A strategy for ecology in an era of globalization

Jeffrey E Herrick[1*] and José Sarukhán[2]

Globalization of labor and capital can increase the rate and extent of global environmental degradation, while enhancing the ability of ecologists to respond rapidly and collaboratively to mitigate these impacts. Nevertheless, ecological research remains focused at local and regional levels, with collaboration limited by national borders and funding. New initiatives are required to increase the utility and availability of environmental research to natural resource owners, managers, and policy makers in the public and private sectors, whose decisions affect land and other forms of natural capital. We propose a four-part strategy to increase the effectiveness of ecological science in addressing environmental issues in an era of globalization: (1) develop an Ecological Knowledge System, (2) increase our ability to anticipate, identify, and rapidly address new research needs, (3) increase the number and diversity of participants in all phases of research and decision-making processes, and (4) increase the flexibility of funding sources.

La globalización de la fuerza de trabajo y del capital puede aumentar el índice y el grado de degradación ambiental global y al mismo tiempo mejorar la capacidad de los ecólogos para mitigar sus efectos negativos. Sin embargo, la investigación ecológica sigue enfocada a una escala local fuera del contexto global, y la colaboración profesional y de investigación está seriamente limitada por fronteras nacionales y por falta de financiamiento. Se requieren nuevas iniciativas para aumentar la utilidad y la disponibilidad de la investigación ambiental a los dueños, a los encargados y a los políticos a cargo del manejo y conservación de recursos naturales en los sectores públicos y privados, cuyas decisiones afectan las tierras y otras formas del capital natural de un país. Con el fin de aumentar la eficacia de las ciencias ecológicas para tratar con los temas ambientales en una era de globalización, proponemos una estrategia compuesta por cuatro partes: (1) El desarrollo de un Sistema de Conocimientos Ecológicos (EKS), (2) El incremento de nuestra capacidad de anticipar, identificar y atender rápidamente nuevas necesidades dentro de la investigación, (3) El aumento del número y la diversidad de participantes en todas las fases de los procedimientos de la investigación y la toma de decisiones, y (4) El aumento de la sensibilidad y la flexibilidad de las fuentes de financiamiento hacia este tipo de investigación ecológica enfocada a resolver problemas multidisciplinarios concretos.

Front Ecol Environ 2007; 5(4): 172–181

The processes associated with globalization – the "growing integration of economies and societies" (World Bank 2001) – can lead to increases in the rate and scale of environmental degradation (MA 2005; Najaf *et al.* 2007). Patterns of degradation are also changing, in association with new transportation and production systems and interactions with changing climate (Lambin *et al.* 2003; Aide *et al.* 2006; Gutiérrez *et al.* 2006). New technologies and increased labor and capital mobility also mean that opportunities for ecosystem recovery can appear more rapidly (Aide and Grau 2004; de Soysa and Neumayer 2005; Liu *et al.* 2006).

In a nutshell:

- The processes associated with globalization lead to increases in the rate and scale of environmental degradation
- A more rapid globalization of ecological science is required, in order to increase the rate at which ecological knowledge is developed, communicated, and applied
- Many of the strategies used by globally successful organizations can be adopted by ecologists
- An Ecological Knowledge System that increases and facilitates access to new and existing sources of knowledge and expertise is a key element of a strategy to increase the impact of ecological research in addressing global sustainability

Authors' contact details are on p181

Environmental degradation and opportunities for restoration increasingly occur in areas of the world where there are few professionally trained ecologists; this includes much of Latin America (Martínez *et al.* 2006). As a result, the consequences of land-use change in these regions are often unanticipated and there is inadequate knowledge to support the development of more sustainable, alternative management systems.

Even when new challenges and opportunities generated by globalization are anticipated, ecologists generally do not have the ability to respond quickly enough to assist decision makers, while decision makers lack access to existing knowledge. Both individually and as a group, ecologists lack the nimbleness of increasingly mobile global capital and labor. Extractive industries, for example, can establish new international operations in less time than it takes to get a research grant proposal written and accepted, and in far less time than it takes to develop new funding sources.

