

AMESH

An Ecosystems Approach to Managing for Sustainability and Health

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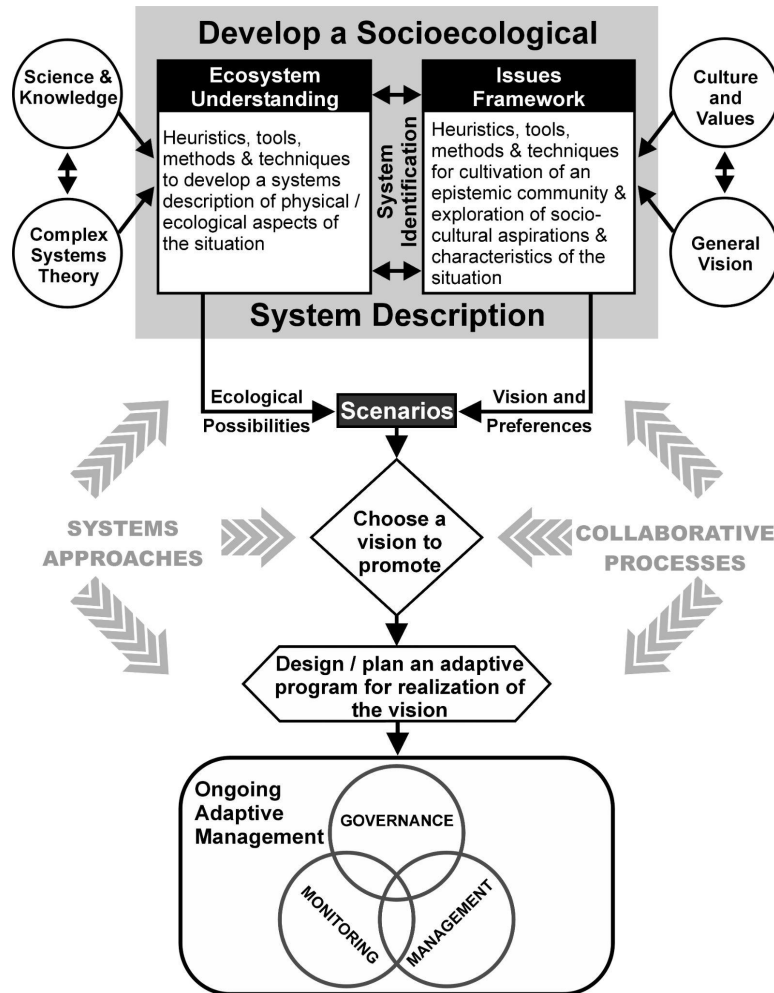
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Introduction

Managing complex eco-social systems in the service of a sustainable, convivial human society, the underlying agenda of such initiatives as the Millennium Ecosystem Assessment, is itself a complex activity. Beginning in the early 1990s, an international multidisciplinary network of scholars and field researchers began a series of collaborations with the intent to strengthen both our understanding of complex systems, and our ability to manage interactions between social systems and ecosystems in ways that acknowledged that complexity. Within the dynamics of eco-social complexity and the uncertainty this generates, scientists and managers are faced with the challenge of adapting to, and finding a way through, a foggily perceived landscape rather than charting a scientifically determined course to a known end point. Together with conflicts over values, disputes over facts, and a sense of urgency with regard to policy decisions, a need emerged for what is now termed post-normal science [1,2].

Foundations: the Diamond Schematic

An adaptive ecosystem approach to sustainability assumes that a sustainable society maintains itself in the context of the larger ecological system of which it is a part. Throughout the 1990s, James Kay, working with colleagues and students at the University of Waterloo, developed a schematic for bringing together some strands of theory and practice related to this challenge. This framing of the process came to be known as “the diamond schematic,” with the central diamond being the area in which the understanding of the ecological system unites with that of the sociocultural system, generating a set of choices for human agents (Fig. 1).



In this framing of sustainability research, management, and governance, the scientist's role shifts from providing predictive statements for policy makers to providing decision makers and community stakeholders with an appreciation of how the future might unfold through narrative descriptions or scenarios. Through systemic framing of the issues as self-organizing, holistic, open systems (SOHOs), science informs society about known ecological constraints and possibilities (top left-hand box in Fig. 1).

