Integrative science in practice: Process perspectives from ASB, the Partnership for the Tropical Forest Margins

Thomas P. Tomich a,1,*, Dagmar W. Timmer b, Sandra J. Velarde c, Julio Alegre d, Veronika Areskoug e, David W. Cash f, Andrea Cattaneo g, Polly Ericksen h, Laxman Joshi i, Joyce Kasyoki c, Christopher Legg j, Marilina Locatelli k, Daniel Murdiyarso l, Cheryl Palm m, Roberto Porro n, Alejandro Rescia Perazzo o, Angel Salazar-Vega p, Meine van Noordwijk i, Stephan Weise q, Douglas White r

a World Agroforestry Centre (ICRAF), PO Box 30677, Nairobi 00100, Kenya
b Resourceful Solutions Consulting, Vancouver, Canada
c Universidad Nacional Agraria La Molina, Lima, Peru
d ICRAF/ASB, Nairobi, Kenya
e Swedish Biodiversity Centre (CBM), Uppsala, Sweden
f Executive Office of Environmental Affairs, Boston, MA, USA
g Organization for Economic Cooperation and Development (OECD), Paris, France
h Global Environmental Change and Food Systems (GECAFS) International Project Office, Wallingford, UK
i ICRAF Southeast Asia, Bogor, Indonesia
j IITA, Ibadan, Nigeria
k Embraer, Rondonia, Brazil
l Center for International Forestry Research (CIFOR), Bogor, Indonesia
m Earth Institute of Columbia University, Palisades, NY, USA
n CIAT/ICRAF Amazonia, Belem, Brazil
o Universidad Complutense de Madrid, Spain
p Instituto de Investigaciones de la Amazonia Peruana (IIAP), Iquitos, Peru
q IITA, Accra, Ghana
r CIAT, Cali, Colombia

Available online 16 February 2007

Abstract

ASB, the Partnership for the Tropical Forest Margins, is a decade-old, complex, multi-institutional, multi-disciplinary, multi-site research and development consortium. It has been recognized for its success in producing scientific outputs and real world impacts and as a pioneer in integrated natural resource management (iNRM). Until now, there has been little understanding of the reasons for its success in integrating different perspectives and ways of working. To fill this gap, an on-line consultation involving ASB researchers was structured following an analytical framework developed by the Initiative on Science and Technology for Sustainability. The structure of the presentation of major results presented in this article also follows that framework, which includes four dimensions of integration (disciplinary, functional, spatial/temporal, and knowledge) and linked challenges of institutional learning and adaptation, fostering appropriate participation, and managing resource and capacity constraints. To lay the foundations for interpreting these insights and to motivate the study, introductory sections present qualitative evidence regarding organizational learning within the consortium (using research hypotheses as indicators) and success in producing integrated results (using a selection of research results as evidence).

This report on ASB’s experience in integrative science and organizational learning is intended to advance understanding of the scope and limits of a complex international consortium to integrate activities across disciplines, organizations, scales and knowledge systems in order to...

* Corresponding author. Tel.: +254 20 7224139; fax: +254 20 7224001.
E-mail address: t.tomich@cgiar.org (T.P. Tomich).
1 From 2 January 2007: University of California, Davis, CA 95616, USA.

0167-8809/$ – see front matter © 2007 Published by Elsevier B.V.
produce knowledge and policy relevant outputs. ASB’s processes and structures have weaknesses as well as strengths. And while there almost certainly are a range of effective alternative approaches to integrative science, the insights from ASB’s experience documented in these online discussions could be of interest to other geographically dispersed teams, especially those working on environment and development issues. Moreover, from a methodological perspective, the use of information technology reported in this article proved to be an effective means of triangulating the perceptions of geographically dispersed researchers. In doing so, this web-based consultation provided a medium for reflection by a large ‘virtual team’ on whether words about integration are translated into practice, at least as perceived and self-reported by the scientists who participated. These techniques could be employed for process documentation by other dispersed teams, thereby adding to the stock of information on what works (and what does not) in efforts to put integrative science into practice on a significant scale.

Keywords: Tropical forest margins; Integrated Natural Resource Management; Organizational learning; Distributed research network; Sustainable development

1. Introduction

This paper explores the results, processes, and some broader implications of ‘integrative science’ from the perspective of ASB, the Partnership for the Tropical Forest Margins. ASB’s experience may be relevant to other international efforts and, in particular to DIVERSITAS’s mission to ‘promote integrative biodiversity science, linking biological, ecological and social disciplines in an effort to produce socially relevant new knowledge’ (also see Dirzo and Loreau, 2005). This paper focuses on challenges of bridging among scientific disciplines and learning within a complex research partnership.

In their seminal review, Clark et al. (2002, p. 6) conclude that the various challenges of integration within science and technology have ‘become the clarion call among advocates of sustainability science’. But, as those authors realize, such integration can be difficult to achieve. ASB has been recognized as one relatively successful pioneer in research and development on integrated natural resource management (iNRM, Fig. 1) (see CGIAR, 1999, p. xix, Barrett, 2003, p. 15, and Clark et al., 2005 for external review comments). After a brief institutional description of ASB in Section 2, Sections 3 and 4 provide two sets of evidence regarding the programme: Section 3 provides evidence that the programme has evolved (i.e. ‘learned’) and Section 4 summarizes a selection of ASB’s previously published results to support the contention that ASB has had noteworthy successes that arise from an integrative science approach. These sections are intended to motivate and set the stage for the main part of this study in Section 5: an inquiry into the organizational processes of ASB. Section 5 begins with a brief description of on-line consultation methods used by ASB to document collaborating scientists’ perceptions of these integrative processes, followed by data on those perceptions and analysis of the integration processes based on the consultation. Section 6 links the process documentation to ASB’s organizational structure, including both its governance and research structures, considering strengths and weaknesses of those mechanisms and implications regarding how ASB operates as a platform for integrative science. In conclusion, Section 7 contains some reflections drawn from the online discussion on the broader relevance of insights from the ASB experience.

