

Poverty and Environmental Degradation: a Literature Review and Analysis

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Abstract

There is much controversy surrounding the poverty-environmental degradation nexus. The predominant school of thought argues that poverty is a major cause of environmental degradation and if policy makers want to address the environmental issues, then they must first address the poverty problem. Another school of thought argues that this causal link is too simplistic and the nexus is governed by a complex web of factors. In this paper, a formal structure for analyzing the complex web of factors is formulated and used to review the existing literature on the links between poverty and the degradation of four natural resource sectors. The analysis highlights the institutional and market failures which encourage unsustainable activities, which in turn forces some income groups into poverty. Another important factor is the role of conflicts between different agents (income groups) in the poverty-environmental degradation nexus. The analysis also highlighted the presence of feedback loops between environmental degradation and poverty.*

Abrégé

Le complexe causal ‘pauvreté-dégradation de l’environnement’ soulève bien des controverses. Pour l’école de pensée dominante, la pauvreté est cause majeure de la dégradation de l’environnement et si les politiques veulent s’occuper des difficultés de ce dernier, il leur faut d’abord s’attaquer au problème de la pauvreté. Une autre école estime qu’un tel lien de causalité est trop simpliste et que le complexe causal est soumis à toute une trame compliquée de facteurs divers. Ce document présente une structure formelle destinée à analyser la trame compliquée de ces facteurs, structure appliquée ensuite à la lecture des publications existantes qui traitent des liens entre la pauvreté et la dégradation de quatre catégories de ressources naturelles. L’analyse met en lumière les déficiences institutionnelles, ainsi que celles du marché, qui encouragent des activités sans durabilité, lesquelles, à leur tour, précipitent dans la pauvreté certaines catégories de revenus. Un autre facteur important réside dans le rôle des conflits entre différents agents (catégories de revenus) au sein du complexe causal ‘pauvreté-dégradation de l’environnement. L’analyse met aussi en lumière la présence de boucles d’auto-alimentation mutuelle reliant les deux termes du complexe.

Resumen

Existe una gran controversia acerca del nexo entre la degradación ambiental y la pobreza. La escuela de pensamiento predominante afirma que la pobreza es una causa fundamental de degradación ambiental y que, si las decisiones política aspiran a tener un impacto sobre los problemas ambientales, deberán primero enfrentar el problema de la pobreza. Existe otra escuela de pensamiento que sostiene que proponer este vínculo causal es demasiado simplista y arguye, en cambio, que tras el nexo existe una compleja red de factores. En este artículo se propone una estructura formal de análisis de dicha compleja red de factores que se emplea en reseñar la literatura

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especializada acerca de la relación entre pobreza y degradación utilizando como foco cuatro tipos de recursos naturales. El análisis hace énfasis en los fracasos institucionales y las fallas de mercado que promueven actividades no sustentables, las cuales a su vez conducen a ciertos grupos sociales a la pobreza. Otro factor importante es el peso que adquiere el conflicto entre los diversos agentes (grupos sociales) en el nexo entre pobreza y degradación ambiental. El análisis también pone de presente la existencia de elementos de retroalimentación causal entre degradación ambiental y pobreza.

Contents

	Page Number
Introduction	1
Poverty and Environmental Degradation	3
Analytical Framework for Literature Review	5
Forest sector	8
Main activities contributing towards deforestation	8
The social and economic consequences of unsustainable deforestation activities	11
Literature analysis	13
Land degradation	15
Main activities contributing towards land degradation	15
The social and economic consequences of land degradation	17
Literature analysis	17
Water resources	19
Main activities contributing to water resource degradation	19
The social and economic consequences of water pollution	21
Literature analysis	22
Air (Indoor and Outdoor)	24
Main activities contributing towards air pollution	24
The social and economic consequences of air pollution	25
Literature analysis	25
Conclusions	27
References	29

Introduction

The poor have traditionally taken the brunt of the blame for causing society's many problems including, more recently, environmental degradation. There is a general consensus that poverty is a major cause of environmental degradation. For example, in one of the conclusions of the Brundtland Commission Report, which incidentally has been accepted as the blue print for environmental conservation, it was explicitly stated that, poverty is a major cause of environmental problems and amelioration of poverty is a necessary and central condition of any effective programmes addressing the environment. Following similar lines, Jalal (1993), the Asian Development Bank's chief of the environment department says, "It is generally accepted that environmental degradation, rapid population growth and stagnant production are closely linked with the fast spread of acute poverty in many countries of Asia". The World Bank joined the consensus when in the 1992 World Development Report, the Bank explicitly stated that, "poor families who have to meet short term needs mine the natural capital by excessive cutting of trees for firewood and failure to replace soil nutrients" (World Bank 1992).

However, there has been a rising trend in the economic literature which disputes the conventional theory and argues that simple generalizations of this multi-dimensional problem are erroneous and that a more complex set of variables are in play (Leach and Mearns, 1995). These studies point to demographic, cultural, and institutional factors as important variables in the poverty-environmental degradation nexus. An intricate web of factors plus the existence of feedback loops from environmental degradation to poverty makes the process of identifying causality links, if any, between environmental degradation and poverty a difficult exercise. However, these studies have been few and isolated and it is interesting to note that until recently, there has been very little in-depth coordinated empirical research in the economics of environmental degradation-poverty causality relationships.

This brings me to the purpose of this paper. Both poverty and environmental degradation have been increasing in many developing countries, hence there is a pressing need first to evaluate and analyze the poverty-environmental degradation nexus, and second, to prescribe policy options to mitigate or eradicate these two problems.

This paper which is part of a larger volume is a response to this demand. The primary objective of the paper is to analyze critically the existing literature on the poverty-environmental degradation nexus and try to make "some order out of the chaos" inherent in this complex and difficult subject. The paper is divided into four sections. The second section gives a brief overview of the present status of poverty and environmental degradation around the world. The section discusses some common definitions used in defining poverty and environmental degradation and provides some guidelines for the definitions to be used in this study.

In the third section, a conceptual framework of the environmental degradation-poverty nexus is provided. The fourth section will contain the main body of the analysis. In this section, a different approach to those of previous literature reviews (Leach and Mearns, 1995, UNEP, 1995) is adopted. Rather than focusing on the "web of factors" which underlie the nexus, the approach used in this paper begins by identifying the resource factors being degraded.

For this paper, we limit our analysis to the following four main natural resources which are under serious threat of degradation in many developing countries: i) forests; ii) land; iii) water; and iv) air. I have excluded biodiversity at this point because the preliminary literature search found only scattered and inconclusive information. I should stress, however, that it should not be inferred that biodiversity is less important than the four resources chosen; indeed it is an area which needs particular attention in the future.

Once the natural resource sectors have been identified, a cause, impact and feedback analysis is carried out. In this manner, we hope first to identify the main agents and the degree of their contribution towards the destruction of the environment and second, the incentives or motivating factors encouraging their unsustainable activities. The impact and feedback analysis should highlight the main impacts arising from the degradation activities and the socio-economic effect these impacts have across the various income groups in the economy .

By using this approach, we intend to filter out some of the factors in the web which add to the complexity of the problem and investigate if any direct causality links between poverty and the degradation of the various natural resource sectors exist. This is not to say that we will ignore crucial socio-economic factors which can influence the links between poverty and environmental degradation, but we shall discuss their relationships within the context of the natural resources under study. The paper concludes with a summary of the main findings of the literature review and some recommendations for future research.

