collaboratively focuses all subsequent analyses and helps ensure that IA results are seen as legitimate and relevant.

Stage 5: Evaluate Various Policy Options

Ultimately, Integrated Assessment should help stakeholders and decision makers evaluate possible response options. Many assessments provide forecasts of likely future environmental, social, and economic conditions under a range of policy or management actions. This often includes either cost-effectiveness, or more formal cost-benefit analyses. Ecological and economic predictions can come from quantitative and predictive models, be based on trend analysis tools, or derived from an assessment of different scenarios. Workshops focused on case studies and panel discussions provide another way to evaluate response options qualitatively. Scenarios and forecasts are subject to considerable scientific evaluation and interpretation and thus, both peer review of results and open dialogue with stakeholders are required to ensure acceptance by the decision-making community.

Stage 6: Provide Technical Guidance for Implementation

It is not enough to outline potential actions; effective Integrated Assessments also provide information on methods to implement each potential action. Stakeholders should be consulted to identify potential barriers to implementing response strategies. The assessment team may be able to provide data, maps, analyses, case studies, educational materials, or decision support tools to improve implementation of potential actions. For example, an assessment evaluating potential impacts of three water quality targets, should also offer guidance on how to reach those targets, such as a comparison of stormwater management techniques or possible land use ordinances.

Stage 7: Assess Uncertainty

Researchers should provide an assessment of certainty levels associated with the information provided in each of the above steps. This information not only helps policy makers understand the strengths and weaknesses of the analyses, but also provides guidance for future research needs to reduce uncertainties.

Stage 8: Submit Findings for Peer Review and Public Comment

The goals, methods, and results of the previous steps should be documented in a comprehensive final report. The Integrated Assessment should not recommend a specific policy or management action, rather the goal is to provide enough scientific information so that decision makers can make informed choices among two or more well-documented options. Peer review of the document is essential to ensure technical adequacy and should take place prior to a final public comment period. The reviewer's comments should be addressed in the final version. Revised results should be presented to a broad public audience and feedback should be gathered and included as a final chapter of the report. Section VIII offers more guidance about the final products of Integrated Assessment.

V. Ensuring an Effective IA

Criteria for Success

The quality and impact of Integrated Assessments are notoriously difficult to evaluate. However, providing some indication of success is important for researchers who need to demonstrate the scientific value and broader impact of their work and for funding agencies that need to ensure that their money is being used effectively. As such, four criteria have been used to evaluate Integrated Assessments (Social-Learning-Group 2001, Farrell and Jager 2006, NRC 2007). Keeping these criteria in mind during IA development will also help ensure a more useful endpoint.

1. Credibility/Technical adequacy

Assessments should be seen as scientifically sound by both stakeholders and experts familiar with the subject matter. The peer review process provides an opportunity to evaluate and demonstrate whether the assessment process and results are accepted by the scientific community. In many cases the assessment team will need to make interpretations and judgments that go beyond the scope of traditional science and their avenue of investigation will be shaped by stakeholder values. The assessment report should explain how and why subjective or speculative conclusions were developed in order to ensure a fair review of this type of project.

2. Salience/Value

The Integrated Assessment should be relevant to the environmental decision-making process. Was the assessment completed at a time when it could influence decisions? Did the assessment frame and tackle the topic in a way that answered policy-relevant questions? Did the assessment address concerns of the end user? Was the assessment accessible to the end user? The salience of an assessment could be evaluated through a survey of key stakeholders.

3. Legitimacy/Fairness

The Integrated Assessment should be seen as balanced and objective. This is typically achieved by engaging a wide range of stakeholders in development and review of the assessment. These stakeholders should see the process as fair, representative of diverse perspectives, and free of bias. The IA team should report the affiliation and level of participation (e.g., number of meetings attended) for stakeholders engaged in the project. Diverse participation demonstrates that the IA project took into account a range of views. Anonymous surveys of participants or other users of the assessment, by a neutral party, could reveal if the IA was viewed as legitimate.

