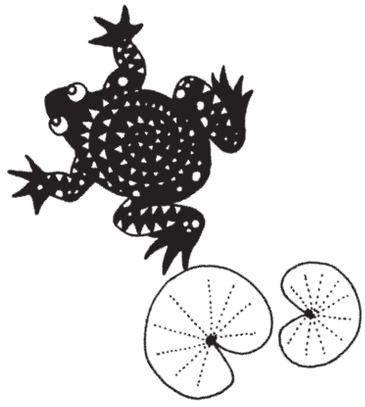
Chapter 5

Causes for the Loss of Biodiversity



India's biodiversity is in trouble. As described in *Chapter 4*, significant erosion of ecosystems, species, and genetic diversity has already taken place (though no one is aware of the precise extent and rate), and continues to take place. Experts estimate that over 5% of plants and animals are threatened with extinction, and these estimates have also been corroborated by the results of Conservation Assessment and Management Plan (CAMP) workshops conducted by ZOO and FRLHT (Kumar, A. *et. al.*, 2000). What are the specific causes of this loss?

In almost all cases, the causes can be traced to human activities. This chapter describes these causes in two parts: first, the proximate causes, or factors that can be pin-pointed as the direct and immediate ones causing the loss; and second, the root causes, or factors that are indirect and often hidden, and which give rise to the proximate causes in the first place. It should be noted that this distinction is not always clear, that the causes could merge into each other in specific circumstances, and that there is significant overlap within each set of causes.

Box 5.1 Indices of Human Impacts

Attempts to measure the impact of human activities on natural ecosystems have yielded two indices, a Living Planet Index (LPI), and the Ecological Footprint (EF). The LPI is the aggregate of trends in species populations in forest, freshwater, and marine ecosystems around the world. For each ecosystem the average population trend for a sample of animal species is taken into consideration. The global LPI declined by about 33% over a span of 25 years between 1970 to 1995, while the regional-level analysis indicated that the LPI for Asia had declined faster than the global average (Wu and Overton Undated).

The EF is the sum of six measures of an individual's impacts on the natural environment: the area of cropland required to produce the crops which that individual consumes, the area of grazing land required to produce the animal products, the area of forest required to produce the wood and paper, the area of sea required to produce the marine fish and seafood, the area of land required to accommodate housing and infrastructure, and the area of forest that would be required to absorb the CO2 emissions resulting from that individual's energy consumption. The same measures can be used to calculate the EF of a region, or country, or of the entire human world. The global EF has approximately doubled from 1961 to 1997 (J. Loh 2000). The EFs of most Asian countries, including India, have exceeded their existing biological resources. The EF measured on a per capita basis for India based on the 1997 population, is 0.8, while the available biological capacity per capita is 0.5, resulting in a ecological deficit of -0.3. The ecological deficit soars amongst the more developed of the Asian countries like Singapore, Taiwan, Japan, and Hong Kong, where it is – 5 and above, and indicates the negative impacts that current developmental trends have on the natural environment.

Source: http://www.ecouncil.ac.cr/rio/focus/report/english/footprint/ranking.htm.

5.1 Proximate Causes

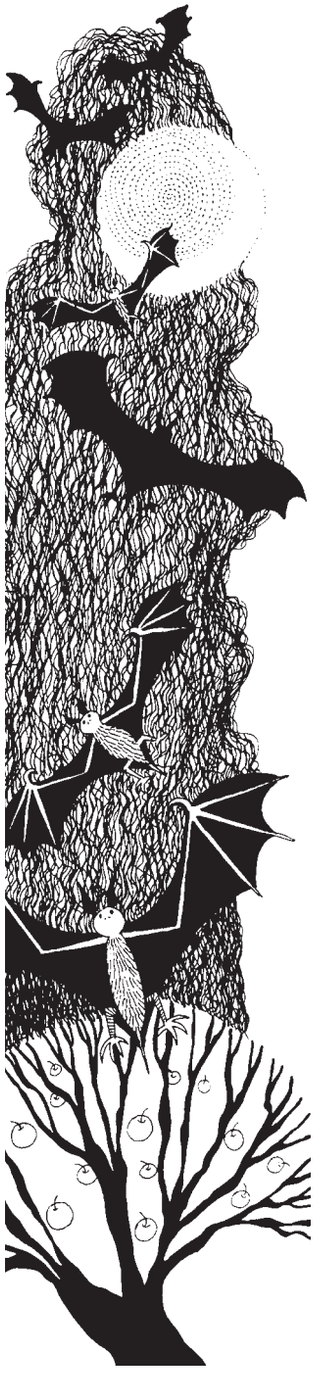
5.1.1 Natural Ecosystems and Wild Taxa[1]

5.1.1.1 Habitat Destruction and Degradation

Among the reasons for species loss, habitat loss is the most frequently cited. **Forest** loss in India has occurred much earlier than in most other tropical countries. For example, by the 1950s most of the clear felling of rainfor-

est in the Western Ghats had already taken place, while several Asian and South American countries had a forest cover exceeding 75%. It has been estimated that between 1920 and 1990, the forest cover in the Western Ghats decreased by as much as 40% with a fourfold increase in the number of forest patches or fragments (Menon and Bawa 1997). The monitoring of forest cover by the Forest Survey of India (in terms of canopy cover) shows that there was substantial loss till the 1990s, though there has been little forest cover loss thereafter. The current forest cover in the country is estimated to be about 20.55% (FSI 2002).

According to the Forest Survey of India (FSI), between 1951 and 1980, about 4.238 million ha of forest land was diverted for non-forest use. Of this, over 2.620 million hectares (26,200 sq km) of forest areas was converted for agricultural purposes (FSI 1988). According to MoEF, about 847,000 ha of forest land has been used for 10,118 projects from 1980 till 2003 (Singh 2003). This is primarily for regularising eligible encroachments, mining, transmission lines, hospitals, hydel power plants, irrigation systems and roads. Interestingly, despite claims of being much more ecologically sensitive, the government has considerably stepped up forest land diversion since the late 1990s… as many as 3,476 projects were cleared during 1999-2003, covering 382,000 ha, or about 45% of the total land diverted in 23 years! While an average of 350 projects were cleared annually from 1980 to 1999, the annual figure increased to 869 between 1999 and 2003.



As an example, in Himachal Pradesh, over the years 22.6% of forest land has been converted to agriculture and horticulture in the Temperate Zone alone (Pirazizy 1993, quoted in the *Himachal Pradesh State BSAP*). Some assessments of the impact of agriculture in the Himalaya suggest that the extent and kind of cultivation is having an adverse effect on forests. It is estimated that for every energy unit of agricultural yield (including milk), about 12 energy units have to be spent, and a substantial part of this comes from forests in the form of manure, fodder, and fuel (S.P. Singh *et. al.*, 1994). Another calculation shows that for every hectare of cultivation, about 30 ha of forests are needed for fodder, and about 42 ha for firewood, whereas the per capita forest area available in the Central Himalayan belt is only 1.6 ha (Negi and Singh 1990). These assessments suggest that current levels of cultivation in the Himalaya are unsustainable, and should be replaced by agroforestry and forestry models that would actually yield greater benefits to local populations.

Shifting cultivation, practiced in the tribal areas of north-east and central India, has been a sophisticated system to sustain productivity by periodically resting the land. However, it has in the recent past, due to shortening cycles and a host of other factors dealt with in *Section 5.2*, also led to forest degradation, the spread of weeds, and loss in regeneration (Ramakrishnan 1992b). According to a study undertaken by the FSI, the cumulative area under shifting cultivation in the North-east between 1987 and 1997 was 1.73 million hectares (FSI 2000). Studies on the impacts of shifting cultivation have also been done by the Indian Institute of Remote Sensing (IIRS 2002).

Large-scale development projects have contributed substantially to the loss of forests. Between 1951 and 1980, 5,02,000 ha of forest were diverted for river valley projects (FSI 1988). Even after the enactment of the Forest Conservation Act in 1980, another 134,588 ha have been diverted for hydel and irrigation projects, till 2003 (Singh 2003).

Degradation and qualitative changes are also a result of state policies and programmes to convert natural mixed forests into monocultural stands or plantations. By 1980 about 20,000 hectares of the Himalayas were covered with chir pine plantations, at the cost of the broad-leaved forests, resulting in depletion of soils and suppression of undergrowth. In the Malnad region of Karnataka, natural forests were replaced by about 30,000 hectares of Eucalyptus by the state government during the First and Second Five-Year Plans, in order to meet the needs of industry (*Tree Plantations and Biodiversity Sub-thematic Review*). Tea plantations have replaced large areas of tropical evergreen forests in Lohit, Tirap and Changlang districts in Arunachal Pradesh (*Arunachal Pradesh State BSAP*). While selective felling and systems like the Andamans Canopy Lifting Shelterwood system have been projected as being 'sustainable', they have also been known to cause significant changes in the composition of the forest, and consequently often adverse impacts on the flora and fauna. The Andamans system, for instance, has caused a change from evergreen to deciduous nature, thereby perhaps affecting species that are partial to the former (Pandit 1992).

As pointed out by Saxena (1999), 'The entire thrust of forestry during the first four decades after Independence was towards the production of a uniform industrial cropping system, created after clear felling and ruthless cutting back of all growth, except of the species chosen for dominance.' Between 1951 and 1979, the Forest Departments raised industrial plantations by clear felling 'economically less important forests' over 3.33 million ha (FSI 2000). In 1976, the National Commission on Agriculture (NCA) announced, 'Production of industrial wood would have to be the *raison d'etre* for the existence of forests.' After the launching of Social Forestry projects from the late 1970s, most plantations were done outside government forest areas, including on village common lands and revenue wastelands. The Forest Development Corporations, however, continued industrially important plantations after clear felling of the commercially less-valued forests (FSI 2000), with certain modifications like reservation of a minimum of 70-80 trees as seed bearers/fruit-bearing trees. The cumulative area of forest plantations done from 1951 to 1999 is 31.2 million ha (FSI 2000).[2]

Many foresters hold that the greatest degrading factors in the case of forests are grazing and fuelwood collection (see, for instance, Sunder 1986). Figures made available by the government would indicate that there is some substance in this argument, though the matter is complicated by the fact that a substantial part of the fuel-fodder demand is met by lopping and leaf cutting, rather than by felling entire trees. Where, however, there is urban demand, as in the case of the several thousand wagonloads of firewood coming into Delhi every year (Agarwal and Narain 1985), complete tree-felling may be involved. Total fuelwood demand in the mid-1980s was 235 million cu m, but only 40 million cu m could be sustainably extracted from forests (FSI 1988). Fuelwood pressures are added to by the pressures of grazing and fodder removal. In the late 1980s, for instance, total availability of green fodder from grasslands, agricultural wastes, and sustainable extraction from forests, was about 434 million tonnes, but the demand was about 882 million tonnes (FSI 1988). The demand for fodder increased to approximately 1074 m t in 1996; 1249 m t in 2001 and the estimated annual requirement for 2006 is 1432 m t. (MoEF 1999c). The pressure of grazing on forests has greatly increased, not just due to a rise in livestock numbers, but also because pasture lands have been taken over for various purposes including irrigated cultivation, plantations, and urbanisation.

Overgrazing can cause biodiversity loss in various ways. For example, a marked increase in wild ungulates (especially *chital* and *sambar*) has been reported from Gir following removal of domestic cattle (Khan *et. al.*, 1996), although it is argued that this is due to the increase in the carrying capacity of Gir due to improvement in management practices. Vijayan *et. al.*, (1999) reported that disturbed habitats in the Nilgiri Biosphere Reserve have low bird species diversity and fewer endemics. Vasudevan (2001) and Ishwar (2001) have shown that disturbance can drastically alter the herpetofaunal assemblage in rainforest fragments in the Western Ghats, with the endemic species being adversely affected. The impacts of goats on forested areas is captured in the words of a wise village woman from Nahin Kalan, 'They make rocks roll, break paths, the grass is gone, there are weeds all over...don't give forests to the goats!' (*Nahin Kalan Sub-state Site BSAP*). However, though degradation of forested habitats due to grazing and fuelwood removal is a reality, it seems to be significantly overplayed as a major cause. Certainly there seems to be little scientific credibility to the assertion that any grazing is detrimental. Long-term assessments in at least a few sites suggest that moderate levels of grazing may not only be sustainable but may help retain ecosystem functions and diversity. A study in Bharatpur, Rajasthan, indicated that the bird diversity had dropped ever since a ban on grazing and fodder collection was imposed (Vijayan 1987).

Forest fires (both natural and human-induced) have also been responsible for considerable changes in the natural forest communities and their species composition, often damaging valuable ecosystems beyond redemption and rendering the constituent species highly vulnerable to survival (Sastry 2002). The area involved in forest fires reportedly rose from approximately 28,000 hectares in 1998-99 to a little over 1,46,000 hectares in 1999-2000 (ICFRE 2002).

It is also noteworthy that there are other important habitats such as hot and cold deserts, grasslands, inland and coastal wetlands, and marine areas the monitoring of which has not been covered by any institution. There are no overall estimates of loss for these ecosystems. Where grasslands, deserts and wetlands have

legally been notified as 'forests', the FSI monitors them for 'tree' cover rather than their natural traits. The loss of **desert ecosystems** (for example to plantations of *Prosopis* or to agriculture following canal irrigation) has not been documented.

Unfortunately for a long time and till very recently, **grasslands** in India have not been viewed as habitats of value. The official policy was to plant trees in the grasslands, be it in the plains or in the mountains. This has destroyed large tracts of natural grasslands.

Box 5.2 Mining and Biodiversity

Mining is a rapidly growing threat to natural ecosystems and wildlife across India. 'Before any type of mine can begin operations, the standing vegetation in the area, along with the large amounts of biomass and nutrients it contains, needs to be removed. For an open pit, the displacement of tonnes of earth, rock and soil during excavation can have a huge impact on the soils and ecosystem balance. Pits and cleared areas for waste rock piles, tailings impoundments, processing plants and other facilities vastly increase the potential for erosion and sedimentation in an area.' (*Mining and Biodiversity Sub-thematic Review*). Besides the mineral production processes, the waste that is generated can also be detrimental to habitats.

Since 1980, when the Forest Conservation Act was passed requiring states to take permission from the central government before diverting forest lands for non-forest purposes, 77,655 ha forest land has been given over for mining (Singh 2003). As many as 70 protected areas, supposed to be free of all destructive human presence, are under threat from ongoing or proposed mining within or adjacent to their borders. For example, mining and ancillary activities in the Kudremukh National Park in Karnataka, which have taken place over the years since the first lease was granted in 1969, have caused extensive damage in the park and also led to the pollution of the Bhadra river (*Mining and Biodiversity Sub-thematic Review*). The Kiriburu mines in the Saranda forest division in Jharkhand are the major source of pollution of the river Koina, which has affected the habitat of elephants. The Bailadila hills in Bastar have been mined for iron ore since the 1960s, with the result that all the rivers and streams including the major river in the area, the Shankini, are heavily polluted with red slurry of washed iron ore (*Central Forest Belt Ecoregional BSAP*).

Deforestation around Dalli-Rajahara in Chhattisgarh occurred due to the opening of iron ore mines there about 40 years ago. Soon after the opening of the mines, Dalli became a growth centre that required fuel for its expanding population. Satellite pictures of the area around Dalli indicate that there was a progressive change in land use from forest to non-forest use in areas closest to the town. With LPG bottling plants and coal mines being significant distances away from Dalli, fuelwood became the cheapest readily available fuel. The forests closest to the then existing roads were the first to disappear (Dhara 1995).

'Currently the coal industry is rendering about 500 hectares of land biologically unproductive every year, mainly because of the emphasis on opencast mining. It is anticipated that land degradation will rise to about 1500 hectares per year by 2005 AD… According to one simple calculation, about 0.24 sq km of land gets degraded for each million tonne of coal production by open-pit method' (*Pachauri* and *Sridharan* 1998). Besides, coal mining reduces underground water levels, thus affecting flora. In Meghalaya, due to storage of coal in open areas, there is water run-off to the streams and rivers during the rains, and acidity develops as a result (*Meghalaya State BSAP*).

Sand mining in rivers poses a threat to several species, e.g. Gangetic river dolphin (Lal Mohan 2001) and *gharial* (*Mining and Biodiversity Sub-thematic Review*). In the Andaman and Nicobar Islands, sand mining has led to the loss of twenty-one marine turtle-nesting beaches between 1981 and 2000 (Andrews *et. al.*, 2001). In Kerala, a proposed deep-sea sand mining project that will involve dredging of 50 lakh tonnes of sand every year over a period of 25 years has caused great concern about the possible negative impacts of increased turbidity, sudden changes in the depth of the seabed, as well as disturbances to fish migratory routes, on the state's fisheries (Babu 2002).

The already substantially reduced *Lasiurus* grasslands in Rajasthan are now being degraded by overgrazing and waterlogging and land-use changes caused by the Indira Gandhi Canal. Overutilization and overgrazing causes vegetation degradation in the form of poor basal cover, low plant density and changes in plant species. Due to degradation of the sandy landforms, the *Lasiurus sindicus – Eleusine compressa* vegetation complex is being replaced by *Aristida funiculate – Dactyloctenium sindicum* (Kumar and Shankar 1987).

Planting of grasslands with trees in the name of afforestation, across a variety of habitats ranging from moist to arid and from lowland to montane grasslands has spelt doom for the resident biodiversity. Examples include compensatory afforestation for the Narmada project in the arid grasslands of Kachchh. This has made the habitat unsuitable for a variety of plants and animals, both in terms of habitat structure as well as quality. Open grassland-dependent species lose out completely. Grasses, which are excellent forage for a variety of species, are unable to grow under a canopy of trees. A similar trend has been seen in the montane grasslands of Western Ghats. Taking water through major canal systems to arid and semi-arid areas also spells havoc, as very significant habitat conversion takes place. The habitat is lost for many species adapted to the arid conditions, and the changed conditions attract many other species, which displace the resident species. Irrigated agriculture gets established and this affects both the native biodiversity as well as common access to land and bioresources over very large areas. Such is the case, for instance, with the Indira Gandhi Canal in Rajasthan (See Box 5.4).

Natural grasslands in the Nilgiris, which harbour several endemic species and served as traditional pasture lands for the buffaloes of the Todas, have been drastically reduced due to the Forest Department treating them as degraded forest land requiring afforestation. About 80% of the original grassland, forming a part of the mountain ecosystem in Tamil Nadu, has been planted with pine, eucalyptus and wattle. While destroying ecosystem integrity and natural biodiversity, this has also led to a decrease in full-time pastoralism among the Toda tribals, as well as in the population of the unique Toda buffaloes they have traditionally reared. (SEVA 2001)

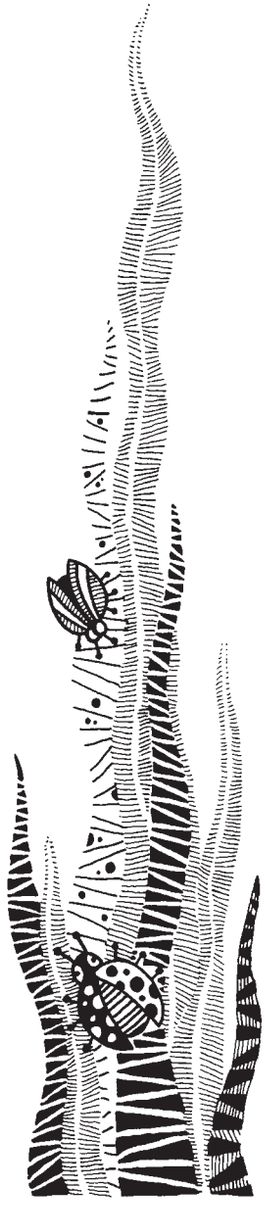
Table 5.1 Comparison of the Different Types of Vegetation in the Nilgiri Biosphere Reserve Between 1849 and 1992

Total Area	Onchterlony's Map (1849)	Current Map (1992)
Sholas	8600 ha	4225 ha
Grasslands	29,875 ha	4,700 ha
Cultivation	10,875 ha	12,400 ha
Tea	0 ha	11,475 ha
Wattle	0 ha	9,775 ha
Eucalyptus	0 ha	5,150 ha

Source: Anon 2002d

While considerable media attention and environmental concern does focus on processes that cause outright destruction and diversion of natural ecosystems, less-highlighted is the slower degradation of habitats that is taking place across the country. The impact of changes in habitat quality in terms of species loss and population reduction has been little addressed.

One factor in grassland degradation is the overgrazing by livestock in a number of areas (though this is by no means as universal a problem as often made out, and is linked to deeper factors as discussed in *Section 5.2*). This has been accompanied by a loss of area under grasslands and pastures and India's conversion of the uncultivated commons into various other uses (*see Sections 3.3.5* and *5.2.2*). Hardly 3.5% of the geographical area is under grasslands, while the domesticated animal population numbers nearly 500 million (MoEF 1992). Considerable pressure therefore falls on other ecosystems like forests, though the stereotype of grazing being inherently destructive for all forests needs to be replaced by a more nuanced understanding of the thresholds of sustainability of each kind of ecosystem under various grazing intensities.



Plant communities on rocky outcrops (*see Section 4.1.1.1*) are highly sensitive to all sorts of human interference. In Karnataka, Maharashtra, and Goa, major threats to the faunal and floral diversity that are supported by rock outcrops, have been quarrying; mining for bauxite, manganese; land-use change (for agriculture, construction of houses, industries, windmills); uncontrolled grazing; fires; tourism growth (leading to trampling and development of roads, shacks) and increasing invasive flora. Since the areas of distribution of certain rock outcrop specialist species are very small, there is already an imminent danger of extinction due to human impacts (Porembski and Watve 2003).

Box 5.3 Impact of Toxics on Biodiversity

Changes in habitat quality and their impact on the freshwater fauna due to toxics have been little investigated, although this is one of the habitats in which toxics have most severely affected biodiversity. The use of pesticides in the Nilgiri district has increased many times over and its impact on birds and fishes is being assessed. Pollutants in the rivers have been reported to cause chromosomal aberrations in fish (Sudarsanam and Ouseph 1997). The decline in the abundance of several species of amphibians in many parts of the world has been reported to be at least partly due to pesticides, the other potential reasons being disease, increase in UV radiation and global warming. However, no attempts have been made in India to monitor amphibian populations. 39 species of fish are on the verge of extinction in West Bengal due to the use of pesticides in agricultural land (Mukherjee and Das 2001).

Large-scale mortality of wild animals has been reported in recent years due to the ingestion of pesticides, especially among birds such as peacock, Sarus crane (Vijayan 1991, Muralidharan 1993), and vultures. A recent survey reported more than 90% decline in vulture population throughout the country (BNHS 2000). It is not clear whether the decline is due to pesticide contamination, disease, intentional poisoning or lack of food (Katzner and Parry-Jones 2001). The drastic decline in some of the very common birds in India (as elsewhere) is a cause of serious concern; this includes House sparrow (*Passer domesticus*), Common myna (*Acridotheres tristis*), Black drongo (*Dicrurus macrocercus*), Green bee-eater (*Merops orientalis*), Grey headed fish eagle (*Ichthyophaga ichthyaetus*), Indian peafowl (*Pavo cristatus*), Sarus crane (*Grus antigone*) and even the House crow (*Corvus splendens*). This decline is not only a threat to the birds, but also an indicator of serious environmental hazards that human beings are unwittingly facing. Recently a large number of birds were found dead in and around a tea estate in Dibrugarh district in Assam, and it is believed that the cause for this is the pesticide spraying that takes place in the estate (Anon 2003). Studies on the effects of DDT on the breeding of the grey-headed fishing eagle, carried out at Corbett National Park, have revealed that DDT causes egg shell thinning leading to either the eggs not hatching or the death of fledglings [Naoroji 1997, as cited in *Pesticides/Toxics and Biodiversity Sub-thematic Review*].

In **marine areas**, habitat loss is associated with unsustainable resource harvest practices and onshore and coastal developmental activities. Examples for the former are damages to benthic habitats by repeated trawling, felling of mangrove trees, collection of coral blocks, and so on. Examples for the latter are reclamation of coastal areas and wetlands (including the quixotically named 'wastelands') for urban development and settlements, for structures like ports and harbours, and, in several instances, for industries that need to be sited near sea water sources (especially for cooling and waste disposal).

Habitat loss is also associated with modified resource harvest practices like construction of aquaculture ponds in mangroves, or salt production units in high saline coastal lagoons and brackishwater spreads. In the case of aquaculture, there has been a rise in production from about 0.78 million tonnes in 1987 to 1.77 million tonnes in 1996, reflecting an increase of 126% (Kutty 1999). But these perceived benefits are offset by many negative impacts, including physical alterations to the coast, increasing coastal erosion and/or coastal flooding, destruction of the nurseries and feeding and breeding grounds of certain aquatic organisms in the backwater and mangrove ecosystems, and increased effluent discharge and eutrophication of adjacent brackish and coastal waters.