Poverty and Environmental Degradation

Of the world's 5.6 billion people, about 1.4 billion live in absolute poverty with a further 1.1 billion living at subsistence levels (Leonard 1993). A more sobering statistic is the 14.6 million children, or one in every five, who live in absolute poverty (UNEP 1995). In fact, relative poverty has not decreased but has been slowly increasing as the disparity between the poor and the rich grows larger, both at a local as well as global level. For example, in 1960, the richest 20% earned 30 times the income of the poorest 20%, while the figures in 1990 show that the richest 20% now earn 60 times the income of the poorest 20% (ibid). This statistic by itself does not imply a worsening situation, until additional statistics are considered: eg the acquisition of wealth by the rich 20% was achieved through the appropriation of natural resource bases which the remaining 80% rely on in some way or another for their source of livelihood. In fact, the higher this reliance is, the higher is the probability of the lower end of the 80% being pushed into poverty.

But what is poverty? The World Bank uses household expenditure as its measuring rod and uses a threshold¹ level to define a poverty line. In other words, people who have a household expenditure below the poverty line are defined as poverty stricken. It is a measuring rod driven by basic needs considerations. There have been numerous criticisms directed at the use of such a narrow indicator to determine poverty levels and critics argue that a broader set of indicators comprising eg infant mortality and literacy rates should be used². The UNDP, in response to these criticisms, developed an index called the Human Development Index (HDI) which comprised of three such indicators. Even so, some authors still argue that this index is still determined largely by objective needs and a broader definition encompassing subjective needs like accessibility (the degree to which people have access to resources) and vulnerability (low income groups who face high income uncertainty because of natural resource degradation) should be used to determine poverty. However, irrespective of the choice of indicator, the absolute number of people living in conditions which are deplorable by any standard are rising and therefore, it is a trend which needs immediate attention.

For the purpose of this paper, we shall use a combination of the poverty line indicator, accessibility and vulnerability as the measuring rod. By including vulnerability in our definition set, we are able to capture a large proportion of people who can be easily pushed into poverty when the natural resource sector they depend on for basic needs is being degraded. We also include accessibility in our set for a number of reasons: people who depend on a sustainable flow of natural resources for their daily livelihood would be handicapped if access is restricted - this is especially important when we talk of common property or open access resources. The mere fact that if access is taken away could force these people into poverty makes it imperative for us to include the concept of accessibility in our poverty definition set.

Defining environmental degradation poses a much more difficult task. The World Bank's 1992 World Development Report cites deforestation, land degradation, water shortage and contamination, air pollution and the loss of biodiversity as some of the many environmental problems

¹ The threshold level indicates the minimum amount which is needed by an individual to obtain the basic necessities like food and shelter within a country.

² Refer to Anand (1994) for a full discussion of the choice of indicators and the implications of these choices.

we face today in both developed and developing countries. However, unlike poverty which can be defined, at the minimum, on the basis of human nutritional requirements, environmental degradation comprises a large degree of subjectivity on the part of the agents involved or who own the resources. Different ecosystems as well as different values placed on environmental resources by different societies makes the definition of environmental degradation difficult and complex. For example, the tolerance level to air-pollution by New York City citizens may be much lower than the tolerance level of Shanghai's citizens. How do we define a degradation of the air-space in the two cities? A common solution is to use physical characteristics of the system as a threshold level beyond which degradation is assumed to take place. However, this is easier said than done, as detailed knowledge of the ecosystems must be known before these physical thresholds can be determined. To minimize conflicts in the analysis, we shall use a combination of ecological thresholds as well as revealed preferences where appropriate as indicators of environmental degradation.

Analytical Framework for Literature Review

We begin by postulating a number of causality relationships which can exist between poverty and environmental degradation. To keep the analysis simple but at the same time not lose the essence of the problem, we limit our analysis to four possible relationships. The relationships are not mutually exclusive and can be present simultaneously. Furthermore, due to the sequential nature of the relationship between poverty and environmental degradation, the following initial conditions were deemed crucial to the analysis: (1) no environmental degradation; (2) no indigenous poverty; and (3) the possibility of the existence of exogenous poverty. We define indigenous poverty as poverty caused by environmental degradation while exogenous poverty is poverty caused by factors other than environmental degradation. It can be seen that condition two follows naturally from condition one.

We begin with the popular poverty-environmental degradation relationship which states that it is poverty which causes environmental degradation in the developing countries. We shall call this Relationship One - R1.

R1: Poverty → Environmental Degradation.

A counter argument to the R1 relationship is the notion that it is not poverty but a combination of greed, power and wealth that causes environmental degradation in many developing countries (Boyce 1994). We call this Relationship Two - R2

R2: Power, Wealth, and Greed → Environmental degradation.

The third possible relationship which we call relationship three A and B looks at the link between market and institutional failures with environmental degradation respectively. In many of the previous studies on poverty and environmental degradation, the authors fail to make a distinction between market and institutional failures. In many instances, a general category called institutional failure is used to define both mechanisms. This aggregation becomes unsatisfactory when policy implications and prescriptions are addressed; and each failure in turn needs a unique prescription. For example, policy responses to incorrect price signals (market failure) will be quite different from policy initiatives needed to establish and enforce well defined property rights (institutional failure). The distinction in many instances is difficult to distinguish but we cannot stress enough that this distinction must be made if policy analysis and prescription is one of the primary objectives.

R3A: Institutional Failure→Environmental degradation.

R3B: Market Failure→Environmental Degradation.

The fourth and final possible relationship which may follow from either R1, R2, or R3A and R3B is the notion that environmental degradation is a major factor causing indigenous poverty. This relationship is termed relationship four.

R4: Environmental Degradation→Poverty

If R1 alone is observed then the poverty induced environmental degradation argument can be accepted and it would be rational to pursue environmental protection through poverty mitigation policies. However, a clarification is needed at this point on the type of poverty which causes the environmental degradation. From the initial conditions defined earlier, it can only be exogenous

poverty which causes environmental degradation and the policies adopted should ideally be focused on the factors which are responsible for the exogenous poverty.

On the other hand if only R2 is observed, then policies adopted under R1 assumptions can be misleading and may in fact exacerbate the degradation process as demonstrated by Binswanger (1989). However, the policy prescription in the R2 case may be problematic and complicated by rent seeking activities on the part of the wealthy and powerful. The first best solution would call for the adoption of policies which internalize the environmental externalities. However, in a majority of cases, especially in developing countries, vested interests could, and would, prevent the adoption of first best solutions and second best solutions may be the only alternative. For example, one of the many incentives for the exploitation of the natural resource base by the wealthy in developing countries is the access to international markets (Chilensky 1994). A second best strategy to overcome this problem could be the insistence of a standardized environmental policy like the Polluter Pay Principle (PPP) among trading partners. Another strategy falling under this category would be the use of international fund transfers as argued by Barbier (1993) to prevent tropical deforestation.

In the case of either R3A or R3B being responsible for environmental degradation, the solution is theoretically relatively simple - remove or correct the market or institutional failure. However, as the saying goes, "easier said than done". To begin with, identifying and make the distinction between relationships R3A and R3B is a difficult exercise. Second, once the respective relationships have been identified, overcoming the market or institutional shortcomings are in many cases the most difficult policy measures to put in place. There are many reasons for the difficulty, ranging from inertia on the part of the bureaucracy to the protection of vested interest by officials or businesses who have powerful and influential positions in the policy making process. However, in this paper, we are primarily concerned with the identification of the problem spots and the corrective actions which are needed to resolve the problems. Although important and crucial, we will not get involved in the discussion on the political aspects of the changes suggested and leave this to the political economist and scientists.

