Boundary Organizations, Objects, and Agents:
Linking Knowledge with Action in Agroforestry Watersheds

Report of a workshop held in Batu, Malang, East Java, Indonesia
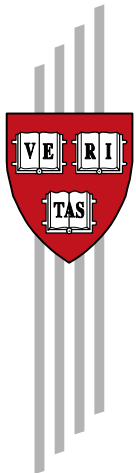26-29 July 2007

Sustainability Science Program, Kennedy School of Government,
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World Agroforestry Center – ICRAF Southeast Asia

Elizabeth C. McNie, Meine van Noordwijk, William C. Clark, Nancy M. Dickson, Niken Sakuntaladewi, Suyanto, Laxman Joshi, Beria Leimona, Kurniatun Hairiah, Noviana Khususiyah

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Abstract

On July 26–29, 2007, researchers, scholars, and practitioners convened at Brawijaya University in Malang, East Java, to share, learn about, and discuss, preliminary findings from a research project conducted by the World Agroforestry Center (ICRAF) South Asia and the Sustainability Science Program at Harvard University called, "Integrating knowledge and policy for the management of natural resources in international development: The role of boundary organizations." Scholarship in the north/west theorizes that boundary organizations, and their compliments of boundary objects, boundary work, and boundary agents, enhance the linkages between various forms of knowledge (e.g., scientific, indigenous, political) and action (e.g., policies, behavioral changes, decisions), thus increasing the usefulness of information for decisions and therefore improving outcomes. The ICRAF/Harvard research sought to explore how well these northern/western concepts apply in the challenging context of linking knowledge with action in Indonesian agroforestry problems. Specifically, they researched an ICRAF program called RUPES (Rewarding Upland Poor for Environmental Services).

The purpose of this workshop was threefold:
- The ICRAF/Harvard research team wanted to share their initial assumptions about the role of boundary organizations as understood from northern/western literature;
- The ICRAF/Harvard team wanted to learn from the expert scholars and practitioners gathered for the workshop experience in linking knowledge with action for sustainable agroforestry and watershed management based on their own experiences and research in Indonesia.
- The ICRAF/Harvard team wanted to synthesize the initial findings from their research with perspectives of the workshop attendees in order to inform the research project and thus broaden their understanding of the role of boundary organizations in sustainable development in Indonesia.

Findings from the workshop indicated that significant differences exist between northern/western notions of boundary organizations, boundary work, and boundary agents and the RUPES (Rewarding Upland Poor for Environmental Services) model. These findings suggest that future efforts to link knowledge with action for sustainable development should consider the following observations when designing their institutions and organizations to achieve desired policy objectives. What follows is a summary of the most important discoveries from the workshop.

Citation, Context, and Program Acknowledgements

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1 Overview

On July 26–29, 2007, researchers, scholars, and practitioners convened at Brawijaya University in Malang, East Java, to share, learn about, and discuss, preliminary findings from a research project conducted by the World Agroforestry Center (ICRAF) South Asia and the Sustainability Science Program at Harvard University called, "Integrating knowledge and policy for the management of natural resources in international development: The role of boundary organizations." Scholarship in the north/west theorizes that boundary organizations, and their compliments of boundary objects, boundary work, and boundary agents, enhance the linkages between various forms of knowledge (e.g., scientific, indigenous, political) and action (e.g., policies, behavioral changes, decisions), thus increasing the usefulness of information for decisions and therefore improving outcomes.

The ICRAF/Harvard research sought to explore how well these northern/western concepts apply in the challenging context of linking knowledge with action in Indonesian agroforestry problems. Specifically, they researched an ICRAF program called RUPES (Rewarding Upland Poor for Environmental Services), which develops mechanisms for rewarding the upland poor in Asia for the environmental services they provide. Specifically, the program strives to enhance the livelihoods and reduce poverty of the upland poor while supporting environmental conservation on biodiversity protection, watershed management, carbon sequestration, and landscape beauty. For example, farmers in the Sumberjaya coffee-growing region of Sumatra were rewarded with conditional land tenure in exchange for inter-planting a variety of tree species in their coffee gardens and adopting other practices to reduce erosion, counter illegal logging, and fight forest fires. The RUPES staff coordinates efforts among several partner agencies, conducts action research, and actively works to facilitate negotiations for pro-poor outcomes (van Noordwijk 2001). RUPES functions as a boundary organization and thus provides an excellent opportunity to examine how existing boundary organization literature and theory applies in a southern development context that is characterized by multiple knowledges, multiple actors, and significant power asymmetries between stakeholders. Utilizing a knowledge intensive and complex program such as RUPES offers fertile ground in which to test the ICRAF/Harvard team's hypotheses regarding the role of boundary organizations and work in linking knowledge with action in sustainable development.

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Findings from the workshop indicated that significant differences exist between northern/western notions of boundary organizations, boundary work, and boundary agents and the RUPES model. These findings suggest that future efforts to link knowledge with action for sustainable development should consider the following observations when designing institutions and organizations to achieve the desired policy objectives.

1.1 Embedded boundary agents play a key role in linking knowledge with action
In northern/western contexts, boundary organizations play central roles in linking multiple knowledges with action. Findings from the workshop, however, suggest that while boundary organizations in Indonesian agroforestry research offer logistical support and resources, the organization itself plays only *a minor role* in connecting stakeholders and linking multiple knowledges with action. Our findings suggest that boundary agents, individuals who may work for or with the boundary organization in order to link knowledge with action, play a central role in creating and sustaining relationships, building trust, communicating information needs and concerns, and bridging gaps between various stakeholder groups. Success of these agents is due largely to their being 'embedded' within the community in which the agroforestry work takes place. The key to their success lies in their ability to develop relationships based on trust and mutual respect, essential qualities in the production, dissemination, and adoption of useful of information. Workshop attendees agreed that trust is grounded in the work of these individuals more than in the organization. In some situations, stakeholders may not have even known about the boundary organization because their primary relationships were with the boundary agents. Embedded boundary agents may be people who already live in the community and possess a good degree of social capital, who then receive additional training and resources as necessary to do their job. Alternatively, they may be trained and formally educated boundary agents who posses the necessary technical knowledge but then physically move into the community in order to develop and expand their social capital over the course of several months. In either case, findings from the workshop suggest that these embedded boundary agents are essential actors in facilitating the linkages between knowledge and action for sustainable development.

1.2 Boundary work involves negotiation support more than decision support
In northern/western contexts, boundary organizations often serve in support of decision making by providing answers, alternatives, or menus of options to particular problems or questions. In Indonesia, however, the context of the problem is quite different, characterized by complex coupled human-environment problems, multiple stakeholders, significant discrepancies between power and access to resources, political marginalization, and significant history of mistrust between stakeholders. Under these circumstances, the boundary work rarely involves simply providing answers to unambiguous questions. Rather, boundary work involves identifying and clarifying the problems to address and involves negotiating the range of possible responses. Additionally, given the wide array of values and preferences among the diverse set of stakeholders, it is rare that any problem can be solved with a single or small set of alternatives. Boundary work in this context thus requires significant effort in working within and among the various stakeholder groups to arrive at mutually-defined problems, information needs, and solutions. This is not to say that scientific information played no role in the process, but rather, the boundary organization often worked on how information would be used, or could be, in order to address policy problems. In this sense, the boundary organization, and specifically the boundary agents doing the work, were able to utilize their social capital in order to build consensus through the various stakeholders—negotiating problem definitions and thus mutually beneficial solutions.

1.3 Clarifying the boundary between science and politics or policy was needed just as much as blurring the boundary
In northern/western contexts, the scientific domain and political domain are largely separate from each other, and so the primary challenge of boundary work is to blur the boundary between the two in order to create two-way communication and resources so that science and politics can co-produce more useful information that responds to the needs of society. In Indonesia, however, the boundaries between the two domains are rather blurred to begin with, and therefore pose different

challenges than those commonly found in the north/west. Many forestry and agricultural scientists work within the national ministries, and their work is often constrained by political forces that set research agendas, define problems, and have deep cultural beliefs and ideas about what constitutes forests, trees, and agriculture. Workshop findings suggest that the national research agenda would benefit through the clarification of the boundaries between science and politics, creating clear demarcations between the two domains and allowing for greater research freedom and inquiry.

1.4 Boundary organization as honest broker and convener

Although boundary agents play a key role in linking knowledge with action in sustainable agroforestry, the boundary organization also plays an important role in transferring legitimacy and credibility to boundary agents. The boundary organization does this in part because of what it is: an international research organization that is set apart from national, regional, and local politics and special interests. Stakeholders largely perceive it to be an honest broker of information, an objective party in the often lengthy and detailed process of negotiation support. By virtue of their association with the organization, boundary agents gain some of this legitimacy and credibility by proxy. In this sense, the boundary agents can tap into the organization 'brand'. For example, if a boundary agent confronts challenges to his or her own credibility or legitimacy, he or she can invoke the boundary organization's name as their sponsoring organization, thus tapping into the organization's social capital to use for him or herself. One interesting condition in the research suggests that boundary agents can utilize one of two brands: either the 'RUPES' brand or the 'ICRAF' brand depending on the circumstance and social capital needed. Boundary agents readily moved from one brand to the other in identifying their affiliation—both of which were true—but that bear different values depending on the circumstances. It is also through their legitimacy and credibly that boundary organizations can convene various stakeholders groups. Realize, however, that, despite the versatility and added credibility and legitimacy conveyed by the organization, the boundary agent is still the primary conveyance of that social capital, as discussed in the previous section.

1.5 Creating a 'safe space' for dialogue, negotiation, and decision making

As mentioned earlier, boundary agents and boundary organizations possess legitimacy and credibility that set them apart from the broader group of stakeholders involved in the policy problems. Through their established relationships based on trust and mutual respect, and their social capital, boundary agents and organizations create what workshop attendees described as 'safe spaces' in which stakeholders could convene, discuss, and negotiate problems, alternatives, and solutions. The safe space is not a physical location, however. In fact, very few meetings with stakeholders were held at the RUPES or ICRAF facilities. But rather, the safe space was based largely on the relationships between boundary agents and stakeholders, and through these trusted relationships, the various stakeholders trusted that the boundary agents had their best interest in mind and thus were willing to share their concerns and questions, learn about other stakeholders' concerns and knowledge, and work toward mutually beneficial solutions. The safe space applied to individual meetings as well as multiple stakeholder events. The point here is that it is important to acknowledge that working across cultural, political, economic, and knowledge boundaries (among others) involves risky propositions involving power, autonomy, economics, and values. Linking knowledge with action necessitates that people feel safe to share their own values, beliefs, and priorities with others. Creating safe spaces through trusted relationships facilitates this process.

1.6 Resources better focused on boundary agents, not organizations

As mentioned previously, boundary agents play an important role in linking knowledge with action by building relationships based on mutual trust and respect, negotiating problem

definitions, identifying and communicating information needs, exploring potential solutions, and implementing the solutions. While boundary agents do receive added legitimacy and credibility by proxy from the boundary organization, workshop attendees agreed that resources would be better spent on training, educating, and supporting boundary agents in lieu of creating new organizations and infrastructure to link knowledge and action.

1.7 Trust is in greatest deficit in the production and adoption of useful information
Scholarship in the north/west has indicated that information is most useful when those who use the information believe the information is salient (contextual, relevant), credible (high quality, accurate) and legitimate (that the information was produced with the users best interest in mind). Workshop attendees noted that legitimacy, particularly trust and respect between producers and users of information, is often the factor in greatest deficit for the production and adoption of useful information. The key difference between the Indonesian case and that of northern/western examples stems from the greater power, knowledge, and economic disparities that separate and marginalize some stakeholder groups. The fact that some stakeholders have so few resources means that they have to rely on outsiders for information more so than other stakeholders do. Due to their vulnerability, however, they are less likely to utilize information in the absence of strong, trustworthy, and mutually respectful relationships.

1.8 Boundary objects can be simple or complex
During the workshop, attendees identified several different boundary objects created and used by scientists and stakeholders. Some of these objects were quite simple in that they provided a rather straightforward way of communicating knowledge, values, and beliefs about a particular situation with a wider group of stakeholders. For example, RUPES created several hand-drawn 'cartoons' of particular communities with their related landscape and agroforest conditions. Although simple, this boundary object provided a way for community members to describe the problems and concerns in their community, while enabling researchers to clarify and better understand their problems. On the other hand, boundary objects can be quite complex, such as the community forest agreement (HkM) that involved significant negotiation, scientific research, and discussion. The lessons learned from the workshop indicate that practitioners should be open to creating and utilizing a wide array of boundary objects in order to link knowledge with action. One must consider the time, energy, and resources required to create a boundary object and balance concerns against the likely utility and value of the boundary object in linking knowledge in action.

