Benefits of using Integrated Assessment to address sustainability challenges

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Abstract Integrated Assessment (IA) offers an effective way to frame and inform decisions for sustainability problems that often lack a clear cause or solution. IA is designed to use stakeholder input to collectively define problems, incorporate diverse perspectives, use best available information, and establish partnerships to identify options for making positive change. Because IA projects are complex and require dedicated time and resources, it is important for participants to understand their benefits. Through interviews with scientists, nongovernmental organization staff, state and federal agency experts, consultants, and community members who participated in four very different IA projects, we developed a common lexicon of tangible and intangible benefits. These results demonstrate IA works effectively at many geographic scales, increases knowledge and understanding of issues among diverse participants, creates new policy perspectives and processes, helps leverage new resources, and builds coalitions that would not otherwise exist.

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Introduction

Organizations are increasingly realizing that sustainability issues are complex and different approaches and perspectives are needed to improve decision making. They need a process that compiles and makes available information for a wide range of audiences, including scientists, managers, politicians, and the public. Because Integrated Assessment (IA) provides a framework to gather and analyze the diverse economic, environmental, and social information that these sustainability challenges require, it is being viewed with increasing interest.

IA is one of several efforts to make scientific research more relevant to policy making by using multidisciplinary and collaborative approaches. Problems that lend themselves well to this type of assessment are typically characterized by competing definitions, uncertain facts, conflicting values, arguable solutions, and where diverse expertise is needed (Gough et al. 1998). While IA can have several goals, typically they are undertaken to: (1) build a multidisciplinary assessment of best available information, (2) inform policy, and (3) improve decision making. Its participatory process leads to relevant, balanced, and credible results and can effectively address the complexity of sustainability problems, including the case studies reviewed herein: resource protection in a recreation-based economy, managing stormwater impacts in developed watersheds, contaminated fish consumption and human health, and impacts of agriculture and nutrient loading on marine ecosystems and fisheries.

Several types of assessment can be used to address sustainability problems. Process Assessment evaluates the status, trends, and causes of a problem; Impact or Risk Assessment focuses on potential consequences of an environmental issue; and Response Assessment identifies

and evaluates possible responses to the issue (National Research Council 2007). IA differs from these approaches in that the process emphasizes both a comprehensive analysis of the causes and consequences of an issue and an evaluation of options to address them. IA also focuses on challenging *questions* that necessitate integrated analysis of environmental, economic, and social dimensions. This approach is especially important when tackling controversial or poorly understood problems (Vaccaro et al. 2009). For IA and typical sustainability problems, there is often no a priori consensus on how the problem is defined or the question that needs to be addressed (Hisschemoller et al. 2001). Farrell and Jager (2006) suggest that IA influences four elements of a problem: the people involved in the issue, the institutional setting, the decisions that emerge, and the environment itself.

While IA varies widely depending on the geographic scope, budget, and range of decision makers, the following steps are often useful to ensure the process is both relevant and factually credible: (1) define the policy-relevant question, (2) document status and trends, (3) describe the causes and consequences of those trends, (4) identify desired outcomes and policy options, (5) evaluate the likely environmental, social, and economic outcomes of each option, (6) provide technical guidance for implementation, and (7) assess uncertainty (Hisschemoller et al. 2001; Scavia and Nassauer 2007). These elements are best seen as a flexible framework that can be modified depending on the policy context and the scientific and public understanding of the issue. Through these steps, IA establishes the importance of an issue, analyzes different policy options, provides technical solutions, identifies new research needs, and evaluates the impact of existing policies (National Research Council 2007).

This framework recognizes that policies can be more effective if they are derived from participatory processes, involve stakeholders from early stages of problem identification, and continue through information gathering, planning, analysis, and option evaluation (National Research Council 2007). The assessment framework encourages broad participation to build consensus among disparate stakeholders, creates a common knowledge base, and increases public support for policy change (Ridder and Pahl-Wostl 2005; Dennison et al. 2007; Vaccaro et al. 2009).

