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Globalization, Local Ecosystems, and the Rural Poor

Rimjhim M. Aggarwal*

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Abstract

Livelihoods of the rural poor in developing countries are critically dependent on the health of the local ecosystems. In this paper we examine the various mechanisms through which globalization can lead to ecosystem degradation, and consequently poverty. Models on ecosystem dynamics from ecology are examined and linked to models in new institutional economics that examine how institutions and technologies evolve in the process of globalization.

To illustrate ecological dynamics, a prototypical model of a semi-arid savannah ecosystem is examined. This ecosystem is characterized by non-linearities, multiple steady states and threshold effects. An important ecological concept in this context is that of resilience, which refers to the ability of ecosystems to absorb shocks without changing their essential structure. In economic models only the productivity of a resource is considered. We discuss why resilience is also an important characteristic and why management institutions that focus only on short-term productivity may lower

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Keywords: poverty, globalization, environment, ecosystem resilience, institutions, traditional knowledge

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* Department of Economics, University of North Texas; email: rimjhim@unt.edu

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resilience and contribute to the emergence of crisis. Within the context of a traditional closed economy, we discuss how traditional knowledge systems and institutions shape resource-use practices and how these practices fare in terms of productivity and resilience. Then we examine the effects of globalization through trade liberalization, international technology transfer and short-term capital movements on institutional and ecological dynamics, and consequently, on poverty.

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UNU World Institute for Development Economics Research (UNU-WIDER)
Katajanokanlaituri 6 B, 00160 Helsinki, Finland

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1 Introduction

Some of the most vehement criticism of globalization has come from environmental groups. These groups allege that the current wave of globalization—in the form of greater trade liberalization, capital movement and the growth of multinational corporations—has led to environmental degradation in developing countries. They further argue that since the livelihoods of the poor, particularly those in rural areas, are closely dependent on the natural resource base, degradation of this resource base has translated into greater poverty. Although there is now a vast literature in economics on the various channels through which globalization may impact the lives of the poor, this specific link that works through environmental degradation has received relatively less attention.

Theoretical models in economics suggest a number of mechanisms through which globalization can lead to environmental degradation in developing countries. First is through the well-known Environmental Kuznets Curve (EKC) which hypothesizes that with rise in per capita incomes, environmental degradation first increases and then falls. Therefore, in so far as globalization leads to rise in per capita incomes, environmental degradation is likely to increase in the initial stages of development before it falls. Although there are sound theoretical grounds for expecting such a relationship, the empirical evidence in favour of the EKC is very weak. A recent survey concludes that there is no evidence for the EKC in general, although for some particular kind of pollutants the evidence is somewhat stronger (Borghesi 1999).

Another well-known mechanism relating globalization to environmental degradation works through the export of 'dirty industries' and the creation of 'pollution havens' in developing countries due to their weak environmental standards. Empirical evidence suggests that this has not happened on any significant scale, possibly because the costs imposed by environmental regulations are small relative to the other costs that affect location decisions of multinational corporations (World Bank 2002). Also contrary to theoretical models that predict that developing countries would exploit their comparative advantage in dirty industries, recent empirical evidence shows that developing countries have not increased their share of global pollution-intensive industrial exports (Mani and Wheeler 1998; Sorsa 1994). This body of evidence is often interpreted to imply that globalization per se has not necessarily led to environmental degradation on any significant scale, at least not in the manner conceptualized in much of mainstream economic theory (World Bank 2002).

Ecological studies, on the other hand, overwhelmingly point to how the world environment is becoming increasingly degraded and fragile as a consequence of globalization. Instead of looking at one or two pollution-intensive industries, or a specific pollution problem such as air quality, these ecological studies have looked at how ecosystems function and how they respond to the stress caused by human intervention. The changes in ecosystems described by ecologists are often very slow and qualitative in nature. Thus it is not surprising that these effects are not captured adequately by econometric analysis. However, the discussion above also points to a deeper source of dichotomy between mainstream economic and ecological perspectives. Even in theoretical work on long-term macro issues such as growth, neoclassical economics models (such as the Solow model) generally assume that the economic system does not affect the biophysical environment in which it is embedded

(Common and Perrings 1992). Other models that do consider effects on the environment often implicitly assume that there are infinite possibilities for substitution of natural and physical capital so that degradation of the natural resource base is efficient so long as the proceeds from it are invested in producing more physical capital. Ecologists, on the other hand, perceive these substitution possibilities to be limited and thus pay explicit attention to the critical life supporting function of ecosystems.

