3 Global development and global externalities: a case study of the need to regulate biodiversity's decline

1 Global development and global biodiversity

Global environmental problems are usually situations that cannot be resolved through uncontrolled development, as this is precisely its source. Many other environmental problems do generate their own solutions with adequate national growth and development. For example sanitary water and adequate air quality tend to be in disproportionately greater demand as living standards increase, and hence adequate income growth often affords the prospect of improving previously degraded air and water quality. For this reason the most cost-effective prescription for many environmental problems brought on by industrialization and development in many of the poor countries may often be simply 'to grow out of them' (Beckerman, 1994).

This is not the case in the context of the environmental problem of biodiversity, for two reasons. First, in biodiversity we have an example of a resource which is generally discriminated against within the process of development, simply because development is usually practised in a very uniform fashion, for example the clearing of land and the establishment of agriculture. As will be discussed in further detail below, development is often seen to be synonymous with the conversion of diverse natural resources to a common roster of uniform national resources: cattle ranching, specialized agriculture and the many other forms of activities that are common across most of the world. Therefore the standard practice of development uniformly discriminates against diversity.

The other reason that it is impossible to allow time and development to work a solution to the biodiversity problem is that it is unlikely that there will be any of these resources remaining at the point in time at which they are adequately demanded. The problem here is one of foreseeable demands in combination with irreversible supplies. As development proceeds it is likely that the demand for diversity will increase (as it does for other environmental resources), but it is the conversion of biodiversity that often lies at the base of the development process as it is currently practised. Since existing biological diversity is a non-retrievable resource ('only God [4.5 billion years] can create a tree'), the engine of development is often consuming the very resources for which it will generate demand in the near future.

The regulation of biodiversity requires the regulation of the development process as it is currently practised. In particular it will be necessary to create global incentive schemes that will induce individual developing countries to pursue development in a manner very different from those states before them. It is a very risky strategy to commit to a unique path of development, different from that undertaken by those who have gone before you, and it is unlikely that any given nation would do so in any substantial manner in the absence of sizeable international inducements, and this will require the establishment of international institutions for that purpose. The problem in the past has been that international institutions themselves have developed in the wake of the first countries' development, usually responsive to and supportive of the choices which they have made. If a diversity of development paths are to be pursued, based upon a diversity of resources, then it will be necessary for a diversity of international institutions to exist in order to support these alternatives. It is the object of this chapter and Chapter 4 to demonstrate generally how the biodiversity convention should be conceived in order to fulfil this role.

2 The development process and the biosphere

Conversion of natural environments has long been part and parcel of the development process. Societies which we know as 'developed' are those which have previously built their economies upon a productive set of assets; societies which we know as 'developing' are those which are still in the process of assembling their asset base. Hence economic development in human societies derives in part from the substitution of more productive assets for the less productive. When this process of substitution is applied to natural resources, it is usually known as the *conversion process*, as in the case of the conversion of forests into ranchlands.

Natural resources may be conceived of as simply *natural assets*: assets whose initial form was determined by nature rather than society (Solow, 1974a). The natural form of any asset is necessarily competitive with other forms in which humans might hold these same assets. Humans can, for example, remove forests for factories or fields. If development is defined as the process by which a given set of assets is selected by society, then development must necessarily imply the decline of natural asset balances, simply because nature initially selected 100 per cent of the assets on which society depended. As humans become more actively engaged in the selection of the form that assets will take, this necessarily implies that the proportion of naturally chosen asset forms must fall.

Conversion in the process of development lies at the root of the endangerment of most biological resources. For example the decline of many traditional plant and animal varieties occurs when the lands on which they are grown are converted to a specialized modern variety. The loss of many other diverse resources also has its source in the development process, albeit less directly. For example a tropical forest replete with many diverse resources may be lost on account of logging activities. In this case the natural asset (the forest) is being converted in a less direct fashion through the liquidation of the standing resources. That is the natural resource is converted to another asset form indirectly through sale with the proceeds then potentially invested in other forms of assets (such as education), resulting in the conversion of the natural asset (to another asset such as 'human capital').