A number of theories, including the "treadmill of production" (Buttel 2004) and the "metabolic rift" (Foster 1999; Clark and York 2005), assert that environmental sustainability is incompatible with global capitalism. Globalization proponents, supported by "ecological modernization" and related theories, argue that manufactured and human capital can often be substituted for natural capital (de Soysa and Neumayer 2005). Where this is true, new ecological knowledge can contribute to the development of substitutable manufactured capital (eg constructed wetlands for waste recycling), while more effective communication of ecological knowledge can increase human capital.

We recognize that there are many factors influencing the nature of the relationship between humans and the environment (Ostrom *et al.* 2002). The objective of this paper is not to debate the ultimate relevance of ecological knowledge, but rather to stimulate discussion of how ecologists' relevance might be increased (Dietz *et al.* 2003) from local to global levels, where environmental policy is largely based on creating, regulating, and managing markets (Najaf *et al.* 2007).

We begin with a brief review of three ecosystem transformations that have occurred in non-forested areas of the Americas over the past 150 years. We selected these studies because they illustrate recurring limitations on the development and application of ecological knowledge relevant to globalization. Furthermore, all three transformations were facilitated by increased global capital flows and were associated with important changes in production systems (see Bennett and Balvanera [2007] in this issue) and human migration patterns (see Meyerson *et al.* [2007] in this issue). These changes, in turn, promoted the spread of invasive species (see Meyerson and Mooney [2007] in this issue). We then describe several elements of a strategy designed to increase the ability of ecologists and decision makers to more effectively anticipate and respond to future challenges and opportunities, including establishment of an Ecological Know-ledge System.


Courtesy of New Mexico State University Library, Archives and Special Collections

Figure 1. *Overgrazed desert grassland in south-central New Mexico, December 1892, associated with early globalization of financial and beef markets.*

Ecosystem transformations associated with globalization

Case study 1: Southwestern United States in the late 19th century

In the past 150 years, much of the grassland in the northern Chihuahuan Desert has been invaded by native shrubs, including *Prosopis* spp, negatively affecting many ecosystem services (Havstad *et al.* in press). Following the US Civil War, the area experienced dramatic increases in livestock numbers as former officers migrated or returned to establish livestock operations (Stoddart *et al.* 1975). Mounting demand for beef was fueled by growing domestic consumption and market globalization: exports to Europe became possible through the introduction of canning and refrigerated shipping in the late 19th century (Graham 1960). High profits attracted both US and British investors (Graham 1960), who rapidly expanded livestock populations beyond carrying capacity (Wooton 1908; Figure 1).

The response to the resulting land degradation included the establishment of experimental stations and the creation of rangeland ecology as a science. Local ecological knowledge was used to justify these new research initiatives; the vast majority of more than 1000 ranchers responding to an 1894 US Department of Agriculture survey indicated that perennial grasses were disappearing. Reflecting on the 50-year period that ended with the establishment of the Taylor Grazing Act in 1934, however, Stoddart *et al.* (1975) state that, "Thoughtful planning and scientific outlook resulted only as time brought to light the errors of earlier [rangeland management] policies". While it is easy to criticize the past, ecology as a science and ecologists as professionals continue to be more reactive than proactive, and we face similar problems today. The Millennium Ecosystem Assessment (MA 2005) and other initiatives are beginning to change our