Complex sustainability issues—such as climate change, water scarcity, and human impact on biodiversity—require the knowledge and participation of scientists, policy makers, decision makers, and the public. However, for participation to be successful, stakeholders need to clearly see and experience the types of benefits derived from IA. Once they become actively involved in this often complex and lengthy process, an understanding of the benefits can continue motivating them to stay involved (Ridder and Pahl-Wostl 2005). This motivation and commitment of time

and resources is also necessary to carry IA results through to implementation.

Most studies have focused on project-specific or theoretical frameworks and processes of IA (Dennison et al. 2007; Gough et al. 1998; Hisschemoller et al. 2001; Lee 2006; Ridder and Pahl-Wostl 2005; Vaccaro et al. 2009). Often missing from these studies are direct accounts from project participants to substantiate IA benefits. The focus of our study was to: (1) go beyond the theoretical premise of IA by adding insightful information about its benefits through the words of actual practitioners and (2) investigate whether responses from diverse participants across several projects and scales are common enough to organize and create a common lexicon for IA benefits.

Research design

This qualitative study focused on analysis of interview responses to add definition and specificity to IA theory around IA benefits. Prior to conducting formal interviews, we interviewed seasoned IA practitioners involved in each of the four case studies and used their insights to guide subsequent interviews and questions (Lund and Dinse 2010). As we gathered interview responses, tangible and intangible categories of benefits emerged and were clarified. The purpose of composing questions to target specific benefits before the interviews began was to ground IA theory in direct experience (Strauss and Corbin 1994).

We interviewed a range of participants—from state and federal agency staff to scientists, consultants, and community members who participated in four IA projects of different focus, scale, and level of stakeholder involvement. We used eight questions to gather responses about benefits and to illicit information about participants' roles, their views on working with other people and organizations, and project outcomes and accomplishments (Lund and Dinse 2010).

We conducted interviews with participants in IA projects focused on[1]:

1. Alternatives for natural resource-based tourism in northeast Michigan,
2. Options for controlling stormwater runoff in Michigan's Spring Lake Watershed,
3. Refining Detroit River fish consumption advisories, and
4. Reducing hypoxia in the northern Gulf of Mexico

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[1] Information on the first three projects can also be found at: www.miseagrant.umich.edu/research/integrated-assessment.html. For the hypoxia IA summary, see: or oceanservice.noaa.gov/products/hypox_final.pdf)

Northeast Michigan Integrated Assessment—connecting great lakes coastal access, tourism, and economic development (Michigan Sea Grant 2009)

Community leaders in the northeastern section of Michigan's lower peninsula—specifically the coastal portions of a three-county area that includes Presque Isle, Alpena, and Alcona—recently turned to tourism to boost their resource-based economy by promoting the natural and cultural assets unique to the area, especially those associated with the coast . The region has many natural and cultural sites, including the Thunder Bay National Marine Sanctuary and several undeveloped public lands. Despite the potential for economic development, the communities are proceeding cautiously to avoid overdevelopment and destruction of the area's resources.

Responding to these needs and concerns, Michigan Sea Grant organized the Northeast Michigan Integrated Assessment (NEMIA) to foster a regional planning process related to economic development and coastal resources in the three counties. The project included a series of stakeholder workshops that brought together representatives from 32 local and regional organizations. The IA process developed a shared vision for the environment and economy and identified potential actions for reaching the region's goals.

Rein in the runoff—tracing the path and influence of water in Spring Lake (Sterrett-Isley et al. 2009)

Spring Lake is a eutrophic lake, located in Ottawa County, MI along the shores of Lake Michigan near the mouth of the Grand River. While the communities in this watershed enjoy a picturesque waterfront setting, this attractive location also poses challenges—particularly after heavy rains. On these occasions, stormwater runoff carries pollutants into Spring Lake and its main tributary streams. Historically, these pollutants result in the impairment of the waters of Spring Lake, the Grand River, and the nearshore areas of Lake Michigan. In addition, pressures associated with increasing development in the Spring Lake area have magnified the stormwater issue.