2 Background information

On July 26–29, the World Agroforestry Centre (ICRAF) and Harvard University invited numerous scholars, government officials, and practitioners to participate in a workshop hosted by Brawijaya University in Malang, East Java. Scholars from ICRAF and Harvard presented preliminary findings from their collaborative research on "Integrating knowledge and policy for the management of natural resources in international development: The role of boundary organizations." This research, funded by ICRAF and the National Science Foundation, explores the role of boundary organizations, boundary work, and boundary objects in facilitating the linking of multiple forms of knowledge (e.g., local, political, scientific, etc.) with action (e.g., policies, behavioral changes, etc.). The ICRAF/Harvard team sought critical commentary regarding their hypotheses about the role of boundary organizations and boundary work in sustainable development to learn about what has worked in the experiences of gathered experts and practitioners, and to synthesize perspectives from theory and practice in order to understand the role of boundary organizations and work in sustainable development.

4

3 Purpose of the workshop

3.1 The context
Watersheds in Indonesia represent complex and interconnected systems of geography, politics, peoples, forestry governance regimes, agricultural practices, economics, communities, biodiversity, traditions, and more. Many of these watersheds are comprised of mixed agricultural and forest systems, or agroforestry systems in which inhabitants make their living from combined agricultural practices such as rice farming, with additional harvesting of a variety of forest products such as fruit, nuts, spices, latex, etc. Some agricultural and forestry practices, such as deforestation for intensive monoculture agriculture, may however have adverse effects on watersheds by causing erosion of topsoil into rivers and increased chemical loads in streams due to pesticides, fertilizers, and herbicides, thus reducing the quality of water to local and downstream users. Such unsustainable upstream practices can cause downstream problems for a variety of stakeholders including farmers, fishers, hydroelectric operators, and others. One of the central challenges of sustainable agroforestry in watersheds concerns balancing the economic and social needs of local inhabitants while maintaining the ecological and economic services that watersheds provide.

3.2 The challenge of linking knowledge with action
Implementing effective policies for sustainable development, and sustainable agroforestry, is a knowledge intensive activity (UNDP 2001; ICSU 2002). For scientists, the challenge is not simply about producing more information, but rather, it is about co-producing policy-relevant, and thus 'useful,' information for stakeholders (e.g., Tomich et al. 2004b; Cash and Buizer 2005). Previous research suggests that stakeholders consider information to be useful when they believe it has three qualities (Cash et al. 2002). First, stakeholders must believe the information is salient and contextual to the problem at hand. Scientists should consider the physical and temporal scale of the problem, local concerns and issues, political restrictions, etc. Second, stakeholders must believe the information is credible, that is, considered to be of high quality and accurate. Third, stakeholders must believe the information is legitimate, in that the information was produced with their best interest in mind, and is free from political suasion and bias (Cash et al. 2003). Consequently, the production of usable knowledge considers both content and process, thus mutual respect between producers and users of knowledge is very important (McNie 2007).

Bringing multiple knowledges to bear in decisions about sustainable agroforestry, including policy implementation and changes in stakeholder behavior in watersheds, is difficult for many reasons. First, multiple forms of knowledge exist including political (e.g., knowledge about laws and governance regimes at local, regional, and national scales); local (e.g., knowledge based on experiences and practices of agroforest inhabitants); and scientific (e.g., agroforestry science, economics, engineering, hydrological modeling, etc.) (Berkes and Folke 1998; Fischer 2000). Second, knowledge also varies by individual, across spatial and temporal scales, and by how people validate knowledge differently. Third, bearers of knowledge are often separated by differences of power, access to resources, language, location, priorities, experiences, and values (Lemos 2003).

One alternative approach to linking knowledge with action is through the use of 'boundary organizations' that carry out the work of demarcating science from non-science while simultaneously blurring the boundary between the two domains so that science and society can interact more effectively in order to bring knowledge to bear on problems of sustainable development. While the literature about boundary organizations has been well articulated in

northern/western contexts, little empirical research has been done to date on the relevance of boundary organizations in the developing world where problems of natural resource management for sustainable development are more complex and where power is less evenly distributed (Escobar 1995).

3.3 Initial assumptions about boundary work, boundary organizations, boundary objects, and boundary agents: Alternatives to link knowledge with action

What follows are descriptions of boundary work, boundary organizations, boundary objects, and boundary agents as described in the literature from the north/west. This summary of the literature provides the theoretical foundation for the research team's hypotheses regarding the role of boundary organizations and work in sustainable development. These theories are what the team sought to evaluate and extend in the research and at the workshop.

3.3.1 Boundary work

Boundary theory grew out of the social studies of science literature and has been well articulated in northern/western contexts (e.g., Gieryn 1995, 1999). Simply described, boundary theory suggests that science is not distinct from non-science through essential or transcendent characteristics, but rather they are separated by deliberate effort and 'strategic behavior' to distinguish the two domains (Guston 2001). 'Boundary work' enables scientists to demarcate their work, protecting their community from "threats to its cognitive authority from within (e.g., fraud and pseudo-science)" (Guston 2001). The concept of boundary work grew to include our understanding of "the strategic demarcation between political and scientific tasks in the advisory relationship between scientists and regulatory agencies" (Jasanoff 1990). This work finds that "the blurring of boundaries between science and politics, even though it can be threatening to important values associated with their traditional and intentional separation, can lead to more productive policy making." (Guston 2001, 399). Boundary work is often done by 'boundary organizations', by producing 'boundary objects', and through 'boundary agents', which we discuss in greater detail in the following sections. Using boundary objects and boundary organizations can mitigate the potential for "confusion, contestation and conflict" by blurring the boundary between the domains of science and politics enough to produce more effective policies, while also respecting the integrity of both domains (Guston 2001). When boundary work is performed intentionally and self-consciously, is often referred to as 'boundary management' (Cash et al. 2003; Guston 2001).

One way to think about the boundary between science and society is to think of it in terms of a cell wall. The wall of a cell in our body simultaneously keeps the contents of the cell from spilling out and other bodily fluids from flowing in, yet also allows nutrients, waste, and other 'information' to flow in both directions through the wall to the benefit of both the cell and the body. The boundary between science and society, like the cell wall, must be permeable to allow for two-way communication, negotiation between and among stakeholders, and mediation in what we call 'boundary work'. When done successfully, boundary work enables multiple knowledges and values to be shared and co-produced among stakeholders without jeopardizing the legitimacy or integrity of any one involved.

According to the literature, the most successful boundary work practices are participatory, inclusive, and bottom-up in nature, and thus one should include stakeholders in the problem identification, policy development, and implementation (McNie 2007). Two-way, iterative, and frequent communication between and among stakeholders is essential (Lemos and Morehouse 2005), and as explained in a forthcoming section, may be facilitated by a boundary agent. Since trust is an essential component of developing useful information, it is essential that processes, communication, and decision making be as transparent as possible. Additionally, scientists should

be careful not to simply 'push' their knowledge and information to stakeholders, but be willing to step back and recognize when more information is not what is needed in the process.

On a more practical level, boundary work is about the practices and processes that contribute to linking knowledge and action, and about how to produce and disseminate 'useful' information, that is, information that is salient, credible, and legitimate (Cash et al. 2003). Boundary work helps different cultures with different beliefs and ideas about what constitutes evidence to share its own knowledge and learn about other cultures' knowledge and understanding of problems. Boundary work involves clearly identifying the particular problem that needs to be resolved by conducting local needs assessments. Put simply, what is the problem we are working on? Boundary work also recognizes the importance of process by which multiple knowledges can be linked with action and outcomes. It is the 'how' by which boundary agents do their work and often how boundary objects are created.

3.3.2 Boundary organizations

As initially described by Guston (1999, 2000), boundary organizations exist at the frontier of two relatively different worlds of politics and science and possess three general characteristics. First, they have distinct lines of accountability to both sides of the boundary, that is, to both science and politics or society. Second, they encourage participation of stakeholders on both sides of the boundary and often use professionals who serve mediating roles. And third, they create opportunities and incentives to create boundary objects and 'standardized packages' (Star and Griesemer 1989) that help both sides of the boundary to pursue their interests both collaboratively and independently. A successful boundary organization manages the boundary in such a way so as to provide 'safe spaces' where politically sensitive questions and experiments can be pursued by innovative scientists who are protected. Evaluation is practiced not as a tracking mechanism for checking off completion of safe projects, but rather as a learning device for better linking knowledge with action.

Most examples of boundary organizations as described in the literature have focused on their role in comparatively simple situations of bringing scientific advice to unitary decision makers in western democratic contexts or in international governance regimes based on western models (e.g., Guston 1999; Agrawala et al. 2001; Keating 2001; Carr and Wilkinson 2005; Miller 2001). One of the earliest boundary organizations to be described in the literature was the United States Congressional Office of Technology Assessment. This organization had clear lines of dual accountability to both Democratic and Republican politicians and received funding from both parties as well. The organization provided scientific advice to politicians based on their policy needs and was perceived to be an object source of information for policy makers (Guston 2001).

3.3.3 Boundary objects

Boundary organizations can produce physical objects, 'boundary objects', that are jointly produced by experts and decision makers (Cash et al. 2003) enabling stakeholders to understand the knowledge, values, and perspectives of others (Star and Griesemer 1989). Boundary objects sit between two different social worlds, such as science and non-science, and individuals within each social world can use them for specific purposes without the boundary objects' losing their own identity (Star and Griesemer 1989). Boundary objects embody the knowledge and experiences of the people who create them, and facilitate the sharing of that knowledge with people across the numerous boundaries that separate stakeholders. In doing so they also take into account the social and political constraints of communities on both sides of the boundaries in their ability to represent information that is context-sensitive and legitimate to both worlds. Boundary objects may be created by individuals within one community as a way of sharing their world-view and knowledge with others across boundaries. More often, however, they are co-

created by groups of individuals negotiating across the boundary in order to jointly produce shared knowledge that is legitimate and credible to stakeholders on both sides of the boundary simultaneously despite widely divergent world views. Paradoxically, while boundary objects may convey undisputed facts, they may also possess multiple meanings to different stakeholders across the boundaries (Star and Griesemer 1989). This flexibility in simultaneously representing shared truths and disparate meanings represents one of the strengths of using boundary objects to facilitate linking knowledge with action. Boundary objects are permanent and durable, lasting beyond the tenure of the individuals who created them. In other words, even if the people who created the boundary object leave, move on, or later disappear, the object remains robust, understandable, and useful to others. The collaborative nature of creating boundary objects also increases the likelihood that the information produced will be salient, credible, and legitimate (Cash et al. 2003).

Examples of boundary objects are varied, for example, a patent on research. Scientists can use a patent on research results to secure priority of a discovery or for commercial gain. At the same time, however, a politician can use the patent to measure the productivity of research (Guston 1999). In some cases, entire organizations can serve as boundary objects, as did public interest organizations created by scientists in mid-century to pursue political goals while protecting scientific ones (Moore 1996). Boundary objects can include assessments, models, or maps that are jointly produced by, "make sense" to, and are used to communicate between stakeholders on both sides of the boundary being spanned. For example, a map that farmers created as part of the application process for a community forest permit for conditional land tenure in Indonesia with the assistance of ICRAF (van Noordwijk et al. 2001), or a map showing fencelines of over 6,000 parcels of land in the middle of a major wildebeest migration route in Kenya developed with the assistance of the International Livestock Research Institute (Reid et al. 2008).

3.3.4 Boundary agents
In order to get much of this work done, boundary organizations utilize professionals who are uniquely positioned to 'straddle' the multiple and varied boundaries between stakeholders, thus facilitating the linkages between knowledge and action (Guston et al. 2000). These 'boundary-spanning individuals', or 'boundary agents', help to communicate knowledge, values, and priorities; mediate between conflicting knowledge domains or problems; and translate information, whether scientific, indigenous, or whatever, to stakeholders across the boundary. One can think of the boundary agents as translators of sorts, fluent in the languages of the scientists, on one side of the boundary, and of policy makers on the other side, able to speak in the 'native' language of each group. They can also serve as travel agents, able to describe and explain to one set of stakeholders the cultural, political, and epistemic conditions and limitations of stakeholders across boundaries. While these boundary agents have less standing in the western literature than the more formal "boundary organizations", our own work in the developing world, including work on Knowledge Systems for Sustainable Development, has emphasized that it is often a single individual—together with his/her reputation, organizational affiliations, and personal agenda—that serves the role attributed to "boundary organizations" in the west (e.g., Kristjanson et al. 2007).

Working Definitions Tabled at Workshop

Boundary work: Boundary work is about the practices and processes that facilitate bringing science and society closer together in order to produce and disseminate 'useful' information, that is, information that is salient, credible and legitimate. Boundary work also ensures that each domain maintains its own authority, independence and integrity.