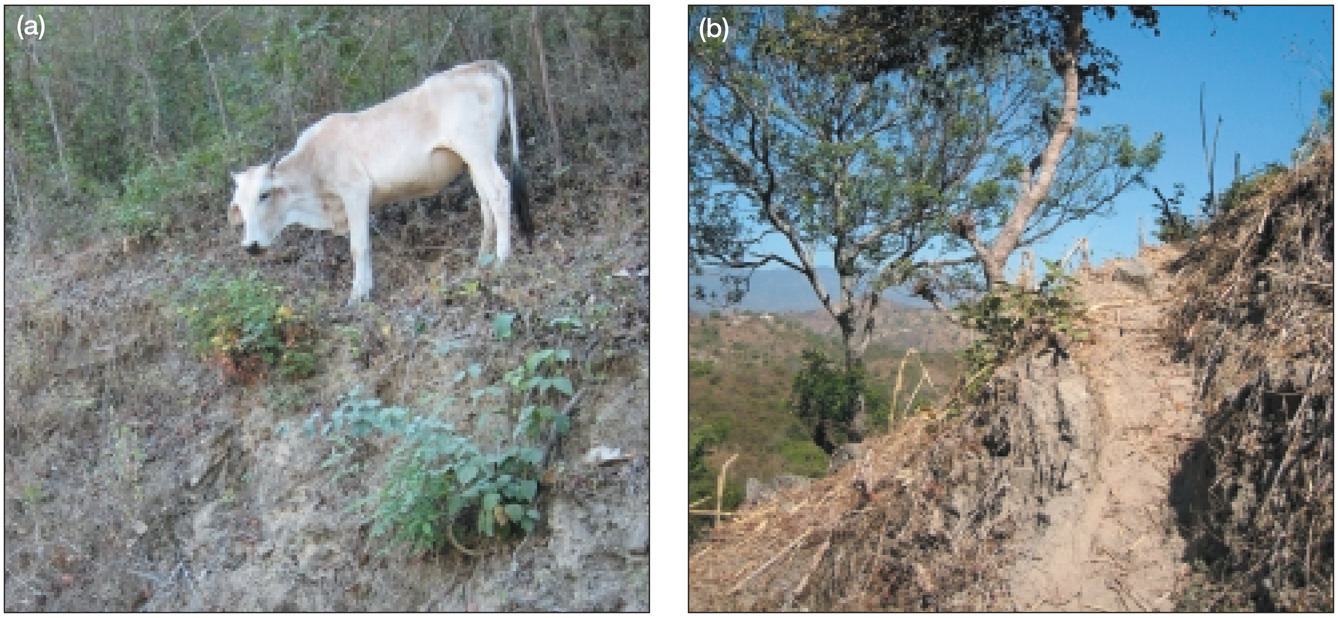

Figure 2. *(a, b) Soil compaction and removal of soil-protecting crop residues and tree litter by increased livestock populations threaten to diminish benefits of the Quesungual agroforestry system in Honduras.*

approach to research, but the forces associated with globalization are arguably changing the world at a much faster pace.

Case study 2: Brazil in the late 20th century

To the untrained eye, mid-20th century Brazilian *cerrados* (savannas) in the midst of an annual dry season would have appeared quite similar to some mid-19th century southwestern US grasslands, but the rate and extent of change are probably even greater in Brazil. Over 8 million ha of native savannas were lost to cultivation between 1980 and 1995 (Cardille and Foley 2003). The forces of change in Brazil today are surprisingly similar to those operating in the US 125 years ago. Brazil can profitably satisfy increased global demand for an agricultural product (soybeans) because it has (1) low production costs relative to other soybean-producing regions of the world, (2) an expanded transportation network, and (3) domestic and international migration of agricultural entrepreneurs into the region (Fearnside 2001; Aide *et al.* 2004).

There is an impressive body of research on the *cerrados*, but much of it has focused on the development of agronomic practices that facilitate replacement of native savannas with more valuable forage species or annual crops (Yamada 2005). The long-term effects of annual cropping on this diverse, high-value ecosystem (Oliveira and Marquis 2002; Grace *et al.* 2006) have been predicted, but few feasible and economically attractive alternatives (Lubchenco *et al.* 1991) have been proposed (Fearnside 2001). Additionally, conversion to mechanized agriculture and the associated displacement or preemption of small-scale subsistence landowners is contributing to increased migration to the agricultural frontier in the Amazon (Fearnside 2001).

Case study 3: Zacatecas, Mexico, in the early 21st century

The case of the southwestern US highlights a missed opportunity for ecologists. In Brazil, as intensive agricultural production continues to expand, opportunities for transformational changes in agricultural production systems (Kirschenmann 2006) are rapidly disappearing (Klink and Machado 2005). In contrast, new opportunities for restoration are emerging in northern and central Mexico (Echavarría Cháirez *et al.* 2004), where marginally productive croplands are being abandoned by migrants seeking higher wages in the growing cities of Mexico and the US (Zamora and Foladori 2006). Agricultural land abandonment is occurring throughout Latin America (Aide and Grau 2004; Grau and Aide 2006; Guzmán Chávez 2006; Izquierdo *et al.* 2006; Morales and Villalba 2006). In north-central Mexico, it is being fueled by three factors associated with reduced trade barriers: lower prices for basic grains due to competition from highly subsidized imports, factory jobs in Mexico, and demand for low-wage labor in the US.