Now, if R4 is present, two interesting observations arise. First, R4 can only be present if it is caused by either R1, R2, R3A, R3B, or various combinations of all four. Second, the presence of R4 can set into motion a R1 type of link but in this case it is indigenous poverty which causes the environmental degradation (we shall call this a R1feedback or R1FB link). Depending on the order of causality, different policy prescriptions need to be formulated.

Let us start with the R1, R4 link. Two outcomes are possible. The first scenario would be that R1 causes R4 and the causality link ends. On the other hand, we can get a situation whereby the indigenous poverty caused by R4 sets into motion more environmental degradation by a R1FB relationship. In this instance we get the downward spiral illustrated by Durning (1989). In either case, the policy strategy would be to eliminate the problem at the source and the policy measures advocated by the Bruntland Commission, the World Bank, and the ADB would be appropriate policy prescriptions.

On the other hand, if R2 and R4 are present, then we are either back to a situation similar to when R2 was observed alone but with the additional presence of indigenous poverty or to a more

complex situation in which the indigenous poverty caused is now itself causing environmental degradation, ie., a R1FB link. In the case where no feedback effects of indigenous poverty is present, the second best strategies outlined in the case where only R2 is observed would be appropriate. Interestingly enough, in the more complex case whereby indigenous poverty is itself causing environmental degradation, the policy prescription may be a relatively simple one; ensure that the degree of environmental degradation does not exceed the level at which indigenous poverty starts. The reasoning is as follows. By the fact that indigenous poverty is able to cause environmental degradation, the resource base is now under threat from two sources. The welfare of the wealthy and the powerful will decrease as the resource base they exploit for their own purposes is now exploited by another group. Depending on the degree of exploitation, we may conclude that if environmental exploitation does not take place beyond the poverty “break-even”³ level, poverty from environmental degradation (endogenous poverty) can be averted. The interesting point to find out is if this “break-even” point is also the “sustainable” level. However, this is beyond the scope of this paper and we leave this as a potential research option.

We now turn our attention to more complex situations in which R1, R2 and R3A and R3B are present simultaneously and together reinforce R4⁴. The solution to this situation is much more complex than the previous scenarios. Here, we have four contributing forces in operation: (1) the Power, Greed, and Wealth (PGW) factor; (2) Exogenous Poverty (EP) factor; (3) the “Institutional Failure” (IF) factor; and finally the “Market Failure” (MF) factor. Together they can be responsible for two externalities, environmental degradation and indigenous poverty. It is in fact the existence of these four factors which introduces the complex set of factors which many of the previous studies highlight when analyzing the environmental degradation-poverty link. Moreover, the fact that there are two externalities present, and that indigenous poverty and exogenous poverty are distinctly different, makes the policy prescription process difficult and complex. For example, policies focused towards the mitigation of indigenous poverty will have limited impact if the primary forces driving the environmental degradation, ie., the PGW, EP, MF and IF factors are still present. This may be one reason why many policies addressing the poverty-environmental degradation issue have failed or have had limited success.

³ We define the poverty break-even point as the point at which an extra unit of environmental extraction by one agent will cause an agent who is presently just above the poverty line to fall below the poverty line.”

⁴ We do not discuss the situation in which R3A and R3B and R4 are present as the solution to this scenario is identical to when R3A and R3B are observed alone; only in this case, the pressure to correct the institutional or market failure is higher due to the presence of two externalities; environmental degradation and indigenous poverty.

Forest Sector

Deforestation itself is not a problem and in fact may be a necessary condition for economic development. However, when deforestation occurs at rates which set into motion negative feedback effects which jeopardize both the ecological as well as economic systems both at the regional and global level, then it becomes imperative to understand why unsustainable deforestation activities are being pursued. It is only when the dynamics of the unsustainable activities have been understood, can the necessary policy measures to correct any distortion be formulated. This brings us to the main activities responsible for deforestation and the reasons why unsustainable rates are adopted by different actors.

Main activities contributing towards deforestation

The literature review identified the following three main activities which have contributed to deforestation in the developing countries.

- logging
- agricultural/pastoral encroachment and expansion
- fuelwood collection.

A large number of studies point towards logging as the principal activity responsible for unsustainable deforestation in many parts of Asia and South America. For example, Somanathan (1991) cites commercial timber interests driven by government policies as the principal incentive for deforestation in the Himalayas. Along similar lines Anderson (1989) asserts in his study that logging was the primary cause of unsustainable deforestation in many parts of Central Africa and Southeast Asia while Repetto (1990) attributes commercial logging as the number one agent for unsustainable tropical deforestation. An econometric study by Cropper and Griffiths (1994) supports, to a certain extent, the argument that logging may have been a primary force responsible for deforestation activities by finding a significant correlation between the price of timber and the rate of deforestation for South America and Asia⁵.

While the studies mentioned above tend to suggest logging as the primary contributor to unsustainable deforestation activities, there are proponents who argue that agricultural and pastoral encroachment have been the primary forces behind unsustainable deforestation and logging has only been a catalyst. In other words, the logging activities themselves did not cause unsustainable deforestation but the infrastructure provided by them, eg roads, played a key role in opening up forest lands for agricultural and pastoral activities which were then responsible for unsustainable deforestation activities.

A case in point is Goodland (1991), who cites cattle ranching and unplanned settlement as the main causes of unsustainable deforestation in the Amazon but which to a large extent were spearheaded by logging trails which had initially opened these new tracts of forest land. Similarly, Westoby

⁵ The main focus of this study is on the correlation between population and deforestation. However, no mention is made of poverty.

(1991) and Cruz (1990) argue that shifting cultivators, agricultural and pastoral encroachment in the wake of logging trails were the major causes of deforestation.

Davidson (1993) cites conversion of forests for cattle ranching as well as the cultivation of cash crops as responsible for 50% of the deforestation in the tropics. She argues that conversion, although driven primarily by market and consumption demands, was to a large extent encouraged by government policies. The author argues that in many cases, governments, driven by the need to service foreign debts, implemented policies which encouraged, first, the felling of trees for timber export followed by, second, the cultivation of cash crops or cattle ranching, as major sources of foreign exchange.

Similar to the Davidson study, Jaganathan (1989) cites the Haskoning study (1987) which highlighted market forces as the main factors causing deforestation in Indonesia. The first stage involved logging followed by the second stage of conversion of these logged forest lands to estates and mixed gardens. The study showed very little correlation between poverty and deforestation and the only time the poor (landless peasants) were involved in unsustainable activities were in abandoned non-productive estates left by previous landlords. In these areas, unsustainable forms of slash and burn agriculture were practiced and the soil deterioration was excessive. Similarly, Lutz and Daly (1990) explicitly mention that squatters' contribution to deforestation was minimal, and even if they were involved in deforestation it was limited to the intention of selling these lands to the cattle ranchers. They identified logging companies, banana companies and cattle ranchers as the primary forces driving unsustainable deforestation activities in Costa Rica.