Development is a process which has long been antithetical to natural resource conservation. This is because it has been based upon the idea of conversion of assets to preferred forms – from forests to factories, from heathlands to health services, from wetlands to water sports. In the past the natural form of the asset was not seen as providing any special recommendation for its retention; if a market-preferred alternative was available, it was pursued. More recently local and national land-use planning legislation in the developed countries has allowed for a broader set of values, other than those which are simply market-based, to be taken into consideration in regard to local resources. These institutions have come far too late for many of the diverse resources that existed in the developed world, and the institutions still do not exist in many of the countries in which they would have the greatest impact on biodiversity. One of the basic objectives of the biodiversity convention should be seen to be the development of the necessary institutions for the incorporation of the values of biodiversity within the land-use decision-making processes of those nations which still host vast amounts of the resource. That is one fundamental object is to develop institutions that generate incentives for land-use management in countries where development has not yet itself generated that institution (since these are many of the same countries which have not yet depleted their biodiversity through development).

3 The impact of development at the global level

Economic development is of course a constructive force in nearly every context in which it occurs. Development has been seen to provide not only the basic needs of many societies, but it is now also seen to provide many of the other requirements, such as environmental services, health services and even individual rights. However the diffusion of the development process on a global basis is also one of the primary forces contributing to diversity losses. The initial, local conversions of natural resources had little impact on the global portfolio of assets, but the aggregation of thousands and millions of these discrete conversions has generated a phenomenon of worldwide importance.

In effect the global conversion process may be conceived of as the diffusion of the idea of asset conversion across the globe, from country to country. Some countries commenced the conversion of their habitats thousands of years ago; for example the forests of Britain were largely removed during the course of the Iron Age. Other countries still retain the vast forests that have been there since time immemorial. The global biodiversity problem comes to our attention now because these processes of conversion are working their way towards the last refugia on earth. The majority of the world's remaining species reside in a small number of the world's states. These are the same states that have been the last to have substantial parts of their territories remaining unconverted (Table 3.1).

Table 3.1 Countries with greatest 'species richness'

Mammals	Birds	Reptiles
Indonesia (515)	Colombia (1721)	Mexico (717)
Mexico (449)	Peru (1701)	Australia (686)
Brazil (428)	Brazil (1622)	Indonesia (600)
Zaire (409)	Indonesia (1519)	India (383)
China (394)	Ecuador (1447)	Colombia (383)
Peru (361)	Venezuela (1275)	Ecuador (345)
Colombia (359)	Bolivia (1250)	Peru (297)
India (350)	India (1200)	Malaysia (294)
Uganda (311)	Malaysia (1200)	Thailand (282)
Tanzania (310)	China (1195)	Papua New Guinea (282)

Source: McNeely *et al.*, 1990.

Asset conversion that has occurred for a millenia on a local and regional scale has now aggregated to become a force at the global level. At base this restructuring of the global portfolio of biological assets is driven by the desire for human development gains obtained from the conversion of assets to more productive forms. However, as this basic strategy for human development reaches the final refugia of many of the world's species, it is projected that a cataclysmic 'mass extinction' of species may result (Lovejoy, 1980; Ehrlich and Ehrlich, 1981). Development practises which had little negative impact when practised on a small and local basis have now aggregated to bring about massive changes on a global basis.

Therefore at the very base of the biodiversity problem is the capability of humans to change the nature of the biosphere from its natural to a human-preferred form. The gains from conversion have been causing the restructuring of the biosphere on a regional basis for several millenia. Now, with the diffusion of this strategy to the final terrestrial frontiers, conversion of the biosphere seems set to occur on a global basis.

3.1 *The nature of the global conversion process*

Reconstruction of the portfolio of biological assets on a global basis is a powerful force, capable of reshaping the whole of the earth's biosphere. However it is not in itself sufficient to explain the potential for a mass extinction. For this, an explanation must be found that will generate not only an expected reshaping of the global portfolio of natural assets, but also a narrowing of that portfolio.

Conversion as an economic force explains only why it is the case that the natural slate of biological resources might be replaced by another on any given parcel of land, depending upon relative productivities. It does not explain why a small number of species would replace millions across the whole of the earth. That is this force implies conversion but not necessarily homogenization. In order to explain the global losses of biodiversity, that is *a narrowing of the global portfolio*, it is necessary to identify the nature of the force that would generate this homogenization of the global biosphere.

This indicates that the depletion of diversity is not a natural phenomenon; rather, it is a socio-economic one. There are good reasons to believe that prevailing methods of production are biased against the maintenance of a wide range of diversity. The idea of agriculture, that originated about 10 000 years ago in the Near East, was centred on the idea of creating species-specific technologies. This implied the inclusion of two new important factors of production in the production of biological goods: species-specific capital goods and species-specific learning.