Boundary organizations: These organizations exist at the frontier of two relatively different worlds of politics and science and possess three general characteristics. First, they have distinct lines of accountability to both sides of the boundary, that is, to both science and politics or society. Second, they encourage participation of stakeholders on both sides of the boundary and often use professionals who serve mediating roles. And third, they create opportunities and incentives to create boundary objects that help both sides of the boundary to pursue their interests both collaboratively and independently.

Boundary objects: Boundary objects are physical objects that are jointly produced by experts and decision makers (Cash et al. 2003) enabling stakeholders to understand the knowledge, values and perspectives of others (Star and Griesemer 1989). Boundary objects embody the knowledge and experiences of the people who create them, and facilitate the sharing of that knowledge with people across the numerous boundaries that separate stakeholders.

Boundary agents: These are individuals serving much the same function as 'boundary organizations,' but at a personal level. They facilitate communicating across the boundary, translating information and mediating between the different domains.

Co-production: Boundary organizations are involved in "co-production" by facilitating collaboration between scientists and nonscientists and creating the combined scientific and social order through the generation of boundary objects (Jasanoff 1996; Latour 1987; see also Jasanoff 2004).

3.4 Intended purpose of the workshop

The workshop had three goals:

- The research team from ICRAF/Harvard wanted to discuss with the researchers and practitioners from the region their initial assumptions about the role of boundary organizations and work based on their understanding of the literature derived from western and northern sources;
- The ICRAF/Harvard team wanted to learn from local scholars and practitioners about what their own experiences and research has to say about what works in linking knowledge with action for sustainable agroforestry and watershed management;
- The ICRAF/Harvard team wanted to synthesize the initial findings from their research with that of local practitioners and scholars in order to inform their research and broaden their understanding of the role of boundary organizations and work in sustainable development in Indonesia.

Some of the questions the team sought to explore with the gathered experts included: How do you communicate your research results? As a scientist or practitioner, how do you create trust? How do you discover what your stakeholders know? How do you incorporate all forms of knowledge?

How do you identify 'boundaries' between knowledge and action, and then how do you manage them? How do you create 'useful information'?

4 Workshop findings

In this section we describe what we did in the workshop in order to evaluate the assumptions discussed in section 3. We also discuss what we learned from the gathered scholars and practitioners about what works best based on their experiences. Finally, we discuss what we learned from the workshop and outline the resulting next steps and additional questions relating to boundary organizations and work.

4.1 Workshop activities and lessons from the field
ICRAF/Harvard researchers shared their assumptions about boundary theory, boundary organizations and boundary work with workshop participants. These assumptions were presented in the previous section (3). ICRAF/Harvard researchers also presented findings from their fieldwork, including the case study from Sumberjaya (see appendix for copy of presentation). Much time, however, was spent discussing the various cases, and how well the boundary theory and boundary work matched the researchers' and practitioners' experiences in the field. Their observations are listed below under subheadings.

4.2.1 Useful information
Discussions at the workshop indicate that most participants agreed with the notion that useful information must be considered salient, credible and legitimate in the eyes of prospective users. The group observed, however, that in their experience legitimacy may be the scarcest quality, because lack of trust and power asymmetries between various stakeholders was much more extreme than in most western or northern contexts. They observed that while information can be corrected and re-worked to become more credible and relevant, legitimacy in the form of trust and mutual respect must be present in the relationships at the beginning and all the way through the process for information to be used.

4.2.2 Boundary work and boundary organizations
Discussion suggested that given the importance of trust, a lot of boundary work must consist of building relationships, that is, about creating, accumulating and utilizing social capital. The Sumberjaya case indicated that this process took months to develop social capital. Self-reflection was identified as another important consideration particularly from the scientist and practitioners' point of view. That is, scientists should critically explore whether their efforts are actually producing information that is salient, credible and legitimate, and try to assess their own role in facilitating or hindering such processes.

The ICRAF/RUPES program is an example of an organization deeply involved in boundary work and much time was spent discussing its role as such. First, it creates what can be thought of as 'safe places' for different stakeholders to convene, share knowledge and preferences, and work toward solutions. Without such 'safe spaces', the various stakeholders would be less likely to get involved and so prefer working with ICRAF/RUPES as a proxy for working directly with other stakeholders. The actual 'coming together' of multiple stakeholders rarely occurred, and if it did it occurred late in the decision-making process. As an internationally-funded research organization, RUPES is also imbued with an added level of legitimacy and is perceived to be 'above the fray' regarding local, regional or national political debates and conflict. ICRAF is also considered to be an honest broker of sorts, providing knowledge, answers, and advice that is free from any bias and is objective and credible. ICRAF/RUPES employees were able to move

between the two different identities, leveraging the social capital of the other organization if needed. For example, if conflict began to arise and RUPES was viewed less favorably, then the employees would tap into their credibility as ICRAF employees, utilizing the stored capital in the ICRAF 'brand'. The opposite was also true, in that employees would emphasize the RUPES 'brand' in order to maximize perceived legitimacy by the association with RUPES instead of ICRAF. Less important in all cases, however, was the physical presence of the organization itself. The virtual existence of the organization, its stored capital, and the safe spaces it creates were viewed as important qualities that made ICRAF/RUPES successful in supporting boundary work.

Unlike formal boundary organizations described in the northern/western literature, ICRAF/RUPES lacks "dual accountability" in which the boundary organization is accountable in direct lines to both the sponsor of research and the user of research. In reality, individuals at ICRAF/RUPES worked with multiple stakeholder groups including a wide variety of farmers; local, regional, and national elected officials; local, regional, and national level civil servants; other NGOs; power and utility companies; researchers at other institutions; and others. The question of accountability for ICRAF/RUPES, and to whom it is accountable, is difficult to articulate compared to northern/western examples reported in the literature (e.g., Guston 1999, 2000). In essence, ICRAF/RUPES has multiple accountabilities to all of the stakeholders involved. In this respect, its job is more dynamic, complex, and difficult than many cases presented in the northern/western case studies. ICRAF/RUPES has to spend significantly more time working among and between the various stakeholders to ensure accountability. Another interesting dynamic is that the donors and ICRAF's headquarters in Nairobi also place demands on ICRAF/RUPES which must also be accountable to them in a way not captured in the simpler model of dual accountability in the north/west.

Another interesting difference between boundary organizations in the north/west and in Indonesia relates to the central purpose of these organizations. One of the primary goals of boundary organizations is to manage the boundary between science and non-science, and much of this work requires the blurring of boundaries to soften the hard boundaries, and thus disconnection, between the two worlds. Discussions at the workshop, however, indicated that the relationship between science and politics or policy in Indonesia is characterized by opposite conditions than in the west: the boundary between the two domains is often too blurred to begin with. For example, workshop attendees discussed the challenges that arise in the context of research conducted in the Indonesian Ministry of Forestry. This research can be constrained by existing national policies, politics, personal preferences, definitions, or beliefs about forests and trees, and thus the research conducted often reinforces pre-existing notions about agroforestry, thus prematurely circumscribing research and policy agendas. This lack of autonomy and demarcation between science and politics can limit the production of useful information, the development of policy options, and the exploration of responses that could promote sustainable development in agroforestry. Rather than blur the boundary, clarification between science and politics requires clarifying and strengthening the boundary between the two domains.

4.2.3 Boundary objects
During the workshop the group discussed several cases and examples of boundary objects in order to improve our understanding of their production and use. One example of a rather simple boundary object that the group discussed was a map that farmers had to create as part of the application process for the Community Forest Permit (Hutan KeMasyarakatan, or HKm) in the Sumberjaya district of West Lampung, Sumatra (see appendix 6). Farmers worked together to create the map using GPS and GIS technologies supplied by PPL (Regional Forestry Extension Agents). The mapmaking process created some minor conflict among the farmers because in clarifying their group boundaries, they were required to mediate and thus clarify their individual

claims within the group. Scientifically speaking, the mapmaking process produced precise measurements and representations of the farmers' coffee gardens within protection forests. The map is a boundary object in that it essentially conveys the farmer's knowledge about their land claims and land use to government officials in a language and manner that they can understand. Moreover, the map carries with it inherent qualities of legitimacy because of how it was produced, measured, recorded, etc., thus enabling the government to use the map in policy processes. In the case of the HKm, the map was an essential boundary object for processing the farmer groups' applications for conditional land tenure. Characteristically, the map is durable, transferable and lasts beyond the efforts of any one individual.

A more complex example of a boundary object is the HKm contract itself. Some background information clarifies the importance of this boundary object. Historically, the government's initial concern over the farmers' use of protection forestland was two-fold. First, the farmers' tenure on the land was illegal, and second, the purpose of the protection forest was to protect watersheds, maintaining both the quality and quantity of water upstream for downstream users. Fundamental to the government's beliefs was the notion that farmers and their coffee gardens undermine forest protection functions and harm the watersheds through deforestation and poor agricultural practices. The government had additional concerns including illegal logging and lack of adequate forest fire fighting and prevention capacity. Underlying the need for the HKm was a history between government and farmers that was rife with conflict. As recently as the mid 1990's government soldiers evicted thousands of farmers from forest protection lands, destroying their coffee trees just weeks before harvest. Mistrust between the government and farmers ran deep prior to efforts to produce the HKm. The production of the HKm, therefore, not only had to overcome historical distrust and antagonism, but also had to respond to particular needs. In exchange for provisional land tenure, farmers living on protection forest lands would plant additional trees in their coffee gardens, contribute to the fight over illegal logging, and help to mitigate forest fires. The central question of this contract was this: what type of trees, and how many, had to be planted in the farmers' coffee gardens in order to achieve the government's goals of protecting watersheds without compromising the farmers' own goals of not harming their ability to make a living growing coffee?

The HKm contract was a boundary object, jointly created with input, negotiation and mediation between and among scientists, government officials and farmers. Initially, the government requested that farmers plant about 1000 timber trees/ha in their coffee gardens. Underlying this requirement was the government's belief that coffee trees were essentially 'not' trees and thus contributed to the deterioration of watersheds. Farmers, however, believed that 1000 timber trees/ha would crowd out their coffee and create too much shade. Additionally, they wanted to plant more fruit and nut trees to enhance their income in between coffee harvests. ICRAF, as a boundary organization, contributed to this process in two ways. First, by identifying the concerns, priorities and beliefs of both government officials and farmers; second, by conducting or reporting research to revolve key disputed issues. In so doing, they were able to conduct research that addressed some of these concerns, translate scientific information, and facilitate the demonstration of scientific knowledge. For example, research at ICRAF determined that coffee trees do provide benefits in stabilizing and protecting watersheds, and that many fruit tree species can also provide watershed protection functions. Additionally, ICRAF responded to farmers' concerns about the number of infill trees required by the government by communicating with the farmers, and demonstrating through shade-grown coffee gardens that shade is not inherently bad for coffee. ICRAF's efforts brought scientific knowledge to bear in the HKm development process in a way that also recognized and included the farmers' local knowledge and values, as well as government officials' understanding and priorities. Ultimately, the HKm required that farmers plant 400 trees/ha and allowed up to 40% fruit and nut bearing trees rather than 100%

timber species. While some disputes over details still remain, the HKm is a good example of a useful boundary object that was jointly produced by ICRAF scientists, farmers, forest extension officers, and government officials and that led to new actions and changed behaviors by farmers and the government. The scientific, local and political knowledge embodied in the document has legitimacy among all of the stakeholders.

Another interesting characteristic of boundary objects is that they can embody multiple meanings to different people without sacrificing its central purpose. For example, while the different stakeholders involved in the development of the HKm agree on the information captured in the contract, the HKm caries different meaning to the stakeholders. To the farmers, the HKm represents legitimacy, security and hope for the future. The creation of the map, representing a concrete expression of their claims to the land, as well as the HKm, conveyed their values, hopes and knowledge to others. For government officials, the HKm means that farmers can be partners in watershed protection, helping to improve conservation, prevent illegal logging and fight forest fires.

Workshop attendees also spent time discussing their various experiences in linking knowledge with action in Indonesian watersheds, and identified those attributes they believed to be important in creating useful boundary objects. They suggested that boundary objects should:
- Be clearly defined and created with the goal of contributing to solving a problem
- Or they can be used to clarify understanding about a problem
- Be flexible and response to change
- Be jointly created, but it is not necessary to do so in all cases
- A good boundary object helps to define or clarify rules of engagement
- They can assist in the development of rules of engagement for decision making
- Boundary objects should not violate law
- They can be used to report outcomes
- Lead to an open mind, open solution
- Look for windows of opportunity (policy windows) in which to create the objects, and explore how to make them sustainable and adaptable in long term

While this list is not intended to be exhaustive, it complements the boundary object literature as described in the north/west.

