



Biodiversity in arid regions: values and perceptions

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With their modest rainfall, arid regions are characterized by relatively fewer species than the better-watered biomes. But this makes it all the more important that the biodiversity that is present in arid environments be given even higher priority; for each species lost from an arid region, the percentage of loss for the region's biodiversity is much higher than in more species-rich regions. And some species, such as bees and ants, are particularly diverse in arid habitats. Realizing the importance of biodiversity in the arid regions where they live, local people have devised numerous ways of limiting their impact. Historically, such regions have been especially subject to changes in climate, which affect productivity; these changes have often been accompanied by conflicts. The paper will describe these from various parts of the arid world, as a basis for comparison. The paper will also examine economic issues relating to biodiversity in arid lands, focusing especially on the relationship between biodiversity and various kinds of development projects. The major challenges in implementing the Convention on Biological Diversity (CBD) in arid lands lie not so much in the biology of the species concerned, but rather in the social, economic, and political arenas within which people operate. We need to build a broader constituency for conserving biodiversity, extend the responsibility for conserving biodiversity far beyond government, bring local people into the conservation movement, ensure that sufficient information is available to those who need it, restore degraded ecosystems, and stimulate far greater public support for biodiversity.

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Introduction

The vast region covering the arid and semi-arid lands of North Africa, the Middle East, and Central Asia — the Palaearctic Desert — is the cradle of Old World civilization. While they have given us most of our domestic animals and some of our most important crops, these arid lands have been devastated by wars, overgrazing, and the vagaries of climate for thousands of years. Today, as populations increase and modern technology becomes more pervasive, many of the rural people living in this region are again facing the ancient scourges of hunger, pestilence, and conflict.

One of the tragedies of this situation is that the biological resources which could help make these lands productive often are abused rather than nurtured. Where the

productivity of biological resources has been seriously reduced, efforts at development, such as road building, borehole drilling, and food importation for people and livestock, have typically caused more overexploitation rather than less.

Thus the major challenges in implementing the Convention of Biological Diversity (CBD) in arid lands lie not so much in the biology of the species concerned but rather in the social, economic, and political arenas within which people operate. Biological resources are being abused because some people — typically those with the greatest economic stake in development — are making money out of depleting wildlife and habitat, and modern technology often helps to encourage them in their exploitation. And they are making money because they are harvesting the benefits of nature without paying the environmental costs for either production or replacement. Instead, the costs are externalized or passed on to society as a whole, to be paid by the public now or in the future.

Cultural adaptations to arid ecosystems

While the public perceives arid lands as endless deserts, these systems in fact are highly dynamic. For example, between 1980 and 1995, the edge of the Sahara moved north and south depending on rainfall, moving as much as 300 km over several years, but in different directions. Around villages and wells, overgrazing can shift vegetation from grasses to equally green, but less palatable, shrubs; thus the community structure may change, but biodiversity is not necessarily lost (Kerr, 1998). More important, the climate-related dynamism of these ecosystems has a profound influence on cultural adaptations to them.

Humans have adapted to arid lands in many ways. At a technologically rather basic level, some human groups are able to survive as hunter-gatherers in arid areas with very low plant diversity. For example, Australia's Western Desert Aborigines have just 10 plant staples, and in times of mild drought, this number drops to three, but the volume of food remains sufficient to feed the people (who live in very small bands). In very bad times, the lack of food and water forces people to abandon their territories and seek refuge among neighbours (Flannery, 1994). For most other peoples living in arid lands, pastoralism or agriculture have been the main approaches to earning a living.

Domestication of livestock apparently arose after domestication of plants and remains the most significant use of arid and semi-arid lands by people. The dangers of overgrazing have led to many beliefs and customs about human relationships, livestock management, and range management. For example, many Middle Eastern pastoralists have developed complex ways of sharing grazing lands, including the idea of *hema*, a traditional grazing reserve. At least some species of trees typically are considered sacred by many pastoral peoples and are not destroyed except in times of dire need; conservation of such vegetation thereby provides an emergency resource reserve (as well as conserving biodiversity).