2. The ASB partnership

The only global partnership devoted entirely to research on the tropical forest margins, ASB grew from formative discussions linked to the 1992 Rio Earth Summit and was launched as a systemwide programme of the Consultative Group for International Agricultural Research (CGIAR) in 1994. Today, its members include over 80 national and international research institutes, NGOs, universities, private enterprises, community organizations, and farmers’ groups. These organizations play complementary roles – providing funding, expertise, governance, coordination, and bridges to impact – in pursuing their collective goal: to raise productivity and income of rural households in the humid tropics without increasing deforestation or undermining essential environmental services.

Partner activities take place at 10 sites in the Amazon, the Congo Basin, northern Thailand, and the islands of Mindanao and Sumatra. These benchmark sites are areas (roughly 100–1000 km²) used by ASB partners for long-term study and engagement with households, communities, and policymakers. Each site is located in the tropical forest biome. This is the world’s most biologically diverse terrestrial biome and supports the livelihoods of an estimated 1.2 billion rural people.

ASB takes a balanced approach to strategic research, action, and capacity building. ASB partners recognize that deforestation has no single cause, but is the outcome of a complex web of factors that influence the landscape mosaics where environmental problems and poverty coincide at the margins of the world’s remaining tropical forests. Understanding the factors at work in a specific situation is crucial if policymakers are to introduce effective measures to curb deforestation, and do so in ways that reduce poverty. ASB

---

2 Formerly known as the Alternatives to Slash-and-Burn Programme, the name was changed to ASB, the Partnership for the Tropical Forest Margins to better convey the scope and activities of the programme.
Partners work not only with households to understand the needs of families, but consult widely with local and national policymakers. In this way, participatory research and policy analysis involving a range of actors guides the iterative process necessary to identify, develop, and implement combinations of policy, institutional, and technological options that are both relevant and workable.

In that regard, ASB’s 2005 External Review Panel (Clark et al., 2005) noted that ASB ‘has employed iNRM (integrated natural resources management) approaches to produce research-based knowledge relevant to its core mission in highly innovative, effective and efficient ways. Its problem-driven approach, anchored in needs assessments... has assured the relevance of its activities.’ Panel members also observed that ‘Independent research at these sites would have been valuable, but in the end could only have added incrementally to the mass of non-comparable natural resources management case studies...’ In the Panel’s view, what makes ASB unusually effective as a research program is that it developed standardized methods and research questions that have been applied at all sites, thereby generating data and knowledge that can be compared across sites and, indeed, across the tropics.’ The panel also noted ASB’s ability to learn and adapt in response to scientific results, lessons learned in the field, and better understanding of users’ needs that comes through participatory engagement. The Panel considered this success in functioning as a ‘dynamic learning organization’ to be one of ASB’s greatest accomplishments: ‘As effectively as any organization we know, it (ASB) has used systematic reflection on its own research and experience not only to learn better answers to its original questions, but also to learn better questions to ask.’

3. Evolution of ASB

ASB has operated as a consortium throughout its history. However, in large part driven by funding challenges, the mode of operation shifted from ‘overtly collaborative’ allocation of budgets for joint activities toward ‘facilitative’ activities across a growing number of dispersed actors (Barrett, 2003) in a loosely connected network focused on the tropical forest margins. ASB has ‘learned’ and adapted as an organization in response to scientific results, lessons of practical experience, better understanding of users’ needs that has come through participatory engagement, and our own successes and mistakes. Using prevailing scientific hypotheses as an indicator of this process at the consortium level, it can be seen that ASB has gone through at least three generations of learning.
3.1. ASB Version 1.0

Following closely on the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (and also derived from Agenda 21), the first generation of ASB could be summed up in terms of a technological optimism hypothesis: ‘Poor farmers destroy the world’s tropical forests by applying primitive slash-and-burn methods to grow foodcrops. These unsustainable techniques mine soil nutrients and, ultimately, these poor farmers must move on to clear a new patch of forest, with large negative consequences for the environment. This cycle can be broken through better soil fertility management.’

This hypothesis was rejected in the 1990s in the first phase of ASB by studies of forces driving deforestation at the various benchmark sites (reported in van Noordwijk et al., 1995; Tomich et al., 1998; Kotto-Same et al., 2000; Cattaneo, 2002; Lewis et al., 2002; White et al., 2005). From ASB studies and work by many others (e.g., Kaimowitz and Angelsen, 1998 and Geist and Lambin, 2002), it was clear that, among many other things, smallholder productivity growth alone (precisely the prescription of the initial phase) could – and typically would – accelerate tropical deforestation by making conversion to forest-derived land uses more profitable. This was named the ‘Pandora’s Box Problem’.