In terms of biological resources, the capital goods applied in production are the chemicals, machinery and other tools of agriculture. These capital goods usually do not enhance the photosynthetic productivity of the biosphere; rather, they increase its productivity by means of the mass production of large quantities of a homogeneous output from much reduced inputs from other factors, for example labour.

The productivity gains in agriculture go hand in hand with diversity losses; in fact, they are often derived from the reductions in diversity. For example farm machinery is developed to work in fields that are planted uniformly in a single crop. Chemicals are fine-tuned to eliminate all competitors of a single species. The fields themselves are 'cleared' for the introduction of the machinery and chemicals of the production process. These capital goods are effective precisely because of the homogeneous environment within which they operate, and they create incentives for conversion by reason of their effectiveness.

At present this process of conversion is working its way across the developing world, having completed its journey through the developed world. The frontier is discernible by reference to the relative rates of conversion and capital good accumulation. For example the number of tractors in Africa increased by 29 per cent over the past 10 years; they increased by 82 per cent in South America; and by 128 per cent in Asia. During the same period the number of tractors decreased by 4 per cent in North America (World Resources Institute, 1990). It is the extension of this previously successful strategy for development to the four corners of the earth that is at the base of the concerns about what is presently happening to the biosphere.

It is not difficult to ascertain the approximate location of the technological frontier in this context. For example data on worldwide land-use trends document the rates at which conversions of lands to uses in specialized agricultural production have been occurring. Between 1960 and 1980 the developing world in aggregate increased its land area dedicated to standard specialized crops by 37 per cent, while the developed world experienced a small decrease in the same (Repetto and Gillis, 1988). Therefore deforestation and land-use changes continue to occur on large scales in those countries with natural resources remaining to convert; it cannot do otherwise. For example the amount of 'wilderness' (that is 20 square kilometres of unaltered landscape) on the European continent is now virtually zero, versus a global average of approximately 30 per cent (World Resources Institute, 1990). These states of the 'North' are the 'already converted' states; it is only a small selection of the states of the 'South' that retain a significant amount of diverse resources.

At present the forces for specialized conversions have moved to the boundaries of the last handful of states with substantial amounts of unconverted territory: Brazil (and the other Amazonian states), Zaire, Indonesia and a few others. These states are in a rapid phase of development and conversion, following in the paths of all those states that have gone before. One very large part of the biodiversity problem is the extension of this same development strategy to each and every country on earth, no matter how different their initial conditions are. This sameness, extended to countries initially so different, is one of the major reasons that the world is being depleted of diversity.

4 The biodiversity problem in agriculture: convergence on specialized varieties of species

The same process is at work within agriculture as is at work against nature. Natural resources continue to be replaced by the sameness that exists within agriculture as it is extended across the globe. Equally the differences that have always existed within traditionally practised agriculture are also being replaced by the sameness of modern intensive agricultural practices. This has created another facet to the biodiversity problem that is sourced in the same fundamental causes – the problem of genetic erosion in agricultural species. In order to understand the forces driving biodiversity's depletion and their relationship to development, it is instructive to enquire as to how biodiversity depletion has occurred within agriculture as well as within nature.

Within nature the problem of biodiversity depletion has been explained as the workings of the force of specialization within the natural world. Human societies have selected a small set of species and relied upon these for their sustenance, replacing diversity with the cultivated and domesticated varieties as part of the process of development. Through specialization societies have been able to achieve productivity gains by combining certain species with specially developed tools and methods of production. The question remains: why only a couple of dozen distinct species, and why only those which were chosen initially? The answers to these questions give further insights into the general nature of the biodiversity problem, and especially to the nature of the problem within agriculture.

The answer comes from considering the agricultural production process as it has developed across time. Besides the tools and chemicals used in agriculture, the other important factor that has been important in the evolution of modern agricultural production methods has been species-specific learning. With more experience with a particular species, it was possible to become even more efficient in its production (by reason of increased understanding of its biological nature, as well as intervention to determine the same). This information became another crucial factor for agricultural production, but it existed only in one form – embedded in the received forms of the domesticated and cultivated varieties.

