

## **Integrated Assessment**

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# Integrated Assessment

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*Integrated assessment (IA) can be defined as an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines in such a way that the whole cause–effect chain of a problem can be evaluated from a synoptic perspective with two characteristics: (i) it should have added value compared to single disciplinary assessment; and (ii) it should provide useful information to decision makers (Rotmans and Dowlatabadi, 1997). Thus (IA) is an iterative participatory process that links knowledge (science) and action (policy) regarding complex global change issues such as acidification and climate change.*

*Assessment comprises the analysis and review of information derived from research, for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. In this context, assessment thus means assembling, summarizing, organizing, interpreting, and possibly reconciling pieces of existing knowledge, and communicating them so that they are relevant and helpful to an intelligent but inexpert decision-maker (Parson, 1995).*

*Providing such a synoptic view required new analytical tools and procedures to integrate a wide range of disciplinary knowledge. As Parson (1995) phrased it: “to make rational, informed social decisions on such complex, long-term, uncertain issues as global climate change, the capacity to integrate, reconcile, organize, and communicate knowledge across domains – to do integrated assessment – is essential.” IA has emerged as an approach that is suitable for accommodating the uncertainties, complexities and value diversities of issues such as climate change.*

The cause–effect chains that IA aims to evaluate start with socioeconomic drivers leading to economic activity and other practices, leading to stresses on the environment, leading to environmental changes, leading to physical impacts on societies and ecosystems, leading to socioeconomic impacts, eventually returning to cause changes in the socioeconomic drivers. Therefore, IA needs to integrate insights from a multitude of disciplines and stakeholders to arrive at a synoptic view of the problem at hand.

One of the consequences of the novelty of the field of IA is that the literature does not yet show a uniformity in terminology. Even the appropriate term to indicate the research field is subject to debate. Some groups talk about *integrated environmental assessment* (IEA), whereas others

use the term IA. The proponents of the term IA argue that adding environmental as the focus detracts from the integrated nature that IA should have. On the other hand, IA makes no reference to complex environmental policy problems, whereas until now, the assessment of complex environmental policy issues has been both the incentive for the development of, and the major concern of IA. There is, however, no *a priori* reason to restrict the application of IA to environmental policy problems. It is obvious that the IA research community has the aspiration that IA be applicable to the entire field of science for policy. IEA can then be seen as the subset of IAs concerned with environmental issues.

In the literature a large number of attempts to define IA can be found. Weyant *et al.* (1996); Van der Sluijs (1997) and Toth and Hitznyik (1998), give reviews of IA definitions. This multitude of attempts to define and redefine IA reflects the novelty and dynamics of the field. For the purpose of this article we adopt the widely cited Rotmans and Dowlatabadi (1997) definition, describing IA as:

an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines, in such a way that the whole set of cause–effect interactions of a problem can be evaluated from a synoptic perspective with two characteristics: (i) it should have added value compared to single disciplinary assessment; and (ii) it should provide useful information to decision makers.

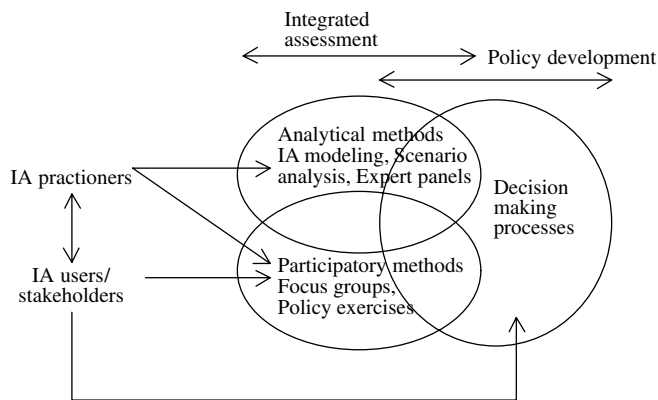
To understand the concept of IA, it is useful to distinguish *doing assessment* from *doing research*. Assessment comprises the analysis and review of information derived from research, for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. Assessment usually does not mean doing new research. Assessment means assembling, summarizing, organizing, interpreting, and possibly reconciling pieces of existing knowledge, and communicating them so that they are relevant and helpful to an intelligent but inexperienced policy-maker or other actor involved in the problem at hand (Parson, 1995).

IA addresses three goals (Weyant *et al.*, 1996):

- coordinated exploration of possible future trajectories of human and natural systems;
- development of insights into key questions of policy formulation;
- prioritization of research needs in order to enhance our ability to identify robust policy options.

The IA process overlaps with the policy development process, as is shown in Figure 1.