This IA identified management alternatives that allow for future development while mitigating impacts of stormwater to improve the quality of Spring Lake and its surrounding waterbodies. Environmental, economic, and recreational aspects of the issue were addressed. Town managers, planning commission members, stormwater managers, and residents were involved in the project. Surrounding communities have begun to see the intimate connections between stormwater and a number of economically and recreationally important aquatic systems.

Detroit fish consumption advisory Integrated Assessment (Kashian et al. 2010)

The Detroit River remains under several fish consumption advisories that are in place to protect human health but which also impact the local economy. Despite the negative impact of these advisories, little progress has been made in developing effective strategies to address them. Many uncertainties remain about these advisories, including the relative contribution of sediment hot spots, the role of point versus nonpoint contaminant sources, and the appropriateness of methods to set and identify allowable contamination levels for consumption advisories.

This IA explored reasons why and when fish contamination occurs in the Detroit River and how consumption advisories can be made more effective. The IA brought together policy makers, interested stakeholders, scientists, and governmental agencies from the USA and Canada to develop a common understanding of issues related to PCB contaminant advisories. New approaches for managing the river were identified as part of the IA.

Policy options for reducing hypoxia in the northern Gulf of Mexico (CENR 2000)

Since 1985, scientists have been documenting a hypoxic zone in the Gulf of Mexico each year. The hypoxic zone, an area of low dissolved oxygen that cannot support marine life, generally manifests itself in the spring. Since marine species either die or flee these areas, the spread of hypoxia reduces the available habitat for marine species, which are important for the ecosystem as well as commercial and recreational fishing in the Gulf.

This IA focused on identifying policy options for reducing the Gulf of Mexico's area of low dissolved oxygen, which affects important ecosystem function as well as commercial and recreational fishing. The complex problem involved agricultural, environmental, and energy interests along with all levels of government. The IA summarized the extent, characteristics, causes, and effects of hypoxia in the northern Gulf of Mexico and concluded that hypoxia was caused by excess nitrogen inputs from surrounding river basins in combination with stratification of Gulf waters. The IA also evaluates alternative solutions and management strategies.

Background on each of these IAs was gathered and project leads identified. When contacted, project leads were asked to identify key participants to interview. Overall, 25 people were interviewed, including five to seven interviews per IA. Interviews took place by either phone or email, depending on the subject's preference. Phone interviews lasted approximately 30–45 min, during which time the interviewers took detailed notes of each conversation.

Relevant quotes were extracted from notes and email responses and were organized by project into benefit categories. A complete list of interview questions, quotes, and case studies can be found in Lund and Dinse (2010).

Results

We were able to categorize responses gathered from individuals with a wide variety of roles/responsibilities across these diverse projects as benefits that are either tangible (reports/data, etc.) or intangible (modified perspectives, new partnerships, process change, and funding opportunities).

Tangible benefits

Reports, datasets, and technical information

A common challenge facing assessment projects is the effective integration and interpretation of information. IA typically culminates in a report that communicates findings and evaluates policy options. These reports provide access to agreed upon, accurate information developed from multiple perspectives and are a foundation to maintain credibility on an issue. A state agency staff person working on the *Hypoxia* project says, "Even though the report is almost 10 years old, I still go back and use it to reference key findings—it helps me take a stronger stand when justifying management actions." In other responses, one scientist thought that reporting products helped strategic planning for future data acquisition while another responded, "The reports compile the best available science into one place so they can be readily accessed to address the controversies. Having these documents helps dispel some of the myths about the science."

Respondents also identified tangible outcomes, including datasets, models, or other technical information that are often used as a factual basis in subsequent debates. These products increase stakeholder involvement because participants become more aware of scientific findings while scientists receive better information to improve their products. "This project really helped to provide accurate information. And if people have accurate information they make better decisions" (*Local Official, Rein in the Runoff*).

Other results show that as scientists receive better information, they improve their data, models, and research approach. The idea that IA improves the link between science and policy making is given greater meaning through the following interview response:

"The IA served as a bridge between the Task Force and the scientists doing the studies. A big part of moving the process forward was to get a readable report that was action oriented to start bridging the gap of science to action planning. This ultimately helped the Task Force focus on opportunities."
State Agency Staff, Hypoxia in the Northern Gulf of Mexico

Intangible benefits

IA also generates intangible benefits that include changes in perspective, new partnerships, modified policies and decision-making processes, and opportunities for spin-off projects and new funding. These intangible outcomes can create common ground for stakeholders—essential when tackling complex sustainability challenges.