Until quite recently, ecologists did not pay adequate attention to the working of human systems (in terms of the social, economic and political dimensions) and its interaction with the ecological system. In recent years there have been some attempts at analysing the dynamic interactions (or 'co-evolution' as Norgaard 1994 terms it) of human systems and ecosystems.[1] In this paper we draw upon some of the ideas put forth in this literature to examine the various mechanisms through which globalization, in its various dimensions, can lead to ecosystem degradation and poverty. As our discussion above suggests, neoclassical economics models are not particularly well suited to examine such an issue. Hence we draw upon models on ecosystem dynamics from ecology and link them to models in new institutional economics that examine how institutions and technologies evolve. The underlying idea is, first, to understand how human and natural systems dynamically interact within a closed community and then to examine the conditions under which integration into the global economy increases poverty and degrades the local ecosystem.

The central ideas within the paper are developed as follows. First we discuss some key conceptual issues related to the dynamics of ecosystems. An ecosystem can be viewed as a system of biotic and abiotoc variables that are associated with different temporal scales (some change fast while others are slow) and different spatial scales (some stretch across several regions while others are relatively localized). Ecologists believe that these cross-scale interactions between constituent variables lie at the heart of some of the most interesting characteristics of ecosystem dynamics. In economic models it is generally assumed that either economic activities do not impact the underlying biophysical environment or that the impact varies smoothly (often linearly) with the amount of stress. Ecologists, on the other hand, have found these dynamics to be largely non-linear, and often associated with sharp discontinuities, high uncertainties, and alternative stable states. To illustrate these dynamics we examine a prototypical model of a semi-arid savannah ecosystem that is characterized by multiple steady states and threshold effects. An important ecological concept in this context is that of resilience, which refers to the ability of ecosystems to absorb shocks without changing their essential structure. In economic models only the productivity of a resource is considered. We discuss why resilience is also an important characteristic and why management institutions that focus only on short-term productivity may lower resilience and contribute to the emergence of crisis.

Next we examine how these ecosystem dynamics interact with the dynamics of human systems. Here we first consider the case of a traditional closed economy and

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1 For a good collection of papers on the subject see Clark and Munn (1986), Gunderson and Holling (2001) and Berkes and Folke (1998).

use this discussion as a benchmark to examine later the impact of globalization. Within the context of a traditional closed economy, we discuss how the shared memory of long-term experiences shapes resource-use practices and how these practices fare in terms of productivity and resilience vis-à-vis the modern resource management regimes. From an ecological perspective, globalization refers to a process of integration across space of some (not all) constituent variables of the human-ecological system. This integration happens at different pace for different variables and this process transforms the earlier structure of relations across space and time. Some variables, such as institutions, change much slower than other economic variables and we discuss how these become important determinants of the outcomes that emerge. Integration into the world economy may happen through several pathways. We examine, in particular, the effects of trade liberalization, technology transfer, and short-term capital movements on institutional and ecological dynamics, and consequently, on poverty.

2 Ecological dynamics

Ecosystems have been changing constantly even before humans first appeared on the planet. Our interest here is to present some stylized versions of how human intervention may impact the ecosystems and how ecosystems respond back to such interventions. Following Scheffer *et al.* (2001) we use stress as a general term for the effect of human use through harvesting, destroying biomass or affecting abiotic conditions (e.g., groundwater reduction or climate change).

2.1 Stylized versions of ecosystem response to stress

In Figures 1a and 1b we present two different stylized versions of the relation between stress and the state of the ecosystem.[2] It is generally assumed in economic theory that either human activities do not have any significant effect on the biophysical environment or that the effect, if significant, varies smoothly with the extent of stress, as shown in Figure 1a. It is increasingly being recognized by ecologists that this representation is highly simplistic and does not fully capture the complexity of ecosystem dynamics that are often marked with sharp discontinuities and multiple stable states. Very often an ecosystem may not show any significant visible signs of stress until it flips over to another state when certain thresholds are crossed, as shown in Figure 1b.

Scheffer *et al.* (2001: 197) describe the case in Figure 1b as one where 'the ecosystem response line is "folded" backwards. This is known as a catastrophe fold and implies that the system has two alternative stable states over a range of environmental conditions'. When the state of the ecosystem lies in the upper branch of the folded curve, it cannot pass to the lower branch smoothly. Instead, when conditions change sufficiently to pass the threshold, a 'catastrophic' transition to the lower branch

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2 It is difficult to capture the changes in ecosystems by a single state variable. However, since many aspects of the ecosystem shift in concert with a few important key state variables, we focus on a single aggregate variable—such as plant biomass (see also Scheffer *et al.* 2001).

occurs. The movement from one stable state to another (also sometimes referred to as a phase transition) may not be reversible, or the reversal may take a very long time or be achieved at a high very cost. An important feature of these systems is that to induce a switch back to the upper branch (in Figure 1), it is not sufficient to restore the environmental conditions existing prior to the collapse. Instead, very often, one needs to go back further, beyond the other switch point, go back further, beyond

Figure1
Schematic representation of two possible responses of ecosystems to stress imposed by human use