The dynamics and structures of SOHOs are well described in the systems literature, sometimes using different terminologies to refer to similar phenomena [3–5]. The language of holons and holarchies, derived from Koestler, provides a useful shorthand for describing the nature of units in a nested hierarchical nature. In brief, any eco-social unit, such as a person, family, pond, or watershed, can be seen both as a whole, with its own internal rules and interactions, and as part of multiple nested hierarchies. Koestler referred to each unit as a holon, and the nested hierarchies as a holarchies ([6]:102). The description of such systems is observer-dependent, and hence dependent on participants in social systems [7].

Within the diamond schematic, these systemic representations of complexity are informed by the images people provide of how they would like to see the landscape of human and natural ecosystems coevolve

(top right-hand box in Fig. 1.) A dialogue (the diamond box in Fig. 1) then explores the desirable and the feasible and reconciles them into a vision of how to proceed. Scientists inform this dialogue by suggesting a range of possible future narratives. These emerge and evolve as scientists engage with other participants. Having agreed to a tentative vision for the future, the next phase is to design an adaptive program for the realization of the vision.

This program consists of a plan and an infrastructure for *governance* (the continuing process of learning, re-visioning, resolving trade-offs, and planning by the parties to adapt to the unfolding situation); *management* (the development and implementation of strategies to promote or discourage specific forms of self-organization through identification of external contextual changes, flows into and from the system, and feedback loops that are to be encouraged and discouraged); and *monitoring* (observing the eco-social systems and synthesizing those observations together into a narrative that describes how the situation is unfolding). This narrative is used as the basis for governance and further management, that is, for learning, re-visioning, and adapting human activities as the human and natural ecosystems co-evolve as a self-organizing entity.

Taken together, the framework of issues and the conceptual model provide the focus for the discussion of sustainability. By furnishing a means for informed resolution of the trade-offs necessary to sustain the health and integrity of the eco-social system, the activities of monitoring, governance, and management, carried out in concert, chart the course to sustainability.

Lessons from Case Studies

From 1993 to 1998, the Agroecosystem Health Project (AESH), a major interdisciplinary Canadian initiative to define agricultural landscapes and communities systemically, incorporated some of the ideas represented in the diamond schematic. However, the perspectives accommodated were limited to professional expertise across a dozen disciplines, and the process relied on expert peer review [8]. This turned out to be unsatisfactory from both theoretical and practical points of view: large amounts of non expert understanding were marginalized, and the information generated by experts did little to enlighten or mobilize the ecosystem managers, who included farmers and other rural residents as well as agricultural policy makers. Furthermore, this Canadian project did not sufficiently take into account cross-scale dynamics within which particular holons of interest such as farms were characterized. It was not clear how, in theory and in practice, one could simultaneously accommodate the dynamics of farms as economic units within a larger agri-food system, ecological units within watersheds, and social units with rural communities.

Drawing on lessons learned from the AESH project, a team of researchers led by Gallopin of the Centro Internacional de Agricultura Tropical (CIAT), attempted to apply complex systems theories to tropical agroecosystems in the Peruvian Amazon [9]. As researchers, we assumed that we could compare our theoretical models to systemic empirical descriptions to assess how well our models performed. Such independent descriptions of the system did not exist. The work, framed in broad terms by Checkland's Soft Systems Methodology (SSM), drew on insights from complexity theory, thermodynamics, social systems design, interactive planning, Beer's viable systems model, participatory action research, adaptive

management, multicriteria analysis, and societal physiology [3,10–13].

Despite not achieving the sought for full systems understanding, the research provided some useful lessons. Based on the results, we were able to specify further steps needed to investigate complex systems, list out guiding questions for each of the steps, and make the process recursive, rather than simply linear. In our autopsy of the research, we discovered that the initial stakeholder-partner group we had selected as consultants, which had been created through a previous, unrelated, research initiative, represented mainly academics and business people living outside the communities being studied. This underlined the need for researchers to be critically self-reflective about the invocation of stakeholders and to question the interests of those stakeholders in the systems being studied.

Follow-up research in the same geographic area focused more specifically on links between health, biodiversity, and natural resource use [14]. In this initiative, representatives of local indigenous groups and women's organizations took their place alongside workers in government ministries and researchers attached to institutions, including Peruvian and Canadian universities, as well as CIAT. This facilitated the integration of local experiential knowledge with data derived by more conventional scholarly inquiries such as surveys, interviews, focus groups, anthropometric measurements, and testing of biological specimens.