3.2. ASB Version 2.0

Version 2 of the ASB hypothesis, which could be termed the ‘win–win hypothesis’, elaborated the intensification process and incorporated local organizations, especially those concerned with land tenure and resource access, and national policies, including infrastructure and trade and macroeconomic policies. The notion was that the right mix of technological change, institutional innovation and policy reform at the national level could achieve development with conservation. But this win–win hypothesis was rejected by the results of the ASB tradeoffs matrix (described below) that emerged in the late 1990s (Tomich et al., 1998, 2005a,b), which revealed strong tradeoffs between local and national development objectives, on one hand, and global environmental concerns, such as habitat conservation and carbon sequestration, on the other. This phase coincided with (and benefited from) development and application of an iNRM research paradigm (Izac and Sanchez, 1998) in the CGIAR. CGIAR (1999) and Barrett (2003) noted ASB leadership and success in early application of the iNRM approach.

3.3. ASB Version 3.0

In the late 1990s, ASB partners (especially in SE Asia) initiated efforts to move beyond assessment of tradeoffs to management of conflicting interests across stakeholders and across temporal and spatial scales. In this ongoing ‘negotiation support’ era (van Noordwijk et al., 2001), ASB emphasis shifted from plots and households to landscape level analysis and an emerging focus on rewarding rural communities for environmental services that are not valued in the market (van Noordwijk et al., submitted for publication). Eight ‘win more, lose less’ hypotheses were developed for the Rainforest Challenge partnership (IUCN et al., 2002).

With the evolution of ASB hypotheses, there also has been a broadening of perceptions both of the necessary disciplinary base within the ASB consortium and also the range of stakeholders, hence potential participants and users. From the ‘technological optimism’ days, in which soil science, agronomy and other biophysical disciplines predominated, the mix of ASB scientists has steadily grown to include more ecologists, economists, geographers, and other social scientists. In parallel, the set of stakeholders has grown from an initial focus on farmers and partners in participating national agricultural and forestry research systems and universities to include policymakers at various levels, environmental NGOs and civil society groups. In each case, the process has brought in new groups – and broader potential scope – while maintaining important roles for the original participants. Broader perception of opportunities for impact was reinforced by more systematic analysis of ASB impact pathways (Liu, 2003).

4. Selected evidence of ASB’s accomplishments in integrative science

ASB’s External Review Panel concluded that ASB studies have significantly influenced the field of iNRM (Clark et al., 2005). To date, over 800 scientific publications have been produced under ASB auspices, including 224 refereed journal articles, 18 books, and 73 book chapters. Citations and links to some of the key publications and data sets are provided in Table 1 and the references section of this article includes a partial sample of additional ASB sources. The external review panel found that these ASB publications are widely cited by specialists and the full range of those particular results will not be covered here. Instead a few of these previously published findings will be mentioned briefly below, not so much as ‘results’ per se but to highlight their integrative nature.

Overall, ASB’s comparative, integrated approaches help place smallholder/indigenous land use systems within a comparative framework with other land use alternatives. This has helped to legitimate smallholder systems that, in many places, have been unjustly viewed as ‘primitive’ or ‘inferior’ to other land uses when in fact the smallholder systems often have been shown to have distinct social, economic, and environmental advantages (Michon and de Foresta, 1999). This is not a new result, but ASB’s integrated approach seems to be an effective means to convey this information (Vosti et al., 2005) and its pantropic set of benchmark sites has
placed these results in much broader perspective than previous studies (Clark et al., 2005).

These results were greatly strengthened by ASB’s comparative approach to assessment of land use alternatives, performing analyses of many of the major land uses at the various ASB sites instead of considering single land use types in isolation from alternatives. For example, ASB’s unique datasets on belowground biodiversity demonstrated that there are substantial differences among land uses with respect to the diversity and/or abundance of one or more of the groups of soil biota at the plot level. These data show a drastic decrease in the number of termite species and the elimination of soil-feeding termites as land-use intensity increases and trees are removed from the system in Indonesia; similar findings have been documented for earthworms in Brazil (Jones et al., 2003; Swift et al., 2004; Bignell et al., 2005). The availability of these data on the soil biota, together with complementary ASB data on nutrient and carbon stocks (Murdiyarso et al., 2005; Palm et al., 2002; Palm et al., 2005b) as well as profitability and labor requirements, provides information that facilitates the development of natural resource management strategies for improved productivity.

ASB research showed that a remarkably wide range of forest-derived agricultural land uses are agronomically sustainable at the plot level, meaning that these land uses can be applied in successive cycles without significant deterioration in productivity (Hairiah et al., 2005). From a broader environmental perspective, the main sustainability issues concern spatial scales larger than the plot (and particularly global environmental concerns related to the effect of natural forest conversion on globally significant habitat and on carbon stocks) (Tomich et al., 2005a, b). Obviously, the ability to produce these empirical results depends crucially on capacity to undertake research at multiple spatial scales and to draw on expertise from a range of physical, biological, and social science disciplines.

The ASB matrix has proved to be a particularly effective tool for compiling and summarizing evidence on the effects of tropical forest conversion from ASB’s comparative, multidisciplinary approach (e.g., see Vosti et al., 2005; Tomich et al., 2005a, b; and the assessment by Clark et al., 2005). The matrix includes global environmental concerns, agricultural sustainability, smallholder’s socioeconomic concerns, and policy and institutional issues. Natural forest and the land use systems that replace it are scored against different criteria that reflect the objectives of different interest groups, including global environmental concerns (carbon storage and biodiversity), national policymakers’ concerns (e.g., growth and employment), and smallholders’ concerns (such as returns to labor and land, risk, and household food security, to name just a few). To enable comparisons across sites, the systems specific to each site are broadly categorized ranging from natural forests and agroforests to crop-based systems and grasslands and pastures. ASB researchers have completed this matrix for representative benchmark sites in Sumatra (Indonesia), Cameroon, the western Brazilian Amazon, the Peruvian Amazon, and Northern Thailand (list in Table 1). At each site, ASB researchers have evaluated land use systems both as currently practiced as well as alternatives that could be possible through policy, institutional and technological innovations. (Tomich et al., 1998, 2001, 2005a, b; Gockowski et al., 2001; Vosti et al., 2001, 2003, 2005).

