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Introduction
By: Tomás Schlichter *

In recent times, both technical and scientific literature have reflected the growing global interest in the environment and its relationship to development. The need to improve the standard of living of our human population, without compromising the options for development of future generations by degrading the resources base, has generated a new vocabulary revolving around the concept of sustainability.

The tropical regions of the developing world demonstrate better than any other area the relationships between resource degradation and poverty. Nontheless, this relationship is not necessarily one of cause and effect. Social inequality is undoubtedly related both to increased poverty and environmental deterioration.

The "supply" of genetic and ecosystem variability contrasts with the destructive misuse that has gone on and the loss of future options for development based on this natural heritage. Increasingly, resource degradation causes negative impacts in the short term and reduces possibilities for developing alternative models in the future.

In spite of the obviousness of resource degradation, it remains difficult to fully understand the complex relations that exist between human society and nature. Our economic systems and natural resources have feedback mechanisms that need to be understood if we are going to propose new, more sustainable alternatives.

We need to examine the philosophical models dealing with human society and nature, and the methodological aspects allowing us to quantify these relations. In this way, we are trying to integrate economics and ecology. It is not just an effort to identify mutually acceptable positions and discuss existing conflicts, but rather an effort to establish an innovative disciplinary approach. This introductory section, as well as the presentations by Robert Constanza and Kenneth Boulding, are efforts to highlight this approach.

The economic evaluation of natural resources is necessary if the general public and decision-makers are to understand the importance of ecosystems, both for conservation and for use. The latter group often is swayed by the relative weight of the benefits assigned to the various management options available.

When these options include the alteration or replacement of natural ecosystems as part of project implementation, it is important that society considers the opportunity costs of these decisions. Reliable information concerning the resources in question and the impacts of proposed changes are necessary to permit a meaningful dialogue between decision makers and interest groups.

Efforts to develop techniques to evaluate natural ecosystems are in full swing, as are efforts to bring together economists and ecologists. Until now, the problem has been the lack of a unified approach, acceptable to all investigators. Bruce Aylward and Edward Barbier present techniques commonly used in economic analyses, such as Cost/Benefit, applicable to the tropics, and especially Guatemalan wetlands.

Craig MacFarland and John Dixon use the same approach to evaluate protected areas and characterize their relation to economic development. Robert Constanza presents a different approach, based on ecological relations and energy flows, and compares the analyses carried out in a Southern U.S. wetland.

Knut Alfsen's presentation shows the importance of reliable data bases and appropriate models for environmental cost analysis, as applied to pollution control. An interesting aspect of this study is the importance of the institutional dimension, which is shown to be crucial for information generation, rapid access to data bases and their use in decision making. While the Norwegian experience is not directly applicable to our societies, I believe that it does show many useful aspects which deserve close study.

Charles Hall's simulation model demonstrated graphically the type of information necessary for agricultural development planning in some countries. The examples are based on the differential use of various agricultural inputs, production levels and population growth, in a form which is relevant to the majority of the Central American countries. His results are controversial, as are many of the papers included in the Proceedings. As Robert Constanza states, these types of controversies will allow us to create a transdisciplinary approach.

The Economics and Ecology Workshop was attended by scientists, politicians, ministers of agriculture and natural resources from the region. Other decisive decision-makers, such as regional bankers, also participated in the event. The interaction of these different players was perhaps one of the most relevant aspects of the workshop, but unfortunately this is only partially reflected in the transcripts covering the three days of the event.

This event was organized as part of the Conservation for Sustainable Development Project (a.k.a OLAFO), joint effort with the World Conservation Union (IUCN), which is being developed as part of the Integrated Natural Resources Management Program at CATIE.

The OLAFO Project is financed jointly by the Swedish and Norwegian Development Agencies (SIDA and NORAD). The Project seeks to tackle the dilemma of sustainable development of rural communities, based on ecologically sound management of natural resources. Its main activity is the development of demonstration projects with local participation, located in moist tropical forests and coastal environments such as mangroves.

Project results to date demonstrate the existence of a wide range of promising natural resources and active involvement of local community groups. In contrast, institutional factors (lack of field personnel, resources and intra- and inter-agency policy conflicts) are increasingly seen as major limiting factors for project implementation.

The conceptual approaches discussed in the workshop, and the field experience generated during the first two years of the project, are mutually supportive. The discussions concerning the evaluation of natural ecosystems have given project staff a broader and more systematic approach for dealing with inter-sectorial policy conflicts. At the same time, results from the demonstration projects serve to anchor theoretical development to the Central

American reality, and thereby, help guarantee that the serious problems that threaten the well being of society and the sustainable management of natural resources, are being addressed.

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Initial Address: José Flores Rodas * Topic: Economics, Policy and Natural Resources Issues in Central America

I was recently at the International Donors' Round Table for Panama's Tropical Forestry Action Plan, where Dr. Stanley Heckadon, formerly of CATIE and now Director General of the National Resources Institute of Panama, described the Central American isthmus as the bridge of life. Indeed, due to its isthmus character, Central America is enormously rich in its biodiversity, which in effect bridges the North and South American subcontinents.

Nonetheless, for the past three decades, Central America has led the world as a subregion in its deforestation rate. Worse yet, this rate has been in itself increasing from 2.9% per annum in the decade of the 70's to 3.4% per annum in the decade of the 80's.

In addition to the existence of a number of well documented structural reasons, it is important to examine a number of economic and policy issues, at a time when a number of structural adjustment programs are being implemented. At a time when the burden of external debt and internal deficit spending are taking their toll in the poorer sectors of the economy, and thereby affecting the natural resources of this region, there is no question of the timeliness of this workshop as part of a process that should provide those analyses and guidelines that point to the linkages between economics, policy environment, and ecosystem deterioration. Natural ecosystems have physical characteristics that affect the kind of institutions that are likely to be useful in coping with or in changing undesired outcomes. Socio-economic characteristics, such as the degree to which potential users can be excluded, also affect resource use. Institutions, in turn, affect human production, human consumption and land use behavior. The outcomes and consequences of policy choices affected by institutions and behaviour, include resource use now and in the future, the quality of life and many other concerns.

If one were to look at four basic areas of natural resources: sustainable agriculture, production from natural forest, management of critical watersheds and protection of wildlife and biodiversity, in view of macroeconomic monetary fiscal and trade policies, tenure issues, regulatory and development issues, the linkages are clearly established in terms of natural resource use, depletion or conservation. In view of the time limitations, an in-depth analysis at this point in time is impossible. Nevertheless, it is my hope that some of these issues will be addressed in this workshop.

Briefly, I would like to mention, just to cause a bit of discussion, some of this issues that affect resource use and conservation. For example, monetary policies, exchange rate, money supply, and interest rate issues may appear to be removed and irrelevant to the decisions taken by users of natural resources. However, these and other macroeconomic policies, have had commanding importance in resource issues. Given the wide scope and effect of these policies, they often have contradictory effects on different aspects of resource use.

For most Central American countries, the exchange rate regime had been represented by an overvalued currency until the mid-80's. As such, this regime had implicitly subsidized, and hence encouraged, imports, and implicitly taxed, and

hence reduced, exports. Several adjustments to the system had effectively created a dual exchange rate to deal with a limited amount of foreign exchange available. The primary effect of the overvalued currencies has been to skew relative prices against agriculture in comparison to other sectors of the economy, resulting in reduced investments and savings in this sector, increasing pesticide imports and reducing real prices to the farmer. On the other hand, with the current floating system, there could be increased pressure for timber exports whithout compensating policies. Therefore, the increased generation of foreign exchange may come in part from the increased depletion of the forest resource base and improved agricultural sector performance, based on incentives to better managed lands. Furthermore, better returns to agriculture can continue extensive farming practices and expansion of the agricultural frontier, since problems still remain with respect to land tenure and forest protection.

Money supply issues in most Central American countries are determined by external trade and by domestic and external debt policy. The purpose of a money supply policy is to maintain a balance between the global supply and demand, in order to avoid inflation or stagnation. Since money supply has an effect on the inflation rate, it also determines the real interest rate. A high real interest rate, in turn, discourages long term investments required by economic growth, as well as those required for maintaining and improving the natural recource base and its productive capacity.

Other aspects of monetary policy, such as credit and interest rate policies in subsidies, have had direct impact on the use of natural resources. Subsidized credits for livestock, for example, in most of the Central American countries, has promoted extensive ranching, which occupies 50% of the agricultural land, with a resulting inefficient use of this scarce resource and its consequent degradation. Subsidized credits for short cycle export crops in most of Central America, promote intensive use of agrochemicals, whose cumulative effects and concentrations are endangering both soil and ground water qualities.

Fiscal policies, on the other hand, as defined for the purposes of this analysis, include not only government receipts, expenditures and debts, but also efforts directed towards increasing revenues through taxes and users' fees. Fiscal deficits have become important elements in determining the effectiveness of governments in meeting their resource managament and biodiversity conservation objectives.

High current public sector expenditures have been difficult to reduce. Most efforts undertaken to date to reduce them have resulted only in slowing down their excessive growth, while current revenues have had a slower growth rate. This has meant until recently, a persistent increase of the fiscal deficit, increased even more by the amortization of internal loans. This deficit, in most cases, up until 1988, was financed from external funds, while that year the trend was reversed to financing through domestic sources.

The basic problem with a fiscal deficit is that it cannot be financed with domestic credit without increasing inflation. This increase in financing through domestic resources in most Central American countries in the latter 80's, was made from resources from commercial banking systems and from resources of the central banks,

thus increasing the money supply and the pressure on prices. Another effect of financing fiscal deficits with internal resources is that it decreases their availability for the private sector, thus lowering its productive activities. The resulting decrease in investments for long term improvements, such as soil and water conservation and natural resource management, also affects its production capacity.

The fiscal deficit reduces the activity of the private sector and/or increases inflation unemployment and poverty, and consequently, the pressure on hillsides and natural forest areas. The population with the lowest income is forced to seek alternatives for its subsistence, turning to these forest areas for farm lands to grow food and for fuelwood to supplement needed additional income, in order to satisfy their basic needs.

The economic growth of the 1970's was largely due to the rise in public investment which, for many countries in Central America, recorded annual growth rates of up to 20%, financed mainly with external loans. The high level of external debt and its interest and service charges, reduced the possibility of long term investments, particularly those related to sustainable growth, natural resource management and conservation measures. Increasing the pressures on natural resources and short term export crops that have promoted over-exploitation of the soil, to obtain maximum short terms yields, leading to further expansion of the agricultural frontier and greater pressures in detriment of the natural resource base.

When government expenditures are limited, the proportion of those expenditures destined to natural resource sustainable management and biodiversity conservation are also further reduced, resulting in more depletion of these resources. One of the hopes that arises in the horizon is the opportunity to use debt for equity swaps to reduce external debt services, and to provide funds for priority sustainable development programs, natural resource management and biodivesity conservation.

Macroeconomic policies, such as trade policies, include such general policies as those which establish import tariffs, export taxes and general trade barriers, in addition to those specific policies associated with resource use, imports and exports, and those associated with wood products, export quotas on wildlife and so on. For obvious reasons, these policies have a direct impact on resource management, use and conservation. The pressures to generate foreign exchange and to liberalize trade barriers may be detrimental to sustainable natural resource use and biodiversity conservation. Tenure issues are critical components to decisions by resource users. Land tenure, forest tenure, water ownership and fishery issues are some, among many that directly affect the nature of the resource as private, or public (open access) resources, and as such, directly influence resource use and management.

Overexploitation is one of the consequences. Many of these issues are not entirely clear in most countries in the Central American region. Natural forests, a major factor in the rich biological diversity of this region, are often characterized by being open access resources, that is, resources that are not effectively controlled by any one user or user group, where the incentives are to mine or overexploit, because forbearance by one user is not matched by others

and the incentives are to get as much as possible before others get to it.

While in this time and space it is impossible to make many points and assessments about economic and policy issues in Central America, some points can be made in conclusion:

1. While this discussion has been organized around the taxonomies of the problems and policies, these policies have cumulative interactive and interdependent effects. It will be necessary to take into consideration other economic aspects and policies when analyzing any priority policy. Not to do so can lead to unintended effects when new policies are implemented.

2. Short run and long run economic trade-offs, when they are understood, present difficult choices to decision makers. Analysis of policy options for resource management and biodiversity conservation will generally have to be concerned with such issues, even though greater knowledge will make political decisions harder, as losers and winners are identified in an intra and inter generational sense.

3. Policies need to be designed to influence decisions and incentives at the resource user level. Often times, policies exist which have perverse effects on resource decisions by, for example, making sustainable resource management practices more expensive than resource mining. This will be a challenge in the major part of Central America, where a large proportion of the rural population lives in extreme poverty and does not have access to good fertile, arable land.

4. The role of ecology, resource management sciences and economics, linked through policy assessment and analysis, is critical and fundamental in establishing an appropriate and effective policy environment that will ensure sustainable resource management and biodiversity conservation in this bridge of life that is the Central American isthmus. It is also clear that those of us here in this workshop, professionally and institutionally, need to make a commitment to these ends. On an institutional basis, it is also clear that there must be an interactive support between institutions as for example, our center CATIE and the Interamerican Institute of Agricultural Cooperation, in the assessment and analysis of these policy issues, along with the Central American countries. This interactive institutional and interdisciplinary support will be an essential factor in creating this appropriate policy environment for sustainable resource management and conservation in Central America.