Concurrent with the research in the Peruvian Amazon, other projects in Kenya [15], Nepal [16] and India [17] were exploring the same methodological territory. These other research teams found that the mobilization of local stakeholders into the research process almost immediately generated a demand for action, so that well-laid-out pathways for the orderly accumulation and assessment of knowledge could at best serve as guides to ensure that important considerations were not overlooked. In all cases, having well-defined holarchic models was important; it was not enough to define household or village dynamics, but also links across scales and across social and ecological perspectives. Thus, problems identified at the village level could be related to both household and individual relationships and larger regional political and ecological contexts. This enabled the team not only to better understand the problematic situations but also to identify potentially effective routes to respond to them.

Furthermore, it became apparent that indicators to measure progress derived from systems theory and thermodynamics could not be defined independently of goals of those meddling in the systems. In Kenya, indicators used by villagers and farmers were often quite different from those used by researchers, because their goals were different. Researchers therefore had to be defined as a separate category of stakeholders with their own interests, goals, and indicators for measuring progress. Farmers and villagers worked on different time frames, with different resources, and had different requirements than researchers.

Gitau, working with Kenyan villagers, also developed techniques for creating influence diagrams that linked all the elements of interest to the participants in the research. These complex “spaghetti diagrams” were used by villagers to identify strategies to achieve desirable ends while accounting for known feedback loops, and by researchers to model the dynamics of known variables in the system [15].

Drawing on the insights generated by these projects, we developed a more complete schematic for sustainability research that explicitly acknowledged the different needs, skills, and resources of

researchers and stakeholders, and further refined the use of influence diagrams drawn in collaboration with stakeholders. We also reassessed our earlier practice of too clearly separating the roles of academic researchers and local participants. If knowledge and understanding are not the exclusive domain of academia, then the important process questions relate to the skills of the participants and the quality of information, rather than to maintaining predefined roles.

The quality of the information generated by both scholars and lay people in a sustainable development research and/or management project relates not just to achieving desired outcomes, but also to the processes by which decisions are made in selecting those outcomes. Challenges faced by researchers included transparency, critical thinking, public counter challenges, and accommodation of fundamentally different epistemologies.

The project in Nepal, which evolved through several stages over the decade of the 1990s brought to the fore two techniques that enabled communication across these epistemological divides (cross-talk). One of these was the use of the type of collaboratively drawn influence diagrams mentioned above. In Nepal, these diagrams were based on comprehensive narrative reports compiled by community researchers. The innovation in this case was that separate diagrams were created for each major issue such as street waste/garbage disposal and water quality from the perspective of each major stakeholder group; these included street sweepers, butchers, street vendors, garbage collectors, shop owners and politicians. These multiple diagrams were then combined to create a richer picture of the webs of interaction and, just as importantly, the perceptions of causes by different stakeholders. Both the single perspective and the combined drawings were presented at a workshop for the community participants for verification and as a basis for planning future initiatives.