In contrast to the previous studies, Southgate and Pierce (1988) cite the small farmer as the main agent responsible for unsustainable deforestation activities. In their study, they estimate that of the 17.6 to 19.2 million hectares of forest that were cleared in Brazil's Amazon basin, 5 million was attributed to commercial logging, 2 million to fuelwood gathering and the remainder to small farms. Southgate (1988) as well as Ives and Messel (1989) go on to cite population growth as the prime contributor to unsustainable deforestation, especially in tropical Africa, and the Amazon basin. The study also highlights the pivotal role government agricultural and pastoral subsidies played in providing the incentives for deforestation to occur. Similarly, Mink (1993) and a FAO study (1993) conclude that agricultural expansion driven primarily by population pressures was the principal cause for tropical deforestation in the past. Again, population pressures as well as government policies which provided incentives for people to move into these areas played a large part in converting large tracts of forest lands into permanent agricultural lands. However, no explicit link is made between poverty and population in either study.

There is a large body of literature which states that population growth which is caused by poverty is a prime cause for environmental degradation. Rather than introduce another dimension in the analysis, we capture population effects through the R1 link. For example, if poverty causes high population growths which in turn cause environmental degradation, then the link between poverty and environmental degradation is captured with our present framework.. The policy prescription of eradicating the poverty to avert the environmental degradation still holds because by alleviating the poverty, we take care of the population problem which in turn solves the environmental degradation.

To summarize, the literature review identified basically three groups under which the majority of the studies could be categorized.

- The first group argues that logging is the principal activity responsible for unsustainable deforestation activities:
 - I. R2**
 - II. R2 together with R3A and/or R3B**

- The second group argues that agricultural/pastoral encroachment with logging acting as a principal catalyst, is the predominant activity responsible for unsustainable deforestation:
 - I. R2**
 - II. R2 together with R3A and/or R3B**
 - III. R1**

- The third group believes that agricultural/pastoral encroachment due to population pressure is the principal activity responsible for the unsustainable deforestation activities. This group also mentions fuelwood collection as an activity which contributes to unsustainable deforestation but the role is secondary:
 - I. R1 link.**

Table 1 below summarises the activities, agents, motives and incentives for the forest sector.

Activity	Agents	Motives	Incentives	Relationship
Logging	Commercial	Profit	market, government policies,	R2,R3A,R3B
Agricultural/pastoral	Commercial	Profit	market, government policies,	R2,R3A,R3B
	Small holdings	Subsistence	Food security	R1 and R1FB
Fuelwood	Commercial	Profit	insecure land tenure, government policies	R2,R3A,R3B
	small holdings	Subsistence	basic needs	R1 and R1FB

Table 1.

The social and economic consequences of unsustainable deforestation activities

The previous section highlighted the main activities contributing to deforestation and some of the reasons why various income groups engage in unsustainable deforestation activities. We now turn our attention to the impacts which can arise from deforestation activities and the income groups which are most vulnerable to these impacts. The literature search revealed four major negative feedback effects of forest degradation on economic activities.

- loss of watershed protection
- soil erosion
- destruction of a safety buffer
- fuelwood supply

Loss of watershed protection

Forests, especially tropical moist forest serve as important water catchment areas, and loss of forest cover disrupts the hydrological cycle. For example, Salati (1985) estimates that as much as 75% of the yearly rainfall in the Amazon Basin is returned from the forest to the atmosphere and loss of this forest cover could reduce future rainfall. Although the actual relationship between forest cover and rainfall is yet to be determined, Meher-Homji (1986) concludes from a vegetation-rainfall study covering 29 stations for over 100 years that, as a rule, the larger the area of deforestation, the larger the number of indicators showing decreasing rainfall. This study only focused on localized effects. If the impacts were globalized, the relationship between forest cover and the hydrological cycle could be far more significant.

Excessive deforestation in the highlands has also resulted in increased potential of flooding in the lowlands and plains. Somanathan (1991) reports that the average area in the Indian state of Uttar Pradesh subject to flooding has increased from 17,000 sq.km in 1953-65 to 41,000 sq.km in 1976-78 which he attributes to deforestation in the Himalayas. Somanathan's argument is, to a large extent, supported by Vohra (1987) who finds such a strong correlation between floods and soil erosion that he explicitly states that the best insurance against floods is the prevention of soil losses.

We were unable to determine quantitatively the socio-economic effects of flooding and water shortages across the various economic agents in the affected areas. This we believe is a major gap in the existing literature and is a potential area for future research.

Soil erosion

Davidson (1992) estimates that soil erosion alone is responsible for the loss of 20 million hectares of fertile land each year while in the Second India Study, Repetto (1994) estimates that 25 million tons of top fertile soil are lost annually due to soil erosion in India alone. The loss of forest cover has been cited as one of the major reasons for soil erosion. From an economic perspective, the loss of fertile top soil implies a drop in agricultural productivity. For example, if there is a significant loss in fertile top soil and if all other inputs to the production process are kept constant, the result would be a drop in crop yields. Even if other inputs like capital and labour are increased to maintain crop yields, the final result is still a drop in productivity because in actuality higher production costs per

unit of output are incurred in comparison to before the soil erosion took place. This problem is further exacerbated when the soil erosion occurs in marginal lands where the marginal cost of increasing crop yields is large and in many instances exceeds the marginal benefits. This is especially true in tropical forests which are characterized by thin top soil layers.

Another externality arising from soil erosion which may not be transparent is water scarcity. Bandyopadhyay (1987) argues that water scarcity as experienced in many parts of Kerala and Goa, India, which are usual high rainfall areas, is due to soil erosion. The loss of soil cover not only increases run-off rates but also implies less water finding its way to the water table which eventually leads to ground water drought. Chengappa (1995) shows how deforestation in the Western Ghats in India has caused most villages in the area to face drinking water shortages in summer.

Destruction of the safety buffer

It is estimated that tropical forests provide some source of livelihood for approximately 140 million people. However, the loss of non-timber products and services of forests are difficult to value as most of the items do not have a market price⁶. Jodha (1991) documents 15 uses and services that common property resources⁷(CPR) provide to village communities in India and how these CPR resources serve as a critical buffer during droughts or other natural disasters. Jodha (ibid) estimates 42 to 57 percent of sustenance income derives from CPRs during droughts. A similar observation is noted by Kadekodi (1995) who documents the subsistence as well as the buffer roles non-timber products play for the low income groups in the Palamau district in India.

The destruction of the safety buffer has dire consequences for the rural poor and indigenous tribes who rely on these resources for sustenance. Although the Jodha and Kadekodi studies give a detailed account of CPRs and their importance to the various income groups, the studies do not quantify the impacts that decreasing CPRs have had across the income groups. It was therefore not possible to deduce from the existing literature if some groups had been pushed into poverty while others had benefited, or if all had benefited or all had lost. This gap in the literature again suggests a potential area for future research.

Fuelwood supply

Fuelwood is an important source of fuel for approximately 40 to 50% of the world's population. The main uses are for cooking and warmth. For example, in Kenya, 78% of the population depend on fuelwood for cooking while in Ethiopia the percentage rises to 95%. It is estimated that in 1980 1.3 billion people faced fuelwood shortages and if present rates of deforestation continue, this figure is expected to increase to 2.7 billion by the year 2000 (Tolba et al 1992). The implications of this impending shortage of a necessary consumption item will have dire consequences, especially for the poor.

Productivity drop

The time taken to collect fuelwood as well as other non-timber forest products increases as the rate of deforestation rises. The longer collecting times imply a larger portion of time is used for collection

⁶ The valuation of non-market goods could be resolved if market substitutes are available. This has been one way of overcoming this obstacle.