4.2.4 Boundary agents
Given the extent of mistrust and power asymmetries between stakeholders, in ways often much more amplified than in northern/western examples, the group identified the development of trust and mutual respect as a key function of boundary work, and particularly of boundary agents. Underlying their efforts to communicate, translate information and mediate conflict is the absolute need for stakeholders on all sides of the boundaries to trust the boundary agents, and believe that they are acting in the stakeholders' best interests. Thus the development, accumulation, and use of social capital to perform their work are absolutely essential for boundary agents to succeed in linking knowledge with action. Boundary agents must also possess a degree of self-reflection in order recognize how their actions affect stakeholders, and then be able to adjust their work and adapt to changing relationships, problems and landscapes.

Successful boundary agents are rarely 'discovered' with all of these particular attributes in place, but rather, as indicated by cases presented in the workshop, potential boundary agents are identified and often trained and equipped in such a way as to compensate for their shortcomings in other areas. For example, in one case, ICRAF identified a few PPLs (Regional Forestry Extension Agents) early on who were interested in facilitating the development of the HKm and

participating in the RUPES program. ICRAF determined that these few individuals already had a great deal of social capital and trust accumulated within the Sumberjaya coffee-farmer community, and thus could serve as boundary agents, yet these PPL agents lacked understanding of some important concepts, and lacked equipment and resources necessary to carry out the work. ICRAF provided training in the use of GPS, GIS, some agricultural science, and finally outfitted the agents with computer equipment and money for transportation. ICRAF tapped into the existing social capital that these agents had built over the years, but in recognizing their shortcomings they also provided intellectual, electronic and financial capital to improve their ability to bridge boundaries with credibility and legitimacy. ICRAF efforts to develop the PPL boundary agents enabled them to communicate, mediate, and translate issues and information across multiple boundaries.

In another case, however, ICRAF did not necessarily have potential agents with established social capital at their disposal. They did, however, have access to college graduates with training in forestry, agriculture and development. They already had the knowledge and equipment that the PPL agents lacked, but unlike the PPL agents they were not known or trusted by the communities with whom they would work. The solution was to 'embed' these potential agents within the communities in order to develop social capital and trust over time. Each of the five ICRAF (and NGO partners) employees moved into a single village for five days each week over six months. The agents developed relationships with the farmers and eventually their trust, while simultaneously conducting needs assessments and trainings in meeting facilitation. Additionally, these boundary agents often were of the same ethnic group, speaking the same language as the farmers, and while not necessarily farmers themselves, at least had some common cultural experiences between them. In addition to boundary agents, so called 'local champions' can be identified and drafted into the process of linking knowledge to action. Local champions often possess a high degree of social capital and act as policy advocates, conveners and liaisons— boundary agents of sorts but with less formalized connections between and among stakeholders. The more they advocate for a particular course of action, however, the less likely they are to be trusted by stakeholders across boundaries.

5 Synthesis: What we learned

Based on the discussions and findings from the workshop, we can draw several conclusions about the role of boundary organizations, boundary objects, and boundary agents in agroforestry research and policy in watersheds, including:

- In many respects, trusted individuals, particularly embedded boundary agents, possess greater influence and thus carry more importance in linking knowledge to action than a boundary organization such as ICRAF.
- The most trusted individual boundary agents are those who have had the most extensive periods of work and relationships with stakeholders on all sides of the boundaries, suggesting that 'embedded' boundary agents constitute a useful approach to doing boundary work.
- ICRAF's greatest value as a boundary organization came in its ability to convene stakeholders, and to enhance the credibility of boundary agents because of their association with ICRAF or RUPES. In this sense, ICRAF and RUPES thus had value as a 'brand' of sorts, in that its reputation as an honest broker could be proxied to individual agents at times in which their own credibility or legitimacy may have been questioned.

- The process of linking multiple knowledges with action appears to be more successful when 'safe spaces' exist in which stakeholders can explore and evaluate their own, and others, knowledge and understanding about the problem. The safe space is not necessarily a physical location such as a building, but is rather a relational space between and among stakeholders that is grounded in trust and mutual respect. Boundary agents play a critical role in creating these safe spaces, but boundary objects and boundary organizations can also contribute to the safe spaces.
- Some scientists and practitioners face significant institutional barriers to conducting boundary work, up to and including prohibition of working to solve real-world problems. Scientists committed to linking their scientific knowledge with action find ways around these barriers and continue to do their work.
- Boundary organizations and boundary work occurs in rather flat organizational hierarchies, in which individuals in the organization and boundary agents act with a degree of independence, thus allowing them to remain nimble, adapting to the evolving context of the problem in which they are working.
- Our field trip during the workshop identified the challenges and opportunities that certain rules and institutional constraints can create. In one area, for example, Ministry of Forestry rules prevented the planting of a particular tree species that was preferred by local farmers. Rather than attempt to change the policy, the farmers accepted the ruling and never approached the Ministry about their desire to plant a different species. Other farmer groups, however, worked hard over several years to overcome such institutional barriers in order to develop a more sustainable agroforest landscape.

The workshop also uncovered many questions about boundary organizations, objects, agents and work that include:
- Regarding the nature of boundary objects, workshop participants began to explore more deeply the nature of boundary objects, asking whether they are means to an end or whether they are the end. In other words, do boundary objects move the process forward toward a desired outcome, or do they become 'answers' in themselves. The group found examples of both, but believes it is worth exploring at what point boundary objects are more 'useful' in linking knowledge with action.
- Another issue worth exploring more relates to the contrast between northern/western boundaries between science and politics and the same boundaries in Indonesia. Whereas the challenge of boundary work in the north/west is to find ways to enhance linkages between science and politics, the challenge in Indonesia appears to be the antithesis, that is, to find ways to separate and thus clarify the relationship between science and politics. How does this need affect the challenges of linking knowledge to action in Indonesia?
- In Javanese culture, meetings tend to be more ritualistic and formalized and thus a lot of work tends to get done in face-to-face activities. How does this influence the choices of boundary work?

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Appendices

Appendices are posted to
http://www.cid.harvard.edu/sustsci/events/workshops/07boundary/program_and_presentation_slides.html

1. Workshop background material
Boundary objects and agents, linking knowledge to action in agroforestry watersheds (070725, Meine van Noordwijk)

The conceptual foundations of boundary organizations (060201, excerpt from NSF proposal, Integrating knowledge and policy for the management of natural resources in international development: The role of boundary organizations; W. Clark, D. Guston, and M. van Noordwijk)

2. Workshop participant list

3. Workshop presentations
Boundary objects and agents, linking knowledge to action in agroforestry watersheds (070727, Meine van Noordwijk)

Exploring and Developing Reward Mechanisms for Upland Farmers for Watershed Functions in Sumberjaya (070727, Noviana Khususiyah and Suyanto)

How boundary agent change over time and space (070727, Daniel Murdiyarso)

Knowledge (070729, Elizabeth McNie)

Boundaries reconsidered (070729, William Clark)

4. Background reports
Environmental Service Pay Principles for Conservation in The Brantas River Basin (070727, English)

The Scheme Activity of The National Movement Partnership to Save the Water (Gn-Kpa) in Upper Brantas (070728, English)

Skema Kegiatan Dalam Rangka Gerakan Nasional Kemitraan Penyelamatan Air (Gn-Kpa) Di Wilayah Das Brantas Hulu (070721, Bahasa)

Upper - Lower Transaction Mechanism for Conservation in The Brantas River Basin (070725, English)

Gerakan Nasional Kemitraan Penyelamatan Air (GN-KPA) (070721, English)

Gerakan Nasional Kemitraan Penyelamatan Air (GN-KPA) (070721, Bahasa)

Summary of Watershed Preserve and Conservation by Jasa Tirta I Public Corporation (January 2005–June 2007) (070726, Bahasa)

Sediment and Erosion in Kali Konto River (070727, English)

Rekapitulasi Kegiatan Perlindungan DAS dan Penyuluhan Perum Jasa Tirta I
(Periode Tahun Januari 2005 s/d Juni 2007) (070717, English)

Tinjauan Hidrologi Dan Sedimentasi Das Kali Brantas Hulu (060313, Bahasa)

Watershed Preservation and Conservation Activities in 2006 (070726, English)

A5. Field trip guide to Kali Konto Watersheds (070726)

A6. Example of a Boundary object: Map farmers created as part of the application process for the Community Forest Permit in Sumberjaya district, Sumatra, Indonesia

Boundary objects and agents, linking knowledge to action in agroforestry watersheds

Brainstormshop 26-29 July 2007, Malang/Batu/Kali Konto

Background

Agroforestry in watersheds is constrained by many boundaries. First of all, the world of foresters and forestry is still quite separate from the world of farmers – 30 years of 'agroforestry' has not changed much on the formal side, though it has produced credible science and local reconciliation of former conflicts.

Secondly, watersheds literally indicate boundaries that decide which way water flows; figuratively, they mark transitions, or 'paradigm shifts', for example in the way formal government, private sector and local communities deal with their common and differentiated interests.
Recently, new paradigms to resolve conflicts over land have emerged, that can lead to improvements on both local livelihoods and conservation. In this era of 'integrated water resource management', the words 'participatory' and 'stakeholders' are used a lot -- but how far have we moved towards accepting 'multiple ways of knowing' and 'negotiations among equals'?

Linking knowledge to action is a challenge at many different scales: from the debate on global climate change to the issues of what type of land use is compatible with 'watershed functions'. Scientists have new findings and theories, stakeholders have fears, concerns and preferences, and policymakers may be 'in denial' or slowly coming to grips with the need for change.

To link 'knowledge to action' one needs to bridge or cross boundaries between the land of knowledge and the land of action, accepting the different rules of the game of either side. The theory of this 'boundary crossing' has primarily been developed on the basis of 'global science' and 'national/ global policy' in the context of climate change. Many of the concepts probably also apply at the 'multistakeholder, multiple knowledge' case of agroforestry in upper watersheds – but this has not been documented and analyzed as yet. We'll set out to do it now.

In the context of a cooperation project between the World Agroforestry Centre (ICRAF) and Harvard University, we will invite a number of 'boundary agents' to jointly reflect on what the experience so far tells us that works in an Indonesian context, what certainly does not, and what new ways might be worth exploring. Brawijaya University (Malang) will host the meeting, as they are actively engaged in 'boundary work' in the context of watershed management, and want to prepare next generations of 'boundary agents' through teaching methods and learning experiences that provide understanding, skills and motivation to link knowledge to action in rural development.
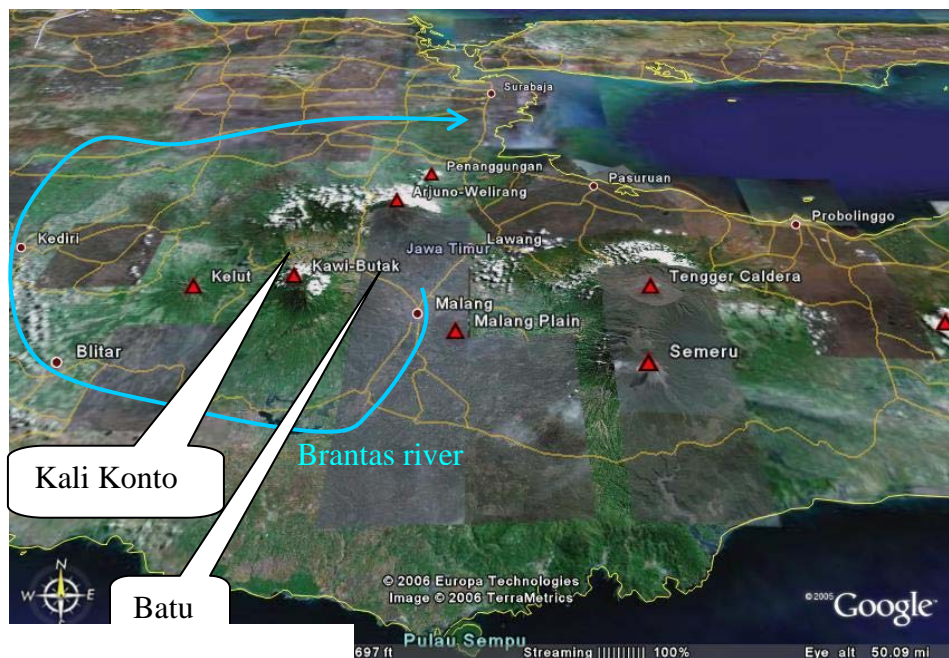
Participants:

Multiple knowledge:	Institutions and negotiation support:	Policy change and action:
Kurniatun Hairiah -- UniBraw Didik Suprayogo - UniBraw Rizaldi Boer -- IPB Fahmuddin Agus – AARD Daniel Murdiyarso-- CIFOR Laxman Joshi -- ICRAF Rudi Harto Widodo -- ICRAF Pornwilai Saipothong –ICRAF	Helmi – Andalas Satyawan Sunito -- IPB Anjali Bhat – ZEF Bustanul Arifin – UniLa Widianto -- UniBraw Suyanto -- ICRAF Gamma Galudra -- ICRAF Noviana Khususniah - ICRAF	Upik Rosalina -- Perhutani Niken Sakuntaladewi –MoF/ICRAF Wisnu Prastowo - MoF Iman Santoso – FORDA (MoF) Hartono – MoF Sukistijono – Jasa Tirta Harry – DFID Budi Afiudin (TAHURA R Suryo) Agus (Administratur KPH, Malang) Arif Lukman Hakim – ESP
Boundary organization theory: William Clark (Harvard), Elisabeth McNie (Harvard), Meine van Noordwijk (ICRAF)		

Expectations for output

1. Watershed Negotiation Support guideline (as next step to Rapid Hydrological Appraisal) – basic materials + case studies to be included
2. Multi-authored manuscript on application of 'boundary organizations' concepts
3. Reflection on/planning for teaching approaches and learning opportunities for universities

Location

Meeting venue:
Royal Orchids Garden Hotel & Condominiums
Jl. Indragiri 4, Batu – Malang
Phone: (62–341) 593083 – 86
Fax: (62–341) 591064
Website: www.royalorchidsgarden.com

Outline of program
Thursday 26 July 2007
Out-of-town participants arrive on the Jakarta – Malang flight SJ 248 at 13.00
Optional brief stop at Brawijaya University on the way to Batu
Check in to hotel in Batu
Evening (19.30 – 20.30): Introductions, framing of the issues

Friday **27 July**
Morning (8.30 – 11.30): Case studies dissected
Afternoon (13.30 – 17.00): Boundary objects identified

Saturday **28 July**
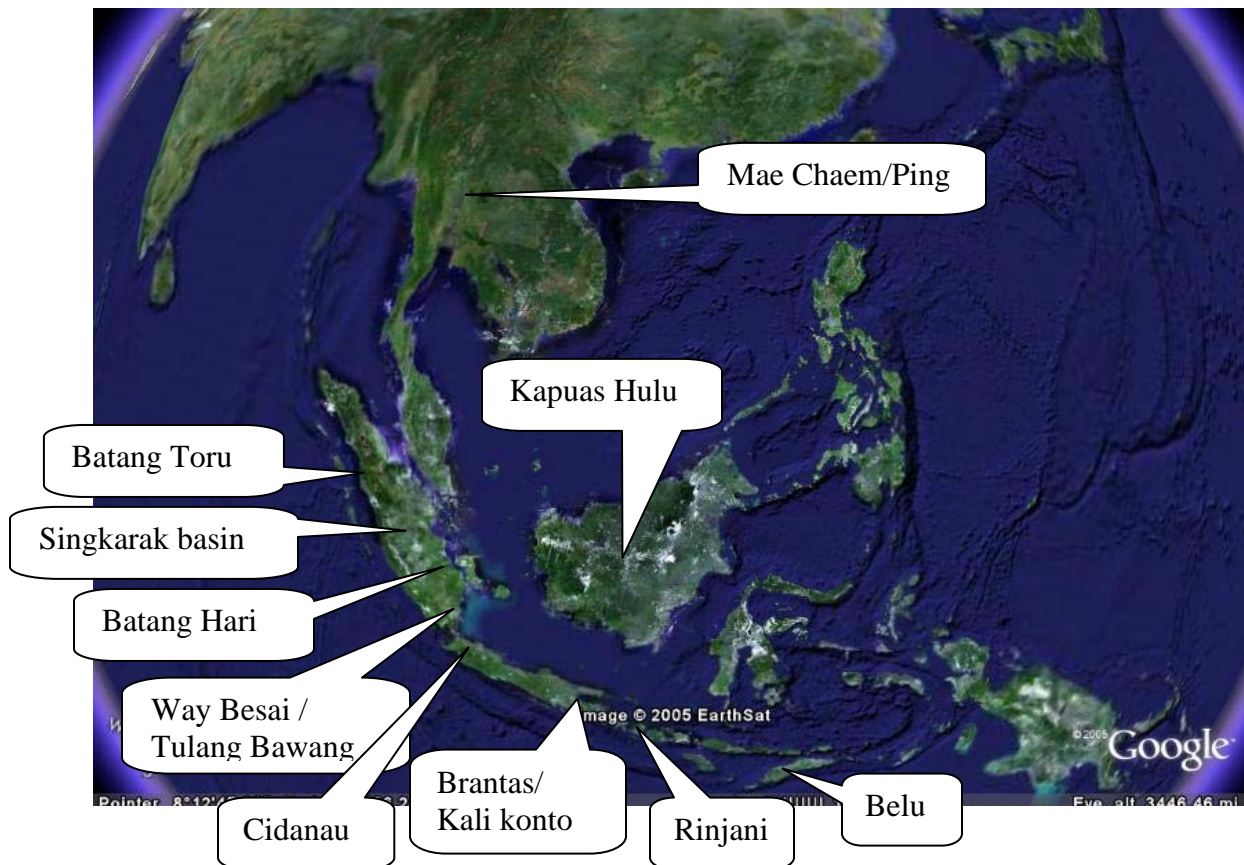7.00 – 15.00 Field visit to Kali Konto organized by Brawijaya University
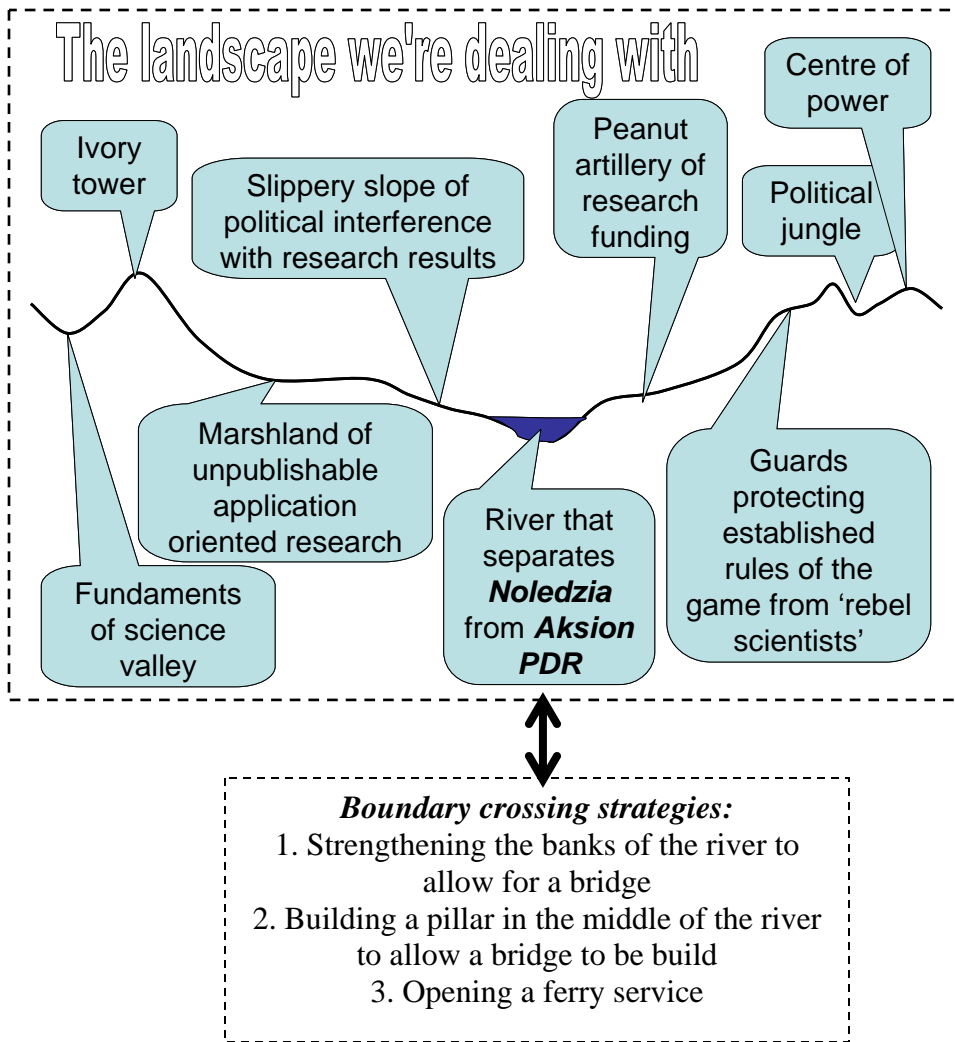19.30 – 20.30: Lessons learnt

Sunday **29 July – workshop ends with an early lunch:**
8.00 – 11.30 What works, what does **not**, what do we **need** to learn to become more effective

Some participants return to Jakarta by SJ 249 at 15.00

Watershed 'cases' known to participants include:

Linking knowledge to action (K2A) in integrated natural resource management: boundaries to be crossed, roles, institutions, methods and strategies

Ivory tower academics.
No action, talk only
Oooh, itu proyek…

We have many expressions for the lack of effective linkage of knowledge to action. Yet, the challenges of sustainable development will require the best brains, cutting edge techniques and multi-stakeholder commitments. What will be the incentives for policymakers to pay more attention to 'knowledge'? What forms of knowledge are most likely to contribute to change? Will 'science' (here interpreted as the pursuit of knowledge of any kind) have to change? Or only the scientists? These are some of the questions that research organizations that want to support development and policy reform ask. These also are some of the questions the universities struggle with when they design their curricula and create the learning opportunities for the next generation of students. Can a new '*sustainagility*' science emerge?

> ➤ Part of the answer is in the *type* of knowledge we pursue
>
> ➤ Another part is in how we go about *setting the agenda* and enhancing shared understanding among multiple stakeholders with different interests and resources
>
> ➤ Another part is in the type of *outputs* that we aim for: some of these may become 'boundary objects' that actually help stakeholders in their actions and negotiations

Types of knowledge
We have two classifications: 1) who holds the knowledge (local actors, the general public or policymakers, or modelers/scientists: the LEK/PEK/MEK triangle of Figure 1), and 2) what is the knowledge about. At least five types of 'knowledge' have to be combined before 'action'
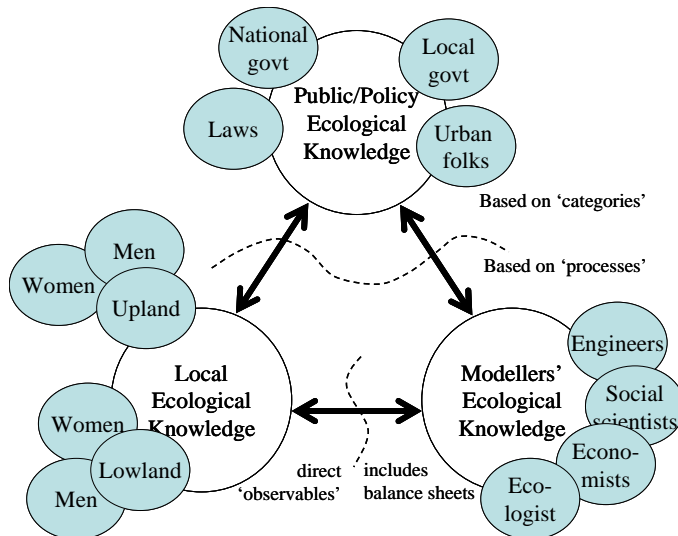