4. Effectiveness

Finally the Integrated Assessment should effectively meet its goals of helping guide policy and planning. There are at least two key elements of effectiveness - did the IA influence how policy makers understand the problem, and did the IA make a difference in a policy outcome? This first question could be evaluated through a pre and post survey of participants in the Integrated Assessment, although this might not capture all of the relevant decision makers. The impact on policy outcomes is probably best determined several years after the assessment is completed. A number of books and papers have tried to address this question and overall the results are mixed (e.g., Social-Learning-Group 2001, Farrell and Jager 2006, NRC 2007).

Early evaluations of environmental assessments searched for clear policy outcomes, such as legislative actions and regulatory changes, which were hard to identify and attribute to the assessment. More recently, social scientists have tried to capture a broader range of impacts within the "issue domain" (Social-Learning-Group 2001, Farrell and Jager 2006). For example, an Integrated Assessment may draw more attention to an issue, help forge new collaborations, resolve disagreements, or initiate a non-governmental approach to addressing a problem. Farrell and Jagger (2006) suggest that an assessment might influence any of the four key elements within the issue domain:

- The people involved in an issue (their interests, beliefs, strategies or resources);
- The institutional setting;
- The decisions that emerge, and;
- The environment itself.

Evaluating Success

The design and evaluation of an Integrated Assessment could be improved by recognizing that assessments can have a range of positive impacts that promote awareness, knowledge, and informed environmental decision making. Project logic models are one way to clarify desired outcomes and identify measures of success. The University of Wisconsin Extension Program provides some useful resources related to logic models and project evaluation. (www.uwex.edu/ces/pdande).

As a complement or alternative to other evaluation methods, the IA team can also document the diverse and sometimes indirect impacts of the IA process. For example, Michigan Sea Grant observed that the relationships and ideas generated during the Northeast Michigan Integrated Assessment catalyzed a number of related spin-off projects and partnerships (www.miseagrant.umich.edu/nemia/) These spin-off projects were able to raise over $400,000 from grants and partner agencies to implement many of the ideas developed during the Integrated Assessment, such as place-based education programs and a joint county park planning effort.

VI. INTEGRATING PARTICIPATORY AND MODELING APPROACHES

Integrated Assessments are sometimes divided into Participatory Integrated Assessments and Model-based Integrated Assessments, although many assessments blend the two approaches (Rotmans 1998, Hisscehemoller et al. 2001). Below we describe the benefits of incorporating stakeholder participation and modeling tools within Integrated Assessment and we recommend using both approaches when possible. In section VII we describe some examples of participatory IA techniques.

The Role of Integrated Assessment Models (IAMs)

In some circles, the terms integrated assessment and integrated modeling are used interchangeably, although modeling is better thought of as a tool within an Integrated Assessment project (Parson 1995). Many of the larger Integrated Assessments have put considerable effort into creating sophisticated modeling tools that integrate different types of data and simulate complex ecological and sometimes social systems. A true integrated model couples different disciplinary modules. For example, predicting the occurrence of hypoxia in the Gulf of Mexico, required the integration of three complex models – a land-use decision model, a nitrogen export model, and a model of ocean ecosystem response. If developing a single integrated model is beyond the scope of the project, existing ecological or economic models can be used to provide information that researchers and stakeholders may integrate through low-tech methods, such as panel discussions and conceptual diagrams.

Common uses of models within Integrated Assessment:

- Organize and synthesize a range of data types (e.g., GIS modeling);
- Describe quantitatively the cause and effect relationships of a specific issue;
- Provide predictions about how an environmental condition will progress into the future without intervention, demonstrating the magnitude or urgency of a problem (e.g., IPCC models forecasted global CO_2 levels under different policy scenarios);
- Evaluate and compare the effectiveness or the cost of different response options;
- Visualize and describe different future scenarios to a broader audience;
- Assess uncertainty by describing the probability of various scenarios;
- Develop decision support tools that allow policy makers to compare the effects of different decisions.

As Hisschemoller et al. (2001) explained, models combine scientific theory and data in a rigorous and precise way. Models provide internal consistency, particularly if a single variable, such as total nitrogen load, is the focus. Sensitivity analyses can be used to assess the importance of different parameters and the uncertainty of different scenarios can be formally tested. In addition, a good model can often be applied to a similar problem in a different location. Perhaps most importantly, models allow us to test multiple scenarios before experimenting with the real system. A report prepared for the European Environment Agency provides more details about how models can be used within Integrated Assessments (www.eea.europa.eu/publications/TEC14) (Peirce 1998).