Research in forested systems supports the hypothesis that agricultural land abandonment associated with emigration can create opportunities for ecosystem recovery (Lamb *et al.* 2005; Grau and Aide 2006). However, experience in other regions suggests that the window of opportunity may be relatively narrow. In southern Honduras, farmers who recently abandoned their land for opportunities in the US are investing their earnings in expanding livestock herds beyond the carrying capacity of the steep hillsides (Figure 2). Demand for biomass for biofuel production is a growing threat to the sustainable management of marginal lands (Lal 2005; Raghu *et al.* 2006). Finally, increased food requirements of a growing population, together with potential changes in agricultural production subsidies, could also rapidly return these lands to production (Babbitt 2005). This emphasizes the need for the simultaneous development of new, more sustainable agricultural production systems (Vandermeer and Perfecto 1997), and for systems that promote the recovery of abandoned lands. With the exception of a number of studies documenting forest recovery, the response of ecologists to new options associated with land abandonment in the Americas has been limited at best. Research designed to develop economically viable strategies (Lamb *et al.* 2005) that promote agroecosystem recovery is problematic, due to its interdisciplinary nature. It is generally poorly funded and often lacks coordination with similar efforts in other parts of the world, or even within the same country.

Case study implications

These three case studies show that, while new ecological challenges and opportunities can emerge in response to changes in a single factor, they are particularly dramatic when two or more of the many factors associated with globalization (eg capital flows, production systems, migration patterns) change simultaneously. In all three cases, the ecological community failed to anticipate the magnitude of the impending changes associated with these three factors, and was unable to generate a timely, policy-relevant response. The case studies also show how globalization has linked these three factors more tightly, allowing feedbacks to occur more quickly and increasing the probability that dispersed, seemingly unconnected events at local scales will lead to catastrophic changes to ecosystem function at regional to international scales (Peters *et al.* 2004; see also Peters *et al.* [2007] in this issue). We argue that these thresholds or tipping points are often accelerated by shifts in capital flows, migration (see Meyerson *et al.* [2007] in this issue), and production (see Bennett and Balvanera [2007] in this issue), and are often associated with changes in invasive species dynamics (Theoharides and Dukes 2006; see also Meyerson and Mooney [2007] in this issue). As our understanding of the complexity of factors associated with globalization increases (eg Blumenthal 2005), so must our capacity to respond. In some cases, the social and economic forces overwhelm potential science-based improvements in policy, while, in others, more effective communication may be sufficient (Palmer *et al.* 2005). In many cases, however, both increased knowledge and site-specific interpretation of that knowledge are required.

A strategy to increase the impact of ecology

We propose a strategy for ecology that addresses some of the challenges presented by globalization by taking advantage of the new opportunities it provides. We argue for a more rapid globalization of ecological science in order to increase the rate at which ecological knowledge is developed, communicated, and applied. We believe that this transformation of ecology must occur in collaboration with local community and government leaders, and that both small and large enterprises can play a positive role in the process.

In order to increase our effectiveness in addressing emerging environmental issues, ecologists need to adopt the four key attributes of a successful global entrepreneur: (1) universal, rapid, comprehensive access to relevant information and knowledge, (2) the ability to anticipate and pursue new research needs virtually anywhere in the world, (3) the willingness and ability to form partnerships with the most qualified individuals and organizations, independent of nationality or formal education, and (4) the ability to rapidly redirect resources to generate the highest rates of return on investment.

Develop an Ecological Knowledge System

An Ecological Knowledge System (EKS) is needed to facilitate the local and global dissemination and interpretation of ecological information. Policy makers and resource managers are constantly required to identify, access, interpret, and apply disparate information sources to support decisions. Information is becoming increasingly accessible through online databases and decision support systems, but no single individual has the ability to locate and interpret all of the information relevant to a particular environmental issue. Internet search engines cannot distinguish between tools and databases that are simply described by websites and those that actually exist. Furthermore, when users finally arrive at a relevant website, they must navigate a unique path to access information. Under intense deadline pressure, even those with advanced degrees and internet skills resort to simply calling individual experts, who themselves often lack the time and specific expertise required to address increasingly complex issues (J Matuszak pers comm). For example, many large banks involved in international projects have now adopted the ten "Equator Principles", including the requirement that borrowers complete "a Social and Environmental Assessment ('Assessment') process to address … the relevant social and environmental impacts and risks … and to propose mitigation and management measures relevant and appropriate to the nature and scale of the proposed project" (Equator Principles nd). Implementation of these principles has been controversial for many reasons (Missbach 2004), one of which is that we often lack the information necessary to assess the environmental impacts of a project (Miranda *et al.* 2003).