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Speaker:Tomás Schlichter * Topic: Relationships Between Ecology and Economics

When we try to look at the causes of the lack of communication between ecologists and economists, we often fall into argumentations about the different time ranges their disciplines are based upon. This could be true when both are referring to the same space range. For instance, that would be the case dealing with the rhythms of landscape-level ecological processes and local level economical processes. Another valid equivalence would be between region at the economical level and life zones at the ecological level. Economic measures taken at one level have faster rhythms, variations and effects than the natural succession and nutrient circulation phenomena of similar areas. Economics respond to market forces and to social and political pressures, all of which work at a faster rate than ecological processes at the landscape or life zone level. This does not exclude the possibility for some ecological processes to have faster rhythms or for economic measures to have effect on the longer term. I am only pointing out prevailing features.

For hundreds of years, the general opinion has been that the difference between animal and plant species and humans, rests on the latter's ability to modify nature.

The potential to dominate implies a hierarchical structure, where the superior level determines in a major way what happens in the lower levels. For centuries, a number of philosophies, including the neoclassic economic theories, have been based directly upon this domination premise. From this, they have deduced that the economical system can dominate the natural system. This includes the possibility, through technology, of substituting a disappearing resource with another.

The theory of hierarchies in ecology provides an interesting conceptual framework to analyze the relationship between economy and ecology and reflects about the domination relationships, according to the position within the system.

The classification of entities within hierarchies, such as cells, tissues, populations and ecosystems, is a well known process, generally applied in particular for the system approach. On the other hand, the relationships between different level hierarchies, and its application to ecological systems, have only been developed recently and can help us reflect upon the issue at hand. According to this theory, the lower-level hierarchical systems function act at a faster rate and reacts to external stimuli faster than the higher levels. A good example of this can be found in the gas exchanges behaviour within a forest, such as photosynthesis, breathing and transpiration. The stoma of the leaves open and close many times during the day, depending on their position within the leaves and other environmental factors. The movement of these cells determines the variation rate, equivalent to the gas exchange processes they control. The photosynthetic activity of the forest, on the other hand, has a much lower rate of movement and is the integrated response of all the cell-level processes.

On the other hand, according to the hierarchical theory, the higher level imposes restrictions upon the lower ones. In the case of the forest, each stomatal cell depends functionally upon its position within the structure of the forest. The intensity of light reaching the stoma, and its

micro-environment of humidity and wind --all of these factors influencing the rhythm and rate of gas exchange-- depends upon the structural characteristics of the forest.

It is then possible to use, within this framework, an analogy for the economical and ecological system. The different time frames and working rhythms would depend on nothing more than the placement of both systems within different hierarchies. Although this would explain the differences in time frames and rhythms, it is still necessary to review its implications concerning the restrictions the natural system imposes on the economy. As you see, we have already altered the relative placement of both disciplines within the hierarchical system. The restrictions at the higher level now imposed can be seen as the rules of the game, set by nature, for the economic activities. These restrictions should be acknowledged and taken into consideration by the decision makers when creating economical policies.

As in many other cases, exceptions to the rule help us clarifying these relationships. A valid example is that of cell reproduction within the human body. Normally, the process of cell division is determined by the functional needs of the body as a whole. In this case, the body is the superior hierarchy and the tissues and cells represent the lower ones. Yet there are cases where a group of cells starts to reproduce at an uncontrolled rate, affecting all of the organism. This process, which can result in death, is known as cancer.

It is possible to analyze the destruction of the natural system, via deforestation, erosion, global warming, as situations generated by an activity within the economical system that does not respect the restrictions, that is, the rules of the game, imposed by the natural system. Thus, the economical system generates a malfunction and threatens the superior system with destruction and, by the same token, its own destruction.

Perhaps by acknowledging the rules of the game, imposed by the natural system, we can create the framework to plan and develop the economic activities which will be the base for sustainable development. At the same time, this would provide the appropriate framework for economists and ecologists to work together.

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Speaker: Kenneth Boulding *
Topic: The Place of Natural Ecosystems in the Human Economy

I have changed the title of this presentation to "The Place of the Human Economy in the Total World System". The total world system consists of three major elements, all interacting: the physical system (soils, oceans) - which is subject to constant change and humans intervene in this quite a bit with dams, artificial lakes, mines and now the increase in carbon dioxide and other pollutants in the ozone layer. Then we have the Biosphere, the sphere of living systems all over the surface of the Earth and a little bit into the atmosphere. Even before the human race, there is evidence that change in physical systems, like the Ice Age, profoundly changed the biosphere, and also the biosphere changed the physical system. In the early days, it was supposed that the oxygen in the atmosphere came from living organisms which eventually breathed this out and it finally killed them off. This was the first great environmental catastrophe, which set off the process of evolution.

Then, after some three billion years, comes the human race as a result perhaps of some improbable mutations. We don't know much about our origins. We may not differ very much genetically from the chimpanzee but, as Robert Browning says, "Oh, the little more, how much it is, and the little less, what will the way."

We have to recognize that all of these systems involve profound discontinuities, which is why I don't believe in differential calculus very much.

Human race comes with this enormous brain. We have as many nerve cells in the brain as stars in the galaxies, a whole universe within. We have an enormous capacity for producing artifacts, competing with other biological systems, species and ecosystems, as a result of the whole physical structure of the world in terms of cities.

Perhaps because of its capacity for speech, the human race organized itself into increasingly larger societies and organizations, much like termites. In fact, we have organizations which cover the whole world, although we still don't have a world government, but the United Nations has increasingly played that role. This is largely the result of improvements in the art of communications. Sometimes, I think it was the telephone which created the twentieth century, the modern corporations, modern military organizations and so on. Now, with the television, we can see what is happening in Irak or anywhere else in the world.

In my lifetime, the world has become a single system in a way that my Grandfather would have never imagined. It's not surprising that the human race can be regarded as an ecological catastrophe, greatly increasing the rate of extermination of species and altering the physical environment of the whole planet. These impacts go back a long way in human history. It's not impossible that the human race played a role in creating the Sahara Desert thousands of years ago. Agriculture began changing the composition of the biosphere five or six thousand years ago, so we have been at this for a long time.

The human race is not the first ecological catastrophe which has occurred in the history of the planet. In fact, the boundary between each geological age seems to be mapped by an ecological catastrophe, a large extermination of

area wants to achieve. It also depends upon each particular area, as an individual case. The first one, the management category, gives a general prescription for management. The second one, then, has variations depending upon each individual case.

This is a set of protected areas, the internationally recognized ones, you might say, presented in summary form. They are the types of protected areas that have been invented through practice and trial and error up until now. These are arranged from most protection, or most strict protection at the top, down to more intensive development towards the bottom. The Biosphere Reserve is a special case that sort of fits near the bottom, but not exactly at the bottom. It's an international category that's a combination of strict protection in a nuclear zone and intensive resource development in part of the area surrounding that.

These are the benefits of protected areas:

* maintenance and conservation of environmental resources, services and ecological processes
* production of natural resource outputs suchs as timber and wildlife
* production of recreational and tourism services
* protection of cultural and historical sites and objects
* provision of educational and research opportunities

The benefits listed are major benefits to society. The costs are those mentioned before, direct cost of establishment or management, indirect damages outside the area, and opportunity costs that are foregone. Buffer zones in this context are generally defined as follows (this is sort of a summary of the way buffer zones are defined, taking into account the way they are used in different countries):

They are peripheral to protected areas of reserves. Restrictions are placed on their use, on use of the resources inside of those areas. They supposedly provide an added layer of protection around the protected area, and there must be some form of compensation for local resource users who are giving up something.

Regions of influence are a more general thing, but really buffer zone is a sub-category of this. So these things that I am going to say about region of influence for a protected area also apply to a buffer zone. Again, they surround protected areas and there are bidirectional flows of energy, materials, goods and/or services, some of those things are all flowing, and there is interdependency generally between the region and the protected area.

In terms of possible legal basis, the general situation that you find is that sometimes there are buffer zones that are declared as formally part of the protected area or part of the zoning scheme. Sometimes, separate legally established buffer zones may be declared around the protected zone, and in other cases, there is no formally declared buffer zone, but there is a generally recognized area in which the agency or agencies involved try to work. It's an informally recognized region of influence where they've

Speaker: Craig MacFarland * Topic: Integration of Protected Areas and Their Surrounding Regions

What I want to talk about in this second part is the integration of protected areas and their surrounding regions - or one might say buffer zones, whether they are legally declared or not.

Professionals in the resource management field working in Central America think of this area, known as a buffer zone, as a way of treating the pressures on protected areas from the protected area managers point of view. A lot of people think it's a panacea, a solution. I want to discuss today some of the concepts and problems to be faced in this.

The concept is in its infancy. Protected area managers worldwide have been spending their efforts inwardly, from the border in, based on the island mentality. In the last decade, and in only a few cases, they have begun to think about outreach, extension, and working around protected areas with local people and with other actors, which might be timber or mining interests coming from the outside and not just the local people. Usually, you have a complex of those two working together on extraction or use of the resources.

I want to talk about this because the key thing that is happening in Latin America is that there is a streamroller front, rolling over these areas and they are disappearing at a very rapid rate. If one had to look ten years back and look now, there are more protected areas, more potencially protected areas, legally declared, but where protection is not yet implemented, but overall the battle is still being lost at this point.

There are two basic types of phenomena: one is extracting or poaching, people going into the area and taking resources out or harvesting resources. The second major factor is encroachment or invasion, with people moving into the area and using it for agricultural or other purposes. The why's are obvious: extreme poverty, population growth, lack of other options, debt development vicious circle (the vast majority of money pumped into development projects is doing more harm than good because the system is badly designed in the first place and it's making the problem bigger and the countries get more indebted).

This is what the decision makers face, and they have a basic choice between protection for long term societal benefits or more immediate exploitation to decrease socio-economic pressures, not only in the areas but over the whole country or sub-region of the country.

There is a resource protection development continuum from strict preservation, such as scientific preserves, through intensive resource development at the other end, which is a multiple use management area, or part of a biosphere reserve, and there can be everything in between. There are enough kinds of protected areas, designed through human practice and conceptualization, followed by trial and error, that exist worldwide now, that the mix of resource protection and resource development can be highly varied, and it can go all the way from one end of the scale to the other.

The choice depends on the management categories, which in turn are picked out because of the objectives that the country wants to achieve or that the agency that is managing the

deep ecologists who regard the human race as not part of nature and want to get rid of us. They are the change avoiders, who regard the ecosystem of 1910 as sacred and you just have to preserve everything. Mother Nature doesn't give a hoot about that. There are 999 extinct species for every stamped one. There is no respect for the species, including us, if we're not careful. We are part of the evolutionary process as well.

Nevertheless, there does seem to be something like arrows in evolution, leading to a certain level of complexity (I'm more complex than an amoeba) and leading towards intelligence. The secret in evolution of survivors is inefficiency and adaptability. The great lesson of evolution is that the efficient always become extinct, because they can't be adaptable. Liquidity, inefficiency, adaptability, is the key to evolution. Where is Tyrannosaurus Rex? Where is the cockroach? The cockroach may easily survive us, because it's adaptable.

Well, we're adaptable. This is why I'm optimistic about the human race, because we're extraordinarily adaptable. We are beginning to recognize this. We have to recognize that the world has become a total system. This is the Spaceship Earth! This is a very small world and in a spaceship, you can't fight. Actually, in a spaceship, it's hard to get rich. If we're going to have this sustainable self-reproducing space colonies, between Mars and Venus, one of these people thought that the capacity of the solar system for human beings is a billion times greater than what we have now. This is if we use solar energy and mining the asteroids.

The economists have something to contribute to this. In terms of markets, they are useful. Market valuations aren't all the valuations, but the great contribution of economics is the concept of cost/benefit analysis. Providing you go beyond accounting, and go into the non-market valuations.

Another thing that we learned from economists and psychologists, is that rewards tend to be more effective than prohibitions and punishments. Prohibitionism is very tempting because it seems both easy and cheap. We tried this in the United States with alcohol, which is a sort of pollution which causes all sorts of diseases. Prohibition failed there and, in fact, it put back the solution. I'm not saying that you shouldn't have any prohibitions. There is a lot to say about individuals owning machine guns. If you look at the murder rate in the United States and Canada, you can see what prohibitions can do.

When it comes to the destruction of tropical rain forests and buying them up to solve the debt crisis, this has probably been better than passing laws agains cutting down trees. The Sierra Club has come around to seeing that the price system can be manipulated environmentally, particularly in the case of air pollution. Putting taxes on negative commodities is better than just prohibiting them. Local environmental problems are easier to solve than the world environmental problem, and I feel I've seen an age of great improvements in that sense. If you have good local leadership, governmental and non-governmental organizations that pester the government, this is the only way to make governments behave. We are all in favor of elections, but we are not going to get environmental governments from elections. You need pressure groups. At the local level, there are many things you can do.