Physical damage to habitats includes construction of embankments, wharfs, breakwaters, sea-walls and other permanent offshore structures and dredging, both capital and maintenance. Habitat damage is also manifested in alterations in water quality. This happens essentially in the form of introduction of a wide variety of pollutants,

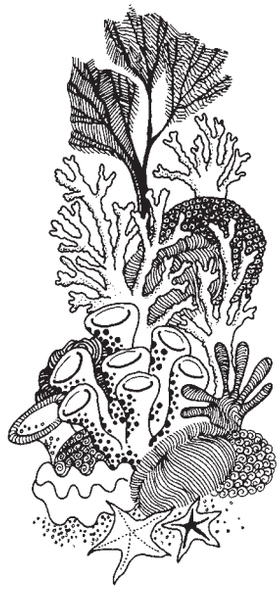
causing direct toxicity to organisms or altering the physico-chemical properties to such an extent that the habitat becomes unsuitable for life.

Industrial effluents discharged in the coastal waters and oil spills qualitatively affect biodiversity, causing changes in species composition and reduction in numbers, though total loss of any one species does not appear to have happened (Sengupta and Qasim 2001). Nevertheless, qualitative changes and shifts in the abundance of species can cause impairment of biological productivity and reduce ecological efficiency. Oil spills can cause temporary loss of bottom organisms, lasting over several weeks or even months, though plankton (free-floating organisms) recover fast. Chronic spills as in the case of the vicinity of oil rigs or oil exploration sites can cause lasting changes in biodiversity abundance, especially with species such as turtles, which need to cross the oil exploration sites to reach their nesting grounds on the beaches. Man-made structures like piers and cooling water intake sites for nuclear power plants can affect species distribution patterns locally by promoting the settling of fouling organisms (e.g. Jesudoss *et. al.*, 1997a&b). Other chronic effects can arise from resource-extraction activities like mining. Long-term records of the impacts of mine wastes in two of Goa's estuaries showed a high biotic variability in less than 10 years (1972-73 to 1982-83), reduction of more than 70% in clam production, near-extinction of resident fauna and the appearance of a low diversity of bottom fauna, comprising of tolerant but vagrant species (Parulekar *et. al.*, 1986).

There have been several studies in India, which have highlighted instances of these above-mentioned negative impacts. According to Kaladharan et. al., (1999), in April 1998 an oil slick was noticed in the inshore waters of Narakkal (lat10 N 76 15'E), north of Cochin port. 'Thick coating of oil was seen on granite stone walls erected against erosion and on the sandy beach. Water up to 10-15 m from shore appeared dark coloured and turbid.' No fishing could be carried out for a week. 'Similar settling of weathered crude oil [occurred] on the beaches along Mangalore during June 1998 and 1999.' It is likely to have 'caused extensive damage to the intertidal organisms including bivalve spat populations attached to the granite wall constructed to check sea erosion.' Devaraj *et. al.*, (1999) report that the 'species diversity index (of Cochin backwaters) revealed a gradual reduction from the bar mouth towards the higher gradients, where the stress due to pollution was very high. The upper reaches of the estuary indicated a low diversity. This reduced diversity index could be due to the changes that have taken place in water quality of the Cochin backwaters. A recent report on the status of pollution in the Periyar river has quantified the annual load of mercury at 92000 kg, zinc 910095 kg, copper 327 kg, fluorides 250 t and iron 30 t dumped into the river. Mass mortality of fish due to industrial pollution has been reported from the upper reaches of the Cochin backwaters at Chitrapuzha and Champakara. Ammonia load of 432 to 560 ppm along with acids and suspended solids, have been found to be deleterious to fish in this backwater lake. Indiscriminate application of about 10 types of pesticide to the tune of 480 t/year in the Periyar catchment area has led to the occurrence of DDT and organochlorines in black clams and fishes in Cochin backwaters. An EIA conducted in the Cochin backwaters during 1994-95 has revealed low benthic populations in Udyogamandlam canal and a general decline in fish production.'

Over 40% of India's mangroves have already been lost (GOI 1987). Surveys by FSI since 1991 at two-year intervals suggest an apparent increase (from 4244 sq km in 1991 to 4871 sq km in 1991). As in the case of forests, however, it is not clear whether this increase translates into an overall qualitative improvement, since much of the area increase is due to plantations, whereas there may still be continued degradation of natural mangroves.

Substantial losses in live coral cover within a reef are common observations, especially in reefs near human settlements. Coral reefs have been adversely affected by silt deposition from inland areas, 'indiscriminate exploitation of coral for production of lime, recreational use and for ornamental trade. Similarly, the fragile environs of island ecosystems have been subjected to pressures of various forms including migration of people from the mainland' (MoEF 1992).



Habitat damage also causes loss of biodiversity in other ways. One is the loss of food source for several organisms that do not dwell there permanently. The classical example is the loss of sea grass beds, causing decimation of the dugong species that feed exclusively on the sea grasses.

In the case of **freshwater wetlands**, the single most important cause of loss of biodiversity is reclamation, especially of rural and urban ponds, for agriculture and construction. Many ponds/lakes, have been converted to building spaces and other uses, though no overall estimate of the area is available. For example, 'of the 204 lakes listed existing as on 1960 at Ahmedabad, very few remain now. Even among the 137 officially shown as existing, as many as 65 have already been built upon. In several other cases, though numbers remain the same, encroachments have reduced the water-spread substantially. For example, encroachments have reduced the size of the most important lake, Saroonayar lake at Hyderabad, from 74 ha in 1964 to 25 ha' (Joshi 2002). In the town of Sonepat in Haryana, over the last thirty years, 15 ponds covering an area of about 60 acres has been lost to encroachments (A. Sharma, personal communication 2002). The second cause for biodiversity loss is the construction of dams, weirs and other structures blocking free water flows in rivers. These alter watercourses and deprive the downstream sites of water (*see Box 5.4*). This also prevents upstream migration of several species for breeding.

Several other causes, their importance varying with the local sites, constitute the third category. This includes industrial pollution, introduction of non-native species, silting, eutrophication, monoculture practices, abstraction of ground water, mining of river bottoms for sand and gravel, spawn collection, dredging etc. The decline of large indigenous carp fish species of peninsular India is a result of silting of lakes and reservoirs (Alfred and Nandi 2001). Research done on the Mula and Mutha rivers in Pune has indicated the disappearance of more than 30 native species of fish over the last six decades, with 11 more species declining in number, due to heavy harvesting and anthropogenic activities like dam construction, chemical pollution, and habitat destruction (Kharat *et. al.*,2003).

In Assam, river flooding, associated with bank erosion of the Brahmaputra and the Barak and their major tributaries, has been the main threat to riverine and adjacent ecosystems. The total area eroded by rivers and floods in the state stood at 49.35 thousand ha in 1997, 5.63 thousand ha in 1998 and 9.83 thousand ha in 1999. Areas that are very rich in biodiversity, including the Kaziranga National Park, the Orang National Park, and the Burhachapari and Pabitora Wildlife Sanctuaries, are regularly affected by flood and bank erosion of the Brahmaputra (*Assam State BSAP*).

The loss of species due to the loss or degradation of wetlands is little documented. One well-known example is that of the Siberian crane whose numbers have greatly reduced, in its last wintering home at Keoladeo Ghana National Park (Rajasthan), partly due to habitat degradation.

Box 5.4 Dams and Biodiversity

Damming a watercourse inevitably leads to submergence of vast tracts of forests and aquatic flora. Official figures record a diversion of 502,000 ha of forests due to river valley projects between 1951 and 1980 (FSI 1988). However, other calculations reveal far greater damage, though there is no unanimity in the estimates. There are about 1550 large man-made reservoirs in India (Gopal 1994), formed by the damming of rivers. From available data regarding forest submergence for 60 dams, the average forest area submerged per dam works out to approximately 4,879 ha. Therefore, the 1,877 dams built between 1980 and 2000 would be likely to submerge roughly 9.1 m ha of forests (WCD 2000). A CWC study (CWC 2000) of 116 dam projects found that the average forest submergence per project was 2,400 ha. Assuming this figure to be correct, the total submergence of forests between 1980 and 2000 would be roughly 4.5 m ha (WCD 2000). Dams are reported to be a major threat to several species of fishes as they block their seasonal migratory routes. Some popular game fish like *mahaseer* (*Tor* and *Acrossocheilus* spp.) have been badly affected (Alfred and Nandi 2001). In addition, damming is also reported to be a major reason for drastic reduction and possible extinction of the population of several hill stream fishes due to the loss of their microhabitats. It is very likely that several species of amphibians would also have been affected in the Western Ghats, where most of the amphibians require running streams for breeding.

The damaging effects of the Farrakka Barrage on the *hilsa* fish in West Bengal and that of the Thanneermukkam Bund on the brackishwater fisheries are well known. The *hilsa* fishery in the estuary of the Tapi river was affected by the Ukai dam (Morse and Berger 1992), and it is feared that the Sardar Sarovar dam will adversely affect the Narmada *hilsa* fishery. The Gangetic river dolphin has also been severely affected by the Farrakka Barrage, as well as by several other dams (Sinha 2000, *Gangetic Plains Ecoregional BSAP*).

In 1970 the proposed dam in the 'Silent Valley' of Kerala destroyed nearly 100 hectares of pristine forest in the initial phase of construction, before the work was finally stopped due to widespread public protest. In the 1980s, the Idukki Dam over the Periyar River in Kerala resulted in the degradation of vast tracts of forest.

The proposed Bhopalpatnam and Inchampalli dams on the borders of Andhra Pradesh, Madhya Pradesh and Maharashtra threaten to submerge 40,000 hectares of rich deciduous forest (Sinha 1997); they have so far been stalled by local *adivasi* opposition. The proposed Manibhadra dam in Orissa is being constructed in one of the pristine forest areas remaining in the country. The Tehri and Vishnu-Prayag dams are being constructed in the environmentally fragile and sensitive Himalaya, and could cause damage to Himalayan biodiversity.

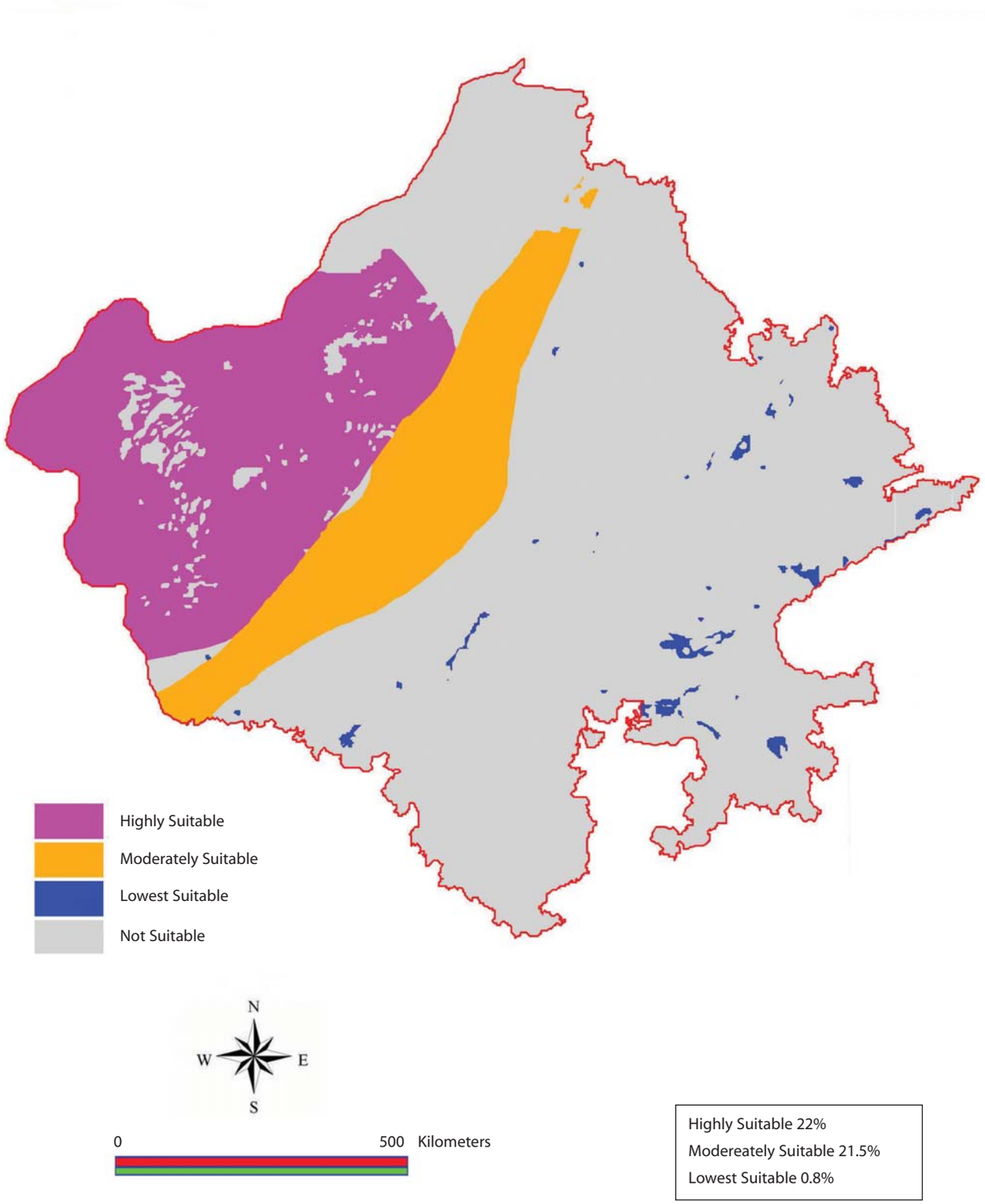
With the construction of the Indira *Gandhi Nahar Pariyojana* (IGNP) in Rajasthan, cover of *Haloxylon salicornicum*, *Prosopis cineraria* and *Lasiurus sindicus* is being fast depleted due to waterlogging and salinity problems. Not only are the Lasiurus grasslands being lost but also the associated scrub vegetation, e.g. *Calligonum polygonoides*, *Leptadenia pyrotechnica*, *Haloxylon salicornicum*, *Aerva pseudotomentosa* and *Calotropis procera*. Many of these and other lesser dominants are marginalized on crop bunds and soon give way to irrigated weeds. The entire 20 km- to 40 km-wide belt of *Lasiurus* grasslands all along the international border from Sriganganagar through Bikaner and Jaisalmer now stands transformed into irrigated croplands, except high dunes dotted sparingly over this landscape. Existence of these grasslands is threatened even in the Desert National Park (DNP) because the tail-end of IGNP is likely to cut through it. Stage II of the project will also affect the scrub and sandy habitat of the *chinkara*, as the canals of the project will fragment the proposed Desert Biosphere Reserve (Alfred *et. al.*, 2001; *see* Map 5.1 and Map 5.2).

The construction of dams and the resultant diversion of water for irrigation has also impacted the mangrove forests, due to increased salinity, especially in West Bengal and Tamil Nadu (C. Sharma 1997).

168 large hydroelectric projects are proposed to come up in the North East to generate a total of about 64,000 MW of power. The projects threaten to destroy some of the most biodiversity-rich areas, and some of the impacts have already begun to show. For example, the Kameng project will submerge 370 ha of rich forests in the Bichom and Tenga valleys; the power house of the project borders Pakke Wildlife sanctuary, one of the finest bird habitats of the country with a birdlist numbering 245 species. During the construction phase of the Ranganadi project, downstream impacts had begun to show up in the form of increased sedimentation of the river and decrease in fish catch downstream. The proposed Lower Subansari project on the Assam-Arunachal border threatens the habitat of the Gangetic river dolphin (*Platanista gangetica*) downstream of the dam site, and the ecology of the *beels*, wetlands which are of prime importance to the livelihoods of local communities as they are used as natural fisheries and for wet rice cultivation. The Loktak Downstream project, if implemented, will be the second on the Loktak lake system, which has already been affected by the Ithai barrage. The barrage has severely impacted the habitat of the endemic *sangai* deer (*Cervus eldi eldi*) in Keibul Lamjao National Park, known for the floating *phumdis* (Compiled from *The Ecologist Asia*. Vol 11. January-March 2003).

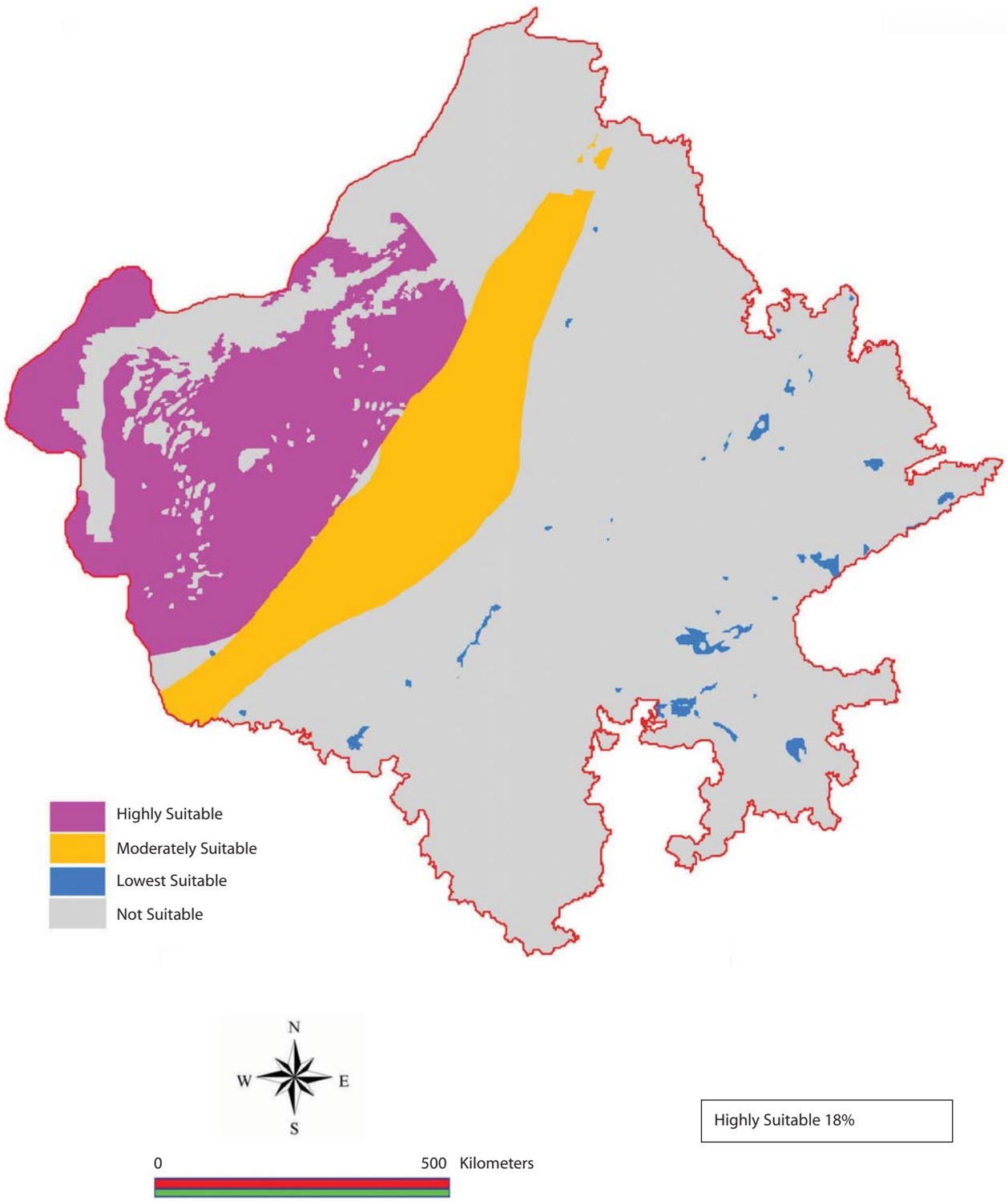
The massive Narmada dams, under construction since the late 1980s, are expected to cause serious ecological damage over a vast area (Kothari and Ram 1994, Singh *et. al.*, 2000a). Upstream, they are submerging forests in Madhya Pradesh, Maharashtra, and Gujarat (over 50,000 hectares by the Sardar Sarovar and Narmada Sagar alone, among the many dams planned for the valley). Ironically, the so-called compensatory afforestation is already creating its own problems, as it is being carried out in Kachchh, where the natural grassland and desert ecosystems are being covered up with exotic tree species. Downstream, the dams are likely to threaten *hilsa* and other fisheries (there are already reports of fisherfolk livelihoods being affected), and possibly result in saltwater intrusion in the coastal parts near Bharuch. In the command area, the massive canal network will cut across the vital habitat of the endangered wild ass, and a report by the Wildlife Institute of India suggests that the impacts could be severe. Finally, in areas where the huge displaced population is being resettled, forests are being cut and grasslands taken over. For example, almost 2000 hectares of forest were cut in the Taloda area of Maharashtra for the purpose.

Map 5.1 Habitat Suitability Map of Chinkara (Present)



Source : Alfred et. al. 2001

Map 5.2 Habitat Suitability Map of Chinkara
(After Commencement of State-II of IGNP)



Source : Alfred et. al. 2001

To what extent habitat loss has already caused species extinction is surprisingly sparsely documented. Known extinctions are that of the *cheetah*, mountain quail and pink-headed duck, and perhaps a couple of dozen plants like *Bunium nothum*, *Ceropegia lucida* and *Ophiorrhiza radicans* (Nayar and Sastry 1988). It is debatable whether these losses have been due to habitat loss *per se* or also because of hunting and poaching. Some species of mammals and several lower vertebrates, not to speak of invertebrates, have not been sighted for several decades, often after the type description. There have been several 'rediscoveries' in the last decade, the well-known ones being Jerdon's courser (*Rhinoptilus bitorquatus*), Forest owlet (*Athene blewitti*); Malabar civet (*Viverra civettina*) (only from skins), and Golden gecko (*Gekko ulikovski*). These rediscoveries suggest that lack of sightings might at times be due to lack of effort, though this would not seem to be the case with large and wide-ranging animals like the Cheetah.

That habitat loss has vastly reduced and fragmented populations of several hundred species is indisputable, although little quantified. For example, bustards and floricans, dependent on grasslands, have lost a considerable portion of their habitat and are consequently seriously threatened (Rahmani 2001). The Asiatic lion, reported from near Delhi and central India in the mid-1800s, is now confined to a single locality. The tiger, which numbered a few tens of thousands in the 1800s, is now reduced to less than 4000 animals. The Asian elephant has also followed a similar fate. A simple application of island biogeographic theory suggests that species loss initially lags behind habitat loss. 'The time delay before extinction makes more species threatened than have already become extinct' (Pimm and Raven 2000). Thus, the extensive loss and fragmentation of wild natural habitats has probably set the stage for numerous extinctions, apart from those that have already occurred, noticed or unnoticed by human beings.

Table 5.2 Commercial Threats Facing Protected Areas in India

(A representative sample)

S. No.	Threat (actual or proposed)	Example
1.	Aquaculture, commercial fishing, expanding salt pans within or in the vicinity of the PA	Kaziranga NP (Assam), Dhrangadhra Wild Ass Sanctuary (Gujarat), Pench TR (Maharashtra and Madhya Pradesh), Sundarbans TR (West Bengal).
2.	Bamboo extraction for paper and pulp mills	Shoolpaneshwar WLS (Gujarat).
3.	Construction of roads, rails, canals, pipelines etc.	Bhimashankar WLS (Maharashtra), Dalma WLS (Bihar), Kalakad-Mundanthurai TR (Tamil Nadu), Gulf of Kutch Marine Sanctuary (Gujarat), Mollem NP (Goa).
4.	Dam construction or other irrigation projects within or in the vicinity of the PA	Madhav NP (Madhya Pradesh), Sitanadi WLS (Madhya Pradesh), Melghat TR (Maharashtra), Dampa TR (Mizoram), Keibul Lamjao NP (Manipur).
5.	Defence establishments such as firing ranges	Dhrangadhra Wild Ass Sanctuary (Gujarat), Bhitarkanika WLS (Orissa).
6.	Total/Partial denotification to serve industrial interests	Narayan Sarovar WLS (Gujarat), Gautala Autaramghat WLS (Maharashtra), Kalsubai-Harishchandragadh WLS (Maharashtra), Melghat TR (Maharashtra), Great Himalayan NP (Himachal Pradesh).
7.	Dumping toxic waste such as fly ash, overburdens, tailings etc. near the boundary of the PA	Bandhavgarh TR (Rajasthan), Panna TR (Madhya Pradesh)
8.	Introduction of exotic species into the ecosystem	Several PAs
9.	Mining within or in the vicinity of the PA	Sariska TR (Rajasthan), Rajaji NP (Uttar Pradesh), Kudremukh NP (Karnataka), Nagajunasagar-Srisailam TR (Andhra Pradesh), Bhadra WLS (Karnataka).
10.	Monocultures/commercial plantations	Kalakad-Mundanthurai TR (Tamil Nadu), Rajaji NP (Uttaranchal)

11.	Poaching of timber and/or wildlife	Palamau TR (Jharkhand), Valmiki TR (Bihar),
12.	Pollution due to seepage of toxic pesticides, oil or other chemicals	Kaziranga NP (Assam), Gulf of Kachchh Marine NP (Gujarat), Keoladeo Ghana NP (Rajasthan).
13.	Setting up of polluting factories or oil refineries in the vicinity of the PA	Gulf of Kutch Marine NP (Gujarat), Dhrangadhra Wild Ass Sanctuary (Gujarat), Dandeli WLS (Karnataka).
14.	Unregulated tourism	Bandhavgarh TR (Rajasthan), Bhimashankar WLS (Maharashtra), Sanjay Gandhi NP (Maharashtra), Balukhand WLS (Orissa), Sariska TR (Rajasthan), Corbett TR (Uttaranchal), Nagarhole NP (Karnataka)
15.	Uncontrolled extraction of medicinal plants and herbs from within or from adjoining areas	Great Himalayan NP (Himachal Pradesh)
16.	Pilgrimage	Gir NP (Gujarat), Periyar WLS (Kerala), Sanjay Gandhi NP (Maharashtra), Bhimashankar WLS (Maharashtra)
17.	Urban growth in the vicinity of PA	Sanjay Gandhi NP (Maharashtra), Nagarjunasagar-Srisailam TR (Andhra Pradesh), Rajaji NP (Uttaranchal).

