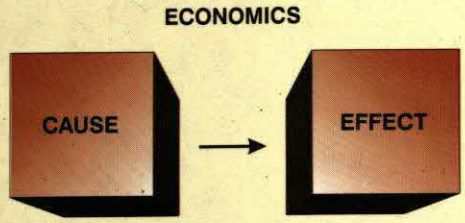
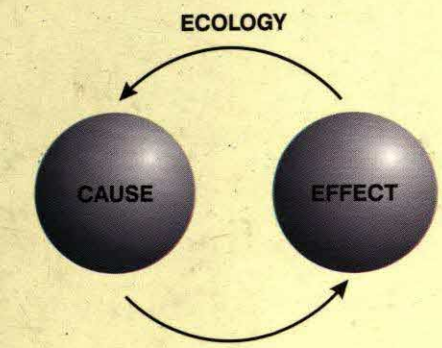
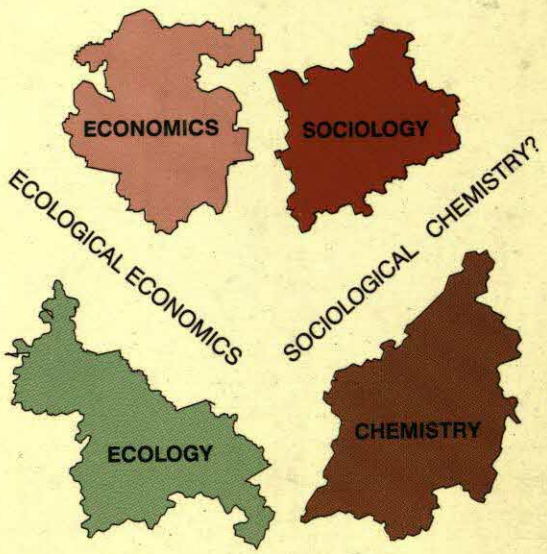
Interdisciplinarity in Environmental Research: Concepts , Barriers and Possibilities

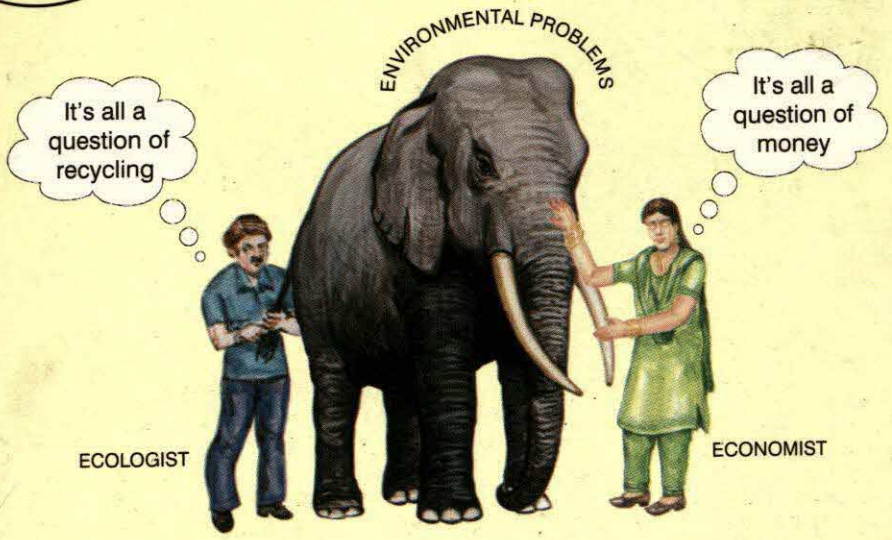
Editors

Sharachandra Lele, Gopal Kadekodi & Bina Agarwal









Proceedings of the Workshop on Methodological Issues in Interdisciplinary Research on the Environment

Held at

Centre for Interdisciplinary Studies in Environment & Development

on July 21 - 23, 2001

Indian Society for Ecological Economics (INSEE)

Acknowledgements

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ISEC Campus, Bangalore 560 072, India

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Contents

Introducing the workshop

Sharachchandra Lele, Gopal Kadekodi and Bina Agarwal

Background

Central to INSEE's goals is promoting an understanding of the "environment question" in all its complexity and dimensions. This would require, for a start, greater interdisciplinarity in research and teaching, involving ecology and economics in particular, and the natural and social sciences in general. The Society realizes that practicing or implementing interdisciplinarity is a difficult and challenging task. However, at our first biennial conference held in December 1999, a roundtable discussion on interdisciplinarity generated enormous interest, suggesting that this is an issue of great importance to this Society. The INSEE Executive Committee therefore decided to organize a full workshop on this topic.

Purpose of the workshop

Interdisciplinary thinking is essential for understanding environmental issues in both their social and natural dimensions. This workshop sought to throw light on:

- The types of interdisciplinary crossings that are needed for successfully addressing environmental issues in research, teaching and advocacy;
- The philosophical, cultural, institutional, and practical constraints to conducting high quality interdisciplinary research and teaching on the environment; and
- The means for facilitating such interdisciplinarity in the work of the Society, its members, and the academia/activists/policy makers at large.

Basic issues sought to be addressed

1. Clarification of terms and typologies

What is interdisciplinarity? We might suggest that it involves:

- Interfacing economics with ecology.
- Interfacing economics with *other* social sciences (including anthropology, sociology, political science).
- Interfacing ecology with *other* natural, physical and engineering sciences.

If so, what are the theoretical and methodological shifts required to achieve the different types of interfaces or crossings? What is the difference between "interdisciplinary" and "multi-disciplinary" research?

2. Understanding the constraints

What restricts scholars working in one discipline from crossing over into other disciplines or establishing a dialogue between other disciplines?

- Differing value systems?
- Differing (competing) models of reality?
- Absence of overarching theoretical frameworks?
- Misconceptions about the "other" discipline?
- Differing methods, differing notions of evidence?
- Compartmentalized institutions of learning?
- Inappropriate criteria for judging quality?

3. Operationalizing interdisciplinarity in theory

- What theoretical frameworks emerge or have emerged when economists work with ecologists?
- What theoretical frameworks emerge or have emerged when economics is merged with non-economics social sciences?
- Are there "overarching" frameworks such as general systems theory or political ecology that help us bridge the disciplinary gap(s)? Are they adequate?

4. Operationalizing interdisciplinarity in practice

- Can interdisciplinary research and teaching be achieved through collaboration between the practitioners of different disciplines, or does it need each individual to integrate different disciplines into her/his work, or some measure of both?
- At what stage and to what extent should scholars be exposed to other disciplines? How is the depth versus breadth tradeoff to be resolved? What would be the appropriate standards to judge interdisciplinary work?
- How can the other constraints identified be overcome at the individual, institutional and cross-institutional levels?
- What can INSEE as a professional society do to help its members overcome these constraints and hence make their work more effective?

Workshop format

The workshop was held at the Centre for Interdisciplinary Studies in Environment and Development (CISED), Institute for Social & Economic Change (ISEC) campus, Bangalore, from the evening of July 22nd through July 24th, 2001. It was structured in the form of four plenary sessions alternating with three roundtable sessions, followed by two concluding plenaries. The inaugural plenary session consisted of a keynote address on conceptualizing interdisciplinarity. It was preceded by a formal inauguration of the Centre for Interdisciplinary Studies in Environment and Development by Professor Madhav Gadgil. In the subsequent three plenaries, nine keynote speakers made presentations based on their personal experience in conducting interdisciplinary research on the environment. These presentations were divided into three themes, corresponding to three kinds of divisions or gaps that need to be bridged:

- The "big divide": Ecology and economics
- The "other divide": Ecology and other social sciences
- The "bigger divide"? Economics and other social sciences

The roundtable sessions were organized in the form of three concurrent discussions, each focusing on one of the following sectors: forests, agriculture and industrial pollution. Each roundtable met for three sessions during the course of the workshop. The objectives of the roundtables were to understand the constraints faced by the general participants in doing interdisciplinary work, to understand how a particular theme might be approached by different disciplines and to prepare an interdisciplinary research proposal on a particular theme as a learning experience. The roundtables actively involved the larger set of workshop participants, including general INSEE members and several doctoral students. Senior scholars (including some of the keynote speakers) acted as facilitators within each roundtable. The concluding two plenaries focused on summarizing the findings of the workshop and coming up with specific suggestions for how INSEE can foster interdisciplinarity through its activities.

Workshop participants

The primary participants in the workshop were 20 general INSEE members drawn from a pool of 45 members who expressed interest in the workshop. Given that the INSEE membership is drawn primarily from amongst economists, the majority of these members were inevitably economists. At the same time, a number of other disciplines were also represented, including sociology, forestry, geography, philosophy and political science. A few additional participants were drawn from the community of ecologists in Bangalore to provide the necessary balance. Five PhD scholars from ISEC, who are also INSEE members, acted as volunteers in the workshop.

The keynote speakers and session chairs consisted of eminent scholars from various disciplines including economics, sociology, anthropology, history, ecology, environmental science, climatology, engineering and science & technology studies.

Proceedings

The discussions in the workshop were extremely lively, each plenary session extending 30-60 minutes beyond its scheduled time. The discussions spanned questions of epistemology, values, world-views, theories, methods, the contents of curricula and the structures of institutions that bear upon the question of interdisciplinary research on the environment.

In order that the larger INSEE membership as well as others benefit from the workshop, INSEE decided to publish this workshop's proceedings, with a particular focus on the keynote presentations. In addition, the proceedings of one thematic roundtable have been included to illustrate how an interdisciplinary research agenda on a particular theme could be developed. The chapters follow the chronological order in which the keynote presentations were made. We end with a summary of the workshop discussions and the suggestions that emerged, particularly for INSEE.

Given the difficulty of persuading most keynote speakers to convert their oral presentations into formal papers, we decided that where written versions were not provided by the speakers we would use the taped transcripts of the presentations as the basis for the proceedings. These transcripts were then sent to the speakers for corrections, modifications, etc. In several cases, speakers took pains to revise the transcripts so as to make them more readable. One speaker, however, preferred that only a summary of his talk be published, and in two other cases, we did not get responses from the speakers and so have edited the transcripts to the best of our ability. Due to limitations of time, human resources and space, we are unable to include or even summarize the lively discussions that took place in each plenary session. Nevertheless, we believe that these proceedings will be of interest and benefit to all those who wish to pursue environmental research in a holistic manner and therefore wish to transcend the constraints imposed by individual academic disciplines.

Inaugural address

1. Reading between the lines: the disciplines and the environment

Sheila Jasanoff

Introduction: environment and interdisciplinarity

I was asked to speak about the challenges for education posed by the interdisciplinarity of fields like environmental economics. The difficulties are partly structural and partly epistemological. I will elaborate on both.

First, finding a niche for "the environment" in modern academia is difficult. Environmental research (which often cuts across disciplines) and teaching (which is usually grounded in disciplines) tend not to map well onto one another. Interdisciplinary work is often seen as applied, while disciplinary work, considered "basic," receives higher status and rewards, as well as more resources and academic positions. There are few systems in place for rewarding and promoting interdisciplinarity in universities.

Second, the language in which we speak of crossing disciplines is also muddled. For much of my life, I have had to field questions about the differences among interdisciplinarity, multi-disciplinarity, and transdisciplinarity. I would like to argue that we should not be making such simple semantic distinctions but should ask instead what we mean by a "discipline" and what work we expect this concept to do for us. In other words, I think the way to enter a fruitful exchange about the meaning of interdisciplinarity is first to look into the meanings of disciplinarity.

Representing and valuing the environment

Let me first digress for a moment about the emergence of environmental economics as a field of research and as an input to policy. Lately, economic representations of nature have become highly popular in policy circles, receiving support even from ecologists. A quotation will help make the point: "...one cannot make a convincing case that nature is undervalued without having a philosophical and empirical framework for assessing nature's values." (Daily, G. C. (ed.), 1997. *Nature's Services: Societal Dependence on Natural Ecosystems.* Washington, D.C., Island Press, p.23). Economic values are being attached to various "natural objects", from greenhouse gases to trees, reservoirs, wetlands, and rain forests. Without such valuation, many policy initiatives, particularly those relying on market instruments such as carbon trading, would not exist or make sense.

Initiatives such as these are referred to as interdisciplinary. The term seems to assume, unproblematically, that it is possible to place a value on nature simply by bringing into conversation the two "finished" disciplines that deal, respectively, with money and with nature (in this case economics and ecology). The reality is more complicated.

History of the concept of discipline

This view of how to combine or move across disciplines ignores the fact that "disciplines" are not themselves natural categories. They have histories and their names, content, and boundaries develop and change. The concept of the liberal arts, for instance, which still forms the basis for many US university curricula, came into vogue through the work of an African educational philosopher, Marcianus Capella (about 420 A.D.). Capella divided the branches of knowledge into the three categories of Trivium (Grammar, Rhetoric, Logic) and the four categories of the Quadrivium (Arithmetic, Geometry, Music, Astronomy). Our ideas of what is basic to the liberal arts has changed enormously since the 5th century, and—although we keep using the term liberal arts—our curricula are organized according to disciplinary principles that would be totally unrecognizable to a 5th century Roman.

How disciplined are disciplines?

We should therefore ask, to begin with, how disciplined the disciplines themselves are. Michel Foucault, the French philosopher and social theorist, offered an ironic perspective on the way disciplines structure knowledge in his classic work *The Order of Things.* He said there that his book arose from reading in a story by the great Argentinian writer Jorge Luis Borges of a Chinese system of classification. Borges mentioned a "certain Chinese encyclopedia" in which it is written that "animals are divided into: (a) belonging to the Emperor, (b) embalmed, (c) tame, (d) sucking pigs, (e) sirens, (f) fabulous (g) stray dogs, (h) included in the present classification, (i) frenzied, (j) innumerable, (k) drawn with a very fine camelhair brush, (l) et cetera, (m) having just broken the water pitcher, (n) that from a long way off look like flies. The very impossibility—to him—of this way of classifying animals moved Foucault first to laughter and then to reflecting on the limitations of our own modes of thought and to question where these come from.

Disciplinary formations

Once we start wondering about the history and authority of our own disciplines, we find that they are a lot odder than they appear at first glance. Take, for instance, a "standard field" such as political science in America. You will find in most US political science departments a mix of four sub-fields: American politics, comparative politics, international relations, and political theory. People are

hired into one of these areas—not, say, into environmental politics, political history, regulatory studies, or Asian or African politics. Yet, the idea of dividing up the study of politics into these four categories and no others is no less strange than Borges' Chinese encyclopedia.

Take, by contrast, an emerging field like Science and Technology Studies at Cornell University. I know this field well because I helped to found the Cornell department and chaired it for seven years. In a way, it is more coherent than political science because everyone in it studies science and technology. Yet, many people persist in regarding S & TS as "interdisciplinary" (while political science is seen as a discipline) and there are, as yet, no other major university departments exactly like the one at Cornell.

These examples suggest that it is most productive to approach any question of what disciplines are not from an essentialist perspective, which assumes they are real divisions of knowledge, but rather from a sociology of knowledge perspective, which asks how disciplines are formed and maintained—and how they exert power.

The power of the disciplines in relation to environmental studies

We have established, then, that the current structure of academic disciplines is historically and culturally contingent and that disciplines divide up the field of knowledge in ways that are far from "natural." Yet, these divisions have tremendous power to structure new fields of study such as the environment. Disciplines shape our perceptions regarding new issues and topics of study in at least four important ways:

- The reception of "the environment" within disciplines elevates some themes as being especially important. Such themes have included: *biodiversity, environmental ethics, environmental social movements.*
- Similarly, some interdisciplinary constructs are seen as more promising for research than others, such as the previously mentioned example of *ecosystem services.*
- Equally, some important concepts resist "disciplining" and hence pose challenges to research and teaching programs. Examples include: *sustainability, vulnerability, environmental justice.*
- Finally, disciplinary perspectives on the environment have tended to exclude some crucially important framing concepts that are implicated in virtually all decisions and actions related to the environment. Chief among these are: *development, power, and governance.*

Theorizing the disciplines

I come now to my final point To make genuine progress in thinking about interdisciplinarity, and how environmental studies can most productively fit across and between disciplines, I would argue that we need to have a better theoretical grasp of what disciplines accomplish in relation to knowledge. Foucault instructed us about the arbitrariness of disciplinary lines —lines created both by and within disciplines. But this arbitrariness, he also noted, produces its own kind of system, or order, in the world of knowledge. In other words, "disciplines order interdisciplinarity". What I mean by this somewhat cryptic idea is that disciplines operate in particular instrumental ways, and each such mode of operation carries with it a different sense of what interdisciplinarity might mean.

I will conclude by reviewing four ways in which we can theorize the interdisciplinary implications of disciplines. Each of the following four ways of thinking about the disciplines helps identify what they illuminate and what they leave invisible. In turn, each gives us a different strategy for thinking about the objectives of interdisciplinarity. I note that only the first of these models underlies conventional accounts of interdisciplinarity, and even then it is rarely explicit.

Disciplines as maps (the standard view)

As the philosopher of science Ian Hacking has observed, science not only represents but also intervenes in nature. In a similar sense, maps provide representations which also operate as tools of intervening. One need think only of colonial era navigational maps that took people to distant places from which they could bring back new resources. If disciplines are like maps, then the work of interdisciplinarity can be seen as threefold:

- Interdisciplinarity seeks partly to guide people carrying one disciplinary map to territories covered by other maps. It is a tool for mutual exploration and communication.
- Interdisciplinarity seeks to create "better" (richer, more detailed) maps by combining knowledge from two separate maps of the same territory. In the process, new ways of characterizing cognitive territories may emerge.
- Interdisciplinarity finds ways of illuminating areas that existing maps don't show.

But we should add three other ways of thinking about the discipline–interdiscipline relationship:

Disciplines as discourses

Through formal languages, disciplines offer us what the philosopher Nelson Goodman evocatively termed "ways of world-making." In this case, the task of interdisciplinarity would be to find new discourses to make apparent what earlier disciplinary formulations failed to account for. Consider examples like subaltern studies or environmental justice or science and technology studies.

Disciplines as models

By offering tools for modeling environmental processes (e.g. ecological and economic tools), disciplines help to identify causes and agents and to make predictions. In this context, interdisciplinarity can make visible the assumptions underlying disciplinary tools and enrich or correct deficient models.