The world environmental problem is harder because of the world population explosion. I'm a little uncomfortable about this because I have nine genetic grandchildren. This is a tough problem, because people like having children. How do you change the social structure of a society to produce? We have to go a stationary population. We almost certainly will go to ten billion, but we can't go to twenty billion. The whole world ecosystem will collapse at twenty billion. This is a tough problem. It isn't possible to protect ourselves from catastrophes... look at Ireland, for example. The real question is: Can we learn from them? The Irish did ... there are just about as many Irish today as there were in 1950.

The learning process of 5.2 billion people is difficult, it cannot be done in the family, it must be done in the education institutions. This is why UNESCO is so important. I despise my government for not supporting UNESCO. Even though badly run, UNESCO is still better than nothing. They still do some very good work. I'm in favor of increasing the budget of UNESCO by a hundred times. Then, there will be some hope for the human race.

* *Kenneth Boulding,*
University of Colorado, Boulder, Colorado, USA

Speaker: Bruce Aylward *
Topic: Valuing Environmental Functions in Developing Countries

I appreciate the opportunity to speak to you all, on behalf of the London Environmental Economic Centre at the International Institute for Environmental and Development in London. Edward Barbier, the Director of the Centre, and myself, have prepared a paper entitled "Valuing Environmental Functions in Developing Countries". In summarizing the material, however, I'll divert somewhat from the structure of the paper. I was struck by the CATIE bulletin that I received last night and I wanted to read you just one quote from it. Hopefully, the talk I give will pertain to this critical item: "Ironically in the world's richest ecosystem, deforestation and natural resource degradation are destroying the resource base that supports the region's agriculture."

As we look at valuing environment functions, you will see how what I have to say pertains to that quote, and hopefully to the mission of this conference. First of all, I will address the value of environmental functions and secondly, I will discuss our views on the relationship between biological diversity functions and these functions. The main points I will be making about valuing environmental functions are to distinguish between direct and indirect use values as components of the total economic value. Secondly, to indicate both the on-sight and off-sight indirect values that are associated with environmental functions or regulatory functions. These functions support and protect economic activity. Thirdly, I'd like to describe how this contribution to human welfare can be valued and include a brief discussion of some of the weaknesses and problems of the techniques that have been used to date. Finally, time permitting, I will review some work on tropical forest from Cameroun and then I'll move on to biological diversity.

To start off, I'd like to talk about total economic value. The components of total economic value are the direct uses, the indirect uses, option values and non-use values. We will mainly talk about direct and indirect uses. I would like to make that distinction clear.

As you can see, this is work on valuing wetland characteristics in Guatemala (see Table 1). The components of the wetlands uses listed are: forest resources, wildlife resources, fisheries, forrage resources and agricultural resources, water supply, etc. Secondly, there are functions of the ecosystem: recreation and tourism and water transport are services provided by a natural system that are directly valued by human beings.

The indirect use functions are what we call regulatory functions, which include in wetlands such items as ground water recharge, flood and waterflow control, shoreline bank stabilization. To give you a few more examples, I'll move to tropical forest, the direct uses that the forest can be put to are timber, non-timber forest products, recreation, sources of medicine, education, human habitat, while among the indirect uses can be distinguished such functions as nutrient cycling, watershed protection, air pollution reduction, microclimatic functions and also a function as a store of carbon.

Traditionally, most of the work in economics has gone into the measuring of these direct use values. The need for an increased emphasis on

Table 1. Use of Wetland Characteristics: Petexbatun, Peten State, Guatemala

Components	Direct	Indirect	Non Use
Forest Resources	XXX		
Wildlife Resources	X		
Fisheries	XX		
Forage Resources	XX		
Agricult. Resources	XX		
Water Supply	XXX		
Functions			
Groundwater re-charge/discharge		X	
Flood and flow control		XXX	
Shoreline/bank stabilization		XXX	
Sediment retention		XXX	
Nutrient retention		X/XX	
External support		XXX	
Recreation / Tourism	X		
Water transport	XXX		
Attributes			
Biological diversity	XX	XX	XX
Uniqueness to culture / heritage			X

Key: X = low
XX = medium
XXX = high

***Source:** Barbier (1989), for Conservation for Sustainable Project, CATIE/UICN*

starting to measure some of the indirect use values is important in developing countries, where a much larger proportion of the population depends on the natural resource system for their livelihood. For this reason, we would like to emphasize these indirect use values.

In measuring, how does one measure the ground water recharge function of one ecosystem? Ideally, one would want to measure the consumer surplus or the willingness to pay for these functions. Obviously, these functions are not exchange in markets. Not only are they not exchange in markets, but quite frequently, their indirect support or protection of economic activity is not even perceived. However, efforts have been made to do this. Work in developed countries has focused on such techniques as contingent valuation, basically in an effort to see what people are willing to pay for various goods and services. Some of these methods are a little more difficult to undertake in developing countries. This may change. There is a recent World Bank study on water supply in Brazil in which contingent valuation measured the willingness of people to pay for fresh water from pumps. This indicates that such contingent valuation studies may be used and at London Environmental Economic Centre, current work in Northern Nigeria may be able to use this technique as one method of measuring the recharge of the Chad formation aquifer that the wetland indirectly supports.

More cost and time effective, but second and third best methods, are often what the researcher in the field resorts to. With second best measures, if the indirect function is supporting economic activity, what you would really like to measure is the change in production and productivity due to the degradation of the resource. For example, in the wetland, we might want to look at the change in agricultural production that occurs as the wetland is degraded. Secondly, a second best measure, if the indirect function is protecting economic activity, would be to model the damage function. Obviosuly, this entails considerable field work and there may indeed be scientific uncertainties involved. But again, these are second best methods.

The third best method mainly consist of methods of measuring what it would cost to maintain or replace the function. Such methods include the cost of existing substitutes, the cost of investment to create substitutes, the cost of relocation. Additional third best measures would be preventive expenditures. For instance, in the case of sedimentation and soil erosion, one method would be to measure the cost of dredging a river or the cost of sedimentation inside of a dam. There are difficulties with these methods and it's very difficult to know, with your second and third best methods, the cost of replacement or the cost of maintaining a service and whether you're getting the real value that you've assumed exists.

Two problems that can be encountered in applying this methodology are the double counting of benefits and the trade-off between benefits. This double counting can occur both for benefits on the site and for benefits that come from off the site. To give you an example: Let's take the example of a nutrient retention function of a coastal wetland. It may be that this function is supporting shrimp production within the wetland, in which case, if you were measuring the direct value of shrimp production under one component and you think that there is a value to this indirect function of the nutrient retention within the wetland, you then ascribe some value

to that and put it under the functions and indirect values. In essence, what you would be doing is double counting, because you can't produce extra value. So what you do is reduce the direct use figure for shrimp production if you're going to contribute some of that value into the indirect use.

Secondly, there would also be the possibility of offsight double counting, for instance, if the nutrient retention function were supporting fish in their early stages of development, which were then later caught in an off-shore fishery. If you were doing a companion analysis of the offshore fishery and the coastal fishery, and you counted the value of the fish as they are harvested and then also count the indirect use value of the nutrient retention function, you would be double counting again.

Trade-offs are very important and can occur both between indirect use values and between direct use values. To give you an example from a tropical forest: if an economist went in and decided to measure the value of the timber, suppose it would be ten million, the value of the non-timber forest products would be five million and the watershed protection function of the tropical rain forest would be three million. Some people would simply add those up to arrive at the value of the tropical forest. Obviously, there is some trade-off there because you can't harvest all the timber and get your non-timber forest product value. If you harvest all the timber, the watershed protection will be gone. There will be a trade-off and the total use value will be somewhat less than the ten plus the five plus the three. Even harvesting the non-timber forest products may entail some damage to the watershed protection function.

Trade-offs between these regulatory functions may occur. An example, again from the wetlands, there may be a tradeoff between the ground water recharge function of the wetlands and the use of the water for agricultural or fish production within the wetland, in which case you have to separate those out to make sure you're not attributing the full value to the recharge function as well as to the agricultural function. The bottom line is that these double counting and trade-offs can lead to grossly overstated values and as economists, we would like to try to avoid that. We'd like the analysis to be as judicious as possible. Broadly speaking, the significance of developing and applying these methodologies to value these regulatory functions is that much of the value will be an off-sight value and come from the outside and that you'll be bringing into the system. You'll have values previously contributed to goods and services outside the tropical forest which will be re-allocated to the tropical forest. What that does is strengthen the economic argument for conservation of these systems.

There has been some tropical forest work done by Rotenbeck in Cameroun. This is a cost/benefit analysis in a national park in Cameroun, where the benefits from protecting the area and the associated projects that are to be funded by the World Wildlife Fund were set off against the development option of logging. I'd like to focus on two watershed protection functions: fisheries and flood control. The watershed protection of the fisheries was valued at 3.75 million pound sterling and the flood control was at 1.6 million pound sterling. This is greater than the timber use value and represents one half of the value of the total forest use. This is an example of how valuing these environmen-

tal functions can aid a conservation argument from an economic point of view. The approach taken was to measure the damage cost and the damages avoided in maintaining the tropical forest. The assumption was that the coastal fisheries would be a total loss if the forests were degraded. That's an assumption made without any ecological support, so we could question that.

David Pearce, also of the London Environmental Economic Centre and the University College of London, tried to value the carbon storage value for tropical forests. What he did was to take the average release rate of carbon, which came out to be a thousand tons per hectare, which is the average over many regions. Then he used an estimate of the damage costs for carbon as attributed to global warming, which was thirteen dollars per ton of carbon. What you come out with is that each hectare of tropical forest could be attributed a value of $13000. This is an example of how degradation of global environment services can be brought into an ecosystem and used to value its functions.

Finally, I'd like to turn to biological diversity. Our view of economic concepts and ecological concepts is based on the assumption that any system will have stocks, flows and some organization. Within an ecosystem, the stocks are the structural components, the flows are the environmental functions and the organization is the biological and cultural diversity. Moving to the economic concepts that correspond to these, and it's important to make the linkage, stocks would be goods and flows would be services and the organizations would be attributes. Goods and services are the outputs: tangible and intangible outputs of an ecosystem. Attributes are not outputs per se, but they indicate how the goods and services are organized and distributed.

The implication of that for evaluation is that, if the attribute for biodiversity affects the value arising from ecosystem outputs, then it will impact on human welfare and must have some value. As an example of how this can be done, I'll refer to a study done by Hodging and Dixon in the Philippines, where they did a cost benefit analysis of fisheries and tourism on the one hand, versus logging on the other, within a drainage basin in the Philippines. What they were doing was looking at the effect of logging on increasing sedimentation and hence, decreasing fish production. There were three ways they saw that the sedimentation could affect the production of fish or fish biomass. The first was a direct impact on the fish, which in fact, they discounted and did not attempt to measure. The second way was its impact on coral cover, which is the feed for the fish. The third one would be through coral diversity.

What they found was that the sedimentation impacted negatively on the coral cover and also resulted in a loss of coral diversity. Their results were that, for each four hundred million tons per square kilometer of sediment deposited, there was a 2.4% decrease in fish biomass. For diversity, they found a comparable figure: for each one hundred million tons per square kilometer of sediment deposited, there was a 0.8% decrease in fish biomass.

Although in their final analysis, they did not actually break out the loss in value that was attributable to the loss in diversity and to the loss in coral cover, it's this kind of detailed ecological work that we believe is important if one is beginning to adscribe a value to biological diver-

sity that is a part of indirect use value in an environmental function.

Additionally, one could say that there might have been other diversity impacts involved in this. There may have been some relationship between the diversity of the tree species, the species that were actually logged and the sediment deposition rate within the fisheries.

The point we are trying to make is that there is a way to bring these regulatory functions into the economic argument, and thus support conservation. Quite obviously, there is quite a bit of work to be done on this area and the jury isn't in yet. The initial results that we have seen indicate that these functions give values that are significant and can have an impact on the economic analysis of options for conservation and development.

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Speaker: Robert Constanza *
Topic: Economic Evaluation of Wetlands

I'm going to broaden the subject of my talk and speak about ecological economics in general, and use the wetlands evaluation case as a specific example. My background is in systems ecology and urban and regional planning. Excuse me for not speaking Spanish in this talk, but as part of my Ph.D. I took economics as a foreign language.

I think it's very important, and some of the early speakers have highlighted this, that we really need to go beyond our academic conceptions and the artificial academic boundaries that have been created between economics, what is called the human part of the world, and ecology, the natural part of the world. We're beginning to realize that the world is an interconnected system and we have to operationalize this conception if we're going to make progress in evaluating and managing our natural resources.

The diagram in Figure 1 shows the domains of some of the existing academic fields, compared to what we're calling economic ecologics. I emphasize again that where these boundaries are drawn is arbitrary. There is no meaning to where they are drawn. They are drawn for convenience and for historical reasons, but we must break down these walls and look at the whole interconnected system, and I think that ecology has been just as guilty in the past of constructing such walls and dealing only with pristine ecological systems with no human intervention. Both disciplines must break the barriers that have separated them in the past and try to communicate with each other.

Some progress is being made in starting this dialogue. We've started a journal called ecological economics and several people here at this conference are in our advisory board, including Ken Boulding and Charlie Hall and several others you might recognize. The idea is getting ecologists and economists working together on this common problem of understanding and managing the whole interconnected global system.