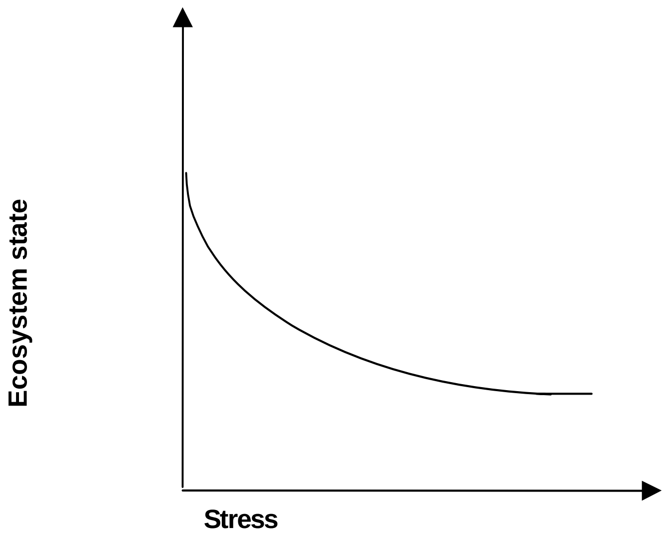

Figure 1A

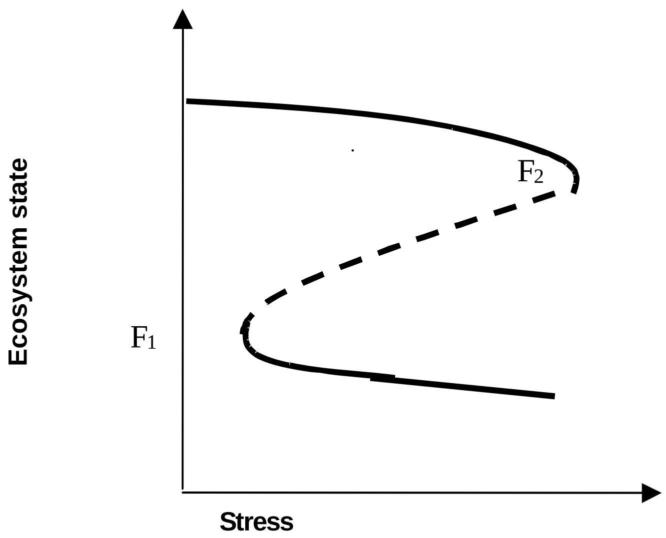

Figure 1B

the other switch point, where the system recovers by shifting back to the upper branch. This pattern, in which the forward and backward switches occur at different critical conditions, is known as *hysteresis*.

A number of ecosystems have been found to exhibit such dynamics. Some widely studied examples include semi-arid savannah grasslands, pest infestations in forest and agricultural ecosystems, and the eutrophication of shallow lakes. In order to clarify further these ecological dynamics and their implications, we describe the case of semi-arid savannahs in detail. The semi-arid savannahs are home to a large concentration of poor people around the world and the transformations in this ecosystem serve as a useful illustration of the central arguments we propose in this paper.

2.2 Ecological dynamics in semi-arid savannah ecosystems[3]

We use the term semi-arid savannahs to refer to those regions of the world which, in their natural state, have a predominant continuous grass cover with scattered to numerous trees and shrubs (Walker *et al*. 1981: 473). Semi-arid savannah grassland systems that were considered to be productive pasturelands have been transformed into arid shrublands (often also referred to as wastelands) in several regions such as the Sahel zone of Africa, southern and Eastern Africa, and northern India.

Semi-arid savannah is a water-limited system. Rainfall is scanty and interrupted by periodic droughts. Thus a critical ecological variable is the water infiltration rate. Biomass of grass is a critical factor in determining rate and amount of infiltration. As grass cover declines (say due to intense grazing), surface pores become sealed and soil erodes, and both of these processes lead to a decrease in the water infiltration rate.[4] The typical vegetation in a semi-arid savannah consists of a mix of grasses (G) and woody vegetation (W), both of which compete for available water in the upper layers of the soil. Grasses are more efficient than woody vegetation in extracting water from the upper layers of soil. Thus grass, with average annual rainfall in a savannah, grows much faster than woody vegetation. But below the grass root zone (subsoil), woody vegetation has nearly exclusive use of whatever water gets through, and under drought condition, performs better than grass.

Cattle and sheep, the major herbivores in the region, selectively prefer grass and only negligible amounts of woody vegetation. Thus under high stocking levels, the common pattern of range deterioration is as follows. Grasses are affected more adversely than woody vegetation. Short periods of high grazing may reduce grass cover to a very low level. But this may not cause an immediate change in equilibrium conditions, because of the slower response of water infiltration rate and even slower response of woody vegetation. However if the grass biomass is kept at very low rate

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[3] The model presented here is based on Walker *et al.* (1981).