⁷ Forests constitute a large share of the CPR's.

and less time available for both economic and other household activities. Studies by Kumar and Hothckiss (1988), Duraiappah (1994), Iyengar (1988), as well as Jodha (1990) highlight this effect in their studies and illustrate how poor households stand to lose more than higher income groups if this time scarcity effect is present.

Table 2 below gives a summary of the main impacts and the groups which we believe would be affected. We should like to stress that quantitatively driven empirical studies identifying which groups are hardest hit by environmental degradation are not available and is an area which needs to be addressed urgently.

Table 2

Impacts	Consequences	Groups	Relationship
Watershed protection	Rainfall disruptions, increased flooding potential	all groups affected but low income group hardest hit.	R1FB ⁸
Soil erosion	Productivity drop, water shortage	all groups affected but low income group is hardest hit.	R1FB
Destruction of safety buffer	Loss of NTFP, increased household expenditure	low income	R1FB
Productivity drop	Income drop	Low income groups	R1FB
Fuelwood shortage	Labour productivity, increased household expenditure	Low income	R1FB

Literature analysis

The activity analysis identified the possible existence of R1, R2, R3A, and R3B relationships being present simultaneously. However, no general consensus could be found among the studies on the magnitude of each relationship. The majority of the studies failed to link the activities causing R1, R2, R3A, R3B type of relationships to the income groups responsible for these activities. More detailed information of the income groups responsible for the environmental degradation as well as the magnitude of their activities could shed more light on the poverty-environmental degradation nexus and assist policymakers to formulate the appropriate and corrective policies. For example, if R1 is the dominant link, then policies should be formulated to address the exogenous poverty problem and less emphasis should be placed on correcting the PGW, MF and IF factors.

The impact analysis on the other hand firmly established the existence of R4 and R1FB links. Although the literature analysis failed to give an indication of the magnitude of these two links, the mere fact that the welfare of one group of agents is being lowered due to the actions of another

⁸ R1FB is indigenous poverty causing environmental degradation which was in turn caused by either R1,R2, R3A, R3B acting alone or together.

implies a Pareto inefficient process which needs to be addressed urgently (Streeten 1994, Green 1994). However, policy makers would need the type of information mentioned in the last paragraph before appropriate policies can be formulated. This we believe is a major gap in the literature which needs to be addressed urgently with micro socio-economic studies.

Although the literature analysis failed to identify the magnitudes of the various contributing factors towards environmental degradation, the majority of the studies highlighted the predominant role institutional and market failure played both as a catalyst as well as a direct factor causing environmental degradation and indigenous poverty (Davidson 1992, Goodland 1991, Lutz and Daly 1990, Jaganathan 1989, Southgate 1991, Chengappa 1995, Browder 1989, and Bromley 1989). This finding by itself is an important result. The bottom line conclusion is that both, market and institutional failure play an integral part in the poverty-environmental degradation nexus. Therefore, a detailed analysis of the role they play in the various types of relationship links is a prerequisite before corrective measures can be formulated and implemented.

Land Degradation

It is estimated that 0.3 to 0.5 percent (5-7 million hectares) of total world arable land is lost annually due to land degradation. Dudal (1982) estimates that this figure will double by the year 2000 if present trends continue. But before we continue with the discussion on land degradation, it may be appropriate to clearly define what is meant by land degradation. Blaikie and Brookfield (1987) very rightly state that the term land degradation is a perceptual word and the definitions vary according to the researcher's intent and purpose. For the purpose of this paper, we define land degradation as a process by which the natural productivity and/or the economic productivity has been impaired due to anthropogenic activities. We intently specify anthropogenic so as to focus the discussion on land degradation caused by economic activities and not to cover the broader spectrum that includes degradation caused by natural forces.

Main activities contributing towards land degradation.

Three main processes were identified in the literature review through which land degradation may occur.

- Soil exhaustion
- Salinisation
- Desertification.

Soil exhaustion

Southgate (1988) argues that small farmers have been the main agents responsible for land degradation activities. The author cites market and institutional failures as the primary reason for farmers adopting non-sustainable practices. Similarly, Pagiola (1995) shows how government price controls on agricultural goods in Kenya has not provided incentives for the small and poor farmers to conserve their land but to "mine" it for maximum output.

However, an alternative response is illustrated in Mortimore's study in the Kano region in Nigeria where he found evidence of small farmers' willingness to forego short term income gains even under price and famine pressure for long term sustainable management strategies (Mortimore 1989). One explanation for the apparent contradiction could be due to the existence or non-existence of secure land tenure systems. Southgate (1988), Mink (1993), Repetto (1989), and Mendelson (1994) all cite the lack of secure land tenure as the primary reason for poor farmers to cultivate their land excessively to exhaustion; for the simple reason that they have no vested interest in preserving an asset which they do not own.

Another activity which leads to soil exhaustion is the non-replenishment of soil nutrients. In the past, in many parts of Asia, small and poor farmers used animal manure to replenish the lands. However, as fuelwood supplies began to diminish, animal manure was increasingly used as a fuel substitute. The poor farmer is left with very little choice when he is forced to make a trade-off between the immediate demands of fuel for cooking and heating or manure for the land. The time preference argument suggests that the immediate and urgent needs are always satisfied.

Another similar form of soil exhaustion occurs when certain nutrients are taken from the soil but are not replenished naturally or artificially with fertilizers (Mortimore 1989). This is especially common when a homogenous crop, usually a cash crop, is grown repeatedly on the same piece of land. This trend has been especially common in developing countries where governments react to world prices of cash crops and initiate policies which encourage cultivation of these crops. For example, in India, large tracts of the Western Ghats were cleared for coffee and rubber when the prices of these two crops rose. The incentives given by governments to encourage farmers to cultivate these cash crops ranged from fixed high prices to easy access to forest lands. However, the institutional support in terms of fertilizers, access to credit as well as to technology was not provided and the small farmers who were lured by the promises of quick profits were then faced with declining yields as the lands lost their productivity. These poor farmers either had to sell the land and become landless peasants or encroach on new forest land (Graff 1993, Bandyopadhyay 1987). The main groups who benefited from the conversion were the large farmers who had access to the necessary resources for the successful cultivation of cash crops. (Oodit 1992).

Salinisation

Salinisation is another process by which land degradation occurs. Oodit (ibid) estimates that about 267 million hectares of arable land have been lost due to salinization. Of this, 143 million is in Asia, 71 million in South America and 53 million in Africa. The primary cause of the salinisation is mis-managed irrigation. Continuous irrigation of lands in an unsustainable manner can lead to a process of reverse osmosis which leads to an accumulation of salt. This, in turn, causes the soil productivity to drop. This form of land degradation has been found to be predominantly located in Asia where irrigation systems have been more common. Oodit (1992) states that salinity has reduced the yield of major crops by 30% in the 15 million hectares of irrigated land in Pakistan. The Second India Study Revisited (Repetto 1994) postulates that land lost through badly managed irrigation schemes has negated the advantages gained through the green revolution.

Desertification

Unsustainable economic activities leave the soil exposed to further erosion by rain or wind, especially in the dry areas, which in turn initiates a process of desertification. Perkins (1993) argues that, in certain areas, excessive grazing by domestic livestock has led to a complete removal of grass cover which in turn has led to soil erosion by both wind and rain. This then results in barren land, with little use for either grazing or agricultural use and over time these regions acquire desert type conditions. But the question we should raise at this point is, what caused the over grazing and who were the responsible agents. The Unemo (1995) and Perkins (1994) studies, both focusing on Botswana, argue that subsidies in the form of fixed high prices by the European Union played a major role in Botswana's domestic tax and investment policies which encouraged livestock production. Table 3 provides gives an indication of the extent of land degradation under the three main processes across the three regions of particular interest.