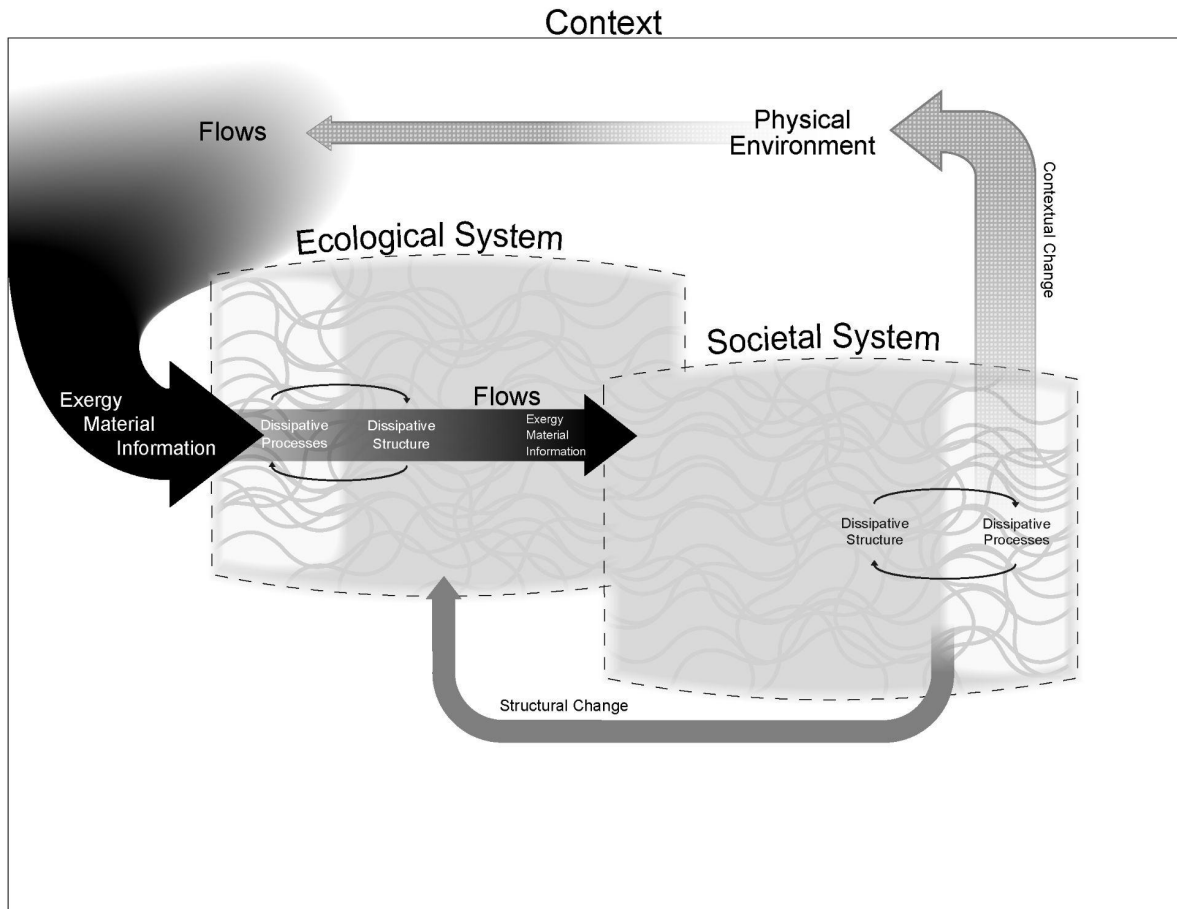
Another tool to facilitate cross-talk was the use of narratives. Narratives are central to how we structure our understanding of how complex systems unfold over time. The role of narratives in human thought processes and actions, including in science and management for eco-social sustainability, has been discussed in many domains of inquiry, including science, law, anthropology, and community development [18–22]. In Nepal, by asking participants to recount the stories they would like their children to tell about them, we were able to foster debate about future scenarios and their relationships to current activities. Working from a complex systems theoretical base, Zellmer, TF Allen and others have proposed that narratives are required to structure our understanding of how multilevel complex systems unfold over time [23].

Carrying this work a step further, Bunch and his colleagues demonstrated the feasibility of bringing together diverse stakeholders including lay people, government experts and academics to communicate across groups, linking spatial understandings of place and scenario creation. Participants working and/or living in the Cooum River valley in Chennai, India, successfully parameterized a simulation model and then ran the model to explore scenarios (desirable and feasible futures) [17].

A New Synthesis

Based on these, and other, case studies, we identified a set of relevant components to an adaptive ecosystem approach. The systems basis for the approach may be depicted in terms of a variety of heuristic,

systemic models of self-organizing, holarchic, open SOHO systems. One figure from a series of such diagrams—the whole series appearing in Kay and Boyle [24]—illustrates this (Figure 2). Ecological systems provide the biophysical context and the flows of exergy (useful energy), material, and information that are required by the self-organizing processes of the societal systems.