The ASB matrix assessments (reported in the various country reports listed in Table 1 and in many other
publications) show that the ‘forested–deforested’ dichotomy is too simplistic. While no forest-derived system is a perfect substitute for global environmental benefits of rainforest conservation, these results indicate that a remarkably wide range of smallholder land-use options are agronomically sustainable, depending upon the larger environmental and economic context. A key policy insight from this work is that these (locally) sustainable options differ significantly in environmental impacts, profitability, and adoptability by poor households. The studies in Indonesia and Cameroon, to cite but two examples, show that a ‘middle path’ of development is feasible, involving smallholder agroforests and (in some cases) community forests. Such a path could deliver an attractive balance between environmental benefits and equitable economic growth. Whether or not this balance can be achieved depends on the ability of the countries concerned to deliver a range of policy and institutional innovations, including means to effectively protect natural forests and to compensate households for foregone opportunities (summarized in Tomich et al., 2005a,b).

5. ASB process documentation: how were these results achieved?

The previous section was intended to make the case that ASB has produced some worthwhile successes that depended crucially on an integrative approach to science. We now turn to the central question of the present study: how was this integration achieved? A short – but largely unsatisfactory – response could be that ASB was designed from the beginning to involve a diverse range of disciplines, organizations, languages, functional roles, and both spatial and temporal scales. Good design certainly played an important role; but this explanation begs the question of how those intentions were converted into a programme that actually put them into practice and, indeed, has sustained those efforts for more than 12 years.

Until recently, ASB scientists have not taken much time to reflect on or attempt to document the processes that have made integrative science possible in practice. Of over 800 entries in ASBs online publications database, only a handful focus on organizational process issues (Swift and Bandy, 1995, Gottret and White, 2001; Liu, 2003; Sanchez et al., 2005, and those associated with the present study). With the ASB partnership being viewed by some as a research and development prototype, it was realized that it could be valuable to ASB and possibly to others to devote increased attention to understanding the way the consortium operates.

A prerequisite for documenting and analyzing the consortium’s processes was to identify an analytical framework with sufficient scope and flexibility to accommodate ASB’s programmatic diversity. Another even larger challenge was to identify a method to document ASB scientists’ perspectives on ASB processes and to explore areas of convergence and divergence in their views.

5.1. Analytical framework

The consultation structure employed to document processes of integration among ASB scientists was based on an analytical framework developed by the Initiative on Science and Technology for Sustainability (ISTS). This framework was derived from a wide range of case studies and included four dimensions of integration (disciplinary, functional, spatial/temporal, and knowledge) and linked challenges of institutional learning and adaptation, fostering appropriate participation, and managing resource and capacity constraints (Clark et al., 2002, Cash et al., 2003).

5.2. Participants

The consultation process was designed to share insights based on personal experience. All current and past ASB Global Steering Group members (the governing body of the global consortium), regional and national facilitators, thematic working group leaders, global coordination office staff, and other active ASB scientists were invited to participate. There were 42 participants (38%) of a potential 109, with a good balance by gender, country of origin, and length of experience with ASB where ‘veterans’ had more than 5 years experience with ASB, and ‘newcomers’ had less than 2 years experience with ASB at the time of consultation (Fig. 2).

It is important to emphasize that this exercise focused on the perceptions of scientists and was not designed to capture the full range of views of major stakeholders. Although a number of scientists who participated in the consultation also had significant experience as development practitioners and shapers of policies, the insights on scientific processes and science-policy linkages arising from this structured, qualitative consultation can not be taken in any way as representing the views of farmers or policymakers. For exploring those other stakeholder groups, their relationships, and their influence over land use change, ASB developed a separate set of instruments and questions. ASB carried out these user needs assessments in Peru, Indonesia, and Cameroon during 2003–2004 as part of its contribution to the Millennium Ecosystem Assessment (those results are reported in Tomich et al., 2005b).

5.3. Polling to test premises, establish baselines, and focus open-ended ‘virtual’ discussions

For each of the ‘challenge of integration’ topics, electronic polls were used to establish a common baseline for facilitated open-ended discussions. The polls consisted of sets of short, provocative questions to which participants were given five response options: strongly agree, agree, neither agree nor disagree/do not know, disagree,
strongly disagree. Due to cultural differences in views on appropriate means of expressing disagreement, it was emphasized to participants that while consensus is fine it also is acceptable for people to disagree as part of a learning process. Participants were free to select topics on which to focus their attention and were not expected to answer all polls or to post comments in every discussion. (See Tomich et al., 2004a for questions and tabulated responses for the polls as well as discussion of potential biases in this approach.)

5.4. Poll results and on-line discussions

This section discusses major results and resulting insights regarding four main dimensions of integration drawn from the Initiative on Science and Technology for Sustainability framework (disciplinary integration, functional integration, integration across multiple spatial and temporal scales, and knowledge integration) plus an additional dimension (North–South integration) that emerged in the on-line consultation.