[4] Kelly and Walker (1976) have demonstrated that rate and amount of infiltration into a loamy savanna soil is about ten times greater under a grass litter cover than its through a bare soil surface. Rate of infiltration rapidly increase with extent of grass cover and then approaches the maximum asymptotically with increasing grass cover.

for a prolonged period, then slowly the soil surface and consequently water infiltration rate decline. The result is that less water enters the soil, and proportionally more of what water is available, penetrates to the subsoil level. Consequently, relatively more water is available to woody vegetation, and it slowly begins to dominate, increasing the biomass of woody vegetation. The reduced infiltration and greater biomass of woody vegetation combined prevent the reestablishment of grasses even if the grazing pressure were reduced. It is only when one or both of these factors are changed to allow the grass to develop above the critical unstable equilibrium in Figure 1 that the system will revert back to its original state of grass biomass predominance. As woody vegetation expands over time, the root system becomes relatively extensive and persistent. Thus the competing root system of the woody vegetation must be removed for a sufficiently long period to enable the grass root system to develop to a point where it can take up more water than the tree roots. It is important to note that the initial state with low stocking rates and dominance of grasses as well as the new state with dominance of woody vegetation are both stable as in Figure 1b.

The case of semi-arid savannah ecosystem illustrates several salient features of ecosystem dynamics that we use as a background for discussion in the rest of the paper. Thus, for instance, many ecologists believe that understanding cross-scale interactions—i.e., interactions between fast and slow moving variables, as well as the interaction between variables that have a limited local impact as opposed to those that have a wider impact spatially—is very important in understanding ecological dynamics. This phenomenon is well illustrated above in the case of semi-arid savannah ecosystem through the interaction of grass coverage (a fast changing variable) with woody vegetation (a relatively slow changing variable), and water infiltration rate and soil characteristics (the slowest changing variables). Variables that change very slowly are often assumed to be constant under management regimes with relatively short time horizons. We will discuss this as an important source of variation underlying ecosystem management at different historical periods. The discussion also points to the presence of multiple equilibria, threshold effects and hysteresis in ecological dynamics which, as we explain later, are important in understanding the emergence of poverty traps.

2.3 Resilience of ecosystems and its implications

In the presence of multiple equilibria and threshold effects, an important concept in understanding the impact of stress on ecological dynamics is that of resilience. Resilience is defined as ‘the ability of a system to maintain its structure and pattern of behaviour in the face of disturbance’ (Holling 1986: 297). Ecosystems are constantly changing and adapting to different kinds of stress. Thus, from a policy perspective, the relevant question is regarding the extent to which the ecosystem can absorb change without changing its basic structure, i.e., without flipping from one state to another, functionally undesirable state, as in the case of semi-arid savannahs described earlier.

The concept of resilience is very useful because it emphasizes the qualitative properties of an ecosystem in terms of its structure of relationships between different kinds of variables and processes that control system behaviour. This also underlies the difference between the concept of resilience and stability of an equilibrium point. Stability refers to the propensity of populations in an ecosystem to return to an equilibrium point following a disturbance. The difference between the two concepts lies in the focus of analysis within an ecosystem: stability is defined in the context of a micro focus on a specific population within an ecosystem while resilience refers to a macro focus on the structure of relations between the different populations (Common and Perrings 1992).

Different structure of relations can produce multiple stable states, each characterized by its own domain of stability. Sometimes the changes within an ecosystem are continuous, for example, when the system moves within the same stability domain. At other times, an exogenous event and/or changes induced by internal dynamics can trigger a discontinuous movement across different stability states. An important determinant of the resilience of ecosystems is biological diversity. Loss of diversity implies that the alternate pathways through which stress could be transmitted earlier are no longer available. This in turn implies greater vulnerability. As key variables (e.g., species composition, age structure, spatial distribution) become more homogenous, stability domains shrink and perturbations that could be absorbed earlier now cascade upwards to produce more drastic effects. In the next section we use the discussion of ecosystem dynamics and the concept of resilience to examine how human systems interact with their local environment.

3 Socioeconomic and ecological dynamics in a closed traditional economy

Humans have been active agents in the evolution of ecosystems. However, the study of ecosystems and human systems developed in relative isolation until quite recently. The different elements of social and economic organization, such as technology, institutions, values and cultures, co-evolve with ecological variables. Thus, for instance, a change in local environmental conditions (say in the form of decline of certain resources or fall in catch per unit effort) may trigger a response in rules governing resource management. The latter, in turn, may affect future resource dynamics. The analysis of these feedbacks from natural to human systems within a dynamic framework is crucial. Unlike other species, which are largely genetically programmed to perform in certain defined ways, humans have the capability of conscious action. This opens up a myriad of possibilities regarding interaction with other humans and ecosystems. In this section we outline some interactions between the ecological system and the socioeconomic system in a traditional closed economy. Although trade and markets were in existence even in pre-modern societies, in this section we discuss a stylized version of a tightly knit closed economy to provide a benchmark for our discussion on the impact of globalization in the next section.