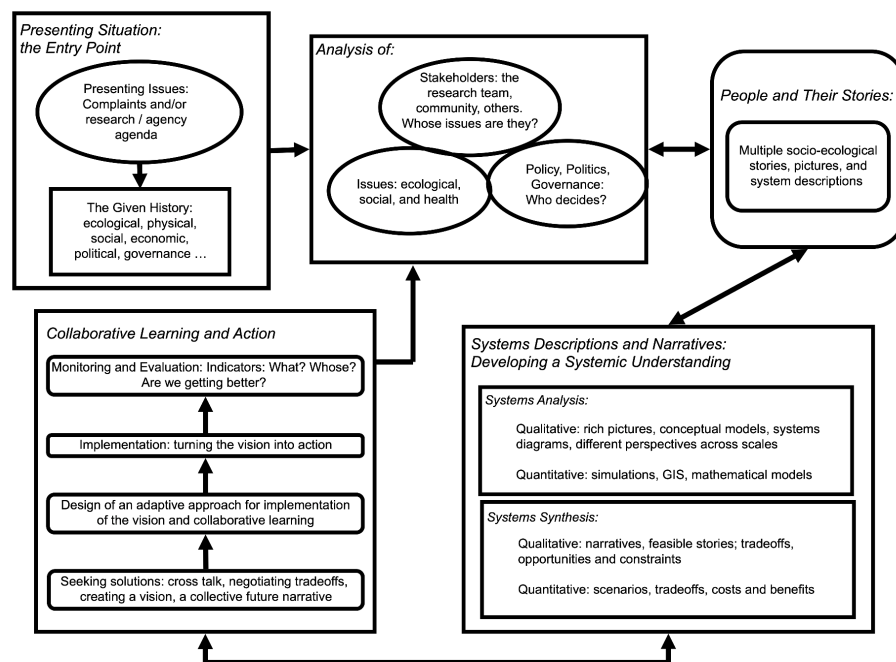


Societal systems can and do alter the structures in ecological systems, for example, through harvesting trees or building or removing dams or roads. Changes in the ecological structure alter the context for the societal systems. Societal systems not only change the structure of the ecological systems, but also the context for the self-organizing processes of ecological systems, for example, by changing the drainage patterns into a wetland or paving a large area, which creates a heat island effect that changes the local microclimate for a woodlot. Changes in ecological processes can alter the ecological structure and, consequently, the context for societal systems.

Figure 2 applies to one particular scale of observation. However, the kinds of resilience, integrity, and health that interest us when we pursue research into sustainable development can best be understood in terms of holarchies. The hydrological cycle may be viewed as a process of a sub-watershed, for instance, which is made up of ecological communities (woodlots, wetlands, open fields), which in turn are made up of species. On the societal side, municipalities rest on the local landscape. These in turn are made up of neighborhoods, which are made up of families, and businesses, and, within them, individuals.

A sub-watershed may define the context for the local municipality. However, the municipality directly modifies the ecological communities in the sub-watershed and thus its own context. Adjacent ecological communities also form part of the context for local neighborhoods. However, the local neighborhood is capable of influencing ecological communities through direct structural change such as harvesting wood from a woodlot, changing drainage patterns into a wetland, or otherwise altering the context for an ecological community.

Faced with the complex theoretical and logistical challenges raised by our case studies, we generated a more complete methodology, applicable to businesses and non-governmental organizations as much as to academic research communities. We integrated those who initiated the process (in our case researchers) into the process more completely and recognized our own role as stakeholders whose characteristics were just as unique as those of the participants from the local community. In this process, which we termed an Adaptive Methodology for Ecosystem Sustainability and Health (AMESH), the expanded peer group includes both scholarly researchers and local citizens. At the same time, in the manner of a true peer group, all forms of knowledge become open to mutual challenge – an uncomfortable position for academic scholars. Although stakeholder participation and the use of a plurality of perspectives and methodologies were implicit in the research process we had proposed in the mid-1990s, these components were made explicit in AMESH (Fig. 3).



Complex eco-social interactions can best be understood through the integration of many diverse and often differing perspectives. To gather and weave together these multiple perspectives, AMESH encourages the use of a range of qualitative and quantitative inquiry and analytical methods. Additionally, AMESH acknowledges the fundamentally important role that local people play in any endeavour to address ecosystem sustainability, and supports their full participation to shape and inform our understanding of the ecosystem. Although the local perspective is critical to AMESH, the larger context in which the local is

embedded is equally important. In the various projects on which we have worked, the nested context has been an important part of both the research and the constraints to the work.

Within AMESH, researchers and practitioners are encouraged to look for and understand system feedback and the emergence of self-organization. The iterative nature of this process and its multi-ocular assessments mean that the unpredictability and uncertainty of eco-social systems, with the potential for dramatic flips, can be more easily accommodated than in more conventional approaches.

Although there is no single prescribed course of action or diagnostic regimen for AMESH, we can describe it in broad categories of action, such as in Figure 3, each category associated with a set of guiding questions [25]. The techniques used to answer the guiding questions have been appropriate to the questions asked and have included the examination of historical records; tests of fecal, blood, and water specimens, personal interviews; visual inspection; focus groups; remote sensing; and GIS-based, food web, statistical, and simulation models. Not all questions are appropriate for all cases, and some require more money, time, or other resources to answer; we have found that communities usually move ahead with policies and plans based on early and incomplete information. For researchers, the important point is to use these initiatives as occasions for learning, rather than frustrations of plans; in other words, the research plans need to be adaptive.