5.4.1. Disciplinary integration and organizational learning

The electronic polls established some fundamental (albeit anticipated) premises. Noteworthy areas of consensus included the central role of scientific collaboration in iNRM research (Table 2, see 2.1). As expected, participants in the consultation broadly agreed that a multidisciplinary approach is an essential element of ASB’s analysis of environment-development tradeoffs (Table 2, 2.2). There also was overwhelming agreement of the value of joint field visits and benchmark sites in achieving disciplinary integration (Table 2, 2.3 and 2.4).

Open-ended discussion focused on the deeper issues underlying success in disciplinary integration. Are there ‘secret’ ingredients to ASB’s success or does success in bridging disciplines basically derive from common sense and persistence? As is widely recognized, the need to forge a ‘common language’ makes interdisciplinary work more complicated. The online consultation suggests that, at least for ASB, the key to successful interdisciplinary research may rest with clear problem definition (Table 2, 2.5) so that each discipline can contribute to the answer drawing on its own skill set without slipping into researching separate, discipline-driven questions. When exploring where the organizational discipline comes from to achieve this, participants pointed to the importance of strong but flexible leadership to keep various teams on the agreed path.

In light of broad agreement among participants on the importance of shared problem definition, it is interesting that the issue of specific scientific priorities and priority setting seems to be an important area of divergent views. Discussion of institutional learning and adaptation raised questions about whether this apparent paradox is a positive feature or a ‘bug’ in the ASB programme. More than whether ASB learns and adapts – apparently it does – the more challenging and important question is how this happens.

Essentially, it appears that ASB creates an environment where individuals learn. Participants were unanimous that this requires space for individuals to learn at different rates and to maintain conflicting opinions (Table 3, 3.1). The need for flexibility also was reflected in near unanimity that some flexibility in priority setting is needed to accommodate different views (Table 3, 3.2). In the resulting discussion, it was agreed that flexibility (balanced by rigor) can be a great asset for widely dispersed teams.

In a similar vein, the online polls and subsequent discussion also provided evidence that development and use of quantitative indicators have accelerated organizational learning and adaptation in ASB (Table 3, 3.3). The value of quantitative indicators in accelerating learning is closely linked to testing of clear research hypotheses. Provisional hypotheses, whether refuted or not, focus efforts on
producing relevant evidence and thereby stimulate learning. Here it also is worth noting an important social dimension: participants felt that continuity of commitment of lead scientists at specific sites and their involvement across sites and thematic working groups accelerates the learning process as well as promoting disciplinary integration (Table 3, 3.4; also see 3.5).

5.4.2. Functional integration: bridging across organizations

Working with multiple institutional partners and individuals within these organizations helps assure continuity of the ASB programme. Although heads of organizations may change with the political winds, numerous participants and a rich institutional network provides a stable foundation.
Moreover, collaborative advantage among organizations derives, in part, from their different institutional mandates and, hence, different skill sets among their scientists. Differences in institutional objectives and mandates also have created challenges in sustaining ASB’s partnerships. The importance of long-term commitment to integration across organizations (functional integration) emerged as a key factor during the discussion. ASB scientists were unanimous regarding the difficulties of achieving functional integration (Table 4, 4.1), although they broadly agreed (as with disciplinary integration), joint field work and shared focus on users’ needs and specific problems are important in achieving integration (Table 4, 4.2 and 4.3).

In the ensuing discussion, functional integration was identified as particularly difficult for ASB given the number of different, and in some cases incongruent, institutional

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1. There needs to be space in ASB for individuals (and institutions) to learn at different rates and to maintain conflicting opinions</strong></td>
</tr>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

**3.2. Some flexibility (and even ambiguity) in ASB priority setting has been needed to accommodate different views and opinions within the consortium**

| Strongly agree       | 5 votes (29%)                   |
| Agree                | 11 votes (65%)                   |
| Neither agree nor disagree / don’t know   | 0 votes (0%)                     |
| Disagree            | 1 votes (6%)                     |
| Strongly disagree    | 0 votes (0%)                     |

**3.3. Development and use of quantitative indicators by ASB has accelerated learning**

| Strongly agree       | 5 votes (26%)                   |
| Agree                | 13 votes (68%)                   |
| Neither agree nor disagree / don’t know   | 1 votes (5%)                     |
| Disagree            | 0 votes (0%)                     |
| Strongly disagree    | 0 votes (0%)                     |

**3.4. Long-term involvement of scientists at ASB benchmark sites and in ASB thematic working groups have been important elements of relationships that underpin institutional learning and adaptation**

| Strongly agree       | 12 votes (63%)                   |
| Agree                | 5 votes (26%)                    |
| Neither agree nor disagree / don’t know   | 2 votes (11%)                    |
| Disagree            | 0 votes (0%)                     |
| Strongly disagree    | 0 votes (0%)                     |

**3.5. Professional and personal relationships built on a shared scientific vision and problem focus have produced continuity and resilience in the scientific team**

| Strongly agree       | 7 votes (28%)                   |
| Agree                | 11 votes (44%)                   |
| Neither agree nor disagree / don’t know   | 7 votes (28%)                    |
| Disagree            | 0 votes (0%)                     |
| Strongly disagree    | 0 votes (0%)                     |

Data are from consultations with ASB scientists held November 2003–January 2004 after ASB had been operating more than 10 years. Each topic and question referred specifically to ASB. See Tomich et al. (2004a) for a full report on those consultations.
mandates involved. Indeed, while challenges of disciplinary integration receive a great deal of attention, integration across organizations may be even more difficult. Participants pointed out that developing, agreeing upon, and planning research in accordance with common priorities is not easy given the practicalities that come along with working on external, often short-term funding. But the objectives of their own organization can be difficult for individual scientists to transcend, and this needs to be taken into account in planning and implementation of activities that involve multiple organizations.