Modified perspectives

From the case studies, it was clear that IA requires contributions from several disciplines and a wide range of perspectives. As such, participants indicated they could see issues from new perspectives and think about challenges and strategies they have not thought of before. One scientist noted that, "Rein in the Runoff helped educate stakeholders regarding the complexities of stormwater impacts and management, including how everyday activities can exacerbate the effects of stormwater runoff to their local waterways." Armed with new information, participants learn innovative ways to implement actions, develop more effective tools and strategies, and use a broader lens to view issues. Responses showed that building a collective understanding of an issue often increased enthusiasm for tackling the problem.

In another example, respondents noted when communities shift their thinking from local to regional perspectives. The awareness that people, places, and things are linked moves IA participants to take greater responsibility in crafting options to address their sustainability problem. A state agency staff person working on the NEMIA project shed light on how perspectives can be modified: "What's really important, what really excited me, is how we now look at our work as more of a regional endeavor as opposed to just a county, town, or single property." From the *Rein in the Runoff* project, a similar thought echoed by a state government representative reinforces this point, "The project brought awareness to leaders that they ought to consider impacts to the watershed when planning for the future."

New partnerships

Partnerships are relationships among individuals or groups involving mutual cooperation and responsibility to achieve outcomes. Most IA involves participation from natural and social science disciplines as well as relevant decision

makers and public stakeholder groups. Results from this study demonstrate that IA practitioners often realize they have similar goals and see the benefit of working together. Staff from a state agency reported that the NEMIA process "is probably of more importance to me than any of the tangible products. We intend to keep the relationships going. We don't want to lose the trust that we have built."

IA can also build multi-jurisdictional partnerships as they gather participants from different sectors and institutional levels. As one federal agency staff person noted about the *Hypoxia* project, "The individual reports and the IA catalyzed partnerships with NOAA and other federal agencies." Collaboration beyond traditional disciplinary boundaries allows researchers to tackle more complex issues and better incorporate human dimensions of environmental problems.

> "To have people working in chorus is always an advantage for any initiative. There is better cooperation and communication and the initiative is more likely to have a positive outcome when you have representation from all communities in the same room at the same time. For this project we were able to understand and communicate about the issue from the very beginning. Now we can work together on common solutions."
> *Community Member, Rein in the Runoff*

IA projects often strengthen existing efforts by helping local communities realize the value of continuing cooperation—even though the final result may not be achieved for many years into the future. "Those meetings brought together a lot of people who hadn't had contact before. It got people talking. The people were great to work with, and we were all working toward the same goal. Could have been quicker, but that's the process" (*Nonprofit Staff, Fish Consumption Advisory*). Interviewees said that many of their working relationships continue long after the process is over because IA builds communication, cooperation, trust, and public participation—all laying the foundation for lasting partnerships.

Change in process

IA's focus on participatory techniques to identify policy options increases the likelihood that recommendations will be successfully implemented and improve decisions. In one response from a Sea Grant Extension agent working on the NEMIA project, he refers to the IA as being a "catalyst" for planning. A community member working on the *Rein in the Runoff* project notes, "I already had the enthusiasm for the issues; this project gave me an avenue for acting in concert with others who were in a position to make an impact." And a third response showing that IA can shift current practices through policy and new strategic planning is emphasized in

the response from a project scientist, "I believe that as a result of Rein in the Runoff, local officials are re-evaluating the way they make certain land use decisions."

It is important to note that while many responses fit into this category, an example that illustrates a difference in participants' views comes from the *Hypoxia in the Northern Gulf of Mexico* project. Compared to other case studies, this IA focused on a much larger geographic area that required more resources, time, and participation from groups located at greater distances and often with more polarized views. Because of these complex challenges, this project had more variation across interviewees' responses as to how much of a change in policy or process they feel the assessments produced. A couple responses indicated views that while the IA resulted in a useful report with convincing science, the planning process resulted in few resources to implement meaningful actions.