To give you some more detail on the differences between conventional economics, conventional ecology and ecological economics, the basic world view of economics has been very mechanistic, static, where individual tastes and preferences are what drive everything. In the ecological economics world view, it is the interaction between human tastes and preferences and the ecosystem that limits and bounds and forms those preferences, which determines why people value things the way they do in the long run.

The big difference, and that has already been alluded to, is the time frame. Conventional economics tends to have a very short time frame. Ecology tends to have many time frames that it deals with. Ecological economics is also multiscale, multi-dimensional. But when we talk about the primary goals of the system, I think the basic difference is that ecological economics has long term goals, like sustainability, instead of shorter term goals like economic growth.

Just to give you a feel of some fundamental differences in assumptions about technical progress, academic stands: both ecology and economics tend to be very disciplinary in the old schools. Ecological economics tends to be mul-

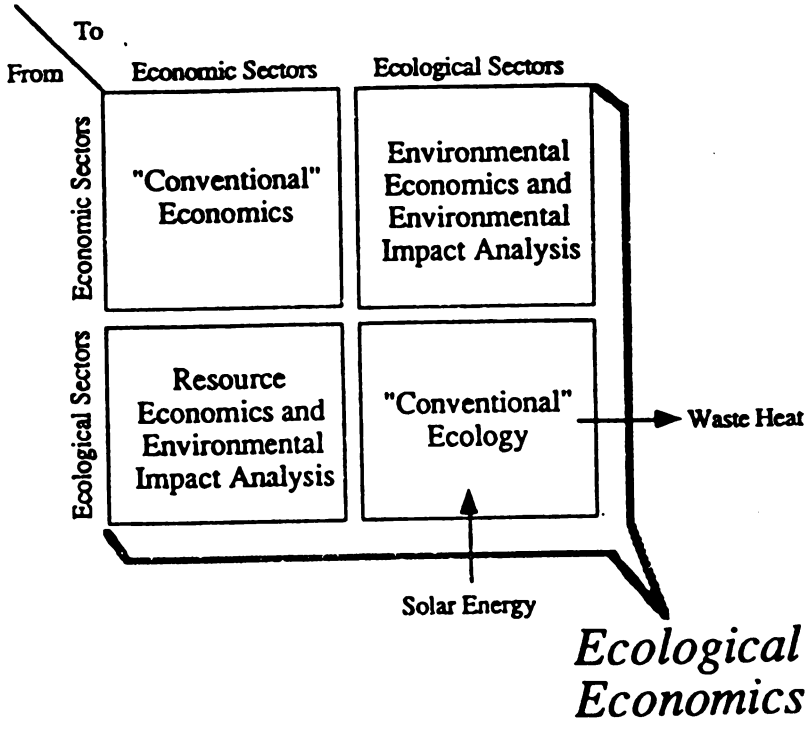

Figure 1. Relationship of Domains of Ecological Economics and Conventional Economics and Ecology, Resource and Environmental Economics, and Environmental Impacy Analysis

tidisciplinary. It goes beyond disciplines and tries to integrate knowledge from whatever sources it can come.

The assumptions about technical progress are also very different. Conventional economics tends to view technical progress as the saviour or the way out of resource constraints. No resource constraints can exist in the long run, because when some resource becomes scarce, its price will rise and that will induce technical progress and change and that will make other resources available and that will solve the problem. Ecological economics is prudently skeptical about the limits of technical progress. It says: that might be true, we might find technical substitutes for these resources, but in the long run, there are all sorts of restraints to the extent that technical substitution and progress can go on, particularly if we talk about issues of sustainability and long term issues, therefore we shouldn't bank on technical progress. We shouldn't discourage it, but we should protect ourselves by not assuming it will happen. It's a more skeptical view about technical progress and the limit to resource use.

Another point is the difference between growth and development. People are always talking about sustainable growth versus sustainable development. I think it's important to realize that growth means an increase in size. Development means an internal reorganization of the parts. I think that applies to economy: the economy cannot continue to grow indefinitely within this planet. You cannot have sustainable growth. Eventually you're going to meet the physical limits of the planet, so sustainable growth is impossible.

Now sustainable development, which means continous improvement in the interactions and relationships between the parts, I think can go on much longer. There may also be limits to that, but anyway that's what we have to focus on: the development aspect and not the growth aspect. Especially because of where the planet is in terms of development and growth cycle. The relative size of the human economy has gotten to such a point where natural resources, the ecological life support system, has become the limiting factor to economic well being and sustainability. It's not to blame anyone. In the past, the economic part was limiting and therefore it made sense to emphasize that part of the system. Now the situation has changed dramatically and if we don't realize that it's changed, we're in trouble.

One graphic indication of that (from a book called For the Common Good): We all know about GNP and other measures of economic welfare. Any economist will point out that GNP doesn't measure welfare, but unfortunately it's often used as the primary measure of performace of economic systems, and it shouldn't be, for some very good reasons. One of the main ones is that GNP does not account for depletion of natural resources. The Exxon Valdez spill, for example, caused an increase in the GNP of the States, because it caused more economic activity, an so if you look just at GNP you're going to say: Great, let's have some more oil spills. But we would all agree that it was not a good thing to happen and we would all have been better off if it had not occured.

Some people are working on revising the systems of natural accounts, to include depletion of natural resources. They have come up with an

index of sustainable welfare, which, in a crude way, accounts for the depletion of natural capital, the destruction of forests, wetlands, defensive expenditures we have to make for air and water polution and a host of other environmental problems, as well as some social problems, one of which is the distribution of income and it's a fact on welfare. When you talk about welfare, a dollar is not worth as much to a rich person as to a poor person. There's not a one to one correspondence between dollars and welfare. These people have tried to correct for these kinds of effects as well.

In the US, since 1970, the GNP continues to go up and everyone cheers about that, but in fact, this index of sustainable economic welfare has pretty much levelled off. With and without a measure of long term environmental damage, this is so. All these apparent gains in GNP have been at the cost of destroying the natural resource base, by depleting our natural resource capital, which provides real economic services that are not adequately accounted in things like the GNP.

The challenge to all of us, and the research agenda for ecological economics is to come up with better ways to implement this sort of accounting and also come up with better economic and social instruments to communicate that information back into the market system and the political decision making system.

I'm now going to talk about this problem of valuation a bit more. Bruce covered a lot of the ground that I was going to cover, so I can at least skip part of this quickly. The one thing I want to emphasize and he didn't point out, comes from the point of view of the economist looking at the outputs of natural resources, trying to look at people's perceptions of these outputs to set up some sort of market price, either using questionnaires or observing people's behaviour, to see what their perceptions of those outputs are.

There are some fundamental problems with that, because people generally don't trade these resources, they don't know what they are doing for them, so the first step would be an ellaborate educational process. Twenty years ago, if you asked people what they would be willing to pay for wetland services, they would say negative numbers because wetlands were considered to be wastelands, where mosquitoes were bred, let's fill them all in, that would be the best thing we could do with them. And this came from an ignorance, from the whole of society, as to what these resources were doing as part of the whole combined economic system.

On the other side, ecologists have been looking from the supply side of this problem, what are the resources doing, how do they function, how are they interconnected and what happens when we make modifications. One application of that idea to valuation has been to look at the energy flow within these systems, so what they're really doing is capturing solar energy, which is being used directly and indirectly to power the whole system, and so all the services that come out of natural systems are directly or indirectly the results of the amount of energy that they capture and process into different forms. One can do an energy analysis, then.

What we did in our study of wetlands in Louisiana was to try and compare these two basic approaches to a particular wetland area. Louisiana has about 40% of the coastal wetlands in the US. These are very valuable for all the reasons that Bruce mentionned in his talk.

The willingness to pay approach tries to enumerate all those values and then, using second or third best methods, come up with an estimate of the annual willingness to pay for those resources. Here (See Table 2) we're combining a bunch of different approaches in the same table. The shrimp number is probably the best that we got because it looks at the relationship between wetland area and shrimp production based on shrimp catch statistics. So we know the marginal productivity of wetlands for shrimp, and then we can value the shrimp at the market, because it's something that people use directly. It doesn't get at the indirect value of shrimp in the ecosystem as a food source for other things, or anything else that the shrimp would do. It just looks at the shrimp as used by consumers.

Oysters, blue crabs, these are all part of the commercial fishery and here we ended up using less accurate approximations, based on average catch values. Trapping, recreation and storm protection were three other services of these wetlands that we were able to put a number on, basically looking at recreational surveys, numbers that came from a series of questionnaires and we did both a contingent valuation and a travel cost analysis on that. The storm protection number, which as you can see is fairly large, came from an analysis of the relative damages to the structures along the coast of Louisiana compared to their distance from the coast, how much wetlands they had protecting them from hurricanes. When hurricanes hit, and there are a lot of wetlands in front, they are going to absorb much of the damage. The other feature, option in existence value, has question marks because we know that people value these systems for the option of one day visiting them or just to know that they exist. So we know there is a number that should go in there, but we were unable to ask them for this study.

The energy analysis that we used in this study was a very crude approximation based simply on the gross primary production of the system and converting that into an equivalent dollar value based on the option value of solar energy, how much solar energy does it take to drive these systems and produce these services and what would the trade-off be if you didn't have that solar energy driving the system and you'd have to substitute other forms of energy or fuels. In a sense, it's a replacement cost.

We expected the first analysis to be low and the energy analysis to be on the upper limit, because we assumed that all the energy was used. Still, we can see it's not such a wide range. How do we evaluate the future value of these resources, to evaluate discount rates, is something we haven't resolved yet.

We must evaluate whether we want to destroy a resource that is going to be producing services indefinitely. It's not like an alternative investment, it's a different decision, so we have to err on the side of being careful. So I would argue that we need to look at the lower discount rates. But even at the higher discount rates, we're talking about a very significant value for these wetlands per acre, 6000 to 10.000 dollars per acre at the high end and 2500 at the low end, compared to a market value for these wetlands which is around 300 dollar range per acre.

Where we need to go in this evaluation of natural resources is to operationalize the diagram that I showed at the beginning, that is, to build models and accounting systems that can include the economic and the ecological parts of

Table 2. Summary of Estimated Economic Value of Wetland Productivity for Commercial Fishery Harvest

Species	(b) Basis	(a) Annual MP estimate (lb/acre)	(d) 1983 ex-vessel price[a] ($/acre)	(c) Value of annual MP ($/acre)
Shrimp	Marsh area			
brown inshore		1.60	2.10	3.36
white		1.44	2.10	3.02
brown offshore		0.90	2.10	1.89
white		1.23	2.10	2.58
Menhaden	Marsh and Open water area	145.00[b]	0.04	2.58
Oyster	Marsh and Open water area	6.00	1.34	8.04
Blue Crab	Salt marsh area	2.30	0.29	0.67
TOTAL			$25.36	

[a] USDC (1983)
[b] Assuming MP-average product

Source: R. Constanza

the system. Can we build models that are comprehensive and including the whole system? The answer is that we can. It's a lot of work but it will be worth it in the long run. One could use this sort of model to come out with numbers that are the shadow prices that will make these markets clear in a general equilibrium sense. So it's another way of getting at the relative value of these natural resources, based on the web of interconnections and not necessarily based on the individual human perceptions of values at this generations, and we could use it at least as a check, based on this evaluations.

The important part of this analysis is that we end up with a high degree of uncertainties, a range of values, not precise numbers, no matter how much resources we put into it, we'll always be facing a fairly imprecise estimation, which is often an excuse for either not doing it or not using the results. The relationship between uncertainties and the stakes involved in a particular problem, in this model, shows that the normal mode of operation of science is normally limited to those problems that have relatively low uncertainty and low stakes. Once you get outside of that range, there is nothing there, just a bunch of consultants running around saying that they know all the answers, and beyond that there's really nothing.

The idea is that we have to learn how to deal with uncertainty. We cannot just assume that we'll take the normal approach to science, with an uncertainty close to zero and we can fit into this normal scientific frame. That works for some problems, but evaluation of natural resources is one where I don't think it will work, we're always going to be faced with uncertainty. So what we do is to hedge our bets, to be prudent and skeptical, to reserve judgement as long as we can.

So we can either be optimistical about technological progress and the ability of technology to remove resource constraints. But here we have the actual state of the world and we can ask ourselves, are the optimists right? Will technology remove those resource constraints? Or are the pesimists right? We don't know the answer to those questions, so what do we do? The optimists would say, let's be optimistic, because the potential returns to being optimistic are very high but if they're wrong, the stakes are also very high.

Now, if the optimists are right, maybe we didn't do quite as well because we might have been too careful, we didn't go as fast, but the results are still moderately good. On the other hand, if the pesimists are right and we pursued the pesimists policies, then the results are still tolerable, we still have a sustainable system into the indefinite future.

So, given that we really don't know what the state of the world is going to be, if we analyze those tables, the optimal policy to pursue is the one that has the maximum of the minimum payoffs, so if we did this, the worst that could happen is disaster, if we did this, the worst that could happen is tolerable. Tolerable is preferable to disaster, so we should pursue this policy, we should be more pesimistic, skeptical, prudently pesimistic about the ability of technology to solve these resource constraints.