5.4.3. Spatial and temporal integration

Multiple spatial and temporal scales were built into the design of ASB from the outset. Electronic polls indicated strong consensus that intermediate scales – landscapes and watersheds – are especially important scales for iNRM research (Table 5, 5.1). On-line discussion of spatial and temporal integration revisited the initial intent of ASB design (Palm et al., 2000; Sanchez et al., 2005), considering how these approaches have played out at different ASB sites. Some provocative and strongly divergent views emerged, particularly regarding the pace of progress on spatial and temporal integration (see for example Table 5, 5.2 through 5.5). Overall, lack of clear consensus on the pace and payoffs of spatial and temporal integration – how long it takes to develop methods and produce results spanning multiple spatial and temporal scales and how valuable those results will be relative to costs – suggests that it may be too soon to assess these efforts or that participants were unclear about how appropriate comparisons could be made. More generally, there may be a need for deeper analyses of time required for and returns to spatial and temporal integration.

5.4.4. Knowledge integration: drawing on diverse sources of information

Participants felt that knowledge integration is an area where ASB has much to offer as a result of its participatory research with rural communities, experience documenting local ecological knowledge (Joshi et al., 2004a,b), and innovative work in Southeast Asia to apply techniques for documenting local knowledge to other types of knowledge, namely ‘policymakers’ knowledge’ and ‘modelers’ knowledge’.

Commitment to and perception of benefits from participatory research involving local people and scientists comes through clearly in the poll results (Table 6). Not surprisingly, the polls also established a consensus on the fundamental premises that natural resource management problems and opportunities must be addressed in collaboration with the people who are directly affected (Table 6, 6.1). Perhaps more
interesting is the unanimity among respondents that local communities can be effective research partners and broad agreement that local knowledge is an important source of information for ASB (Table 6, 6.2 and 6.3). It is widely understood among ASB scientists that the comparative analysis of major land use alternatives – particularly the ‘indigenous’ systems such as agroforests – simply would not have been possible without close engagement and good rapport with local people. In line with these views, there also was unanimity that scientists and local people can produce better solutions when they engage with each other early in the research process (Table 6, 6.4 and 6.5).

These views on participation are tempered by on-line participants’ appreciation that local people, policymakers and scientists all face serious time constraints. These time constraints are part of the reason why the greatest divergence in views during the consultation appeared in polls on participation (Table 7, compare 7.1 with 7.2, 7.3, and

---

### Table 5
Selected poll questions and results on spatial and temporal integration

<table>
<thead>
<tr>
<th>5.1. Intermediate scales – landscapes and watersheds – are important scales of analysis for natural resource management problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.2. ASB’s ‘benchmark site’ focus can be a barrier to integration across spatial scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.3. ASB’s multi-spatial scale framework required nearly 10 years to implement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.4. ASB had its most important initial successes working at the plot scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.5. ASB still had far to go in developing methods for research at landscape and watershed scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
</tr>
<tr>
<td>Agree</td>
</tr>
<tr>
<td>Neither agree nor disagree / don’t know</td>
</tr>
<tr>
<td>Disagree</td>
</tr>
<tr>
<td>Strongly disagree</td>
</tr>
</tbody>
</table>

Data are from consultations with ASB scientists held November 2003–January 2004 after ASB had been operating more than 10 years. Each topic and question referred specifically to ASB. See Tomich et al. (2004a) for a full report on those consultations.
especially 7.4), which are in line with the observation by Clark et al. (2002, p. 10) that ‘there is relatively little understanding of the tradeoffs involved in participation decisions (e.g., how increasing public participation might increase political legitimacy, but might decrease the scientific credibility of the research designed to support the decision making).’ Striking a workable balance between limited time for participation (of local people as well as scientists) and necessary interaction for true broadbased participation is a major challenge.

5.4.5. North–South integration: working in partnership around the world

Although the four dimensions of integration identified by Clark et al. (2002) proved very useful in structuring the online event, two additional aspects of integration emerged in the discussion that also need to be considered in the case of ASB. One of these is North–South (‘rich’, ‘developed’–‘poor’, ‘developing’) integration. Participants noted that differences in political power (which affects ability to influence international policy debates) and disparities in

### Table 6
Selected poll questions and results on knowledge integration

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither agree nor disagree / do not know</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1. Natural resource management problems and opportunities must be addressed in collaboration with the people who are directly affected</td>
<td>20 votes (83%)</td>
<td>4 votes (17%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
</tr>
<tr>
<td>6.2. Local communities have been effective research partners</td>
<td>12 votes (50%)</td>
<td>12 votes (50%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
</tr>
<tr>
<td>6.3. Scientists have learned from local communities</td>
<td>18 votes (75%)</td>
<td>6 votes (25%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
</tr>
<tr>
<td>6.4. To produce useful results for local people, scientists had to be engaged with local communities early in the research process</td>
<td>16 votes (67%)</td>
<td>6 votes (25%)</td>
<td>2 votes (8%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
</tr>
<tr>
<td>6.5. Working together, scientists and local people have produced better solutions to local problems than scientists working alone</td>
<td>21 votes (88%)</td>
<td>3 votes (13%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
<td>0 votes (0%)</td>
</tr>
</tbody>
</table>