Figure 1. The LEK/PEK/MEK triangle of local, public and modellers' ecological knowledge

can be expected (Fig. 2). The left site of Figure 2 is the subject of biophysical, geographical and economic types of science, while the right hand side relates to social and political sciences. All, however, depend on an emotional basis of 'caring for the issue' that is usually the primary target of publicity and educational campaigns, but that 'objective' science tries to ignore.
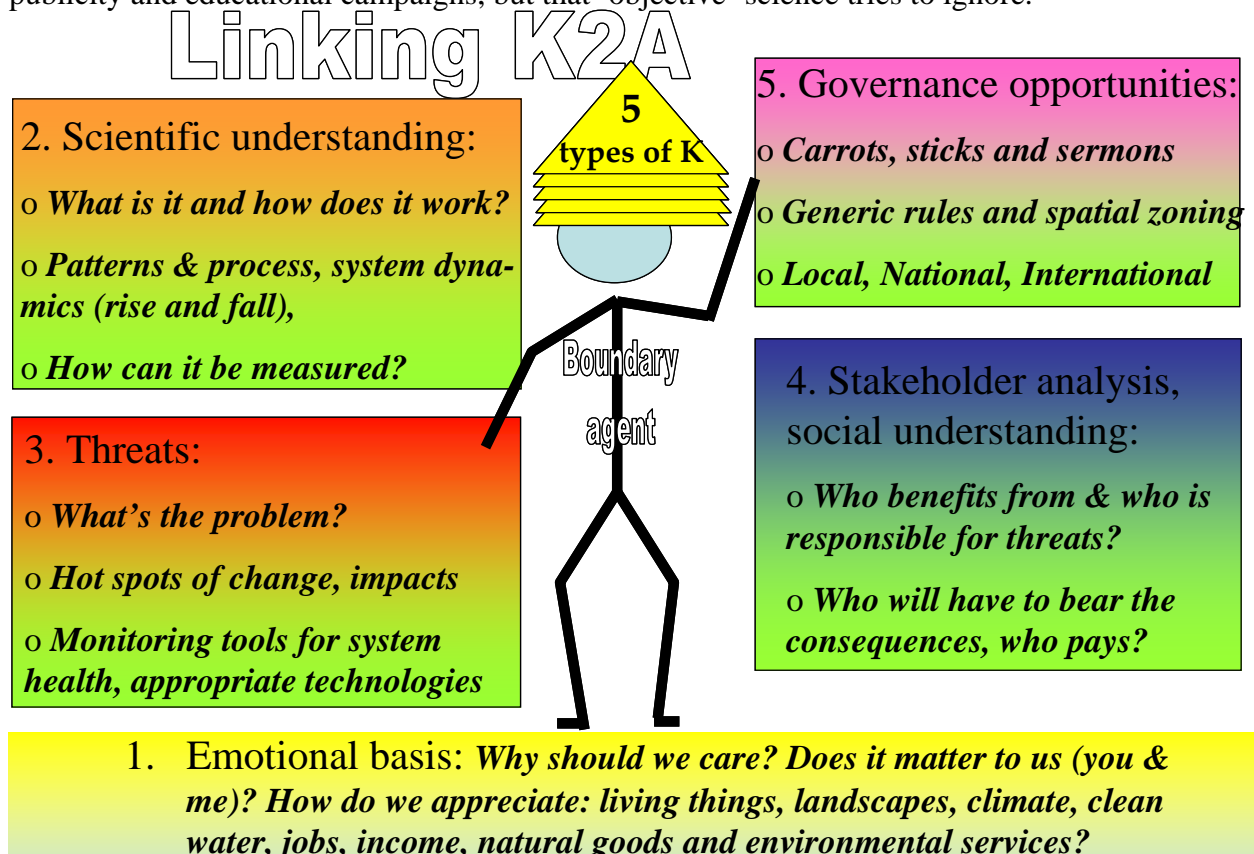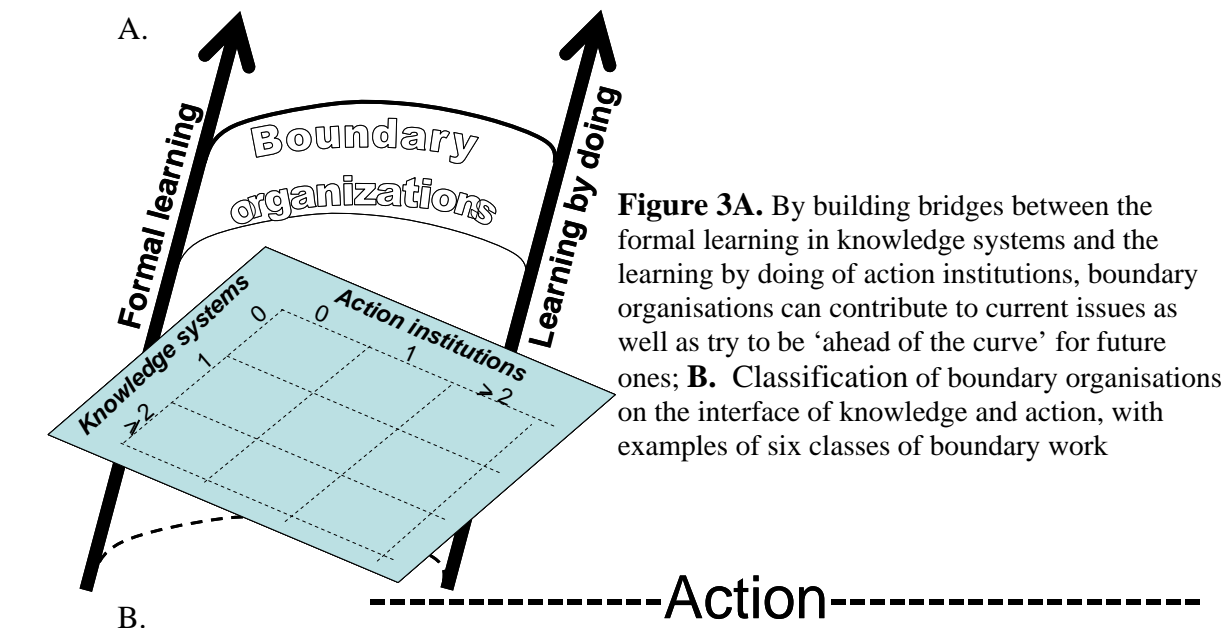
Linking K2A

5 types of K

2. Scientific understanding:

o *What is it and how does it work?*

o *Patterns & process, system dynamics (rise and fall),*

o *How can it be measured?*

3. Threats:

o *What's the problem?*

o *Hot spots of change, impacts*

o *Monitoring tools for system health, appropriate technologies*

Boundary agent

5. Governance opportunities:

o *Carrots, sticks and sermons*

o *Generic rules and spatial zoning*

o *Local, National, International*

4. Stakeholder analysis, social understanding:

o *Who benefits from & who is responsible for threats?*

o *Who will have to bear the consequences, who pays?*

1. Emotional basis: *Why should we care? Does it matter to us (you & me)? How do we appreciate: living things, landscapes, climate, clean water, jobs, income, natural goods and environmental services?*

Figure 2. Five types of knowledge (that can be held in different forms by the stakeholder groups identified in Figure 1)

Agenda setting

Salience, credibility and legitimacy have been identified as three important criteria for research organizations that aim for impact on sustainable development. *Salience* indicates the impact potential ('is this the right type of question, could an answer to this make a real difference?'). *Credibility* ('is this the right way to do it?') refers to the more traditional academic standards of quality of methods, peer review of results and track records of researchers and their institutions. *Legitimacy* ('are we the right people to do this?') is forward looking toward the application of results: if all relevant stakeholders have been involved in identifying the questions and commenting on the approach, they are more likely to be interested in the output, and may turn knowledge 'outputs' into action 'outcomes'.

Boundary crossing

The concept of 'boundary crossing' organizations has first been formulated in the science <> policy interaction on the issue of climate change, with the IPCC as one of the main interfaces. But similar approaches are needed (and have evolved) where other types of 'knowledge' and 'action' are involved. Figure 3 presents a simple classification based on the number of types of knowledge and action that is involved – with the 'many types of knowledge, many types of actor' probably being the most common cases, and the others derived as simplification.

A.

Boundary organizations

Formal learning

Learning by doing

Knowledge systems

Action institutions

0 0
1 1
≥2 ≥2

Figure 3A. By building bridges between the formal learning in knowledge systems and the learning by doing of action institutions, boundary organisations can contribute to current issues as well as try to be 'ahead of the curve' for future ones; **B.** Classification of boundary organisations on the interface of knowledge and action, with examples of six classes of boundary work

-------------Action-------------------

B.

----Knowledge----

	0. None	1. Decision	≥2 Collective action
0. Conjecture & ignorance	*Daily life of U&Me* ☺	A (ignorant decisions)	**0** $A_1 \Leftrightarrow A_2$ (ignorant politics)
1. One truth	K (science, Knowledge for own sake)	**II** $K \Leftrightarrow A$ (Technology Transfer; Scientific policy advice such as IPCC; Decision Support Systems - DSS)	**III** A_1 $K \Leftrightarrow \Updownarrow$ A_2 (Joint fact-finding)
≥2 Multiple ways of knowing	$K_1 \Leftrightarrow K_2$ **I** (Interdisciplinarity, tacit + scientific knowledge)	K_1 **IV** $\Updownarrow \Leftrightarrow A$ K_2 (Integrated Assessments such as MEA)	K_1 A_1 **V** $\Updownarrow \Leftrightarrow \Updownarrow$ K_2 A_2 (Negotiation Support Systems - NSS, RUPES)

Negotiation support systems

In the ICRAF work in Indonesia, the concept of Negotiation Support Systems was first formulated and has gained prominence with the Sumberjaya site (W. Lampung) as the first test of how serious conflicts over land, forest and water between local farmers and various layers of government can be transformed into productive agreements.
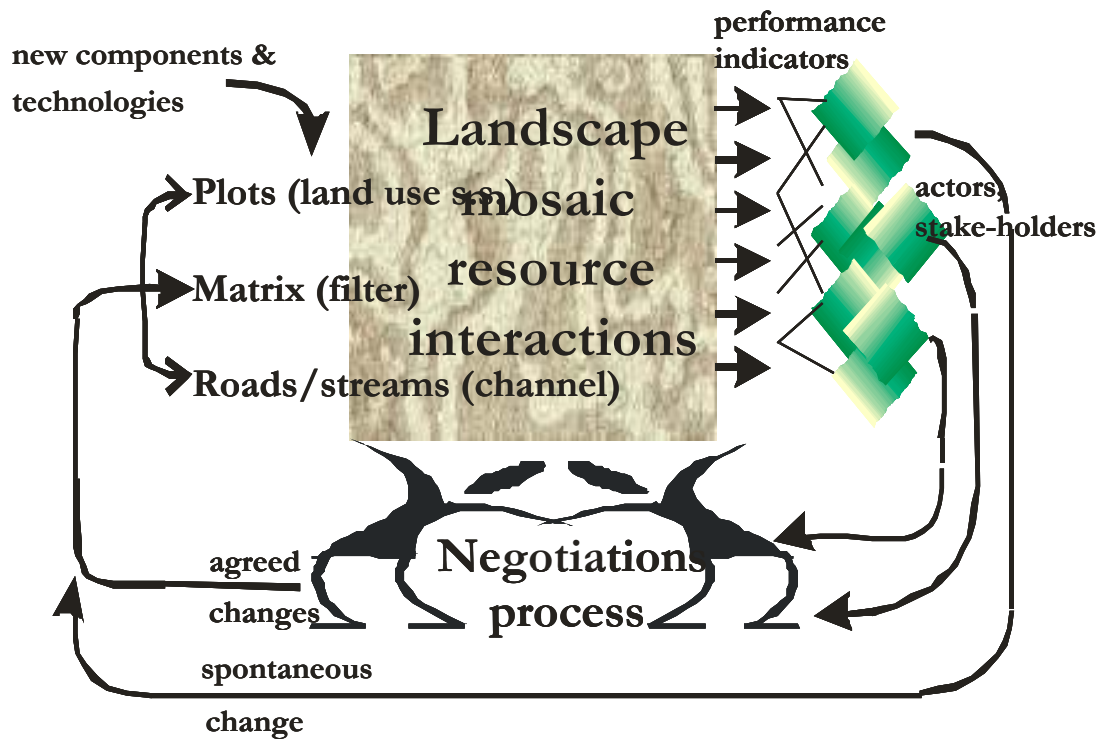
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Figure 4. Schematic representation of *Negotiation Support Systems* as defined and tested by ICRAF and partners in Sumberjaya (W. Lampung); the system recognizes multiple stakeholders with multiple ways of interpreting the '*utility*' of current or plausible future landscape configurations, as starting point for their negotiation process, as well as a complex response of the landscape to changes in human activities

Managers need multiple skills and types of knowledge

The M of INRM refers to 'managers', and these include farmers, public sector entities, private sector and government. They all need to
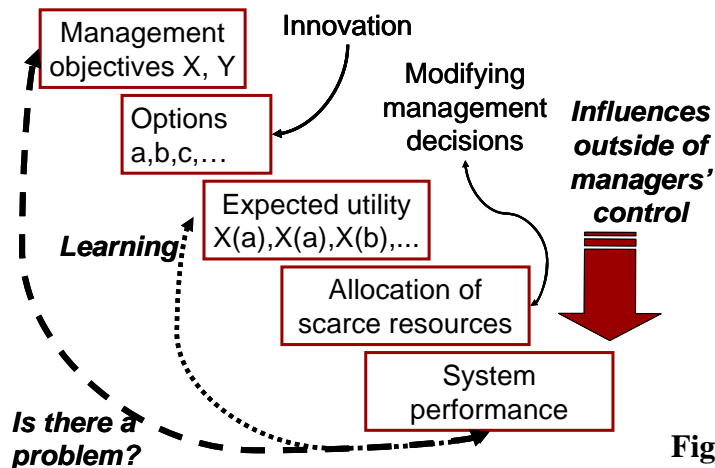
➢ Define targets (objectives) and assess how far the current system deviates from what is desirable,

➢ Know about options and alternative ways of managing the system,

➢ Evaluate how good these options will be for the various objectives,

➢ Allocate scarce resources on the basis of these expected outcomes,

➢ Implement these decisions and learn from the contrast between expectation and outcome.