Despite these benefits, IA participants should recognize the potential weaknesses inherent in models.

1. Models can only be created for well-defined problems. The most useful models greatly simplify the world in order to answer a specific question. Integrating social and natural systems is particularly challenging, and incorporating non-quantitative variables, such as "quality of life", is virtually impossible (Peirce 1998, Rotmans 1998, Hisschemoller et al. 2001).
2. Modeling of ecological and biogeochemical systems is still relatively new and so far these models have a poor track record of accurately predicting the future (Oreskes 2003).
3. Models that are able to accurately predict conditions on a regional or local scale require reliable data from this location, which may not be sufficiently available. Reliable economic data can be particularly hard to find.
4. The modeling process is foreign to many people and an individual model may be opaque even to expert users. As a result, it can be challenging to describe the certainty and applicability of modeling results. Stakeholders may place too much weight on the results or distrust them completely (Schneider 1997).
5. Computer models allow scientists to test and refine their understanding of a system, thus they are attractive tools for advancing science. However, creating and calibrating an integrated model can be a labor intensive process that can distract investigators from more simple methods of synthesizing information and developing forecasts.
6. It is challenging to ensure that a model is truly useful to decision makers. In most cases, modelers, not the end user, determine which variables are included and how results are reported. The modeling answer may not match the decision maker's question, leading to misinterpretation of or disregard for results (Rotmans 1998, Hisscehemoller et al. 2001).

The Role of Participation

Integration of knowledge and different perspectives can happen effectively through diverse participation and discussion rather than, or as a compliment to, integrated modeling efforts. Participatory assessments can be "carried out as an iterative dialogue between stakeholders from the science and policy communities" (Hisscehemoller et al. 2001). Most Integrated Assessments strive for participation from different natural and social science disciplines, and in many cases, IA projects also incorporate relevant decision makers and stakeholder groups. The participation of stakeholders from outside the research community can take many forms, but usually involves at least some face to face communication at workshops or within working groups. Engaging stakeholders is a time consuming process that requires skilled facilitation, so it is important to recognize how participation can benefit an assessment.

Participatory Integrated Assessments can examine a wider range of perspectives than can be accommodated through a strictly modeling-based approach. Although environmental problems involve the interaction of natural, social, and economic systems, relatively few models effectively link these dimensions within a single model.

Public participation in environmental problem solving has been shown to build trust, resolve conflicts, and educate those involved (Beierle and Cayford 2002). Collaboration should lead to a

greater understanding of the problem by researchers and stakeholders and, ideally, a greater commitment to joint problem-solving as new information emerges in the future (Hisschemoller et al. 2001, Reed 2008). In cases where stakeholders need to be convinced that the problem should be addressed, active participation throughout the IA process can be far more transformative than receiving a summary report at the end.

Stakeholder participation can increase the impact of the assessment within the policy context. Audiences are more likely to see the results of an assessment as relevant, credible, and objective if they participated in the assessment (Social-Learning-Group 2001, Mitchell 2006). In addition, feedback from participants may allow IA projects to identify innovative ways to implement ideas and to develop more effective tools and strategies for communicating ideas to different target audiences (Dennison et al. 2007).

One weakness of participatory approaches is that they are time consuming and challenging; skilled facilitation is required and techniques need to be modified to match the audience and the topic. It is possible that different groups may reach different conclusions and some stakeholder opinions may be seen as subjective or short-sighted (Hisschemoller et al. 2001). Integrated assessments that base most of their findings on discussions and expert panels may find that their results are not seen as robust and scientific (Hisschemoller and Midden 1999). Although these challenges are significant, diverse participation can help assessments avoid the most common and tragic pitfall – the possibility that results are unusable or ignored (Social-Learning-Group 2001). Thus an approach that combines both on-going stakeholder dialogue and modeling may provide the scientific robustness and policy relevance necessary for an effective Integrated Assessment.

Combining Methods

Many scholars recommend integrating quantitative and participatory approaches within an assessment to ensure both relevance to policy and scientific credibility (Rotmans 1998, Toth and Hizsniyik 1998, Hisschemoller et al. 2001). Figure 6 illustrates how technical assessment tasks and stakeholder meetings were integrated in an IA led by Michigan Sea Grant. Meetings were an opportunity to discuss the technical results and develop priorities for the region which then focused the next stage of the analysis.