Data are from consultations with ASB scientists held November 2003–January 2004 after ASB had been operating more than 10 years. Each topic and question referred specifically to ASB. See Tomich et al. (2004a) for a full report on those consultations.
wealth are not adequately covered under the existing integration categories. ASB has found it useful to explicitly recognize these North–South gaps regarding access to information (application of information technology), access to funding, and in capacities in iNRM research, but much remains to be done to close these gaps, both in the incidence of costs and benefits but also in capacity to participate in the search for solutions. Capacity of many developing country organizations to participate in development of workable interventions is constrained by relatively poor access to information and funding. There is great demand among stakeholders in the tropics for capacity building that will enable them to rise to the unconventional challenges they now face in balancing environment and development objectives. Unfortunately, ASB has faced chronic problems in raising funds and funding uncertainties have had a particularly deleterious effect on training and institutional strengthening initiatives.

6. Implications of process insights for organizational structure

As Clark et al (2002, p. 11) point out, ‘the challenge is not merely to mobilize more resources and to allocate them... but also to mobilize and allocate in a manner that fosters integration, adaptation and appropriate participation.’ Existence of an integrated ASB global agenda contributes
to uses of resources that foster integration and adaptation, which in turn, depends on organizational structures and mechanisms for governance and coordination.

ASB started with funding from a grant from the Global Environmental Facility (GEF). Work had to conform with GEF priorities, which were new to (virtually) all partners. However, even in that phase, there were extensive consultations at the national and local levels. For example, Indonesia established a national steering group (Director level representatives from Departments of Agriculture, Forestry, Transmigration, Internal Affairs) and a national committee (comprising representatives of national steering group members plus universities and NGOs). A key role of that committee was managing a process of competitive, peer review of proposals for use of global funds passed through to the national programme.

ASB’s governance meetings typically have been held in conjunction with science meetings involving other scientists in addition to members of the Global Steering Group (GSG) and also with field trips to ASB sites. So scientific discussion and testing of notions through joint field observations have been integrated with the priority setting role of the GSG. These science meetings and field experiences also play important roles in building social cohesion. And, without these professionally rewarding activities in conjunction with GSG meetings, it likely would be difficult to obtain sufficient participation to attain a quorum to make decisions.

Through the late 1990s, thematic working groups formed to implement work under the GEF grant played an important role in identifying and debating new priorities and building understanding and consensus. A distinct ‘Capacity Building’ working group in the early years was not effective. That working group was dropped and capacity building roles were incorporated within the responsibilities of global coordinator and facilitators at the regional, national, and thematic working group levels. Similarly, after some initial work to develop an approach to policy work in ASB, a distinct ‘Policy Task Force’ decided to disband itself and integrate within other working groups (e.g. on Carbon stocks, biodiversity, etc.) In this way, priority setting mechanisms for knowledge generation, action, and capacity building were integrated within themes.

Because many GSG members participated actively in thematic working groups, they already had formed a good understanding of priorities emerging from those groups when those issues were brought to the GSG for discussion. Candid discussion was possible because professional and personal relationships already were established, either in the first phase of ASB or even pre-dating ASB. These existing relationships – and the mutual respect they engendered – made possible the systematic and orderly widening of the ASB agenda after the initial GEF funding phase. For example, in Cameroon, politicians and policy makers pushed for greater emphasis on poverty reduction within the ASB national agenda. Although poverty reduction was a primary concern, the agenda still retained both elements (poverty reduction and environmental sustainability) because of the interest and awareness that developed among policymakers in Cameroon but also because this combination proved an effective way to secure funding for ASB Cameroon activities from other sources.

With decline in funds for global activities, the thematic working groups became inactive. However, a reconstituted working group called ‘Synthesis and Linkages’ played a central role in identifying new ASB strategic directions. Its meeting in Costa Rica in 1999 was a watershed event in ASB history. That meeting developed a set of three new directions (shifts from plot to landscape, from prescription to adaptive management, and from tradeoffs analysis to managing inevitable conflicts) that, in many ways, still guide the programme.

Two aspects of ASB maintained priority for and production of global public goods even after global funding declined. First, is the Global Coordination Office, which from mid-2000 explicitly had the role of global synthesis, with endorsement and monitoring of that role from the GSG and from the World Agroforestry Centre (ICRAF) management. The Global Coordination Office plays a pivotal role in communication and synthesis of global public goods (Clark et al., 2005). In addition to the global coordination office, ASB has three regional facilitators (Amazon, West/Central Africa, Southeast Asia) and six national facilitators provided by partner organizations on a voluntary basis. Each of these facilitators has many other competing responsibilities. Without funding for their time or operational costs, realizing the full potential of ASB across its national and regional consortia is impaired. The ASB GCO and the various facilitators recognize this. There are, however, few opportunities to obtain such funding.

Second, and just as important, the earlier GEF funding allowed creation of a modus operandi in which global concerns could be incorporated with local and national agendas—in effect a ‘meeting in the middle’ of top down priorities from GEF and bottom up priorities from local and national partners. By the time global funding for activities began to drop, local and national partners already perceived the value to them of elements of the global agenda. Moreover, there was a fortunate coincidence of this global agenda with local and national needs for a more integrated, multidisciplinary perspective. Recently, however, there has been growing concern regarding the extent of splitting of the global and local/national agendas. If that trend toward parallel agendas continues, ASB could lose one of its most striking advantages, which is precisely the connection between local and global.