An important notion in the definition given above is that IA is understood as a process and not a method. In the early period of the development of the field (that is from the early 1980s till the mid 1990s), the label IA was often used to refer to the technical analytical



**Figure 1** IA involves practitioners and users, uses technical analytical methods and participatory methods and overlaps with the policy development process

methods used in the process, with integrated assessment models (IAMs) and scenario development as the dominant tools. Nowadays, it is widely recognized that IAM is not a complete IA methodology, it is one set of analytical tools for integration used in conjunction with other methods of integration in a broader participatory assessment process.

Historically, IA is rooted in scientific and public policy efforts to understand and control acid deposition in the 1970s in Europe and North America. Public policy organizations had asked the scientific community to prepare IAs of the acidification problem (Toth and Hizsnyik, 1998). In practice, traditional forms of knowledge integration, such as books, expert panels and advisory bodies combining mono-disciplinary assessments were too slow and too inflexible to fulfill all the needs of the dynamic and issue-driven policy process. Examples of policy needs where traditional means of integration were weak, are the *ex-ante* evaluation and comparison of the potential impacts of a wide range of policy scenarios, and estimates of the effectiveness of alternative (combinations of) conceivable policy measures. Facilitated by developments in computer technology and systems analysis, IA modeling emerged in the 1980s as a new methodology that was capable of addressing such questions in a fast, flexible and consistent way.

IAMs are computer simulation models in which knowledge from many different disciplines is combined in an analytical computational framework to analyze the problem at hand in an integrated fashion. IAMs are used for several purposes, such as scenario analysis, (*ex-ante*) evaluation of the environmental, economic and social consequences of different policy strategies, translation of environmental quality standards into acceptable emission trajectories (*safe landing corridors* or *tolerable windows*), and optimization of key policy variables such as rate of greenhouse gas emission reduction or level of carbon taxes.

Within IAMs, both the natural system and the socioeconomic system are simulated. A perfect policy evaluation IAM would model the complete so-called *causal chain*, including all the feedbacks within this chain. The major innovative characteristic of an IAM, which has made it an essential tool in IA, has been its capacity to dynamically include feedback loops between different stages of the causal chain. There is no other means of integration of insights into complex interlinked cause–effect relationships from multiple disciplines with that capacity.

The first generation of these integrated models focused on acid rain. The Regional Acidification INformation and Simulation (RAINS) is the most obvious example (Alcamo *et al.*, 1990). RAINS was developed in the 1980s at the International Institute for Applied Systems Analysis. The RAINS model played a major role in the international acid deposition negotiations in the framework of the United Nations (UN) Convention on Long-range Transboundary Air Pollution, and became an annex to the UN SO<sub>2</sub>-protocol (*see RAINS (Regional Air Pollution Information and Simulation)*, Volume 4).

In the second half of the 1980s, the success of the RAINS model led to the belief that integrated modeling would be the optimal way to interface science with policy, regarding environmental issues. Consequently it is not surprising that IAMs were developed all over the world. For the climate issue more than 50 IAMs coexist (Van der Sluijs, 1997). Looking back at the developments in the IA field over recent decades, the role of IAMs in the IA process has been closely linked to the policy development process. The climate change problem is a key example to illustrate this changing role and its consequences for evolution of IA and its toolbox.

The development of international climate policy can be roughly divided into five periods (Table 1). IA started to play a role in the agenda-setting phase. In this process of agenda setting, the 1985 Villach Conference on the Assessment of the role of Carbon Dioxide and other Greenhouse Gases in Climate Variations and Associated Impacts (*see Villach Conferences*, Volume 4) and the 1988 World Conference on the Changing Atmosphere: Implications for Global Security in Toronto were the milestones. These conferences were typical attempts to bring together experts from a multitude of scientific disciplines to arrive at an integrated view on the climate problem. These meetings were successful in putting the issue of climate change on the policy agenda, and were the first steps towards the creation of IPCC (*see Intergovernmental Panel on Climate Change (IPCC): an Historical Review*, Volume 4).

In the pre-negotiation phase, climate IAMs began to be developed. For instance, in 1986 the Netherlands National Institute of Public Health and Environmental Protection developed the Integrated Model to Assess the Greenhouse Effect (IMAGE)-1 model (Rotmans, 1990). IMAGE was

**Table 1** The development of international climate policy

Period	Phase	Major characteristic
1895–1985	Foundational period	Scientific concern about global warming developed
1985–1988	Agenda-setting phase	Climate change was transformed from a scientific into a policy issue
1988–1990	Pre-negotiation period	Governments became heavily involved in the process
1990–1992	Formal intergovernmental negotiations phase	Led to the adoption of the FCCC <sup>a</sup> in May 1992
1992–present	Post-agreement phase	Focus on the elaboration and implementation of the FCCC and the initiation of negotiations on additional commitments; more and more stakeholders became involved in the climate policy debate

<sup>a</sup> UN Framework Convention on Climate Change.

a pioneer in the field: the (completely revised) IMAGE-2 model (Alcamo, 1994) is still one of the leading models, at the frontiers of IA modeling. IMAGE was developed at the time when the climate problem appeared on the policy agenda. In that phase, scenario analyses were needed to support the thinking about the question of how much greenhouse gas emission reduction was needed in order to manage the risk. IAMs were also used for scenario analysis in the successive assessments produced by the Intergovernmental Panel on Climate Change (*see Intergovernmental Panel on Climate Change (IPCC): an Historical Review, Volume 4*).