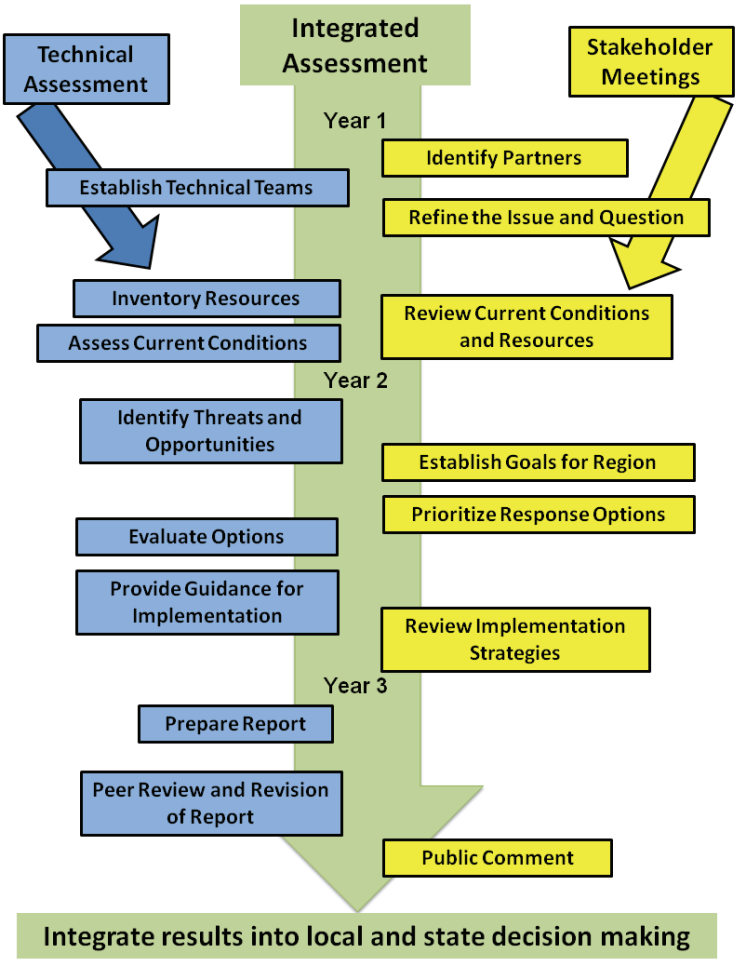

Figure 6. Timeline of an IA led by Sea Grant in northeast Michigan

Other projects have also combined approaches. For example, the Adaptive Environmental Assessment and Management (AEAM) approach involves a series of workshops with managers, decision makers, resources users and scientists who are connected to a particular natural resource. Together they synthesize their knowledge and collaboratively construct a computer simulation model of the management problem. The exercise provides an opportunity to develop a common understanding of the natural resource and develop a simple, but useable management tool (Holling 1978, Toth 2001). Another project in the Swiss Alps used stakeholder workshops as an opportunity to define and elaborate scenarios for use in numerical simulations of the landscape. In a well described account of this project, the researchers conclude that stakeholders were able to both deepen and validate their models of the ecosystem (Walz et al. 2007). However, workshop facilitators found the desire to build local capacity through an open meeting format sometimes conflicted with the need to focus meetings and provide specific input to the modeling efforts. Thus, IA practitioners continue to improve methods for productively engaging stakeholders and effectively integrating qualitative and quantitative research methods.

Decision-support Frameworks

Practitioners of Integrated Assessment may also benefit by reviewing other approaches used to assess multiple risks and guide policy development. A variety of frameworks have evolved to simplify decisions regarding a particular type of problem, including:

- Adaptive Resource Management,[1] for wildlife and natural area management
- Environmental Impact Statements, for approval of infrastructure projects
- Aquaculture Dialogues, for encouraging industry stakeholders and scientists to develop environmental standards
- Conservation Action Planning,[2] for collaboratively developing conservation strategies

These frameworks include well developed analytical and participatory techniques that could be useful tools within IA. For example, the WWF developed a guide for initiating a stakeholder-driven process and facilitating decisions within its Aquaculture Dialogues.[3] Another more general framework, Structured Decision Making,[4] uses a range of visual tools to organize information and evaluate tradeoffs. The conceptual models and visuals aids could be useful tools for focusing an IA workshop. Although Integrated Assessment shares a similar end goal with these approaches, the scope of IA is unique because it emphasizes a comprehensive analysis of the causes of an issue in addition to an evaluation of the options, which is important when tackling controversial or poorly understood problems.