Table 3

Activity	Agents	Motives	Incentives	Relationship
Soil exhaustion	Small holdings	Subsistence	lack of land tenure	R2, R3A,R3B and R1FB
Soil salinisation	Commercial	Profit	Cheap irrigation water	R2, R3A,R3B
	Small holdings			R3A,R3B & R1FB
Desertification	Commercial	Profit	lack of land tenure	R2 , R3A,R3B
	Small holdings	Subsistence	survival	R3A,R3B

The social and economic consequences of land degradation

The main economic impact of land degradation is on agricultural productivity. Panayatou and Sussangkarn (1994) postulate that soil exhaustion and erosion were the primary factors which caused land productivity to drop in Thailand. Magrath and Doolette (1990) go one step further to estimate the economic costs to the Indonesian economy caused by soil erosion. In a similar study for Nepal they find that a cereal output drop of 1% a year was attributed to soil erosion. Jones and Wild (1975) and Harkness and Yayock(1979) demonstrate in their studies how the cultivation of different crops removes nutrients from the soil, and the necessity of replenishing the soil with fertilizers if productivity is to be maintained.

Literature analysis

In the case of soil exhaustion, the initial analysis suggests that poor farmers consciously degrade their land and drive themselves to poverty. However, as the studies in the last section highlight, the absence of secure land tenure may be the primary factor behind these degradation activities. The absence of land tenure itself, as historical trends suggest, does not cause degradation activities. It is the knowledge that the land can be appropriated at any time that causes the unsustainable activities (Mendelson 1994). The fear of losing land by the poor is a direct function of the PGW factor and this is a clear case of how institutional failure can act as a primary contributor to environmental degradation.

The R1FB as a contributory factor for soil exhaustion arises from two sources: 1) the first from within the sector due to decreases in agricultural productivity; and 2) from the fuelwood-manure relationship. In the first case we found evidence of declining agricultural productivity in degraded lands causing indigenous poverty which in turn forced many of the people to continue to degrade their land further to extract subsistence outputs. In the second case, we had shown in the previous section how fuelwood demand by commercial interests causes firewood shortages for the low income group. This R2 link in the forest sector causes a R1FB effect in the land degradation category. This example demonstrates how the situation becomes complex when activities in one

sector have feedback effects in another natural resource sector. The ideal solution to this problem would be a policy which corrects the unsustainable firewood collection activities which are driven primarily by R2. However, if R1FB was not identified as a contributory factor and the problem was attributed to land tenure, as in the first case, and land reform policies had been initiated, the problem would not have been resolved and the degradation process would have continued and increasing levels of indigenous poverty would have been witnessed.

In the case of salinization, the linkages are a bit more straightforward. We identified three relationships, R2, R3A, R3B, and R1FB. Irrigation excess is a privilege of the rich (Repetto 1994). Therefore, the salinization which occurs is primarily a direct cause of the PWG factor. However, one should also bear in mind that it is not in the interest of this group to pursue unsustainable activities especially if land tenure is secure. Two explanations are possible. The first suggests that the rich have alternative sources of income and therefore their decision making is short sighted. The second reason is that this group is ignorant about irrigation systems and therefore are not aware of their unsustainable practices. A solution to the first is problematic but the second can be addressed with education schemes.

The R3A factor was also responsible for salinization of soils and can be attributed to the over zealotness on the part of governments to introduce irrigation schemes to increase agricultural productivity. In their eagerness to adopt the Green Revolution techniques which were heavily dependent on irrigated water, governments provided water subsidies as an incentive to use the irrigation systems. Again, lack of knowledge on the part of farmers resulted in mis-management of the water supply which over time caused the salinization process to occur. The R1FB links arose from both links discussed above. Salinization caused by the R2 link had cross boundary effects and lands belonging to the other groups were also affected. The resulting drop in agricultural productivity had a larger detrimental impact on the lower income groups causing a rise in indigenous poverty. The resulting poverty in turn forced many farmers to pursue unsustainable practices in other natural resource sectors causing further environmental degradation. For example, in Bangladesh, the salinization of agricultural lands forced many farmers to pursue fishing as an alternative vocation. However, the massive increase in the number of fishermen resulted in over-fishing and the fishery sector has been to a large extent depleted to extinction (Atiur 1995).

In the case of desertification, the primary links which were highlighted in the analysis were R2 and R3A, and R3B. In the case of Botswana, owners of livestock were given tax concessions which could be used against total income: In other words, a professional working in the city could have tax relief if he had livestock in the rangelands. This prompted a massive increase in livestock production in Botswana which eventually led to degradation of the rangelands. Open access was also a contributing factor to rangeland degradation. The resulting degradation caused by R2 encouraged existing livestock owners, who were typically small herdsman, also to increase their loads. The total impact of R2, R3A and R3B resulted in degradation which in turn caused indigenous poverty among the small livestock owners.

In conclusion, the literature analysis highlighted the existence of R2, R3A and R3B which together produced R4 and R1FB. Similar to the forest sector, the magnitude of the relative effects were not available. However, a common theme found in the land sector which we also found in the forest

sector was the different role institutional failure played in the respective relationships and the importance of identifying these roles before policy measures be formulated and adopted.

Water

The literature review identified two major issues within the water sector which play an important role in the poverty-environmental degradation nexus.

- water shortage
- water pollution or contamination

At the global level, 22 countries are presently facing severe water shortages while a further 18 are in the danger of facing shortages if fluctuations to the present rainfall patterns occur (World Bank 1992). At the regional level, the water shortage issue takes on a more important dimension as the water shortages in regions within a country can have significant economic and social impacts across the country. It is estimated that approximately 2 billion people live in areas with chronic water shortages and the numbers are expected to increase, with increasing demand for water caused by growing populations and economic activity (UNFPA 1991, Davidson 1992).

Although water shortage is a major threat, water contamination and pollution poses a more immediate serious problem. Access to safe drinking water is still considered a luxury for many in developing countries (Mink 1993). The UNEP (1995) study estimates 1 billion people with no access to running water while 1.7 billion do not have access to sanitation facilities. In the past, human waste was deposited in natural systems but with increasing populations, the load of human waste has far exceeded the natural systems absorption and cleansing rate. Therefore, without modern sanitation systems to help relieve the natural systems, it is only logical for the natural systems, including water, to become degraded.

Water contamination also comes in the form of industrial and agricultural pollutants. The cheap and easy alternative of dumping industrial and agricultural effluent in water systems in-lieu of expensive cleaning systems has made water systems an easy target for waste dumping.

Main activities contributing towards water resource degradation

Within the water shortage and water pollution issues, a number of activities were identified as the primary contributors to each problem.

1. Water shortage

- excessive or badly managed irrigation systems
- industrial demand

2. Water pollution and contamination

- human waste
- industrial waste

Water shortage

Oodit (1992) cites the expansion of irrigation systems as well as the industrial demand for water as being the two main reasons for water shortages in developing countries⁹. A UNEP study (UNEP 1995) estimates that 95% of water use in developing countries is for the agricultural sector. Excessive pumping of groundwater for irrigation, assisted by the introduction of electric pumps as well as the lack of a well defined water property rights, have caused withdrawal rates to exceed regeneration rates of the various water systems (Shah 1993). This is clearly evident in the Indian state of Maharashtra where bore holes were being continuously dug to provide irrigated water to sugar cane plantations but each bore hole was going dry within a year of drilling (UNEP 1995).