The various ethnic groups that occupy the various parts of the Palaearctic Desert have developed powerful attachments to the grazing lands, water sources, and ancient migration routes between dry- and wet-season pasture, the basic resources around which their ways of life have been formed. At least part of the biodiversity problems in these arid lands are due to the erosion of traditional means for controlling the use of agricultural and pastoral lands, as the modern states have proven unequal to the task of resource management even though they often have far-reaching powers. For example, traditionally, the customary chiefs prevented herders from digging two wells within a radius that would put two herds in the same pasture, thus avoiding both overgrazing and potential conflicts between groups of competing herders; but modern forms of development often make this very basic mistake of providing too much water too close together.

At least historically, pastoralists also frequently fought over grazing land or access to water. The battles often were ritualized, with the result being resolution of conflict and a better adaptation between people and the available resources. With relatively sparse populations, various social means were adopted to avoid all-out war.

Based on work done in the Sahel (IUCN, 1989), it appears that at least some local communities share a set of productive interests and sufficient economic and political cohesion to make and enforce rules about common resource use, and may be expected to do so in ways that protect long-term continuity in such resource use. Communities that lack these fundamental characteristics are unlikely to be able to conserve biodiversity in an effective manner. But generally speaking, effective management of biological resources should be based on enabling local communities to regulate their own biological resources, with the role of the central government being to establish the general policy framework and act as guarantor of the tenure rules that are negotiated locally, and helping to ensure that no individuals or groups become so impoverished that they fall outside the consensus and it becomes rational for them to break the tenure rules.

In short, the local people who have lived and prospered in arid lands for many generations have developed considerable knowledge about how to adapt to local ecosystems, though this knowledge is seldom fully appreciated by either developers or policymakers. Local people habitually deal with complex systems of grazing and farming, on marginal soils with few external inputs. Natural selection is a very real part of their lives. Under such conditions, pastoralists have amassed an impressive body of useful information on how to manage livestock, and on the relations between their livestock and the rest of the region's biodiversity. This information, called ethnobiology by scientists, needs to be harnessed to support implementation of the CBD.

Biodiversity and conflict in arid regions

While pastoralism is the major approach to earning a living in arid lands, at least in terms of land area used, farming is also found wherever local conditions — especially soils and water — permit the growing of crops. Given the dynamic nature of the climatic conditions in arid lands, such agriculture often is a risky business. And one of the major risks, at least historically, is the potential conflict between farmers and herders, between Cain and Abel.

The historically frequent conflict between farmers and pastoralists is exacerbated by their interdependence, as each group produces something that the other needs. Farmers may also intrude on the favoured habitats of the nomadic peoples, leading to additional ecological pressures (e.g. Suliman, 1996a). Thus, frontiers between different ways of life are dynamic zones where possibilities for conflict are also often at their highest; this dynamism also means that such areas are often extremely rich in biological resources.

One of the underlying causes of such conflict in modern times involves the subsidized support of governments for certain types of agriculture, leading to neglect and marginalization of some groups of people, leading in turn to tensions that can eventually escalate into violence. In places like the Sudan-Ethiopia border area, at least some dispossessed and economically marginalized pastoralists have become bandits who raid both farmers and nomads.

Biodiversity and the ancient conflict between farmers and pastoralists

The age-old conflict between farmer and herder serves to maintain a sort of balance between different forms of land use. If the population of farmers increases and

starts to occupy the marginal lands that can be used more sustainably for herding, the herders react violently and in turn may drive the agriculturalists off the marginal land. Conversely, if the herders exceed the carrying capacity of their grazing lands, they may increase their raids on the farming lands, triggering a violent reaction on the part of the farmers (Harris, 1974; Vayda, 1976).