As previously mentioned agriculture originated approximately 10 000 years ago in the Near East. It consisted of a set of ideas, a set of tools and a set of selected species. At that time and in that locale, each of these selections was locally optimal. However the set of ideas–technology–species were transported out of that region as a single unit, as the continuing investments in this combination caused the ideas and tools to become embedded in the chosen species. For example when the species of sheep and goats were domesticated in the Near East, a lot was learned in the process. It was of course possible that other peoples in other places might take note of the practice of domestication, and apply it to the species indigenous to their parts of the world; however this would require that much of the knowledge associated with sheep and goats be relearned in the context of other species. In most cases it would likely be easier to simply adopt the already domesticated species, and the existing learning with it.

In short a bias was introduced within the decision-making process, by reason of the non-rival nature of the information embedded in the specialized species (that would be costly to produce for any diverse species). This is the essential difference between the specialized (domesticated) species and the diverse (wildlife) species. For one group an information set is publicly available as an input into their production; for the other it is necessary to construct that same information. The global conversion process has consisted of the extension of these chosen species' ranges. As a consequence much of the face of the earth has been reshaped in order to suit these few species and the tools used in their production. It is the diffusion of this 'bundle' of ideas–tools–species that is at the base of the biodiversity problem.

Therefore it is not simply the globalization of the strategy of asset conversion that is determining the global portfolio of species, it is also the special way in which conversion occurs under agriculture. It is the perceived gain from the substitution of the specialized biological resources for the diverse that is generating an ever more narrow portfolio. It is this force, now acting globally, that is shaping the incentives for investment, and hence extinction.

This is a form of *dynamic externality* in operation with regard to decision making; that is earlier choices regarding conversions are having an impact on the way that later ones are being made. In the context of the biosphere, this bias is creating a 'natural monopoly' for a small number of species. The biosphere is converging upon this small, select group of specialized species as the sole providers of living resources to human societies.

This is seen in the fact that an increasingly narrow roster of species meets all of the needs of humankind. Of the thousands of plant species which are deemed edible and adequate substitutes for human consumption, there are now only 20 which produce the vast majority of the world's food. In fact the four big carbohydrate crops (wheat, maize, rice and potatoes) feed more people than the next 26 crops together (Witt, 1985). The same applies with regard to protein sources. The *Production Yearbook* of the Food and Agricultural Organization lists only a handful of domesticated species (sheep, goats, cattle, pigs and so on) which supply nearly all of the terrestrial-sourced protein for the vast majority of humans. The number of domesticated cattle on the globe (currently over 1.2 billion or one for every four humans) continues to increase, while the numbers of almost all other species continue in decline.

The same process of specialization is evident with regard to variety within a species. Not only are human societies becoming more reliant upon a narrower range of species, they are also becoming reliant upon specific varieties of these species. Specialization works beyond the species level of genetic convergence to produce a technically calibrated uniform biological asset, something which is capable of working well with the specific tools of agriculture: tractors, harvesters and so on. For this reason the problem of biodiversity concerns the conservation of greater varieties of specialized species as much as it concerns the conservation of any varieties of non-specialized species.

The global diffusion of specialized species within agriculture is demonstrated in Tables 3.2 and 3.3 below. It presents a snapshot portrait of the conversion of various countries to modern high-yield varieties in agriculture. Table 3.2 provides a static portrait of the progress of this technological change in the period 1978–81. It shows that some developing countries had already embraced this strategy of specialization (for example Philippines with 78 per cent of their rice production converted) while others were only just initiating the process (for example Thailand with only 9 per cent of the same).

Table 3.2 Area devoted to modern rice varieties (11 Asian countries, 1978–81)

Country	Year	1000 ha	% of Rice Area
Bangladesh	1981	2325	22
India	1980	18 495	47
Nepal	1981	326	26
Pakistan	1978	1015	50
Sri Lanka	1980	612	71
Burma	1980	1502	29
Indonesia	1980	5416	60
Malaysia W	1977	316	44
Philippines	1980	2710	78
Thailand	1979	800	9
South Korea	1981	321	26

Source: Anderson and Hazell (1985).

Table 3.3 shows the progress of this process within individual states. In those states that initiated modern agricultural specialization (for example the USA), food production is now almost entirely specialized (the majority of food production involving only a few varieties of a small number of species). In the states adopting the strategy more recently, this 'scoping in' process has reduced the number of varieties in production from thousands to a few in a small amount of time (Table 3.2).