NP = National Park

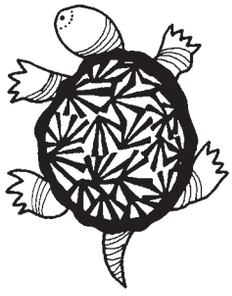
WLS = Wildlife Sanctuary

TR = Tiger Reserve

Source: Kutty and Kothari 2001. Original sources listed in this publication include: Bittu Sahgal, 'Fifty Indian Tragedies in the Making', Sanctuary, October 1997; various Kalpavriksh studies; and various issues of Protected Area Update, Kalpavriksh, Pune.

5.1.1.2 Hunting/Exploitation/Collection/Fishing

Hunting or live harvesting of animals for local consumption or trade, rampant till the promulgation of the Wild Life (Protection) Act, 1972, has been attributed to be the major factor for the reduction of populations of several species like large carnivores, some primates, water birds, turtles and crocodiles. Though the ban on hunting imposed in 1972 resulted in several species reportedly bouncing back, some with restocking e.g., freshwater crocodile, hunting continues to be a problem. In Nagarhole National Park, data gathered to estimate the intensity and impact of local hunting showed that six of the nine focal species of large mammals hunted occurred at significantly lower densities in the site studied (Madhusudan and Karanth 2002). In Bastar, organized hunting called *paradh* is practiced locally during the summer season; while at other times it takes place as the need arises (*Central Forest Belt Ecoregional BSAP*). In the forests around Simlipal the tribals practice *akhand shikar*, during the months of March to June, when they go mass hunting in large groups (*Simlipal Sub-state Site BSAP*). While at one time such mass hunts were practiced under strict norms and in a situation of wildlife abundance, today they are less regulated and could be impacting already depleted animal populations. Although poaching is now feared to threaten the survival of even species such as the elephant and tiger, quantitative data on the incidence of poaching and associated trade are either non-existent or highly variable or contradictory (MoEF 1994). Some available figures show the magnitude of the problem. For example, in 1996-98 at least 253 elephants were poached in India (Menon and Kumar 2001). The effect of selective removal of tuskers over a short period has had a major impact on the adult sex ratio of Asian elephants in the Western Ghats, affecting their reproduction for several years (Sukumar *et. al.*, 1998). Although small and isolated populations of tiger can survive relatively low incidence of poaching, this, combined with poaching of their prey base (or reduction in their density due to other reasons such as livestock grazing), can drive some populations to extinction (Karanth and Stith 1999). In fact, low prey density due to poaching is thought to be the main reason for the absence or low densities of tigers in many parts of its 300,000 sq km potential habitat (Wikramanayake *et. al.*, 1998; Karanth and Stith 1999). Carnivores like tiger and leopard, with overlapping prey species, interact in complex ways depending on the changes in the relative abundance of different prey species (Seidensticker *et. al.*, 1990; Karanth and Sunquist 1995). Such changes can come about through the synergistic action of poaching and habitat degradation. It should also be noted that small populations, resulting from habitat loss and fragmentation, are far more susceptible to local extinction from poaching than large populations, though of course the abundance of any ani-



mal population is no guarantee against its susceptibility to extinction by other factors. Again, hunting (combined with pressures on habitat) has taken a toll of many avian species as well, for example the Black-necked crane, the Siberian crane, and the Western tragopan.

Many incidents of poaching have been attributed to intentional poisoning or snaring – to get rid of animals which lift cattle (large carnivores), raid poultry (small carnivores) or crops (elephants, monkeys, bears, birds and pigs) – and not necessarily for consumption or trade. For example, in Andhra Pradesh, according to official records, 28 tigers and leopards were reportedly poisoned in two years' time, apparently due to rampant cattle-lifting (WWF 1999). In Gir Sanctuary, with the increase in human-lion conflicts, the *maldhari* community has increasingly lost its tolerance, and 3 lions were electrocuted in the first six months of the year 2000 (Indian Express, June 30th 2000, New Delhi, as quoted in the *Human-Wildlife Conflicts Sub-thematic Review*). Up to 18 elephants were poisoned in the Sonitpur district in 2001, of which 10 died in Nameri National Park (*Human-Wildlife Conflicts Sub-thematic Review*).

Box 5.5 Human-Wildlife Conflicts

Conflict between humans and wildlife – which takes many forms, and varies greatly in intensity – is one of the most serious threats to India's wildlife and people's livelihoods. 'Not only does conflict directly threaten individual species (through, for example, revenge killings) and their habitats, it also indirectly exacerbates other factors (the illegal trade in wildlife, for example) that threaten the continued existence of wild India. Further, the *causes* of human-wildlife conflict are, in many cases, themselves factors that *independently* threaten wildlife.' [*Human-Wildlife Conflicts Sub-thematic Review*]

An estimate of crop damage for Madhya Pradesh, based on a rapid survey undertaken in the Noradehi Wildlife Division of Sagar Circle, is approximately 93 crore rupees per year, while the estimated cost of protecting the crops (calculated as labour cost of watching over the crop) is approximately 527 crore rupees (Pabla 2002). The report of the 8th Meeting of the Steering Committee (April 2002) of Project Elephant highlights that there were 196 human mortalities due to elephants in the year 2001-2002 [*Human-Wildlife Conflicts Sub-thematic Review*]

A brief overview of human-wildlife conflicts is presented in *Table 5.3*

Table 5.3: Overview of Human-Wildlife Conflict across India

Species	Types of Conflict	Areas
Tiger (*Panthera tigris*)	A. Cattle lifting B. Injuries or death to humans/man-eating	A. All India B. Sundarbans
Leopard (*Panthera pardus*)	A. Livestock depredation B. Injuries or death to humans/man-eating	A. All India B. Garhwal, Kumaon, Himachal Pradesh
Snow Leopard (*Uncia uncia*)	Livestock depredation	Ladakh, Himachal Pradesh, northern Uttaranchal, parts of North-East India
Lion (*Panthera leo*)	A. Habitual livestock depredation B. Injuries or death to humans	Gir Forest, Gujarat
Elephant (*Elephas* 2)	A. Crop raiding B. Injuries or death to humans	A. All wild elephant-bearing areas B. Injuries or death caused by domestic elephants
Wolf (*Canis lupus*)	A Livestock depredation B. Child-lifting	A. Pockets of Northern, Central and Western India B. Uttar Pradesh

Bears 1. Asiatic Black Bear (*Ursus thibetanus*) 2. Sloth Bear (*Melurus ursinus*) 3. Himalayan Brown Bear (*Ursus arctos*)	A. Livestock depredation (Brown Bears) C. Injuries or death to humans (Sloth Bear)	A. Ladakh B. All India, particularly Central India
Deer, Antelopes, Wild Cattle, Wild Boars	Crop raiding	All India
Reptiles	A. Injuries or death to humans B. Man-eating (Saltwater or Estuarine Crocodiles)	A. All India B. Sundarbans
Birds/Bats	A. Crop raiding B. Bird hits to aircraft	All India

Source: Human-Wildlife Conflicts Sub-thematic Review

'The utilization of reptiles and amphibians for food, pet trade, indigenous medicines, laboratory practice/experimentation, religious and other traditional uses have increased over years. In spite of imposing restrictions the state School/College Board continue dissecting frogs and lizards for education, year after year. *Haplobatrachus tigrinus* and Garden lizard are the major victims' (*Gangetic Plains Ecoregional BSAP*).

Until the complete ban on trade in live birds in the 1991 amendment to the Wild Life (Protection) Act, 1972, India was one of the major exporters of live birds. Many species of birds continue to be trapped in Uttaranchal in the Himalayan foothills by *baheliyas*, traditional bird-trapping communities. The main species traded are parakeets, *munias* and weaver birds, including the threatened Finn weaver (*Uttaranchal State BSAP*).

Box 5.6 Musk Deer Hunting

The scale of hunting musk deer for commerce today is not as large as it used to be. A broad and informal estimate of current levels would be up to 60 musk deer a year killed in the Gori basin in Munsiari, Uttaranchal. Till five years ago, an estimated 90 were killed every year.

Hunting of the deer is done in large communal groups of a dozen or more people, with the younger apprentices driving the deer up the steep gullies and ravines which constitute their escape routes. Musk deer have certain predictable behavioural propensities that make them especially vulnerable to the marksman. While fleeing, they tend to stop periodically and look back at the pursuer. The other is their revisiting and stopping at their 'latrines'…

Every fleeing animal in range is shot at. The male, for whatever musk it yields, (an average of one to three *tolas* or 10 to 30 grams per pod), and the female too for the pod. The other most harmful method is the practice of driving musk deer out of hiding with the help of fire. In autumn and early winter, while the marksmen lie in wait on the ridge, one or two men will set ablaze tinder-dry grass in the sub-alpine krummholz, or even the high cold-temperate forest shrubs lower down, when the wind is up-slope, and send the deer fleeing to the ridge. Every autumn, large areas of very fragile sub-alpine and alpine slopes are set ablaze in the Gori basin. Beautiful old stands of hemlock and yew, hundreds of years old, stand charred in testimony.

A certain amount of trapping musk deer with wire foot-snares is also resorted to by some hunters. The results are more uncertain, but the procedure is safer for those involved, since being caught with an unlicensed gun can cause serious problems.

In 2001, the purchase price of musk in the valley ranges from Rs 2,800 per *tola* (10 gms) to Rs 3,200 per *tola*, though it is nego-

tiated afresh with every seller. At the bottom of the valley at Dharchula, which is the gateway for all such 'informal' trade into the global market, the purchase price is Rs 4,000 per *tola*. One animal, depending on its age and size, could bear anything from 1 *tola* to 7 *tolas*.

In contrast, musk is reported to cost US$22,000 per kilogram in the international market, and more than twice as much in the black market. For one kilo of musk, 40 to 50 deer may have to be poached. Japan is said to be the world's biggest buyer, consuming around 150 kg of musk a year, for `medicinal' use.

The global perfume industry transacts about US$15 billion annually. European perfumeries alone are estimated to use 20 to 30 kilos of musk per year.

Source: Munsiari Sub-state Site BSAP

In the **marine** ecosystem, over-harvesting has begun to deplete the stock of many species of fish, especially on the west coast following the introduction of trawlers. Current marine fish harvest in India is confined to the traditional fishing zones extending up to 50-100 m depth-line, i.e., the shelf waters. Around 1970, the harvest was of the order of 50,000 tonnes per year. At that time, detailed assessments of the biological productivity of the coastal waters and construction of fishery models that define optimum levels of exploitation indicated that there was a scope for increase in fish production. This increase was facilitated by increased mechanization of the craft, introduction of new gears and fish-locating devices and improvements in infrastructure for marketing the products inland and abroad. The current harvest is to the order of 2.5-3 million tonnes per year. This is already at the maximum sustainable yield (MSY) for most fisheries and has in fact exceeded the MSY in some of the species, notably the shrimps, and in some of the coastal states, notably Kerala. The declining trend does not *per se* cause a loss of species, but there is a loss in their abundance (Devaraj and Vivekanandan 1999).

Over-exploitation has also been well documented in several studies (see Venkataraman 2001, for a recent review of CMFRI publications). It is estimated that due to over-harvesting, the per capita production per active fishermen declined from 3250 kg in 1980 to 2240 kg in 2001 (http://www.cmfri.com/cmfri_abt.html). However, decline in catch or conservation status at species or other taxon level has been rarely assessed. An example is that of sea horse. India was one of the largest exporters of sea horse, at least 3.6 tonnes (approximately 1.3 million animals) per year, contributing to about 30% of the global sea horse trade (Vincent 1995), although most of the sea horses in the Indo-Pacific area are in the IUCN Red List. This exploitation had led to a decline of the sea horse population by 25-75% (Sreepada *et. al.*, 2002). Export of sea horses was therefore banned in 2001 (MoEF 2001c).

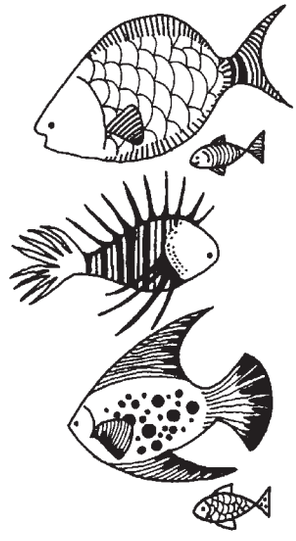
Loss of marine biodiversity has been especially aggravated by the entry of non-traditional fishers and poor enforcement of regulations. This includes non-adherence to minimum mesh size, fishing in prohibited zones, non-use of devices like TED (turtle exclusion device), and use of equipment like iron chains in trawlers that do great harm to benthic biodiversity. Target fishing for high-value species also generates a large amount of by-catch, which is routinely discarded, causing a great loss of associated biodiversity from the habitat of the target species. Even targeting for low-value species like bait fishes or shells is accompanied with destruction of the immediate vicinity of the habitat. Targeted harvest has also decimated those species which are low in natural abundance from several habitats. Examples of this are the sea cucumbers, seashells, corals and macro algae like *Gelidiella* and *Gracilaria* species used for agar industry. At times, even species that are of only scientific interest suffer the same fate. For example, *Balanoglossus* (a prochordate) populations in some of the coral reefs in the Gulf of Mannar have been decimated by excessive collections for scientific museums (*East Coast Ecoregional BSAP*; Wafar 1986).

Unsustainable and selective harvest of wild resources motivated by cultural tradition (e.g. of hornbills for the 'casque' used in traditional headgear or tail feathers of the wire-tailed swallow used by the Gond tribals in Bastar for headgear) (*Culture and Biodiversity Thematic BSAP*), survival needs, and need to generate cash income to supplement earnings from other resources have endangered certain animals and plants. Commercial exploitation of

entire plants, roots, rhizomes, tubers, bulbs, seeds and fruits is the prime cause of depletion of important wild plants. This trade flourishes by both legal and illegal means. Some medicinal plants have been over-exploited to feed the growing demand from the pharmaceutical industry. *Valeriana jatamansii*, commonly used in *Ayurvedic* and *Unani* medicine, and also exported to Europe, is now virtually extinct from much of its known range in the Himalaya (WCMC 1988). *Aconitum heterophyllum* and *Dactylorhiza hatagirea*, two Himalayan alpine/sub-alpine species occurring in the western Himalaya, have also been over-exploited because of their medicinal value (Uppeandra Dhar, personal communication 2002). In North-east India large-scale exploitation of species like *Dipterocarpus macrocarpus*, *Shorea assamica*, *Taxus baccata*, and *Cephalotaxus* has gravely threatened the conservation of these species. Similarly the ornamental family *Orchidaceae* is facing a threat in its natural habitat due to over-harvesting. A perusal of distribution of number of species of orchids in the North-east region reveals that out of about 850 species, of which about 187 are endemic, 108 are endangered or threatened and 18 extinct or nearly extinct (Hegde 2000). The famous lady's slipper orchids (*Paphiopedium*), blue vanda and red vanda (*Renanthera imschootiana*), once abundant in the region, are facing a threat to their survival, due to over-exploitation by the unscrupulous traders and unabated forest destruction.

5.1.1.3 Introduction of Exotics

The accidental or deliberate introduction of alien species into a natural ecosystem is believed to be one of the world's major causes of species loss; in many countries it is the most important cause. Such introduction is believed to be the cause of 39% of extinction of species that has occurred world-wide, where the cause for extinction is known (Groombridge 1992).



Freshwater fishes have been perhaps the most affected by the introduction of exotics, not only in India but also elsewhere in the world. The deliberate introduction of exotics into the wild in India goes back at least to 1847. In the Himalaya the introduction of the Rainbow trout by the British is reported to have displaced several indigenous fish species (IIPA 1996). These introductions have had a disastrous consequence on the native fish fauna. In the Western Ghats, fishes introduced and excessively stocked for improving fisheries production in the reservoirs have been a major reason for the decline in the population of several species of endemics (Unnithan 2000). In Thirumoorthy reservoir in the Annamalai Hills (Tamil Nadu) for example, the contribution of endemic species to fish catches declined from 19.2% (4-5 kg/ha/year) during 1978-82 to insignificant levels by 1993-94 (Unnithan 2000). Similarly the loss of *Schizothoracine* fishes in the Kashmir valley and several native species in the Loktak lake, due to the introduction of exotic common carp, are other well-known examples (Alfred and Nandi 2001).

Exotic species have been introduced intentionally or unintentionally in the Andaman and Nicobar Islands over the past three centuries or so, particularly since 1858 (Mohanraj *et. al.*, 1999). Some of the threats faced are damage to trees (by elephant); reduction of regeneration (spotted deer); competition with endemics for nesting sites (mynahs); destruction of sea turtles and nests (feral dogs) (*Andaman and Nicobar State BSAP*). Expanding populations of some of the introduced large herbivorous mammals are of special concern in the absence of their natural predators. The invasion of the exotic climbing weed *Mikonia cordata* has been so rapid that it is now posing a big threat to native forest vegetation in the islands (Upadhyay 2000).

It is estimated that 18% of Indian flora comprises invasive aliens, of which about 55% are American, 10% Asian, 20% Asian and Malesian, and 15% European and Central Asian species (Nayar 1977, cited in *Invasive Alien Species and Biodiversity Sub-thematic Review*). The intentional or accidental introduction of exotic plants such as water hyacinth (*Eichhornia crassipes*), Eupatorium (*Chromolina*), *Lantana* and *Parthenium* has had major impacts on wild animals, which are widely recognised, but seldom documented. *Lantana* has spread dangerously all over the country in moist and dry deciduous forest. *Ipomoea cornea* is capturing roadsides and agricultural fields where even a little water is present. During the last 15-20 years *Parthenium hysterophorus* is occupying every open place available to it (Verma and Mudgal 1999). Many of these are also not palatable, and hence the habitat quality for native herbivores is greatly reduced.

There is great concern over the introduction of *Euchema cottonii*, a red algae, which is being cultivated by Pepsi Foods Limited on a large-scale in Rameshwaram, near the Gulf of Mannar National Park. The algae, which was

imported from the Philippines, is a source of carrageenan, a stabilizing substance used in beverages. Scientists fear that this exotic species could damage the coral reefs in the region (Bagla 2003).

In recent years, attention is also being paid to the unregulated discharge of ballast water in marine and freshwater system. This discharge, along with hull fouling, leads to the introductions of harmful aquatic organisms, including diseases, bacteria and viruses. Today it is regarded 'as the most important vector for trans-oceanic and inter-oceanic movements of shallow-water coastal organisms' *(Invasive Alien Species and Biodiversity Sub-thematic Review)*.

Box 5.7 Mesquit (*Prosopis Juliflora*)

Prosopis juliflora was introduced in India through seed obtained from the Kew Botanical Garden, and the earliest records of its cultivation in the Indian subcontinent date back to 1877. In Gujarat the state Forest Department started planting this species in the coastal area in 1953 as part of the Desert Immobilization Programme. Plantations were carried out extensively for checking the spread of desertification towards the mainland and for establishing a shelter belt (*Invasive Alien Species and Biodiversity Sub-thematic Review*).

In Kachchh district, about 3478 sq km area (i.e. 7.6% of the total geographical area) is covered by *P. juliflora*. During the second half of the 20th century, *Prosopis* invaded the *banni* grassland in Kachchh, which covers a total area of about 2900 sq km. The quality of these once luxuriant grasslands (already affected by salinity) changed due to these invasions, and a substantial area has now been transformed into *Prosopis* forests. The Velavadar National Park, the Wild Ass Sanctuary in the Little Rann of Kachchh, the Great Desert Wildlife Sanctuary in the Great Rann have all been affected to some extent by this exotic (*Gujarat State BSAP*; *Kachchh Sub-state Site BSAP*).

In Rajasthan, the economic benefits to the local populations, particularly as a source of fuelwood, has been significant, but there is no doubt that there have been very serious ecological costs. Many habitats have been completely taken over by this species, with native vegetation totally displaced. The *birs* or the grasslands that are under the control of the Forest Department have been invaded by *Prosopis*, which has adversely affected the growth of herbaceous flora. The degradation of these areas has impacted wildlife, particularly grassland birds like the Lesser florican, Houbara and Great Indian Bustard (*Rajasthan State BSAP*; *Arvari Sub-state Site BSAP*; *Aravalli Ecoregional BSAP*).

5.1.1.4 Other Factors (Including Accidents and Climate Change)

There is increasing incidence of accidental mortality of animals belonging to endangered species due to a variety of reasons such as electrocution from high-tension power lines, train hits, road kills, accidental catch, damage by trawlers and power boats, and ingestion of plastics. There has been no detailed documentation of these. Examples include:

a. Death of four elephants in 2001 in the Periyar Tiger Reserve due to electrocution from high-tension power lines, which pass through the Reserve; similar deaths have been reported in Nelliampathy hills. Deaths due to power lines in the forest boundaries are also not uncommon, but rarely reported;
b. Repeated train hits in the Delhi-Dehradun route, which have led to the deaths of several elephants in the last decade;
c. Apart from incidental catch in fishing nets, mortality due to propeller hits from ships, trawlers or power boats has been reported in the case of several species of dolphins, whales, dugongs and turtles, e.g. the Irrawady dolphin in the sea as well as in Chilika lake, and the Olive Ridley turtle in Orissa coast. According to Dr R.K. Sinha (Chairman of Asian River Dolphin Committee), about 15 dolphins were killed in Chilika lake alone during the last two years, out of about 50 animals in the lake (Mishra 2002);
d. Road kills are a major mortality factor in the case of several species of small mammals and herpetofauna, especially in the Western Ghats and northeast India where these taxa show high species richness and endemism. Such kills might have an unexpectedly high impact on the population (Vijaykumar *et. al.*, 2001).

Box 5.8 Wildlife Disease and Faulty Reintroductions

Wildlife diseases have taken a toll on a number of herbivores in the past, especially *gaur*, elephants and deer. Anthrax, FMD, gastro-intestinal diseases, ecto- and endo- parasites are some of the common diseases that have been reported. Bhadra Tiger Reserve and the Mudumalai Wildlife Sanctuary have lost huge numbers of *gaur* due to anthrax, as reported by respective forest department officials (Srinivasulu 2003). One of the possible reasons sited for the significant decline of vulture populations is viral disease. Worldwide declines of amphibian populations are partly attributed to chytrid fungus and irido virus, but information on such impacts on amphibians in India is not available.

In the past several species of animals have been released into the wild without a scientific and systematic protocol. There are several examples of deer parks and zoos in the country that are affiliated to the forest departments that release excess stock of deer into nearby forests (Khadri *et. al.*, 2002). When such releases take place, wild populations are at high risk due to the spread of diseases from the released stock to the wild. Given the fact that most Indian zoo animals are neither screened for diseases regularly, nor scientifically quarantined for any reason, diseases like tuberculosis, gastro-intestinal diseases, parasites, viruses, etc. picked up in the zoo could be transmitted to susceptible wild populations.