In response to developments in the post-agreement phase of the international climate policy debate, in which quantified emission limitation and reduction objectives were negotiated, IAM results from different modeling groups were fed into the negotiations. A typical IAM application in this phase has been the calculation of so-called safe landing zones and corresponding safe emission corridors (or tolerable windows). *Safe emission corridors* are defined as the allowable lower and higher bounds of greenhouse gas emission scenarios, relating to a set of criteria for climate policy whose purpose is to protect both the environment and the economy from disruption. Ecological constraints (maximum acceptable total temperature increase; maximum acceptable rate of temperature change; and maximum acceptable sea level rise) determine the upper limit and economic constraints (maximum acceptable rate of emission reduction) the lower limit of the corridor. Such calculations have played a role in selecting the emission reduction targets in the Kyoto agreement. Overall over the past decade, IAMs have played an increasingly important role in the legitimization and scientific underpinning of policy targets regarding global environmental risks.

With the Kyoto protocol, a new phase has started. Major changes of global economic structure are being envisaged, as implied by long-term reductions of greenhouse gas emissions. As the 1998 Buenos Aires Conference of the Parties (COP)-4 and the 1999 Bonn COP-5 meetings have shown,

however, no such major changes are currently being implemented. Rather, a long-term effort has started to design possible institutions and mechanisms whose implications are gradually being explored by international environmental diplomacy.

This phase is essential to build up the know-how and the trust required to develop effective environmental policies at a global scale. However, it is clearly insufficient if the problem of climate change is to be effectively addressed. If effective policy is to emerge, actions taking place at the level of international environmental diplomacy must be combined with actions involving various stakeholders, who range from peasants to forest managers, from tourist operators to inhabitants of coastal zones, and from financial investors to ordinary citizens. Involving the latter will be necessary because climate mitigation measures will require consumer and worker cooperation, as well as citizen consent, to be successfully implemented.

For IA, this implies a growing need for the integration of social science research, and in particular of participatory techniques into research on global change. Social science is needed to provide knowledge about stakeholders and their ways of opinion forming, and also to provide opportunities for including the knowledge of stakeholders and their judgments about controversial issues in policy making.

An innovative development in the IA field has been the design of *Participatory IA* (PIA) methodologies. A key example and pioneer in PIA is the European Urban LifestYLES, SuSustainability and Integrated Environmental Assessment (ULYSSES) project (*see ULYSSES (Urban Lifestyles, Sustainability, and Integrated Environmental Assessment)*, Volume 4). ULYSSES has developed procedures allowing interfaces between expert models of environmental change on the one hand, and lay participants in focus group discussions on the other hand. ULYSSES conducted IA *focus groups*, in which selected citizens debated climate change and mitigation options, and were supported in their deliberations by access to expert information. IA

focus groups undertake group discussions conducted with citizens and guided by a moderator. The citizens are given access to computer models on complex environmental topics to support their debates. For this process, a model moderator supports them. At the end of the process, the citizens give their assessment of the problem and of policy options. The PIA methodology developed in the ULYSSES project is comprehensively described at <http://www.zit.tu-darmstadt.de/ulysses/tutorial.htm>.

ULYSSES has shown that IA focus groups can increase the possibilities for ordinary citizens to articulate their views on environmental issues in a thoughtful manner. This can help to bridge possible gaps between decisions by policy makers and citizens' views. Exploring alternative explanatory and moral frames in such processes can complement expert assessments on complex environmental issues. In particular, focus group procedures involving open-ended discussions are well suited for PIA. In PIA, the discussions can broaden into directions impossible for the researchers to imagine beforehand. This is vital if we are to learn more about how the diversity of everyday life and experience affects the understanding, values, and objectives that different social groups bring to complex environmental issues.

Analytical IA methods and PIA methods complement each other in the IA process, the one being strong where the other is weak and *vice versa*. The fruitful combination of the two approaches yields a powerful means to interface science and policy with the capacity to cope with the complexity, uncertainty and value diversity that characterize present-day environmental problems.

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