We propose the development of an EKS that facilitates dynamic access to, and interpretation of, traditional and non-traditional knowledge sources. This system would promote the integration and application of a wide variety of information and knowledge sources, including many that are already being organized relative to a specific theme, such as invasive species (Grosse and Sellers 2006; Molnar

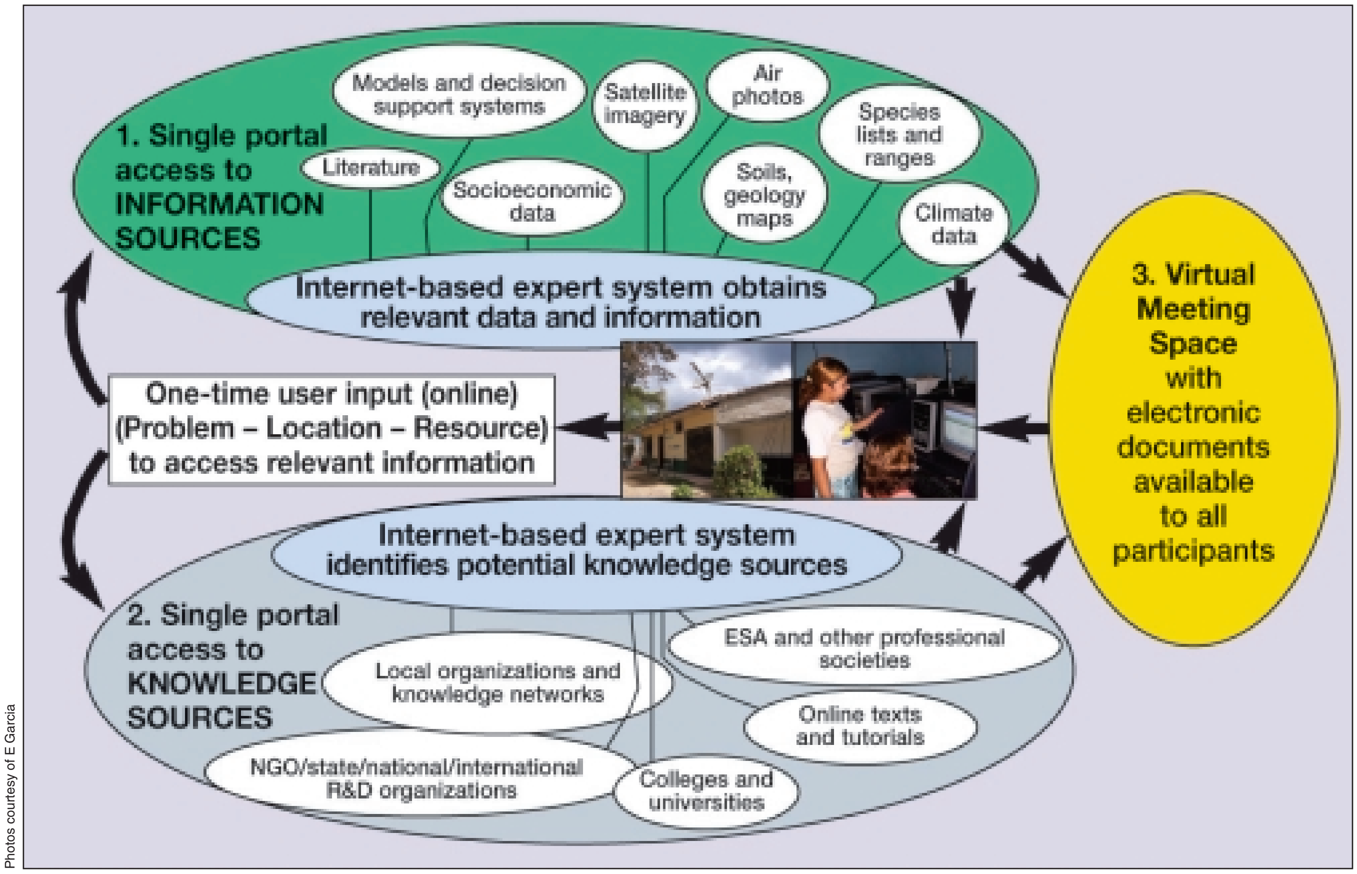

Figure 3. *Three components of an Ecological Knowledge System, with sample elements for each. Initial versions of components 1 and 2 would simply assemble information from multiple websites; later versions could provide expert, system-based integration.*

et al. 2006; Parks *et al.* 2006) and biodiversity (Besana and Valdespino 2006; IUCN 2007). As currently envisioned, it would consist of three components (Figure 3).