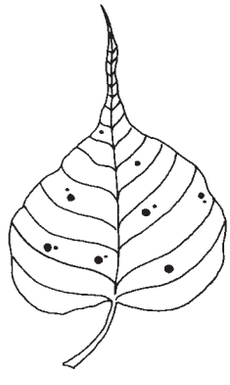
Problem animals like monkeys and leopards are captured and released in alternate sites, much in the same fashion as deer from zoos, without much consideration to reintroduction principles and risk factors. Monkeys have in the recent past been released from laboratories into forest areas, an example being those released from the scientific laboratory of the National Institution of Nutrition in Hyderabad into forests of Adilabad district in Andhra Pradesh. Monkeys from urban areas have been released in forests (Imam and Yahya 2002; Imam *et. al.*, 2002) without assessing the risk to the wild, and without strict veterinary protocol. A typical case for failed reintroduction in primates can be learnt from Gupta (2002), where he has documented release of Golden Langurs in Tripura and listed the lessons learnt from such an exercise.

Contributed by Sanjay Molur

Flora and fauna loss is also reported from human-induced disasters, such as mine or dam bursts, flash floods caused by sudden releases of water from dams (e.g. hundreds of nests and birds have been swept away at least twice in the Ranganithittu Sanctuary in Karnataka, due to sudden releases from the Krishnarajasagar dam).

Modern-day emphasis on propagation of short-lived commercial species, or the preference for ornamental species of trees over indigenous varieties like *peepul*, *ficus* and *semul*, has resulted in depriving many birds, reptiles, insects, etc. of food, shelter and nesting sites (Gautam 2002).

About two-thirds of India's terrestrial boundary is internationally shared with other countries. Trans-boundary activities, like grazing, unsustainable harvest of NTFP, control of forest fires, smuggling or illegal wildlife trade across India's borders – all these have a negative impact on biodiversity. Smuggling of timber across the international border has been a cause for the degradation of forests in border areas in the north-eastern states. Efforts to prevent timber theft either through the Border Security Force or through the State Forest Protection Forces have not been successful (*North-East India Ecoregional BSAP*). Tripura shares an 839 km long border with Bangladesh, and there has been large scale smuggling of forest produce across the border, with total loss of forested areas that lie along the border (*Tripura State BSAP*). Closure of the border with Tibet (China) to nomadic pastoralists in the Trans-Himalayan ecoregion over the last three decades has led to intense grazing pressure by both the domestic and wild herbivores which earlier had a larger range (*Sikkim State BSAP*).



The armed forces control large amounts of land and water that contain significant biodiversity in the country, and some of their defence related operations result in negative consequences on the local biodiversity. For example, in Sikkim, there has been instants of *Kiang* (Wild Ass) and other endangered wildlife getting killed and injured by landmine blasts (*Sikkim State BSAP*).

'The long insurgency problem in some states such as Assam and Tripura has had considerable impact on forest conservation. Large tracts of plantation forests in the entire state of Tripura are being destroyed in the absence of any watch and guard either by the forest department or by the JFM committees, due to insurgency. Besides, there have also been numerous inter-state border disputes amongst the north-eastern states. Most of these border areas are forest lands and because of boundary disputes, such lands are often declared as 'no man's land'. Hence, they do not come under any form of management. This leads to the degradation of forests in such areas' (*North-East Ecoregional BSAP*).

Incidental catches and poaching has been a major reason for the drastic reduction in the population of the sea cow (*Dugong dugong*) in the Gulf of Mannar and the Andaman and Nicobar islands. The sea cow takes 15 years to mature; it has a gestation period of 13 months, producing only one calf at a time. Incidental catch also poses a threat to the marine turtles off the east coast and the Andaman and Nicobar islands. Marine turtles have also been affected by poaching (Bhupathy *et. al.*, 2000). One of the world's largest nesting populations of Olive Ridley sea turtles off the coast of Orissa has been severely impacted by mechanised trawlers. Hundreds of dead sea turtles are washed ashore after they are drowned in trawl nets. In the Andaman and Nicobar islands it is estimated that between 2000-3000 marine turtles of all size classes are caught annually in fishing nets (Andrews *et. al.*, 2001). The Gangetic dolphin, a freshwater mammal, is also threatened by incidental catch (Lal Mohan 2001).

Several factors other than the above have had or are predicted to have major impacts on animal diversity. The most documented one in recent years is the massive mortality of coral reefs due to the El Nino effect. Other factors include increased UV radiation due to ozone depletion and global warming, to both of which amphibians seem to be more vulnerable. However, these factors have not been adequately studied in India (*see Box 5.9*).

There are apprehensions about the possible long-term impacts of Genetically Modified (GM) technology on the environment. GM organisms could pass new genes borrowed from other species to the local biodiversity in a given area, and thereby change the natural gene structures. However, long-term monitoring is needed before any conclusion can be drawn on this.

In the case of micro-organisms, there is a serious lack of information on threats. Even in well-studied biodiversity hot spots, it is extremely difficult to assess the loss of microbial diversity. Some of the important causes of such loss could be:

1. Loss of habitats and species with which microbial species are associated, and,
2. Pollution.

Box 5.9 Impact of Climate Change on Biodiversity

According to the Intergovermental Panel of Climatic Change (IPCC 2001), the range and abundance of plants and animals could change dramatically under changing climatic conditions, and some species are likely to be unable to adapt or migrate to new locations. Most plants and animals can tolerate only a narrow range of ambient temperature. If the temperature varies significantly from this range, normal physiological functioning breaks down. Sukumar (2000) highlights the threat to the isolated coastal tiger population of Sundarbans due to possible sea level rise, on account of global warming.

Ravindranath and Sukumar (1996, 1998) and Sukumar *et. al.*, (1995) describe the possible impacts of climate on the forests of India under 2 different scenarios.

Scenario I: Greenhouse Gas forcing

The radiative forcing of greenhouse gases as a result of direct emission of a particular gas is referred to as direct greenhouse forcing. But GHG concentrations can change not only as a result of emissions of that gas, but also when emissions of other

gases lead to chemical reactions, which alter the concentrations of that gas. This is termed as the indirect GHG forcing (N H Ravindranath, Centre for Ecological Sciences, personal communication 2003).

This scenario shows the following changes in forest types:

Western Ghats

A possible shift in vegetation-type boundaries along

- *East-West Gradient*, with moist forest types expanding eastward
- *Altitudinal Gradient* with species adapting to warmer climate, and lower elevation species migrating to higher altitudes

The montane forests of the Western Ghats would change into grasslands. Further, in the absence of management of these grasslands it is envisaged that exotics of C3 photosynthetic type would establish themselves. This includes most trees and agricultural crops such as rice, wheat, soybeans, potatoes and vegetables (N.H. Ravindranath, Centre for Ecological Sciences, personal communication 2003).

Due to the reduced frost and enhanced photosynthetic activity, fast-growing species like Wattles and eucalyptus would also be enabled to spread to grassland areas (where they are now absent) displacing slower growing forest trees and shrub species.

One vertebrate that is almost certainly likely to be affected in the absence of conservation and management measures is the Nilgiri Tahr, which is endemic to the montane grasslands of the Western Ghats.

Central Forest Belt

The increase of dry season length due to global warming would increase the risk of forest fires in moist- and dry-deciduous forests of India. Central Indian forests which are mostly moist-deciduous may be exposed to increased rainfall and soil moisture from the south-west monsoon and be transformed to moister vegetation types. Sal (*Shorea robusta*) characteristic could replace teak (*Tectona grandis*) in the drier belt.

North-West India

Certain biomes, namely Evergreen Warm Mixed Forests and Taiga, are likely to show a marked expansion regardless of degree of climate change. Likewise, Tundra and Wooded Tundra will probably shrink in the future under all possible scenarios. But the mix of trees is likely to be different from the present, due to the additional influence of biotic factors. Some economically and socially important species such as *deodar* (*Cedrus deodara*) and the oaks (*Quercus* spp.) will almost certainly decline due to the interaction of climatic and biotic factors. At the same time, resilient species such as Blue pine (*Pinus wallichiana*) and *Chir* pine (*Pinus roxburghii*), which may not be particularly useful for fulfilling the day-to-day needs of people, may increase in numbers as various changes eliminate competing species (Deshingkar *et. al.*,1996).

North-East India

The increase of temperature may result in shift of lower altitude tropical and sub-tropical forests to higher altitude forests. The practice of slash-and-burn cultivation in this region, may however, survive climate related change.

The increased rainfall and soil moisture coupled with increasing CO_2 could stimulate productivity in tropical forests there by increasing levels of diversity (Ravindranath and Sukumar 1998).

Scenario II: GHG and Sulphate Aerosol forcing

Atmospheric aerosols influence climate in two ways, directly through the reflection and absorption of solar radiation, and indirectly through modifying the optical properties and lifespan of clouds. Both the effects are dependent on particle size and chemical composition and cannot be related to aerosol mass source strengths in a simple manner. Future concentrations of anthropogenic sulphate aerosols depend on both fossil fuel use and emission controls. Even if globally- averaged concentrations were stabilized (through stabilization of total global emissions) the geographical distribution of sulphur-

dioxide emissions, and hence the aerosol concentration, would be likely to exhibit major changes (N.H. Ravindranath, Centre for Ecological Sciences, personal communication 2003).

This second scenario explained by Ravindranath and Sukumar (1998) involves a more modest increase in temperature and a decrease in precipitation in central and northern India. This could have adverse effects on forests. The strength of the monsoon is also expected to decline. In this model no significant change is to be expected for southern India, but there is a major impact on central and northern India.

In central India a shift from moister to drier types is expected with drier teak forests replacing the moister sal forest . Similar trends at lower magnitude may be observed in northern India.

The authors conclude that in both the cases species extinction and decline of biodiversity is expected. This depends on the rate of change of climate and time available for species to adapt (*Climate Change Sub-thematic Review*).

There is new evidence on these issues presented in the Third Assessment Report of the IPCC, and some of the conclusions are as follows:

i. Populations of many species that are already threatened are expected to be placed at greater risk by the synergy between the stresses of changing climate and land-use change that fragments the habitats.
ii. The latest vegetation distributional models suggest that mass ecosystem or biome movement is most unlikely to occur due to different climatic tolerance of the species involved, different migration abilities and the effects of invading species.
iii. Species composition and dominance could be altered, resulting in ecosystem changes.
iv. Some species that are currently classified as 'critically endangered' could become extinct, without adaptation.
v. Terrestrial ecosystems appear to be storing increasing quantities of carbon. Productivity gains are occurring due to changes in climate parameters as well as changes in uses and management of land.

Ravindranath and Sathaye (2002) conclude that though there are uncertainties, evidence is growing to show that climate change coupled with socio-economic and land-use pressures is likely to adversely impact forest biodiversity, as well as carbon sink and biomass productivity (or carbon uptake rates).

Climate changes would also have serious impacts on coastal and marine biodiversity. The most obvious impact would be shore erosion, leading to loss of beach habitats and coastal ecosystems like mangroves and low-lying islands. If sea levels were to rise at the rates predicted through the early part of the 21st Century, then most of our low-lying islands like the Lakshadweep atolls, along with their land biota and the coral reefs, would be drowned (Wafar 1990). Other possible impacts would be alteration of metabolic and physiological functions of marine organisms, proliferation of opportunistic species, and changes in ocean circulation patterns that affect the current distribution of marine organisms, and consequently local and regional fisheries. While some attempts are being made to address impacts of global changes from the perspective of marine environment, they are generally limited to predicting weather and monsoon patterns. It is essential that serious attempts are made to understand how the global changes would, directly and indirectly, affect coastal and marine biodiversity.

5.1.2 Agricultural Ecosystems and Domesticated Taxa

Since agriculture is intimately connected to human societies, it is inevitable that it changes with larger social changes. Agriculture and animal husbandry give way to other land uses, methods and technologies of growing food; other crops evolve, food and drink tastes change, consumer demands swing, and new and additional needs are defined – all of these influence the way agriculture is carried out. In India, the shift from agriculture to industry, urban growth, the need for rapid increases in foodgrain (or milk/wool) production, the change in consumer preferences towards a few cereals and increasingly towards branded foods, the encouragement to cash cropping, commercial animal husbandry, agro-exports, the dumping of cheap imported produce, and a whole host of related changes have drastically affected agricultural patterns. The result has largely been an adverse impact on the diversity of agro-ecosystems, crops and livestock, which characterised traditional farming systems in India.

Box 5.10 The Genetic Poverty of Modern Agriculture

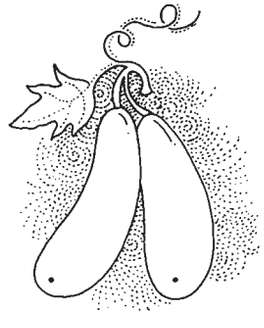
Overwhelming evidence is now available on the severe loss of genetic diversity entailed in the transition to `modern' agriculture (Soule *et. al.*, 1990), typified in India by the Green Revolution. Some of the factors involved are given below:

1. Modern agricultural fields are immensely more simplified than traditional agro-ecosystems, stressing as they do the aspect of single-crop productivity. They also replace the critical role of livestock manure, animal draught power, trap crops, wild and weedy relatives, and natural pollinators and dispersal agents by external inputs like fertilisers, mechanical energy, pesticides, and laboratory-generated hybrids. The overall loss in genetic diversity cuts across both domesticated and wild flora and fauna.
2. Inter-cropping is severely reduced in modern monocultural systems, resulting in the loss of crops like pulses, which were grown interspersed with the main crop to help in regaining soil fertility.
3. Inter-species diversity is lost due to the emphasis on a few crops which can be marketed over a large area. While in the not-so-distant past the people of the world were growing and consuming several hundred crop species, today 80 to 90% of the world's calories are met from only 10 to 20 crops (Soule *et. al.*, 1990).
4. Genetic diversity within a single crop is lost in modern agriculture, in which a few widely adapted varieties replace a large diversity of locally specialised varieties. Consider this opposition: In the Philippines, the Hanunoo shifting cultivators grow 92 varieties of rice, while on the other hand a single variety, IR36 from the International Rice Research Institute, is grown over 2.46 million hectares (Plucknett 1987). A recent study on the impact of intensive agricultural practices in the Hirakud Command Area of Orissa revealed that there were about 152 varieties of rice that were cultivated 40 years ago, but that this declined to only 30 varieties during the 1990s (Mishra, In Press). The situation is the same with several other crops in India.
5. Hybridization and genetic recombination are constantly taking place in traditional agro-ecosystems, either through the conscious activities of farmers or naturally; in modern agriculture, this possibility is eliminated, either because relatives of the cultivar are absent, or because seed produced from modern hybrids is infertile. This has been well documented, e.g. in the case of maize (Salick and Merrick 1990).

5.1.2.1 Habitat Destruction and Homogenisation

Worldwide, an estimated 60-70,000 sq km of agricultural land is made unproductive each year by erosion. Waterlogging, salinisation and alkalisation claim an additional 15,000 sq km every year, due to badly managed irrigation schemes (IUCN/UNEP/WWF 1991). Thousands of square kilometers are also lost to urban and industrial growth, road networks, river valley projects, mining and other development-related works. This kind of loss has been seen in India as well, with millions of hectares of agricultural land being eaten up by various non-agricultural activities, and over 50% of agricultural land facing moderate to severe degradation (Virmani 1991). A substantial part of this loss is that of the traditional agro-ecosystems which harboured high levels of crop and livestock diversity.

Information on loss of specific agro-ecosystems in India is scanty. A recent compilation by Sehgal *et. al.*, (Undated) provides some idea of the kind of natural constraints and human-related activities threatening each agro-ecological region (for details of these regions, *see Section 4.1.3.1*), though they do not specify the precise impacts of these factors. Of the human-related activities, severe deforestation and the consequent soil erosion are adversely affecting Regions 2 (Western Plain), 15 (Western Himalayas), 17 (Eastern Himalayas), 18 (North-eastern Hills), and 21 (Andaman and Nicobar Islands). Surface irrigation-related problems, including waterlogging, salinity, and alkalinity, are affecting Regions 5 (Central Highlands and Kathiawar Peninsula), 7 (Deccan Plateau and Eastern Ghats), and 9 (Northern Plain). Excessive withdrawal of groundwater is said to be affecting Region 4 (Northern Plain and Central Highlands). There appears to be no information on the extent to which any of these regions, or any specific agro-ecosystem types, are threatened.



While the extent of habitat destruction is to some extent known, what is almost completely undocumented is the impact of this on domesticated biodiversity. Goat breeds, for instance, are known to be losing ground rapidly due to the loss of browsing habitat, while the loss of pastures due to developmental projects and agricultural expansion in the semi-arid zone of western India has adversely affected indigenous livestock breeds

(Balain1993). Drought conditions, and the consequent shortage of fodder and water, force major migrations during which many animals perish, with possible reduction in indigenous breed numbers (CAZRI1993).

The drought-resistant hardy germplasm of *Cymbopogon*, *Cenchrus*, *Panicum* and *Lasiurus* is getting fast depleted. The once-famous dairy cattle wealth of Khajuwala-Banduwala in Stage 1 of the IGNP in Bikaner and Sriganganagar districts is now lost because of removal of *L. sindicus* for irrigated cropping. In Stage II, a significant proportion of the IGNP's command area (3544 sq km) has hard pan at 5-10 m depth, making it vulnerable to waterlogging upon intensive irrigation. It was suggested that protected grasslands for pastoralists be established at these sites (Kumar and Shankar1987). But economics prevailed over ecological concerns, and the entire stretch of Stage II of the IGNP has been brought under irrigated cropping. A recent survey of these areas revealed not only the large-scale devastation of *Lasiurus sindicus* grasslands in this area but also large areas being waterlogged near Deva in Jaisalmer. Crop weeds as well as *Echinochloa colonum* and *Arundo donax*, the water grass, have come up. Such changes in plant cover indicate that widespread destruction of natural vegetation is taking place in the Canal command area.

Another factor is the rapid loss of pastoralists' access to habitats and resources, especially in the case of nomadic communities. In Virudhunagar District of Tamil Nadu, it is believed that the *Malaimadu* breed of cattle may be threatened by a number of factors, one of which is reduced access to grazing grounds which are now notified as a wildlife sanctuary (*Nomadic Pastoralism and Biodiversity Sub-thematic Review*); in many parts of India, migratory routes have been cut off by irrigation channels, expressways, urbanisation, forest enclosures (including through JFM), and changes in land uses that are no longer compatible with pastoralism, leading to reduction in the population of indigenous breeds. The *Ponganur* breed of cattle from Chittor District and the *Vechur* breed from Kerala are both critically endangered, each with less than a hundred animals surviving (Scherf 2000). In north-eastern India and some other regions, the decline in shifting cultivation due to a variety of factors could be leading to loss of agro-biodiversity.

Oliver *et.al.* (In Press) and Andrews and Sankaran (2002) note that the feral pig in the Andaman Islands is highly endangered by a combination of factors, including deforestation and over-hunting by settlers in tribal reserves such as the Jarawa Reserve and Little Andaman Island, currently the two last strongholds for the Andaman pig. This has become a major threat to the Jarawa and Onge tribal communities, for whom the pig is a staple dietary item (Andrews 2000, 2002). In addition, it could threaten the domestic pig, as some of the tribes (in the Nicobars, for instance), have traditionally encouraged the genetic mixing of wild and domestic pig populations (Mathew 1967). In North-east India, a whole range of 'minor' cultivated and semi-cultivated varieties are threatened because their areas of cultivation are losing out to non-agricultural land uses (Arora 1983).

Downstream effects of the damage done upstream are very serious. 'Indo-Gangetic agriculture, often described as a potential breadbasket in the world, is being damaged beyond repair as a result of soil degradation. Some areas are facing problems of waterlogging and rising water tables because of poorly planned and ill-executed irrigation. In other areas, the water table is receding because of over-exploitation of groundwater. Furthermore, the quality of groundwater is being affected due to chemical pollution, and in coastal areas due to the ingress of seawater. The excessive use of fertilizers and pesticides poses a threat to human health, and to the genetic stocks, and reduces the natural soil fertility in the long run. The absence of an integrated land- and water-use policy for the country is taking a heavy toll on these basic natural assets' (MoEF 1992).

Like all plants, crops are susceptible to damage by certain pollutants, though there is no clear indication of the loss of diversity due to this factor alone. Short-lived, fast-growing herbaceous plants are more vulnerable to ozone damage than the slow growing woody vegetation. Crops of cereals and pulses are more susceptible, mainly because of intensive agricultural practices, which have not allowed them to evolve defence mechanisms comparable to woody plants (Pandey *et. al.*, 1992).

Uncultivated and 'wild' species that are associated with agriculture – and are part of the diet of farming communities – have also lost out due to pollution, especially from toxics like pesticides. This is widely reported by

farmers from various parts of India. For instance, there has been a definite loss of uncultivated food plants like *bathua* (*Chenopodium album*), and of small aquatic fauna like snails, fish, and crabs, which were earlier gathered and consumed by the poor.

5.1.2.2 Introduction of Exotics and Hybrids

The recent large-scale introduction of exotics and modern cross-breeds is, undoubtedly, the biggest factor in the decline of both cultivated plants and domesticated animals. Though information on the exact nature and extent of the threat to each kind of plant and animal is not yet available, enough evidence exists to give a broad and undisputable picture.

Crops: In the recent past, the incredible diversity of crops – both in terms of species and the genetic variety within each species – grown in many parts of India has rapidly given way to a handful of varieties, largely developed in the laboratory, often introduced from outside India. Introduction of agricultural crops from outside India is by no means a recent phenomenon; indeed, a considerable proportion of what is today considered 'Indian' has been brought from elsewhere. But in the past, as far as is known, introductions appear to have been slow, starting at a small scale, allowing time for absorption and for their own diversification, and not leading to large-scale displacement. The more rapid process in the last five decades has happened as part of a conscious policy to `upgrade' agriculture, in order to increase productivity and economic profitability, at least in the short run. The big push to this process came after the mid-1960s, when the so-called Green Revolution was introduced, initially with wheat and subsequently with some other major crops. The new varieties of wheat rapidly replaced local or indigenous varieties in Green Revolution areas (Querol 1992; Mehra and Arora 1982).

The rapid spread of the new package has converted the majority of cereal-growing agricultural land in India to High-Yielding Variety (HYV) monocultures. The area under HYVs for some major crops from 1993-94 up to 1997-98 is given in *Table 5.4*.

Table 5.4 Area (in million ha) Under High Yielding Varieties of Select Crops

Crop	1993-94	1994-95	1995-96	1996-97	1997-98 (Provisional)
Paddy	28.9 (68.0)	31.0 (72.4)	31.4 (77.0)	33.4 (70.9)	32.2 (74.2)
Wheat	22.0 (87.3)	23.2 (90.3)	23.1 (92.8)	23.7 (91.5)	23.0 (86.1)
Jowar	6.8 (53.5)	7.1 (61.7)	7.5 (79.6)	8.3 (73.5)	9.0 (81.8)
Bajra	5.1 (53.7)	5.4 (52.9)	5.5 (74.2)	6.1 (61.0)	7.0 (72.2)
Maize	2.7 (45.0)	3.4 (55.7)	3.6 (58.30)	3.8 (60.3)	3.6 (57.1)

Note : Figures in bracket indicate percentage of HYV coverage to total area under the crop
(Source: MoEF 2001b)

Table 5.5 Decline in 'Minor' Crops, After the Green Revolution

Area in Million Hectares

CROP	1964-65	1974-75	1984-85	1994-95	% Loss
Sorghum (*Jowar*)	18.1	16.2	15.9	11.8	35
Pearl Millet (*Bajra*)	11.8	11.3	10.6	10.1	14.4
Little Millet (*Sama*)	4.6	4.5	3.2	1.9	59
Finger Millet (*mandua/ragi*)	2.6	2.5	2.4	1.8	31

(Source : The Hindu Survey of Indian Agriculture 1998)

At an all-India level, most varieties of sugarcane, including the indigenous *Saccharum barberi*, have given way to the hybrid *S. officinarum* (Director, Sugarcane Breeding Institute, personal communication 1993). Strains of *S. barberi* now exist only at the Sugarcane Research Institute at Coimbatore. Local potato varieties have been abandoned in many places due to what were considered to be poor yields and disease susceptibility (Khoshoo 1992). The introduction of high-response hybrid varieties has pushed out 'primitive' cultigens like *Solanum melongena* var. *potangi* (brinjal), *Abelmoschus tuberculatus* (okra), *Musa balbisianum* (banana), and *Piper schmidtii* (pepper).

In Tripura, the percentage of total area under local varieties of rice decreased by over 75%, while that under HYVs increased by 65% over a twenty-year period, as shown in the *Table 5.6* (*Tripura State BSAP*).