Disciplines as standpoints

As historically and culturally situated ways of thought, disciplines create platforms for reflecting in particular ways on the human condition. From this perspective, the task of interdisciplinarity is to expose which issues are systematically excluded from disciplinary reflection, such as possibly issues of power, equity, and distribution in discipline-based studies of the environment.

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Theme 1: The big divide—ecology and economics

Session chair: Jyoti Parikh

2. Reconciling ecology and economics

Charles Perrings

Introduction

Ecological economics is a field with its roots in two quite different sets of disciplines. What I propose to do here is to consider the tensions involved in the combination of these disciplines. In what follows 'economics' stands broadly for the social sciences, and 'ecology' stands broadly for the natural sciences. My ultimate aim is to identify the essential differences between the disciplines, and what is needed to reconcile those differences if ecological economics is to be successful as a field of inquiry.

To begin, though, let us consider why multiple disciplines are needed in the first place. Figure 1 illustrates a number of major global trends. The trends in CO_2 and other greenhouse gas emissions may be the most familiar. But trends in nitrogen fixation, land cover and species extinction are only marginally less well known. The common feature of all of these trends is that they are at least partially anthropogenic. There are common threads running through them and those threads are human behaviour and economic development. At the same time, the trends *themselves reflect environmental responses* to human pressures. One cannot understand these trends unless one studies the underlying drivers of both human behaviour and environmental responses. This necessarily involves collaboration with colleagues across the boundaries between the natural and the social sciences.

The valuation of environmental resources

Why is it so difficult to do this? In the balance of this paper I am going to consider the particular topic of the "valuation" of environmental resources. This topic turns out to illustrate the problem nicely. Let me give you an example that will later be developed in more detail – the valuation of biodiversity and, in particular, the valuation of functional diversity. Most of those present here are economists. So, let me first ask why ecologists interested in this problem would wish to collaborate with economists, and then answer the question as to why economists need to collaborate with ecologists. Ecologists are generally very clear *in their own minds* that whatever their science is about, it is not about human behaviour. Their science may tell them that something is wrong when human pressure causes the loss of biodiversity, but it does not tell them why it is wrong or how it can be fixed. So, from an ecological standpoint, there is an obvious case for interaction with economists.

Looking at the same problem from the economist's viewpoint, the immediate answer to the question why economists should collaborate with ecologists in the valuation of biodiversity appears to be that there is no obvious reason to collaborate. Table 1 summarises the results of a selection of valuation studies. It is drawn from the Global Biodiversity Assessment that I was associated with a few years ago. What almost all these studies did was to take a certain number of products which happened to derive from the environment, and which were marketed either directly or indirectly, and then to estimate the market value of these products. Hardly any of these studies involved natural scientists, and given what they were trying to do it could be argued that it was not really necessary to do so. With a knowledge of the products sold, their opportunity costs could be calculated or at least approximated.

The contingent valuation of environmental resources is an example of what economists can do without the involvement of anyone else. Contingent valuation involves a standard social science survey technique—it is a type of market research. Admittedly, it can be done more effectively if the researcher understands the psychology of the exercise. But it is not a technique that requires any input from the environmental sciences beyond a few lines at the top of the survey to describe what is being valued. Questions such as 'what are you willing to pay to conserve an elephant?' or 'would you be willing to pay x to increase/decrease the probability of the extinction of the Northern Spotted Owl?' require some initial information. This might cover the relation between the size of a protected forest and the probability of the extinction of the animal concerned. But the information required is very limited. So, it appears to economists that they can do their business without ecologists.

This is a misconception. Consider the different components of value. A lot of the products covered in Table 1 come under the heading of 'direct use value'. Economists can estimate direct use value reasonably well without input from other sciences. They can also estimate things like bequest value (the value accorded by people to the probability that some asset will be left intact for their heirs) and at least some option values. For instance, economists can easily elicit statements of what people would be willing to pay in order to gain access to a national park, not next year but, say, ten years in the future. But economists cannot estimate the value of ecosystem functions and processes without the assistance of natural scientists. That is, they cannot estimate the indirect use value of ecological services without some understanding of ecological science.

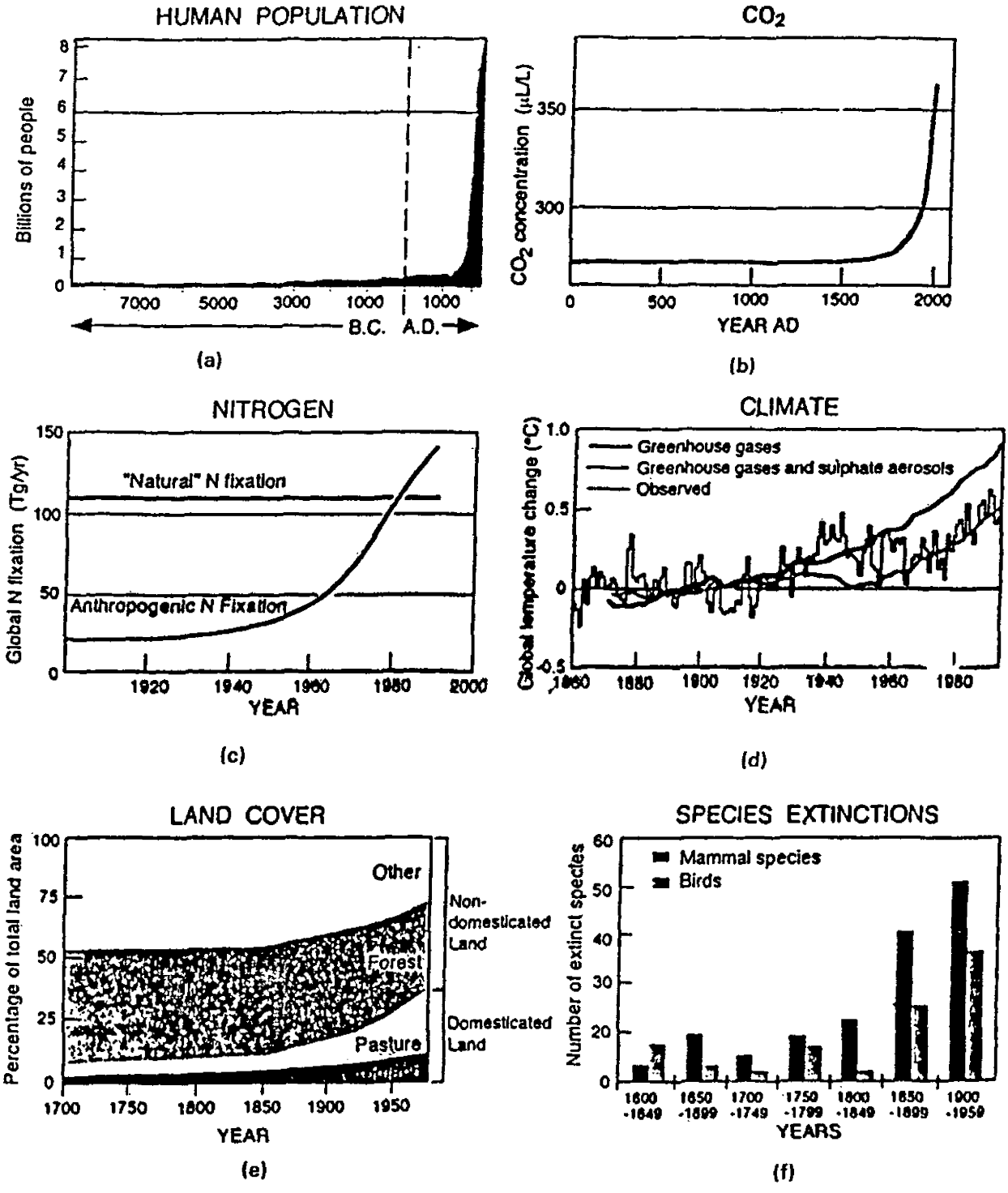

Figure 1: Some components of global change: (a) increase in human population; (b) increase in atmospheric CO concentration; (c) anthropogenic alteration of the nitrogen cycle; (d) modelled and observed change in global mea temperature; (e) change in global land cover; and (f) increase in extinction of birds and mammals. Source: Hey wood, 1995.

Table 1: Direct use values of tropical forest habitats

Location	($/ha/yr)	Comments	Source
Venezuela	0.75	Experimental caiman harvest	Thorbjanarson (1991)
Korup National Park	1.06	Net present value of foregone gross benefits from hunting = $2.7 m at a 5% discount rate; area = 126,000 ha; hunting said to be non-sustainable.	Ruitenbeck (1988) and Infield (1988)
Mudumalai Sanctuary, South India	3.0	0.02 elephants/ha at $1,500 per elephant. Excludes cost of domestication and training. Price refers to a domesticated animal. Assume a 10% discount rate.	Sukamar (1989) and personal communication
Ituri Forest, Zaire	0.50-3.18	318 kg of game/km^2 of primary forest of 50 kg/km^2 in climax forest at $1/kg. Estimate leaves out costs. Price is for prized meats.	Wilkie (1989) and Wilkie and Curran (1991)
Amazon, Brazil	4.8	Estimate is gross return/ha/year; flora only.	Schwartzman (1989)
Sarawak, Malaysia	8.00	Values wildlife in one square kilometre.	Caldecott (1987)
Maya Biosphere Reserve, Guatemala	10.00	550,000 hectares produce about $5.5 million/year in exports of chichle, xate palm, and allspice; gross value.	Nations (1992)
Western Amazonia	5-16	Gross value varies by the size of the extraction area (150 to 300 hectares).	Hecht (1992)
Cross River National Park	16.50	Yearly income from hunting, gathering, trapping = $826, Naira/person = $108; population = 38,300; area = 250,000 hectares. Gross value.	Ruitenbeck (1989)
Iquitos, Peru	16-22	Based in part on villagers' dairies.	Padoch & de Jong (1989)
Iquitos, Peru	20	Potential value of about six species of latex and fruits.	Pinedo-Vasques, Zarin Jip (1992)
Hantana, Sri Lanka	50	50 randomly chosen household surveyed in three villages; used contingent valuation and opportunity cost approach; estimate leaves out cost of extraction.	Abeygunawardena & Wickramasinghe (1992)
Kalimantan, Indonesia	53	Includes kernel, charcoal, and feed meal of babassu palm. Unclear if returns net or gross.	Anderson, May & Balick (1991)
Combu Island, Guama River, Brazil	79	$3171/year/family; average of 5 families in 1984-1988. Estimate is gross value and only includes semi-wild cacao, acai, and rubber. Assumes each family worked 40 ha of forest.	Anderson and Ioris (1992)
Tamil Nadu, India	80	Fuel and fodder.	Appasamy (1993)
Brazil	97	Value of Brazil nuts only ($/ha); Collector's price = 97; Exporter's price = 176; Retail price = 1059.	Mori (1992)
Para, Brazil	110	Value after selective thinning of competitors and pruning of acai palm.	Anderson (1990b)
Veracruz, Mexico	116	Estimate leaves out lumber and coffee.	Alcorn (1989)
Amazon, Ecuador	120	Values wildlife over 500 square kilometres.	Pauca and Gardner (1981)
India	117-144	Gross benefits; includes fruits, herbs and medicinal plants.	Chopra (1993)
Iquitos, Peru	420	Values the inventory in one hectare, only includes plants.	Peters, Gentry and Mendelsohn (1989)
Belize	36-166	Medicinal plants; 5% discount rate.	Balick & Mendelsohn (1992)

Source: Heywood (1995)

Ethical and moral questions

The first plenary suggested that the valuation of ecosystem functions requires recognition by both ecologists and economists that each needs the other. I will later consider an example that illustrates this. But first, we need to understand why natural scientists find it difficult to work with economists. Several years ago *The Economist* published a leaked memorandum from the World Bank that argued the economic case for encouraging more migration of the 'dirty' industries to developing countries. One of the points made was that measurement of the cost of sickness due to pollution depends on foregone earnings. Hence, it is logical to locate polluting industries in places where foregone earnings are lowest. The memorandum claimed that the economic logic behind dumping toxic waste in the lowest-wage countries was 'impeccable'. Needless to say, natural scientists get alarmed when they see arguments of this sort. To understand why, we need to understand the philosophical underpinnings of economic valuation, and how these mesh with the vision that scientists have of the importance of the natural elements of our world.

Economists generally believe in a utilitarian framework. They evaluate alternatives in terms of a measure of performance relative to some index of social well-being, defined by a social welfare function. There is a belief that welfare is in some sense cardinally measurable, and that

the welfare of different individuals can be aggregated both across space and over time. The essence of the utilitarian approach is that it allows alternatives to be ranked in terms of their contribution to social welfare by using measures such as willingness to accept and willingness to pay. This ranking then guides the actions of decision-makers through a set of familiar benefit-cost tools.

A different philosophical view on the evaluations of alternatives is that associated with the philosopher, Emmanuel Kant. Kant held that decisions are guided not by a utilitarian ranking of alternatives, but by a set of moral rules. It is a strongly normative approach. Kant argued that individuals should never act except in such a way that should wish that their own rules should apply to the rest of society i.e., "do as you would be done by." This creates a set of moral imperatives. Instead of asking questions about how an action will benefit oneself, one instead asks questions about how one *should* act given the nature of society and the institutional conditions that govern it. Other philosophical positions that support such an approach include that of John Locke, and the more modern 'justice as opportunity' approach. Sagos's notion that people separate out in their minds decisions made as individuals and as citizens, has elements of a Kantian deontological approach.

Many natural scientists implicitly approach the valuation of environmental resources in a Kantian way. A modern environment philosopher, Norton (1989), has provided a simple way of thinking about the scientists' problem. Figure 2 reproduces his decision box. One axis of this box measures the severity of the environmental effects of economic decisions. The other axis measures the degree of reversibility of those effects. The top left-hand corner of the box indicates those decisions that lead to very severe irreversible outcomes while the bottom right-hand corner shows trivial reversible outcomes. Norton's argument is that decisions involving severe irreversible costs (i.e. near the top left-hand corner) are too important to be determined using simple benefit-cost tools. If the environmental effects of economic activities are trivial and reversible, then benefit-cost analysis is acceptable. Using the traffic light model, he identifies three decision zones: 'red' which is in the top left hand corner of his decision box, 'green' which is in the bottom right hand corner, and 'amber' which is in the middle. He claims that only if one is in the green zone is it acceptable to apply benefit-cost rules. If one is in the 'red' zone, then the Kantian moral rules apply. A lot of ecologists think about the problem in a similar way. They tend to draw lines in the sand where economics and economists should not trespass.

Of course, it is important to note that even when doing benefit-cost analysis, there are very strong ethical considerations. If one looks at a standard benefit-cost rule, the choice of time horizon, the choice of discount rate and the selection of the vector of benefits involve important ethical judgements. So, even when we are looking at the decision zone where we thinks it safe to let economists loose, we cannot assume that the result will be free of ethical judgements.

Differences in scientific method

It is now time to get to the concrete differences between the two disciplines. First of all, consider the scientific methods of the natural and the social sciences. Everyone familiar with papers in economics will be familiar with their typical structure: Introduction, The Model, Estimation of the Model, Policy Implications, and Conclusions. By contrast a paper in ecology will typically comprise: Introduction, The Data, Analysis of the Data, Implications for Theory, and Conclusions. Ecologists typically operate from data towards theory, while economists typically operate from theory towards data, or more particularly, towards an estimation of that theory. That is, the two disciplines tend to operate at different ends of the spectrum. Collaboration with natural scientists necessarily forces social scientists into a different mode of thinking, and a realisation that the model needs to fit the data. If a model does not fit the data, then the model had better be adjusted.

Other major differences between economics and ecology include the spatial and temporal scales of economic and ecological analysis. Economists typically work on problems with a time-frame of a month or two to 25 years. Ecologists typically work on problems with a time frame of anything up to several hundred years. They are generally not interested in problems that can be grappled through the space of one year. These differences have to be reconciled. There are also problems of aggregation. For example, range ecologists typically model the growth of every blade of grass on the range. It is neither possible nor desirable for range economists to do the same. This is partly because optimisation requires that models be relatively tractable, and anyone who has tried to work with optimal control theory knows that finding a solution where there are two or more state variables is very difficult. So economists tend to aggregate while the ecologists tend to disaggregate.

In practice, the most common way of dealing with such differences is to separate the work of the disciplines. The multi-disciplinary approach to environmental science involves each discipline working on the same problem but from its own perspective, generating its own models and data, and reaching its own conclusions. The approach adopted in ecological economics is interdisciplinary (sometimes referred to as transdisciplinary) rather than multi-disciplinary. In this approach the problem drives the

structure of the models. The various disciplines involved don't do their work separately, but reconcile differences in the concepts and the methods applied, differences in the spatial and temporal dimensions of the problem, the degree of aggregation or disaggregation and so on.

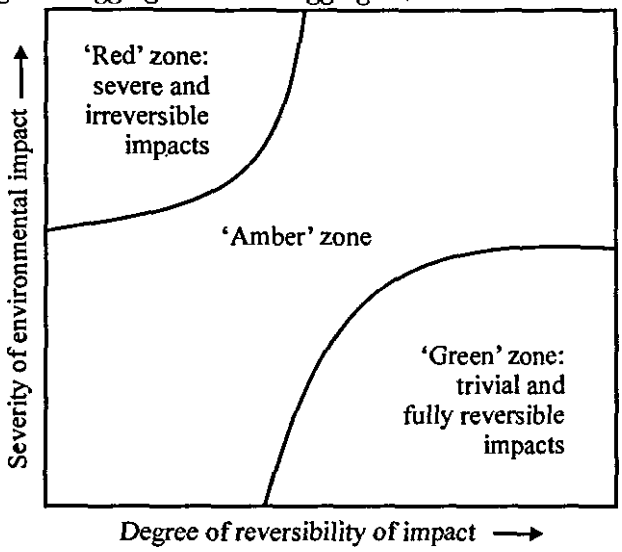

Figure 2: Norton's decision box

Functional biodiversity: a valuation example

To illustrate, let me take the example of the valuation of functional biodiversity. The reason for looking specifically at functional diversity is that if one wants to understand and value ecosystem functions, this is the aspect of biodiversity that matters. Biodiversity loss usually refers to two different things. One is the irreversible loss of genetic information caused by the extinction of species (this is an intergenerational global public good) (Sandler, 1999). The other is the exclusion or deletion of species populations from managed ecosystems. This may or may not mean that the excluded species is at risk of extinction. Once again there is a public good at stake—indeed a set of public good. But these are local public good. Examples include watershed protection and the mitigation of floods and droughts, waste assimilation, detoxification and decomposition, microclimatic stabilisation, the purification of air and water, the generation and renewal of soil and its fertility, the pollination of crops and other vegetation, the control of agricultural pests, the dispersal of seeds and the transport of nutrients (Daily, 1997). These services are provided over a range of spatial and temporal scales.