In practical terms, back to the ecosystem valuation and management problem, we should assume that the values we come up with will be at the high end of the enveloppe, the worst case

scenario. That's what we should assume at first and we could implement systems that make that assumption, systems like insurance bonding systems, where one would require a bond for the worst case environmental damages and then allow refunds of that bond in proportion to the ability of the perpetrator to prove that the damages were not as a great. So that protects society and puts the cost of that uncertainty about environmental values on to the appropriate party, which is the party that stands to gain and not the general public. So our problem in the past has been the ability of individual firms and groups to externalize cost and what we need to do is to internalize that cost as well. The pollutor should pay for the pollution, but he should also pay for the uncertainty about the damages of that pollution. If we can implement that sort of idea, using instruments like insurance bonding or other sorts of deposit and refund systems, we have gone a long way towards adequately managing our natural resources and also encouraging new technology to better manage these resources and encourage the removal of some of that unceratinty through research.

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Speaker: Charles Hall *
Topic: How to Make Development Computer Simulations Accesible to Non-computer Experts

I want to talk about two things today. In the first part, I'm going to talk about development, which is often considered from the aegis of economics, which I am quite unhappy about. From the perspective of economics, I want to talk about the development of technologies which may allow us to communicate much better with each other and, more importantly, with the great number of people who are not scientifically trained.

Most people, certainly in my country, don't read books or magazines anymore, but watch the television and I think it's becoming increasingly true in your countries as well. That's what people relate to: the video screen. There's a tremendous amount of information, or more generally, disinformation or non-information, but the potential for displaying information on a video screen is incredible. You have the three regular dimensions: time, color and intensity and hue in color. You have all types of possibilities. I want to talk about developing systems that can allow us to understand the processes, the economic and ecological processes in a broad sense that indeed are taking place within Central America.

The first thing I want to talk about is how we make decisions about development or about economics or about the differences between economists or ecologists. We need information systems that allow us all to display to ourselves and to the public what it is we are trying to do.

I'm going to do some economist bashing now, just a little bit. There are three things that bother me about economic analysis. First, economic analysis is based on misplaced concreteness. Economics is very numerical, very solid. You come up with real numbers. We have some basic problems with this: should we put a price on an ecosystem in the first place? Should we lower ourselves to take our most incredible natural resources and make them into mere commodities? That's the same thing as saying: Do we want to put a price on honest government? Do we want to put a price on friendship, on love or on God? Do we want to put a price on ecosystems to begin with? I don't know, but we shouldn't simply say that this is the price and that's it, and if the price is less than what you get from development, then go develop.

Secondly, the concept of value, measured in willingness to pay or in price, is also misplaced. In Central America, shrimp used to be very cheap, it used to be poor man's food. But now they are gone because they are overfished and yet the price has become very high and they are worth more in somebody's evaluations. Shrimp used to cost next to nothing and be very valuable to the ticos, but now they are very expensive and have a very large weight in economic evaluations. But they're almost worthless to the poor people who live on the coast of Central America because they can't afford them. Then, is shrimp more valuable now?

Thirdly, I am trained as a scientist, and I believe in the testing of hypothesis and have looked through a dozen economics textbooks and journals, looking for somebody to test the basic hypothesis of economics. I found an almost complete lack of hypothesis testing. In the few cases

where they were tested, the basic economics hypothesis and how human behavior relates to economic models, they failed.

I want to talk about how I go about doing an analysis and how this might interrelate with how economists are doing it. Anyone who lives in Costa Rica or drives around the country, knows that land is used very intensively here. I have never seen land used more intensively, except in China. There is very intensively used grazing land with very low production. Everywhere you go, land is being converted into crops, on a small scale and on a large scale as in Guanacaste. I understand that DDT, which is outlawed in my country, is used thirty times a year here.

Let's take a look at the driving forces for what is happening here in Costa Rica. Obviously, one driving force (a forcing function) appears to be population and expectations of greater economic activity. From 1950 to 1990, the population has increased by a factor of three. The land in Costa Rica is being used more intensively because there is three times more people using it since 1950. What happens when you project this into the future? By the year 2048, the population of Costa Rica, depending on the growth rate, could be between seven and fifteen million people. We already have a country where the land is being used intensively for three million people, how do you project this into the future? What is the correct projection? This requires a well structured model and more information and guesses.

I am very concerned about the relationship between ecology, agriculture and energy. Everything to me goes back to energy because everything I look at seems to be closely related to energy. Let me talk about it with respect to Costa Rican agriculture. Let's look at site quality, which is the intrinsic ability of a site to grow crops.

One of the problems we had in doing this analysis, is that very rarely people who are involved in agriculture, do not fertilize their plots. We have very little data about what the intrinsic productivity of the soil is and how that changes over time. In general, we might find that with grains or maize you can get from one to five tons per hectare per year. If we can produce from one to three tons per hectare per year, without any additions of fertilizer, then we don't have to worry for twenty years for Costa Rica. If we can produce five, we don't have to worry for thirty years, but if we can only produce one, we have to worry a great deal right now. In fact, Costa Rica imports about 20% of its food calories.

There is another side of this, which is the energy input. You can take sand in Florida and put on lots of fertilizers and lots of pesticides and produce wonderful orange trees by just dumping the chemicals on the sand. Most agriculture lies in between. So you can get good yields from sand, from land that is no good at all, but it requires energy in terms of fertilizers, irrigation and pesticides, all of which cost dollars.

People tend to settle first in regions where the fertility is high, such as the valleys around San José and Turrialba and so on. Over time, people begin to add fertilizers and other energy inputs and the yields increase. However, due to erosion, there is a decrease in productivity of the system that supports this agriculture. Central America used a fallow based system and when the indigenous people were here, they supported agriculture for thousands of years on a fallow based system. And it worked. Shifting cul-

tivation worked for a long period of time. But now, there are too many people in Costa Rica for there to be fallow based systems and the functions of the fallow are increasingly replaced by fossil fuels, by oil derived derivatives, fertilizers and pesticides.

We have attempted to put this into the computer model. What happens when the price of oil changes? The price of fertilizers increases because they are very energy intensive. Costa Rica becomes vulnerable to a strategy of using industrial inputs to feed its ever growing population. More fertilizer in general is being used over time. There is some relation between fertilizer applied and yield.

All of the improvements in agriculture in Costa Rica in the last forty years have been eaten up by more mouths. Population growth is obviously using up a lot of the potential wealth producing capacity of development in Costa Rica. We have done this now for about twenty countries and they all show nearly the same things. Land and agriculture for Costa Rica have stayed the same, pastures have increased a great deal, and lands in forest have decreased.

Agricultural yields per unit of fertilizer tend to drop. The first fertilizer that you use tends to be very effective, but as you pour on more and more, it becomes less effective even though it costs you as much and costs the world as much to produce that next incremental yield, its effectiveness tends to be less. In most countries, there is no economic development without an increase in the use of energy use of those countries.

Kenneth Boulding talked about the failure of our country to win the war on poverty. Well, this here is the per capita wealth in the United Stated adjusted for inflation. We got richer and richer and richer in the United States since 1935. Every year we got richer until 1973. And then, our per capita income actually declined. It came up again a little bit. Reagan got a little credit for it, but it was only in his last couple of years and now it's gone back down again. So, the per capita wealth in the United States is the same as it was in 1973. Why? Well, I think it has a little bit to do with oil price shots and their implications, perhaps.

Meanwhile, in the United States, it's rather interesting. We've gone from working on an average, the average worker in the United States, of forty hours a week to fifty, to make less money. The United States is getting poorer. We no longer have cheap oil from Texas; it's gone. We have to pay a lot for oil now. I understand it's two billion dollars a day we're paying. There is irony in that because we used to pay two billion dollars to go drop bombs on those poor folks over there.

Back to Costa Rica. We have a model that projects many things, including the amount of calories that will be required to simply feed a vegetable diet to Costa Ricans into the future. This model has a lot of uncertainties, because it assumes a number of things and several different strategies. I'm very interested in what strategies you would use in Costa Rica to hedge your bets. This is a real technological optimist strategy ... agricultural technology optimistic, and assumes that you'll be able to affort the inputs. What do Costa Ricans do? They trade coffee for exchange, they take the foreign exchange and buy fertilizer and they take the fertilizer and put it on their coffee plants and they take what is left over and put it on their other crops. One might

look at it that way and get the yields. The relative price of fertilizer and coffee is very important to Costa Rica, which comes as no surprise. This is an attempt to have agricultural self-sufficiency. Here is how much land you would need if you didn't have agricultural self-sufficiency, if you instead put half of your land, more or less, into coffee assuming someone wants to buy it. You can feed about ten to twenty people per hectare from coffee by getting money and buying wheat with it from the United States and then you can only feed four or five people per hectare if you grow crops and you can feed one person every ten to fifty hectares if you grow cows.

Now let's extrapolate that into the future. Around the year 2015, with the continued growth of population in Costa Rica and at the rates that it has been growing, you simply run out of land that is thought suitable for agriculture. This area is in pasture, so maybe this pasture land could be put into growing food crops. This is what happens if there is a coffee intensive project and you try to feed people with coffee instead of growing maize.

The last thing I want to do is come back to where I started and say that I have a computer model which can help us communicate. We have a series of data sets for Costa Rica so that we can look and give information to people who may not be familiar with computer technology. These boxes are called Topography, Soil, Land Use Model, Forest. Let's look at Topography first. You have a map of Costa Rica. The technology is just getting started. It will be vastly more detailed in about a month. We're just learning how to use it. We're working with a wonderful group called RPA, in Ithaca, New York. I have some literature that is helping to develop this. Anyway, here you have the topograhy with the different elevations colored. What can you do with that topography?

Now, let's take a look at the forest area. Here we have a map of the forest area represented in green of Costa Rica in 1940. The brown is developed land and the green is forest area. You can put 256 colors of anything you want on here. The potential for doing other things is almost unlimited. But right now, we are going to do a simple thing and show the developed area in brown and the forest area in green. That's in 1940. This is 1961. About half of that forest is gone if you believe these numbers. I'm not guaranteeing these numbers are right.

Now, what I'm interested in is being able to make development decisions and having the consequences appear in a format that everybody can relate to. What we want to do is take this information and put all kinds of viewpoints and perspectives together. If I have an economist friend who says he has some good ideas on how to evaluate, for example, land use change or the area of estuaries. We were able to get it going for our Puerto Rico work where we were working on the hurricane Hugo damage in Luquillo Forest. You can watch this forest recover over time as a function of whatever information (meteorological, soils, topography) that is important in understanding how the forest recovers from a hurricane.

The same could be done for development and pulling back from development in looking at the development of a landscape. This could go the other way. We could animate or make move the process of development in Costa Rica. As you're watching it over time, it changes and meanwhile, ten parameters of interest (i.e. the hydrograph, the sediment yield, the fertilizer use, the agricul-

ture production, the population level, the erosion, the productivity per hectare) can be plotted around the edge of this graph, giving it tremendous amounts of information. At one time, that represents how things occur over time.

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Speaker: Craig MacFarland * Topic: Economic Evaluation of Protected Areas

Worldwide, if one looks at the growth in protected areas, you can see that the major increase in protected areas has happened since the 60's, most of it in the 70's and 80's, both in terms of total numbers and in total areas protected. In addition, if one looks at the numbers of protected areas created, the vast bulk of that increase has been in developing countries, not in the industrialized countries. Many areas are being set aside and a lot of attention has been paid to at least legally declaring them. Managing them on the ground is another question.

The typical process that occurs worldwide, but is particularly pertinent to developing countries, in terms of political decision making in regard to protected areas and their surrounding lands, is that when an area is suggested, there is a lobby for establishing it and there is a lobby against, and depending on who's stronger, then the people who have to make the decision and sign the legislation or the decrees will act. They are either rejected or established, and once established, a budget is allocated and allowable uses are determined. That's a typical process.

Frequently what happens is that if there is a battle here, the battle is very strong. The area is declared and then when it comes to implementation, very little budget or no budget is allocated and the area is languished for years. That, by the way, happened in the industrialized countries as well. Yellowstone Park sat for decades before it was managed at all.

There are many ways to look at the benefits protected areas provide:

1. Market based or financial benefits from protected areas.

These are the benefits that have some economic number attached to them. Financial analysis can give you a number and you can say: these areas are worth something because of logging, fishing or game harvesting.

2. Social benefits.

These can't be evaluated financially, but can be evaluated to some extent by economic measures. In many cases, these benefits have to be evaluated in qualitative terms, because we don't have the techniques that allow us to measure them and in some cases we may never have them. These are benefits such as biodiversity conservation, ecological processes, regulatory functions, or educational research, etc.

Another way to look at a more detailed breakdown is as follows. (As I go through this, you will see which ones are applicable to financial analysis, which ones to economic analysis and others which need to be evaluated in qualitative terms):

* recreation and tourism
* watershed protection
* erosion control
* flood reduction
* stream flow regulation

* ecological processes or regulatory functions
* nutrient fixing and cycling of soil formation
* circulation cleansing of air and water
* global life support
* maintenance of carbon in biomass
* biodiversity conservation
* gene resources
* ecosystems and evolutionary processes
* education and research

Then there is a series of consumption resources. These are the ones that some sort of market value can be attached to: timber, foods, fiber, medicines.