Table 5.6: Coverage of Different Categories of Rice Cultivation in Tripura

Area in 000 Ha

5 years Average Ending	Total area	Local variety		HYV	
		Area	% of total area	Area	% of total area
1984-85	285.52	131.32	45.99%	154.2	54%
1998-99	241.78	26.31	10.88%	215.47	89.11%
Over a period of 20 years-trend	(-) 43.74	(-) 105.01		(+) 61.27	
Over a period of 20 years-trend in %	(-) 15.52%	(-) 79.96%	(-) 76.34%	(+) 9.73%	(+) 65.0%

Source: State Agriculture Research Station, Agartala, as quoted in the Tripura State BSAP

In West Bengal, the damage caused by the HYVs is considerable: 'The *toria*...has almost been pushed out of its centre of origin in the Himalayan foothills, yielding place to yellow *sarson*. Likewise, the progenitor of cultivated maize which existed in Sikkim and Darjeeling hills and Assam hills has been lost. Of the millets, *Ragi* (Finger Millet, *Eleusine coracana*), *Cheena* (*Panicum milliaceum*), *Kaon* (Foxtail Millet, *Setaria italica*), and *Gundli* survived the onslaught. The scented *moong* (pulse) of Malda and Nadia districts also face extinction...' (*West Bengal State BSAP*).

The effect of single-output production-targeted agricultural development, on other crops in particular and agrodiversity in general, has been lethal. Punjab has been extremely destructive in its treatment of non-rice, non-wheat and non-cotton crops. This is clear from Table 5.7.

Table 5.7 Area and Production of Some Crops in Punjab

Crops on the rise

Crops	1960-61		1999-2000		% Increase	
	Area `000 ha	Production `000 MT	Area	Production	Area	Production
Rice	227	229	2518	8716	1009	3706
Wheat	1400	1742	3278	15910	134	813
Cotton	447	563	709	950	26	68

Crops on the decline

Crops	1960-61		1999-2000		% Decline	
	Area `000 ha	Production `000 MT	Area	Production	Area	Production
Gram	836	681	13	6	98.44	99.12
Groundnut	67	62	6	5	91.04	91.93
Bajra	123	58	5	4	95.93	93.1

Source: Punjab State BSAP

For every acre and tonne of rice Punjab has sacrificed its gram, groundnut and *bajra* – crops which inherently promote diversity, eco-friendliness in farming, and food health security. In the decade between 1985-95, *ragi* (finger millet *Eleusine coracana*) cultivation has entirely stopped, while other millets have lost 15% of the cultivated area and 25% in production (*Punjab State BSAP*). In Himachal Pradesh as well, along with the decline of rainfed rice, *ragi* (finger millet *Eleusine coracana*) and other millets have lost out (*Himachal Pradesh State BSAP*).

The situation is the same across the country. States like Andhra Pradesh and Karnataka in their respective state agricultural policies have declared rice as the *grain of food security* in their states (e.g. see Andhra Pradesh Draft Agriculture Policy 2000, GoAP 1999), completely overlooking the fact that sorghum, pearl millet and other millets are eaten and grown in at least 50% of the districts in each of these states. Thus, all these grains, which are products of diverse farming systems, have been systematically marginalised.

It is important to mention here that most of the rice varieties which have suffered badly due to the homogeneity of the crop are the non-irrigated varieties. For instance, in Himachal Pradesh, where a large variety of dryland varieties used to be grown, rice cultivation has come down from 90,800 ha in 1985 to 83,000 ha in 1995. The production has also fallen by 12% during this period from 125,400 tonnes in 1985 to 111,800 tonnes in 1995 (Source: Statistical Outline of Himachal Pradesh, 1988, 1994, 1997 as quoted in *Himachal Pradesh State BSAP*). At the same time, the figures for rice cultivation in Punjab provide a totally contrasting picture. Rice is cultivated only under irrigated and extremely homogenised conditions in Punjab. Between 1960 and 2000, Punjab increased its cultivation of rice by nearly 11 times (from 227,000 ha to 2,518,000 ha) in terms of area, and 38 times in terms of production (from 229,000 MT to 87,16,000 MT) (*Punjab State BSAP*).

Livestock: The threat to domesticated animals comes from a similar thrust to 'improve' productivity by cross-breeding programmes and introduction of exotics, as also by accidental genetic dilution (CAZRI 1993; Balain 1993). In the case of cattle, this thrust was partly fuelled by the White Revolution. In the case of sheep, large-scale migration due to drought and other factors has given opportunities to intermix with other breeds, and the deliberate introduction of exotics has further diluted the genetic stock; breeds from Jammu and Kashmir in north India, such as *Bhakarwal*, *Gurez*, *Karnah*, and Poonchi, face extinction in their pure form due to intensive cross-breeding with the Soviet Marino variety (Pino *et. al.*, 1992; S. Parthasarthy, personal communication 1992; Balain 1993).

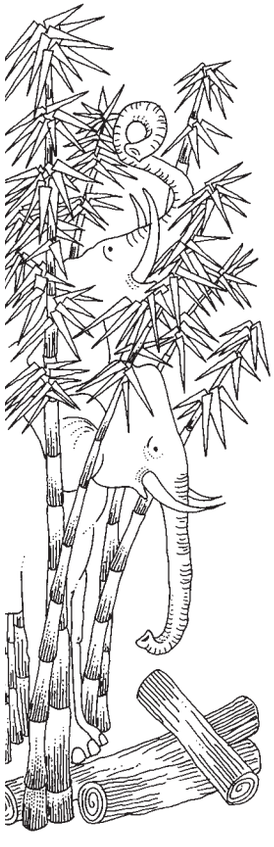
The loss to India of a substantial part of the indigenous camel population when Pakistan was created has left small vulnerable populations in Rajasthan and Gujarat. Several factors like the lack of adequate pasture and grazing lands, lack of adequate veterinary services, lack of male breeding camels, as well as the replacement of the camel by mechanised transport have caused a further decline in population (CSIR 1962; Balain 1993; Khanna 1993; Koehler-Rollefson and Rathore 1999; *Rajasthan State BSAP*). In the case of goats, the impact of destruction of browsing habitat has been accentuated by large-scale cross-breeding programmes, due to which at least five varieties are threatened (CSIR 1962; Balain 1993). The *Thakrana* goat, for instance, is facing extinction due to indiscriminate cross-breeding with *Marwari* goats (Balain and Nivsarkar 1991). Besides, at

times official policy (as in the state of Andhra Pradesh) has favoured sheep-rearing over goats, partly due to the perceptions of the Forest Department of goats as being destructive browsers (Deshingkar 2002). A serious decline in population size due to various factors has threatened all but the *Kathiawari* and *Marwari* breeds of horses and ponies (CSIR 1962; Balain 1993). The Manipuri pony too has suffered neglect. In Sikkim, a decline in the yak breeds has taken place as a result of inbreeding after the closure of the international border (*Sikkim State BSAP*).

Some breeds of indigenous buffalo and cattle already have very small populations, such as the *Toda* breed and Nili-Ravi breed of buffaloes, and the *Tharparkar*, *Sahiwal*, and *Red Sindhi* breeds of cattle. The last three first reduced in numbers due to the break-up of the country into India and Pakistan. Subsequently, all these breeds have been further endangered by cross-breeding programmes (CSIR 1962; Balain and Nivsarkar 1991; Balain 1993). Another, the *Vechur* cow, is on the verge of extinction due to extensive cross-breeding with exotic breeds, a fate that has hit the *Ponganur* cattle breed as well (Balain and Nivsarkar 1991). The *Khariar* bull became extinct in the Naupada district of the Kalahandi region of Orissa, after a scheme was initiated in the late 1970s that castrated all the *Khariar* bulls and artificially inseminated the cows with Jersey semen (Sainath 1996).

A massive influx of exotic breeds, which now make up 80% of the population, has threatened all 18 indigenous breeds of poultry (CSIR 1962; Balain 1993). The *Kadaknath* breed, for instance, has been pushed almost to extinction by this process (Balain and Nivsarkar 1991).

Little information exists on the loss of indigenous breeds of pets in India. It appears that several indigenous dog breeds have been displaced by exotics, which seem to find more favour with dog lovers. But the dimensions and process of this loss has remained undocumented. During the colonial period, `educated' Indians aped the British in keeping exotic breeds, neglecting Indian breeds, which came to be contemptuously known as 'pariahs' (Baskaran 1985). Many indigenous breeds were genetically diluted by interbreeding with the exotics, while some like the *Rajapalayam*, degenerated due to inbreeding. The Tibetan Mastiff, a magnificent pure breed of dog belonging to the nomadic 'Dokpas' or Tibetan graziers in trans-Himalayan Sikkim, has over the last two decades been reduced to one very old male, due to dilution of the breed with mixed breeds taken there by army personnel from lower altitudes (*Sikkim State BSAP*). Other reasons for indigenous breeds dying out include the decline of hunting as a pastime, and the replacement of guard dogs by modern safety systems (Baskaran 1985). Unfortunately, little is documented about the loss of dog breed diversity in India. Even less is known about domestic cats.



5.1.2.3 Others: Loss of Wild Relatives, Market Orientation, and Consumer Preferences

Crop and livestock (including poultry) genetic diversity has also been affected by the loss of related wild taxa: wild relatives of crops, as also natural pollinators and dispersal agents. Traditional agro-ecosystems often contained a complement of such related species and varieties, including through the interspersion of fields, pastures, forests and wetlands. The natural cross-breeding which occurred in such a situation ('gene flow') was one factor increasing crop and livestock diversity; another was the widespread dispersal and pollination by insects, birds and other natural agents. It has been shown, for instance, that tomatoes moved out of the range of their natural pollinators tend to self-pollinate, increasing the chances of inbreeding and reduction in genetic diversity (Rick 1950). The loss of natural habitats, the high-intensity monocultural nature of cropping under modern systems, and the use of agricultural chemicals have all caused a severe loss of these wild relatives and their associates, adversely affecting crop genetic diversity (Salick and Merrick 1990). This process has unfortunately not been documented in India, though it is known that several wild relatives are threatened. For example, the red jungle fowl may be critically endangered, due to introgression of genes from domesticated and feral chickens, which could lead to the erosion of the gene bank for the poultry sector (Fitzpatrick and Ahmed 2000).

A shift in cultivation practices to more market-oriented crops (such as wheat and rice in preference to coarse grains), and to mono-cropping rather than the traditional multi-cropping systems, has meant the large-scale loss

of indigenous crop diversity. This has been the case, with small millet varieties all over India, such as *raishan* (*Digitaria compacta*) from the Khasi hills of Meghalaya (A. Seetharam, personal communication1992). A number of 'minor' traditional foods have lost out – Job's tears (*Coix lachryma jobi*), for instance, has been replaced by maize in the Garo Khasi hills of Meghalaya and in Nagaland. This is not surprising, for monocultures have replaced mixed cropping over more than 75% of the cultivated area even in north-east India (Maikhuri *et. al.*, 1996a; Maikhuri *et. al.*, 1996b; Maikhuri *et. al.*, 1997).

In parts of the Himalaya, cultivation of chenopods, plants of the beetroot family which are an important nutritional addition to local diets, has declined due to a shift towards commercialised agriculture (Partap 1990). Various Citrus fruits, endemic to the north-east, such as *C. ichangensis* (Nagaland), *C. assamensis* (Meghalaya), *C. latipes* (Shillong plateau), and *C. indica* (Garo hills of Meghalaya and parts of Assam and Nagaland), as also other fruits like the apple (*Malus baccata* var. *himalaica*) and the peach (*Prunus jenkinsii*), have also become threatened due to inappropriate shifting cultivation practices and to replacement by higher-yielding varieties (Arora 1983).

Current market orientations, which increase the prices or marketability of certain crop species or varieties, have resulted in a decline in home garden diversity, though it is also true that some diversity is market-driven. The level of diversity most beneficial for a farming family may not be the one most desired by larger society. Besides government policies, which provide subsidies to certain crops (as in the case of rubber) and also to technologies that supported monocropping practices, have also impacted home garden diversity. The erosion or neglect of traditional knowledge and consequent lack of information has also led to a decline in the diversity found in home gardens (*Home Gardens and Biodiversity Sub-thematic Review*).

The need or desire to use new, `artificial' inputs, and their increasing availability under the `Green Revolution', has also eliminated the practice of growing nitrogen-fixing and soil-enriching plants in conjunction with the main crops. Thus all over India pulses which were grown after harvesting the cereal crop are now felt to be redundant as chemical fertilisers can do the job (Chandra 1991).

With increased irrigation the crop diversity is reduced, as farmers go in for cash crops like banana, coconut and areca. Decrease in forests has led to shortage of biomass for agriculture and livestock, leading to reduction of organic inputs and low yields. This has forced many farmers to abandon cultivation of traditional paddy and vegetable varieties.

The impact of climate change on the cultivation of crops has only recently begun to be studied, but there are apprehensions of possible negative effects. For example, with rising levels of sea water, river deltas will see an incursion of saltwater, thus possibly impacting agriculture. In a crop simulation study, it was estimated that in a climate change scenario of a doubling of the carbon dioxide levels, the wheat yields could decrease by 28 to 68% (Rao and Sinha 1994), without considering the carbon dioxide fertilization effects. It has also been estimated that a rise of temperature of 2˚ to 3.5˚C could result in the loss of about 9-25% of farm revenues (Kumar and Parikh 1998).

The introduction of Genetically Modified Organisms (GMOs) or Living Modified Organisms (LMOs), without ad quate research on its possible long-term impacts, could also be a potential threat to crop diversity in the years to come. Reports from other countries that have introduced GM crops before India suggest a cross-over of genesfrom such crops to non-GM crops ('genetic pollution'), as also possible impacts on wild species (Munro 2002). There are also doubts that have been expressed on the sustainability of a GM crop's long-term stated benefits, as well as a fear that this technology will in the future only increase the stranglehold of the corporate sector on the farming population (*Agricultural Biotechnology and Globalisation Sub-thematic Review*).

Box 5.11 Diversity, Drylands and the Public Distribution System

The rice-wheat-based Public Distribution System (PDS) in India, initiated by the government as a food security instrument for the poorest of the country, has also been one of the factors most responsible for the reduction in the area under other food crops, especially sorghum and millets.

Through agricultural financing and other policies, successive governments have systematically underprivileged rainfed agriculture growing millets and cereals other than rice and wheat, and thus forced a regular shrinkage in millet-cropped areas. In many states, neither crop loans nor crop insurance are available to farmers growing these crops.

Currently, large areas of cultivable lands, which were earlier used to grow millets and cereals other than wheat and rice, are left fallow because farmers do not have money to invest in their cultivation; besides, due to the rice-based PDS, the farmers no longer feel a need to grow the millets they earlier used to grow on these lands.

To understand the implication of this denial in conjunction with the wheat-rice PDS, it is interesting to compare the quantum of rice supplied through PDS in the seven dryland states of AP, Karnataka, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu, with the extent of cultivable fallows in those states:

Table 5.8: Rice Distributed and Current Fallows (in 1990)

S. No	State	Rice Distributed ('000 tonnes)	Current Fallows [1000 Ha]	Production Capacity of the Current Fallows	Excess of capacity over PDS rice distributed	
				In '000 tonnes	In '000 tonnes	In %
1	Andhra Pradesh	850	3392	3392	2542	300
2	Karnataka	510	1671	1671	1161	227
3	Gujarat	350	759	759	409	116
4	Madhya Pradesh	310	719	719	409	131
5	Tamil Nadu	605	984	984	379	62
6	Rajasthan	39.2	1597	1597	1558	4000
7	Maharashtra	675	1106	1106	431	64
	Total	**3339**	**10228**	**10228**	**6889**	**206**

Source: http://alfa.nic.in/lsdeb/ls10/ses1/0114089103.htm

Every year, these states receive more than 3 million tonnes of rice through the PDS system. In these very states there are nearly ten million hectares of cultivable fallows, which, if brought under production, could offer a very rich biodiverse agricultural landscape, producing up to 10 million tonnes of food grains, which include millets, pulses, oilseeds and a variety of uncultivated greens and vegetables. Together this will amount to 200% more than the rice distributed through the current PDS.

5.2. Root Causes

The factors and causes of loss mentioned above are the ones that are most visible. But they are in turn symptoms, themselves results of underlying factors that often remain hidden and are therefore not dealt with. These factors are largely socio-economic (Anon 1999; Wood *et. al.*, 2000), or legal and policy changes in other, appar-

ently unrelated sectors (Ghotge 2001). The relationship between these underlying or root causes and the destruction of biodiversity is indirect, and therefore not easily grasped or visible. Root causes are qualitative in nature, and their impacts are felt through a complex interplay of different site-specific social, economic and environmental factors. The root causes of biodiversity loss discussed below may have different effects in different places. It is often difficult to pinpoint or delimit the temporal and geographical parameters of analysis while seeking to understand root causes. Many of these factors go back a long time in history, and many have interconnections spreading throughout the world. The discussion below is largely applicable at the national level, though at various points the international links are also pointed out.

Finally, biodiversity loss in this analysis is indicated not only by directly observed and quantified loss of species and ecosystems, but also by general environmental degradation as well. The chain effects of such degradation often combine biodiversity loss with loss of ecosystem integrity.

5.2.1 Current Model of Development and Economic Progress

Box 5.12 The Planning Commission on Development vs. Environment

'There is enough empirical evidence to establish that environmental conservation must go hand in hand with economic development because any economic development which destroys the environment will create more poverty, unemployment and diseases and thus cannot be called even economic development. It may just be transfer of resources from the poor to the rich. This is because the poor depend on nature for their daily survival – for them the Gross Nature Product is more important than the Gross National Product. Environmentally destructive economic development will impoverish the poor even further and destroy their livelihood resource base. Therefore the environmental concern in the developing world must go 'beyond pretty trees and tigers' and must link it with peoples' lives and well-being. The environmental problems facing India are different from those facing the affluent countries and are more immediate and health and livelihood threatening in nature. Pollution in our air, soil degradation, deforestation, desertification, shrinking wetlands, inadequate public health and sanitation, indoor pollution in rural areas, growing water scarcity, falling groundwater tables, the lack of minimum flow in rivers, and over-extraction of water for irrigation purposes are some of the environmental problems that need to addressed first before any poverty alleviation programme can meet with success. In the ultimate analysis, environmental management and economic development are mutually supportive aspects of the same agenda. A poor environment undermines development, while inadequate development results in a lack of resources for environmental protection.'

Source: GOI 2002a.

Since independence, the country has aggressively adopted one basic model of 'development', with the stated goals of achieving livelihood and economic security and, till recently, food security and other forms of self-sufficiency for the citizens of the country. This model centred on large-scale industrial production and associated infrastructure development, and commercial agricultural development, with centralized state ownership, regulation and planning. This path has been premised on increasing average per capita income and the consumption of goods and services through exploiting the country's natural resources. This concept of 'development' is defined in terms of linear economic growth at ever increasing rates, without any regard for natural resource limits. At best, current limits to extraction are taken into consideration, but these limits are seen to be on account of technological constraints. This mindset is manifest in the use of an increase in the GNP as the primary indicator of 'progress' (problems with such concepts are dealt with in *Section 5.2.6*).

Increases in economic growth indices like average per capita income, energy consumption and consumer expenditure are equated with development, largely irrespective of their distribution among different sections of the population. Such development implies ever-increasing exploitation of resources combined with environmental degradation and generation of hazardous and toxic wastes, and the perpetuation or accentuation of socio-economic inequities.

Box 5.13 Is Industrialisation Sustainable?

'It has been India's firm conviction that it is the process of industrialization, and the continued profligacy of industrialized economies that have created the problems which threaten our planet and its life forms. Not only do they use up non-renewable natural resources in disproportionate quantities, but create discharges and emissions which disturb delicate balances in ecosystems and atmospheric equilibrium. It is true, of course, that this has not been done consciously or intentionally (except in matters such as dumping of hazardous wastes, or the use of nuclear and chemical weapons). Nevertheless, the responsibility is clearly established, as also the need for urgent and effective action, by the developed world, to prevent global disaster. This includes not only direct action, but also indirect measures such as creation of an economic order which helps developing countries to exert less pressure on their own natural resources' (MoEF 1992).

More recently, development indices have been considerably expanded to include several socio-economic dimensions of progress, especially with the introduction of Human Development approaches by agencies such as the United Nations Development Programme (UNDP). Ecological aspects including biodiversity, however, continue to receive very low priority. Indicators such as per capita or general availability of forests, pastures, fresh air, fresh water and productive soil are yet to be integrated into mainstream development approaches.

From the Second Five-Year Plan period onwards, the industrial sector has continued to receive higher allocations despite generating limited employment. Similarly urban areas have received a disproportionate share of resources compared to the rural areas that are home to the majority of the population. Environmental concerns did not find any mention in national plans till the Fourth Five-Year Plan in 1969 (Roy *et. al.*, 1992). Even subsequent to this, environment has been largely compartmentalised as a separate subject, rather than being infused throughout the Plan.

Abundant evidence is now available of the negative impacts of this development model on natural and agricultural ecosystems, habitats and species as well as ecosystem-based livelihoods and socio-economic equity. Till recently forests continued to be treated mainly as a resource to be exploited for 'national' interest with scant regard for long-term sustainability, the numerous functions other than timber provision played by forests, or the livelihoods of forest-dwellers dependent on their natural biodiversity (Gadgil and Guha 1992). Highly subsidized leases to forest-based industries during the post-Independence decades laid waste large tracts of natural forests, while silvicultural prescriptions of forest working plans continued to be designed for sustained yield of commercial timber – in these plans biodiversity conservation found little place. The predominant focus on timber is still being extended even to some participatory forest management programmes, through the requirement that JFM micro-plans conform to Forest Department Working Plan prescriptions (MoEF 2000), and offering a share of timber on 'final' felling as a major JFM benefit. Unless the working plans by themselves also become flexible enough to allow silvicultural innovations in the areas governed under micro-plans, as is beginning to happen, the problem of dovetailing the two will continue.

Large tracts of good forests were also cleared for agriculture, plantation crops, other development projects and for raising fast-growing commercial plantations. Sectoral policies for agriculture, irrigation, urban development, industry, mining, energy or animal husbandry still do not take their impact on biodiversity or ecosystems into account. Dramatic increases in food production through the Green Revolution have been achieved at the expense of the health of agricultural ecosystems and agricultural biodiversity, through the intensive inputs of chemical fertilizers, pesticides and irrigation. The emphasis on HYVs has displaced locally adapted indigenous varieties of food crops and a large number of nutritious uncultivated foods earlier available to the poor. Schemes that support a very low consumer price (for example, rice was supplied at Rs 2 per kilo in Andhra Pradesh), have also led to so-called 'coarse' grains being replaced by polished rice or wheat in local diets (Rajamani Undated). Large centralized irrigation schemes have provided incentives to farmers to cultivate water-intensive cash crops with scant regard for long-term environmental consequences (Baviskar 1995). Large dams have submerged vast areas of valuable ecosystems and attendant biodiversity while simultaneously displacing millions of people, with disproportionate representation of Scheduled Tribes among them,

destroying their cultural traditions, lifestyles and livelihood systems (*Dams and Biodiversity Sub-thematic Review*; Singh and Banerji 2002; *see also Box 5.4*). Damming of rivers has disrupted seasonal migration paths of inland fish species and destroyed their breeding habitats, while the introduction of exotic species has negatively impacted indigenous fish diversity (Gadgil *et. al.*, 2001). The recent World Bank-funded project for widening of national and state highways all over the country has resulted in tens of thousands of trees being clear-felled, many of them very old trees, some having been planted over four centuries ago (Imam 2002). The environmental clearance procedures have undergone several amendments due to the increasing pressure from commercial lobbies (*see Box 5.14*).

Box 5.14 Relaxations in Environmental Amendments and Procedures

Environment clearance procedures and related Acts/Notifications have undergone several amendments (e.g. *see Box 6.65* on amendments to the CRZ notification), which go against the very spirit with which they came into being. These amendments have often been in response to pressure from industrial and commercial lobbies, or committee reports that focus on factors that allegedly 'hinder' economic growth. For instance, the Government of India's committee meant to examine the extant procedures for investment approvals and implementation of projects and suggest measures to simplify and expedite the process for both public and private investment (Govindarajan *et. al.*, 2002), has suggested a number of steps to quicken the environmental clearance procedure. It recommends that visits for site clearance be done within a month of the submission of the application, with the proviso that if this is not done, it may be concluded that a visit is not necessary. Though this suggestion is intended to hasten the process of clearance for an investor, it does not take into account ground realities. There are only 5 regional offices of the MoEF in the country and one pollution control board per state. With the number of projects coming up for clearance before these agencies (in addition to their other work), it would surely not be feasible for them to complete the site visits in the suggested time.

Schemes like the Indira Gandhi Canal have caused xerophytic vegetation to be changed to mesophytic and hydrophytic character (*see Section 5.1.1.1*). As grasslands have changed to croplands, or been afforested with tree plantations of predominantly fast-growing exotic species, the remaining pasturelands have come under increasing pressure, simultaneously increasing grazing pressure on adjoining forests. For example, in Kachchh *Prosopis Juliflora* was introduced by the Forest Department in the early 1960s. This exotic species has greatly affected vast areas of the Banni grasslands (*see Section 5.1.1.3*).