At both local and global levels, the public good nature of biodiversity conservation implies that if it is left to the market there will be too little conservation effort. But because biodiversity conservation is an impure public good; i.e. a public good yielding both locally or nationally capturable benefits as well as a set of non-exclusive and non-rival benefits to a wider community, there will be some conservation effort. In the absence of cooperation, the level of conservation effort will be determined by the privately capturable value of conservation.

The economist's approach to the problem is to model the supply of the public good—in this case biodiversity conservation. Suppose that V^i denotes the welfare of the ith of n communities, which we take to depend on consumption of a bundle of market goods, x^i, and a global public good, biodiversity conservation, $Y = (y_1, y_2, \ldots, y_n)$. If there are m members of that community, the optimal commitment of resources to conservation by that community requires the solution to a public good problem in which $V^i = V^i(U^i_1, \ldots, U^i_m)$ and $U^i_j = U^i_j(x_i, y_{jj}, y_{i1}, \ldots, y_{im})$ for all $j = 1, \ldots, m$. Each of the m members of the ith community has an incentive to free-ride on the conservation efforts of other members of that community, and to neglect the benefit that their own conservation efforts confer on other members of the same community.

Formally, the problem faced by the ith community is of the general form:

$$\max_{xi,yi} V^i = V^i(x^i, y^i, Y)$$

That is, the ith community obtains benefits directly from its own conservation effort, y^i, and from the global benefits offered by its contribution to the global conservation effort, Y.

Barbier and Perrings (2001) pose the problem for the ith community in the following way:

$$\max_{xi,ui} V^i(.) = V^i(x^i, y^i, C(Y,Z)|x^i + py^i = I^i)$$

where $C(Y,Z)$ is a conservation function, which is increasing in the size of the global public good (the level of biodiversity), $Y, C_Y > 0$, and the resources committed to conservation, $Z, C_Z > 0$. If all communities behave in a noncooperative way, the welfare of the ith community is maximised where:

$$\frac{V^i_{Y^i}}{V^i_{x^i}} = p - \frac{V^i_c}{V^i_{x^i}} C_{y^i}$$

whereas the welfare of the global community requires that:

$$\frac{V^i_{Y^i}}{V^i_{x^i}} = p - \sum_i \frac{V^i_c}{V^i_{x^i}} C_Y$$

The extra terms in this reflect the conservation benefits that the ith community confers on others. If the 'cost' of conservation is denoted w, then the globally optimal level of conservation will satisfy:

$$\frac{V^i_{Y^i}}{V^i_{x^i}} = p - w\frac{C_Y}{Y_Z}$$

The value of individual species derives from the value of the goods and services those species support. The value of the mix of species-biodiversity is derived in essentially the same way. Biodiversity underpins the production of goods and services over a range of environmental conditions. In ecological terms, it ensures that the ecosystems supporting the production of goods and services are resilient, where resilience is measured by the capacity of a system to retain productivity following disturbance (Holling, 1973; Levin et al., 1998). In economic terms, biodiversity is equivalent to a portfolio of assets, and community conservation effort is equivalent to investment in that portfolio (Perrings et al., 1992; Perrings, 1995). The level of community conservation effort (investment in biodiversity) will depend on both the mean yield of the portfolio, and the covariance in yields. The Capital Asset Pricing Model indicates that investors will only be rewarded by the market for risks that cannot be diversified away by holding an efficient portfolio of assets. If different species vary in their sensitivity to environmental change, then reducing the variety of species included by the community in its portfolio increases the risk borne by the community. Lower diversity increases mean yields (at least in the short run) but increases risk. Conversely, greater diversity reduces overall risk, but at the potential expense of lower mean yields. The community's attitude towards risk will determine how much it is concerned about the effect of diversity on the variance of yields.

The value of the functional diversity of species may therefore be derived from the value of the services they provide. This requires the specification of a 'production function' describing the relationship between environmental inputs and economic outputs. If an ecological service depends on the contribution of a different set of organisms under one possible state of nature than it does under another, and if the output has value under both states of nature, then both sets of organisms will have derived value.

The physical effects of changes in biodiversity on ecosystem services are determined, then valued in terms of the change in the output of activities that depend on those services. Consider the following simple example. Suppose that Q is the marketed output of an economic activity, that $x = x_1, \ldots, x_n =$ denotes produced inputs (capital, labour, materials, etc), that R denotes the exploited ecosystem, and that $\mathbf{s} = s_1, \ldots, s_m$, denotes the set of species in that ecosystem. It follows that we can specify a 'production function':

$$Q = Q(x_1, \ldots, x_n, R(s_1, \ldots, s_m))$$

Suppose that P is the price of output Q and if the value of the ith species, w_i, is the value of the marginal impact of that species:

$$w_i = P\mathrm{d}Q/\mathrm{d}R.\mathrm{d}R/\mathrm{d}s_i$$

If a change in the abundance of the ith species affects the abundance of other species in the community, then the value of the ith species is

$$w_i = P\mathrm{d}Q/\mathrm{d}R(\mathrm{d}R/\mathrm{d}s_i + \mathrm{d}R/\mathrm{d}s.\mathrm{d}s/\mathrm{d}s_i)$$

Both equations say that the value of the ith species is the value of it marginal physical product. In the second case this is the value of the marginal physical product of the ith species directly, plus the indirect impact of a change in the relative abundance of the ith species or the other species in the system.

The important point here is that the estimation of the value of the ith species is not something that economists can do alone. It requires the specification and estimation of the functional form of $R(.)$, and this is pure ecology. At the same time, $R(.)$ has to be specified as an element in the production of economic goods and services, and this means that it has to be compatible with the general production function $Q(.)$. It has to refer to the same spatial and temporal structure, to the same units of measurement. It must also have a compatible mathematical structure. This is ecology, but it is an ecology different from the norm. It is the ecology needed to implement an ecological-economics research agenda, not a traditional ecology research agenda.

Concluding remarks

In conclusion, my experience of working with ecologists for a number of years is that the changes that need to take place in the way that each approaches the task takes time. It is not something that can happen overnight. There is a great deal of learning to be done on both sides and a great barrier of mistrust that needs to be overcome. The barrier of mistrust, as I have earlier suggested, has as much to do with the philosophical dispute about the relevant role of economists in the valuation of goods and services as it does with technical disagreements over data, model structure, etc. These last-mentioned problems can be handled. There are ways of dealing with data differences. The dimensions of the model can be reconciled. The hardest thing of all is to breach that gulf of mistrust. But once that is done, the power of an ecological economics approach to environmental problems can be realised. The world is your oyster.

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3. Exploring the ecology–economics divide in the context of climate change

Anand Patwardhan

Introduction: the climate change context

Climate change provides a useful and topical context in which to explore issues of interdisciplinary research, and in particular, the divide between ecology and economics, which can be regarded as a proxy for the larger divide between the natural and the social sciences. This is because the problem of climate change has certain unique features that make discipline-based analysis not only intractable, but often not very useful, or relevant. This paper uses the experiences accumulated while working in the area of climate change to highlight the divide and to analyze the efforts to bridge the gap. In particular, we examine "Integrated Assessment", a new area of interdisciplinary research that is often regarded as an approach that seeks to bridge this divide.

This paper is organized in the following way. We begin with an overview of the problem of climate change, and identify some of the challenges facing policy analysis of climate change. We then examine Integrated Assessment as an approach for aiding the process of policy analysis in this context, and also as an approach for conducting interdisciplinary research. We conclude with some thoughts on interdisciplinary research.

The issue of climate change is well known today. The problem arises as a result of an increase in the atmospheric concentrations of *radiatively active* trace gases such as carbon dioxide, methane, nitrousoxide and fluorocarbons which lead to a change in the radiative balance which in turn leads to changes in the climate system. These changes in the climate system may be described in terms of changes in the mean values and statistics of climate variables such as temperature and precipitation, as well as changes in larger weather patterns such as the Summer Monsoon, or the El Niño Southern Oscillation (ENSO).

The current evidence for climate change is quite strong, and the link between human activity, emission of greenhouse gases and future climate change has been reviewed in the recent reports of the Intergovernmental Panel on Climate Change (IPCC). As an example, Figure 1 plots the historical record of the co-evolution of carbon dioxide and global mean temperatures over the last one hundred and fifty thousand years. As the figure indicates, there is very high correlation between these two variables.

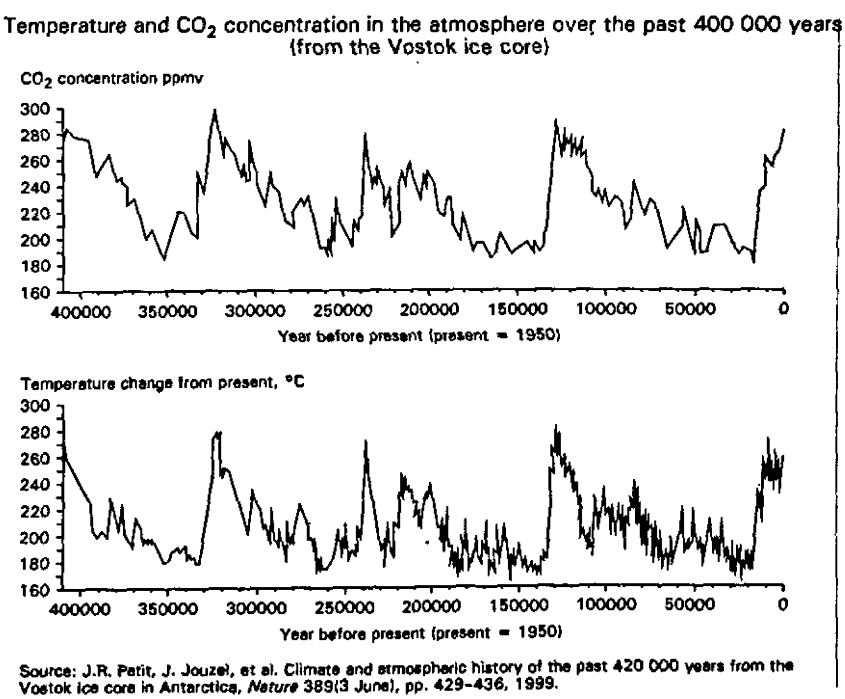

Figure 1: Carbon dioxide and temperature

Figure 2 plots the recent record of global mean surface temperature, indicating increase in global surface temperature in the recent past. The primary cause of climate change is the emission of greenhouse gases. There are a number of greenhouse gases, the most important of which is carbon dioxide, followed by methane. The relative contribution of the different greenhouse gases is illustrated in Figure 3. CO_2 is often used as a proxy while discussing future trajectories of greenhouse gases.

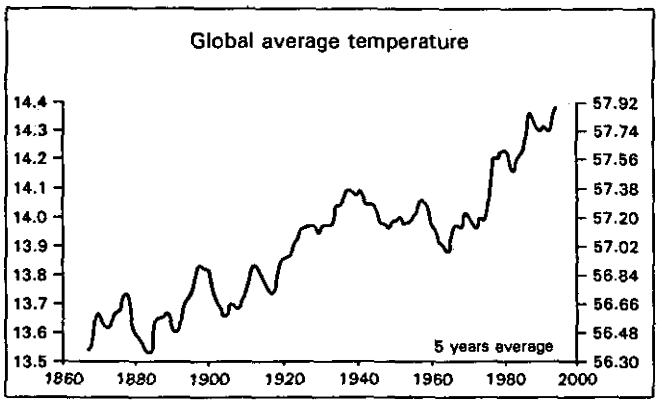

Figure 2: Historical record of global surface temperature

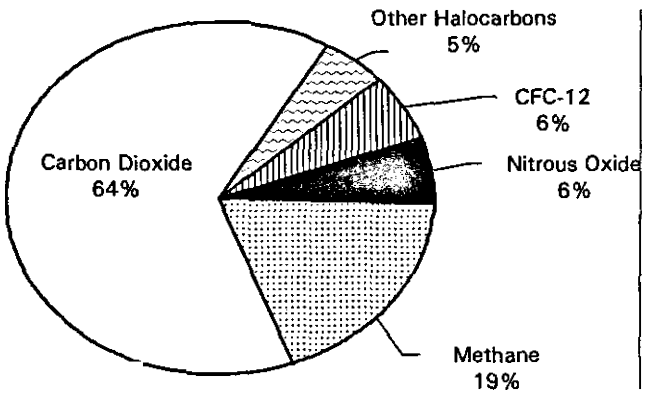

Figure 3: Relative importance of different greenhouse gases

CO_2 emissions are associated with the use of fossil fuels, primarily in the transportation and energy infrastructure. Figure 4 shows the total world emissions broken down into regions in 1995 with a projection for the year 2035. As the figure suggests, developed countries dominate greenhouse gas emissions today, although developing countries are rapidly catching up, and are likely to equal the developed world in aggregate terms two or three decades from today. If one considers the fact that climate change is a result of cumulative emissions from pre-industrial times, the relative magnitude of the responsibility of developed countries is even greater.

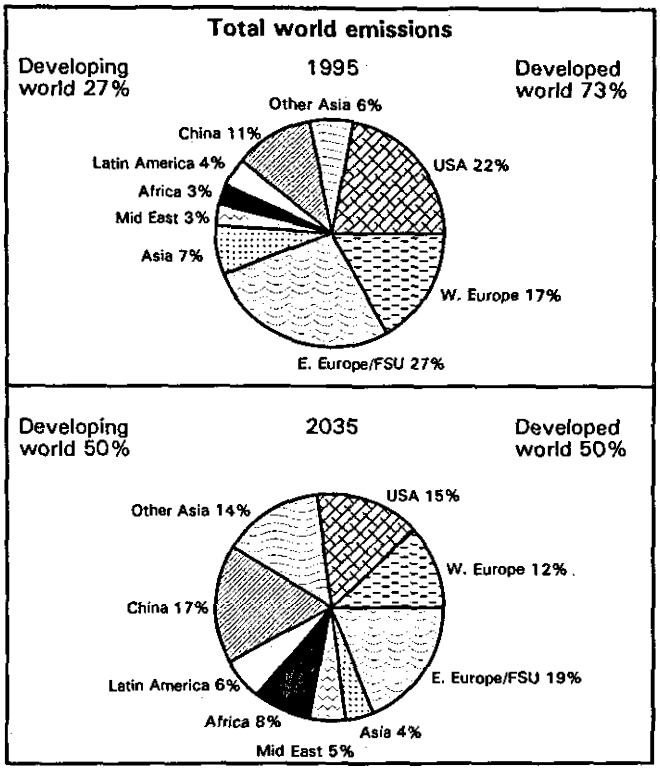

Figure 4: World emissions in 1995 and 2035

Climate change and the ecology–economics divide

The interaction between ecology and economics becomes more and more pronounced as one moves from an evaluation of the causes and processes of climate change to the assessment of the consequences. For example, as long as the objective is to describe the evolution of the physical climate system, the analysis and research fall squarely within the domain of the natural sciences, and disciplines such as meteorology, oceanography, and biogeochemistry. The models, tools and related analytical methods emphasize quantitative and mathematical formulations of the problem. The primary assessment tools are coupled ocean-atmosphere-biosphere general circulation models that are evaluated using advanced computers. Climate change science thus represents a natural evolution for the individual disciplines that studied components of the problem domain. For this reason, attempts to create a more unified "Earth System Science" have been reasonably successful, and interaction and interdisciplinary work within the natural science domain somewhat more prevalent.

As the objective has shifted now to being able to describe and perhaps quantify the consequences of climate change for human socio-economic and natural systems, the need for bridging the natural—social science divide becomes more urgent. While doing this, it is worth noting that predictions of climate change are very uncertain and

that these models do not represent very well important phenomena such as the monsoon or the El Niño oscillation. The importance of this is of course that when one steps from the realm of pure predictions or trying to understand what is likely to happen to climate systems in the future to the question of what is likely to be the impact of those changes on socio-economic or natural systems, one starts seeing the problem of taking predictions that are uncertain and do not capture natural phenomena adequately and using them to understand what is happening to impacts.

Unique features of climate change problem

Among the range of environmental problems confronting society today, climate change is perhaps the most complex and intractable. This is not only because it is a global issue, but also because the physical nature of the climate system poses some unique challenges when trying to assess future consequences. Some of these are summarized below.

The first of these is that the physical climate system acts as an integrator that means that the response of the system ensues from the cumulative effect of the entire forcing history. It is not a situation where one has a response, which is proximate to the cause, in either a spatial or a temporal sense. The cause may have happened around 150 years ago but the system has integrated the entire forcing and the response is a result of that. This automatically means one needs to look at human activity not as of today but over a fairly long time-scale in the past.

The second issue pertains to the dynamical behavior of the climate system. The ocean-atmospheric system exhibits lags in response on a variety of time-scales. As a result the response of the system may manifest itself decades or even centuries after the forcing has been applied. As a result even if today the emissions were to be stabilized in some magical manner, it would take many years for the climate system to reach some other relatively stable state. This means that one is already committed to some level of climate change. The implication for developing countries is that regardless of the outcome of the international negotiations or agreements such as the Kyoto Protocol, they will be exposed to some level of change, which, however, may take many decades to manifest itself.

The third observation is that the actual manifestation of climate change is likely to result from very proximate events like monsoons, tropical cyclones, heat and cold waves, wet and dry spells in monsoon rainfall, etc. So, the place where there is an immediate climate to societal/economic link is where one is likely to see the manifestation of those impacts and not so much in gradual changes although the ways the models are calculated may indicate otherwise. What will actually be perceived are changes in climate phenomena which are much more proximate to us in terms of space and time. The spatial distribution of these impacts is also likely to vary considerably which means that not all parts of the world may be equally affected and some may actually be benefited. In fact, as the recent IPCC reports suggest, developing countries are likely to be more severely affected as a result of climate change. In terms of the negotiations, not only do we have to contend with differentiated responsibility in terms of who is causing the problem but also have to cope with the differentiated outcome of the impact on different societies and groups.