Then a series of non-consumptive benefits that generally have to be evaluated exclusively in qualitative terms: aesthetic value, spiritual value, cultural and historic values, simple existence value, which is that where many people are quite happy knowing protected areas exist, but they'll never use them or visit them and at best, they may see them on a video or a television presentation or movie or they may read about them, and then, future values, which means keeping options open.

The costs of creating and maintaining protected areas generally can be calculated and one can put financial values to that directly. Sometimes, there are costs associated with the establishment, the acquisition costs of the land that has to be bought. Many times, the government controls the land and can simply declare the protected areas. In many cases, land needs to be bought, and this is becoming more and more common, as there is less and less potential protected area out there, because most of it is being settled or agricultural fronts are steamrolling over these areas. Then there are management maintenance costs.

There are also indirect costs, frequently associated with damages outside the area. An example of that, which is particularly common in industrialized countries and not too common in developing countries yet, is those cases in which wildlife, animals that are maintained in the park or reserve, wander outside and cause some economic damage around the area to agricultural systems or some other kind of damage.

Opportunity costs also can be calculated. These, of course, are not financial estimates, but economic evaluations or foregoing outputs. In other words, local people who may have used the area before to extract medicinal plants or to extract wildlife or extract lumber, be it for subsistence use or be it for artisanal type markets, once the area is established, they may have to stop doing so and that has a value.

Then, of course, one can also run scenarios of foregoing the conversions to alternative uses. What would happen if the area was settled and used in some other way, or mining was allowed inside of it, or some other direct exploitation or extraction of resources?

There is a series of known techniques, benefit and cost techniques that can be applied. The first set includes cost analysis, net present value, benefit cost ratios, internal rates of return which all can be calculated in some cases.

Another technique is safe minimum standards. Another is cost effectiveness analysis, and with this one, you don't calculate benefits, but you evaluate costs to arrive at the objectives and choose the least costly method. And of course, opportunity cost analysis: What would happen if the area was settled or was turned over to agriculture or was used for mining or was used for some extractive use other than protection?

Once one examines benefits and costs, this leads to benefit/cost based decisions and protected areas then tend to fall into one to three categories, once you've applied these techniques.

There are privately beneficial areas, in other words, areas in which a corporation, a company, an individual, an organized group, may directly benefit from extraction or use of a resource. Very few, in fact, fall into this category. There are some examples, but very few.

Many fall into the second category, where the analysis comes out of applying economic evaluation techniques and qualitative techniques. The vast majority of the protected areas that have been looked at tend to end up here. These are things like the regulatory functions, ecological processes, biodiversity and those types of evaluations that are being attempted more and more.

Finally, there may be areas in which using any of the economic analysis available may not work and you may end up with an error that you really can't judge and the benefits may be undetermined and you may have to put a hold on trying to figure what the long term relationship between cost and benefits might be.

Another way to look at that same thing is to ask, "If we do anything other than to absolutely protect that one area and don't let any one use it at all, without any human use or intervention in the area of any type, what might the impacts be?"

There are basically two general lines: either there will be some measurable change in production or, if that's not the case, there may be some change in environmental quality. If there is a measurable change in production, so that some economic valuation technique can be applied, that will show some numbers, then our non-distorted market price is available and then two basic options are coming out of it. If one is in the situation that this can't be done, but one can measure change in environmental quality, that may appear in various types: habitat change, air and water quality, environmental health impacts or recreational use that has certain types of impacts. This is just a redistribution of these same economic valuation techniques that we looked at in that list.

In their book, Economics of Protected Areas: A New Look at Benefits and Costs, 1990, Dixon and Sherman use a lot of case studies, principally from Thailand, where they looked at a number of areas, but also citing examples from developed areas. The book is mainly aimed at the problem in developing countries, but not exclusively. I would like to discuss an example. This is the case of a park in Bangkok, which in fact is an urban park, not a national park. It might be best described as an intensively used recreational area.

They use basically three approaches to valuation: travel costs of people visiting the area and

what did people actually spend to get there, plus, what could they have been earning had they not been spending that time traveling and being there. They also looked at a contingent valuation method of users and a contingent valuation method based on interviews. What they found out was that the park had a very high value anyway you look at it; annual value or capitalized value.

Then they looked at a case in Cameroun. There they evaluated a more complex set of factors. This is a national park, about 160 kilometers from Bangkok and heavily visited by both Thais and foreign visitors. It also is the headwater for four major watersheds which serve agricultural and serve potable water uses downstream. It's a fairly sizeable park and they had some figures on research and educational experimentation use in the area. They did a calculation for maintaining future options existence value. They were not able to evaluate watershed protection because they did not have enough information. They were able to get rough estimates of tourism income generation, expenditures and then consumer surplus of users. They then looked at the costs and they had fairly exact figures for management. The losses to villagers when the park was established for not being able to continue to use it for certain extractive uses they were able to estimate, but for logging and other types of uses, there wasn't any information available at the time. In any event, they added all of this up, they came out with a very definite, positive value of benefit over cost.

What this then leads to is a message for decision makers which is that, up to a point, economic evaluation methods of either of the financial type or these various types of direct economic evaluation which give some numbers, can be used as part of the process of decision making. I say as part, because there are qualitative evaluations that have to be taken into account too.

One of their conclusions was that it was very important not only to look at single areas, but to look at the system of parks and reserves in the country. If one only looks at individual areas totally out of the context of the country, bad decisions can result. The value of individual areas has to be evaluated and put into the context of the whole system. Basically, one defines goals for protected areas in biological, social and economic terms, evaluates the area for contribution to the protected areas system, which I just mentioned, and from then on out, it's basically a question of looking at the quantifiable benefits, the non-quantifiable ones, determining the relation of those and, if benefits are considerably larger than costs, then one goes for establishment.

As one gets more into the situation in which a large percentage of the potential benefits can only be estimated in qualitative terms, then the decision becomes more political in operation in a sense.

There are a number of lessons that come out of this. One of these is that use of contingent valuation methods or welfare based methods have limited usefulness when applied in industrialized countries versus developing countries. They have rather limited use in developing countries. The travel cost approach can have useful results in cases where it's applicable, but in many other cases, it really doesn't provide much information.

A lot of the production based approaches look good at first, give some numbers and in cases where the benefits are clearly larger than the costs, then the decisions are fairly easy to take in terms of the importance of the areas either for establishment or management or both. What about areas that fall out in the undetermined benefits category? Does that mean that they're not worth protecting? Their main point there is that the techniques available now are too limited and one has to rely on using qualitative valuation in many cases, so that major mistakes won't be made.

I just want to read quickly their final conclusions to the book. Many of these are very significant for developing countries. This is after looking at many cases which are discussed in the book.

In conclusion, first of all, economic analysis offers valuable insights into the process of establishing and managing protected areas, but data may be often very difficult to obtain, which puts limitations on what one can do. Very few protected areas turn out to be privately beneficial and thereby protected and managed by individuals. In other words, some governments have to be directly involved and it can't be left in the hands of individuals generally.

Establishment of protected areas does not ensure that these areas will be effectively protected, in fact if you look around broadly over the developing countries, you will find that a very huge percentage of these areas that have been declared have minimum or no management and very little implementation ... not in all cases, but in large numbers.

The costs and benefits of protection are often not distributed equally, thereby leading to management problems. A key point there, particularly in developing countries, is that the people who initially, and for some time to come, pay the cost of establishing the area, are usually local people who previously had certain extractive practices and they can't continue them after establishment mentmentmentmentmentof the protected area, yet the benefit goes far beyond those people for the whole society.

Economic values can be placed on many, but not all, benefits of protection. Estimates of tourism and recreation benefits yield useful information for protected areas with a large direct use component. If there is a direct use component, very often recreation and tourism is one of the main uses and those can give hard data, in many cases demonstrating major benefits.

One example which I am very familiar with and that's the Galapagos Islands which is 97% national park on land and it has a 70,000 square kilometer marine reserve cleared around it. It receives about 50,000 visitors a year, in a tourism industry which has developed in twenty years. Tourism started in about 1970 and the rough economic benefits for that country from that one national park at this point are about $150 million dollars a year. It's the third source of foreign income in Ecuador.

A final conclusion is that the opportunity costs of not developing the resources in a protected area may vary, but can usually be calculated in some form or another and it is worth trying to do so.

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Speaker: Craig MacFarland * Topic: Integration of Protected Areas and Their Surrounding Regions

What I want to talk about in this second part is the integration of protected areas and their surrounding regions - or one might say buffer zones, whether they are legally declared or not.

Professionals in the resource management field working in Central America think of this area, known as a buffer zone, as a way of treating the pressures on protected areas from the protected area managers point of view. A lot of people think it's a panacea, a solution. I want to discuss today some of the concepts and problems to be faced in this.

The concept is in its infancy. Protected area managers worldwide have been spending their efforts inwardly, from the border in, based on the island mentality. In the last decade, and in only a few cases, they have begun to think about outreach, extension, and working around protected areas with local people and with other actors, which might be timber or mining interests coming from the outside and not just the local people. Usually, you have a complex of those two working together on extraction or use of the resources.

I want to talk about this because the key thing that is happening in Latin America is that there is a streamroller front, rolling over these areas and they are disappearing at a very rapid rate. If one had to look ten years back and look now, there are more protected areas, more potencially protected areas, legally declared, but where protection is not yet implemented, but overall the battle is still being lost at this point.

There are two basic types of phenomena: one is extracting or poaching, people going into the area and taking resources out or harvesting resources. The second major factor is encroachment or invasion, with people moving into the area and using it for agricultural or other purposes. The why's are obvious: extreme poverty, population growth, lack of other options, debt development vicious circle (the vast majority of money pumped into development projects is doing more harm than good because the system is badly designed in the first place and it's making the problem bigger and the countries get more indebted).

This is what the decision makers face, and they have a basic choice between protection for long term societal benefits or more immediate exploitation to decrease socio-economic pressures, not only in the areas but over the whole country or sub-region of the country.

There is a resource protection development continuum from strict preservation, such as scientific preserves, through intensive resource development at the other end, which is a multiple use management area, or part of a biosphere reserve, and there can be everything in between. There are enough kinds of protected areas, designed through human practice and conceptualization, followed by trial and error, that exist worldwide now, that the mix of resource protection and resource development can be highly varied, and it can go all the way from one end of the scale to the other.

The choice depends on the management categories, which in turn are picked out because of the objectives that the country wants to achieve or that the agency that is managing the

area wants to achieve. It also depends upon each particular area, as an individual case. The first one, the management category, gives a general prescription for management. The second one, then, has variations depending upon each individual case.

This is a set of protected areas, the internationally recognized ones, you might say, presented in summary form. They are the types of protected areas that have been invented through practice and trial and error up until now. These are arranged from most protection, or most strict protection at the top, down to more intensive development towards the bottom. The Biosphere Reserve is a special case that sort of fits near the bottom, but not exactly at the bottom. It's an international category that's a combination of strict protection in a nuclear zone and intensive resource development in part of the area surrounding that.

These are the benefits of protected areas:

* maintenance and conservation of environmental resources, services and ecological processes
* production of natural resource outputs suchs as timber and wildlife
* production of recreational and tourism services
* protection of cultural and historical sites and objects
* provision of educational and research opportunities

The benefits listed are major benefits to society. The costs are those mentioned before, direct cost of establishment or management, indirect damages outside the area, and opportunity costs that are foregone. Buffer zones in this context are generally defined as follows (this is sort of a summary of the way buffer zones are defined, taking into account the way they are used in different countries):

They are peripheral to protected areas of reserves. Restrictions are placed on their use, on use of the resources inside of those areas. They supposedly provide an added layer of protection around the protected area, and there must be some form of compensation for local resource users who are giving up something.

Regions of influence are a more general thing, but really buffer zone is a sub-category of this. So these things that I am going to say about region of influence for a protected area also apply to a buffer zone. Again, they surround protected areas and there are bidirectional flows of energy, materials, goods and/or services, some of those things are all flowing, and there is interdependency generally between the region and the protected area.

In terms of possible legal basis, the general situation that you find is that sometimes there are buffer zones that are declared as formally part of the protected area or part of the zoning scheme. Sometimes, separate legally established buffer zones may be declared around the protected zone, and in other cases, there is no formally declared buffer zone, but there is a generally recognized area in which the agency or agencies involved try to work. It's an informally recognized region of influence where they've

decided that they are going to apply some of their attention.

Land tenure variations are very great. They go all the way from the most simple case, when it's in the State's hands, at least simple administratively, to communal lands, which are generally somewhat easy to deal with because if it's a cohesive, organized group, you can have direct dialogue and direct dealings with the people on the lands. Mixed cases and private ownership, obviously, can go from one owner all the way to many, but generally, around any sizeable, protected area, or even moderate protected area, private ownership patterns are complicated. Sometimes you have all these mixed together and that must be taken into account.

In terms of administration or jurisdiction management variations, who is in charge, there is a great deal of variation. Again, generally from the top to the bottom, one is going from a simpler situation to a more complex situation. Generally, in this particular case, the lower end of this list of things is the more complex situation. The protected area, plus the region around it, make the situation complicated, because of all the different actors involved. It goes from the traditional single government agency in charge of the protected area and the buffer zone, which is very rare, where the same agency will be in charge of the buffer zone also.