> "The six scientific assessment reports and the IA synthesis were all valuable and laid a foundation for the 2001 Action Plan. However, while the IA involved much planning and policy work, there were few actions implemented to reduce nitrogen loading. Both the 2001 and 2008 action plans relied on voluntary actions and when something is voluntary, it requires money to pay for it. The planning and goals needed more resources allocated for implementation."
> *Consultant, Hypoxia in the Northern Gulf of Mexico*

Leveraging new opportunities and resources

IA can often lead to leveraging of new resources and opportunities. While this benefit seems like a logical project outcome, few studies highlight the importance of these IA benefits that are so important for continuing momentum and progress. One staff member from a federal agency working on the Fish Consumption Advisory IA noted that, "Through the IA process, many good things came out and people found value in different areas that I hadn't thought of. Participants came up with ideas for their own relevant spinoffs." In another project, a Sea Grant extension agent noted:

> "The NEMIA process has provided research-based and community-based input and guidance toward our own Sea Grant Extension program investments in northeast Michigan. As a result of the IA process, I have designed and focused my Extension plans and programming around addressing and developing three specific action opportunities identified in the NEMIA project and relevant to our mission. These include creating a coastal tourism business support website, methods for revitalizing fishing-related tourism, and a Great Lakes youth stewardship education initiative."

Multiple respondents from each project said that IA helped leverage additional support and grant funding. By creating a foundation of information while also demonstrating time and commitment, participants are better positioned to compete for funding from agencies and foundations. Many respondents indicated that they still use the IA reports as tools to support development efforts and often quote technical information in grant applications. Two examples show that participants with different roles and projects have similar responses:

"The final report has been a good tool to support community development efforts. We have quoted the final report on several different grant applications." *Government Representative, Northeast Michigan Integrated Assessment*

"Rein in the Runoff put us in a better position to gain resources, because now we have all the information, a common understanding, and a relationship with [researchers]. We are informed, knowledgeable, and we know what we need. For grant writing, we can cite the report or the knowledge gained." *Community Member, Rein in the Runoff*

Discussion and conclusions

The utility of Integrated Assessment in helping decision makers enhance the effectiveness and legitimacy of their policies has been reviewed and demonstrated (Hisschemoller et al. 2001; Ridder and Pahl-Wostl 2005; Reed 2008). IA practitioners recognize that these projects need to involve many stakeholder groups including scientists, businesses, nongovernmental organizations, and the general public (Ridder and Pahl-Wostl 2005). This diverse participation can help assessments avoid the possibility that results will be unused or ignored (Lee 2006; Social-Learning-Group 2001).

For IA participation to be successful, it is necessary to develop trust and confidence among the parties involved in the process (Beierle and Cayford 2002; Ridder and Pahl-Wostl 2005). This will strengthen the commitment to joint problem solving (Hisschemoller et al. 2001; Reed 2008). As participants are asked to collaboratively explore new styles and strategies for policy making, their core knowledge and attitudes can also change (Hisschemoller et al. 2001).

Through engaging stakeholders and policy makers, IA can also help scientists increase the utility of their work and build broader support for their research agenda (Lee 2006; Vaccaro et al. 2009). By bridging the gap between science and policy, IA can be used to evaluate conditions under which scientific findings are most useful (Gough et al. 1998; Lee 2006). It also establishes a forum for scientists

seeking relevance of their research in decision-making situations (Ridder and Pahl-Wostl 2005).

While most other studies have focused on descriptions of IA as a process or describe outcomes generally, our work documents direct experiences of IA stakeholders. Since stakeholders often have difficulty justifying the efforts required for IA because of time lags in recognizing their impacts on policy change, it is important to document clear benefits that might be hard to measure or notice otherwise. The significance of this study is the documentation of five categories of clear benefits from diverse participants and projects:

- The IA report and associated datasets, models, and outreach materials;
- Modified perspectives and creative ways of thinking;
- New partnerships and ways of interacting;
- A change in process with new policies and strategic planning; and
- Opportunities and resources that include additional funding and support for a project.