Implications for policy analysis

The analysis of policies in the context of climate change has to address the unique features of the problem. It is therefore worth exploring whether the underlying assumptions in conventional policy analysis hold, and if they don't, then how should the issue be addressed and what is the mechanism that should be used to go beyond what can be done now? Some of the assumptions are well known. A number of models that look at climate change mitigation use the idea of a global commoner—a single rational actor who will behave in a particular way when it comes to taking action. This assumption is clearly not valid—the climate problem is one where there are multiple stakeholders at a variety of scales—subnational, national as well as transnational.

Another very common assumption in the assessment of impacts is that they are of manageable size and can be valued at the margin (*ceteris paribus*, in economic terms). While this assumption may hold in developed countries for specific sectors, it may not hold in many other contexts, for example, in island states like say the Maldives an attempt at marginal analysis may result in a loss of perhaps 30% of its land area. When analysing impacts, one has a tendency to do a partial equilibrium study which assumes that everything else being constant, one can for example consider sea-level rise. But if sea-level rise is a dominant physical process that is going to affect a large part of the economic system, is it reasonable to assume that everything else can be kept constant while one set of effects are being evaluated?

Another common assumption and one that has been mentioned earlier is that when values and preferences are known, one can apply the decision-rule of expected utility maximization. The issue of decision-rules is again quite complex, and it may be argued that in the climate problem, one may need to explore other rules, such as the precautionary principle, or ethics/rights based rules.

The final example pertains to uncertainty. It is often assumed that uncertainty is modest and that in some way the changes that are going to take place can be treated

as incremental, partly-known or at least can be quantified in terms of probability-distribution so that one can understand the likely distribution of future climate change. This does not take into account the fact that the natural system often behaves in extremely non-linear ways and that there could be an element of surprise. This is again an area where the linkage between the natural sciences and economics becomes very clear. If one has to somehow deal with the concept of surprise or non-linear response of the natural system, one has to really understand what may happen in the natural system.

A final area where the integration of ecology and economics is critical is in the context of studying adaptation. One of the points mentioned earlier is that though it may be assumed that values and preferences remain stable, this may not be actually so while looking at a time-frame of say a 100 years. It is certain that people are going to change and their preferences, whether it be with reference to natural resources or other things, are not going to remain stable. One of the ways that this is described in models is through the process of adaptation where it is common knowledge that human systems adapt to the environment and the situation around them. Adaptation is often represented as cost-less, something like a switch which is thrown and people adapt and thus it can be decided in what manner the effects on them can be treated. But this may not always happen. Adaptation always involves some process of transition. More importantly, in the case of natural systems, one may not be left with the option or opportunity to adapt.

Integrated assessment: a tool for bridging the divide

The previous discussion has highlighted a number of challenges posed by the climate change problem, and the need for bridging the ecology-economics divide. Integrated Assessment (IA) came into being many years ago as an approach that would try and reconcile some of these differences. The logic here is that if one really needs to make progress in understanding climate change and how to respond to it, one needs an approach that will be able to combine insights from different disciplines to obtain a perspective that is not available from an individual discipline. The underlying objective behind integrated assessment is to provide policy-relevant insights.

The important question that is of relevance now is the defining of Integrated Assessment. There is a lot of disagreement on this issue as is probably the case with many interdisciplinary areas that are striving for a definition. For example, is IA a single model, a modelling approach, a methodology or is it a process in which one gets people to work together and the integration happens because of the process? One can see all the three things happening. The practitioners of IA have largely been drawn from both the natural sciences and the economics communities. A large part of IA consists of models where one believes that building the model is the real vehicle for integration and that the model actually serves as the tool for bridging the divide—this will make it possible to combine insights from different disciplines because one will be able to put them together in a combined modeling framework which becomes the vehicle for integration. There is a wide variety of models and they could follow either the economics or the natural science paradigm depending upon what the practitioners choose to apply. There are broadly two types of IA models: Policy Evaluation Models & Policy Optimisation Models. Policy evaluation models emphasize process realism. Here the objective is to capture as much of the system as possible within the modeling framework. On the other hand, the policy optimisation models, whether they choose to measure cost-effectiveness or cost-benefit, often choose to focus on consistency where an attempt is made to get a macro-level description where all the parts are consistent with each other. These models are used to produce a number of insights.

Features (bugs) of IA models

Users vs practitioners

The basic problems of models are the fact that the user and practitioner communities are different. The user community determines the value of the insight but it is the practitioner community which has to determine whether the integration has been adequate or not. The issue of quality is determined by the practitioners. This is unlike many areas of the natural sciences, where there is no such distinction between a user and a practitioner community.

Anchoring to parent disciplines

With regard to anchoring, models have never really been able to cut the umbilical cord connecting them to their parent discipline. They have always been anchored to the basic assumptions of their original disciplines. The modeling paradigm itself meant that certain aspects could not be included because they could not fit into a modelling framework.

Quality

Quality is a very important issue in interdisciplinary work and applicable to the issues of climate change and IA. How can one judge adequacy or the quality of models? If models are heuristic tools, how is it possible to evaluate judgments/insights that the models provide? If the model is going to be used for making forecasts, then it is a question of evaluating performance and the problems of peer review.

Transparency and communication

If the goal of IA is to provide insights to the policy community, then issues of transparency and communication are of paramount importance. How are the results being communicated to the users? What does one have to communicate? How does one ensure that the results are binding in terms of what they are used for keeping in mind the great divide between the user and practitioner groups.

Finally, it is important to ask and examine whether IA is only an interdisciplinary approach or a new discipline? Over the years, there have been a number of attempts to create interdisciplinary contexts for the exploration of scientific issues. Some of these have, over time, evolved to become full-fledged academic disciplines. Attempts have been made to create new disciplines in academic communities over a period of time like System Dynamics, and Sustainability Science. A similar effort has taken place in Integrated Assessment also. There is now a "Society" for Integrated Assessment, a journal and the notion that a community has to be created to define the new discipline.

Conclusions

While discussing the issue of the ecology–economics divide, it is important to ask ourselves whether this requires the creation of new disciplines that act as a bridge—whether one talks about "ecological economics" or integrated assessment. If the underlying motivation is to improve the understanding of processes, focus on problems and solve them, is it then necessary to create a new discipline for this objective? These were the underlying motivations for developing Integrated Assessment as a model. If that was the reason for creating the bridge for interdisciplinary work, is this the only way or are there other ways too? Perhaps another route to integration could be through creating human resources, and have the integration performed internally! For example, many of the researchers in INSEE are living examples of integration within themselves and of interdisciplinarity, because in their training and in the work that they are doing they are consciously combining insights from different disciplines. So is there really a need to create a new discipline or is it possible to actually get people to be the vehicle for integration? Will this really work in a real setting where one has to worry about careers, institutions and how their rules and policies are framed?

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4. Incremental cost of achieving global environmental benefits: a tiny bridge between environment and economics

Dilip Ahuja

Introduction

An attempt will be made here to briefly describe the development of the concept of incremental costs; its application to the global environmental arena and how it tries to cross the divide between economics and environment.

The concept of incremental costs was not set up for the global environmental treaties that came about in the late 1980s and the early 1990s but it has a longer history. It had earlier been used in Project Economics. For example, if the optimum height of a dam has to be decided, we estimate the cost of, say, one foot or one metre of the dam, add to it the cost of resettlement on account of increased submergence, and compare this with the increased benefits from irrigation and the electricity that would be generated. The application of a standard economic cost-benefit analysis would recommend increasing the height until the marginal cost of the extra one foot or metre equals the benefit derived. The height of the bridge will continue being increased as long as the incremental benefits are in excess of incremental costs.

In the global environmental arena, incremental costs were first used in the London Amendments to the Montreal Protocol adopted in 1990. When the Montreal Protocol was negotiated (in 1987), the provisions for resource transfers from the North to the South were very weak. At that point, the Southern countries had argued that since povertyalleviation was their first and over-riding concern, and since their historical contributions to causing damage to the global environment were insignificant, any incremental costs for addressing global concerns should be met by resource transfers from the North to the South. All these negotiations were taking place at a time when the overseas development assistance was declining from US$ 70 billion to US$48 billion and is probably US$ 40 billion today. The Southern countries also insisted that the funds that would be earmarked for addressing global environmental concerns be additional to existing overseas development flows.

Soon after the Stratospheric Ozone agreements, the Global Environmental Fund (GEF) was created in 1991 and that picked up the concept of incremental costs. The Climate Convention that was negotiated during the period leading to the Rio Conference also has a provision for this. So does the Convention on Biological Diversity. The Convention that has been recently negotiated on Persistent Organic Pollutants (POPs) also contains similar provisions on incremental costs. In the Climate Convention the incremental cost provisions exist only for mitigation projects right now but they can also be extended to adaptation projects if incremental costs were viewed as costs imposed on Southern countries because of climate change.

The concept of incremental cost is now being widely applied in the international environmental field. All global environmental agreements provide for new and additional funding to meet the incremental cost of activities to protect the global environment. These are the three legs of the stool on which all of the global environmental agreements stand. Since the word "additional" was appropriated for total flows, what went towards individual projects was called "incremental." One could also have called additional costs at the project level but since the word "additional" was appropriated in the treaties for total flows, the word "incremental" was applied for individual projects.

We should also consider what the different motivations were that led to the concept's adoption. The donor countries were particular that if the flows were to be additional to overseas development assistance, then they were not to be used for the same purposes that the overseas development assistance was used. The other motivation was that the Southern project hosts should not have to bear the "additional" burden to address global environmental issues. The third motivation was that it was easier for the Northern legislators to appropriate resources for global environmental protection if they were assured that these funds were only going to be used to pay for the incremental costs and not being used to fund "business as usual."

Incremental cost concept: key elements

In all work pertaining to incremental costs, the words "baseline" and "alternatives" are frequently mentioned. Each is defined with respect to the other. A baseline is the course of action that would occur in the project area in the absence of a proposed project or an alternative. The alternative is defined as what the project would establish instead of a baseline. One can define a baseline and an alternative at various levels, at the level of an individual, a project, a sector, a country or a globe. Wherever emissions are concerned, the same boundaries are used for the baseline and the alternative.

One motivating factor for the GEF to define the concept in such a way was that it would apply to all the thematic or focal areas—Biodiversity, Climate Change, International Waters and Stratospheric Ozone—uniformly rather than having to define different ways of estimating

incremental costs for the different thematic areas. So, it appraised additional net costs for a project always relative to some baseline course of action. It is incurred as a result of redesigning an activity, or selecting an alternative activity and that alternative can either be additional to, or a substitute for, a baseline plan.

When the baseline plan is designed only to achieve national benefits and the redesign or the alternative selection is made to achieve also a global environmental objective, then the incremental cost is defined as that of achieving the resulting global environmental benefits.

A classic climate change example would explain the above concept better. Given the baseline of a coal-fired power station costing Rs. 5 billion for X megawatts as the cheapest way for a country to produce electricity and the alternative renewable energy source delivering the same amount of electricity but costing say Rs. 6 billion, then the incremental cost is Rs. 1 billion. There is no "incremental component" in this project as the alternative is a substitute project. Instead of having a coal-fired power station, the country opts for a renewable energy power station and one can't say that this incremental cost is incurred for any additional component as the whole plant is a substitute. The coal-fired power station would not be built if the renewable energy station gets built.

This can be shown in a matrix form (see Table 1 below) where the alternative is what the project does and the domestic benefit is power. In the case of the baseline, there will be no global benefit but rather global disbenefits. It is shown as a negative benefit as there will be emissions of CO_2 . The costs are shown on the right and the Increment is the difference between the two. The global benefit can also be shown in the matrix and this is indicated as 15 million tonnes of CO_2 emission averted for a cost of Rs. 1 billion. There is no additional domestic benefit as both the baseline and the alternative deliver the same amount of power. There might be some air quality benefits but those have not been estimated here.

There is a general feeling that the above concepts can apply to Climate Change and Stratospheric Ozone because these are linked with industrial pollutants but can not be applied to Biological Diversity projects. The following example will indicate how the concept can also be applied to biodiversity.

Assume that there is a factory polluting a wetland. Different levels of abatement of that pollution are possible at different costs. One would be able to remove different percentages and the same industrial activity would cost more after the pollution levels were abated. The national laws would call for only a certain amount of abatement, which in this example are inadequate to protect biodiversity of global significance.

The baseline is the development of the industrial sector. The alternative is continued development with the same output but with the threat removed and then incremental cost is the difference between these two costs of development. There are certain complications can arise because domestic benefits can result from attempting the alternative instead of the baseline. For example, one might assume that fishing might increase and also tourism leading to extra domestic benefits. But if the incremental costs were to be much greater than the estimates of these increased benefits, then the benefits could be ignored and the entire amount could be given as a grant.

There are some implications. The grant does not cover the cost of the industrial development; so it will not include the cost of the factory. The wetland will not be saved in the baseline course of action. And the alternative is not a protected area management project as most Biological Diversity projects are. Only the change in the process or the substitute clean technology for the earliest technology is funded. The difference in incremental costs is the difference between the two least-cost ways of changing the process—one that would be followed to satisfy national regulations and the other that would protect the global biodiversity, which a country may not be interested in protecting without grant funding of the incremental cost.

Common criticisms of incremental cost

One of the commonest criticisms of incremental costs is that it encourages "incrementalism" and that no radical efforts are possible. But this is not true. Thousands of projects based on this philosophy have been funded. The word "incremental" means small but as explained earlier, this word had to be used because the word "additional" had been appropriated earlier in the negotiations to represent total flows from the North to the South for global environmental protection.

Table 1: Incremental cost matrix

	Baseline (B)	Alternative (A)	Increment (A-B)
Domestic Benefit (MWh)	X MWh of power	X MWh of power	0
Global Benefit (MT CO_2)	-15	0	+15
Costs (Rs. billion)	5	6	1

Incremental need not necessarily mean small. If the baseline were to be "no action," then 100% of the costs would be incremental and therefore mean complete project-funding.

The other common criticism is that since global and domestic benefits are impossible to separate, one cannot use this concept. But if the matrix approach were to be adopted and a comparison done between two ways of accomplishing something, there would be neither be a need to separate global and domestic benefits nor to monetise environmental benefits.

Related to the first criticism is another that incremental costs lead to small transfers of resources but this again need not necessarily be so. Another criticism is that it is unnecessarily complex.

In the implementation of incremental costs, there are sometimes conflict of interests in the sense that the host countries where the project will be located, the co-financiers, the implementing agencies and all others involved have an interest in inflating the incremental cost numbers as much as possible. Secondly, the length of communication is too long: the people in the field, people who are responsible for developing the project proposals, need more clarity. Between Washington, New York, the national and state capitals right down to the person who is actually developing the project is a long communication chain and there exists a lot of confusion about the process. Thirdly, it is also unpopular because if there is a question asked about what one hopes to achieve from the project, those involved are not able to give a proper reply as they may not have given enough thought to what they hope to achieve. This leads to exposure of strategic flaws in the project resulting in unpleasant interactions between the GEF and those who have prepared the projects. There is also sensitivity to certain assumptions (as pointed out by Dr. Charles Perrings in this workshop) like discount rates, time-horizons, different assumptions, etc.

Alternatives to incremental cost financing

What might then be some of the alternatives to incremental cost financing for global environmental measures? But as indicated earlier, there are three motivations for the selection and use of incremental costs, and each of the suggested alternatives fail on at least one account. They will either result in the imposition of a burden on the Southern project hosts or in jeopardizing further replenishments of resources for global environmental efforts by Northern parliaments or legislators, or do nothing for the global environment. Some critics are of the opinion that, not the incremental, but the total costs of the projects should be financed. The other alternatives suggested are the grant financing of the total cost of standalone projects and components only or the grant-financing of items on an indicative list. The latter would imply that only those items on the list would be financed and the others left out. Another alternative of requiring costs to be internalized would mean having the same costs imposed on the Southern project host. Grant-financing of economic loss would lead to the temptation of attempting to show a loss in the project. This would be a perverse incentive. Grant-financing of foreign exchange costs and financing of "flexibility" would lead to the financing being more, or less than, the incremental costs which is not really acceptable.

Comments on interdisciplinarity

A few comments now on the boundaries between and within disciplines. Boundaries serve dual functions. Not only do boundaries deter outsiders from entering a discipline but they also prevent people belonging to that discipline from venturing out. One striking example of this is that of the Great Wall of China which, more than keeping the barbarians out, kept the Chinese in. It was more difficult for the Chinese to leave than for the Mongols to enter. It was the same case with the Berlin Wall where it was easier for an outsider to enter East Berlin than for a resident of East Berlin to cross the divide.

On the other hand, it can be said that drawing analytical boundaries is probably the most important task in any research activity. Most of the problems that face society today are multi-disciplinary. If the boundaries are drawn too wide, then the problems become intractable and if they are drawn too narrowly, then important matters affecting one's situation can be left out. Interdisciplinary research is the collaboration between two disciplines while multi-disciplinarity cuts across many disciplines and may or may not be collaborative. Interdisciplinary work is something that is attempted after one gets a tenure and this is because of the way the reward systems in this country are structured and linked to having a permanent job.

In interdisciplinary research, it often happens that some disciplines will dominate. In an atomicresearch institute, the physicists will dominate; in a space research organization, the engineers dominate; in the field of biomedical engineering, the physicians dominate and in the social sciences, the economists dominate. If one were to look at the term ecological economics, one has already given away the fight and acknowledged the superiority of economics as the subject that will help in finding answers and solutions in this field. Often, when one discipline dominates, the other person working on the field gets the impression that she or he is working towards solving someone else's problems all the time. This would seem acceptable for a consultant but not so for a researcher. When one is young, it is very difficult to find hospitable hosts for this kind of work and one depends on some maverick to give one an opportunity. But by and large, based on my experience in this field in

the United States, the attrition rate of interdisciplinary centers is quite high. But a word in closing to the new entrants to multi-disciplinary work: the most pressing problems that affect society today like power-sector reforms or those related to energy do not fall into neat disciplinary boundaries, and the only way to make a significant contribution to their solution is to adopt a multi-disciplinary approach.