The process of mining nature for meeting the raw material needs of industry and earning revenue from export has laid waste many natural ecosystems and accelerated soil erosion, toxic releases, and in many places fragmenting of habitats while displacing tens of thousands of adivasis and other poor people (*see Box 5.2*). Deforestation for mining has caused further downstream effects through soil erosion and siltation of mangroves. Increase in soil salinity caused by mining in desert areas has led to xerophytic plants being replaced by halophytic plants.

The focus on perpetually increasing productivity for commercial returns has similarly impacted marine and inland wetland ecosystems. For instance, in Kerala, government-supported introduction of mechanised fishing vessels with the capacity to harvest indiscriminately has destabilized sustainable and equitable community-based small-scale fisheries, depleted fish stocks, and weakened the potential of fish and prawn populations to renew themselves (Kocherry 1987; Kurien and Vijayan 1995).

The process of economic globalisation and liberalisation that India has embarked upon since the early 1990s, has considerably increased the destructive potential of the current 'development' model. It is interesting, for instance, that about 45% of the total forest land diverted in 23 years since 1980, has happened in the period 1999-2003 (Singh 2003)! While an annual average of 350 projects were given clearance from 1980 to 1999, the yearly figure dramatically increased to 869 between 1999 and 2003. One of the reasons for this renewed spate of diverting forest land for non-forest purposes, could be the pressure for greater industrial and infrastructural developments that are needed to meet the demands of a globalising economy.

Box 5.15 Development-related Perverse Incentives in Agriculture

The current state lending policies have an adverse impact on the farmers who practice biodiversity in their agriculture. These policies are oblivious to principles of ecological agriculture. For example, lending by rural banks for agriculture promotes crops like grape, which, because they are monocropped, guzzle water and require high pesticide use, are environmentally disastrous. On the other hand, in dryland areas where traditional farming practices are inherently diverse and use very little or no chemicals at all, loans advanced by the same banks for such agriculture are abysmally low.

Table 5.9: Loans offered by Manjeera Grameena Bank in Medak District of Andhra Pradesh

Crop	Loan per Acre	Level of Water Used	Level of Pesticide Use	Whether environmentally positive or negative	Whether positive to biodiversity or not
Grape	Rs 107,900	Very high	Extremely high	Highly negative	Very negative
Banana	Rs 18,000	Very high	High	Negative	Negative
Ginger	Rs 15,000	High	Low		
Sugarcane	Rs 10,000	Very high	Low		Negative
Potato	Rs 10,000	High	Medium	Negative	Negative
Sorghum	Rs 1400	Nil	Nil	Highly positive	Highly Positive
Millets	Rs 1400	Nil	Nil	Highly positive	Highly positive

Source (for loan figures): Manager, Manjeera Grameena Bank, Zaheerabad, personal communication, 2002.

As can be seen from *Table 5.9*, a crop like grape which has a highly negative effect on the environment and biodiversity qualifies for a loan of Rs 107,900 per acre, while sorghum and millets which are highly positive both for environment and biodiversity, receive just Rs 1400 per acre, which is just about 1.5% of the loan for grape.

It is also very interesting that the loans are offered only for *pure crops*, i.e. crops which involve monoculture. Therefore even the paltry Rs 1400 loan for sorghum will be paid only when a farmer grows a monocrop of sorghum. But the farmers' regular practice is to grow at least six to eight crops along with sorghum. Such farmers, who are naturally diversity-oriented farmers, have no hopes of getting any bank credit for their crops.

This disregard for agro-biodiversity in the lending policy weans farmers away from cultivating diversity on their farms. In this fashion, the state has actually encouraged the loss of agricultural diversity and indigenous knowledge.

Box 5.16 Losing Out?

'Much of what we had, such as disease-free livestock and agriculture, has disappeared today or is on its way out. Since most of the developmental activities are undertaken by the government, the locals are often not taken into confidence. Moreover new technologies, new seeds, chemicals, etc. are brought in, supplied or freely distributed. Despite knowing that they weaken the soil, there is growing dependence on these... People have stopped growing their traditional crops such as '*Phapar*' (Buckwheat), relying instead on cheaper foods from Siliguri, like '*atta*' and '*maida*' transported into their areas by roads. Faulty educational practices have made the new generation fit neither for school, home nor work in the fields. Now instead of natural dyes made from local plants, chemical dyes are in use, which is harmful to the people and the environment. New hybrid and exotic fodder species were introduced in various government programmes without much thought to accidental release into the nearby wilderness areas, many of which are protected areas. Traditional systems of rotational grazing and rotational collection of medicinal plants and herbs have almost disappeared due to new systems of governance, e.g. the time-honoured *Pipon* system of administration with a host of ecologically sound rules and regulations, practiced in Lachen and Lachung in North Sikkim, has been given a backseat by the Panchayat Raj system.'

(Extracted from Sikkim State BSAP)

5.2.2 Erosion of Customary Rights and Community Management, and Inappropriate Tenurial and Institutional Arrangements

The erosion of traditional communal property rights regimes over forests, pastures, other common lands and water bodies, and their progressive replacement by inappropriate tenurial and institutional arrangements, has been one of the main root causes of resource degradation and loss of biodiversity. Historically, cultivated lands and the uncultivated commons in the majority of the country's forest, wetland and even marine areas were managed as an integrated resource base by diverse communal resource management traditions and systems. Most of these systems rested on customary boundaries defining communal property rights and responsibilities that enabled community regulation of access to natural resources and ecosystem services (Guha 1989; Chakravorti-Kaul 1996; Gadgil and Guha 1992; Sundar 1997 and 2000; Sarin 2001a&b; Agarwal 1996; Somanathan 1991; Sengupta 1996; Kurien 1998a).

Barring the north-eastern states, state appropriation of the uncultivated commons, (termed 'the wastes'[3] by the colonial government due to their not yielding land revenue), began in the late 19th century. Colonial appropriation of the commons as government 'forests' and revenue 'wastelands' seriously undermined existing community-based resource management systems. Reservation of forests under Indian Central and State Forest Acts was probably the single most important turning point in forest-people relations in India. Forest reservation artificially fragmented people's holistic livelihood resource base into different legal categories of forest and non-forest lands, making customary livelihood uses of forest lands largely illegal, even as people's dependence on them remained unchanged. Access to government forests was further fragmented through the allocation of *individual* (instead of collective) rights, privileges or concessions administered by the state (instead of by community institutions) predominantly to *male* land owners. Women's customary rights of access to communal lands and to the produce/income from them became subsumed within the rights of the male heads of their households (Sarin 2001a).

Colonial forest policy effectively delinked the resource users from management of the resource, and also introduced management for sustained yield of commercial timber for increasing revenue.

In areas such as Uttarakhand (the hill regions that are part of the new state of Uttaranchal) and Himachal Pradesh, forest reservation was accompanied by forest 'settlements' involving the recording of customary rights of users. In areas such as Bastar in Chhattisgarh, some tribals, especially shifting cultivators, had to leave the forests, while for others twice the area of cultivated land was left aside for villagers' use as *nistari* forests (Sundar 1997 & 2000). In many areas, blanket notifications were issued declaring all uncultivated 'wastes' as state-owned Protected Forests. Thus in 1893, all uncultivated lands, including those under permanent snow and alpine pastures in the area of Uttarakhand under direct British rule, were declared state owned 'District Protected Forests' (Agarwal 1996). The legal designation of such lands has remained frozen as forests till today irrespective of whether they have ever had forest cover or not.

Widespread protests against colonial reservation enabled local communities to recover some common lands for their livelihood needs in the form of community (*Panchayati*) forests in Uttarakhand (Guha 1989 & 2002; Saxena 1995a; Agarwal 1996), *Gramya Jungles* in Orissa, extensive forest rights under the Chhota Nagpur Tenancy Act, the Wilkinson Rules and *Mundari Khuntkhatti* forests in Jharkhand (Kelkar and Nathan 1991) and *nistari* forests in the Central Provinces (Sundar 1997 & 2000). In some areas, such as Uttara Kannada in Karnataka, a wide diversity of forest tenures was established, often for the benefit of betel-nut plantation owners (Shrinidhi and Lele 2001).

Coming to the post-Independence period, the 1952 National Forest Policy clearly restricted the rights of communities by stating, 'The accident of a village being situated close to a forest does not prejudice the right of the country as a whole to receive benefits of a national asset' (cited in Saxena 1999). Simultaneously, the 'national' forest estate was substantially enlarged through two major processes. First, after abolition of the Princely States and the *zamindari* system, all uncultivated lands under their control were vested in the state. The larger tracts were handed over to Forest Departments, and the rest to the Revenue Departments as 'wastelands'. Thus in undi-

vided MP, for example, management responsibility for the commons was transferred from *ex-malguzari* and princely rulers to the Forest Department (Buch 1991), replacing diverse institutional arrangements with uniform, centralized management. Second, the state governments acquired large areas of private forests during the two decades after Independence (Saxena 1999).

The post-Independence period of transition, from diverse owners and institutional arrangements for resource use and management to Forest and Revenue Department control, witnessed massive forest destruction. The abolition of proprietary rights of princely rulers and the fear amongst private forest owners that they would lose their lands to the state resulted in both resorting to large-scale fellings before they lost their properties altogether. A quick process of transition could have helped avert this. But the management vacuum spread over several years (e.g. from 1951 to 1961 in the former Central Provinces & Berar) converted the erstwhile commons due for state takeover into open access lands. As pointed out by Saxena (1999), rapid degradation of forests has taken place during specific periods due to such changes in institutional arrangements, rather than as a result of a continuous, linear process caused by increase in population pressure.

Further state appropriation of common lands after Independence eroded even peoples' hard won community control over limited areas obtained from the colonial government, with most *nistari* forests and *Gramya jungles* and other common lands also being vested in either the Revenue or Forest Departments, often unaccompanied by detailed surveys and settlements. These included village grazing lands, natural grasslands, alpine pastures, village ponds and wetlands, and snow-covered peaks, as well as areas inhabited by Primitive Tribal Groups or under shifting and/or settled cultivation by tribal communities. Many of these lands have still neither been surveyed, nor have the land rights of their pre-existing occupants been settled. Revenue land settlements carried out during the 1970s in Orissa, for example, simply did not survey hilly lands predominantly inhabited by tribal communities (due to the higher surveying costs they entailed) and declared them state-owned revenue 'wastelands' or forests (Saxena 2001a). 44% of Orissa's supposed forest land is actually land used for shifting cultivation by tribal communities, whose ancestral rights have simply not been recorded. In Andhra Pradesh, the tribals' shifting cultivation lands lying fallow at the time were declared Reserve Forests, without recording their rights (GoAP 2002). The declaration of common lands as 'forests' in such areas was often more for state appropriation rather than a measure of the quality of natural forests they harboured.

Box 5.17 Conversion of Community Forests into State-owned Forests' – Village Women's Experience

How conversion of their customary commons to state-owned forests impacted tribal women's resource access is best illustrated in the words of middle-aged tribal women from south-west Bengal. At a camp held in the early 1980s, the women recalled that when the surrounding forests belonged to the local *Zamindar*, they felt his presence only occasionally when his '*Gomostha*' came to collect rent for the agricultural land. For all practical purposes, the villagers owned the forest using it for hunting, grazing, collection of wood and other forest produce besides clearing new land for agriculture. For generations the forest had been an integral part of their livelihood resource base.

Everything changed dramatically within a decade after independence. In 1947, the Government created a Forest Division for Bankura district to manage the private forests and afforest wastelands acquired by the Government. In 1953, the Estate Acquisition Act vested all local forests with the Government. Rangers, Beat Officers and Forest Guards appeared and took charge of all local forests. Forests were separated from village settlements. Maps were redrawn, excluding the forests from revenue village boundaries. By 1955 the villagers' alienation from their forests was complete. The women at the camp described in great detail the immense humiliation and harassment they had faced from 1955 for obtaining food, fuel and other livelihood needs from their forests. They said they could not understand why they needed permission to enter their forest for fulfilling their minimum needs and why such need fulfillment had been labelled as illegal (Banerjee 2001).

The *net* area under the control of Forest Departments increased by 26 m ha between 1951 and 1988 (from 41 million hectares to 67 million hectares). During this period, the area under reserve forests, in which people have lim-

ited or no rights, increased from 26 million hectares to 46 million hectares. The net cultivated area also increased by 24 million hectares (less than the increase in forest area) from 118 million to 142 million ha during the same period. This post-Independence increase in both cultivated and forest land use categories was largely at the expense of the uncultivated commons (culturable wasteland, grazing/pasture lands and groves under official categories) (Saxena 1999). Many of these included fragile ecosystems harbouring rich floral and faunal biodiversity, and a vast diversity of livelihood systems with equally diverse customary institutions for sustainable use and management as common property resources (Chakravorty-Kaul 1996; Sengupta 1996; Brara 1989; Jodha 1992).

Box 5.18 Unresolved Issues in Tribal Empowerment

The Vth Schedule of the Constitution of India empowers the Governor to make special laws on the advice of the Tribal Advisory Council regarding the transfer of land to non-tribals, to prevent land alienation, regulate moneylending, and modify or withhold the application of any other central or state laws to Scheduled Areas. The objective was to protect tribal culture and tribal communities from inequitable impacts of mainstream development. In practice, however, apart from legislation preventing tribal land alienation, state and central laws have been extended to Scheduled Areas without any changes. Hardly any of the empowering provisions of the Panchayats (Extension to the Scheduled Areas) Act, 1996 (PESA) have been implemented and little effort has been put into making the *adivasis* aware of their rights (Sundar 2001). On the contrary, courts, legal advisors to the government, politicians and bureaucrats (all predominantly non-tribal) have advised amending the Vth Schedule itself, to open up tribal areas for commercial exploitation by corporate interests. As tribal areas are also rich in biodiversity, such moves portend a serious threat to biodiversity conservation as well as tribal livelihoods and customary rights over resources.

In a candid admission, the 10th Plan Approach paper of the Government of India states: 'From the viewpoint of policy, it is important to understand that tribal communities are vulnerable not only because they are poor, assetless and illiterate compared to the general population; often their distinct vulnerability arises from their inability to negotiate and cope with the process of integration with the mainstream economy, society, cultural and political system, from which they were historically protected as the result of their relative isolation. Post-Independence, the requirements of planned development brought with them the spectre of dams, mines, industries and roads on tribal lands. With these came the concomitant processes of displacement, both literal and metaphorical – as tribal institutions and practices were forced into uneasy existence with or gave way to market or formal state institutions (most significantly, in the legal sphere), tribals found themselves at a profound disadvantage with respect to the influx of better-equipped outsiders into tribal areas. The repercussions for the already fragile socio-economic livelihood base of the tribals were devastating – ranging from loss of livelihoods, land alienation on a vast scale, to hereditary bondage.

'As tribals grapple with these tragic consequences, the small clutch of bureaucratic programmes have done little to arrest the precipitous pauperisation, exploitation and disintegration of tribal communities. Tribals occasionally respond with anger and assertion, but more often with anomie and despair, because many persistent issues have by and large remained unattended. These include:

- Land alienation and non-restoration of alienated land
- Indebtedness
- Tribal Forest Rights; Development of Forest Villagers and Shifting Cultivators.
- Giving effect to the provisions of Panchayats (Extension to the Scheduled Areas) Act of 1996 (PESA) through required legislations at the State Level.
- Involuntary displacement due to development projects and lack of proper rehabilitation
- Rehabilitation of displaced and disabled tribals.
- Survival, protection and development of the Primitive Tribal Groups.
- Effective and meaningful implementation of the strategy of Tribal Sub-Plan.

'To tackle the various unresolved problems of the tribals, the Tenth Plan shall formulate a comprehensive National Policy for Empowering Tribals through their integrated development, which will lay down the responsibilities of the different wings of Government with appropriate accountability.' (GoI 2002a)

Erosion of customary rights in common pool resources is also rooted in the colonial administration's interest in establishing private property to facilitate revenue collection. Under *zamindari* revenue settlements (introduced in Bengal and Bihar in 1793), the administration of common pool resources (CPRs) was left to the *zamindars* who, by and large, left the customary management systems undisturbed till the abolition of *zamindari* after Independence (Sengupta 1996). The *Ryotwari* settlements went further in establishing private property by settling the rights of individual tenants. During these settlements, no individual could lay claims to common properties such as tanks, village forests or grazing grounds, and the colonial government declared its ownership over them and thus committed itself to their upkeep and maintenance (Sengupta 1991).

With the *Ryotwari* settlement model being extended to almost the whole country (barring Schedule VI areas in the north-east) after Independence, the government became owner of the erstwhile CPRs even in areas where these had remained outside state control during colonial rule. Many tenurial conflicts are rooted in such blanket processes of state appropriation, without detailed surveys of existing uses and users. These created a situation of 'poorly defined property rights', often a negation of customary rights; due to statutory sanction not being extended to existing common property resource rights, these resources were made open-access in *de facto* property law (Sengupta 1996). State takeover of most CPRs after Independence relegated the panchayats and community institutions to the background (Iyengar 2001). Despite this, for many government-owned CPRs, community management has continued by default, with many traditional CPR institutions surviving to this date. Community management of smaller tanks is a noteworthy example (Sengupta 1991). Community-managed forests and grasslands have also survived in some areas.

Box 5.19 Impact of Inappropriate Institutional Changes on Community Management in Goa

In Goa, village communities locally known as *Communidades* or *Gaunkaris*, were responsible for managing community natural resources for centuries. The Code of Communidades of 1961 elaborates the procedures for maintaining the community's natural assets. Till the system continued functioning, there was very little impact on wild or domesticated biodiversity. Opening the area to the mining industry in 1946 changed the overall land resources situation. The transition from community-based management to panchayat-based administration led to confusion about the respective roles and responsibilities of the two institutions in natural resource management within the same social and political space. Implementation of land reforms under the Agricultural Tenancy Act, 1964, did not take into account the complexity of existing tenures related to land or how these impinged on agricultural ecosystem management and habitat conservation into account. The singular focus on granting land ownership to the tiller disrupted the institutional arrangement under which ecological security was earlier ensured by the Communidades, the private owners and other stakeholders.

Similarly, although ownership or managerial responsibilities have been centralized in different departments, lack of inter-departmental coordination, poor understanding of local complexities by departmental staff and a general lack of bureaucratic accountability has resulted in ecologically insensitive management interventions. Thus, although the Marine Fisheries Regulation Act, 1989, specifies the mesh size for fishing nets, it is rarely enforced. The Fisheries Department has inadequate knowledge of inland fishery resources. The Agriculture Department is responsible for conserving agricultural lands and crop biodiversity but has no voice when agricultural lands are converted to non-agricultural uses. The Revenue Department administers the coastal *khazan* lands but has no knowledge of the agricultural operations, credit resources or sources of income from land. Absent or weak mechanisms for inter-departmental coordination for biodiversity conservation are one of the major reasons for habitat destruction and species loss in Goa.

Source: Goa State BSAP

In the few states where common lands have been vested in village *panchayats*, their jurisdictional authority has seldom been clear, leaving them ill-equipped to enforce their property rights. Devoid of finance and powers, with no *panchayat* elections held for years in many states till the 73rd constitutional amendment in 1992, these common lands effectively became open-access lands with powerful elites within communities encroaching on them for agriculture, construction, or overgrazing their own livestock herds (*see also Section*

5.2.3). In many states, there is also a mismatch between the social boundaries followed by user groups of common pool resources such as grazing/pasture lands, village common lands and forests, and the administrative boundaries of *Panchayats* expected to manage them. Policies for common property management continue to be framed by goverment line departments. In Haryana, *panchayats* auction leases for cultivation of their cultivable common lands to the highest bidders. The Forest Department has carried out extensive plantations on them under social forestry programmes, after obtaining just the sarpanch's signature on a resolution permitting them. The Fisheries Department similarly makes the *panchayats* auction village ponds to the highest bidders for commercial fish farming. The user community as a whole, and marginalised groups and women in particular, have little say in such decisions.

The state governments also retain the right to reappropriate control over the commons from *panchayats*, as has recently been done in MP with the decision to distribute village grazing lands to the landless without either the panchayats or the users of these lands having a say. Such a step has serious environmental, equity and livelihoods-related implications.

Serious jurisdictional conflicts also exist even between different government departments, particularly between revenue and forest departments. In many states there are wide disparities between revenue land records and records of lands declared 'forests' through blanket notifications. In Sariska Tiger Reserve, Rajasthan, this conflict enabled the destructive spread of mining on lands claimed by the Revenue Department to be under its jurisdiction. A women's group that was leased a piece of land by the Revenue Department for undertaking afforestation in East Singhbhum district, Jharkhand, was taken to court by the Forest Department for 'encroaching' on forest land. In a converse case, the Deccan Development Society in Andhra Pradesh supported a number of dalit women's groups to afforest degraded forest lands, but the Revenue Department has given *pattas* (leases) to these lands to other households.

In the north-eastern states, despite the limited government ownership of forest lands, inclusion of community-owned shifting cultivation lands in its assessments of 'forest cover' by the FSI is leading to pressure on villagers to protect them as 'forests'. Interestingly, while the FAO does not include lands under shifting cultivation in its assessments of 'forest cover', distinguishing them as 'forest fallows', FSI makes no such distinction (FSI 2000). Recording of lands under shifting cultivation as 'forest cover' portrays land use assumed to be desirable instead of *actual* land use, leading to development interventions conflicting with livelihood uses and community rights over resources. This is an indirect means for curtailing community rights and is reflected in the substantial budgets allocated for tree plantations on shifting cultivation lands during the 10th Five-Year Plan by labeling them as 'degraded forests', which they are not.

Nationalisation of important NTFPs during the 1970s (though carried out with the stated intention of eliminating exploitative contractors), combined with commercial forest exploitation (which changed the nature of the forest itself through replacement of natural vegetation by commercial plantations), further reduced forest-based communities' access to forest resources, simultaneously eroding valuable biodiversity (*see Section 5.1.1.1*).

Centralized, commercial forest management led to a second wave of protests in Uttarakhand (the home of the Chipko movement), Bastar, Jharkhand and other areas during the 1970s. The seventies also saw the rise of environmental ideology among the urban middle class. In 1976, forests were moved from the State to the Concurrent list of the Constitution, empowering the Government of India to have a decisive say in forest management priorities. The Forest Conservation Act (FCA), 1980, made central government permission mandatory for converting forest lands to non-forest use. This was in response to the rapid deforestation being witnessed in many states, which were all too happy to divert such lands for other purposes. The FCA has significantly reduced the rate of conversion of forest lands to non-forest uses. Between 1952 and 1980, on an average 154,571 ha of forest land per year was converted to non-forest uses.[4] Between 1985 and 1989, after the FCA began to be implemented strictly, the annual diversion of forest land to non-forest uses declined to 26,896 ha/year (Saxena 1995b).[5] However, the FCA also made it difficult to get permission for conversion of even small patches of forest land to non-forest uses for basic livelihood purposes. Given the highly uneven geographic distribution of forest lands

within the country, this became a serious problem in areas like Sarguja, Koraput, Dangs and Uttarakhand, where large percentages of the total area have been declared 'forests'.

Box 5.20 From *Chipko* to *Ped Kato*

The Forest Conservation Act 1980 was a welcome initiative to halt the rampant diversion of forests to non-forest uses, by state governments. Hindsight suggests, however, that the process could have been somewhat different. The standard and uniform approach neglected the diversity of contexts across the country, and caused suffering to many village communities, thereby inviting a backlash even in the heart of the Chipko movement (India's most famous mass forest conservation movement, active in the Himalayan belt). Many *Chipko* activists, who had lobbied for conservation with sustainable use for local livelihood and development needs, were now up in arms against the FCA. In 1988-89, some of the Chipko activists started yet another, relatively less known *Ped Kato Andolan* (cut trees movement). They argued that the FCA 'was being used to hold up basic development schemes for the hill villages while the builders' mafia continues to flout it brazenly under the guise of promoting tourism' (Rawat 1998). More recently, resource displacement and loss of livelihoods caused by expansion of the PA network produced the *Jhapto Cheeno Andolan* (snatch and grab movement) against the Nanda Devi Biosphere Reserve, reflecting the intense feelings of alienation and disempowerment. Some of the village women who earned international fame for stopping contractors from felling their forests during *Chipko* have come to hate the word *paryavaran* (environment). As one of these women from Reni village complained, 'They have put this entire (surrounding forest) area under the Nanda Devi Biosphere Reserve. I can't even pick herbs to treat a stomach ache any more' (Mitra 1993).

The contentious question of 'encroachments' on forest lands, many of which are actually disputed as per MoEF's own September 1990 circulars, is inextricably linked to these historical developments (*see Box 5.21*).