[1] US Department of Interior, www.doi.gov/initiatives/AdaptiveManagement/, accessed July 19, 2009.

[2] Conservation by Design, http://conserveonline.org/workspaces/cbdgateway/cap

[3] World Wildlife Federation, www.worldwildlife.org/what/globalmarkets/aquaculture/whatwearedoing.html, accessed July 19, 2009.

[4] Compass Resource Management, www.structureddecisionmaking.org/, accessed July 19, 2009.

VII. Effective Stakeholder Engagement

Integrated Assessment is intended to support environmental decision making, therefore understanding needs of decision makers is crucial to success. To address an environmental problem effectively, the assessment team must consider decisions of official policy makers as well as businesses and user groups. The term stakeholder will therefore be used here to refer broadly to the wide range of citizens and decision makers who can be part of an innovative and effective solution. This section describes the process of engaging stakeholders and provides some tips for managing the process successfully.

Outreach coordinators, who have connections with the study region and community, are critical members of an effective Integrated Assessment team. These specialists can become a single point of contact for stakeholders during and after the project and ideally help promote the implementation of ideas generated by the assessment. Whereas researchers involved will typically begin focusing on new projects, an outreach coordinator provides continuity after the IA process concludes. Cooperative extension agents, museum or park educators, or non-profit leaders might be in a position to partner with an Integrated Assessment team and facilitate the stakeholder engagement process. Many of the assessment teams supported by Michigan Sea Grant choose to work closely with Sea Grant's field educators. Thus, many "best practices" described here come from these partnerships with research teams.

Envisioning an Authentic Role for Stakeholders

Before inviting stakeholders to participate in Integrated Assessment, it is important to identify how they will contribute and how both stakeholders and researchers will benefit. Remember, the goal of collaboration is to accomplish something that couldn't be accomplished otherwise. Time is limited for all participants. Most stakeholders will be more invested in the process if their opinions, skills, and ideas are used and incorporated throughout the Integrated Assessment.

Some stages of the Integrated Assessment can only be accomplished through discussions with decision makers and a range of stakeholders. The following steps could form the basis of scoping meetings and stakeholder workshops:

- Defining the problem within the decision-making context
- Identifying influential stakeholders
- Establishing desired outcomes and local priorities
- Identifying realistic response options
- Examining implementation challenges
- Integrating a range of expert opinions and local knowledge
- Reviewing results and identifying overlooked factors
- Incorporating intangible, quality of life factors

Identifying Stakeholders

Identifying and engaging the right stakeholders can determine the success of an Integrated Assessment. In most cases, Integrated Assessments develop in collaboration with one or a few influential "decision makers," who often support the Integrated Assessment financially or intellectually and seek to use the results. These individuals should be very involved early in the project, shaping the focus on the assessment and identifying important stakeholders. Figure 7 offers some suggestions for identifying individuals who could be essential to the process and ultimate impact of an IA.

The IA team must identify the stakeholder groups most affected by or interested in the issue as these are people most likely to contribute positively if they are involved, or impede the implementation of new ideas if they are excluded. Stakeholders might include: industry associations or individual businesses; citizen groups or advocacy organizations; or government agencies, e.g., visitors' bureau, economic development corporation. Representation should be diverse and balanced and, if there are multiple, distinct sides to an issue, it is critically important that all stakeholders see their position reflected in the assessment process.

The next step is to engage a few influential, opinion leaders from each stakeholder group. Ideally the most vocal and critical individuals should be at the table. Many projects utilize a "snowball approach" to identify participants, where initial contacts are asked to identify other people they think should be involved in the project (Heckathorn 1997). The individuals identified by several people are likely to be key players within the community.