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Theme 2: The other divide—ecology and other social sciences

Session chair: Joan Martinez-Alier

are involved in a whole variety of activities—sustainable natural resource management, sustainable soil fertility, issues relating to the coexistence of communities residing in the same areas and sharing the same resources and also a whole plethora of problems both of human and ecological (biodiversity conservation management and rehabilitation of Degraded systems) dimensions.

As indicated earlier, my formal training has been as a botanist and a biologist and not as a social scientist. My knowledge of the social sciences largely evolved from a need to understand their practical applications to help me answer questions pertaining to ecological concerns. The method evolved is unorthodox and does not follow any standard methodologies practised by social scientists. I am now a part of both natural and social science meetings and have been involved for quite a while now and since inception in many global change programmes. I have made an effort to impress upon the biophysical scientists in the IGBP that the human dimension should be taken into consideration in their programmes. I am also currently involved in an exercise to include certain aspects pertaining to biophysical problems in the International Human Dimensions Programme (IHDP).

An attempt will now be made to give a bird's eye view of the kinds of issues and methodologies which one would consider invaluable, in addition to the other approaches spoken about earlier. Figure 1 has two sets of boxes, the set on the left are the ecological boxes and the set on the other side are the boxes indicating human dimensions. There is a misconception that each discipline, be it anthropology, sociology, economics or ecology, can work independently on one particular component of a research problem and then one could do a cut and paste job and find a solution. The approach that is indicated in this diagram is far removed from the above method. After 30 years of experience, I have observed that if the attention of policy makers has to be drawn to issues both in the ecological and the social sciences and particularly in the interface areas, it is extremely important to be able to move back and forth between the ecological and the sociological boxes rather than work independently of each other and put together one's findings at the end of the day to make sense of the jigsaw puzzle. Such an approach alone will provide meaningful policy-linked solutions.

As one goes down the set of boxes, a number of issues are addressed along a spatial scale starting from a plot-level analysis. Starting at the plot-level, a number of processes that operate at that level are listed till one arrives at the ecosystem level, and then an attempt is made to integrate this with the human dimensions of the problem. Finally, one comes further down to the landscape level to see how a variety of inter-connected ecological systems function and how a complex variety of social and institutional arrangements can determine the landscape structure that has been built up on the basis of a historical process operating within the system ultimately leading to sustainability. Note that sustainability is a very complex term and it means different things to different people.

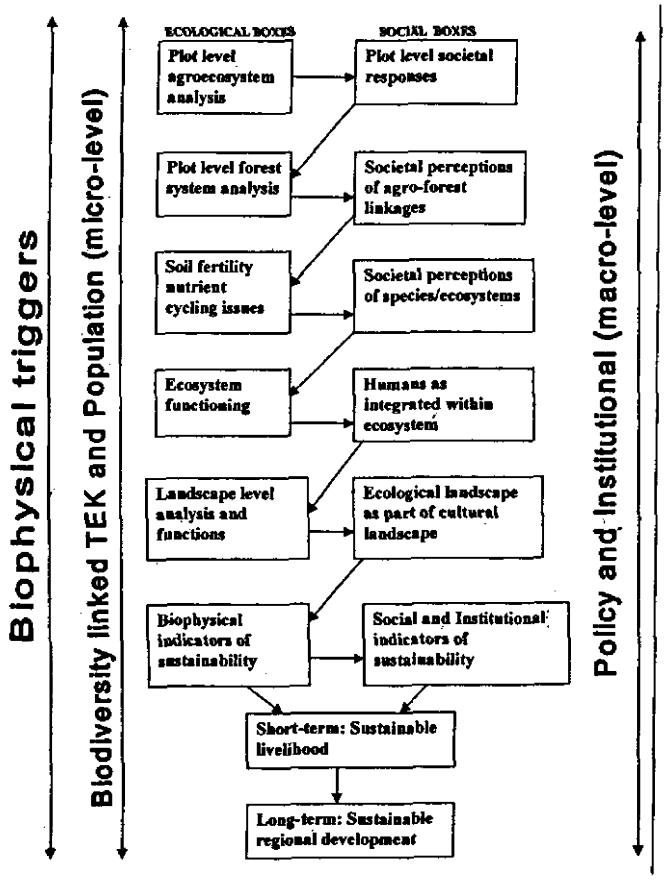

Figure 1

The first box on the left shows the plot level analysis of an agroecosystem and the corresponding box on the right indicates the responses of the family involved. A shifting agricultural farmer in North-Eastern India has two-three hectares of land on which he practises slash and burn agriculture. When the cycle of the shifting agriculture is for a shorter duration of four or five years, he grows four or five species of crops and when the cycle is for a longer period of 20–30 years, he can grow up to 45–50 species of crops. In the case of a crop species like rice, one may end up with six to ten varieties on a three hectare plot of land. This implies that one is not necessarily dealing with a biodiversity of only 45 but up to something in the range of 60 or 70 units of biodiversity. When a farmer practices slash and burn agriculture, he does not remove all the weeds that are present but leaves a certain number behind on his plot. (This has certain implications which will be taken up later). If one were to include the weedy species as part of the biodiversity on these three hectares of land, one

is looking then at about a hundred units of biodiversity. When one goes to a plot of land and looks at the 40–50 species, one may get the impression that they have been randomly thrown in there. This is a complicated situation to study because a farmer is not in a position to articulate his choice of species. The only way then to find out how he operates is by working with him over a twelve month calendar period. Using the information gathered over this period, it becomes possible to embark on a series of experiments on the farmer's plot to find out how he organises his choice of species. For example, it has been found that if a farmer grows his crop on a hill spot with a 30–40 degrees slope, one can observe, that on the top of the slope he has organised crops which do not need too much of nutrients in the soil for adequate growth and reasonable productivity. As one goes down the slope, the fertility of the soil increases. At the bottom of the slope, the soil is very fertile and one will find that this is where the farmer has planted species which are very heavy suckers of nutrients. This indicates that the farmer, on the basis of his intuitive experience, has over a period of time, evolved his own brand of traditional ecological knowledge to get the optimum value in terms of resources and nutrients from his plot of land.

This is another example at the plot level of a natural ecosystem. When a farmer practices the shifting form of agriculture for a shorter duration of time, the lands starts degrading more rapidly and the external pressures on forest resources which have been very heavy (on account of deforestation taking place for more than 100 years and large-scale timber extraction over huge areas) compounds the problem. The farmer is not left with much of a choice then as to where to practise his shifting agriculture. This has resulted in the shifting agricultural cycles being reduced from 30 years to 4–5 years and this is a trend that has been visible for the past 25 years. The implication here is that the forest has been converted into a weedy community. The weeds are not able to progress to the forest-stage resulting in what in ecological parlance is called "arrested succession."

Arrested succession has two forms of species–one the invasive form which has come from outside (largely from the Latin American countries but they have become part of the ecosystem and are very difficult to eradicate) and the other the native form. If one were to study the invasive versus the native species, one would find a distinct pattern in the ecological system and one which has a great bearing on the decision-making process at the family level. The native species are of the grassy variety and more efficient in terms of nutrient-use while the invasive species are non-grassy and heavy suckers of nutrients. Based upon species, the farmer is also to determine which plot to select for shifting agriculture and better return. There are many such examples to illustrate issues that develop at the plot level.

The farmer has a particular way of organising his crop species within an agricultural system based upon how he perceives the fallow phase– the length of time when he leaves the land. This has a bearing on determining the kinds of species that he conserves or destroys when following the slash and burn system. There are certain species which have social, cultural and religious value and these are left *in situ* in the agricultural plots while the other species are cut down to ground level. The species which are left untouched in the plots also often have an important role to play. They help to regenerate the fallow by growing fast and providing a landcover quickly and serve one more important purpose. They help in soil fertility in two ways. An example will help to explain how a single species can determine the functioning of the ecological system at the soil ecosystem level. One of the species that is conserved by the shifting agricultural farmer is the Nepalese Alder. It has been traditionally conserved by the many societies in the North-Eastern region. These traditional communities have evolved the principle of identifying this particular species independent of each other. The Nepalese Alder has the ability to fix 120 kg of nitrogen per hectare per year. When a farmer practices shifting agriculture under a five-year cycle, he loses 600 kg per hectare of nitrogen during one cropping phase. In order to put back the lost nitrogen back into his system, he needs to have a fallow phase of at least 10–15 years. However since today he can have a fallow phase of only five years, he is able to recover only up to about 300 kg of Nitrogen and therefore has to start work with a deficit of another 300 kg. Nepalese Alder with its high nitrogen-fixing ability not only helps to put the deficit nitrogen back into the soil but also contributes towards improving the soil biodiversity.

Earthworms are indicators of soil fertility status. In the improving of the soil biodiversity, one of the socially selected species is the earthworm. The farmer has no idea about the kind of earthworm that comes into the system but has enough experience to know that this is largely determined by the above-ground biodiversity. So, by manipulating the above-ground diversity, the farmer is able to manipulate the below-ground diversity which ensures that the right kind of species comes into the soil ecosystem. This contributes to improving the soil fertility! So, even under a five-year cycle, the farmer is able to maximise his production by getting the best out of the ecosystem. This explains the concept of societal perceptions of species and ecological systems.

When the shifting agriculture reduces to five years from 15–20 years, one of the shifts that takes place is in terms of the crop mixtures. Whilst he emphasises on cereals in the long cycles, he tends to move towards tubers and

vegetables under the shorter cycles. What is of significance here is that cereals are heavy suckers of nutrients so a shift in cropping pattern takes place. This shift helps to cope with the uncertainties in the environment which in this particular case may be the availability or non-availability of nutrients under the shorter shifting agricultural pattern.

One example will help to illustrate the landscape analysis. Apatanis in Arunachal Pradesh practise a very interesting form of rice cultivation. These people are not shifting agricultural farmers, but practice wet-rice cultivation very close to their villages. They also follow pisciculture. As they move further away from their villages, they eliminate fish-rearing and grow only rice. There is a nutrient gradient and a gradient in terms of the availability of water and in order to adapt to these differential ecosystem situations, they grow a long-duration variety of rice which ripens along with the maturity of the fish so that they are able to combine both activities closer to the village. Moving further away from their villages, they eliminate fish-rearing and grow a short-duration variety of rice as uncertainties are more in terms of not only water-shortage but also shortage of nutrients; there is also the fear of predatory attacks by wildlife.

While looking at sustainability, I have tried to pick up a few triggers to handle the problem. The same will be explained with the help of two examples. In the Central Himalayan region, there are two-three species of oaks which are part of the natural forest ecosystem. In the last hundred years the oak has been harvested by timber extractors and an attempt has been made to grow pine as replacements. A study was done recently to understand the impact of oak in terms of soil fertility and the ability of the ecosystem to retain moisture within the soil during the dry season.

Oak species because of their litter quality improve soil fertility, and because of this root distribution pattern in the soil retain soil moisture more effectively outside the monsoon season. The real causative factor for the 'Chipko' movement is this conversion of the landscape from oak-dominated to pine-dominated. It may be noted here that this set of oak species which play a keystone role in the forest ecosystem, are also socially valued with a lot of music, poetry and folk literature woven around them.

Some time ago, a rapid social analysis was done of mountain communities in which they were asked about what kind of support they would like from the scientific community. The strange reply that came was a request for water during the dry season. This lead to the creation of water-harvesting systems. When this was done following very economical methods in the Central Himalayan region and elsewhere in the eastern parts, the water started flowing down the hill-slopes keeping them moist throughout the year. This happened accidentally but resulted in the regeneration of the oak (which normally in an ecological process of succession comes up only after 200–300 years of forest development) in a time span of the first 6–10 years. The point to be noted here is that there are some triggers available but they are not amenable for investigation by biophysical scientists alone. The starting point here was the social analysis. Not only have the biophysical dimensions to be brought in, but also more importantly, the social dimensions have to be integrated.

To sum up the efforts of 30 years, traditional ecological knowledge has to be judiciously combined with science to achieve sustainable development. Two types of strategies have to be taken into consideration when dealing with sustainable development. One involves the short-term possibilities that can be adopted to give the people in the region a better quality of life without degrading their environment. When this kind of an effort was first attempted to find a solution to the problem of shifting agriculture, there was a lot of skepticism from the scientific community, policy planners and development agencies in the north-eastern region. It took fifteen years of hard work to convince them. At this point of time, there is a major initiative in the state of Nagaland under the India-Canada Environment Facility based upon this kind of research. The current network of 150 scientists working in various projects linking ecological social process not only brings out 50–70 research papers in research journals, but also contributes towards one or two synthesis volumes every year, with a policy document attached to each of the synthesis volumes. Unless the research results are based upon linking ecological processes with social processes, research results will have, at best, very limited value for policy planners and developmental agencies.

6. Perspective of a biological anthropologist

Kailash Malhotra

The attempt of this paper will be to say something based on my personal experiences. My basic graduate degree is in Biological Anthropology. Anthropology has four branches: Biological, Cultural, Prehistoric and Linguistics. The first effort of any anthropologist would be to find out whether there are any barriers to permitting transgression from one discipline to another. I was very fortunate after my master's degree in coming to Deccan College where all these four subjects were included in the syllabus as four sub-disciplines, each having its own department. I had the opportunity to interact with all the four departments, was appointed a lecturer in 1965 and was asked to teach in all the four departments. So, I really did not face any barrier whatsoever and also had the opportunity to learn all the basics of the four sub-disciplines in anthropology.

In the early years, like the speakers before me, I worked in the conventional framework of anthropology. My early papers dealt with human skeletal remains from different parts of India and also with genetic markers and other biological aspects of the 500 different types of populations of India. This resulted in the shifting of my thoughts to the peopling of India—how biological tribes brought in different technologies and cultures and how society evolved. While still working on conventional lines, I had broken the barriers of interdisciplinary research and so had absolutely no difficulty in making efforts at collaborations.

The two previous speakers mentioned how over a period of time they internalised and learnt about other disciplines through the strength of their personal experiences and exposures thereby carrying out their own work. In my own case, I carried on with my own work as a biological anthropologist, an area I am very comfortable in, but went in for a lot of collaborations. As of today, I have had the experience of collaborating with more than 150 persons, both in India and abroad, spanning disciplines like Human Genetics, Medical Genetics, Statistics, Forestry, Economics, Sociology, History, Ecology, etc. This approach appeared the most productive, under the circumstances, though it may not be so for others. Instead of internalising and trying to carve out a project which would include all dimensions, it suited me to collaborate with others who had better access and competence in their own areas of specialisation.

In 1969, there was a change in my work at the behest of my supervisor, Irawati Karve, who suggested that some work be undertaken on a neglected component of Indian society, namely, the nomads. She took the responsibility of preparing the project and approaching the University Grants Commission for an approval but made it clear that it would be my responsibility to run the project, undertake the field work, etc. In 1969, the work on nomads started, both pastoral and non-pastoral, the former comprising 22 groups and the latter 10, located in the state of Maharashtra and bordering areas like Karnataka, Andhra Pradesh and Gujarat. The entire framework, developed in consultation with Irawati Karve was still largely conventional anthropology but it also involved a heavy bias (about 60%) towards cultural anthropology. The team of 16 people comprised young scholars from Pune University some of whom had specialised in social anthropology. This work resulted in the conventional publishing of some papers and articles.

Ecology of pastoral nomads

It was only in 1975, when looking at my earlier work, that the realisation dawned that there were limitations to the work that had been done by my colleagues and myself on the pastoral and non-pastoral nomads. It appeared then that I was not in a position to go beyond a certain stage in my research because there were some questions which were left unanswered and these answers seemed critical to understanding the nomads in their full sense. One such question was the diversity of the animals that these nomads maintained and their reasons for doing so. A particular group preferred to rear only buffaloes, while another preferred sheep and yet another kept horses, etc. It was also difficult to understand whether these groups of people moved on account of their relationship with the sedentary human population or because of ecological or environmental parameters.

One particular group called, Gavli Dhangars, were spread out from Panvel in Maharashtra to Chikmagalur in Karnataka. During the first study, their numbers were about one lakh and they were spread out all over the Western Ghats in small settlements. A detailed sampling and study had been done on them and what showed up was differences in the kinds of animals and the combinations of animals that they maintained and also out-migrations on account of shifting cultivation to nearby cities like Satara, Pune, Kolhapur, etc. All these details were mapped but still an explanation could not be found for the diversity of occupations and preferences of this one particular group. This was the time that I realised that it was time to be pro-active and seek outside help.

It took a while, till 1978, when a chance meeting with Professor Madhav Gadgil at the Indian Institute of Science, Bangalore, lead to a collaborative effort. At that time, coincidentally, Professor Madhav Gadgil and his

group were also working with the Gavlis but these were located around Dandeli in Karnataka and their research was undertaken to study the impact of the Gavlis on the bamboogroves of the forest region.

This collaborative effort lead to fresh studies being undertaken. The field work stretched out from Pune district to Chikmagalur with many villages enroute being used for sampling. This work was published in a human ecology journal under the title "Ecology of a Pastoral Caste: Gavli Dhangars of Peninsular India. (Human Ecology; 10(1): 107–143, 1982)" The methodology for this study was designed by Professor Gadgil and his students. They worked out how to estimate the total biomass of grasses available in a given area and whether the livestock in that area could be sustained on this grass. They also estimated the frequency and the pressure of the predators. Among the findings was one about how cows only entered when the forests had degraded, the water reduced and also when there was less of predator pressure as cows can be lifted more easily than buffaloes. The life cycles of these livestock which were not taken into consideration in the earlier study was integrated in this one by Dr. Gadgil and his students. They also undertook the task of working out the methods required to collate all the data that was collected. While they took charge of this, the Biological Anthropology group took charge of areas where they had expertise like nutrition and health status using simple anthropometric measurements like height, weight, girth, etc. All the information was put together as a collaborative effort and published in the form of the mentioned paper. Unfortunately, despite the encouragement that this provided to both the groups, this has been the only study on a particular group that ensued. Though attempts were made to study other groups subsequently, there is no such comprehensive study available on any caste or any other particular group in India. The interesting thing that happened when the two groups worked together was that there were no barriers and the two groups established strong interlinkages. While Professor Madhav Gadgil learnt about the anthropological aspects, the methods and the rapport-building techniques, I had the opportunity to understand the sociological approach and the methodologies adopted. This has resulted in there developing a very good rapport between Professor Gadgil and his group over the last twenty-two years and there have been many collaborations on account of this. It has developed into a time-tested relationship.