Hence the biodiversity problem is a problem with its source in the ever increasing specialization taking place within the biological production sector. All societies are embracing the strategy of supplying their needs from a mere handful of species, and increasingly it is the same small group of species and

Table 3.3 Examples of genetic uniformity in selected crops

Crop	Country	Number of Varieties
Rice	Sri Lanka	from 2000 varieties in 1959 to 5 major varieties today 75% of varieties descended from one maternal parent
Rice	India	from 30 000 varieties to 75% of production from less than 10 varieties
Rice	Bangladesh	62% of varieties descended from one maternal parent
Rice	Indonesia	74% of varieties descended from one maternal parent
Wheat	USA	50% of crop in nine varieties
Potato	USA	75% of crop in four varieties
Cotton	USA	50% of crop in three varieties
Soybean	USA	50% of crop in six varieties

Source: World Conservation Monitoring Centre (1992).

varieties that is supplying every society. This means that the biodiversity problem has two interrelated but very different facets: the problem of ensuring an adequate supply of genetic diversity for the supply of specialized industries such as agriculture and medicine and the problem of ensuring an adequate supply of unconverted habitats for the supply of genetic diversity.

The two problems are interrelated in that unconverted habitats are one source of supplies of the genetic diversity required by specialized industries. The two are also distinct because industrially important genetic diversity can be supplied through means other than non-conversion, for example the retention of genetic diversity in 'banks', and because non-converted habitats can generate many other values than those emanating from the specialized industries, for example the values from visits or known existence. However, in the first instance, it is important to focus on the need for diversity to sustain the specialized methods of production in order to establish an overall constraint on the process of conversion. Once again this approach is adopted in order to place a 'floor' under the minimum required amount of biodiversity. There can be no argument (even from the most rabid pro-growth perspective) for the continued pursuit of the gains from specialization by sole reliance upon a strategy that places those same gains at risk. Biodiversity provides many different values to human society, however its most fundamental value is in the support of the specialized production system which is its greatest threat.

5 The 'uneven' nature of global conversion: human development and diversity depiction

Before we proceed to the discussion of the value of biodiversity, it is important to recognize the benefits received from specialized development to human societies. These conversions from diverse to specialized resources have generated substantial worldwide productivity gains. World cereal production grew at an average annual rate of 2.7 per cent between 1960 and 1983 (Anderson and Hazell, 1989). For example the substitution of specialized rice varieties for diverse is estimated to have increased yields by 1.0 tonne/hectare on irrigated lands, and by 0.75 tonne/hectare on non-irrigated lands. Although the conversion of lands from diverse to specialized production methods must reduce global diversity, it is apparent that these losses are compensated for, and driven by, development gains.

The economic relationship between conversion and development is demonstrated in part by the state of human development in the 'diversity rich' states. Almost without exception, these are some of the poorest nations on earth in terms of human wealth. They range between 1 and 7 per cent of the OECD average per capita income. Although non-human species are faring relatively well in these countries, the human species is doing comparatively poorly (Table 3.4).

Table 3.4 GNP per capita in the species-rich states

Country	1988 GNP p.c.	Country	1988 GNP p.c.
Tanzania	$160	Papua, NG	$810
Zaire	$170	Thailand	$1000
Uganda	$280	Bolivia	$1099
Ecuador	$284	Colombia	$1139
China/India	$340	Peru	$1300
OECD Average	$17 400		

Source: World Bank (1990).

From this perspective the decline of diversity has been closely linked with the human development process. The conversion of biological resources has taken the form of substituting the specialized species for the diverse causing diversity to decline. This has generated a gain for that human society, a gain that could be allocated to either increased wealth or fitness. Thus conversion to the specialized species has been a strategy for generating human development gains.

To date much of the gain achieved from this strategy has been expended on the expansion of the human niche. For the human species a revolution in niche expansion has occurred over the last 10 000 years. Scientists estimate that the introduction of the ideas of agriculture at that time coincided with a 'take off' in the level of the human population. Since that time the human population has expanded from approximately 10 million to approaching 10 billion individuals.

Despite the scale of the human population it remains the method of appropriation that is the gravest threat to diversity. This has been demonstrated in various ecological studies. The ultimate scarce resource, biologically speaking, is known as net primary product (NPP). This is the total biomass generated by the process of photosynthesis on this planet. It is also the total amount of usable solar energy available for the sustenance of all life forms on earth. The expansion of the human niche has resulted in the exclusion of most other species from a substantial part of NPP. Ecological studies show that the human species now appropriates about 40 per cent of terrestrial NPP (Vitousek *et al.*, 1986).