More and more common in Latin America, as governments fail to be able to do anything about their protected areas, NGOs are taking over. A good example of that is Peru, where basically now the protected areas are being managed by NGOs. The government has essentially given up and is finding NGOs, writing them letters and putting them in charge. Legally, they are still in government hands, but in practice they are not. They are even deputizing private wards hired by the NGOs, and giving them credentials to act as managers.

Then, there is the single government super agency or corporation, the Tennessee Valley type of approach. There is a similar case in Colombia, and the Great Barrier Reef approach in Australia, where a super agency is created and staffed by all the different specialities that you supposedly need, from the social sciences through natural resource management through basic sciences. They manage the area as a giant agency.

Then there is community based management, which is very uncommon, but starting to occur in a few cases in developing countries, where responsibility for managing the area is directly given to the local community. There are a few cases where that's coming about. Usually, it happens in relatively small areas, municipal watershed-type size areas, or even smaller, but in some cases they are larger, particularly if the group is very cohesive and organized. An example of that is the Kuna Biosphere Reserve, in Panama, where the Indians themselves are directly establishing and managing their own reserve, or at least they are trying to. They are in a very initial stage.

There is the numerous government agencies model, sectoral, where they don't generally talk to one another, they don't coordinate, and everybody's there doing their own thing, with lots and lots of overlapping but also huge gaps. There is also commissional governmental agencies, which are basically ruled by a committee, which, as you also know, does not work very well, but is better than the previous case.

Then the final case, which is starting to be used more and more in cases with Biosphere Reserves, there is still very few in the region, maybe a dozen that I would count, where government agencies at the various levels, local through national, particularly national ones, NGOs and the resource-user groups themselves, are beginning to form a united front and work together in the form of a Commission, to try to work together on the management of the area and the buffer zone or the region around it together.

There are some of these categories of management that permit, by international standards, people to reside inside the area, not just extract resources or use resources in other ways, but to actually live inside areas. These are: protected landscapes, anthropological preserves, multiple use areas, and biosphere reserves.

The Biosphere Reserve concept is an international one. The "Man and the Biosphere" program, of which UNESCO is the Secretariat, is a particularly intriguing approach, because it really tries to connect sustainable development, conservation, research and education into one area. These are generally very large areas, with a nuclear zone that is strictly protected, but then there is a very large area, as part of the reserve, inside of the boundaries, a buffer zone that is managed on a multiple use way with people living in at least parts of that.

The supposed benefits of these buffer zones are as follows:

Ecological benefits: they are a physical barrier to effects on the protected area, they help prevent invasion by exotic species, they protect against natural impacts, hurricanes, tsunamis, and they extend the habitat of wide ranging species, or they extend the protective function somewhat outside the protective area, at least for some parts of the natural system and some of the resources.

Social benefits: protection of some of the traditional land rights and cultures, protection of genetic resources, protection of regulatory functions, ecological processes, and building local and regional support. It's a flexible mechanism for conflict resolution, a more flexible mechanism than the protected area itself. It should provide a way to compensate local resource users. It should improve quality of life for the people living in the buffer zone and it should improve environment, which is, of course, part of quality of life.

For legally established buffer zones in most countries, there are in the legislation very restrictive rules: no permanent, or in other words irreversible, major changes in land or resource use in the region should be permitted. Product harvesting is controlled in a strict way and there are special regulations for resource management practices.

Two of the key things in developing countries, are that you either have people where there is a protected area established, who have some of their rights or their traditional practices intervened, or an agricultural front reaches the area and people want to use the resoures inside of it, as well as in the buffer zone.

Two things really have to be kept in mind: compensation must be provided, particularly if you are removing traditional practices or decreasing the traditional practices. In other words, you're trying to cause a change in the resource use pat-

tern and you're trying to improve the situation, but at the same time that you are doing that, you are affecting at least their subsistence level use of resources, sometimes artisan or even more major economical benefits that they were deriving from it. That has to be taken into account and some form of compensation has to be looked for.

Secondly, all the actors have to be taken into account, and one has to try to develop a process, not just a plan, but an ongoing, never ending process, in which the self interest of all the individual actors is taken into account. That means that local people or resource extractors who use local people as the extractors, have to be taken directly into account and figure out how to deal with them. In some cases, you can legislate them out or get them kicked out, but generally that doesn't work because of economic pressures. So in some ways, compromises have to be looked for.

There are a lot of different management options. The number one we all know about is the traffic cop approach or stick approach: regulation and enforcement, which basically, from the point of view of the people using the resources, is coercion. Another approach is the carrot approach, holding a carrot out in front, you might say, that is, offering incentives. Many times, protected areas in the buffer zones can offer jobs to different people in the region, particularly depending upon the types of uses, particularly if recreation and tourism are part of these uses, they are very often their jobs.

Direct compensation is another option, in other words directly paying people. That is not very practical in developing countries because of economic problems, but it has been used in some of the developing countries. Generally, the results have been negative, because the people have become dependent and sit on their duffs and don't do much, they just receive the funds. So it is not a very appropriate solution in most cases.

You can continue to allow the controlled harvesting of certain products. You can look for alternative sources of supply, for example, if they were gathering firewood inside the area, you could establish or work with people and establish wood production mechanisms outside in the buffer zone area. You can look for new alternatives, new economic alternatives, be they subsistence or be they things that can be sold in the market in some way.

The final alternative is community based management, which as I said before, is a rare thing, it's just starting to be used in very few cases. In certain cases this has turned out to be the best option, particularly if the area is relatively small, the direct benefits are principally to the local people, the areas do not contain resources that are of major significance to the whole sub-region or the country or national level. If their main importance is to the local people, then community based management is very often a very good choice because you can get the people totally committed to protecting their own resoures, that's important.

Now the kind of tools that you use for these different options include regulation and enforcement: zoning, restrictive seasons, catch and size limits, permits, monitoring, and penalties. For incentives, there are lots of different kinds, like revolving loan funds, sharing of revenues by the government or the agency that is benefitting from the area in some way with the local people.

Outside support, in other words, income that is coming in from third parties, neither the local people nor the agencies that are working in the area, extension services and training and again monitoring and control.

In the community based management case, you generally need some of these incentives but they don't have to be so intensive in most cases. The one key thing in a community based management case is that there has to be some sort of control, not just by the local people but by some agency or university, or something similar, like an NGO, but it is monitoring and control in an advising sense. The people have to have control of the resources and control of the area, but there is a board of advisors or a group of advisors who can monitor and control in order to give feedback into the system, so that irreversible changes and mistakes don't occur.

Some other key principles on buffer zones are that it is very important to avoid rigidity. Importing concepts of buffer zones from the First World to the Third World doesn't work. Rigid definition of what a buffer zone is can be dangerous, so one has to maintain some flexibility with it.

The gradient principle, the principle that, as one goes from a protected area outwards, the use of resources can become more intensive, must not be used rigidely. It states that the closer you are to the resource area, the less intense the use should be, and as you move outwards it can become more intense. I would sustain that, in general, this is a good principle, but that it's not always necessary, and exceptions can be made. An obvious exception, particularly with coastal and marine protected areas, is that, very often, the immediate area and the buffer zone surrounding it, are not the areas where the problems are coming from. The problems are coming from way up high in the watershed. If you use the strict gradient approach in this case, you would be off base. What you really need to do is go up to the place where the sediment is coming from, and pesticides and so forth, and look at management of that area. So the principle does not always work.

There are other cases in which I would sustain that, if you look at all the trade-offs and look at the compensations, you might get better protection of the protected area and its resources by allowing intensive agricultural development right up to the border by the local people. The problems that you can get into with that are pesticide flows, but if the uses are designed properly, and it is the right type of subsistence level use, very often that's not a problem and it can be managed. This absolutely rigid concept of grading it from A to Z as you go out from the protected area is not always appropriate.

Another point is that efforts should be focused on critical areas and pathways of impact. You may have around the whole protected area, selected areas where there is critical pressure, so that is where the efforts ought to go, or there may be critical pathways, ecotones, for example, where rivers are coming into the protected area and the river is where the problem is, because that is where the sediment and pesticide loads are that are affecting the resources. A great deal of your border is not having any of these problems. From a manager point of view, that needs to be taken into account.

Now some principles on buffer zone projects. These are my own ideas, but they are based on twenty years of working in Latin America. All

the actors have to be involved from the onset, or as near the onset as possible, or you are going to run into problems if you exclude any of them. Explicitly, get them into the process in selection of the area, planning it and implementing it, the entire process. And it is a spiral, it's a never ending process.

The second point is that scale is really important and, in general, small is beautiful. I don't really mean small, I mean properly scaled. Most development projects don't work because they are the Iraq War approach to development: the big aid agencies and the bilateral agencies from industrialized countries think that they can solve the problems by dumping large amounts of money into the system, and what makes things work locally is very small amounts of money applied in a very appropriate way. So it needs to be scaled to the size of the problems, and the size of the protected area and the size of the buffer zone and the capabilities of the local agencies and local resource users.

Support and commitment, this is obviously for the support agencies from the outside, as well as national agencies that are going to become involved in these projects. Minimum commitments are fifteen to twenty years. It's absolutely ridiculous to go into these things and be talking in three to five year increments.

There are no blueprints or recipes. There are certain types of recommendations, generalizations such as the ones that I am giving today, that can be drawn from the experiences, but there is no blueprint that is going to work over and over, it's case by case.

Intense dialogue with the beneficiaries or the resourse users has got to be a main part of the process. That dialogue process has to be managed very carefully and the scientists and managers need to understand their role. They are not gods, they don't know it all, they are part of the process.

Avoid creating dependency, that goes back to the scale question. This is what most big agencies and most big projects fail to understand, that this is the first sin they commit. They do it all through their project, and then when the project ends, everything dies.

Practical on the ground action needs to start very soon after the project starts and there needs to be some returns so that people see that something is happening.

It's very atractive for NGOs, which are some of the most effective project implementers or advisors in countries, to work with local people, local groups of resource users and more or less ignore government agencies. That won't work either. The government agencies have to be brought into the process and have to be a part of it.

The final part is that there can't be any ends in this kind of project; it's all means.

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Speaker: Knut Alfsen *
Topic: Accounting in Natural Resources, the Norwegian Experience

I am here to talk about experiences in natural resources accounting in Norway, and it's going to be a very practical talk. We have heard a lot about philosophy today. Some grand questions have been raised. Now we are going down to earth and I will tell you what we have been doing in Norway, and how we evaluate that experience after some 10 or 20 years.

The outline of the talk is as follows: I will first say something about the history of natural resources accounting in Norway, then a few words about the specifics on the Norwegian resource accounting, as it was yesterday and as it is functioning today. Then I will go on to the use of such accounts, and the major use in Norway is for analytical purposes, to make projections, policy studies. I will show you, I hope, some interesting case studies. Finally, I will try to draw some conclusions from Norwegian experiences and obviously the questions that arise: Is this of any relevance to anyone who is not a Norwegian? Hopefully, what we have learned will be of use to other countries and other problems than we have been considering.

A major feature of Norwegian resource accounting is that we look upon resource accounting, and by resource accounting, I mean both natural resources accounting, material resources accounting, like oil and gas in the North Sea, and forests and fish and so on, and also environmental accounting, although it is more problematical to define what environmental accounting really is. We look upon these activities as extensions to the more or less traditional planning system we have in Norway.

The planning system we have in Norway is very much focused on economic planning. We have our Ministry of Finance, which is sort of a super agency within the society. This system of planning in Norway evolved largely after the Second World War. We had quite a number of big damages during the war and we had the need for reconstruction and that was going to be done according to some plan. For that reason, there was a need for economic data and this manifests itself in the establishment of national accounts. The national accounts containing the data then gave birth to models and analytical tools for the study of the economic behaviour on short term and long term perspectives.

But then came the 1970s, the energy crisis, the resource crisis, the Club of Rome, limits of growth, and the questions to whether we were using up our resources. This gave then birth to the natural resources accounting activities. Lately, there has been a growing concern for the environment. Polluted air and water, hazardous waste, has resulted in what one could call environmental accounts or environment statistics. Both of these new additions are looked upon as additions to the national accounts and we are trying to keep the same classifications that we have in the national accounts, carry them over to both the natural resource account and environmental statistics.

Once more, and perhaps the most important thing, is that we are the end users of this data. We are always the main planning apparatus within our society, which essentially is the Ministry of Finance. We are not the Ministry of the Environment. That Ministry is not by itself an

important end user. We are trying to focus on one group of end users.

Natural resource accounting emerged as an activity to collect data for natural resource management in some sort of rational manner. One should not have a hundred people collecting the same data. One should try to rationalize the collection of data. One should try to impose some sort of classification or structure on this data, which should be common to the different types of resources and different types of problems, as far as possible. One should make the data comparable, as far as possible, with economical statistics. That is not just because we are working with the Ministry of Finance, but also because there is a lot of information in economic statistics which can be used to highlight different questions regarding natural resources and the environment. So, it's a sort of cheap way of obtaining information on resources use and also, in some cases, the environment, by using existing economic data.

Now, the resource accounts generally have a structure. They contain three main sub-accounts. One is a reserves account, which shows what is happening to our resource base, both resource base in physical terms (the amount of oil, the amount of gas, the number of fish), and in economic terms. As prices of these commodities vary, what is economically useful also varies, of course. We try to keep track of that.