Three years ago, Professor Gadgil published a paper called "The History of the Peopling of India," which is based on prehistoric archaelogy, linguistics, social anthropology and biological anthropology. I would like to think that this paper was a result of the give-and-take policy developed over the last so many years. That paper still remains a masterpiece in this genre.

One of the important findings that I came to realise after my collaborative effort is that though there have been volumes and volumes written on the Indian caste system, it has not been looked at from the ecological point of view. While working with the Gavli Dhangars, I realised that all over the Western Ghats, wherever the Gavlis were inhabitants, they were located at the top of the settlement. All other human settlements were below the Gavlis and this was with 100% correlation with not even one exception. It was also found that people who were positioned lower in the terrain had partitioned their resources. While the Gavlis concentrated on the fodder in the upper reaches of the terrain, the Kunbis preferred the middle terrain where they cultivated and engaged in hunting wildlife.

Community ecology of human systems

These findings led to asking whether ecological models could be used in understanding the Indian caste system. After a marathon brainstorming session in Bangalore, I chanced upon the concept of "community ecology." Madhav Gadgil said that animal and plant behaviour indicated that there was always a pattern indicating reduction of overlap over the sharing of resources on which they are dependent. This reduces the competition and indicates a degree of complementarity. The same concept was applied to another study which lead to the publishing of a paper called "Adaptive significance of the Indian caste system: an ecological perspective," (*Annals of human biology*, 10(5):465–477, 1983). At that time, this was the first work of its kind in this particular area and provided many interesting insights. These led to deeper and wider implications about the Indian caste system from the ecological point, a view which had never been considered before. There are 40,000 endogamous groups in India which are based on caste, religion, tribe, immigration, etc. Of these, 30,000 are estimated to be part of the Hindu caste system. This led to the finding that in a single given village there will not be two endogamous groups who have the same identical name, who cannot marry each other and who depend on the same natural resources. For example, in a particular village, one will never find two castes calling themselves "Sonar" and not marrying into each other's families. On the other hand there may be two types of "Sonars," who will make distinctions between each other and will also be able to prove that they have different histories. The nature of their work, though both work with gold, will also differ. This indicates that the "community ecology" theory gets practised among human beings also. In a given village one cannot have two endogamous groups fighting to utilise the same resources, so the strategy here is to partition.

The principles that were applied in that paper also provided many other insights. One of them was that partitions are not always based on caste but sometimes also involve territory. This is a very important point to be noted by ecologists, especially those dealing with wild animals. The territorial issue came up as a major factor in the study. For instance, if the group were to be very widespread, some territorial mechanism has to be worked out between two villages if the same castes are living in both. And in the case of nomads, there are specific territories delineated for a particular group for the use of resources vis-à-vis another area for another group of nomads. Another finding was that within castes the territoriality was maintained at the level of one's lineage which meant that a particular lineage would have full rights on a particular natural resource which was out of bounds for another.

Ecological anthropology of forest use

One more example of how ecologists and anthropologists have benefited from each other is related to a study undertaken in West Bengal in 1990 on the joint-forest management issue. One of the answers that the Forest Department wanted from academicians was the level of dependence of the people who live in and around that particular forest patch on non-timber forest produce (NTFP). There were many studies available on forests at the state level but till then there had been no detailed study undertaken at the household level covering the whole range of NTFPs and not just the five scheduled NTFPs. When designing the study, I realised that there were many questions for which the anthropologists could not provide the proper answers as they were not equipped with either the theories or methodologies to handle these issues. So, I collaborated with those from other disciplines like sociologists, economists as well as two ecologists, one trained in taxonomy and the other a pure ecologist. The area where I felt a sense of inadequacy was in being able to figure out whether the products that the forest-dwellers were using and the methods being used by them, were sustainable or whether they were damaging to the environment or the population of species. To answer all these questions, a multi-disciplinary approach was adopted with a team of seven people working together closely for two years in the forests of West Bengal. This resulted in the publishing of a monograph called "The Role of Non-Timber Forest Produce in Village Economies" and if one were to read this work one would certainly get a flavour of the multi-disciplinary approach—some portions will sound as if written by an ecologist, other portions by an anthropologist and yet others by an economist or a sociologist.

Concluding remarks

While concluding I cannot but help agreeing with Ram Guha's forceful presentation which indicated what was needed for an individual to grow. During my collaborative efforts, I never had any hiccups which indicates that working with people from different disciplines is not really a problem. If one were to look for the problematic areas, one of these is related to the issue of hierarchy. At the Indian Statistical Institute, where I am presently employed, an anthropologist is a bit of a misfit. The Institute has a different focus and collaborating with the faculty there can prove to be a problem. But collaborations with my students who are statisticians has been relatively easy.

The other problematic area is in organisations which are focused on a particular discipline like the Archaeological Survey of India. An organisation like this will primarily have archaeologists but will also include people from other disciplines to provide certain inputs. But an interaction with the people in this organisation from these other disciplines will provide a feedback that they are always treated as second-rate citizens in the organisation. They are not provided with openings that would enable them to grow and head the organisation some day. They are mostly looked upon as technicians to provide the additional inputs. As a result of this marginalisation, most people today hesitate to join organisations where the central discipline is removed from the area that they have a degree in.

A third problem area is to work out large-scale collaborative efforts in one's own institute because most people are caught up with their own time-lines and it is very hard for them to come together at a given point of time. The issue of leadership can also prove to be a hurdle in a collaborative effort within an organisation. To overcome these problems, what is needed is a human touch, a personal rapport rather than an institutional imposition. Finally it can be said that what works for an individual scientist is something for him to figure out on his own. In my own case the collaborative efforts with people from my own discipline would not have yielded the kind of results that a multi-disciplinary approach has yielded.

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7. Barriers to inter-/trans-disciplinary research

Ramachandra Guha

Summary of talk

In the Indian academic context, five barriers to inter- or trans-disciplinary research can be identified.

- *The Partitions of Knowledge*: The partition between "Arts" and "Sciences" is imposed as early as tenth standard and strongly reinforced thereafter.
- *The Tyranny of the Discipline*: Each discipline has its own history, logic, turf, and socialisation. There is no discounting the individual achievements of each discipline, and there may be good reasons why university departments are structured along disciplinary lines. But these boundaries become forms of tyranny when one is asked to make a choice not only regarding one's primary affiliation but also regarding one's sole affiliation. One cannot say, e.g., that one is a sociologist-cum-historian. Those who chose to do so are labelled as incompetent in both disciplines by their peers.
- *The Fetishisation of Method*: Each discipline also has its own privileged method. Thus the historian is supposed to use the archives, the anthropologist is supposed to spend twelve months in one place, the sociologist is supposed to use the survey questionnaire, and the economist must work with numbers and run regressions. While each discipline may legitimately have a methodological preference, currently these methods are often seen as mutually exclusive, and use of multiple or unconventional methods is discouraged.
- *The Partitions of Time*: No historian is encouraged to study anything after 15th August 1947, and no political scientist, anthropologist, legal scholar, sociologist, etc. is supposed to study anything before 15th August 1947. For instance, in my own case, what began as a sociological dissertation rooted in the ethnographic present eventually became a historical exploration because of the remarks made by a peasant, not because of any impetus given by peers and superiors in sociology.
- *The Tyranny of Intellectual Fashion*: There is a strong tendency for the research agendas in each discipline to be dictated by notions of what is fashionable in academic circles (as discussed in their disciplinary journals) rather than by what is important in the real world. (The present speaker escaped this tyranny by not studying in a conventional sociology department at a "top" university, but by being located at the Indian Institute of Management, Calcutta.) This tyranny is perhaps the most crippling of all. For instance, till twenty years ago, there must have been hundreds of sociological theses on "Agrarian Structure in Colonial India" and many more history theses on the "Evolution of Nationalism and the Congress Party", but not a single thesis on "Forestry in India". But in fact, 23% of India's land is owned by the Forest Department, every single inhabitant of India has an intimate relationship with the forest: whether it is a peasant, a tribal, a pastoralist, an industrialist or a city-dweller. But forests were off the map, as far as the social sciences were concerned. Now, fortunately, ecology is part of the discourse. But again it may happen that the choice of research topic is dictated not by the problems of the real world but by what is deemed to be fashionable or important in the ecological economics or environmental sociology journals. This tendency or tyranny needs to be fought the most. Living in a society as complex and diverse as India provides an unbelievable plenitude of social and ecological problems at all times. One should take one's soundings from society and having identified the problem from the "field" rather than from the "text", the problem should then define the methods and not the other way around.

Theme 3: The bigger divide?—economics and other social sciences

Session chair: Kaushik Basu

8. The links between ecological economics and political ecology

Joan Martinez-Alier

Ecological economics assumes that there is a clash between economic growth and the environment. This cannot be made good by simply wishing for sustainable development, or by hoping for ecological modernisation and increased eco-efficiency. Hopes are prematurely placed on a dematerialisation of the economy relative to the growth of the GDP or even in per capita terms. The "new economy" (what it used to be called in the United States a few years ago) becomes less industrial (in terms of the active population employed and in terms of economic value added), more based on services and information technologies. However, the incomes gained in the "new economy" still go to buy big cars and big houses or to import gold, for instance, or to other very material expenditures. The year 1999 was the record year of car sales in the United States. To a large extent, the economy is driven by consumption. In ecological economics we need a theory of consumption on the lines of Max-Neef, different from the inscrutable preferences of neoclassical economics.

From the point of view of ecological economics, the economy should not be seen as an isolated system which can be explained solely by an internal logic, but it should be seen as a subsystem of the physical system. The economy is open to the entry of energy and materials, and to the exit of residues. The economy is also inside a social system (of property rights, of distribution of power and income).

To give an example, growth of an economy based on fossil fuels may (or may not) encounter a first limit in the structure of property rights on carbon sinks. It may encounter a second limit in the absorption capacity of the biosphere to recycle carbon dioxide, in a given time, without a change in climate. Starting now from the outside, carbon emissions in excess of the absorption of oceans, soils and new vegetation might be curtailed by a change in property rights on carbon sinks, and/or by changes in the price structure (through eco-taxes or emission permits) in the economic sphere. Climate policy or the historiography of climate change requires an integration of the analyses at the three levels. Thus in terms of response to climate change, one possibility would be the Kyoto Protocol, another the Bush Policy, which is to do nothing, and another policy would be contraction, convergence and the compensation for the ecological (carbon) debt.

Another example is more European and it indicates how an agricultural policy should be decided. Yesterday, one of the speakers, Professor Ramakrishnan, emphasised the virtues of traditional agriculture. There is a 25-year-old debate showing that modern agriculture is supposed to mean increased productivity in economic terms and also it means increased genetic and soil erosion, increased water and pesticide pollution and also decreased energy efficiency. Are students being taught to work out their own sums on the basis that productivity is increasing and energy efficiency is decreasing and then draw their own conclusions? In the best of cases, productivity is increasing in the faculty of economics and energy efficiency is decreasing in the faculty of ecology or agro-ecosystems. The students are asked to choose one of the visions but there is no real interdisciplinarity.

The economic view has led the European Union to increase subsidies to help productivity in some regions of Europe. But there is a new policy being proposed in support of agro-ecological practices. In the present disarray in Europe on agricultural policy, radical positions such as those expressed by the French Confederation Paysanne, which partly rely on plausible scientific agro-ecological research, are unexpectedly gaining ground. Others supporting this radical move are the new green German Minister for Agriculture who is of the opinion that so-called organic agriculture should not be done away with but should be supported because it makes good landscapes and also helps to have healthy food, and to get votes. Her view is that agro-ecological practices should be supported, and that there should be no subsidies to European agricultural exports as these have brought ruin in other places. This alternative implies income support for organic small-holders, lower economic productivity, though higher environmental values. There is a clash of scientific perspectives, also a clash of values with other viewpoints which would promote productivity, and would open Europe to very large imports from overseas "efficient agriculture."

In a recent paper (*Environment and Planning-Government and Policy*, 79(5):713–728, 2001), I have discussed the conservation of mangroves against the production of shrimps grown for export in many parts of the tropics. This has been the case in Ecuador, Thailand and the Honduras. In India too there has been a debate on the production of shrimps for export versus the conservation of mangroves, or of paddy fields. One could do a cost-benefit analysis or one could also apply one of the methodologies of multi-criteria evaluation, and say that one has different alternatives and criteria coming from a participatory exercise. Criteria would include biomass production, landscape value, revenue-generated (tallying the foreign exchange with its special price is very necessary) and livelihood, including the gender aspect, because

women are very often dependent for livelihood on the mangroves.

This approach has often been used. The main difference is that in the cost-benefit analysis, everything is reduced to a single standard of value whilst in the multi-criteria method one operates with different incommensurable standards of value. Biomass production can be counted in calories which again can be valued in the form of money. But the purpose of preserving biomass is not always to generate money. In the case of mangroves, it is to preserve life in it which different species can live off. Landscape can be valued in terms of its own units of landscape value too.

The awareness of the need to consider simultaneously the different types of knowledge appropriate for the different levels of analysis is shown not only by the birth of Ecological Economics, but also by the frequent demands for Integrated Assessment, or a Holistic Framework, or Consilience (without Reductionism) or Systems Research, or even a Dialectical integration of scientific findings (which perhaps are contradictory) or an Orchestration of the sciences (as Otto Neurath of the Vienna Circle put it 60 years ago). Otto Neurath's metaphor is very interesting because it talks about different instruments as in an orchestra playing the same tune. But this may not be a fine-tuned orchestra because sometimes there might be different predictions and one would have to take into consideration the different contradictions arising from the different points of view.

Who gets the power to impose a decision? Who can impose a language of valuation? These are two different questions. In the first, power is the capacity to impose a decision, to build a dam, to open an oil well. Who was more powerful? Was it Texaco in Ecuador or the government of Ecuador or the people who opposed Texaco in Ecuador? There is a court case against Texaco in New York which has been going on for the last eight years, without any success.

The second question is, "Who has the procedural power to impose particular languages of valuation which in fact are like particular languages of analysis at different levels?" Should the Narmada dams be decided on the basis of cost-benefit analysis and environmental impacts assessment, or through multi-criteria evaluation? In the United States, sometimes the Endangered Species Act could be used as a kind of veto inside the multi-criteria problem. It is quite common to have different legitimate views about reality because reality is very complex and complexity means that there can be several legitimate points of view according to the scales and according to the levels of analysis.

The final question and one which runs like a thread through my presentations is about the "bottomline". The bottomline is that there is no bottom line. This is an interesting American metaphor that has evolved from the profit and loss account in a firm's accounting system. The American way of arriving at a conclusion is to ask about the bottomline. The conclusion is that there is no bottomline in money terms. There are different standards of valuation. Who has then the power to simplify complexity, in any practical case? Who gets the power to simplify complexity, ruling that some points of view are superior? Politicians need to simplify complexity because they have to take decisions while scientists don't need to do so. Scientists should not simplify complexities. Ecological economics is supposed to take Nature into account, and this should be done through incommensurable values, and not on the basis of a reductionism to monetary values. Who has the power to say that landscape values should be reduced to money through a "contingent valuation" exercise, or that sacredness in not a relevant value, or that tribal rights and livelihoods must be simply weighed in a cost-benefit analysis in terms of money?

9. Economics and other social sciences: an inevitable divide?

Bina Agarwal

The divide between economics and other disciplines is only partly based on fact. In large part it is also imagined, based on a number of misconceptions. Some of these misconceptions exist in the minds of economists, others in the minds of non-economists. Both add to the divide.

Some misconceptions among economists about other social sciences

A common misconception among many economists is that while economists use a quantitative approach other social sciences basically use a qualitative approach, and that the two approaches are in opposition; indeed the former is superior. In fact, many non-economic social sciences also use quantitative methods, and some economists also use qualitative ones.

Political scientists and sociologists, for instance, also extensively use quantitative data and statistical analysis. A review by White (2001) of two recent issues of the American Journal of Political science showed that over one-third of the articles used mathematical modeling similar to that found in the Economic Journal or the American Economic Review; 80% used some form of regression, including logit analysis. Similarly, 10 out of 23 articles in two recent issues of the American Journal of Sociology, were found to use some form of quantitative analysis. Again, demography is essentially quantitative, with a strong mathematical tradition.

In fact, quantitative and qualitative analysis are by no means in opposition, but complementary. Political scientist Robert Putnam (1993) in propounding his concept of social capital both described it and sought to quantify it and statistically test its links with regional variations in economic development in Italy. Elinor Ostrom (1990), another political scientist, in her work on common pool resources frequently uses quantitative techniques, while also drawing on qualitative information.

There is, however, an interesting difference in this regard between Indian social scientists and many of those in the West. Indian political scientists and sociologists tend to draw less on quantitative analysis than do their American or British counterparts. In other words, the methodological divide with economics appears to be greater in India than perhaps elsewhere. And it is becoming increasingly so as economics becomes more like the West while the other disciplines remain more rooted in the Indian tradition.

Another misconception among economists is that economics is more rigorous than other social sciences. Again in large part this misconception arises because many economists link quantitative analysis with rigour and quantitative analysis with its absence. Again, this is an unjustified assumption. Good ethnographic work in anthropology, for instance, involves a careful cross-checking of interpretations of what people say or how they understand their own and other people's worlds (Harriss, 2001). Rigour does not come merely from using large data sets. Much depends on how the scholar interprets the data or takes into account evidence to the contrary. This is important in any good social science analysis, be it economics or another discipline.

Equally important is the need for anthropological methods in order to increase accuracy in gathering certain types of quantitative data. Anthropologists and nutritionists well recognize, for instance, that information obtained from villagers can be affected by whom the researcher speaks with, the degree of trust established between the researcher and the researched, and sometimes even by the researcher's mere presence. For example, the accuracy of information on land ownership can vary significantly, depending on whether it is obtained on immediate entry into a village or after say a month's stay; and by a stranger to the community, or by someone familiar to the villagers. Similarly, in measuring the food intake of different household members, just the presence of the researcher in the kitchen can change consumption patterns (Chen et al., 1981). In both these examples, anthropological techniques, which place much emphasis on rapport and trust between researcher and researched, can yield more accurate data and hence make for more rigorous analysis.