Violent conflicts between herders and farmers go back at least to Biblical times, perhaps arising from their different ecological adaptations; farmers are closely tied to the land, making it difficult for them to move away should they make an enemy, while pastoralists frequently move their families and herds, and doing so to avoid the consequences of a serious quarrel is no particular problem (Edgerton, 1992). Some recent examples are as follows:

- The conflict in Somalia is the continuation of a 100-year-old movement of major Somali clans southward into agricultural areas from nomadic grazing areas that have been becoming more and more overpopulated due to mismanagement of biological resource systems (Hutchison, 1991).
- In the Sudan, mechanized farming has been a key contributing factor to civil war between north and south that broke out in 1983 and continues today. Large-scale commercial farming and ranching projects are in conflict against peasants and pastoralists, fostering confrontation (Suliman, 1996b).
- Northern Niger has been the setting for consistent, low-intensity civil disturbances since 1992, affecting the Air Tenere Reserve (a world Heritage Site). The conflict with armed groups from the pastoral communities of Tuareg, Fulani and Tabu has never led to major battles or to the capture of any urban cities, but has fostered consistent insecurity in rural areas and frequent raiding that has hampered development in the rural agricultural areas. This rural insecurity has also led to the loss and near-extinction of many wildlife species, including the addax (*Addax nasomaculatus*) and scimitar-horned oryx (*Oryx dammah*). But it is also possible that in remote areas of the Air Tenere, the unrest has enabled wildlife to survive.

Conflict is often associated with periods of severe drought or other natural calamities that exacerbate problems like competition over limited resources. Ember & Ember (1992) found that societies that have a history of expectable but unpredictable disasters, such as droughts, floods, insect infestations, and so forth, were the ones most frequently at war; in areas plagued by drought, the dry years tended to be those in which raiding parties were sent out. In Ethiopia, periods of conflict and political instability invariably have reached their greatest pitch during or following major droughts, some of which have resettled up to 600,000 people, leading to even greater environmental disruption (Hutchison, 1991). Thus the climate change that is generally accepted to be inevitable, if not already upon us, is likely to enhance the likelihood of warfare, or at least conflict, through its impacts on biodiversity.

At any given level of technology, a society will have a maximum population size that can be supported by the habitat, a population level that is commonly called 'carrying capacity'; farming societies have a higher carrying capacity than herding societies, again a function primarily of rainfall. As a society approaches the maximum population for the carrying capacity, the relationship between population and food supply becomes critical, and even minor variations in annual food availability can cause major disruptions. And if societies have become dependent on traded products, their carrying capacity can depend on maintaining the flow of the traded products. And if trading partners refuse to trade, raiding is often a ready option.

Territoriality may not have been a particularly important concept for nomadic peoples. Although they certainly were attached to certain grazing lands and may have conceded the claims of others to theirs, the fluid composition of the tribal group was a salient characteristic of their way of life. Groups expanded and contracted in

unpredictable ways. Life in the grazing lands was a living illustration of the concept of carrying capacity, where life was subject to sudden and highly disruptive climate change. Warm moist years with good rainfall made for good grazing and a higher survival rates of the herds, which in turn enabled the human population to increase; but such years inevitably were followed eventually by drier years which left larger flocks short of grazing, and humans short of livestock. Migration within the region was not helpful if the climate change were widespread, because neighbours were similarly stressed and highly resistant to invasion. The obvious move in such a case was toward the agricultural lands where cultivation could provide at least emergency rations. Thus raiding from the pastoral peoples into agricultural lands has an ancient history indeed. And some historians believe that the threat of war on behalf of the nomads helped ensure a willingness to trade on the part of the agricultural civilizations (Keegan, 1993). Thus the Silk Road linking China to the Middle East was able to function for over a millennium even though nomads could have disrupted the trade at any moment, and of course such trade requires a structural balance between what is desired and what can be offered in trade.

The pattern of sporadic warfare in arid lands appears to be a global phenomenon. For example, in the pre-Columbian American South-west, the more-or-less constant warfare has been explained by environmental factors, particularly carrying capacity, which affected the number of people able to be supported (LeBlanc, 1999). When a series of bad climatic years resulted in food stress that might have led to starvation, outbreaks of warfare were more likely. During good times, populations would have been able to increase at moderate rates, with the population constantly approaching carrying capacity. When the carrying capacity subsequently declined during periods of less favourable climatic conditions, the population would have exceeded its carrying capacity and would have declined, with warfare involved in the population reduction. The dynamic environmental character of the American South-west meant that the effective carrying capacity changed over time, and this implies that the human population had to respond to such changes. Climate, particularly rainfall, was probably the critical variable.