Population pressures have also been cited as a reason for water scarcity but no single study could be found which focused solely on establishing a link between population pressures and water shortage. The majority of the studies mention the causality as an afterthought (UNFPA 1993, Mink 1993).

Water pollution and contamination

One of the main pollutants for water contamination in the developing countries is human waste. High rural-urban migration rates have placed existing inadequate and antiquated sanitation and waste disposal facilities in cities in many developing countries under stress. By and large, the water contamination problem caused by human waste is an urban problem and has been largely ignored in many developing countries because policymakers do not recognise slums as legal entities. The status of illegality then relinquishes policy makers of any obligation to provide adequate sanitation facilities.

The second contributor to contaminated water is dumping of industrial waste. Similar to human waste, if industrial waste is dumped in amounts excessive to the cleansing rate of the systems, it can only result in an accumulation of waste to toxic levels as well as the deterioration of the water system of its cleansing properties. It is estimated that 40 of Malaysia's major rivers are polluted by industrial and agricultural waste, while 54 out of 78 rivers in China are clogged with industrial pollutants (Davidson 1992).

A third form of water contamination comes from fertilizers and pesticide run-off from the agricultural sector. The Green Revolution technology relied heavily on the use of fertilizers and pesticides for increasing crop yields. However, a factor which was overlooked by the experts is the contamination of the groundwater system as these substances eventually find their way into this crucial water supply which experts estimate takes 14,000 years to replenish (UNEP 1995).

⁹ Asia in particular due to the heavy reliance of its agricultural sector on irrigation and the high rates of industrial growth observed over the last decade.

Table 4

Activity	Agents	Motives	Incentives	Relationship
Water shortage	Commercial	Profit	Water subsidies & economies of scale	R2
	Small holdings	Profit	Water subsidies	R3B
Water pollution	Commercial	Profit	No pollution taxes	R2
	Small holdings	Survival	Lack of governmental support	R3A and R1FB

The social and economic consequences of water pollution and scarcity

Three primary impacts were identified during the literature review.

- Health effects
- Food source
- Drought conditions

Health effects

One of the major problems associated with polluted water is the spread of diseases. The World Health Organization highlights four forms of diseases caused by water pollution from human and animal waste: waterborne, water-washed, water-based, and water-related. It is estimated that 4 million children die from diarrhea, a water-borne disease, each year and is a leading cause of child and infant mortality. Davidson (1992) extends the estimate across all age groups and estimates 25,000 people a day or 9 million a year die from diarrhea while UNICEF estimates 12.4 million deaths annually due to dirty water and sanitary conditions.

The contamination of water supplies by industrial and agricultural pollutants can also have detrimental health effects. Lead levels in the water supply of many countries have been found to be significantly higher than the minimum safety level prescribed by the WHO. The impacts on health include mental retardation in children and lower productivity in adults (Leitman 1993).

The main groups of people affected by water contamination are the poor, especially the urban poor. The four million children who die from diarrhea come mostly from low income urban households. The poor are marginalized when it comes to access to clean running water.

Food source

Fish from rivers, lakes and other water systems provide a cheap but highly nutritious source of protein. However, the pollution of these water systems renders this source of food supply useless (Mink 1993). The poor are either forced to purchase more expensive protein substitutes or forego their protein intake. The latter has consequences on productivity as illustrated repeatedly by Dasgupta (1994).

Drought conditions

Water is a necessary prerequisite for the agricultural and husbandry sectors. The number of events in which large scale destruction of crops as well as deaths of animals arising from droughts are many. Gasser (1981) postulates that the lack of a reliable supply of water would be the crucial inhibiting factor for rice production in Asia while Kadekodi (1995), found that water supply was the one crucial variable which drove the entire agricultural and social system in the Palamau district in India. The people primarily affected by water shortages are the poor who can ill-afford the expensive and sophisticated technology needed for drawing water from distant sources or from deeper bore holes. Furthermore, most of these farmers are already living on the margin and any slight disruption to their present state could cause them to lose their crops and push them deeper into poverty.

Table 5

Impacts	Consequences	Groups	Relationship
Health	Mortality increases, productivity drop	Low income groups	R4 and R1FB
Food	Drop in protein source, Productivity drop	Low income groups	R4 and R1FB
Drought	Agricultural productivity drop	Low income groups	R4 and R1FB

Literature analysis

As Tables four and five show, all five relationships are present in the water degradation-poverty link. However, similar to the sectors discussed earlier, the literature analysis failed to give any indication of the magnitude of each relationship. We are therefore unable to conclude which of the relationships are predominant in the nexus and which need immediate policy attention. However, similar to the previous sectors, the consistent presence of different forms of institutional failure, either as a catalyst or as a principal agent, was observed.

A common theme that most of the studies point out is the absence or mis-use of property rights pertaining to the use of water. Jodha (1990) as well as Singh (1977) show how in the past, village communities adhered to very stringent rules on water use and they observed that water shortage was never a serious recurring problem as it is nowadays. With the establishment of individual property rights¹⁰ and the breakdown of traditional institutional structures, the rights to water have quite often resulted in benefits to the high income groups who either had the resources to acquire the water property rights or take advantage of the access to government subsidized water supplies. In this manner, a clear R2 relationship is observed.

Another avenue through which water supplies are being diminished is through the destruction of traditional water catchment areas by the deforestation which takes place in the highlands (Bandyopadhyay 1987). As mentioned in the previous section on deforestation and some of the impacts which arise, water catchment was one of them. We were able to identify a combination of relationship links but no clue to the magnitude of the relationships was forthcoming from the literature review. This again is an area for future research.

¹⁰ The establishment of individual property rights itself does not imply water shortages but the manner in which the rights were initially distributed as well as the inability or reluctance of the political and judiciary system to protect the property rights caused water shortages for the low income groups.

With respect to the impacts arising from water degradation, the literature analysis highlighted that any form of degradation of the water supply places the low income groups in a more vulnerable position than other income groups. For example, the loss of a cheap source of food supply results in either malnourishment or a decrease in welfare level caused by substituting more expensive food supplies. This establishes the R4 relationship. Disruptions to water supply either for economic activity or personal consumption have higher consequences for the low income groups due to their lack of access to substitutes.

Air (Indoor and Outdoor)

The World Bank estimates that 1.3 billion people, most of them in developing countries, live in town or cities which do not meet minimum WHO standards for Suspended Particulate Matter (SPM). This statistic covers only outdoor air-pollution. If the coverage is extended to include the 400 to 700 million (mostly rural women and children) people who are exposed to unsafe levels of indoor pollution, we have approximately two fifths of the world population, most of them located in developing countries, who do not enjoy the basic right to clean air.

Main activities contributing towards air pollution

It is important to differentiate between outdoor and indoor air-pollution because of the unique characteristics associated with each. . The primary activities responsible for outdoor pollution are industrial activities and vehicular emissions while for indoor pollution they are cooking and heating.