Either way, the assumption that figures mean rigour is incorrect. Figures can hide many inaccuracies, and qualitative insights can be quite accurate. Here Amartya Sen's much quoted remark is a good reminder, namely that it is better to be vaguely right than to be precisely wrong. Also as some social scientists remark: "Data will tell you whatever you want if you torture them long enough" (White, 2001). Equally, the simplifying assumptions used in many economic models use can undermine relevance.

Some misconceptions about economics held by non-economists

Now consider examples of misconceptions about economics held by non-economists. A major misconception arises from assuming that the work of all economics is alike; that it uses the same assumptions, methodologies and approaches. Many non-economists view economics as unduly narrow, technical and far from the real world. This is certainly true in fair degree, but it is true mainly of a

certain type of economics. What critics have in mind is mainstream neo-classical economics, and especially that characterised by high degrees of technical modelling.

Heterodoxy within economics

In fact economics is not uniform and the divide between it and other social sciences reduces substantially as we move away from the end of the range occupied by neoclassical economics, toward the other end of the range occupied by more heterodox economics, for instance, towards economics that uses more political economy approaches, Marxist economics, institutional economics, feminist economics, and even some elements of ecological economics.

Interdisciplinary economists

Another misconception among non-economists is the belief that economists do not draw on other disciplines (the reverse of this is the belief among many mainstream economists that economists who draw upon other disciplines are not doing economics at all!). In fact many heterodox economists have drawn extensively on other disciplines. This has enabled them to open up new areas of thinking and to challenge assumptions in both economics and other disciplines. Consider some examples.

A number of economists have drawn on anthropological descriptions of the family to formulate alternative models and approaches to the household to those existing within mainstream economics. Mainstream economic theory has long treated the household as a unitary entity wherein resources and incomes are pooled, and household members share common interests and preferences, or an altruistic head ensures equitable allocations of goods and tasks. Most collective action literature is no exception in its assumptions about the household. In studying the effect of inequalities on cooperation in the management of common pool resources, for instance, the inequalities recognized stem entirely from *household level* heterogeneity in say wealth (or class), ethnicity, or caste. Typically, these alone are treated as potentially embodying a conflict of interest.

In recent years, however, virtually every assumption of the unitary model has been effectively challenged on the basis of empirical evidence, including assumptions of shared preferences and interests, pooled incomes, and altruism as the guiding principle of intra-household allocations. Gender, in particular, is noted to be an important signifier of differences in interests and preferences, incomes are not necessarily pooled, and self-interest resides as much within the home as in the marketplace, with bargaining power affecting the allocation of who gets what and who does what.

Among the factors that led economists to challenge the unitary household model, anthropological descriptions of households, and data gathered by public health experts were especially important. The former alerted economists both to the complexity of intra-household interactions and the latter to certain types of basic inequalities, such as in food and health care, between girls and boys within the home. Anthropological descriptions of how men and women behaved within the home also alerted economists that self-interest and bargaining were as much a characteristic of family behaviour as of market behaviour. In recent years, a range of bargaining models have drawn on these descriptions to both challenge the unitary household model and to present alternatives, thus opening up a whole new area of research, and one with significant policy implications (see e.g. discussions in Agarwal, 1994, 1997; Folbre, 1986; Haddad, et al., 1997; Lundberg and Pollack, 1993).

Indeed, some feminist economics has gone further, in pointing out that even the bargaining models have limitations, since they do not take into account the importance of social perceptions in determining economic outcomes. Hence, for instance, the fact that women get a worse deal than men within the home has much to do with the perception that women contribute less to the household than men because their non-wage work is perceived to be less valuable than the cash-generating work done mainly by men. Perceptions, however, cannot readily be modelled and call for a more qualitative analysis (e.g. Agarwal, 1997).

Again, in the debate on the "missing women" of South Asia (Dreze and Sen, 1989), economists were first alerted by demographic data on female adverse sex ratios. Equally important, in trying to explain this phenomenon of female-adverse sex ratios, they (including myself) drew on both anthropological descriptions of cultural practices such as dowry and marriage patterns, and ecological variations in cropping patterns such as the rice/wheat divide which affect economic variables such as female labour force participation rates (see e.g. Agarwal, 1986a; Bardhan, 1984; Dreze and Sen, 1989). In fact, anthropologist Barbara Miller who was amongst the first to highlight the link between female adverse sex ratios and factors such as dowry and female labour participation (FLP) in her book: *The Endangered Sex* (1981). Dowry has both a cultural and an economic dimension; FLP again varies by ecology and culture.

Similarly, in my work on gender and property rights (especially land rights), I drew substantially on anthropology as well as law and history to move well beyond the narrow understanding of property rights that characterizes discussions on this subject within mainstream economics (Agarwal, 1994). For instance, economists think of property rights largely in terms of incentives, investment and efficiency. But property has many other dimensions.

Economically, it is also linked critically to physical well-being and a reduced risk of poverty. In addition it has legal, social, political and symbolic facets. Property ownership enhances social status and political power. And it is its symbolic importance that explains why in property disputes people often spend more to defend their claims in ancestral property, than its market value would ever justify. The economics literature misses most of these dimensions.

A second major discipline that has enriched heterodox economics is philosophy. The most well known exponent of this is of course Amartya Sen, his vast body of work on inequality, capabilities, ethics, and freedom.

A third discipline from which heterodox economists are increasingly drawing is social psychology. Using experimental games (the standard methodology of social psychology) a number of economists are today challenging the basic assumption within mainstream economics that human behaviour is primarily guided by self-interest and some have demonstrated that altruism is as much if not more important. Also economists Frank et al., in a 1993 paper in the *Economic Journal* set up Prisoner's Dilemma games among US university students to test differences in cooperation between those studying economics and other disciplines, and between women and men. They found (no prizes for guessing right!) that economists were much more likely to defect than non-economists, and men were more likely to defect than women.

More generally, experimental games are increasingly being used by both economists and political scientists working in the field of environmental studies to test expected degrees of cooperation in the management of common pool resources (see e.g. Cardenas, 1999).

A fourth discipline from which heterodox economists have drawn extensively is agronomy. Here I have particularly in mind agricultural economists. Indeed good agricultural economics has always needed some understanding of agronomy, of cropping patterns, soil types, water tables, and so on. And this goes a long way back within economics. Today, this knowledge can be put to good effect in examining the ecological implications of the green revolution. Also, agrarian studies and peasant studies have drawn extensively on anthropological techniques and insights.

A fifth discipline that economists have drawn on extensively is geography. Indeed, this has been so cloaked in studies of regional variations in, say, poverty, sex ratios, forest cover and development indicators, that many economists in university centers of regional development would be surprised if told that they were doing interdisciplinary work.

A sixth discipline with which heterodox economists are in constant conversation now is political science. This can be seen in the proliferating work on institutions and governance, in particular, the governance of common pool resources, and of course the contentious issue of social capital.

Finally, apart from the ecology-related examples given above, if we specifically take the field of ecological economics, there are many examples of economists learning from and drawing upon the insights of several disciplines simultaneously. Cases in point are the writings of Jean-Paul Baland, Jean-Philippe Platteau, Pranab Bardhan, Partha Dasgupta, Juan-Camilo Cardenas, N.S. Jodha, my own 1980s work on rural energy and current work on collective action and community forestry, and so on (see variously, Baland and Platteau, 1996; Bardhan, 1999; Cardenas, 1999; Dasgupta, 1997; Jodha, 1986; Agarwal, 1986b; 2000b, 2001).

All in all, therefore, the divide between economists and other social sciences is based at least in part not on reality but on misperceptions. Among heterodox economics there has been a good deal of crossings-over into other social sciences. At the same time, taking economists as a whole, we have not gone far enough. And part of the reason of course is the dominance of neo-classical economics over heterodox economics—a divide sustained by university departments, hiring and tenure practices within the academia, and strict disciplining within the discipline. And this is also driven by global politics. For instance, many Russian and Chinese economists today are being trained in neo-classical economics in Western universities.

Equally important to recognize, however, is that relatively few non-economists have drawn upon insights from economics. Those that have, tend to be more particularly those working with quantitative techniques rather than qualitative methods. Few in anthropology, sociology science and law, for instance, appear to have examined the advances in economics, even heterodox economics. (Exceptions to this are limited largely to the domain of feminist studies and agrarian studies.) So the divide such as it exists, cannot be laid only at the door of economists.

The need for and advantages of crossing the divide

Why is it so important for both economists and non-economists to learn from each other, but especially for economists to go further afield in this respect than they have done? Interdisciplinarity is important for several reasons:

1. *For allowing greater scope for originality in questions asked and methodologies used*: Some questions would not have been asked at all within the domain of mainstream economics. A case in point is the whole arena of intra-household inequalities, and of

gender inequalities more particularly, both within and outside the households, that I had mentioned earlier. Indeed if I had not ventured into other disciplines in my book *A Field of One's Own*, I would have had fewer new insights.

2. *For the sake of accuracy*: A case in point is the issue of deforestation. One would think it is difficult to go wrong on this one. But it has happened. In Guinea in West Africa, for example, ecologists, economists, scientists and others had long believed that deforestation rates were massive. But when anthropologists James Fairhead and Melissa Leach (1996) talked to the villagers they got a different story: that forest area had in fact grown in parts and remained stable in others. They confirmed this from historical records and aerial photographs taken at different points in time. Their analysis revealed that many interested parties had kept the colonial narrative of rapid deforestation alive, especially forest officials who benefited from the replantation schemes and the control they enjoyed over forest resources (which enabled them to impose fines on villagers caught breaking strict forest laws, to issue permits and licenses for timber extraction, and so on). Thus, while economists would be trying to use models to explain deforestation in Guinea, Leach and Fairhead showed that there was little to be explained in the first place.

   Again, in my ongoing work on local commons governance and community forestry, I find that institutions which appear to fulfil most of the conditions set out by a number of scholars as necessary for successful institutional functioning, are found to be far from successful when viewed from the lens of gender. This lens reveals many forms of non-cooperation, inequity and inefficiency (Agarwal, 2001).

3. *For challenging entrenched assumptions within one's discipline*: For example, the standard practice within agricultural economics, when aggregating different types of labour, is to treat female labour time as half or one-third of male labour time, on the untested assumption that female labour is less productive than male labour. When I was doing my PhD in agricultural economics, however, I questioned this assumption and found evidence in a most unlikely place: the agricultural engineering department of Punjab Agricultural University. Here engineers, when testing the efficiency of use by men and women of different types of potato digging equipment, found women to be almost three times as productive as the men. I was thus able to justify treating male and female labour time at least as equivalent in my thesis (Agarwal, 1983).

4. *For explanatory depth*: For instance, explanations of phenomenon such as female adverse sex ratios, of gender or race discrimination in the labour market and so on, lie in the interface of economics and culture. Culture mediates many economic outcomes, as does ecology. For example, suppose you were to ask: why is female wage labour supply so much lower in northwest India than in the northeast, even though wages are so much higher? Economics would suggest that this has to do with leisure preferences in the more affluent region. Anthropological studies, however, correctly locate it elsewhere, namely in female seclusion practices and social status issues in the northwest. And the women who are not visibly working are not enjoying leisure; they are slogging just as hard, but in the home compound.

5. *For more multi-dimensional richness and insight*: The example of property rights and gender given earlier is a case in point. Another example is how notions of "power" are treated within different disciplines: from Michel Foucault's (1981) writings and literary theory, to the economic formulations of "bargaining power".

6. *For more appropriate policy formulation*: Policies based on narrow and sometimes false economic assumptions about human behaviour, about social dynamics, and about political imperatives have often proved grossly ineffective and sometimes positively harmful.

I hope this workshop will serve as a positive initial step in removing misconceptions about interdisciplinarity among both economists and non-economists present here, and bring us closer to working together, even if we might disagree on some counts. For it is through disagreement, challenge and grappling with contradictions that most knowledge moves forward.

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10. Economics and sociology: staying on or merging the borders—reflections on the sociology side of the boundary

Gopal K. Karanth

What does one say to a group made up largely of economists who know more about sociology than the speaker? So, there is hardly any need to introduce the subject. I have, therefore, decided to speak about my initiation into economics and also try to give my perceptions on why there has been a bigger divide between sociology and economics. This will not be a history of the division or the attempts at a merger because there is plenty of literature on this. I will try to give my perspective on how students of each discipline are exposed to the other disciplines in the social sciences, how they gather insights from them but finally stick to their own area of specialisation, keeping the divide as it were.

Inculcating the boundaries

Having decided that I would be a sociologist, one of the first insights into economics was during my graduate course. There were three introductory papers that were taught, one of which was titled "Is sociology an art or a science" and then others which discussed sociology in relation to other disciplines. When I went through this process of understanding sociology's relationship with economics, history, political science. psychology, etc., I expected that there would be an overlap. With this came the hope that at least one question in all the three papers would be a common one thereby needing a little less of preparation! But this was a misconception that was soon set right when I realised that both economics and history did not seem to feel the need to establish a reciprocal relationship with the other social sciences. This resulted in my having to put in a little effort in learning about sociology's relationship with economics. But, unfortunately, this effort to establish a correlation ended with these introductory lectures. For the rest of the three years of graduate study, both sociology and economics stayed as standalone subjects. Any occasional curiosity that I might have developed about my relationship with the other, was silenced with unfavourable responses among which was the stock one that such queries were out of the syllabus. If I wanted to know something about poverty, that was the sociology's teacher's business, while answering a question on employment or unemployment was the economics teacher's business. Though there were some themes that came up in both the disciplines, I had to eventually opt for a fashionable topic when it came to a discussion and here also the questions were not answered properly.

After having completed my graduation, after studying history, sociology and economics, I entered the postgraduate department for a master's. Here too the experience was no different in the sense that sociology continued to be an isolated subject as much as the other disciplines which came under the heading of the social sciences. Soon after joining the post graduation course, I was told by a well-wisher to keep off economics if I was particular about getting good marks in the internal assessments. The reason given was that the heads of departments of both sociology and economics were vying for the vice-chancellor's chair and had slapped court cases on each other. I took this advice so seriously that I made it a point to even stay away from the economics section in the library!

There were some very interesting papers taught in sociology, one of them was the "Sociology of Organisations" while the other was "Industrial Sociology." These were the papers which had some kind of an overlap with economics and gave one an insight into the subject. Looking at sociology's interpretation of the above two papers, I cannot but help feel that it was very superficial and nowhere near the perspective of what the other social sciences could have offered on the subject.

Twenty years have passed since I made sociology my profession. One of the most favourite papers that I have taught is "The Sociology of Economic Development," which is taught in many other universities as "Economic Sociology," or "Economy and Society." I have to confess that I taught and theorised on that paper without having any knowledge about what was really going on in the other discipline, economics. So, that is the level of my initiation into economics.

The turf battle

In the Institute of Social and Economic Change, where I am presently tenured, the sociologists are in a minority while the economists dominate. When a presentation is called for at a seminar or a discussion, I spend half of my time defending the sociological aspect of my study. Whether it be a study on drought, survival strategies of the poor, natural resource management or the changing rural livelihood, half of my time is spent on explaining how these topics come within the scope of sociology. This indicates that I am not the only sociologist to feel embarrassed about his lack of knowledge about economics and what it contains. Even if one does have a little knowledge about economics, one has to always contend with the problem of not being abreast with the latest in findings which is an essential prerequisite to being able to engage in a dialogue

on the subject and stay on top of the discussion. This is one more reason for a sociologist to be embarrassed. With regard to explaining why certain topics have been chosen for discussion by a sociologist, my reading is that those from the other disciplines, say an economist or a political scientist, seem to have this notion that the topics chosen are not sociological. The other assumption is that if a sociologist were to choose such topics to present papers, he would first need to give a justification on why such topics have been chosen by him in the first place.

Given this kind of a backdrop, I would like to draw an analogy to the firecrackers being used during Diwali. As a boy, I have observed that when the whole bundle of crackers come home, the youngsters automatically pick up the ones which are the least harmless, the women veer towards the crackers which light up while the big brother picks up the noisy, dangerous ones like the atom bomb, the aeroplane, etc. I would like to say that sociologists have picked up the smaller crackers and left the bigger ones for those who are brave and capable of handling them. The connection here is that the ones who fire the big crackers would often take the help of the smaller ones like the sparklers to help light up the atom bomb, etc. The point to be noted here is that both in India and abroad a sociologist continues to do his work in the way that he thinks fit, without making any effort at trying to tailor his findings to suit the other social sciences, and leaves it to the economist to pick up what he thinks fit. The same is applicable to the other social science disciplines as well. This is the prevalent attitude.

Reasons for the segregation

Without going into the technicalities, I will just try to apply the sociological viewpoint to understand why this segregation occurs. There are four levels:

Knowledge-based

The knowledge base of sociologists with regard to economics, be it theory or methods, is generally poor. This is the general assessment. But if one were to review the course content of sociology in the different universities, specially with reference to papers which have a connection with economics, rarely do the names of authors like Adam Smith, Malthus, Ricardo, etc. figure even in a paper like "The History of Sociological Thought." The feeling is that since these authors were economists, they should not be there. So, I start with Comte but do not think it necessary to verify whether he had any specific views against economics. Of course I do know that he did not look on economics very favourably. I did study Durkheim and Weber, both of whom are known to be founding pillars of economic sociology. While Durkheim's work on property has hardly been read and very few universities have this as part of the syllabus, his writings on religion, morals, suicide have a large readership which fits in with the analogy of the small crackers helping to light up the big ones. A majority of students get the message that the works of those authors who are known to be specifically economists are not really relevant, though this is not directly stated. This is how there is a gap in the knowledge base and as earlier speakers have stated, one can only make up for this after getting a permanent tenure or appointment. But when this happens, one is constantly forced to provide justifications on what is sociological about one's work. It is not that this problem occurs only at this stage, however.