Figure 5. The Five levels of understanding that managers need in order to do their job (van Noordwijk et al., 2001)

Compensation and Rewards for Environmental Services

When more than one type of 'manager' is involved, it is quite likely that their objectives don't fully match, their array of options differs, as does their resource base and decisions on its use. It is quite likely that the outcome at the level of agro-ecosystem function does not match the expectations or objectives of at least some of the stakeholders. This happens typically for 'downstream' stakeholders, who are influences by the volume, timing and quality of water flows, by smoke and haze produced or (in a more abstract sense of 'downstream') relate to the impacts on biodiversity.
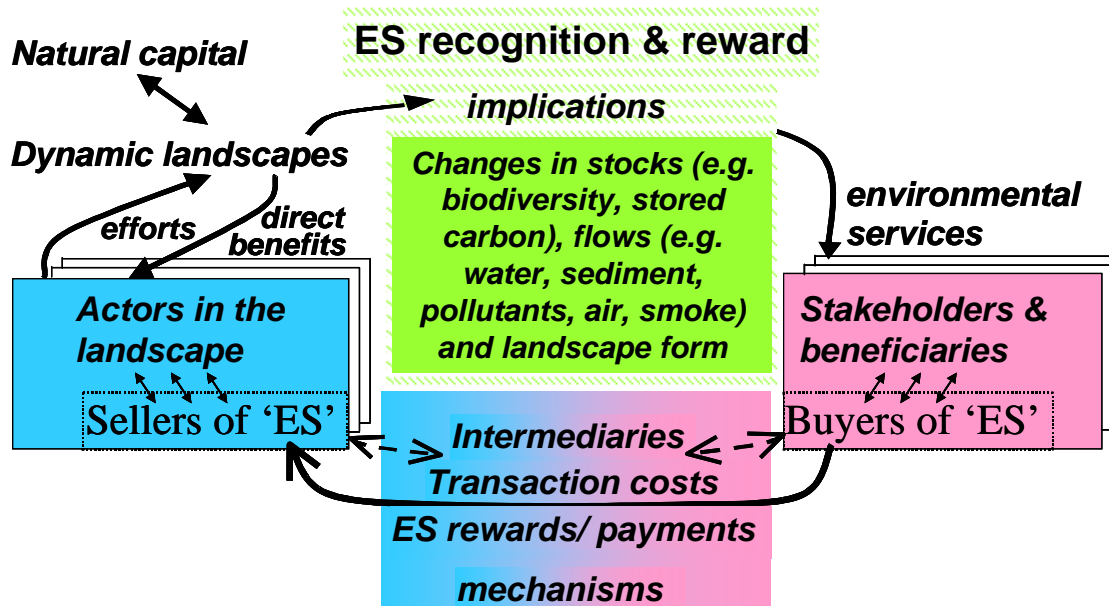
Figure 6. Schematic relations between 'upstream' (left) and 'downstream' (right) managers and stakeholders that suggest the relevance of a 'feedback' loop of compensation and rewards for environmental services as modifier of upland land management decisions

The experience so far in RUPES Phase 1 has helped to identify four dimensions existing attempts to enhance environmental service contracts that provide positive incentives for guardianship (avoiding damage) and stewardship (restoration) have to meet:

Realistic – or in line with the opportunities, opportunity costs and trade-offs that constrain the decisions of the upstream and downstream actors, and linked to their preferences

Voluntary – complementing existing regulations and providing 'additionality' from the downstream perspective and bridging collective and individual action at the upstream side, alleviating the most constraining livelihood concerns

Conditional – with clarity on performance and evaluation criteria in a contractual sense; conditionality can be a mix of 5 levels

Pro-poor – acknowledging the distributional impact of rewards on resource-poor local stakeholders and selecting mechanisms that enhance equity

The ultimate combination of realistic, voluntary and conditional may be called a 'market', but many of the current environmental issues derive from 'market failure', and further analysis of these failures is needed before we can expect constrained markets to provide sustainable, effective and efficient solutions.

In the emergence of location-specific reward mechanisms, and the role of intermediaries (boundary organizations) can be differentiated in four stages:

I. Scoping of multiple knowledge types (K ⇔ K)
II. Identifying stakeholders (A ⇔ A)
III. Negotiations (K ⇔ K) ⇔ (A⇔A), aiming for (unified K ⇔ unified A)
IV. Implementation, monitoring and learning (unified K ⇔ unified A)

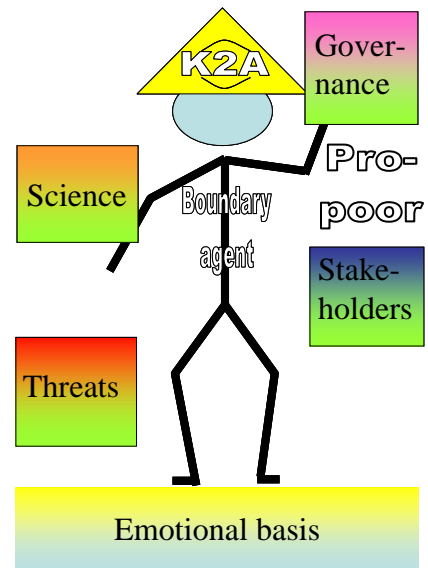| Scoping: K⇔ K	Stakeholder identifi-cation: A ⇔ A
Realistic	*Voluntary, Pro-poor?*
Negotiation: (K ⇔ K) ⇔ (A⇔ A), aiming for (unified K ⇔ unified A) *Conditional*	
Implementation, Monitoring and Learning: unified K ⇔ unified A (or reverting to (K ⇔ K) ⇔ (A⇔ A) *Transparent*	

Figure 7. Relationship between the four phases of a CRES mechanisms, the main criteria ('realistic, voluntary, conditional and pro-poor) and the five types of knowing of Fig. 2

Table 1: Typical '***boundary objects***' for the four stages of ES reward mechanisms

Scoping: K⇔ K	**Stakeholder identification: A⇔A**
Words (articulation of existing land use and effects on products and services, such as 'kebun lindung' or 'shifting forestry')	Stakeholder classification based on concerns and preferences
Icons/images	Maps of 'rights and resources'
Maps of space and lateral flows	Negotiation table ('neutral')
Representation of historical roots of the present situation	Workable bounds in the tradeoff between an 'all stakeholder' paradigm, leakage ('external impacts') concerns and transaction costs
Explanatory models used by various sta-keholders for local system dynamics	

Negotiation: (K ⇔ K) ⇔ (A⇔A), aiming for (unified K ⇔ unified A)
Tradeoff matrix as 'agreement to disagree' and baseline of current ES provision
Scenario analysis based on all major stakeholder concerns and plausible change
Assessments of additionality, leakage and permanence issues
Project Design Document (PDD) in the Clean Development Mechanism cycle
New use of existing legal opportunities for 'community based forest management'
Standards of service delivery respecting multiple 'ways of knowing'
Contracts: conditional service delivery agreements with realistic rewards and voluntary 'buy in'

Implementation, Monitoring and Learning: unified K ⇔ unified A (or reverting to (K ⇔ K) ⇔ (A⇔A)
Operational indicators for monitoring aligned with the main criteria for success
Certificates of compliance to agreed standards

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Table 2: Typical '*boundary work*' carried out in the four stages of ES reward mechanisms

Scoping; K⇔K	Stakeholder identification; A⇔A
Participatory landscape analysis to appraise the logical relations perceived	Trust/confidence building
Reconstruction of recent history of land use and its socio-ecological impacts	Support key individuals with (potential) leadership roles in local organisation
Local land-use options and tradeoffs	Presence at site level to be 'on call' for events initiated by stakeholders
Mapping of terrain and boundaries of jurisdiction and applicable rules	Transparent handling of resources
Rapid Hydrological/ Agrobiodiversity/ Carbon stock/ Tenure Claim appraisal	Enhancement of negotiation and mediation skills
Develop local monitoring tools and skills	Nomination for environmental/social reward (recognition)

Negotiation; (K ⇔ K) ⇔ (A⇔A), aiming for (unified K ⇔ unified A)
Formalise plans in Project Design Document (PDD) for participation in C market
Negotiate contacts under Community Based Forest Management rules
Auctions of contracts for improving watershed services
Auctions of contracts for conserving (agro)biodiversity

Implementation, Monitoring and Learning, unified K ⇔ unified A (or reverting to (K ⇔ K) ⇔ (A⇔A)
Monitoring protocols for the key environmental service of interest (I)
Monitoring protocols for land cover as a proxy for environmental service provision (II)
Compliance monitoring tools at 'activity' levels (III)
Compliance monitoring tools at community scale 'resource use planning' level (IV)
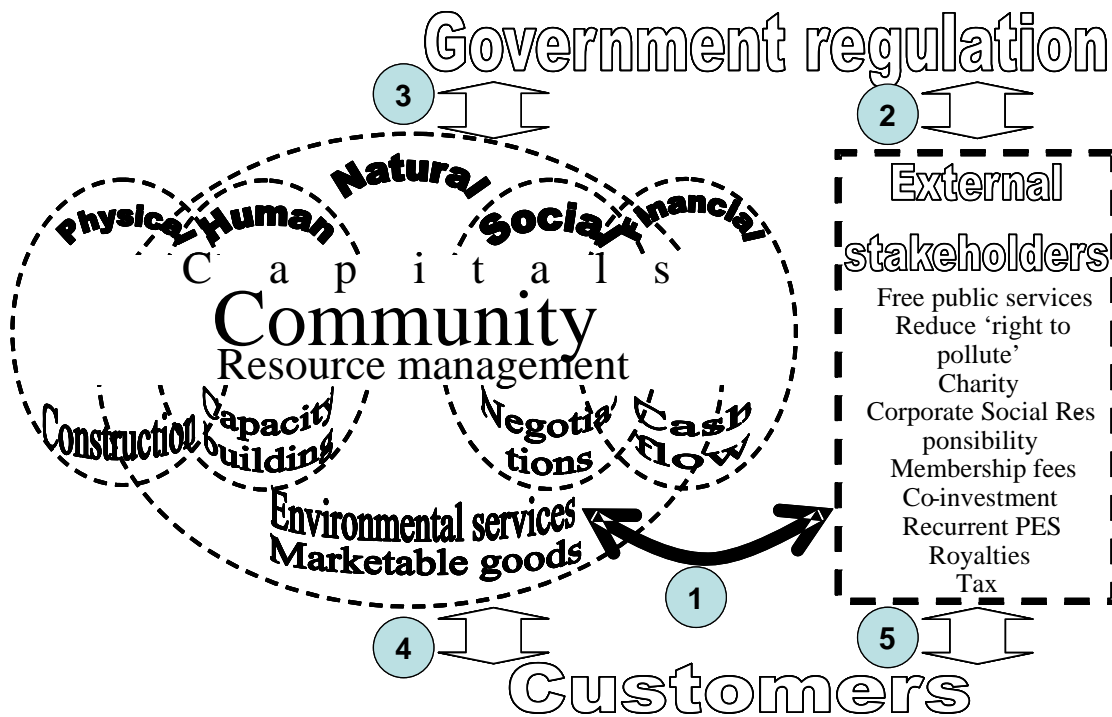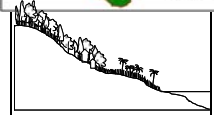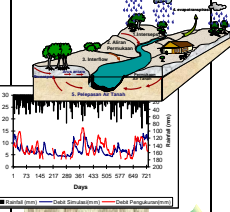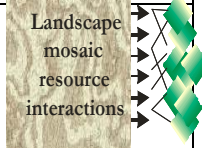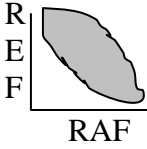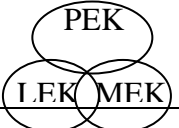

Figure 8. Alternative conceptualization of the stakeholders involved in CRES mechanisms, with a 'community scale' interaction between natural, human, social, physical and financial capital as the basis of marketable goods and environmental services coming from an 'upland' area, external stakeholders who primarily rely on government regulation to secure their interests, but who may be pressured by their next-level customers to engage with the upland community on ES issues