When identifying stakeholders, ask yourself whose help do you need to…

….get the data, knowledge and insights necessary for an informed assessment?

….be perceived as credible or legitimate?

….access the necessary resources (e.g., expertise, funds, organizational support)?

….manage the process of collaboration (get the right people to the table and facilitate the process)?

….ensure the project helps guide policy and planning?

(Wondolleck and Yaffee 2000)

Figure 7. Tips for identifying essential participants in a collaborative process.

Engaging Stakeholders

To fully engage representatives from all sides of an issue, it is important that stakeholders view the outreach coordinator and technical assessment team members as both competent and neutral or unbiased. There may be issues for which it is not possible to compile an assessment team that is viewed by all stakeholders to be neutral on the focal issue(s). In such an instance it is critical that all stakeholder viewpoints are represented on the assessment team by individuals who are recognized as authoritative and competent.

When discussing the IA with potential participants, we anticipate at least four questions from stakeholders: 1) Why are we doing this? 2) How will this benefit my organization? 3) What type of commitment is required? 4) What will the project produce?

Stakeholders will be most engaged if they have a clear role and the IA project is focused on a task or problem that is compelling to them personally, perhaps because it draws upon their interests or advances their priorities (Figure 8). The IA teams should identify past or on-going initiatives, resources, and opportunities related to the IA topic. For example, during Michigan Sea Grant's first IA project in northeast Michigan, the IA team realized that the assessment could compliment the strategic planning process of the Thunder Bay National Marine Sanctuary and three state parks, as well as advancing management priorities established for the Sunrise Side Coastal Highway. The IA provided an opportunity to acknowledge and publicize these related projects, helping establish a mutually beneficial relationship with community members. In addition, the IA team found opportunities to connect stakeholders with similar interests, which helped initiate several successful collaborative proposals.

Integrated Assessment can be made more transparent and inclusive by publicizing project meetings through media outlets, list serves, or websites. However, many stakeholders will respond best when an invitation is extended to them personally as part of a conversation about their interests and needs. The outreach coordinator could use other meetings, workshops and conferences as an opportunity to discuss the IA project goals. Many projects begin with a phone, paper, or web survey about opinions, resources and needs of stakeholders. Such a survey could also be used to solicit information from individuals unable to participate in project meetings.

Assessment projects may progress slowly and participants can lose motivation along the way. The outreach coordinator should try to establish realistic expectations for both the time commitment and the anticipated timeline, and explain this clearly to potential participants. Throughout the IA, it is crucial to demonstrate that the project is progressing and stakeholders are influencing the assessment and potentially benefiting the larger community or issue (Figure 8). Pre and post visits with key decision makers and stakeholders can help maintain communication and interest throughout the process. Such informal meetings are also a useful way of gauging their level of investment and identifying pertinent concerns with the process. Websites and email lists are also a valuable way of disseminating meeting notes and soliciting feedback for a broader stakeholder group.

What Makes Collaboration Work?

1) A compelling task, problem or project
2) Clarity of purpose and role
3) Convenient opportunities to participate
4) Evidence of impact and progress along the way
5) Respect!

(Wondolleck and Yaffee 2000)

Figure 8. Tips for making a collaborative process work.

Participatory Techniques

A wide range of facilitation techniques have been adopted for use in Integrated Assessment. Here we provide a brief overview of a few techniques that have been described in the literature. The European Environmental Agency prepared a useful summary and bibliography of participatory methods for IA (www.eea.europa.eu/publications/Technical_report_no_64) (Toth 2001).

Workshops

Stakeholder meetings and workshops are often a key part of both modeling-oriented and participatory Integrated Assessment. Nearly every stage of an assessment benefits by carefully constructed dialogue between stakeholders and the technical assessment team (see Figure 6 for an example). Workshops offer an opportunity for open-ended discussion, brainstorming, updates from various project teams, and more structured activities designed to elicit specific information or evaluate different options. Panel discussions provide one way of integrating discipline-specific knowledge and local knowledge to build a broader understanding. As participants see the value of these meetings, interactions will become more productive. Stakeholders will bring new information and ideas to meetings and researchers will modify their analyses based on the feedback provided by stakeholders.