Outdoor pollution

One of the prerequisites for modern economic growth is energy and one of the primary sources of energy is the burning of fossil fuels. Coal, which is one of the cheapest fossil fuels and also the most abundant is considered to be the most polluting of the fossil fuels. It emits CO₂ which by itself is not toxic but is a significant greenhouse gas when left to accumulate. Coal also emits large amounts of particulates and is a significant source for SPMs. Another growing and potentially important future source of SPMs is vehicular emission. The rising trend of affluence within developing countries has caused a rising demand for gasoline based transport systems. Many developing countries do not legally prohibit the use of lead based gasoline for vehicles nor restrict emissions of SPMs.

Another contributory factor to outdoor pollution is the emissions of various gases from industrial plants. The emission of sulfur dioxide and nitrous oxide, to name a few ,in the industrialized countries are well documented in the air pollution literature. It is easy to extrapolate from the experience of the developed countries to conclude that the emissions from the industrial sector can only increase over time if the developing countries continue with their present style of industrial growth. However, this does not imply that we advocate no industrial growth. What is needed however are industrialization policies which: 1) internalize the ensuing environmental externalities; and 2) ensure that additional costs incurred by the internalization do not impede the industrialization process (Carrero:1995).

Indoor pollution

Biomass is still the dominant form of fuel used for cooking and heating in developing countries (Tolba et al, 1993). Stephen Mink (1993), in one of the rare studies which covers the social aspects of fuel consumption, gives a detailed breakdown of the type of fuels used by the various income groups for Indonesia and Senegal and clearly illustrates the dependence of the poor on biomass based fuel. Although substitute fuels are available, the possibility of the poor gaining access to them are negligible, due to both price and income effects.

Table 6

Activity	Agents	Motives	Incentives	Relationship
Outdoor pollution	Industry	Profit	No pollution taxes	R2
	Affluent groups	Affluence	No pollution taxes	R2
Indoor pollution	Low income groups	Subsistence	Survival	R1 and R1FB

The social and economic consequences of air pollution

The most important negative externality arising from air-pollution, indoor or outdoor, is health deterioration. Indoor pollution arising from biomass based cooking and heating stoves is known to be a primary contributor to respiratory problems. It is estimated that 300,000 to 700,000 deaths can be prevented if SPM concentrations can be held to WHO standards (World Bank 1992). Other indoor pollution related impacts are lower productivity among adults and mental retardation among children. It is estimated that urban centres which have SPM levels above the WHO standards lose an equivalent of 0.6 to 2.1 working days per year for every adult in the labour force due to respiratory related illness (ibid). Furthermore, the medical cost burden on the economy can also be staggering although no studies focusing on this aspect could be found. The low income groups are the hardest hit by health deterioration. A day lost due to illness implies a day's loss of wages as well as the possibility of job loss. The lack of health insurance as well as labour laws to protect workers in this group only further heighten their chance of falling into the poverty group.

The effects of outdoor pollution are also similar to indoor pollution. Accumulation of lead in the blood stream can cause significant medical problems which then translate into loss in productivity and high medical costs. The impact on children results primarily in the form of mental retardation.

Literature analysis

Table six above highlights R2 as being the significant factor in the poverty-outdoor air pollution causality argument while R1 was found to be the primary factor for indoor air pollution. In the case of the former, the primary reason for R2 type of behavior can be attributed to a lack of pollution internalization policies. The popular reason used by policymakers in developing countries supporting the absence of these policies is the environment-growth trade-off argument. However, the trickle down theory of growth has been disputed in recent literature with the benefits of the growth accruing to a small elite minority while the "benefits" of the resulting environmental degradation have been borne by the majority who fall in the low income group: a form of institutional failure working as a catalyst for environmental degradation. Although the issue of identifying affected groups is a bit more difficult for outdoor air pollution (Mink 1993), environmental valuation methods such as hedonic pricing find that residential prices are a function of environmental quality. Therefore, higher income groups can to some extent if not completely, protect themselves from outdoor pollution

effects by locating themselves away from the polluting points. Policy prescriptions to correct the existing situation should focus on correcting the environmental externalities.

The main groups suffering from health related effects caused by indoor air pollution are predominately the poor. In this case, poverty was found to be the primary reason people resort to biomass fuels and it was also found that it is the low income group which suffers the most from the environmental degradation that occurs from indoor air pollution. The R1 relationship together with R4 are predominant in this particular problem. Policy prescriptions need to address the exogenous poverty issue before the environmental degradation problem can be resolved.

Conclusion

The clear distinction between the two schools of thought, as discussed at the beginning of the paper, did not materialize as expected from the literature review. Although some authors made the argument that the poor do pursue activities which result in environmental degradation, they qualify their conclusion by highlighting the pivotal and crucial role market and institutional failure play in the decision by the poor to adopt unsustainable activities. The authors who argue that the poor just do not have the resources to adopt unsustainable activities also cite institutional and market failure as the crucial variable in the poverty-environmental degradation nexus.

For example, Dasgupta (1993) found a positive relationship between rural poverty, fertility and environmental resource base degradation and concludes his study by stating that it was not only poverty but also institutional failure that were the root causes of environmental degradation. Jeganathan (1989), and Jodha (1989) both disagree with Dasgupta's conclusion, and assert that the poor do not: 1) have the resources to degrade the environment; and 2) have the short time preference which propels them to destroy a resource which they regard as safety buffers during time of destitution. However, they do agree with Dasgupta on the role institutional and market failure plays in providing incentives to: 1) the poor to have short time preferences; and 2) the rich to exploit the resource base at unsustainable rates.

A prevalent theme in all the studies but which was not highlighted other than as ad-hoc references, was the contribution to resource degradation by conflict between different groups of users of the natural resources. The role of power and conflicts between various user groups in the use of common as well as private property resources is well researched, but the use of this literature in explaining the poverty-environmental degradation nexus has been minimal to date. To summarize, the following points were identified as important factors in the poverty-environmental degradation nexus.

- The conflicts between different user groups of natural resources, especially from different income groups in many cases cause agents to adopt unsustainable practices which in turn marginalizes some of the groups which eventually fall into the poverty group.
- The conflicts to a large extent are either initiated or encouraged by institutional or market failure. Certain groups benefit while others suffer.
- Unsustainable use of natural resources inevitably causes poverty (we use the term indigenous poverty in this paper to describe poverty caused by environmental degradation). To solve the problem, policy must be focused on environmental policies and not poverty alleviation policies.
- Environmental degradation can be caused by poverty. However, to resolve the problem, the first objective is to first identify if it is indigenous or exogenous poverty. If it is indigenous poverty, then policies must be focused on environmental policies. However, if it is exogenous poverty, then poverty alleviation policies need to be formulated and implemented.

In conclusion, there are substantial gaps in the literature which need to be addressed. To begin with, studies on the poverty-environmental degradation nexus should be natural resource specific. The tendency to generalize across all resource sectors only contributes to the complexity of the subject. The next step involves a detailed microeconomic-ecology study focusing on three aspects. The first involves the study of the users of the natural resource, and should include behavioural characteristics of each user group as well as their interactions with each other and the natural resource base. The second aspect should investigate the impacts of resource degradation across the user groups and their reactions to these changes. The third aspect, which incidentally is ignored in a majority of economic studies, focuses on the dynamics of the natural resource itself.

The approach described above is not an easy task; it would need determination, perseverance and commitment on the part of multi-disciplinary research teams as well as policy makers. However, due to the severity of the problem at hand, and the lack of existing studies looking at the three aspects, especially in an integrated and quantitative form, there is no other option but to start on this research agenda as soon as possible.

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