Most importantly, however, the same study argues that the vast majority (90 per cent) of all human niche appropriation occurs 'indirectly', that is for reasons other than direct use. The vast majority of NPP appropriated by the human species is not used but rather lost to other species, by reason of clearing and burning lands in particular. The biodiversity problem is as much a problem of diversity-unfriendly methods of production as it is human niche expansion. Still these gains are usually routed initially to the expansion of the human niche, and this is indicated by the growth in the human populations on the conversion frontier (Table 3.5).

Therefore development (human development) is a process that has been driven in part by the process of conversion. This has resulted in a remarkable

Table 3.5 Population growth in the species-rich states (percentage per annum, 1980–90)

Tanzania	3.1	Papua, NG	2.5
Zaire	3.2	Thailand	1.8
Uganda	2.5	Bolivia	2.5
Ecuador	2.4	Colombia	2.0
China	1.4	Peru	2.3
India	2.1		
OECD Average	0.6		

Source: World Bank (1992).

asymmetry in the world. The states with high 'material wealth' have low 'diversity wealth', and vice versa. The problem of biodiversity stems primarily from the attempts of the remaining, unconverted states to follow this same development path. At present the margin of the global conversion process rests at the threshold of the last refugia for diverse biological resources. If development continues in the future in these states as it has in the past in all others, then there will be much less global biodiversity to be concerned about in the very near future.

6 Regulating the global conversion process

To a large extent the problem of biodiversity depletion may be attributed to the absence of an international institution dedicated to its conservation. That is the global biodiversity problem may be conceived of as the set of difficulties that derive from the fact that the conversion process has been regulated on a globally decentralized basis. Historically each state has been able to make its own conversion decisions regarding its own lands and resources without regard for the consequences for other societies. This creates an important regulatory problem because the cost – in terms of the value of lost services – of each successive conversion is not the same. The global stocks of biological diversity generate a flow of services to all societies on earth. As we shall see in this chapter, all of us rely upon the stocks of diversity for the maintenance of our various support systems: agriculture, medicine and ecosystems. The first subtractions from global stocks did little to hinder the flow of these services, but the final subtractions from these stocks will render these flows non-existent. As the last refugia for diverse species dwindle, the cost of each successive conversion (in terms of diverse resource services lost to all societies on earth) escalates rapidly. The absence of any mechanism to bring these costs into the decision-making framework of the converting state is a big part of the biodiversity problem.

Although it may be threatening the very existence of a continuing flow of services from global stocks of biological diversity, the depletion of these stocks may nevertheless be to the clear benefit of the individual or society that is undertaking it. This is the nature of the regulatory problem of biodiversity losses – it is a conflict between what is in the interests of the development of the individual country and what is necessary for the protection of a production system relied upon by the global community. The individual country simply wishes to undertake the conversion process, as have all states that have preceded it in this development process, while the global community wishes to internalize the global costliness of the final conversions to these last, unconverted states.

Therefore the global policy problem of biodiversity losses involves the management of the global conversion process so as to reach the correct end-

point, taking into consideration the 'global externalities' that individual societies do not. That is it is necessary to ascertain a global stopping rule that will determine when the marginal conversion by an individual country is not globally beneficial, and then alter the decision-making framework of that state so that the conversion will not occur.

The development process drives society to convert more and more of its land area to specialized uses over time. Each such conversion confers a gain upon human society – the value of converting between assets – and thus continues to drive the conversion (and development) process. The pertinent question then becomes: what forces might halt the conversion process prior to total conversion? What countervailing force is there to offset the perceived value deriving from specialized conversions?

It is the value of diversity itself that should provide the stopping point in the global conversion process. That is, with successive conversions, the quantities of lands in specialized production will be increasing while the quantities in diverse resources decline. At some point in this process the relative values of the two uses might switch, so that the use of the land in diverse resources is preferred. It is the value of biological *diversity* that should arrest the conversion process at its optimal point. The stock of global diversity provides important inputs into the processes of biological production, and it is this value (and not the individual values of the biological materials themselves) that is the essential force to be given effect within the biodiversity regulatory process.