For us, the main challenges have been in the use of narratives and in collaborative learning and action. Because there are no definitive experiments and no final, unassailable truths in the field of sustainability, collaborative learning and action are central to an implementation of this approach. For some researchers, this incorporation of elements of management into the research itself is problematic. In AMESH, every policy initiative is a hypothesis, and every implementation or management program becomes a test of that hypothesis. Because of the complex nature of the issues with which we are dealing, proposed solutions and desired outcomes must be negotiated. As researchers, we ask questions about how different perspectives conflict with, or complement, each other, and what kind of sustainable futures might be feasibly designed. Moving from visioning and designing to implementation, we can ask specific questions about the logistics of management.

The process requires participants to monitor changes, with a view to adapting interventions in the light of changes in context and outcome. However, when there are multiple stakeholders with varying interests in the outcomes, we are faced with questions about what the indicators actually measure and who “owns” them, that is, who thinks they are important and is likely to take action on them. If measuring certain indicators requires very expensive technical equipment and/or takes a long time, then such measurements are not likely to be useful for day-to-day decision making by local householders, farmers, or businesses. They may, however, be useful for detecting long-term trends and setting policies. On the other hand, if not dealt with carefully and self-critically, some of these indicators may be used by governmental and quasi-governmental agencies to promote centralized control mechanisms and undermine local initiatives. At the local household and community levels, people will own and act on indicators (which may or may not be quantitative) that can be measured and understood with relative ease. Furthermore, radically different cultural understandings of the relationships between people and natural environments can result in indicators that may not cross cultural boundaries in any obvious way. This is particularly true when postcolonial scientists look for ways of working with indigenous people (for one example from New

Zealand, see [26]). There is no one correct set of indicators, because they reflect both cultural-based understanding of the complex reality and human goals within those local realities.

Conclusion

The research process we arrived at is similar to that proposed by Walker et al. [5], which emerged from their consideration of resilience and social-ecological complexity. The fact that our networks worked independently and drew on different case material gives us some confidence that such a process may be robust and have general applicability.

One important difference between the two processes appears to be with regard to the role of stakeholders. According to a typology of participation, the role of stakeholders in the process of Walker et al. appears to fit into the category “participation by consultation,” whereas in AMESH it is closer to “interactive participation” [11].

One reason for this may be that our work was informed not only by issues arising from the adaptive management of ecological systems, but also by the challenges faced when implementing sustainable community development projects that simultaneously addressed socio-economic, cultural and ecological processes and outcomes.

In our case, we found that the diamond schematic and AMESH changed not only our understanding of the places we were studying but also the academic researchers, our governmental and nongovernmental collaborators, and the communities with whom we worked. In Peru, the researchers’ perspective changed from one in which they saw only a forested landscape with rivers running through it, troubled by cattle and logging, to one that also viewed that landscape as a watery floodplain with trees growing in it, inhabited by people who lived on fish. This facilitated engagement between government and local indigenous groups and changed the nature of the initiatives being proposed to promote health and sustainable use of the landscape. In Nepal, an improved understanding of the complex social dynamics among castes, economic and occupational classes, religious groups, and governmental and nongovernmental agencies generated opportunities for some creative solutions. Ward governments were able to restrict slaughtering areas and replant riverbanks, religious groups rehabilitated naturally flowing artesian fountains, and local volunteer clubs were able to promote recycling and garbage collection programs. In Kenya, the links between environmental management issues and social and economic activities clarified some possibilities for improvement that had not previously been obvious. Villagers developed, implemented, and found funding for integrated water management programs, and women for the very first time found themselves in respected positions of governance at the local level. In India, what were seen by urban planners as problems of slums along the Cooum River, were seen by citizens there as a solution to rural landlessness and lack of opportunity.

In the years after AMESH was first introduced and implemented, the general approach has been adapted to new situations, at various scales, where new challenges have been identified. We identified narratives as being important, but did not fully appreciate the ways in which those narratives are embedded in structures of political, cultural and economic power [27]. In Latin America, issues of economic disparity, social movements and power inequalities, which AMESH in its original formation does not explicitly address,

can alter and sometimes sabotage the process [28]. Similarly, AMESH as originally formulated under-appreciated the historic relationships between colonial powers and indigenous people, and the challenges faced when there are radical differences in what constitutes legitimate knowledge [29]. One of the recommendations that has emerged from these challenges is the creation of safe spaces for constructive debates.

Ultimately, what we have sought is a way of integrating our ways of knowing with our ways of doing. By ways of knowing, we mean not just what has been considered science in conventional terms, but also different kinds of knowledge that reflect different epistemological stances. Both the diamond schematic, as a way of framing sustainability issues, and AMESH, as an approach to research and management, provide coherent, self-reflective ways to accomplish this.

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