(1) An ecological information acquisition tool. This internet-based expert system would allow individuals to use a single interface or portal to extract relevant information from existing databases, based on spatial coordinates, current land use and cover type (eg forest), type of land-use change or impact (eg agriculture, irrigation, mining, roads, climate change), and resource concerns (eg soil, water and air quality, hydrology, biodiversity, single species). The tool would serve as a common interface for the many spatial and non-spatial databases, search tools, and decision support tools that already exist or are being developed. Technical staff and a scientific advisory board would be responsible for evaluating, adding, and replacing new information sources (ie websites) as they are developed. This would resolve one of the biggest difficulties for policy makers, managers, and scientists today – keeping up with the growing number of internet databases and tools – and would provide a comprehensive knowledge source as the basis for promoting public participation in policy development (Kasemir *et al.* 2003). This tool might also be expanded to include a collaborative website (wiki) modeled after Wikipedia, in which individuals could document local data, information, and knowledge not otherwise available, including qualitative observations (eg Liebig and Doran 1999). Although inherently vulnerable to manipulation, Wikipedia has been shown to be roughly as accurate as Encyclopedia Brittanica (Giles 2005). Following new initiatives like Citizendium (Leslie 2006), the entries associated with an EKS could be subject to continuous review both by other users and by a voluntary professional committee.

(2) An ecological knowledge identification tool. This global catalog of databases of both traditional and non-traditional experts would serve a function similar to that of the information acquisition tool. An increasing number of expert databases are being developed, but they, like the information databases, are dispersed. Furthermore, few include local and traditional ecological knowledge experts. Using the same user inputs provided for the information acquisition tool, this tool could also provide customized links to relevant online tutorials and the scientific literature through existing products such as Google Knowledge and Wikipedia.

(3) A synthesis, interpretation, and application tool. Using currently available software, this internet-based teleconferencing tool would provide users, including those in remote locations in the developing world (Galperin 2006), the opportunity to consult with several experts simultaneously, and would provide all with relevant information direct to their desktops. This tool would

facilitate the cooperative development of conceptual models, integrating biophysical and socioeconomic factors, which could then be used to identify areas where management intervention and research are most likely to be effective (Reynolds and Stafford Smith 2002; Ayarza and Reynolds 2006; Callo-Concha 2006; Liu *et al.* 2006). In the short term, this tool could simply act as an extension of the Ecological Society of America's (ESA) Rapid Response Network (ESA 2006).

In summary, most of the elements of an EKS already exist, but they are not being used to their full potential. The technology necessary to integrate them already exists or is being developed (eg Tapscott and Williams 2006; IUCN 2007). Our proposal is to take the final step to simplify access to relevant information and the knowledge necessary to apply it, and to provide new options for individuals with diverse types of knowledge to interact directly with each other and the available information.

Anticipate, identify, and rapidly address new research needs

We need to anticipate research needs and be willing and able to rapidly shift the focus and location of our research to address those needs. In addition to the development of new centers and networks designed to accomplish this (Palmer *et al.* 2005), we need local identification of emerging issues (Martínez *et al.* 2006; Rodrigues and Hogan 2006). As ecologists, we then need to respond to these issues, as suggested in a newly proposed "contract between science and society" (Lubchenco 1998; Mayor 1999).

Today, individuals committed to providing rapid responses to new needs in the environmental arena find themselves working as consultants, because this type of work is not generally rewarded in academia (Castillo *et al.* 2005; Hobbs 2006). We believe that a restructuring of the academic reward system may be required to encourage academic and government ecologists to take the risks involved in working with managers and policy makers on demand-driven research projects. For example, the promotion requirements for many US government researchers increasingly include demonstrating societal impact, in addition to the number and significance of publications.