3.1 Role of institutions

An important channel through which the relation between ecosystems and human systems is mediated is through institutions. Following North (1989), we define institutions as the constraints that structure repeated human interaction. Customs, conventions, norms, and values that influence and guide individual behaviour are examples of informal institutions. More formal institutions include markets, labour unions, stock markets, and property rights. Our focus here is on institutions that govern the use and management of natural resources.

It was believed earlier that users of common-property resources would end up in the inescapable tragedy of the commons. However, several studies over the past two decades have drawn attention to the complex set of rules and regulations that govern common-property resources in rural communities. Thus the tragedy of the commons is not inevitable, as a diversity of outcomes is possible. The tragedy, where it does occur, happens as a result of institutional failure more than because of any intrinsic feature of common property. Property rights arrangements in traditional societies are often very complex because these involve a ‘bundle of rights’ including use rights, rights to exclude others, rights to manage, and rights to sell. For instance, among the Barabaig (who are semi-nomadic pastoralists in the semi–arid Hanang district of Tanzania), a bundle of rights exists for pastures, trees and water resources (Lane 1992). Open rangeland is regarded as property of the community and its use is regulated by customary rules. The Barabaig, however, also recognize private property in the form of a homestead and its surroundings. Permanent settlements along lake shores, where wells would provide permanent sources of water, are restricted because this would deplete the pastures near the water source, which is critical for the community in the dry season. Water routes are also closely protected and homesteads are not allowed to be built there (Lane 1992). This structure of rights has evolved in accordance with the rotational grazing patterns and is generally quite adaptive to changing ecological conditions.

3.2 Role of traditional knowledge systems and practices

The strong reliance on the natural environment led traditional societies to become highly responsive to environmental feedbacks. Through a process of trial and error, traditional societies learnt how to recognize the signals of environmental distress and to respond by developing flexible institutions. This knowledge was then carried across generations through rituals, religious practices and oral history. The embedded long-term institutional memory of shared experience in these societies forms the basis of customary practices and institutions for the use and management of natural resources (Berkes and Folke 2001).

In their extensive research on traditional ecological knowledge systems and practices, Berkes and Folke (2001) find that unlike modern management regimes which are science-based and draw on a short span of recent experience, the institutional memory embedded in traditional systems affords resource users a keen awareness of long-term trends in resource populations. In particular they find that traditional knowledge systems have ‘certain similarities and parallels to the theory of complex systems, with emphasis on non-linear relationships, threshold effects, multiple equilibria, the existence of several stability domains, cross-scale linkages in time and space, disturbance, and surprise’ (2001: 124). To support their argument they give examples of several traditional resource use practices that mimic the behaviour of such systems. An important example is that of pulse grazing practised in several traditional pastoral communities throughout the world. Under this practice, a segment of pasture is grazed intensively for some time and then allowed to rest. Recent ecological studies have found that these pulses of grazing contribute to the capacity of semi-arid grasslands to function under a wider range of climatic conditions and thus contribute to greater resilience (Holling 1986). The awareness of uncertainties and multiple stable states also led traditional societies to devise various practices that could serve as buffers and provide informal insurance. For instance, under rotational grazing patterns, the use of certain pastures was restricted for use only in dry seasons and in times of crises (Lane 1992). Resource-use models based on linear relationships may find these resource practices unproductive over the time horizon generally considered in these models, thus neglecting their role in enhancing long-term resilience. Global integration has led to a breakdown of many traditional knowledge systems, as we discuss in detail in the next section.

4 Impact of globalization

We define globalization as a process of integration of flows (such as trade, capital, labour, and information) and the policies that facilitate such flows (in the form of reduction of barriers on trade, financial flows and migration). Individuals have been exposed to global flows ever since the advent of trade in history. However, as argued in World Bank (2002: 23), 'historically before about 1870 none of these flows was sufficiently large enough to warrant the term globalization'. Since the 1870s, there have been periods of more or less globalization but in this paper we abstract away from these details and focus on the long-term impact of globalization on a traditional agrarian economy.

In section 2 we discussed how an ecosystem can be viewed as a system of interrelated variables that operate at different scales spatially and temporally. Extending this insight from the ecological literature to economics, the process of globalization can be conceptualized to have the following effect. It leads to an integration of some (not all) of the constituent variables across space. The different rhythms of integration and transformation of constituent variables lead to different outcomes depending on how the resultant opportunities/tensions are utilized/resolved. Thus, pests or disease pathogens (as in case of HIV) for instance, which previously had a local effect, spread out more across space. However, it is not generally true that their natural predators/host in the original ecosystem would similarly also spread out across space. Similarly, goods and services may be traded globally but institutions, culture, and values remain more strongly embedded locally. As described in section 2, it is these slowly changing/integrating variables that become an important determinate of the nature of the outcomes that emerge. New configurations of variables with different spatial and temporal scales emerge and it is difficult to say *a priori* how the outcomes would affect ecosystem resilience and the welfare of the poor. We outline below some pathways through which the effects could be transmitted.