The second sub-account has to do with extraction, conversion and trade of these resources. Typically, some of the resources are used in the extracting sectors. We have refineries. We have export and import of the resources.

The final group is perhaps the most useful, which is the consumption account. How is the resource used? By whom is it used? In what quantities is it used?

The details of these sub-accounts differ among the resources. Some resources, like the fish outside the Norwegian coast, have only a few end uses and the consumption accounts are very simple. Other resources, like energy, have consumption accounts that are of primary importance. It varies somewhat between the resources.

This is the formal structure of the resource accounts. The content of the resource accounts in Norway, in praxis, has changed a lot over time. In the early 1970's, when we started this exercise, we wanted to cover a lot of resources in a lot of detail. We started out with energy, land use, fish, forest, minerals, and gravel. There were also attemps at taking account of fresh water use in Norway. Now, for a number of reasons, this has coliapsed into two and a half basic things in the 1990s. They are the accounting of energy and the emissions to air, concerned with air pollution problems, and also some efforts in forest accounting.

Why did this happen? The answer to that question is based on an observation of how these accounts are going to be used. In our experiences, rational management of natural resources does not stand or fall with data. Very seldom does a lack of data make rational management of natural resources difficult or impossible.

In order to have a rational management of resources, you need at least four elements, in our experience. You need data, of course. You need

some sort of analytical studies which tell you what these data are really telling you. What do you get out of this table? Typically then, what you use are models. Then you need some experts or some interpretation of results, because a model can lie very easily, unless you know the background of the model. You need to know the parameters. Then finally, you have the political value of it, the decision making, where the real action is taking place. If you aren't getting any action here, then it does not help, even if you are perfect with these other elements.

What is important is that all of these elements are in place and all are functioning. The communication between them should be functioning. If only one of these links is broken, then you are done. That is what happened in Norway with our beautiful resource accounts. It was not possible to get the information from the data stage to the decision makers for most of the resources. We managed to do it in two cases, which are the energy accounts and the emissions to the air. The reason for our success in these cases, and implicitly our failure in the other cases, was our ability to hook the question of energy management and air pollution management to the macroeconomic models used by the Ministry of Finance in Norway for planning purposes.

There were also models collected for the other resources, but those models were not used by the Ministry of Finance and were treated as separate activities, and given less importance than what came out of the official Norwegian economic model.

In summary, we had a movement from broad coverage of data to the demand in selection. Only in those cases were we able to put the data into good use through the models, then getting it all the way to the decision makers, having continued our effort in resource accounting, instead of doing partial analysis of a few economic sectors or restricted type of problems. We have been more and more concerned with doing integrated and more general studies of interactions between the economy, as presented by the economic model, and the resources, energy and air pollution.

In our experience, the main obstacle to rational management of resources and the environment is not lack of data. One has to recognize that one needs all these elements in order to get the information, the continuing data, and in order to have an impact on the decision making.

Now, I am going to say something about the analytical tools that have been used in regard to energy accounting and emissions to air. We have in Norway a number of macroeconomic models. We've been able to extend those models to also cover the energy use and demand, make forecasts and provide information of emissions to the air and the air pollution problem. These models are used for making forecasts on economic development, on energy use and emissions to the air in a consistent fashion. These three forecasts all depend on the same sort of initial data and the same sort of technological development. Thus, you get a consistent picture of the economy, the energy sector, the environment and the emissions to the air.

So we make forecasts and those forecasts are useful because we have some targets in Norway. By 1993, we are not going to emit more than a certain amount of Sulfur. We have a ceiling on Nitrogen Oxide and we are talking about putting a ceiling on the Carbon Dioxide emmissions.

Then, it is very useful to have the forecasts, to see if you are breaking through that ceiling. We make certainty analysis in order to get some hold on the uncertainty questions. These models depend a lot on certain assumptions. Typical uncertain variables are market oil prices. So we try to make some sensitivity analysis on that. We make analysis on control policies of different kinds. We have regulations and various economic incentives that you can use. We study those, to compare them with each other. We also compare them with a reference scenario.

When we make analysis on the control policies, it is very easy to make use of these models to get some estimate of the cost of the control policies. Introducing a tax on the Carbon emissions to the air is going to lower the GDP by 2% in the year 2000, for instance. That's some sort of measure of the cost of this. But you also want to look into the economic gains from these policies. The gains that we have at this moment are health damages and how health damages are influenced by the emissions to air. Corrosion on materials due to acid atmosphere is another measure. Some sort of measure of recreational benefis and some other external effects mainly connected to road transports are two more. We have some congestion problems connected to the damage to the roads. These are affected by what you do to the gasoline price.

The effects of emmission taxes at the moment show effects of four classes. One is that we have a problem with acid rain in Norway. Actually most of the acidity comes from mainland Europe to Norway. What we do in Norway with Sulfur emissions doesn't have a large impact on Norwegian nature. It has to be done in other countries like Poland and Great Britain. The gains from reducing the sulfur emmissions are very small. The health effects are not very large. Corrosion damages are also affected very little by reducing emissions. The fourth group, effects related to road traffic, seems to be quite substantial. This group is composed of different elements. We have a benefit of reduced number of accidents. We are taxing fossil fuels. The price of transportation is going up and this is affecting the whole transportation pattern, both in the demand of transportation and how it is distributed along different transport means. The accidents are going to come down and that is creating benefits. The congestion on roads is going down. Damages and noise level are also going down.

The benefits of reducing emissions create environmental benefits of the same order as the benefits you gain in the economic system. By pricing the road traffic more appropriately, you have some efficiency gains here which are on the same order of magnitude that we can have in the environmental benefits.

These are a lot of very uncertain numbers. There are a lot of assumptions going into these numbers. What we do is make simulations, to see what sort of arrangements we are talking about. Yet the general picture is still quite robust. Very often, you have economic efficiency gains comparable to the economic benefits you can get from introducing a control policy.

In our view, it has been crucial to the success of what we have been doing, that we have been using already existing administrative bodies and existing administrative routines as end users of our data. In those cases where one has tried to establish separate planning procedures and separate agencies for handling resource and environmental problems, there has been very little

success, much less than in this case. We have been able to use existing political bodies. A point in case is that, by now, the Ministry of Finance in Norway is calculating emissions to the air to every scenario that they are making in the long term. That's quite extraordinary. I don't think that there are many ministries of environment or economy that do that around the world.

Today, they do that in Norway because they have the tool and it's very easy: they make a scenario, they get the numbers on the table and bang! they have to look at them. Obviously, one shouldn't drawn the decision makers with all kinds of data or all kinds of materials. You have to select some important and preferably controllable problems to handle. One should collect data with discipline. In our experience, having a model saying something about the problem and also defining the data needs quite precisely is crucial. If the model is good, it is going to answer your question in an adequate manner, and it's also going to define the data needs. You are saving on the data gathering by using the model. We recommend to rely on formal, economic models, because a number of those give you a very consistent picture, it may not be the very best guess that an expert on air pollution would do, for instance, it may tell you that air pollution in the year 2000 is going to be like this.

In using a model, we make a very consistent picture with the economy, the energy use and the emissions to the air connected in a sound manner. We always want to extract operational information from our model runs. Some robust rule of thumb: it's easy to make perfect recommendations. We try to avoid these kind of traps. One should try to harmonize the effort along the chain, data, models, experts and decision makers. It doesn't help you to have perfect data bases or perfect models if they don't reach the decision makers in a manner that is comprehensible to the decision maker.

Finally, what we find, time and time again, is that improvements in the efficiency of the economics sytems very often give you large environmenal gains or preserve natural resources in the best possible manner, because what you get is negative costs. Time and time again, our recommendations to our government are given along this line: you should really try to solve some economic problems, that in turn, will usually give you some advantages on environmental and resource issues.

Now, this leads me to a final observation on the question of environmental and resource problems. In Norway and Western Europe, we have a history of reconstruction after World War II, with a certain kind of power structure in the society. Privileges were given and certain rights to resource use were given to certain groups. In one word, we have a history that has more or less frozen a number of structures in the society. These structures have led to a number of wasteful uses and damages to the environment over time. It was perhaps rational to do it after the Second World War, but today, that structure is really quite wasteful in many ways.

It turns out that perhaps the most important aspect of environmental concern, and in Europe, environmental issues are really hot topics, is that by getting a very strong opinion backing environmental issues, one can break down the power structure, the historic structure of the society, and make a new economic order that is more efficient, and therefore more environmentally sound and sustainable, than what is possible with today's societies.

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Final Recommendations

We were supposed to talk about valuing the ecological systems and these discussions were framed by two main guidelines that we received. One of them is the need to ensure, the need to value ecological systems so as to measure it with traditional ecological analysis, something that we were also discussing in the preliminary session yesterday. Second, it is essential to expose the decision makers to the consequences of their decisions in a way that everyone can relate to.

The specific objective of our meeting was to produce a set of recommendations for valuing ecological systems and improving the relations of institutions and individuals with respect to ecological systems. Along the discussion, we tried to recuperate a few points, which, briefly, different participants had put forward.

First of all, it is necessary to use some form of cost benefit or cost effectiveness analysis, giving an adequate way to uncertainty and qualitative measures. Another important point is that, in doing this analysis, we're interested in both capital accounting and cost accounting. This is an important consideration for those who are familiar with positive evaluation. We usually pay very little attention to capital accounting, and in terms of natural resources, it is quite an important aspect to explicitly be considered in the evaluations. Another aspect related to this is that interest rates, or the discount rates that we use in economic analysis, become more important than in other areas when we are dealing with ecological systems, because of the time, the problem of inter-temporal comparisons, and those who are familiar with these aspects know that the selection of the discount rate or the interest rates that we use are obviously going to affect the selection and the outcome of the analysis that we are going to do.

Another aspect that was pointed out and that experience has shown is that the most successful projects are those that have most participation of the so-called beneficiaries, particularly those that are managed at the community level and hopefully by NGOs.

Something that created a lot of discussion is the aspect of valuing, trying to put price to all benefits and to all costs. What we agreed in the end is that whereas we should strive to value all benefits and all costs, we should recognize that there are certain categories in which it is going to be quite difficult to do so, and probably those should be treated as meritory, in terms of certain things that we do want as an oucome. If we can't, we don't necessarily put a value on that. Nevertheless, when we're not too sure as to what type of an ecological impact we are going to have, it is better to err by caution and not by an excess of optimism.

Finally, in terms of the general considerations, the CATIE-IUCN approach cannot be one that puts development and conservation in opposition to each other, but rather one that links development with conservation. That was something that was strongly felt by the group, that it is quite important for the CATIE approach.

So, after saying all this, the main recommendations that the group puts forward are the following: donors, like World Bank, Inter-American Development Bank, USAID, and technical institutions like IICA, FAO, CATIE, should do ecological economic analysis of all projects in

collaboration with host institutions. What is behind this is that we recognize that, in spite of the fact that, particularly funding agencies, pay attention on paper to ecological aspects, in fact, when the time comes to really implement the project, very little attention is paid to ecological aspects. What we are saying here is that more than just lip service should be paid to these aspects.

The second recommendation is that it is very important to recognize the role of the private sector in ecological systems and natural resource conservation. There is a need to strengthen ties and working ties between international organizations and regional organizations and the private sector. The discussion put forward the fact that most of our organizations (CATIE, IICA, and some others), were not created to allow for interaction with the private sector. The example that someone put in during the meeting was that the board of directors of all of our organizations do not have a chair for any representative of the private sector or private sector organizations. So that is the reason why we put this second recommendation there quite explicitly.

The role of CATIE, one of the main roles of CATIE within this subject matter, should be generating all the necessary information to research, which is quite obvious given the mandate of CATIE as a research institution.

The fourth recommendation is that all efforts should be made to ensure a way to spread dissemination of results to all parties involved in the subject. To name a few types of organizations, such as NGOs, governments, the media, which we feel are quite important for a wide spread of dissemination of results and impacts, learning institutions local group interests, the church, all denominations, of course, donors' technical cooperation institutions and some other relevant institutions. The last category is like a bag in which we put everything which we didn't put before.

We feel that CATIE should pay attention to the following: first, develop workshops involving donor agencies, technical cooperation organizations, and national institutions, to ensure adequate ecological accounting in project evaluation. In other words, this subject matter we're talking about merits more consideration, and deeper consideration than just one morning discussion of a group or something like that.

Second, CATIE should support policy dialogues as a process for bringing all institutions along and allowing ongoing inputs to the process.

Third, it should participate in the development of long term ecological monitoring and analysis systems. This is basically thinking in terms of developing an information system that, regionally, for Central America, could collect and analyze some indicators and data which would allow everybody to monitor what is the state of the ecological system of Central America and what sort of impact we are having along the way with different projects and activities that are being developed.

And fourth, we recognize the problem of timing and the fact that sometimes studies, particularly in the area of ecological systems and natural resources, take quite a long time to produce results. There was consensus in the group that we don't have much time. We can't, in each case, sit for too long to wait to see what

happens. Therefore we are proposing that CATIE develops a capability to carry out some rapid assessment, we call it rapid ecological assessment in the region, which we feel could be quite useful and produce more immediate results than traditional methodologies.

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