Increase diversity of participants in the research and research application process

When entrepreneurs seek to develop new businesses, the market obliges them to partner with the most qualified individuals. We need to increase our ability and willingness to rapidly forge new partnerships (Palmer *et al.* 2005) and to terminate or restructure these partnerships when they no longer support the development of socially and environmentally sustainable solutions, even when this results in a reduction in the size of our own research program (Garcia Barrios 2006).

Figure 4. *A national technician, international soil scientist, and local farmer each bring different forms of knowledge to a discussion on how to increase the sustainability of crop production systems on steep hillsides in Central America. An international Ecological Knowledge System could increase the frequency and quality of these conversations by providing all participants access to existing information and knowledge.*

It is frequently stated that we need interdisciplinary, international teams that can access local knowledge to address future environmental challenges (Palmer *et al.* 2005). We believe that, in order for local knowledge to be effectively applied, local knowledge experts must play an active role in making decisions. These experts, together with decision makers, must become active participants in the development and application of new ecological knowledge (Sabatier *et al.* 2005; Contreras 2006; Hall *et al.* 2006; Hobbs 2006; Figure 4). This requires increasing opportunities for experts in the field to share their knowledge online (Figure 3), changing the way many of us think about local partnerships, and, in some cases, throwing open the search for solutions to the entire online community. This revolutionary approach has led to a number of successes in both traditional industries, such as mining, and in the new online knowledge-based corporations (Tapscott and Williams 2006). At a more local level, Barrios *et al.* (in press) describe a new type of partnership that was used to generate soil quality indicators for local application. The process involves technical specialists (eg scientists, extension workers, teachers), who bring knowledge about basic soil and ecological processes, and local

Table 1. Economic benefits of wildlife management units in Mexico (total 1995–2005)

Activity	*Millions of pesos*
Intensive plant and animal facilities (eg nurseries, zoos)	93
Hunting	4870
Live plant and animal exports	7
Whale watching ecotourism	27
Taxes	3
Approximate total	**5000**

Figure 5. *Concerns about smoke from annual burning of forest regrowth and crop residues in the hills surrounding Candelaria, Honduras (a), stimulated teachers at the local high school (b) to work with farmers and, later, national and international scientists to develop a unique agroforestry production system.*

experts (eg farmers), who contribute knowledge of the local environment, the type of information required, and how it can best be organized, presented, and applied.

In the long term, increasing the integration of ecological knowledge into daily decision making requires strategies that will help local individuals and organizations improve their understanding of fundamental ecological principles and their ability to apply these principles (Bartuska 2006; Martinez-Mateos and Castillo-Burguete 2006; Tyler 2006). This requires increasing ecological knowledge at all educational levels in multiple sectors of society (Figure 5). At the university level, ESA's Strategies for Ecology Education, Development, and Sustainability (SEEDS) program has the potential to serve as a model for broadening the diversity of ecologists by introducing students from different disciplines to professional ecologists and the science of ecology (Parker 2006; Figure 6). For younger students, environmental education, which is often based in natural history, needs to be integrated with environmental science education, which promotes critical thinking about ecological processes. Finally, scientists will need to work with policy makers to develop new programs, such as Mexico's Environmental Management Units system, which allow local managers to benefit economically from using this knowledge to improve natural resource management (see Sisk and Castellanos [2007] in this issue; Table 1).

Figure 6. *ESA member Mark Brunson and SEEDS student Jorge Acosta learned that they share a similar approach to research on human–environment interactions in very different systems, at the 2006 annual ESA meeting. Development of collaborative relationships through professional meetings is highly effective, but high costs limit participation.*

Increase flexibility of funding sources

Funding sources that allow new issues to be addressed as quickly as possible by the most capable individuals, irrespective of their national or institutional affiliations, are required. In 2004, Mexico spent just US$4.3 billion (US$40 per capita) on all areas of research and development, compared to US$312.5 billion (over US$1000 per capita) in the US (OECD 2006). Only a tiny fraction is allocated to environmental and natural resources research; in 2003, just US$43 million was devoted to these issues in Mexico (INEGI 2003). By contrast, the National Science Foundation's Environmental Biology Division alone provides over US$100 million to US scientists. It is easy to say that more funding is necessary worldwide, but we also need to find ways to distribute funds more flexibly and efficiently. Recognizing that many ecological issues are now global in scale, national funding agencies need to eliminate restrictions on international expenditures. The National Science Foundation's International Division supports these efforts, but even these funds have many limitations. A combination of new, innovative funding initiatives and increased flexibility of current funding sources is necessary.