Box 5.21 The Threat from Forest Encroachments

Encroachments on forest land are a major threat to biodiversity. Official figures put the extent of encroachment at 1.25 million hectares (MoEF circular to all states, dated 3 May, 2002). Such encroachments are a threat in many ways, including large-scale clearfelling of natural forests. Many such encroachments may even be small in size, but when combined they lead to fragmentation and 'honeycombing' of the forest, or disruption of wildlife corridors, with significant impacts on biodiversity. States with a very high level of reported encroachment include Assam, Madhya Pradesh, Karnataka, Maharashtra and Chhattisgarh.

The situation is, however, complicated by the fact that the definition of 'encroachment' is unclear. As has been pointed out by a number of NGOs and social activists, large stretches of land which have traditionally been under cultivation have been labeled encroachments due to improper and outdated land records, confusion between the records of the Forest and Revenue Departments, and incorrect classification of temporarily unused lands as forests (e.g. lands under shifting cultivation) (Kalpavriksh 2002). There are also poor people who have been forced to encroach on forests due to economic compulsions or lack of rehabilitation after being displaced from 'development' projects. But, on the other hand, there are also powerful vested interests that have encroached.

A series of circulars issued by the MoEF in 1990 indicated this complex scenario, and suggested methods of dealing with encroachments in a nuanced manner. A report by the then Commissioner of SC/ST also suggested various responses. But there was little further action taken on this for over a decade. Since early 2002, the matter has again gained prominence, with a May 2002 circular of MoEF, a report urging action by the Supreme Court's Centrally Empowered Committee, evictions in a number of states, subsequent protests by communities and social action groups, and a clarificatory letter by MoEF later in 2002. As of early 2003, the matter is pending in the Supreme Court.

It is also worth mentioning that there is little, if any, attention being paid to encroachments on non-forest ecosystems. Vast areas of grasslands, including those that were common grazing lands of communities, as also wetlands and coastal areas, have been taken over by vested interests. In general, little action has been taken against such encroachments, either by panchayats or by government agencies.

It is critical to distinguish between poor forest-dwellers and powerful vested interests, who have ended up getting clubbed together in the same category of forest land 'encroachers'. This clubbing has taken place due to the following reasons:

i. The arbitrary processes by which the erstwhile commons, often including the cultivable lands of tribal communities, were designated as state-owned forests without survey and settlement of existing rights as required under the Indian Forest Act, a fact noted by the MoEF itself (MoEF 1990a; Das and Associates 1995; B.D. Sharma 1990 & 2003).
ii. The poor condition of land records on the basis of which people get classified as encroachers. For example, most hilly lands with more than 10° slope in Orissa, have still not been surveyed but are being treated as state property. The majority of the state's *adivasi* population lives in these areas without being granted their legitimate land titles (Das and Associates 1995; Sarin 2002). In many states, whereas the Revenue Departments have continued issuing *pattas* for such lands under land re-distribution programmes, the Forest Departments hold such *patta* holders to be encroachers on forest land (Sharma 1990; MoEF 1990b). Steeped in customary and oral traditions, the impoverished *adivasis* are unable to produce the kind of documentary evidence required to prove their pre-1980 occupation of land (Sharma 1990).
iii. Continuing displacement of forest-dwellers from their lands and forests by 'development' projects, without clear state commitment to ensuring their fair and just rehabilitation. Large numbers of *adivasis* in Orissa have frequently been evicted from their lands without even minimal compensation, as they do not have land titles (Saxena 2001a). The only option for such forest-dwellers is to go and settle on other public, often good quality, forest land.

The other large category of state-appropriated common lands – the revenue 'wastelands' – have received little attention despite harbouring rich biodiversity. Poor recognition and protection of customary CPR rights over them has resulted in their easier diversion to other uses. Revenue wastelands have been a major target for 'afforestation' programmes, overlooking their existing livelihood uses or the natural ecosystems of which they form a part. Nomadic pastoralists have probably been the single largest livelihood group deprived of access to their primary livelihood resource base through such interventions (*Nomadic Pastoralism and Biodiversity Sub-thematic Review*). In Gujarat, the *maldharis* have been among the worst sufferers of the conversion of their traditional grazing and pasture lands to other uses. Nomads now have to regularly, and often illegally graze in forest areas causing degradation and conflicts. Gujarat is losing good indigenous livestock breeds and expert breeders due to this (Iyengar 2001). Non-recognition of revenue lands' erstwhile function even as village grazing lands and the absence of any policy for grazing lands has created an acute crisis for small and marginal farmers and landless households with livestock. Recent policy initiatives of some states to promote private and corporate investment in such lands for afforestation (as in Tamil Nadu and Madhya Pradesh), and distributing grazing land, to the landless in Madhya Pradesh, will further reduce available grazing lands, while negatively impacting the biodiversity they harbour and the livelihoods of the poor.

The Government of India set up the National Wastelands Development Board (NWDB) to promote peoples' participation in afforestation programmes and regenerating India's wastelands in 1985, and created a Department of Wastelands Development (DWD) in 1992. While issuing sanctions for projects, the DWD insisted that the government agency involved with plantations should have complete control over the lands on which trees were planted. Its guidelines stipulated that the executing agency produce a certificate even from private land owners that they had authorised the agency to execute works on their lands. The people themselves were often expected to be mere spectators on both public and private wastelands with no role in planning or execution of the programme (Saxena 2001b). There are, however, also many examples of afforestation and silvipasture development on such lands being handed over to *Gram Panchayats* after the initial period of plantation establishment by Forest Departments. The survival of such handed-over plantations has varied considerably with the capacity of the concerned *Panchayat*. In Seoni district of Madhya Pradesh, for instance, Pauanar Panchayat sold bamboo from such lands worth Rs 90,000 in 2001. Many villages with effective *panchayats* are now flush with bamboo, grasses, and other species being used by the *panchayats* and *gram sabha* members.

A NSSO study (*see Section 4.2.3*) found that government-owned forest and revenue wastelands continue to func-

tion as CPRs despite changes in their legal classifications and ownership. However, depletion of CPRs was evident, both in terms of size and productivity (NSSO 1999, quoted in Chopra and Dasgupta 2002). A study of 82 villages from seven drier states found that between 1950-52 and 1982-84, common pool land resource as a percentage of total village area declined by 31% in some states and by a high of 55% in others (Jodha 1986). A recent study in Andhra Pradesh found a rapid decline in both quality and area of village common lands since the 1970s, ranging from 20% to 65% of their area (CWS 2001). Changes in the institutional arrangements, including the legal status of these resources, have been identified as a major causal factor behind this decline (Jodha 1986 and 1997; Pasha 1992; Iyengar and Shukla 1999; CWS 2001).

In a radical departure from previous forest policies, the 1988 Forest Policy gives substantial importance to the twin objectives of conservation and social justice, including the livelihood and survival needs of forest-dwellers. However, whereas achieving conservation objectives is backed by stringent legislation such as the Indian Forest Act (IFA), the Forest Conservation Act (FCA) and the Wild Life Protection Act (WPA), compatible changes in the forest legislation or in the institutional arrangements for achieving the social justice objectives remain weak. In many places forest officials have used JFM for these objectives, and have managed to combine conservation and livelihood security, but gaps remain in institutionalizing this within the system (*see Section 6.1.5*). Equity and livelihood concerns also remain weakly implemented in the protected area network (*see Section 6.1.2.3*).

Overall, although stringent wildlife protection legislation has stemmed the tide of rapid destruction of biodiversity-rich areas, and in some cases even protected tribal communities from further displacement from their ancestral habitats, this has been at the cost of severely disprivileging many forest-dwelling communities. Not only have they suffered loss of access to survival resources, but the wealth of their indigenous knowledge-based community management systems, evolved through generations of interaction with local ecosystems, has also been marginalised. These factors often make them hostile to conservation goals (Kothari *et. al.*, 1996). Of late, programmes like eco-development in and around protected areas are trying to overcome some of these limitations, with varying degrees of success and failure (John Joseph *et. al.*, 2002).

Top-down bureaucratic interventions for the management of water resources, both inland and marine, have similarly disrupted customary resource use and management systems geared to meeting local needs on a sustainable basis. Loss of local control over the management of village ponds, combined with powerful local vested interests, has resulted in their being filled up and encroached upon. Promotion of commercial fish farming in them has often resulted in their semi-privatization. Lining of such ponds for fish farming destroys the habitat for birds while depriving the poor of access to biomass for fuel and fodder (Sharma 2001). Similarly, in marine fisheries, the fishers' customary rights have not received any statutory sanction, and there have been a large number of inter-community conflicts on questions of trespass in customary territories (*see Box 5.22*).

Box 5.22 The Marginalisation of Small-Scale and Artisanal Fishworkers

There has been a massive growth in the fisheries sector, especially from the 1970s, fuelled by rapid technological changes and supportive government policies. The focus has been on development and modernization of the sector and on increasing production and exports. This period has also witnessed the entry of outsiders and big business interests into the sector, attracted by the huge export potential. Given the absence of a well-defined legal framework protecting the access and use rights of fishworkers, particularly those engaged in subsistence, small-scale and artisanal fisheries, these developments have had several adverse impacts. Artisanal and small-scale fishermen have been forced to compete directly with the mechanized sector, especially due to the regular encroachments, especially by trawlers, into inshore coastal areas. This has also led to several accidents and the loss of craft and gear and even of lives. The artisanal and small-scale sector have also been affected by the destructive impact of gear like bottom trawls on the benthic habitat and on fish resources (given the high incidence of by-catch and discards).

As a consequence, severe gear-related conflicts and widespread protests have erupted in several parts of India. In the 1980's,

as a consequence of these conflicts and pressure by the small-scale sector, the state-level Marine Fisheries Regulation Acts (MFRAs) introduced by most of the maritime states in India made provision for a zone reserved exclusively for artisanal fishers (*see Section 6.1.4.2*).

The demand by the artisanal and small-scale sector for a uniform ban on trawling in the monsoons, believed to be the spawning period, is also linked to this conflict. Partly as a consequence of this, 2003 was the first year when there were uniform ban periods, both for the East and the West Coast.

In India, like in many other developing countries, while the State has sought to put into place a centralized fisheries development and management framework, in effect *de facto* open access conditions have been created. Those with greater access to capital and technology have been able to take advantage of the situation. This has also prompted artisanal communities to adopt technology and to modernize. The struggle for survival and the pull of the market has led to great changes within the artisanal and small-scale sector itself. Clearly, these developments have increased the pressure on resources and several inshore stocks are considered to be overfished.

In the case of coastal lands and resources, the provisions of the Coastal Regulation Zone (CRZ) have been systematically diluted to allow for activities prohibited under the original notification. For example, while the original notification permitted construction/ reconstruction of dwelling units in CRZ -III between 200 to 500 m of the high tide line, as long as this was within the ambit of traditional rights and customary uses such as existing fishing villages and *gaothans*, this was subsequently changed by amendment dated 11th January 2002. 'Traditional and customary' was replaced by the term 'local inhabitants'. The term local inhabitant used in this clause and elsewhere in the notification is defined as a person or his descendants who have inhabited the area prior to 19th February 1991. By widening the definition, the recognition of priority rights of traditional users has been removed.

The rapid expansion of semi-intensive forms of shrimp aquaculture along the coast have, in many cases, disrupted the access of fishworkers to the sea, led to the contamination and salinization of groundwater and inshore waters, destroyed mangroves and affected fish production. Following a Public Interest Litigation filed in 1994 against shrimp aquaculture activities in the coastal zone, the Supreme Court ruled that no shrimp culture farm can be set up within the Coastal Regulation Zone (CRZ), except traditional and improved traditional types of ponds. However, the draft Aquaculture Authority Bill of 1997 passed by the Rajya Sabha seeks to amend the CRZ regulations with retrospective effect, by excluding shrimp farming from its purview. The Bill has yet to be passed in the lower house of Parliament, the Lok Sabha.

In the case of deep sea resources, the main emphasis since the 1950s has been on bringing in deep sea fishing vessels, either under charter, lease or joint venture arrangements. Subsequent to the 1981 *Maritime Zones of India* (*Regulation of Fishing by Foreign Vessels*) *Act*, a Deep Sea Fishing Policy highlighting joint ventures was adopted in 1986. This was subsequently revised in 1991 to allow foreign equity participation up to 51%. This sparked off a major nationwide agitation by the traditional and small-scale fisheries sector. This was the first time that the entire national fisheries sector, ranging from traditional fishworkers to deep sea trawlers, came together to form the National Fisheries Action Committee against Joint Ventures, spearheaded by the National Fishworkers' Forum (NFF). Their main contention was that with local vessels already targeting resources in deeper waters, a capacity that could be further developed, there was no justification to bring in bigger foreign fishing vessels.

In response to the agitation, a high-level committee, the Murari Committee, was set up in 1995 to review the 1991 deep sea fishing policy. The Report of the Murari Committee recommended that the policy be revoked. It also recommended that an area up to 100 nautical miles from the seaboard on the West Coast and 50 nautical miles from the seaboard on the East Coast be reserved for Indian mechanized fishing vessels below 20 m. length. The Committee also stressed the importance of building the capacity of the small-scale fishing sector. The Recommendations were accepted by the Cabinet Committee on Economic Affairs in September 1996 and a decision to rescind the 1991 Deep Sea Fishing Policy was taken in November 1996.

In November 2002, six years after the decision, a new set of guidelines for deep sea fishing were announced. The guidelines are for the conduct of fishing operations in the Indian EEZ, particularly to increase fishing effort to exploit India's untapped marine fisheries resources. These guidelines have been challenged as well, especially as there is no provision to protect the interests of hundreds, if not thousands, of coastal fishing vessels who fish outside the territorial limit.

Given the growing emphasis on environmental issues and the need for conservation and management, artisanal fishers, unfortunately, are also finding themselves at the receiving end of some conservation measures. A case in point is that of Gahirmatha in Orissa, which was declared as a Marine (Wildlife) Sanctuary under the Wild Life Protection Act of India, 1972. The Fisheries Department issued a Notification in June 1997 prohibiting all fishing round the year within the seaward radius of 20 km from the Gahirmatha area. With this, the livelihoods of subsistence fishermen, using passive gear, with minimal impact on the sea turtle population, have also been affected. Another case is that of Jambudwip island in the Sundarbans, where 10,000 small-scale fishworkers using the island for fish-drying purposes on a seasonal basis are faced with eviction. The Jambudwip island is part of a reserved forest area and is part of the mangrove belt in the Sunderabans. In both cases, what was needed was to distinguish between the destructive trawler or big mechanised fisher on the one hand, against whom action would be justified and necessary, and traditional artisanal fishers on the other, who could well have been integrated into a more participatory conservation process.

Contributed by Chandrika Sharma

Indian law recognises only use rights and not ownership rights over flowing surface water. Even participatory water harvesting and watershed development programmes are hampered by the fact that control over the harvested water lies with the state. In Rajasthan, where community efforts under the leadership of Tarun Bharat Sangh resulted in the reappearance of water in wells and streams that had long been dry, and in the revival of considerable aquatic biodiversity, a conflict arose between the communities who had brought this recovery about and the State Government which claimed legal rights over the water. The traditional water harvesting structures being rebuilt by the Tarun Bharat Sangh have repeatedly been declared illegal under the Rajasthan Drainage Act, 1956 (WCD 2000). Ironically, while community institutions lack the right to develop local water resources, some state governments have initiated a process of granting rights over river and other waters to corporate entities, e.g. the Seonath river in Chhattisgarh.

Alienation along with other factors, including demographic and lifestyle changes, has often compelled communities to resort to unsustainable and reckless harvesting from state forests, wetlands, and other ecosystems, for sheer survival. The hundreds of thousands of predominantly women head-loaders, seen in forest-rich tribal areas, fall in this category. Programmes like JFM and women's Self Help Groups have tried to address some of these issues with limited success. In many states, the limited common lands left for villagers' use were vested in Revenue Departments who did little to promote community-based institutional arrangements for their management, and largely treated them as land banks for allocation to other uses. Even where their management was transferred to *panchayats*, this often involved overruling hamlet-based rights, concentrating management control in the elected representatives of multi-village *panchayats* (*see Section 5.2.3*). Substantial areas under such village control, including forests, pastures and wetlands have also been severely degraded with the breakdown of customary rules, demographic changes and ambiguous authority devolved to local institutions.

Increasing recognition of the impact of inappropriate tenurial and departmental arrangements has led to a few corrective steps. This includes official measures under the 73rd Constitutional amendment, fresh recording of tenurial arrangements in a few areas, and new partnership arrangements such as JFM. It also includes attempts by many peoples' movements at restoring or clarifying community tenurial rights (*see Section 6.1.2.2*). However, despite the 73rd Constitutional amendment of 1992 and the enactment of PESA in 1996, neither clear authority nor property rights over common pool resources such as common lands, waterbodies and grazing lands have been devolved to *panchayats* or *gram sabhas* in most states (Sengupta 1996). The powerful forces that local communities have to contend with when attempting to protect their rights and access to natural resources are immense, as shown in *Box 5.23*.

Box 5.23 The Ama Sangathan's Struggles in Orissa

In 1993, the Ama Sangathan, a tribal women's group in Kashipur Block of Rayagada District in Orissa was able to obtain the lease for the Kashipur Forest Range to buy, process and sell hill brooms. Perhaps for the first time in Orissa, a tribal women's group had broken into a hitherto exclusive domain of businessmen granted monopoly rights to NTFPs by the government. The women valiantly took on the challenge of producing brooms for the market. In 1995, the women's group was taken to court by the Orissa Forest Development Corporation for processing the grass into brooms, as they did not have a valid license for doing so. Their stocks were seized and not released for months, causing a huge loss to the women's group.

Then, on 1st April 2000, the new state Government finally transferred the rights over 67 NTFPs to the *panchayats* and all systems of royalties and permits for these were lifted within the state. This was a major policy change, which seemed to affirm the state government's commitment to the welfare of its poorest communities. Despite no appropriate pricing system being put in place, the Ama Sangathan was able to negotiate the market and able to obtain nearly double the minimum support price for its brooms.

Unfortunately, the gains may be short-lived. The state government has leased the land to Utkal Alumina International Ltd (UAIL) for bauxite mining. Exercising their rights under PESA, the *adivasi* villagers have met and passed resolutions in their *gram sabhas* that they will not give up their land for Utkal Alumina, as they have seen the fate of other *adivasis* in the region displaced by such 'development' projects.

According to one estimate, UAIL's mining will negatively affect the livelihood resource base of over 5000 *adivasi* households, cause immense environmental damage and biodiversity loss, while generating employment for only 1000 highly skilled workers who will be brought in from outside the region.

Sources: Das 2001a; Das 2001b.

5.2.3 Increasing Social, Political and Economic Inequities

Social, political and economic inequalities pervade India, both rural and urban, traditional and modern. Indian communities are not homogenous entities, but differentiated by caste, class, tribe, religion and/or ethnicity, and within and between each of these groups by gender and age. Although the Constitution of India guarantees equal fundamental rights to all citizens, the ability to exercise these rights is profoundly influenced by the unequal power and social relations between these group or strata. Such unequal relations have a profound influence on how the country's biological resources are used and managed, and therefore also on the conservation of biodiversity. Inequities between land-owning peasants and forest-dwellers in the past have, for instance, often led to severe deforestation. Unequal political power and influence over state policies and programmes, combined with inequitable laws structuring state-people relations are leading to over-exploitation of natural resources for unsustainable consumerism of elite groups on the one hand, while leading to deprivation from (or over-exploitation and mismanagement of) basic survival resources of tribal, pastoral, fisher and other ecosystem-dependent communities.

Thus although the livelihoods of the vast majority of the rural population are directly dependent on natural resources and elements of local biodiversity, the currently dominant notions of biological resource utilization and biodiversity conservation are governed by the interests of the more privileged, predominantly urban sections of society with little direct dependence on biodiversity.

Box 5.24 The Odds Against the Forest Department

While undoubtedly the role and functioning of the Forest Department needs critical scrutiny, it also needs to be acknowledged that the Department faces considerable odds in discharging its duties. Amongst these are:

i. The Forest Department is amongst the weakest, compared to other departments of the government, especially depart-

ments dealing with politically and financially more powerful subjects. The Forest Department is often overruled when diversion of forest land for developmental/commercial purposes takes place. Resistance to such decisions often leads to arbitrary transfers, 'punishment postings', and harassment. The overall lack of adequate budgets and personnel compounds this weakness.

ii. Within the Department, the wildlife wings, which are primarily entrusted with biodiversity conservation responsibilities, are weak relative to other wings. Territorial or other wings are often able to dominate in terms of budgets, decisions and humanpower. The lack of biodiversity sensitisization amongst many of these wings adds to the problem.

iii. Ground staff are especially vulnerable to dangerous working conditions (deaths and injuries in armed encounters or in other incidents are common), arbitrary transfers and harassment, lack of amenities for themselves and their families etc.

Studies indicate that although *adivasis* are only 8% of the total population, they comprise 40% or more of those displaced by 'development' projects (Fernandes 1993). The inevitable result of all these trends has been the increased poverty and deprivation of many *adivasi* groups and other poor forest-dependent people. This not only increases inequity but also decimates biodiversity. While some of the displaced millions have been absorbed in the market economy (at the lowest rung of the socio-economic ladder as wage or plantation labour) others have been forced either to migrate seasonally or permanently to urban slums and other areas in search of wages (Sarin *et. al.*, 1998a), or to encroach on forests, grasslands, or wetlands in order to survive.

Large development projects often tend to promote inequity, partly because equity impacts are not taken into consideration. If appropriate weightage were given to the impacts on equity in the cost-benefit analysis for large dams, most of the existing dams and projects would be found wanting (WCD 2000).

Significant inequities have also been generated by the negation of customary common property rights. (In many cases, the remaining rights have been left ill-defined.) Nomadic pastoralists have been among one of the largest livelihood groups negatively impacted by poor protection of CPR rights. For example, when the Indira Gandhi Canal was being extended to erstwhile CPRs used by pastoral communities, it was suggested by many environmentalists that protected grasslands for pastoralists be established at sites vulnerable to waterlogging under intensive irrigation. However, economics prevailed over ecological and equity concerns and the entire stretch of Stage II of the IGNP has been brought under irrigated cropping. Due to the poor recognition of community property rights, the livelihood and resource rights of the relatively voiceless pastoralists dependent on the land have been systematically denied.

Root cause number 2 (erosion of customary rights and community management) is linked to such inequities, in particular to the ability of an elite minority section of society to take political decisions regarding biodiversity and bio-resources. As shown earlier, this can lead to high degradation of biodiversity, as occurred with the colonial administration carrying out large-scale commercial exploitation of forests it had taken over. Simultaneously, in many parts of India, local communities, left with much smaller forest areas than they earlier had access to, were divested of their authority to manage even those that remained, which effectively made them open access, leading to their degradation. This is one reason for the large-scale degradation and loss of biodiversity of village forests in several parts of India (*see Section 5.2.2*).

Recognising the importance of secure ownership of cultivable land for increasing equity and food security, distribution of land to the landless and ownership rights to agricultural tenants were major elements of government policy after Independence. However, half-hearted implementation of land reforms has in several states increased rather than reduced inequities. In many states, large land owners have successfully evaded acquisition of their lands above permitted ceilings. Even where some ceiling lands have been acquired, these have largely not been distributed to the landless. Most states resorted to the easier, populist approach of distributing common lands, often unsuitable for cultivation, among the landless. According to one study, however, 50-80% of the privatized common lands went to people who already had relatively more land (Jodha 2000). Thus, despite the underlying concern to help the poor, the privatization of common lands failed to

achieve the desired equity objectives (Chopra and Dasgupta 2002). In many parts of India, village commons have been seriously degraded, or encroached upon, by the activities of powerful vested interests from within and outside the communities.

Political power easily translates into economic clout. Industries, for instance, have received highly preferential treatment in the use of forests, particularly after Independence, as compared to tribal or other rural communities. Till recently, many states were providing bamboo and other forest produce at highly subsidised rates to paper mills, while maintaining market rates for local villagers. In Karnataka, for instance, paper mills were paying Rs 15 per tonne of bamboo, while the poor could purchase it only at Rs 1200 per tonne (Agarwal and Narain 1985)! The results: industry had incentive to rapidly decimate bamboo forests, while villagers were forced to turn to alternatives like cutting wood for selling as fuel. The same has been the case with the government giving monopoly contracts to traders for NTFPs after divesting the *adivasis* of their customary forest. In Orissa, while the government charges a royalty of Rs 30 per tonne for bauxite mined by industry at high cost to livelihoods, environment and biodiversity, impoverished *tendu* leaf pluckers are charged a royalty equivalent to a whopping Rs 1200 per tonne (Saxena 2001b). Many of these grossly inequities have now been reduced.