Planning and facilitation of stakeholder meetings is challenging and requires specialized skills. Here are a few general recommendations drawn from our experiences:

- Schedule meetings for a convenient time, avoiding the times when participants are likely to be most busy, such as the beginning of tourist season (Figure 8).
- Be aware of and respect any cultural issues/rituals associated with particular stakeholder groups. Doing so will go a long way toward building respect with participants.
- Respect the time of participants. Use meeting time efficiently. When possible, minimize the number of meetings and schedule them in tandem with other events to reduce travel time and cost.
- Provide food and an opportunity for informal interactions. Meetings should be an enjoyable and beneficial opportunity to network and begin new collaborations.
- Create a neutral and open meeting format. Ask participants to suggest a few ground rules or discuss a few standard guidelines such as: 1) participate, 2) don't dominate, 3) everyone advocates and group decides, 4) it is OK to disagree… respectfully (tough love), 5) cell phones off, no email and no side conversations.
- Be aware of any past history or potential mistrust among stakeholders.
- Dedicate time to building relationships among stakeholders and researchers.
- Use experienced neutral facilitators who are familiar with a topic but not invested in the surrounding issue(s).
- Prepare participants for the meeting by distributing an agenda or soliciting information in advance.
- Clearly state how the meeting will contribute to the larger assessment process. At the next meeting, demonstrate how the assessment responded to the feedback and ideas generated during earlier meetings.
- Do not expect to create consensus during a single or a series of meetings. Facilitators will have more success if they focus on structuring the issue and outlining the diversity of stakeholder views.
- Use engaging visuals, relevant case studies, or story-based scenarios when discussing possible response options and future conditions. Specific, concrete, personalized examples are always easier to grasp than abstract conceptual discussions.

- Take careful notes and distribute key outcomes to all stakeholders.
- Have a plan for maintaining contact with participants who miss a meeting.
- Check-in with participants after the process- Is everyone being heard? Is the process still relevant to local needs?
- Most importantly, *listen*. Solving environmental problems requires an integration of natural sciences, social sciences, and the policy context. Meetings are an opportunity to learn about social, cultural and economic sides of the issue.

Policy Exercises, Simulation Games, and Future Scenarios
A policy exercise is essentially a carefully constructed simulation game in which policy makers take on a role similar to one they actually hold and then are asked to make decisions based on different scenarios. In some cases facilitators have access to a computer model, and as participants make decisions, the model predicts how environmental parameters would change. This is seen as a valuable to way to expose policy makers to scientific information and to gather information about the behavior and thinking process of policy makers (Parson 1996, Parson and Ward 1998). This technique has been used successfully in both involved climate policy exercises as well as simpler simulation games implemented in a wide range of contexts. Many policy application of games are profiled in the journal, *Simulation and Gaming* (e.g., Joldersma and Geurts 1998). A related activity involves alternative future scenarios which offers stakeholders a tangible perspective on possible outcomes of policy decisions (Nassauer et al. 2007b).

Focus Groups
Focus groups are essentially structured interviews with a small group of people and a well prepared facilitator. Participants are selected based on specific relevant criteria, such as profession, demographics, or a common interest. This technique is used widely in social science research to gather information about the opinions and knowledge of a certain group of people. Participants interact with each other and the facilitator, which often generates a richer and deeper range of responses than one-on-one interviews or surveys can yield. Focus groups are typically used to gather information about a group of people, rather than to build consensus or a common understanding. For example an Integrated Assessment team may need to understand the practices and attitudes of fruit farmers or urban planners. A concise introduction to focus group techniques is provided by Wisconsin Extension (www.uwex.edu/ces/pdande/resources/pdf/Tipsheet5.pdf).

VIII. The Final Products

Some scholars describe Integrated Assessment as essentially an opportunity to enhance communication, thus both the IA process and final products should be developed with the target audience in mind. In addition to stakeholder meetings or workshops, most Integrated Assessments culminate in at least two types of communication products: a technically complete final report, and a non-technical executive summary that is geared for a broader audience. The full report should be written for other experts in the field as a way of demonstrating credibility of the assessment approach and conclusions. Policy makers should have access to both the full report and an executive summary.