4.1 Trade liberalization, specialization, price volatility, and loss of resilience

An important consequence of trade liberalization is that it leads to production specialization in a narrow range of products in which the community has comparative advantage. In the case of developing countries, this tends to be primary commodities which in the past have shown considerable price volatility. Although specialization in a narrow range of activities leads to static economic efficiency, it often also results in a loss of biodiversity (as in the case of monocropping). As discussed earlier, loss in biodiversity leads to increased vulnerability because the number of pathways through which environmental stress can be absorbed is reduced. The economy on the one hand, becomes exposed to higher risks due to price volatility, while on the other hand, the ecosystem becomes more vulnerable and thus less capable of handling any external shocks. Furthermore, market integration leads to higher spatial connectedness and to the possibility that shocks which earlier had only local impacts are now transmitted more widely.

It has also been argued by ecologists that external trade introduces a wedge spatially between the source of stress (i.e., increased consumption in distant places) and the locus of impact (i.e., the local ecosystem), thus impairing the natural ability of ecosystems to self-correct and regulate. Economists, on the other hand, would argue that so long as domestic prices adequately convey the information on scarcity, an optimal allocation of resources would result. There are several reasons why the price system may fail here. First, property rights may not be well defined. Second, the response of resource managers to prices may be too rigid and sluggish to halt the degradation of resources in time (we elaborate on this point in section 4.3). Third, there might be significant externalities leading to a divergence between the social and private optima.

Moreover, if the ecosystem dynamics exhibit the non-linearities shown in Figure 1b, then even if a decentralized regulatory system involving taxes or charges is in place, it may fail to prevent a resource crisis if the international price shock is large (as often happens with primary commodity exports). This is because the bifurcation points in Figure 1b may not be seen by the regulatory agency before the system draws very close to these critical points. In response to a large price shock, the system may cross the threshold and move to a different state before the regulatory agency has had time to respond to these changes.[5] As Brock, Maler and Perrings (2001: 288) argue, ‘the observable level of environmental quality does not generally offer a reliable indicator of the system’s relative position with respect to the thresholds’. Once the system has flipped over to the lower branch in Figure 1b, then the taxes would have to be high enough to move the system beyond the original point because of the hysteretic effect. This may often be very difficult politically.

4.2 Technology transfer, short-term capital movements, and myopia

International technology transfers and short-term international capital movements have led to modern resource management practices that can be characterized as follows. These practices, largely funded by external speculative funding sources, have a very short time horizon. Thus the emphasis is on producing quick results by focusing on a specific target variable (say a particular type of livestock or forest product) in order to meet short-run productive efficiency goals. The relationship of

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5 Some of the political economy considerations associated with regulatory agencies are discussed further in section 4.3.

this target variable to other variables (particularly the slow changing variables, such as soil quality or water infiltration rate) in the ecosystem is neglected or given insufficient attention. In addition, since the resource is exploited to meet strict external market delivery schedules, there is also the need to control temporal variability in the flow of the target variable. For instance, in semi-arid savannah ecosystems in the Sahel region in Africa, the wide diversity of natural grasses (both perennial and annual varieties with different degrees of palatability to herbivores and drought resistance) was replaced by a couple of faster-growing varieties but with much lower drought-resistance properties. These changes, carried out over vast tracts of land, reduce the functional diversity and increase spatial uniformity in grassland ecosystems, leading to a loss in resilience. Ultimately, any time there are external shocks such as droughts, there are very few alternative pathways through which the stress can be absorbed. Thus, the effect is more drastic in magnitude and no longer localized because of high spatial connectedness.

Another important example comes from modern forest management regimes where the frequency of forest fires was successfully reduced in order to promote recreational demand. Over time, more fuel accumulated as forest crowns closed. These changes created a forest system in which the intensity of a fire, caused by stochastic ignition such as lightening, is much greater and the consequences much more catastrophic. Although a longer period may elapse before a fire occurs, the impact is more drastic because of changes in the structural characteristics of the forest system.[6] Similarly, in many developing countries, transient success with DDT for controlling mosquito populations has led over time to human populations with diminished immunity and mosquito vectors becoming resistant to DDT. Some countries have reported a 30-40 fold increase in malaria cases in the 1980s compared with 1969-70 (Holling 1986).