Our research focused primarily in the Midwest and mostly at the local level, and therefore our results, while representative, are not comprehensive. Expanded studies with open-ended questions, more participants, and covering a broader range of projects with different settings and scales can lead to a greater understanding of this topic. In addition, our study focused on completed IA projects. Future analyses could be designed to track participant perspectives throughout the IA process, and we are developing formal ways to evaluate those changing perspectives.

This study shows that IA projects are effective at multiple scales, based on stakeholder input and scientific assessment, provide flexible frameworks that evolve based on participant interests, and produce a diversity of tangible and intangible benefits. Recognition of these benefits should lead to a better understanding the IA process. Ultimately, this awareness can result in greater commitment of time, energy, resources, and motivation for participation.

References

Beierle T, Cayford J (2002) Democracy in practice: public participation in environmental decisions. Resources for the Future, Washington, DC

CENR (2000) Integrated assessment of hypoxia in the northern Gulf of Mexico. National Science and Technology Council Committee on Environment and Natural Resources, Washington, DC

Dennison WC, Lookingbill TR, Carruthers TJB, Hawkey JM, Carter SL (2007) An eye-opening approach to developing and communicating integrated environmental assessments. Front Ecol Environ 5:307–314

Farrell AE, Jager J (eds) (2006) Assessments of regional and global environmental risks. Resources for the Future, Washington, DC

Gough C, Castells N, Funtowicz S (1998) Integrated assessment: an emerging methodology for complex issues. Environ Model Assess 3:19–29

Hisschemoller M, Tol RSJ, Vellinga P (2001) The relevance of participatory approaches in integrated environmental assessment. Integr Assess 2:57–72

Kashian DR, Drouillard K, Haffner D, Krause A, Liu Z, Sano L (2010) What are the causes, consequences and correctives of fish contamination in the Detroit River AOC that cause health consumption advisories? Final Report [MICHU-09-206]. Available at: www.miseagrant.umich.edu. Accessed 11 Jul 2010

Lee N (2006) Bridging the gap between theory and practice in integrated assessment. Environ Impact Assess Rev 26:57–78

Lund K, Dinse K (2010) Benefits of integrated assessment: information for decision makers, project leaders, and scientists. University of Michigan, Ann Arbor, MI. Available at: www.graham.umich.edu/ia/benefits.php. Accessed 4 Apr 2010

Michigan Sea Grant (2009) Northeast Michigan integrated assessment final report [MICHU-09-207]. Available at: www.miseagrant.umich.edu

National Research Council (2007) Analysis of global change assessments—lessons learned. The National Academy Press, Washington, DC

Reed MS (2008) Stakeholder participation for environmental management: a literature review. Biol Conserv 141:2417–2431

Ridder D, Pahl-Wostl C (2005) Participatory integrated assessment in local level planning. Reg Environ Chang 5:188–196

Scavia D, Nassauer J (2007) Policy insights from integrated assessments and alternative futures. In: Nassauer JI, Santlemann MV, Scavia D (eds) From the Corn Belt to the Gulf. Resources for the Future, Washington, DC, pp 1–8

Social-Learning-Group (2001) Learning to manage global environmental risks volume II: a functional analysis of social response to climate change, ozone depletion and acid rain. MIT Press, Cambridge

Sterrett-Isley E, Steinman A, Thompson K, Vander Molen J, Koches J (2009) Alternative stormwater management practices that address the environmental, social and economic aspects of water resources in the Spring Lake Watershed (MI). Final Report [MICHU-10-202]. Available at: www.miseagrant.umich.edu. Accessed 15 Jul 2010

Strauss A, Corbin J (1994) Grounded theory methodology. In: Denzin P, Lincoln P (eds) Handbook of qualitative research. Sage Publication, Thousand Oaks, pp 273–285

Vaccaro L, Read J, Diana J, Scavia D, Horning A (2009) Tackling wicked problems through integrated assessment. [MICHU-09-506] University of Michigan, Ann Arbor