The Final Report

An Integrated Assessment final report is similar to any other scientific report. It should include a description of the project's background, methods, and results such that an expert external to the process can understand and evaluate the quality of the work. However, because this is an assessment, the report would also likely include some judgment about facts and how they relate to the policy-context. These judgments should also be explained and justified (e.g., Are they based on model outputs, a panel of experts, or results of a stakeholder focus group?). Researchers are encouraged to go beyond the facts, but they should clearly state the certainty of their statements and distinguish between data and interpretations or conjecture. Modeling projects should be able to indicate the confidence level associated with any predictions or inferences. Less quantitative projects may need to find other ways to document the level of confidence associated with different inferences.

Peer Review

Peer-review is crucial for ensuring a scientifically-sound, balanced Integrated Assessment. In some cases, the purpose of the assessment is to create consensus among the scientific community or stakeholder group about a particular issue, thus the process must be perceived as unbiased and credible in order for the assessment to have the desired impact. Typically the organization requesting or funding the assessment project will facilitate a peer-review process. Reviewers should be respected experts within their field. Truly inter-disciplinary reports will need a diverse set of reviewers to ensure that the different types of analyses can be competently evaluated. The assessment team will need to incorporate or acknowledge comments in the final revision. A summary of the reviewer comments and any needed response from the authors could be made available as an indication of the level of certainty and consensus about the assessment. A transparent peer-review process is another way to document the certainty associated with an assessment, particularly for less quantitative or highly inter-disciplinary assessments.

Public Comment

After peer review, the revised report should be presented to the public and their feedback should be gathered and included as a final addendum of the report. The public distribution and comment opportunity should be arranged to suit the project, and could range from a town hall meeting to electronic notification and web-based comment opportunities. This process informs the implementation of the assessment results and provides feedback regarding the following types of questions: Are the response options considered politically and economically feasible?; Are there better ways to implement a solution?; Are there major discrepancies between public perceptions and the assessment findings? In addition, the public comment process can draw attention to the assessment results and generate momentum and creativity for moving forward with new ideas.

Other Publication Tools

Several journals regularly publish the results of environmental assessments, including *Environmental Modeling and Assessment, Integrated Environmental Assessment and Management* and *Integrated Assessment.* Researchers will often publish sections of the assessment results in discipline-specific journals such as *Biogeochemistry* (Scavia and Bricker 2006) or *Journal of Climate* (Ray et al. 2007) .

In addition, many IA teams work with communications specialists to develop more specialized posters, factsheets, videos, management guides, or press releases about certain aspects of the assessment results. In many cases the funding agency or government partners may lead the effort to publicize results and the researchers can act as technical advisors. The CLIMAS project in Arizona illustrates a range of educational products resulting from an assessment (http://www.climas.arizona.edu/index.html).

Piloting various communication or decision support tools with project stakeholders can generate valuable insights for effectively reaching specific audiences. The process of developing conceptual diagrams and visual aids collaboratively can also be a powerful way to both develop and communicate a common understanding of an environmental issue (Dennison et al. 2007). Ideally, the IA process will help generate ideas and build collaborative relationships that continue after the project ends. For example, there may be an opportunity to conduct joint monitoring and undertake future projects with the most engaged stakeholders.

IX. CONCLUSION

Integrated Assessment first emerged as a way of helping policy makers understand and address complex environmental issues such as acid rain and climate change, and it will continue to be a key approach for tackling the wicked problems that threaten the health of the human-ecological systems upon which we depend. Constructed and implemented effectively, IA can help to shift our current course to ensure a healthy planet and prosperous future.

IA promotes the collaboration and data integration needed to build a common understanding of a targeted issue among the scientific and environmental management communities. More recently, scholars have recognized a need to better connect the technical assessment with the policy making process to increase the relevance, legitimacy, credibility, and ultimately effectiveness of Integrated Assessments. Combining participatory and analytical techniques throughout the assessment process is one way of maintaining the necessary two-way communication among researchers, stakeholders and decision makers (Toth and Hizsniyik 1998, Hisschemoller et al. 2001, Mitchell 2006). A fully integrated process has the potential to make both the scientific and policy making communities more responsive to social and environmental needs. On-going evaluation and reflection should allow IA to continually evolve and best support the types of problem solving and the types of decision makers required to address emerging issues at the local, state and national levels.

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