Traditional systems, by allowing small perturbations, enabled the ecosystem to develop greater adaptability and functional diversity. On the other hand, modern management systems, by controlling natural variability, cause the accumulation of perturbations. This accumulation leads to larger and less predictable feedbacks at a level that impairs the functioning of the whole ecosystem. Based on an in-depth study of several ecosystems, Holling (1986) points out that this phenomenon of focusing on a narrow range of target variables to attain short-term production goals and ignoring the long-term system-wide effects, is responsible for the global resource crises. The phenomenon is more significant in developing countries because in recent years there has been a large inflow of short-term external capital into the primary sector. Large foreign debts have also pressured governments in these countries to focus on those resource management practices which quickly could earn foreign exchange to meet

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6 Holling (1986: 302) gives the example of cycles of ground fire experienced prior to fire management in the mixed conifer forests of the Sierra Nevada in western USA. He points out that in several areas, these fires:

> occurred with a remarkably consistent interval of seven to eight years, and helped maintain conditions of tree regeneration and nutrient cycling. In addition, these light fires killed only the young white fir thereby introducing and maintaining gaps in forest canopy and, in essence, producing natural fire breaks. However, if the undersurface is raised because of increased moisture or effective fire control practices, more fuel must accumulate before an average ignition event triggers a fire. This results in a longer period before a fire but also in a more intense fire.

critical short-term needs. When the ecosystem flips over to an undesirable state, external capital shifts to other more profitable ventures while the local residents, and generally the poor with fewer alternative options, are left behind.

4.3 Institutional dynamics, rent seeking, and poverty

Institutions play an important role in the interaction between humans and ecosystems. In section 2 we discussed the functioning of institutions in a traditional closed economy. Now we examine how globalization affects the evolution of resource management institutions and its consequences on poverty.

Recent developments in new institutional economics have made a significant contribution to our understanding of existing institutions. These theories, however, are still somewhat vague on the mechanisms through which new institutions emerge. The persistence of dysfunctional institutions over long periods is in sharp conflict to the presumed optimality of existing institutions (Akerlof 1984). The biological analogy of natural selection in the survival of the fittest institution cannot be applied naively to the case of social choice of institutions (Bardhan 1989). Based on his long-term study of several ecosystems around the world, Holling (1986) makes an interesting observation. He argues that modern resource management institutions and technologies that have become over time more efficient in meeting short-term production goals and controlling variability, have also become more rigid and less responsive to environmental feedback. He believes that this rigidity is an important factor in the fall in long-term resource productivity and eventual crises in many ecosystems around the world.

This phenomenon is very well illustrated by the long-term impact of the spread of the green revolution in the form of monocultures of high-yielding rice and wheat varieties in many developing countries. The initial spread of green revolution technology in areas most favourable to its growth had phenomenal success over the short term. However, with the help of international aid agencies and massive state support, technology soon spread to areas not very suitable for its adoption. Technology was widely adopted in arid and semi-arid areas as well as in regions with marginal soil not particularly well adapted for intensive cultivation of a single crop. Several recent ecological studies have compared this technology with more traditional methods and have shown how monocultures have made local ecosystems more vulnerable to external shocks, whether induced by weather changes or pest attacks.[7] Recent evidence indicates significant yield increases in diverse cropping systems compared to monocultures.[8] But despite the growing evidence on the unsustainability of monocultures, this technology continues to spread. Its initial success in some areas has locked it in a groove where further innovation is restricted and more appropriate technologies fail to get a footing. As Bardhan (1989: 1392) argues, 'this lock-in

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7 Altieri (2002) provides a comprehensive survey of these studies

8 As Altieri (2002) points out, 'enhanced yields in diverse cropping systems may result from a variety of mechanisms such as more efficient use of resources (light, water, nutrients) or reduced pest damage. Intercropping, which breaks down the monoculture structure, can provide pest control benefits, weed control advantages, reduced wind erosion, and improved water infiltration'.

happens dynamically as sequential decisions “groove” out an advantage from which the system finds it hard to escape’.

North offers an interesting reason why new institutions do not automatically develop to embrace the more complex interdependence such as that brought about by globalization. He argues that ‘the breakdown of personal exchange is not just the breakdown of a dense communication network but also the breakdown of communities of common ideologies and of a common set of rules in which we all believe’ (North 1989: 1321). Institutional change involves an enormous collective action problem which may be difficult to overcome when people embrace different beliefs and aspirations. For instance, consider a closed primitive community of people who are highly dependent on their local natural resource base. Over time, they create a set of rules governing the use and management of these resources. These rules may not be equitable but are likely to be consistent with shared experiences and collective knowledge of resource dynamics and the perceived threat from the destruction of their resource base. Now as the community opens up and there is greater movement of people and new ideas, this shared belief may begin to dissolve. The opening up of the community may also provide some people with exit options and thus the old enforcement mechanisms working through threat of punishment or community sanctions may begin to break down. Divergence of interests within the community may also imply that the ‘critical mass’ required for initiating institutional change may no longer exist.