Ten step approach to watershed negotiation support (ACIAR-W)

| Step	Main questions	
1	*Characterization* (rainfall, population density, migration status, main agricultural enterprises, ….) and *diagnosis* of main issues and problems related to watershed functions and livelihoods (incl. sources of drinking water)	
2	*Landscape appraisal*, slopes, land use and vegetation zones, toposequences of soil from ridge to river (lake)	
3	Understanding the *flows of water* and consequences for lateral flows (entrainment, filtering) of soil, nutrients, pollutants etc. Interception, transpiration, overland flow, subsurface flow, deep groundwater flows, springs etc. What entrains to water mass flows (soil, nutrients, salt, pollutants, org matter, domestic waste..) and what can separate (filter)	
4	Characteristics of *land use systems* as regards yield/labour/cash input requirements/profitability and impacts on water flows (evapotranspiration, impacts on soil compaction, surface cover)	
5	Characterization of landscape mosaic on *segregate – integrate* spectrum, and consequences for the way productive and environmental functions are being met	
6	Understand *tradeoffs* between relative agronomic function (RAF) and relative environmental function (REF), e.g. in the form of the number of people provided with adequate income per km^2 as RAF and number of people provided with adequate clean water as REF indicator – builds on to point 4	
7	The *landscape mosaic* (building on to 5) in the context of lateral flows and 'externalities' for on-farm decision making; *existing regulation and incentives* ('carrots and sticks') at community and government level; is the existing landscape mosaic a stable configuration meeting all needs?	
8	Analyzing the existing patterns and land use practices from a multi-stakeholder (incl. *gender and equity)* perspective	
9	Understanding the existing problems and conflicts at the level of *local, policy and scientific knowledge*: is there a shared perspective (but possibly different appreciation of the various outcomes) or is there a need for 'levelling off' as first step in *negotiations*	
10	Follow up to *negotiated agreements*, monitoring compliance and impact on environmental services and peoples livelihood	

Flow chart of the way the various appraisal tools and methods can be combined

PALA: first steps	Appraise land use, stakeholders and issues that require attention; Review of secondary data, Stakeholder appraisal of landscape, Scoping of issues and perceived solutions, Livelihood strategies; Emerging 'technologies',				
RTA: Land tenure	Rapid tenure claim survey to be followed by in depth exploration of strongly contested claims; links to collective action, property rights; revise 'stakeholder' lists				
RMA:	Rapid market appraisal of options for local products				
Land use change analysis	Changes in market access (physical access, increase or decrease in policy constraints)		Spatial analysis of recent changes and current trends within the focal area and its wider context (accessibility)		
Priority issues	<== Key driver of change ==>		Main environmental service of concern		
	T: Change in AF technology	I(m): Major change in infra-structure or market access	RHA: Hydrological services * Productivity	RABA: Agrobio-diversity * Productivity	RaCSA: Carbon stocks * Productivity
LEK = local knowledge & values	Perceived benefits/ weaknesses and op-tions for Participatory Technology Development	Local expec-tations of res-ponsiveness	Interviews, local	Interviews, ethnoecolo-gy	Soil + vegetation typology
PEK = policy perceptions& values	Perceived benefits/ weaknesses : Interviews, sec. Data	Macro economic drivers of access & commodity markets	Interviews, sec. data	Interviews, sec. Data	Check Kyoto eligibility, DNA, local government support, transaction costs
MEK = ecological and bioeconomic models	Technical AF sustaina-bility appraisal of soil, nutrient, water balance (WaNuLCAS), biological interactions	Market chain analysis	Landcape hydrological Model (GenRiver)	Survey + scaling rules	Measure C-stocks
Plausible ΔLU scenarios + indicators: tradeoffs	Scenario analysis using FALLOW (validated on past decade of LU change), with boundaries of plausible price trajectories: predicted welfare and ES indicators; tradeoff analysis				
	Local negotiation processes – based on local/national modalities				

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A Battle of Wits: From Litigation to Negotiation, Finding a Breakthrough on Land Tenure Policies in Mount Halimun-Salak National Park, Indonesia[1]
Gamma Galudra[2]
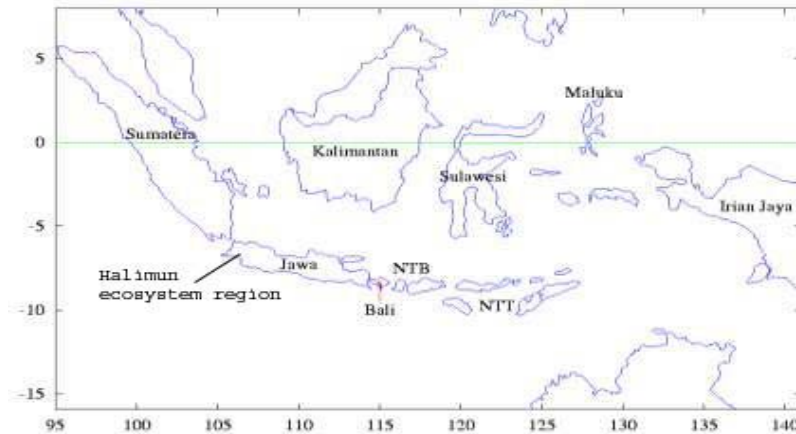
The Government of Indonesia (GoI) declared the Mount Halimun-Salak area as national park in 2003, based on the forest ecosystems richness and hydrological function. Administratively, it is located in West Java and Banten Provinces within three regencies (namely Bogor, Sukabumi and Lebak) covering an area of 113,357 hectares. The national park itself can be reached within four hours of journey from Jakarta, capital of Indonesia, toward the interior of Lebak District.

When the government changed the status of Mount Halimun-Salak into a national park, the people living within its boundaries saw this as infringement on their customary rights. Several signposts declaring national park designation were erected surrounding its boundaries, causing concern among the people. According to the government officials, the customary people have never had legal rights to settle and farm the land. Fearful of being evicted, on 16th – 18th October 2003, the customary people from 31 villages within the national park held a meeting in Bogor and refuted the government's declaration. To support their resistance and claim over their customary land rights, the people set up a local organization, named *Forum Komunikasi Halimun Jawa Barat-Banten* (FKMHJBB). A local NGO, named RMI (*Rimbawan Muda Indonesia*), assisted and advocated their cause during the campaign and litigation processes against the government.

As the processes develop, there is a need to involve more support from other institutions. In 2005, ICRAF, an international research institution, got involved in these processes as advisor on science and research refinement, especially on legal status of state forestland and historical findings. Another local NGO named HUMA also participates on legal and policy aspects. In the processes, these two institutions have changed the community representative's mind and approach from litigation against the government to dialogue and negotiation with the government. To support these new processes, a working group on land tenure issues (WG-T), facilitates the process as a convener. After a long process of negotiation, in the end of 2006, all the stakeholders agreed to give more secure land rights for the customary people through district regulation. An ongoing study tries to explore the struggle of the people of Mount Halimun-Salak in securing their customary land rights after the national park declaration. Even though the district regulation on customary land rights is not a new policy in Indonesia, but at least, it is a breakthrough for the customary people in Mount Halimun-Salak for securing their land rights within the national park boundaries.

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Linking Knowledge with Action for Sustainable Development:

The Role of Program Management - Summary of a Workshop

2006 **Authors:**

William Clark and Laura Holliday, Rapporteurs, Roundtable on Science and Technology for Sustainability, National Research Council

This report summarizes a workshop organized by the National Academies Roundtable on Science and Technology for Sustainability. The workshop brought together a select group of program managers from the public and private sectors to discuss specific cases of linking knowledge to action in a diverse set of integrated observation, assessment, and decision support systems. Workshop discussions explored a wide variety of experiments in harnessing science and technology to goals of promoting development and conserving the environment. Participants reflected on the most significant challenges that they have faced when trying to implement their programs and the strategies that they have used to address them successfully. The report summarizes discussions at the workshop, including common themes about the process of linking knowledge with actions for sustainable development that emerged across a wide range of cases, sectors, and regions.

2
THE ROLE OF COLLABORATIVE, USER-DRIVEN DIALOGUE IN LINKING KNOWLEDGE WITH ACTION

This chapter highlights one of the most ubiquitous and important features of programs that successfully link knowledge with action: collaborative, user-driven dialogues. In particular, it explores the role of user-producer dialogues, the boundary organizations that facilitate such dialogues, and the importance of user-driven problem definition and ongoing user-driven dialogue.

The Knowledge-Action Supply Chain

Linking knowledge from research and development systems with action for sustainable development is not a simple process, such as one that requires a single step from basic science to end use. Efforts to link knowledge with action entail undertaking some R&D in response to articulated needs of decision makers, rather than only in response to interests of researchers. It has proven difficult to ensure that research informs decisions, even in circumstances where a system is developed explicitly with the goal of affecting decisions, such as some decision-support systems; for example, one workshop participant pointed out: "Commonly (computer-based decision-support systems) are developed by software engineers based on what they think the end user needs or wants. Consequently, these systems are often not used by the intended user. Decision-support systems, predictive models, and other forms of scientific information, when used to inform a collaborative process, can be thought of as aids to the conversation that occur as part of the multiparty negotiation." Systems that successfully link knowledge with action tend to involve various groups in the conversation about research priorities, including knowledge producers (e.g., climate scientists, engineers, or economists); knowledge users (decision makers, such as city managers, farmers, consumers, or politicians (e.g., those who ultimately take action or make the decisions that initiate action); and program managers who often bridge those two groups, attempting to ensure that what the knowledge producers develop assists the users in making their decisions and in taking action.

Appendix 1B

The Conceptual Foundations of Boundary Organizations

Excerpt from NSF proposal, Integrating knowledge and policy for the management of natural resources in international development: The role of boundary organizations; W. Clark, D. Guston, and M. van Noordwijk, 1 February 2006

The scholarship on "boundary organizations" that this project seeks to enrich is one of the most vigorous areas of empirical research within the broader body of scholarly literature that has emerged over the last decade examining the dynamics and consequences of collaboration among researchers, users, and intermediary bodies in the integration of knowledge and policy (Gibbons et al. 1994; Etzkowitz and Leydesdorff 1997; Nowotny et al. 2001).

Boundary organizations are one of several institutional means identified in that literature for carrying out the work of both demarcating science from non-science, and of blurring or bridging those demarcations so that science and society interact more seamlessly (Jasanoff 1990; Gieryn 1995, 1999). Research on boundary organizations involved in linking science and practice has accumulated a number of case studies and produced several generalizations regarding structures and functions likely to be associated with their effective operation (Guston 1999; Hellstrom and Jacob 2003). According to this work, boundary organizations are more likely to be effective in fostering used and useful knowledge to the extent that they: 1) are situated at the frontier between the worlds of politics and science, but have distinct lines of accountability to each; 2) involve the participation of actors from both sides of the boundary, as well as professionals who serve a mediating role; and 3) provide the opportunity (and, even more, the incentives) for the construction and use of shared creations (e.g., models, research plans, etc. or, as the literature has it, "boundary objects" and "standardized packages") that help each side pursue its interests in both collaborative and independent senses (Guston 2000).

Far from being of only academic interest, the concept of boundary organizations has struck a resonant chord with research managers, policy analysts, and decision makers wrestling with the kinds of "usable knowledge" challenges in sustainable development that provide the policy motivations for this proposal (e.g., Tomich et al. 2004; Cash and Buizer 2005). Before proceeding to a discussion of the possible bearing of boundary organization perspectives on policy making for sustainable development, however, a note of caution is in order. Most of the existing empirical work on boundary organizations has focused on their role in comparatively simple situations of bringing scientific advice to unitary decision makers in Western democratic contexts or in international governance regimes based on Western models. Relatively little attention has been given to the messy networks of multiple experts, practitioners and intermediaries that characterize efforts to bring science and technology to bear on sustainable development, nor to the overwhelming importance of power asymmetries that typify so many sustainability problems. This raises a number of questions regarding the extent to which the explanatory and predictive utility of the boundary organization concept is restricted to the developed and (largely) democratized world. Indeed, Guston (2001) describes the balancing logic of boundary organizations as "Madisonian"—a helpful logic in the US but to what extent is it applicable where Madisonian institutions are lacking? In the present proposal, even as we attempt to apply boundary organization perspectives in pursuit of our core objective, we therefore seek to look critically at several of those questions. We have singled out the following for special attention: i) The basic descriptions of boundary organizations refer to a particular and well-bounded entity. Are the dynamics of boundary organizations limited to such entities, or can their functions be meaningfully spread among various more complex entities, none of which are

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themselves boundary organizations? ii) The basic Western case studies of boundary organizations provide some evidence that their presence improves outcomes by enabling all participating actors to achieve their goals, even if those goals differ. Can such outcomes be identified in the broader field of science for sustainable development? iii) More generally, looking across a broad range of cases in the more and less developed world that seem to exhibit things that look like boundary organizations, are these in fact all of a type?

The more general intellectual objective of this project is thus to answer the following questions:

> "*To what extent does the existing boundary organization framework illuminate the role of institutions in the multi-party, power-embedded negotiations characteristic of efforts to implement science-based sustainability strategies in international development? How can the existing boundary organization framework be generalized to cover this important class of expert-practitioner collaborations in knowledge production?*"

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Appendix 2

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