7. Discussion

Few would dispute the observation that ‘interdisciplinary science is often promoted in words and not in practice’ (Ecology and Society Announcement, 2004). Changes in
knowledge, attitudes, perceptions, and beliefs of individuals – including collaborating scientists but also farmers, policymakers and other stakeholders – are fundamental determinants of whether such intentions become reality. Much remains to be done to develop indicators or appropriate proxies that can be used to ‘observe’ these outcomes, which are manifested when people change their minds about possibilities for and payoffs from interdisciplinary science. Challenges for future work include how to measure or even to ‘observe’ these changes in people’s ideas; and how to link these changes to research activities and outputs.

These on-line consultations among ASB scientists revealed that the major challenges of sustainability science identified by Clark et al. (2002) are interrelated in the case of ASB; this seems likely to hold in other cases too. The consultations also showed the need for additional categories of integration – North–South integration and mediation across conflicting interests – that may be especially relevant to global research networks like ASB. Success in meeting each of these integration challenges depends crucially on participation, which in turn rests on (or is limited by) human and financial resources (topics discussed in greater detail in Tomich et al., 2004a).

Certain tried and true scientific methods and principles function well in support of innovative approaches to integrative science. For example, clear problem definition derived from users’ needs emerged as a key ingredient of disciplinary, functional, spatial/temporal and knowledge integration in ASB. Sustained focus on specific sites facilitated co-location of measurements, which was essential in disciplinary integration. But participants in the ASB consultation also stressed there is an important social dimension: professional and personal relationships built through collaboration on a shared problem focus were reported to contribute continuity and resilience in ASB’s scientific teams.

ASB’s ability to incorporate new partners (at acceptable transaction costs) has facilitated adaptation as new scientific needs emerged. Furthermore, some flexibility in specific scientific priorities may be an asset for disciplinary and functional integration, perhaps because this flexibility creates space for individuals and organizations to learn at different rates. Flexibility also creates space for scientists to maintain conflicting opinions, which can facilitate learning by making possible ‘fringe experiments’ (Senge, 1990).

Despite the greater attention to challenges of ‘interdisciplinary science’, ASB’s experience suggests that integration among organizations (functional integration) can be more difficult than disciplinary integration (among teams of individual scientists). Sustaining financial and human resource sharing among organizations would appear to require special care – organizational partners (as distinct from individual scientists) will continue to participate and share their resources if they clearly see the purpose and benefits from an institutional perspective. The long-term involvement of many ASB scientists and its importance both for functional and disciplinary integration was noted in the discussion, but questions remained: how did this happen, especially since there is nothing to guarantee such commitment at the organizational level and much that would tend to interfere? This suggests that bureaucratic politics, institutional incentives, and inter-institutional political economy deserve more attention in our efforts to understand successes and failures in integration across organizations.

Boundary roles – communication, translation, mediation – are key to integration across functions (organizations) and across knowledge systems and arenas (local, civil society, policy, science) (Fig. 3). ASB’s global coordination office, with staff who understand and can translate the scientific research for different audiences, and its regional and national facilitators, play central roles in ASB’s functions

---

Fig. 3. ASB as a “boundary organization”.

---
as a ‘bridging’ or ‘boundary crossing’ organization (Guston, 2001; Liu, 2003; Clark et al., 2005).

It is perhaps obvious that dialogue and collaboration across various boundaries play key roles in the success of iNRM work. But establishing this fundamental premise led ASB participants to discuss not only how to carry out dialogue, but also with whom ASB should seek dialogue. This was linked to the poll results on functional integration, with its emphasis on bridging policy and research at various levels. Building on discussion about multi-disciplinary team leaders, a new thread emerged on the importance of ‘bridgers’. It was noted that these bridging leaders not only need to bring people together as part of a broader vision, but they also must ‘translate’ this vision for the team and outsiders to understand. Such a person does not just acknowledge and give space to other disciplinary contributions but s/he actually internalizes and incorporates ideas for different sources and viewpoints and comes up with something totally new. Questions that were raised (but unanswered) and that may be worth exploring further include the following: how can ASB or other organizations attract (and retain) involvement of its ‘bridgers’? Is ‘bridging’ innate, or something learned? Does participation in ASB and similar organizations help build individual bridging capacity? What more could ASB and organizations facing similar challenges do to nurture ‘bridgers’ and create opportunities to enhance interactions?

Acknowledgments

Funding for the on-line event in November 2003 and January 2004 was provided by the Government of the Netherlands. We also wish to acknowledge funding from the Millennium Ecosystem Assessment. Nancy White of Full Circle Associates developed the on-line environment and provided superb professional facilitation to support the virtual consultation. In addition to the coauthors of this paper, many other ASB colleagues have contributed insights over the years of this collaboration, which contributed to this article. An earlier version of this article entitled ‘The Challenges of Integration: Insights from integrated natural resource management research in the tropical forest margins by the Alternatives to Slash-and-Burn Programme’ was presented at the Millennium Ecosystem Assessment Workshop, ‘Bridging Scales and Epistemologies’, Alexandria, Egypt, 17–19 March 2004. We also are grateful for thoughtful comments from two anonymous reviewers and the editors of this special issue.

References


cepts and Models with Multiple Plant Components. CABI, Wallingford Oxfordshire UK (Chapter 2).