Without intervention it is very unlikely that this force will be of any effect. As indicated the main source of benefits from diverse resources lies in their 'stock-related values'. In other words these are benefits that accrue to the world at large, rather than to the state hosting them. Such diffuse values will not in general be taken into consideration in state decision making regarding conversion. If diverse biological resources are systematically undervalued, then they will be too readily converted to their specialized substitutes. This will result in the retention of a quantity of diverse resource stocks that is less than optimal.

Figure 3.1 demonstrates how the non-appropriability of these stock-related values will lead to the mistargeting of the conversion process. That is this is a figure illustrating the misdirection of the conversion process over the very long run, as conversions erode the remaining diverse resource stocks, on the relative values of lands in specialized and diverse biological resources. This diagram demonstrates that the quantities of lands dedicated to the production of specialized resources in the very long run (allowing all factors to adjust) will be determined by:

- *domestic supply of conversions* (S) – this downward-sloping curve represents the *internalized* marginal cost of converting to specialized

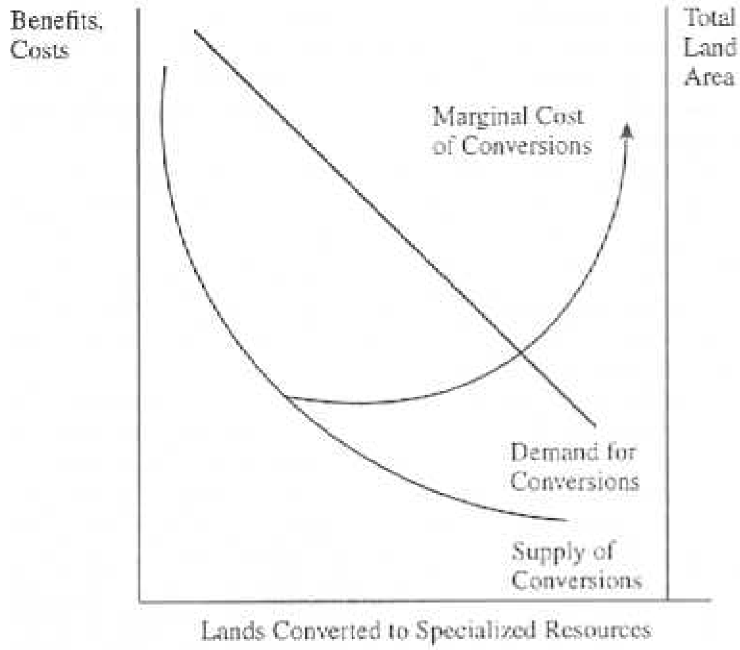

Figure 3.1 *Optimal policy regarding conversions*

resources. This curve is perceived to be downward-sloping because of the increasing returns to scale available to capital-intensive methods of production. Each state that decides to convert its resources incurs decreasing costliness because of the fixed costs incurred by its predecessors.

- *demand for conversions* (D) – this is the perceived benefit to the marginal state from the conversion of its resources (that is reshaping its portfolio from diversity to specialization). This benefit is declining because there is consumer resistance to the acceptance of specialized substitutes for some naturally diverse resources. It is also declining because the by-products of conversion, that is human niche expansion and development, probably yield positive benefits (with consequent population growth, urbanization and industrialization) but at a declining rate as these characteristics become less scarce with additional conversions. In short the downward-sloping demand curve takes into account both the declining value of specialized resource flows and the increasing appropriated values of diverse resource flows.
- *global marginal cost of conversion* (MC) – one of the important marginal costs of the conversion of lands from diverse resources to specialized is the opportunity cost of foregone diverse resource stocks. These costs are included in MC, but not in S, because these represent the full costs rather than the domestically appropriable costs of conversions.

Even accounting for the global values of biodiversity, a large part of diversity would be converted into specialized resources; however there would necessarily be a stopping point in this process as the value of diversity began to bite. Figure 3.1 indicates where the stopping point would occur in the unregulated global conversion process. This is the point where the marginal piece of land remains unconverted because the benefits of conversion are no greater than the actual benefits flowing from its retention in its natural state.

The divergence of the *S* and the *MC* curves in Figure 3.1 provides the explanation for the mistargeting of the global conversion process. In this scenario the supply curve for specialized lands is misperceived, because of the failure to internalise the full costliness of increasing the land area dedicated to specialized production. The global externalities flowing from reduced stocks of diversity are not being considered in the supply cost of marginal lands, and as these are increasing with each successive conversion (and especially when the final stocks are endangered), the supply curves deviate from one another more substantially with each conversion. The individual or state making the conversion decision considers only this costliness (within a 'decentralized' regulatory framework), and thus an excessive quantity of specialized lands (Q_d) results under a domestic decision making regime. It is possible, even probable, that Q_d would fall at the point of total conversion, in the absence of institutions that render some of these global values appropriable.