Capability

Even if one were to surpass the stage of fulfilling all the requirements of a knowledge base, the ability to speak, write and articulate on the subject in the manner that economists across the border would also be doing it, is an issue. For instance, I would hesitate to speak on Rational Choice Theory today for fear that some economist would contradict the interpretation saying that my understanding was outdated as there had been newer findings on the subject. I would like to talk about my experience as a graduate student when I was studying Agrarian Social Change for my doctorate degree. It was fashionable in those days to enter into debates pertaining to modes of production in Indian agriculture. Whenever I spoke about my thesis which dealt with change and continuity in agrarian relations, I was asked whether I had referred to the latest Economic and Political Weekly which had a paper pertaining to the most recent findings on my research topic and was also informed that the debate had been taken further. It was very difficult to keep up with these changes and I was constantly made to realise that there was a lot of information that I needed to acquire and a lot of this should have been done at the graduate level or post-graduate level. One more difficulty that came up at a stage when I felt that I had got abreast of the latest in the debates pertaining to my research subject was when an author who had earlier published his findings in the Economic and Political Weekly, revised his original position because of reading and reinterpreting the latest of one of Marx's translated works.

Audience phobia

This is one of the problems faced by a sociologist. Even a sociologist with some understanding of economics faces this fear. His tendency, therefore, is to speak and write keeping fellow sociologists in mind leaving economists the option to pick what they like. Of the few sociologists in India who did specialise in the multi-disciplinary approach, none was able to make it into mainstream sociology. One of them, when he died, did not even merit a proper obituary in professional journals. The point to be noted is that

such persons will not be considered as insiders in sociology and one is not sure whether they would be considered an insiders in economics either. Professional sociology journals often return my manuscripts stating that there is too much of economics in them. Suggestions are then proffered on how the economics part should be reduced and the paper made more sociological to merit publication.

Institutionalisation

This is by far the worst problem. The parochialism of the disciplines can be the most crippling. I can recall the story of an eminent sociologist who was keen to join this Institute but not allowed entry because he did not have a doctorate in sociology. This is ironic considering that his works are considered as essential readings in many of the papers that are being offered here. Crossing the institutional border thus is another big hurdle to bridging the divide.

Concluding remarks

I would like to make a few random statements before concluding. There is a big battle of the methods between the two disciplines and this continues. Notwithstanding the periodic attempts to merge the boundaries between the two disciplines, these methodological battles remain the chief hurdle. Sociology, as has been practised in most countries has been empirical in nature and usually after an event has occurred, i.e. *post factotum*. Economic predictions are made earlier and therefore it is little wonder that economists are there more often in policy-making and planning bodies as compared to Sociologists.

Economists and sociologists also differ in terms of the level and unit of their observation. Economists are comfortable both at the micro and macro units of analysis while sociologists rarely speak about the macro level. It is always "my village," "my study," "my region," "under the circumstances this is how it is," and that is the maximum that a sociologist will go up to and not beyond. The units that the sociologists work on are generally smaller and result in skeptical questions being raised on generalisations. Perhaps sociologists respect for data and interpretations by economists is limited. Despite this, I have to admit that there are new books and articles in professional journals which are a blend of sociology and economics. Some of these pertain to the Rational Choice Theory, the Logic of Collective Action, Free Rider Problem, etc. But what has to be understood is that many of these are offshoots of original works in economics rather than original sociological works.

Round Table: An exercise in developing interdisciplinary research agendas

11. Urban pollution and human health

Round Table Chair: **Gopal Kadekodi** Rappoteur: **K. Subodh**

Defining the research problem

The first task was to identify the theme on which the research proposal was to be designed. A consensus that emerged was that major types of pollution: air, water, noise, urban waste, etc were to be studied. It was agreed that only anthropogenic pollution was to be considered. Events such as fires, floods and other natural calamities are certainly important, but may not fall in the scope of the present study. All the members agreed that more than desk research, field-based research was important in the current context.

An interesting suggestion that emerged was that the topic had to be selected by going from the "end point" which was public health, and then looking into the problem of pollution. It was noted that while some types of pollution like water pollution had a rural and urban setting, certain other types of pollution like outdoor air and noise pollution had just an urban setting. Thus the objective emerged as improving public health conditions or situations. The group took this as the 'Impact' variable, to be followed by 'Responses' at the policy level.

The next question was: What should the approach be? Studies like 'Air pollution in Delhi', 'Water pollution in Damodar River' or 'The impact of mining in Talchar, Orissa' are location-specific studies. This approach can at best cover some specific aspects of public health and not all aspects. There was already a suggestion that instead of one type of pollution, all types of pollution and their impact on public health should be studied. There was also an interesting suggestion that instead of just looking into the level of pollution and its impact, it would be worthwhile to study as to 'why people do not act[in response to such pollution]?'. Keeping all these suggestions in mind, the group felt that the study could take up urban centres of different scales, covering all types of pollutants. The group emphasised that both the intertemporal and spatial dimensions (point and distance) had to be considered. Finally the members selected the topic as ' A comparative study of urban pollution and human health'. [This led to the change in the roundtable's title – Eds.]

Shaping the research question

Having decided on the research theme, the second session tried to sharpen the research problem. The different types of pollution were mentioned, such as indoor air pollution, outdoor pollution, noise pollution and solid waste. The outdoor pollution would include pollution generated by transport industry and other activities.

As one approach, a comparative study could be conducted based on the use of pollution standards as the benchmark and the current and future scenarios. This raised the question of why current pollution standards should be adopted as the appropriate benchmark for purposes of assessing public health. There was a suggestion that research could help to develop newer pollution standards. But this raised a whole set of questions about pollution standards: Who set the standards? Why were the standards static? and so on. Therefore, it was thought best to look for alternative research questions.

Some of the primary research questions identified were: Who gains and who loses due to pollution? How does the community respond to pollution? The differential impact of pollution in the area where the people live as against the dispersed impacts were also to be studied. With the spatial (including habitat-wise) and inter-temporal impacts to be studied, the group suggested that the methodology be defined accordingly. After much discussion, the following stages of enquiry were suggested: causation, outcomes, perceptions and approaches to resolution. This way a more inter-disciplinary methodology could be explored. These stages also imply assessments of pressures, impacts and responses (public, private and government).

Having identified the way to approach the research problem, the group sought to understand how the questions of causation, outcomes, perceptions and approaches to resolution could be addressed using an interdisciplinary approach.

There was a suggestion that this framework was just a set of building blocks and linkages had to be developed for more clarity on the problem. It was finally decided to look into the problem as a 'Comparative analysis of differential health outcomes of pollution across different scales of urban settlement.' The methodology to address these questions is enquiring into causation, outcomes, perception and approaches to resolve the problem by using the interdisciplinary approach.

Methodology for the research problem

Causation

The first aspect in this is to look into the link between pollution and public health. What the sources of pollution are, and how each kind of pollution affects health have to be studied. This is where pollution experts and epidemiologists and public health specialists play a major part. There was consensus among the participants that there should be measurements of these pollutants and health parameters to determine how pollution affects health.

There was a suggestion that the measurement of pollution differed across pollutants. For example, in transport pollution, there was the need for finding out suitable emission levels of vehicles, where the economists and engineers have to work together. There was also a suggestion that urban growth patterns should be looked into. This is done by seeing how land use patterns have changed. A geographer together with a demographer could look into the air pollution problem by doing some mapping of land use and habitat using GIS. The demographer and a transport engineer together can look into transport use pattern, mobility of people, settlement patterns and emerging demand pattern, etc.

There was consensus that public policy factors were also to be considered, to understand what the situation was at present and that could help to solve problems later. Some elements of the legal position on land use and property rights are to be studied as part of causation.

Outcomes

Having identified the causation, the next attempt is to look into the outcomes. Members, belonging to different disciplines, pointed out different types of outcomes. The economists were concerned about the loss of income and loss of wages and the money needed for averting diseases. The sociologists were concerned about how different types of people are affected, whether children or old people, etc. There were the spatial outcomes (living near the vicinity of pollution and not), occupational groups (who works and who doesn't) and the socio-economic groups.

The outcomes can be grouped as exposure, disease, mortality, morbidity, social security and income loss. The group suggested diverse methods to measure these outcomes. While the economists were more interested in using the dose-response method and measuring the health effects and also household utility functions or loss of utility, the sociologists were more interested in focus group interviews and opinion polls to get the feel of outcomes from the people. The importance of epidemiological survey was also highlighted although the cost involved in it was acknowledged. Finally, it was felt that secondary data from hospitals (on incidence, morbidity, prevalence, and mortality) together with household level data and focus group discussions were required to get correct information on outcomes.

Perceptions

The group was unanimous in acknowledging that different disciplines (as also communities and individuals) had widely differing perceptions as to how to rank or value a pollution-related health problem.. There was a suggestion that a new '*mental model approach*' in the field of risk communication could be very useful in eliciting people's perceptions regarding the importance of public health problems. There was general consensus that just economic valuation based on contingent valuation, hedonic pricing or opportunity cost calculations would be inadequate. A wider perspective was required. For instance, alcoholism in mining sites may lead to social tension and crime. It was suggested that different types of costs, economic costs, human costs and other subjective costs (pain, suffering, mental tension) all had to be dealt with separately.

Approaches to resolve

On the question of policy and other responses, different suggestions emerged from the discussion. While the economists used the 'polluters pay' principle, the sociologists suggested the importance of collective action. The use of legal methods was also highlighted. There was also a very important suggestion that the question of why people don't react should also be addressed and taken back to the stakeholders concerned. It was agreed that as a policy suggestion, polluters should be made to stick to standards and the costs for that had to be estimated. The need for civic action was highlighted. For example in case of transport pollution, there should be suggestions for restructuring traffic, and change existing management structures. There was also a need for more social movement to put pressure on the polluters. The responses of different entities—communities, industries, NGOs, households and women, and government—are to be assessed for mapping a response matrix for different possible actions.

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Workshop summary

Session chair: Kanchan Chopra

12. A summary of the workshop deliberations

Gopal Kadekodi, Bina Agarwal and Sharachchandra Lele

We have been entrusted with the difficult task of presenting an overview of the workshop. It is difficult *not least* because the presentations did not come under any single disciplinary framework! Of course this was only to be expected since the workshop was aimed precisely at spelling out an interdisciplinary approach to environmental research. All three of us who organized this workshop are pleased with the outcome and the range of views that have emerged. In this overview, we will confine ourselves mainly to the issues that emerged in the plenary sessions. The deliberations are grouped under four aspects:

- The necessity and advantages of doing interdisciplinary research;
- Institutional, disciplinary and personal barriers to doing such research;
- General recommendations for promoting such research; and
- What role can INSEE play?

The need for and gains from interdisciplinary work on the environment

From the beginning, most of the participants thought that interdisciplinarity is both useful and necessary for creatively and effectively researching environmental problems. This was first formulated by Sheila Jasanoff in her lead presentation. She asked: "Do environmental questions demand interdisciplinary approaches?" She gave examples of studies and drew from her own experience of research to illustrate the benefits of interdisciplinary work, and the need to bring together ecology (for sustainability), economics (for development), law (for justice and governance), and sociology (for social movements and vulnerability) under a wider interdisciplinary network of research. Joan Martinez-Alier's plea for a humanitarian approach also makes it necessary to combine history, anthropology and sociology in this framework. Both Jasanoff and Martinez-Alier highlighted the value positions underpinning different disciplinary perspectives.

Subsequently, Bina Agarwal specifically outlined several advantages of crossing the divide between economics and other social sciences. She posed the question: 'Why is it important and advantageous to cross the divide between disciplines?' She listed six major reasons that we need to ponder over: (a) for allowing greater scope for originality in the questions we ask and the methodologies we use to answer them; (b) for the sake of accuracy; (c) for challenging entrenched assumptions in our own disciplines; (d) for explanatory depth; (e) for multidimensional richness and insight; and finally (f) for more appropriate policy formulation. Several others, including Kailash Malhotra and P.S. Ramakrishnan, concurred with this and shared their own experiences in this regard. Charles Perrings also gave some examples of the limits of economics. He argued that when it comes to ecological issues of 'irreversibility' and 'severity' of damages from human interference (for instance), economics has very little to offer as a discipline.

Crossing disciplinary boundaries: the barriers

The presentations provided an in-depth understanding of the barriers that prevented people from crossing the boundaries between their own discpline and other disciplines. The barriers are basically of three types: institutional, disciplinary, and individual. Several examples of institutional barriers were given, in particular, the partitioning of knowledge into the "arts" and the "sciences" immediately after high school (10th standard), the university system in India which needs early specialisation and choice of discipline for admission, the pressure on teachers to stick to their discipline for getting jobs and tenure, and so on. Disciplinary barriers include conflicting views between basic theoretical research and applied research (a point touched on by Sheila Jasanaff), or differences in understanding the 'value' of a resource (ethical, economic, community and so on). Ramachandra Guha identified four other barriers that operate within disciplines, which he characterised as "the tyranny of the discipline", "the fetishization of method", "the partition of time", and "the tyranny of fashion". Similarly, economists are trained to believe that "quantitative" data are superior to "qualitative" data, and that in fact the latter are not believable or usable at all. These tyrannies may originally be choices (of, say, method or temporal scope) made in accordance with the subject matter of a discipline, but eventually become sanctified as the only way to study reality.

Finally, there are self-imposed barriers because scholars trained in one discipline hesitate to cross the line, often because of their limited knowledge of other disciplines. Gopal Karanth's presentation eloquently expressed the depth to which this hesitation pervades the non-economists' minds. The good news is that many individuals in the social sciences have begun to overcome this hesitation, leading to very productive cross-fertilization of ideas and methods. For instance, game theory is being used by economists and political scientists, and the methods of social psychology are again being used by other

disciplines (e.g. multi-criterion approach to measurement and evaluation). The presentations by Dilip Ahuja and Anand Patwardhan also illustrate the gains of crossing disciplinary boundaries and overcoming individual hesitation.

Many of the participants added to this discussion from their own experience. Among the points they raised were the following:

- In practice, collaborative research is not easy. In formulating a research project, one may not have on board persons from all the various disciplines with which one needs to collaborate.
- Constraints of time and data-collection can pose a problem, as different disciplines have different time frames.
- The natural scientists sometimes object to social scientists taking leaps without "sufficient" corroborating evidence.
- Universities that register PhD students (including, e.g. those at ISEC) generally impose rigid disciplinary boundaries, thus discouraging interdisciplinary research.
- Universities and even some ICSSR institutions have equally rigid disciplinary rules regarding faculty recruitment. For instance, till recently ISEC faculty recruitment rules specified that the candidate must have a Masters and a PhD in the same subject.
- Interdisciplinarity may be easier to implement for faculty, but difficult (and perhaps not advisable) at the undergraduate level.
- Those trained in the natural sciences are taught to keep away from day-to-day problems (applied research). In contrast, in the social sciences, there is greater involvement with such problems.
- When presenting a proposal for a PhD, the experts have a tendency to look at the title very closely. In the case of interdisciplinary dissertations, there may be a feeling that the title is not sufficiently focused.

Recommendations

How should interdisciplinary research be promoted?

Firstly we need *a new space.*

- In the last 10–15 years, new journals have come up which have cut across interdisciplinary barriers, both in India and globally. They need to be strengthened and promoted.
- Academic and teaching institutions have not really encouraged the interdisciplinary approach, though a few research institutions have permitted it. There is a need for UGC, NCERT and other institutions to develop interdisciplinary teaching programmes, course syllabi and teaching materials.
- There is a need for building a curriculum for upgrading the skills of faculty and students. This is possible by making UGC-supported Faculty Upgradation Programmes cut across disciplines.
- Donor agencies often impose (implicit or explicit) limits on the nature of the research they sponsor. There is a need to impress upon donor agencies the importance of supporting truly interdisciplinary research.

Secondly, we need a *common language* for interdisciplinary research. Each discipline has its own jargon, which is not easy for other disciplines to follow. This communication barrier can be reduced if more interdisciplinary courses are put in place at universities and if special journals concentrate on such common approaches.

Thirdly, *policy makers* can play an important role in encouraging the interdisciplinary approach. For this to happen, policy makers as well as donors need to be made aware of the advantages of interdisciplinary research. For instance, an agency promoting watershed development should ensure that its research teams are constituted not only of soil scientists and hydrologists, but also of, say, anthropologists, political scientists and geographers.

Finally, there is a need for *advocacy*, that is, for some kind of pressures to originate from civil society on academia, policy makers and researchers to make research and policy discussions more holistic.

To round off this discussion, some additional comments were made by the chair, Kanchan Chopra. She noted that:

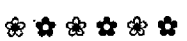
- Having or developing a common language or vocabulary is important. E.g. in a recent meeting that involved the presence of a mixed group of scientists, the term "ecosystem goods and services" was the source of much confusion. Each group interpreted this term differently and finally it was decided that a glossary should be prepared to explain the jargon.
- At the same time, the real constraint is not language or even the absence of a common unit of valuation, because it is the power structure that determines policy more than numbers. Policy makers are interested in the impact of different decisions on different stakeholders. Hence, multi-criteria analysis was quite acceptable to policy makers; ultimately it was

his/her value judgement that would determine the decision.

What role can INSEE play to promote interdisciplinary research?

In conclusion, the participants engaged in a vigorous debate on what INSEE could do. All the suggestions cannot be outlined here since they were not all discussed adequately, but the ones on which some form of consensus emerged are listed here. The participants strongly recommended that INSEE should consider:

- Providing cross-disciplinary training for its members through:
  - Holding a one-day pre-conference workshop on "Basic hydrology for social scientists" preceding the upcoming INSEE conference on "Water", and similar such workshops before each INSEE conference.
  - More extended training programmes at other times.
  - Compiling a reader of interdisciplinary research on the environment for INSEE members.
- Shedding its image (partly imposed by its very name) of being a society of economists, and actively broadening its membership base by reaching out to ecologists, environmental scientists and non-economics social scientists in India who are working on environmental issues.
- Urging the University Grants Commission to create interdisciplinary degree programmes, to include ecological economics as a subject in the NET and Junior Research Fellowship examinations, and to promote the appointment of interdisciplinary scholars to faculty positions in UGC-supported institutions.
- Urging ICSSR to broaden its rules for faculty recruitment so as to enable the hiring of interdisciplinary scholars in ICSSR-supported institutions.
- Urging the Ministry of Environment and Forests in the Government of India to broaden the scope of its Environmental Management Capacity-building Programme so as to make training and research activities truly interdisciplinary.
- Educating decision-makers about the need to move away from simplistic cost-benefit calculations to a more broad-based understanding of the socio-environmental impact of development projects.



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