Biodiversity loss as a contributor to conflict

Resource degradation, including loss of biodiversity, can create scarcities that push people out of the regions where they live. Insufficient supplies of firewood and timber, depleted aquifers, and soil erosion can form a feedback loop of poverty, insecurity, and environmental degradation. In rural areas where people directly depend on the soil, water and grazing lands for sustenance, poverty is essentially an environmental trend. People living in arid lands are usually cash poor, yet so long as they are natural-resource rich, they can remain home and prosper. But when people flee poverty, they are often fleeing environmental impoverishment — after the topsoil has blown away or the well has run dry — in places without a rural economy that would offer them alternative sources of livelihood (Kane, 1995).

A major global illustration of the impact of biodiversity loss on human security is taking place in the Sahel, where natural resources are diminishing and competition over their use is increasingly tense. Violent conflicts at levels ranging from interpersonal to international are becoming increasingly frequent. While environmental degradation might not be the sole cause of conflict in the Sahel, it is an increasingly important factor, and ecological decline carries implications that spread far beyond the region. In some parts of the Sahel, the land has been defoliated, burned, polluted with chemicals, or infested with landmines, so the land can no longer be managed productively. But in other areas, abandoned land has recovered its vegetation and wildlife because it is no longer overexploited by humans and livestock.

Resource scarcity can arise from three sources: degradation or depletion of a resource, increasing consumption of the resource (for example, due to population growth or rising per capita resource consumption), and uneven distribution that gives relatively few people disproportionate access to the resource and subjects the rest to scarcity. Resource scarcity can lead to declining agricultural production, economic hardship, migrations of people from areas of environmental stress, and tensions within and among groups — a melange of factors that can contribute to violent conflict (Homer-Dixon, 1994). When resource scarcity reduces the ability of states to meet the needs of their population, dissatisfaction can lead to declining state authority, which in turn nurtures violent collective action.

Resource scarcities in many arid lands are already contributing to violent conflicts that may be early signs of an upsurge of violence in the coming decades that will be induced or aggravated by scarcity. Poor societies — lacking the benefits of oil-related income — will be particularly affected because they are less able to buffer themselves from resource scarcities and resulting social crises. These societies typically already are suffering acute hardship from shortages of water, pasture, and fertile land. A major problem is that fast-moving, unpredictable, and complex environmental problems can overwhelm efforts at constructive social reform. Moreover, scarcity can sharply increase demands on key institutions, such as the state, while it simultaneously reduces their capacity to meet those demands. These pressures increase the chance that the state will either disintegrate or become more authoritarian, both of which can enhance the likelihood for conflict.

Conservation for peace

Some countries are using biodiversity conservation efforts to help promote domestic peace. Lebanon suffered a violent and bloody civil war from 1974 to 1990, resulting in significant loss of human life, massive destruction of property, fragmentation and weakening of the central authority, and various forms of environmental degradation. Following peace, a massive building boom further accelerated the rate of environmental destruction, as contractors demanded access to diminishing water supplies, concrete, stone, and sand, with little regard to the environment. Trees were cut for firewood and charcoal, livestock was released to graze eroding slopes, and hunters continued to slaughter migrating birds by the thousands (Abu-Izzadin, 1997). Several non-governmental organisations (NGOs) were developed to meet conservation needs even during the war, and now are mobilizing funds from the financial mechanism of the CBD to use protected areas as one means of fostering recovery from the war. Abu-Izzadin (1997) identifies at least four ways that the new system of protected areas is promoting peace in Lebanon:

- (1) Visiting the reserves: the fragmentation of the country is being repaired by bringing people together from different parts of Lebanon and reintroducing them to their natural heritage through properly organised and guided tours in protected areas.
- (2) Appointing local NGOs: national reconciliation is promoted by appointing local NGOs to plan, protect, and manage protected areas, thereby diffusing tensions and minimizing unwanted friction between opposing fractions; this measure also helps to ensure that management practices are fully compatible with local political, social, and religious institutions.
- (3) Bringing institutions together: bringing the government, NGOs, and scientific institutions together to establish a network of protected areas is expected to enhance national reconciliation.
- (4) Allowing ideas and solutions to interact: national reconciliation is being approached from the perspective of people, communities, and institutions, allowing

ideas and solutions to be brought together on many different levels through the peaceful activities of nature conservation.

More broadly, some countries are recognizing the possibility of using protected areas designed to conserve biodiversity along their borders as ways of promoting peace. In many countries, boundaries are in mountainous areas which also tend to be biologically rich because of the great variety of habitats and ecosystem types found within relatively small areas affected by differences in elevation, microclimate, and geological factors. While such ecologically diverse areas are often particularly important for conservation of biodiversity, they also are frequently sanctuaries in war, especially civil wars and guerrilla wars.

Given that national frontiers are both especially sensitive areas where conflict is endemic and biological resources are especially rich, the idea of establishing protected areas on both sides of the border — as so-called peace parks — has attracted considerable attention, providing a symbol of the desire of the bordering countries to deal with many of their problems in a peaceful way (see, for example, Westing, 1993; Thorsell, 1991). Zbicz & Greene (1997) have found that transboundary protected areas cover well over 1.1 million km², representing nearly 10% of the total area protected in the world. In addition to indicating the importance of transfrontier protected areas, this also demonstrates how much of the world's land area are devoted to biodiversity conservation is in remote frontier areas where of war historically are highest.

Transfrontier protected areas

Many protected areas are located on national borders, and some have adjacent protected areas on the other side of the border, forming complexes that could be the focus of collaboration. The IUCN (1997) calls these (perhaps optimistically) Parks for Peace. Table 1 indicates how widespread and important such areas are.

Brock (1991) concludes that although peace parks have probably have had relatively little independent effect on international relations, transfrontier cooperation on biodiversity issues has the potential to develop into an important factor in at least regional politics by helping to internalize norms, establish regional identities and interests, operationalize routine international communication, and reduce the likelihood of the use of force.

Conserving biodiversity in arid regions

So what needs to be done? Under the CBD, a number of measures are already being proposed to be taken by governments (UNEP, 1999). Beyond these, I propose several suggestions.

First, we need to build a broader constituency for conserving biodiversity. The point here is that most economic sectors depend on biodiversity: agriculture depends on wild genetic resources and biological controls; human health depends on nature for many pharmaceuticals; industry requires raw materials, all of which ultimately come from nature, and uses nature as a way of absorbing waste products; tourism increasingly bases its attractions on natural amenities linked to biodiversity; traditional peoples have a deep vested interest in ensuring the conservation of the biological resources upon which their cultures are built; water resources often require intact vegetation to protect watersheds and prevent siltation; disaster prevention needs natural vegetation to help people respond to drought; and the list goes on and on. Each of these sectors needs to be reminded of its reliance on biodiversity and provided with opportunities to invest in ensuring the continued survival of the biological basis of their prosperity.

Table 1. *Transfrontier protected areas and designated protected areas*

Continent	Transfrontier protected area complexes	Designated protected areas
Africa	39	110
Asia	31	74
Europe	54	138
North America	10	44
Latin America	35	89
Total:	169	455

Compiled on the basis of information presented in IUCN (1997).

Second, we need to extend the responsibility for conserving biodiversity far beyond government. Even the most prosperous governments are not able to conserve their nation's biological diversity by themselves. Instead, various kinds of incentives and disincentives are required to promote human behaviour which will in turn promote the conservation of biodiversity. This may require various measures in the private sector, including exclusive use rights, private reserves, easements, tax benefits, game ranches, and so forth (McNeely, 1988). Game ranches in east Africa, for example, have demonstrated that local people can both conserve the diversity of wildlife species that can make the best use of locally available vegetation and can earn a profit while doing so (Kay, 1987; Du Toit & Cumming, 1999). Such approaches could be broadly applied in arid lands; Jaffe (1975), for example, has shown that oryx can produce far more meat on far less water than either goats or sheep.