A distinguishing feature of developing countries today in contrast to the historical experience of developed countries is that the opening of traditional communities is happening at a greater pace and intensity, thus limiting the possibility for institutional response to emerge organically. In many cases it is also true that the process of opening up of primitive communities has been accompanied with a gradual disempowering of local communities and a rise in the power of central government. North (1989) argues that the rise of the state with unequal coercive power provides an opportunity for individuals with superior coercive power to enforce rules to their advantage. This happened, for instance, with trade liberalization in Thailand when timber became very valuable. State officials undermined local institutions that had been regulating the use and management of this resource. Ross (2001) argues that the officials, by undermining local institutions, were able to create opportunities for corruption and what he calls ‘rent seizing’. However, it is important to bear in mind that an increase in the value of a local natural resource does not always lead to a breakdown of existing institutions and resource degradation. For instance, there a number of countries where specific natural resources have become major determinants of tourist revenue, such as Ecuador, Bhutan, Maldives and Seychelles (World Bank 2002). Since tourist revenue in these countries depended on keeping local ecosystems healthy, environmental regulation was strengthened to protect resources (Wheeler 2000).

The poor rely heavily on the local natural resource base for their basic needs. The transformation of savannah grasslands to arid shrubland in the Sahel region as well as parts of eastern Africa and northern India has meant a loss of livelihood for the poor living in these regions. For the system to revert back to its original state requires a significant effort in pushing the system back beyond the point at which the initial shift to the new phase had occurred because of hysteresis (see Figure 1b). This may be difficult to achieve in a poor region. Moreover, the effort needs to be coordinated and collectively managed among the different pastoralists, and this may be very difficult. Once the system is already shifted into the lower equilibrium, the transaction costs of negotiating, bargaining, coordinating and enforcing a collective agreement increases given the high investment needed (due to hysteresis effect).

Very often the problem is that institutions exist (say at village, state or national levels) but their governance structure does not match the scale of ecosystems that frequently transcend political boundaries. Watershed management practices, for instance, may require cooperation among different villages or even different countries. In this case even if management institutions exist at the micro level (i.e., village or the country level), these alone are not sufficient. A reverse problem with scale arises when institutions at the macro level (say at national or international levels) govern diverse local ecosystems. As Costanza *et al.* (2001: 7) point out,

> large-scale ecosystems are not simply small-scale systems grown large, nor are micro-scale ecosystems mere microcosms of large-scale systems. The driving forces and feedback mechanisms in large and small-scale systems operate at different levels and exhibit distinct patterns. The solution, then, is to match ecosystems and governance systems in order to maximize the compatibility between these two types of systems.

The matching of ecosystems and governance systems continues to be an important challenge for policymakers in the process of globalization.

5 Conclusions

In this paper we have examined how globalization may affect the wellbeing of the poor through its effects on local ecosystems on which the poor depend for their livelihood. In mainstream economic models, it is generally assumed that either economic activities do not impact on the underlying biophysical environment or that the impact varies smoothly (often linearly) with the amount of stress. Ecologists, on the other hand, have found these dynamics to be largely non-linear, and often associated with sharp discontinuities, high uncertainties, and alternative stable states. To illustrate these dynamics, we examined a prototypical model of a semi-arid savannah ecosystem characterized by multiple steady states and threshold effects. In economic models only the productivity of a resource is considered. An important ecological concept that we discussed in this paper is that of resilience. We think that this concept of resilience is very useful in examining the long-term effects of globalization, particularly in relation to poverty. Given the non-linearities, multiple stable states and threshold effects, the relevant question from a policy viewpoint concerns the buffer capacity of the system to absorb disturbances without undergoing a structural switch to an undesirable state. In the paper we examined how trade liberalization, short-term capital movements, and technology transfer have affected the resilience of ecosystems and wellbeing of the poor.

The linkages between ecosystem and institutional dynamics sketched somewhat informally here, need to be developed more rigorously and tested empirically. This is likely to be a challenge, given the cross-disciplinary nature of such an enquiry.[9] Most of the current debates on globalization have focused on the growth of multinational corporations, rising influence of institutions such as the World Bank, the IMF and the WTO, and loss of national sovereignty. We have not explicitly discussed these factors in this paper. This is not because we do not perceive these factors to be important but because the overwhelming emphasis given to them often distracts from our basic understanding of the underlying dynamic evolution of ecosystems and human systems. An important consequence of this mode of thinking is that we have placed far too much attention on the control of external shocks and short-term crisis management as opposed to addressing the underlying problems that lead to loss in resilience and chronic poverty.

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9 However, it is encouraging to note the efforts being made in this direction particularly in the emerging field of ecological economics.

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