The global problem of biodiversity is the result of this decentralized approach to the global conversion process. Each state has converted its lands to specialized resource production without consideration of the stock-related costliness of these decisions. Early conversions were able to be undertaken at low global costliness (because *S* and *MC* did not diverge significantly when substantial quantities of other stocks remained). However, as the final stages of the conversion process are undertaken, this divergence becomes increasingly severe and ultimately unbounded. The global problem of biodiversity involves the creation of an international regulatory mechanism which will bring this divergence within the decision-making framework of the remaining, unconverted states.

7 The need for international environmental agreements

This chapter has demonstrated how the developmental process has generated several different facets of a global environmental problem: declining levels of the resource, asymmetric holdings of the resource and asymmetric wealth in the nations involved. In the case of the resource we call biological diversity, the pursuit of development in the same manner in one state after another has resulted in a world increasingly devoid of biological diversity. There also appears to be a coincidence between those countries which developed first (and hence have least biological diversity) and those with highest levels of material wealth. These asymmetries contribute to the problem, because they contribute to the level of difficulty involved in solving it.

Most importantly it is clear that the continuation of the unregulated development process cannot by itself resolve this problem. This problem, and others, are in fact the result of the pursuit of development on a decentralized, state-by-state, basis. When this is the case there are certain resources which every state relies upon but which is unavailable in sufficient quantities to support the same sort of development in each and every country. Then the decentralized development process, when pursued to its logical conclusion, will result in far too much pressure on a few important resources.

This is the case in the context of biological diversity. If every country on earth completely converts its biological resources to the same small set of species, then there will be insufficient variety remaining on earth to support that level of development. It is also the case for the atmosphere. If each and every country pursues fossil fuel-based development to the same extent as those countries of the West, then the stress on the natural climatic and atmospheric systems will just be too great, and environmental conditions may change dramatically.

This means that the global development process, when pursued on a decentralized basis, sometimes provides adequate global resource stocks for the first countries to develop, but that these resources are then too heavily utilized to provide the same support for all later countries to develop to the same extent. In effect the first developing countries have had the benefit of free use of the global commons while there were sufficient resources available, but increasing pressure requires some sort of a rationing mechanism.

This is the reason that there is a need for international environmental agreements – they provide the mechanism for rationing global resources between states competing for their use in their development. This is also the reason that it is very difficult to agree on the shape of these new institutions – they will determine explicitly the shares of individual countries to necessary global resources and they will determine implicitly the shares of individual countries to global development and global product.

4 Relations between nations: the reasons that different states view the same problem so differently

1 Uneven development and disparate perspectives

One of the largest hurdles to the development of effective international environmental law is the range of perspectives on a given problem. Although the resources to be regulated are 'common' to all of the states concerned, each state views the resource uniquely. Then each comes to the negotiating table with its own well-defined perspective on the management of the resource (based in this individual viewpoint), and finds that every other state is similarly armed with a very different perspective. These differences drive much of the disagreement about the joint management of common resources.

Similarly the same problem emerges when joint management is based upon a uniform standard. That is, even if the parties are able to agree upon a regime of resource management, the proposal of a management regime based upon uniform treatment of the parties is unlikely to receive much support. This is because the parties each view their own contribution to the management regime differently – in accordance with their own views on what they should contribute and how much they previously were contributing to the management of the resource.

All of this results from the fact that resource management is a function of development status. Many studies have shown that investment in public goods rises with the level of accumulation of private goods, and in fact that individuals tend to demand relatively more public goods when their stock of private goods are already very high. This makes sense: there are many substitutes for consumer goods and services but very few for the services of the environment (air, water and aesthetics). Hence we see at national levels that countries with substantial quantities of basic consumer goods tend to increase their demands for environmental ones.

At international level this same phenomenon exists, albeit at a diminished rate on account of the fact that the provision of the public good is embedded within the IEA process. Nevertheless different countries (dependent upon their development status) will view their individual interest in the efficient management of a common resource differently. Individual countries will even invest in the management of a common resource differently, even when other countries sharing the same resource refuse to do so.