When international ecological research projects are funded by wealthy, developed countries, they are generally led by principal investigators from those countries. These scientists subcontract predefined tasks to local scientists, or send their own representatives, who often have little local knowledge and limited language skills. There are some notable exceptions and the number of truly collaborative relationships increases yearly. An alternative to the subcontracting approach was recently developed by Miguel Ayarza and others working with Centro Internacional de Agricultura Tropical (CIAT) in Brazil and, more recently, in Central America. The Manejo Integrado de Suelos network brought local investigators together twice annually to discuss regional problems of land degradation with internationally trained scientists from CIAT. Before funding was eliminated in 2006 as part of a broader organizational restructuring, the network included a small grant program which provided funding for innovative studies initiated by members. This microcredit, incubator model is similar to the micro-finance model that has been successful in promoting local development (Yunus 1998; Rhyne 2001). The bottom-up approach, which combines informal, professional peer-group training with funding, is not a replacement for large, international projects. It does, however, have the potential to cost-effectively help local researchers contribute more pertinently to our ecological knowledge base and improve their ability to generate local solutions, such as the ones described by Ayarza and Reynolds (2006) and Kirschenmann (2006). When combined with the EKS described above, this approach also has the potential to increase the ecological community's ability to rapidly respond to new threats by increasing the likelihood that relevant research is initiated early.

There are a number of other alternative funding mechanisms, including foreign aid programs, international funds such as the Global Environmental Facility (GEF), and partnerships with non-profits and the private sector (Martínez *et al.* 2006). These sources remain underexploited, in part because of cultural differences between scientists and many of these new potential funding partners.

Adapting the model of the global entrepreneur

While many of the strategies adopted by globally successful organizations can also be adopted by ecologists, some can be counterproductive if they are not carefully applied. For example, compartmentalizing production systems and subcontracting specific components based on current capacity and cost is often an effective strategy for rapid, low-cost production of new goods, such as cars and computers. The same strategy applied to a research project can limit ecologists' ability to increase local capacity and integrate local knowledge. It can also breed resentment, leading to failure of the project. The balance between rapid response and maximizing knowledge and involvement is difficult to achieve, as local involvement requires the development of long-term relationships, often at the expense of short-term efficiency. However, the potential benefits of opening up the development of ecological solutions to the global community are tremendous. The creation of a set of principles, similar to those proposed for "Wikinomics" (Tapscott and Williams 2006) and the "Conservation Commons" (IUCN 2007) could increase the probability of success of this endeavor.

Conclusions

In order to more effectively address emerging environmental issues associated with globalization, and to be more relevant to society, ecologists need to broaden what and for whom we study. We also need to be more strategic about where and with whom we study, and about how and with whom we communicate. Finally, we must take advantage of the tools of globalization to increase our ability to rapidly develop and implement research projects, in addition to continuing curiosity-driven basic research. The quality and relevance of our research will increase as we work together with those who are prepared to apply it. The strategy proposed here is designed to accelerate this transformation, which is already occurring, while increasing access to new and existing ecological knowledge through the development of an Ecological Knowledge System.

Acknowledgements

We thank the presenters and participants in the ESA-sponsored conference, *Ecology in an era of globalization: challenges and opportunities for environmental scientists in the Americas*. This paper was stimulated by interactions with this unusually diverse group of over 500 individuals, including over 150 Latin American and US students funded by grants from the Ford and National Science Foundations. We also thank the organizing committee, C Duke, and the ESA Governing Board for their continuing commitment to increasing ESA's relevance in a globalized world. Conversations with J Matuszak and with scientists at the Jornada Experimental Range and Jornada LTER, and with ARIDnet workshop participants also contributed substantially to the development of the idea for an Ecological Knowledge System. Finally, we thank E Courtright for assistance with manuscript preparation.

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[1]*Agriculture Research Service, US Department of Agriculture, Jornada Experimental Range, Las Cruces, NM 88003* *(jherrick@nmsu.edu); [2]Instituto de Ecología, Universidad Nacional Autónoma de México, Ciudad Universitaria, Mexico*