Third, we need to bring local people into the conservation movement. Local people, especially those who have lived in the arid lands for many generations, have the best knowledge about the local species and a real stake in ensuring that local biodiversity can continue to support their communities. Problems arise when outside forces — such as foreign markets for hunting, development projects, or markets for cash crops — start to compete for local resources, leading to a free-for-all where the biggest losers are the biodiversity and ultimately the local people. But where local people are given greater responsibility for resource management — in other words, when they are given a real stake in conservation — they have shown both a willingness and a capacity to conserve (Borrini-Feyerabend, 1997). More generally, civil society should be given much greater responsibility for conserving the biodiversity upon which their welfare depends (McNeely, 1999).

Fourth, as called for in Article 7 of the CBD, we need to ensure that sufficient information is available to those who need it. Obviously, effective action must be based on accurate information, and the more widely this information is shared, the more likely it is that individuals and institutions will agree on the definitions of problems and solutions. The current state of knowledge about genes, species, and ecosystems remains woefully inadequate in arid lands as well as elsewhere in the world. Thus increasing our knowledge base about the kind and variety of organisms that inhabit the arid regions, and the ways that these organisms relate to each other and to humans, must be a foundation of conservation action (see, for example, Abu-Zinada *et al.*, 1989). The modern information technology that is now readily available is enabling an interlinked and decentralized system of conservation databases, thus providing full access to the information required to solve local problems. Geographic information systems that include many species and habitats already are being established, but our challenge is to link them together so that they can provide the information needed for taking sound decisions on how biological resources are to be allocated and managed. We can also link

these biological databases with new work on climate, geology, and water resources to build integrated databases. We simply can no longer allow ignorance to be an excuse for inaction or for inappropriate action.

We all recognize that many threatened species find their last stronghold in protected areas, but as these areas come under various social, economic, and political pressures, the survival of these species and ecosystems becomes increasingly difficult. Information generated by scientists can help guide management options that will enable species to recover to productive levels, and ongoing monitoring systems can feed back essential information to resource managers. More generally, we need to apply our science to resource management. One challenge is that the results of research are not yet hitting the ground, so we need to find new ways for interpreting science and transforming it into practical action that can be implemented by resource managers, including farmers, fishermen, pastoralists, and foresters.

Fifth, we need to give more attention to restoring degraded ecosystems. Many arid lands have been so abused by past human activity that they are no longer as productive as they could be. Many such areas can be brought back to more productive levels, thus enabling them to support important biological resources and take pressure off of other areas important for conservation. One challenging part of restoration ecology is the reintroduction of species that have been extirpated, driven to local extinction. On the surface of it, perhaps it is overoptimistic to suggest devoting greater efforts to bringing back species that have been lost from all or part of their ranges. But many populations of large mammals have been extirpated due ultimately to ineffective management, so once the management capacity is improved, then we might reasonably expect to consider reintroducing species to at least part of their historical ranges, thereby enhancing the value of the habitat, the survival chances of the species involved, and the ability of the habitat to support rich human cultures. One outstanding example is the recovery of the Arabian oryx (*Oryx leucoryx*).

Finally, we need to stimulate far greater public support for biodiversity, and through this support generate greater investments for its conservation. Once we demonstrate that conserving biodiversity is a mainstream concern, as essential to human welfare as health, security, and education, then the general public, governments, and development agencies will see new opportunities for investment. Building public support should not be terribly difficult, since biological resources provide the very basis for life on Earth. The fundamental social, ethical, cultural, and economic values of these resources have been recognized in religion, art, and literature from the earliest days of recorded history. Given these multiple values, it is not surprising that most cultures and governments in arid lands have generally embraced the principles of conservation.

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