Inequities of this kind can have very indirect but equally destructive impacts. Apples, for long affordable only by the rich, have required enormous quantities of wood for packing – most of it initially coming by destroying the *deodar* forests of the Himalaya (Agarwal *et. al.*, 1982). Increasingly, the consumption patterns of the rich across the globe are making inroads into biodiversity hotspots and the livelihoods of resource-dependent people. The enormous purchasing power of these classes has also indirectly dictated changes in the marine and coastal policies of India, allowing large-scale commercial aquaculture (e.g. demand for shrimp from the US and Japan), as well as changes in practices relating to many terrestrial ecosystems, permitting massive mining (e.g. iron ore from the Western Ghats, bound for Japan).

Class, caste and ethnic inequalities within and between villages can be equally damaging. It is normally the poorest and most marginalised socio-economic groups within communities (and individuals within households) who are acutely dependent on local natural resources for survival and livelihoods. In contrast, the relatively better-off and more powerful may have limited or no natural resource dependence (Sarin *et. al.*, 1998a). But these more powerful or 'higher' classes, castes and ethnic groups are often able to enter into alliance with powerful outside forces, including traders, contractors and government functionaries, for the exploitation of natural resources. In many parts of tribal India, including the North-East, non-tribals and some tribal leaders have colluded with outsiders to grab land, encroach upon forests, carry out illegal timber felling or amass large herds of livestock, all of which lead to biodiversity loss. In coastal India, some fisherfolk with the necessary connections have acquired technologies that facilitate much more intensive fishing, adversely affecting both the fish stocks and the livelihoods of poorer or less powerful fisherfolk (*West Coast Ecoregional BSAP*). Traditional denial of access to livelihood resources to the poor and underprivileged sections (e.g. *dalits*), coupled with the increasing need for some monetary income amongst these sections, leads to destructive practices such as head-loading of firewood or illegal trade in bio-resources.

Caste-based social exclusion, particularly of the lowest 'untouchable' castes has often translated into denial of access to common pool water and land resources. Even 55 years after Independence, in many states the Scheduled Castes are still denied access to drinking water sources and other resources used by the higher castes. Although the widespread tradition of maintaining sacred groves in India has facilitated community conservation of biodiversity, in socially stratified villages the lower castes and women are often forbidden entry into these groves. This translates into the latter being deprived of access to the selective harvesting of bio-resources from sacred groves while perpetuating denigration of their social status.

Perhaps the most pervasive of all inequalities in Indian society are those between women and men. Women usually have multiple, often disproportionate, responsibilities, but little ownership or control over land or other resources, education, technical skills and market information. Even among *adivasi* communities, where women generally enjoy a better status, there have traditionally been two crucial areas of inequality – property rights and political participation. Among both tribal and non-tribal communities, the traditional village assembly (*gram*

sabha) is virtually an all-male institution. Women are provided access only under highly exceptional circumstances (Kelkar and Nathan 1991), though this is now slowly changing due to progressive movements, laws, and policies.

Given that it is often women who are most closely connected to and dependent on biodiversity, the denial of decision-making power over natural resources has led to decisions that are not only insensitive to their priorities but also detrimental to biodiversity. In the Garhwal Himalaya, for instance, the widespread conversion of natural mixed forests into *chir* pine (*Pinus roxburghii*) plantations by the Forest Department was often welcomed by men, since they would get some cash income from it, but objected to by women who, understood its negative impact on their workloads as well as on the household subsistence economy (Guha 1989, Agarwal *et. al.*, 1982). Women's contribution to agricultural production among many communities is as high as 75-85%, focusing on food production and household food security rather than cash cropping. Yet women's use and knowledge of crop and livestock diversity have been ignored by agricultural policies and practices, thereby excluding and causing the loss of agro-biodiversity knowledge.

Economic inequalities also affect the ability to respond to ecological degradation. This is most apparent between countries, with nations like India having inadequate resources to tackle widespread pollution and land degradation, or acquire the latest eco-sensitive technologies (MoEF 1992). Marginal farmers find it difficult to carry out land improvements or respond to disasters, and small-scale industries are hard-pressed to install expensive pollution control measures; in both cases, ecological degradation and biodiversity loss may be the results. 'Small land holdings lead to severe economic pressures on farmers, to obtain sufficient food and income to meet immediate needs. Because of such pressure in the short term, labour, land and capital resources cannot be spared to care for the land, for example, green manuring or soil conservation structures. This is also the underlying reason for two of the direct causes of environmental degradation, viz. improper crop rotations and unbalanced fertilizer use' (Pachauri and Sridharan 1998).

All this does not mean that in all cases increased inequity causes biodiversity loss. Indeed, in many cases conservation has been achieved despite increasing inequity, as when the state has used its power to declare the agricultural and communal forest lands of *adivasis* as protected areas. However, the sustainability of such measures may be short lived, as those deprived of access to their livelihood resources in the process may sooner or later try to undermine them.

Furthermore, it should not be assumed that the promotion of equity is sufficient to achieve biodiversity conservation or sustainable use. As pointed out in *Section 5.2.4*, decentralisation of governance, even where implemented, has not necessarily led to biodiversity-sensitive management of natural resources. There are after all many other factors that determine the management and use of biodiversity, including the other root causes and factors outlined in this chapter. The main argument here is that inequalities in access and control over local resources can be one root cause of biodiversity loss, and redressing and preventing them is often a necessary (but not necessarily sufficient) condition for reversing this loss.

The lack of serious analytical work on the relationship between inequities and biodiversity loss is striking. The highly inadequate integration of socio-economic equity goals in environmental policies and activities, both by government and by non-governmental agencies is a serious lacuna. This is commented upon in greater detail in Chapter 6, while analysing ongoing initiatives in biodiversity.

Increases in inequity are inherent even in practically all the recent 'participatory' programmes, be they for watershed, forest or irrigation management. Most of them are centred on improving the condition of the *resource* without much attention to how the costs and benefits of the interventions would be distributed among different socio-economic groups of users. Thus, although the GoI's guidelines for watershed development emphasize and require 'people's participation', the largest proportion of the budgetary allocations are for land development and provide 90% subsidy to private land owners, irrespective of the size of their holdings. (MoRD 2001). The focus on tree plantations on common lands in many watershed development programmes, on the other hand, leads to pressure for the enclosure of these common lands, depriving graziers and poor women and men of access to

an important livelihood resource base. Several studies on the gender and equity impacts of JFM indicate similar increases in inequity (Sarin *et. al.*, 1998a; Bhogal and Bhogal 2000; Kumar 2002).

5.2.4 Changes in Cultural, Ethical and Moral Values

It is generally observed that people today are much more alienated from nature, than was the case before. The cultures and lifestyles of most communities (particularly in urban areas), are no longer in tune with the natural surroundings.

A part of the reason for a major rupture in people's spiritual and cultural links with nature is the appropriation of large areas, including forests, wetlands, pastures and sacred groves, by the state. While being divested of their customary rights to use local natural resources primarily for meeting their subsistence needs, local communities watched the same resources being ruthlessly exploited for commercial purposes. Initial protests against this often took a destructive form. In Uttarakhand, for example, large areas of commercially valuable reserved pine forests were set on fire by the same villagers who had traditionally revered forests, to express their anger against the colonial administration (Guha 1989). Forests in the Saranda division of the then state of Bihar were similarly destroyed by *adivasis* during the Jharkhand movement in the 1970s when the Forest Department attempted to replace them with teak plantations.

What further alienated local communities from their links with biodiversity was the devaluation of their traditional/indigenous knowledge that began during the colonial period and has continued to some extent after Independence.

Continuing exposure to state-promoted commercial exploitation of local resources and increasing penetration of the market has progressively changed social relations even within and between communities. With some villagers aligning themselves with both state and commercial agents to take advantage of the new opportunities, they are now often in conflict with other members of their communities who continue to depend on the same resources for their subsistence as well as religious, cultural and spiritual needs.

Development-related displacement has resulted in a severing of the cultural links that people had with biodiversity. Many displaced people, have ended up in urban slums due to poor or non-existent rehabilitation programmes, and even if rehabilitated, were often in social and cultural milieus which were alien to them. Often this leads to erosion of indigenous knowledge related to biodiversity.

Existing protected area models based on the exclusionary approach have affected villagers' spiritual and cultural links with nature, often making them hostile to conservation, or forcing changes in sustainable culturally regulated practices. Palob, a Durva-Gond village in central Bastar is now hemmed in by reserved forests and the Kanger Ghati National Park. The Forest Department's control over what used to be the resources of the *adivasis* has resulted in changes in their fishing methods. While traditionally fishing was done using nets, lines, or plant poisons, the alienation from the forests due to the exclusionary approach of forest laws has resulted in chemical pesticides being used, as it is quicker and can be done covertly (Ramnath 2001).

Box 5.25 Adivasi Workshop Statement on Biodiversity

As the destruction of biological and cultural diversity increases across the world, there is increasing realisation that a greater understanding of the links between traditional cultures and the environment may well provide answers for the future. This was one of the important issues discussed at a National Workshop on 'Biodiversity and *Adivasi*/Indigenous Peoples', organized under the aegis of the NBSAP, on 29-31 January 2001.

Adivasi participants shared their anguish regarding the violation of their rights over their territories, the destruction of their land and biodiversity, and their struggle for survival and self-determination. They stressed the need to recognize that their existence, identity, cultural diversity, lifestyles and livelihood are fundamentally and essentially based on their territorial rights.

A statement with major conclusions was issued, including the following:

1. The Biological Diversity Bill, 2000, is potentially a powerful tool for the conservation of biodiversity and the protection of adivasi livelihoods based on biodiversity; but to achieve its full potential, it needs to include stronger provisions for: prior informed consent of communities before accessing biodiversity and related knowledge from their territories; the principle of consensus decision-making through the gram sabha; locus standi to citizens to approach the court under the Bill; the same stringent requirements for Indian corporations and institutions as were put on foreign entities; dropping the exemption given to plants registered under Plant Varieties Protection Bill; recognition of all common property resources as belonging to gram sabhas for the purposes of benefit-sharing; and inclusion of *adivasi* representatives on the National Biodiversity Authority and State Biodiversity Boards.
2. *Adivasi*/Indigenous peoples strongly reject the notion of intellectual property rights, including patents, on life forms, and on knowledge relating to biodiversity. All such knowledge must be in the public domain, and indigenous and local community must be protected through alternative regimes of collective knowledge rights. Therefore they strongly reject the Patent Bill and Plant Varieties Bill, as they remain within the framework of privatized intellectual property rights (IPRs).
3. All developments in technology, including biotechnology, should conform to the principles of biodiversity conservation, ecological safety, and security of the people's livelihoods.
4. The current model of protected areas, while useful for wildlife conservation, is also a threat to livelihood rights. A new model is needed in which their traditional resource rights and central management role are accepted, along with conservation principles.
5. The principle of participatory local self-governance should be vigorously pursued, including the full implementation of Panchayat (Extension to Scheduled Areas) Act 1996.
6. Specially endangered *adivasi* peoples, such as the Birhors, Jarawas and Onges, must be given special protection.

The model of development with a focus on linear economic growth that has been followed in India (*see Section 5.2.1*) has seen changes in cultural values that lead to lifestyles that impact biodiversity negatively. Urban lifestyles, which often set the model for rural and semi-rural areas, are largely bereft of cultural or ethical links with biodiversity. There have been changes in food habits, with consumption of rice and wheat becoming dominant over a variety of coarse millets and other cereals. There is an increasing preference for branded foods. There has also been a declining cultural significance of 'non-market' crop species in emerging rural and urban lifestyles. Special food preparations associated with fasts, festivals, and rites of passage, for which particular genetic varieties were traditionally prescribed, are now found acceptable even if made with substitute varieties of the 'market' type (. Khadpekar, 2002). Lifestyles, especially those of the elite classes, are also becoming increasingly consumeristic, affecting biodiversity through over-exploitation of raw materials and excessive mining of minerals and destruction of natural habitats. The corporate sector has focused on producing an ever-increasing range of consumer goods, with little regard for the impacts on biodiversity in particular and the environment in general. The links between such consumerism and biodiversity are not well studied, but there are some indications available. Based on surveys by the Central Statistical Organisation and the National Council of Applied Economic Research over the 1980s and 1990s, the Tata Energy Research Institute (TERI) has documented the rapid rise in the use of non-renewable materials (like minerals), manufactured consumer goods (including those with direct environmental impact like refrigerators and air-conditioners using CFCs), transport vehicles, and so on (Pachauri and Sridharan 1998). This is not just a result of rising populations, but is probably more due to changing lifestyles. For instance, consumer preferences are changing from non-packaged goods to packaged ones – TERI estimates that consumption of packaged paper will rise from 2.7 kg per person per year in 1997 to 13.5 kg per person per year by 2047. This would mean a total paper use of 23.1 million tonnes for packaging alone, and the consequent rise in solid wastes.

5.2.5 Lack of Recognition of the Full Values of Biodiversity

Section 4.2 describes the various values of biodiversity, both intrinsic and in relation to human beings. Most or all of these values, however, have become seriously under-appreciated, especially in the lives of 'modern' and urbanised societies. This under-valuation is one of the root causes of biodiversity and biological resources getting treated in a casual, callous, or unsustainable manner.

In particular, the following kinds of under-valuation are prevalent:

Ethical and Cultural Under-valuation: Traditional societies in India, as across the world, appear to have given a central place to the ethical and moral dimensions of other species and of ecosystems. Sacred landscapes and ecosystems, sacred species, a large range of rituals and beliefs associated with biological elements, and other such phenomenon are reflections of this value. Unfortunately, there has been a massive erosion of this value system. As the 'commodification' of nature increases, especially under the influence of commercial demands on biological resources, its spiritually central role decreases. The reflections and results of this are many. They include the rapid decline in sacred groves and landscapes, with literally thousands of such sites no longer enjoying the protection that communities once offered them. In many areas species once considered sacred – or stages of an animal's life cycle (such as pregnancy) which were once considered worthy of such respect that hunting was prohibited – are no longer accorded the same value. The *mahua* (*Madhuca indica*), *banyan* (*Ficus bengalensis*), *pipal* (*Ficus religiosa*) and other such species, which were earlier never cut, no longer enjoy such an exalted status. Pilgrimage sites, such as origins of rivers that were simultaneously biodiversity-rich and culturally important, have suffered similar commodification and commercialisation. The result is that such sites and their surroundings are increasingly defiled, and many pilgrims no longer follow the rules by which the area and its beings were respected. Plastic refuse thrown into what were once sacred waters, or into groves around such pilgrimage spots, is a classic example of such devaluation.

In the case of agriculture, the way traditional communities dealt with the soil – and with seeds, with water, and with much else that goes into farming – often demonstrated a concept of holistic agriculture. Unfortunately, in more recent times this has been overtaken by agronomy, with the primary focus being on making money. As farmers lose their spiritual and cultural links to their farms, and lose out in an increasingly competitive environment in which the big land-holders and corporates dominate, there is an increasing tendency to sell off the land, especially small landholdings. As communities lose such links under the influences of 'modernisation' and mass consumerism, the respect provided to biodiversity declines.

Productivity Under-valuation: One reason that prompts agricultural planners to steer clear away from biodiversity in their planning is the myth that all traditional cultivars which are essential for a diverse cropping system are low yielders. A large number of examples and arguments are available now to prove that this apprehension is unfounded.

Yegna Iyengar's (1944) treatise *Field Crops of India* mentions traditional rice varieties from Coorg in Karnataka which yielded 11000 pounds (five tones) of paddy per acre and varieties which yielded up to 12000 pounds (5.5 tonnes per acre) at Salem in Tamil Nadu, all with very low external inputs. These levels of yields have not been touched by the highest yielding varieties under the Green Revolution technology, which demand enormous amounts of inputs in terms of chemical fertilisers, pesticides and irrigation.

In his experiments with rice varieties from the *adivasi* region of Madhya Pradesh, the renowned rice scientist Dr Richaria systematically documented varieties that yield up to 9 tonnes per hectare (Richaria 1977). In the Garhwal region of the Himalayas, activists from the Beej Bachao Andolan have documented varieties like *Thapachini*, which have recorded yields up to 7.2 tonnes per ha. One must stress again that these are the crops grown under low external inputs and organic conditions, and are in the very nature of their farming are highly favourable to agro-biodiversity.

Moreover, the parameters of productivity are very narrowly defined in terms of a single yield, that of grain or milk or wool, depending on the agricultural system being promoted. In a biodiverse farming system, productivity consists of multiple yields – grain, uncultivated foods, a variety of food, fodder, fuel, fencing and thatch material, soil fertility enhancement, pest- and disease-resistance and the total biomass production. Such a system also regulates the flow of grain into the household at regular intervals, wisely manages the available labour in the community and in households by staggering production seasons and works within the constraints of the local agro-ecosystem. A study conducted by Navdanya in 1992-93, of traditional rice varieties grown in the Garhwal area of the Himalayas, showed a combined output of rice and straw equal to 17,600 kgs per hectare (7200 kgs of grain

and 10,400 of straw) in the case of some varieties (like *Jhumkya*), while the highest yielding HYVs like *Saket* have shown combined yields of only 13,200 kgs (6200 kgs of grain and 6400 kgs of straw). As shown in *Section 4.2.5*, ecologically diverse agriculture also scores above conventional and chemically-intensive farming on several other productivity, sustainability, and soil health input-output ratio parameters.

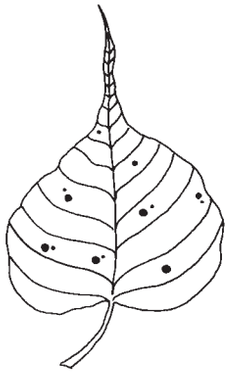
Therefore the argument that biodiverse farms growing traditional cultivars are low in productivity is untenable. For some reason or the other, research into the productivity of traditional cultivars has been given low priority, and HYVs have been promoted over the traditional cultivars due to responsiveness of HYVs to high inputs. In fact the refusal of a farmer to demand external inputs becomes a reason to describe her as a non-progressive farmer, ignoring the above mentioned aspects of productivity.

Non-appreciation of Water and Other Ecosystem Benefits: There are numerous invisible but essential benefits that ecosystems provide, but these are hardly recognised or understood, especially by development planners. These include soil formation and fertility generation, reduction of soil salinity, productivity, carbon sequestration and balance of atmospheric gases, stabilisation of climate and mitigation of climatic change, nutrient cycling, check on soil erosion, water and soil retention, water and air filtration, flood and drought control, and regulation of water supply (*Western Himalayas Ecoregional BSAP*).

Forests on slopes were (and still are) often left untouched by community-managed systems, as they recognised these to be critical for the water and other ecosystem services they provide downstream, thus ensuring household food and ecological security. In Mizoram, in the system of 'safety and supply forests', the function of safety forests is to protect the village from *jhum* fires while also maintaining ecosystem services, whereas supply forests take care of the villagers day to day needs (*Mizoram State BSAP*). In modern times, however, such an orientation has declined. One interesting exception, though, is the Shimla Water Catchment Sanctuary, first notified as a sanctuary in 1958, but preserved since the last century specifically to protect the water source feeding Shimla city. Generally, however, though India spends more and more money on the control of floods and droughts, on coastal and sand-dune stabilisation, and on soil and water conservation, it does not seem to understand that the same functions could be performed much more effectively, at a fraction of the cost if nature were simply allowed to do its job. A classic case is that of Mumbai city, a substantial part of whose drinking water comes from the Tansa and Borivili reservoirs (Anon. Undated). These reservoirs are in turn protected by surrounding forests that are protected under the Wild Life (Protection) Act. Yet Mumbai's citizens do not pay for the upkeep of these forests and reservoirs, and a shortage of funds for the Forest Department is one constant threat to their continued survival.

Naini Tal lake is serviced by Sukha Tal (or 'dry lake'), a valley-fill catchment which provides 40-50% of filtered water to the Naini Tal lake, and also keeps the water level high and increases its recreational value. Unfortunately this benefits has not been valued. Instead, the valley-fill is being valued negatively and a part of it is being developed into a car park (*West Himalayas Ecoregional BSAP*).

Health Value: Biodiversity has provided human beings with a range of health benefits, from nutritious food to medicinal plants to emotional and spiritual well-being. Traditional health systems, both formalised ones like *Ayurveda*, *Unani*, *Siddha*, *Swa-rigpa*, and informal folk or tribal medicine have emphasised this role. Modern India's health policies and programmes have, however, consistently undervalued the role of biodiversity, till recently paying only lip-service to elements like medicinal plants. Agricultural policies and programmes do not even acknowledge the role of agro-biodiversity in nutrition and health. These policies, coupled with vigorous educational and media drives, have caused serious decline in the traditional health systems and traditional agricultural practices. The direct result of this is, once again, erosion in the respect with which biodiversity used to be treated, and decline in the use of diversity in agricultural, animal husbandry, and agroforestry systems. Fortunately the last few years are seeing a revival in interest in the health values of biodiversity, but a considerable part of the lost ground will be impossible to retrieve.



Economic Value: Economic planning and budgeting in India has never taken adequate account of the enormous economic contribution of biodiversity. If the value of ecosystem benefits like water security and soil pro-

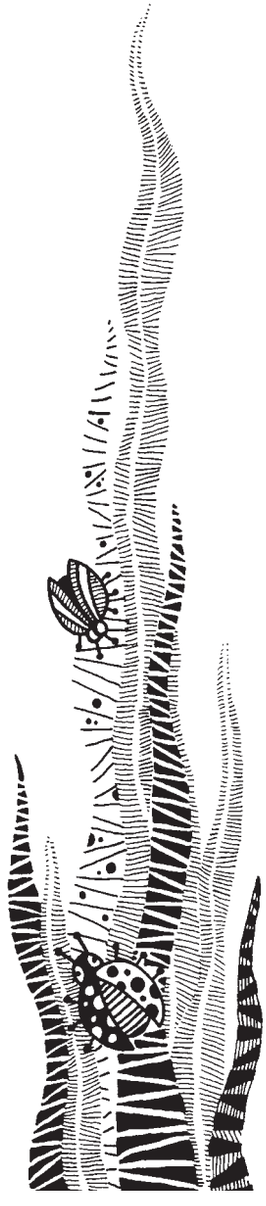
ductivity, survival, livelihood and health to a majority of the rural population and a significant proportion of urban population, were to be provided for through 'modern' means, the cost to the economy would be colossal. Though a comprehensive valuation of these services has not been done, it can be safely assumed that it would amount to much more than India's GDP. Since, however, these costs are not immediately visible, the value of biodiversity is not included in the official planning processes. Indeed, by a strange quirk of conventional economics, the destruction of natural forests for extracting timber is shown as a benefit, adding to the GDP; but the loss of all the ecological benefits provided by such forests is not shown as a liability or loss. The sewage treatment and recycling functions provided by the East Kolkata wetlands would cost several hundred crores to replace if sewage treatment plants are to be set up. Yet because this value is not acknowledged, the wetlands are continuously being built upon.

The net result of this set of under-valuations is a neglect of biodiversity in the wild and in domesticated conditions, and its continued destruction through various human activities.

5.2.6 Inappropriate and Contradictory Laws and Policies

India has amongst the world's largest number of policies and laws relating to environment. However, as elaborated in the next chapter, there are a number of deficiencies, including:

1. Contradictions between polices and laws relating to environment on the one hand, and those relating to industrial development, commerce and welfare on the other. For example, at the policy level, macro-economic policies are in conflict with aspects of the Forest Policy's emphasis on conservation and protecting forest-based livelihood rights. Similarly, at the level of statutes, aspects of the Panchayat (Extension to Scheduled Areas) Act, 1996, come into conflict with aspects of the Mines and Minerals (Development and Regulation) Act, 1957.
2. Lack of adequate integration of biodiversity concerns into most policies and laws, including many of the 'environmental' ones. For example, although there exists an elaborate Environmental Impact Assessment (EIA) procedure, that flows from the Environment (Protection) Act, 1986, there remain serious conceptual and implementation-related defects. These include the lack of full integration of biodiversity into the parameters of evaluation (especially the total absence of agro-biodiversity indicators), and the rather weak procedures to involve the public and make the decision-making accountable.
3. Absence of or inadequate legal coverage for a number of biodiversity elements and aspects, such as domesticated biodiversity, community conserved areas, traditional knowledge, and so on (*see Section 6.1.8.3*). It is hoped that the Biological Diversity Act 2002 will help to plug some of these gaps, but others may remain without policy and legal measures specifically oriented at each of these elements and aspects.
4. The centralising tendency of some laws, which, coupled with inappropriate models of development, has led to destruction of biodiversity. The Land Acquisition Act dating back to the 19th century, under which the state can acquire any private or communal land for a 'public purpose', has been used for destroying rich ecosystems for so-called 'development' purposes, and has been a major instrument of displacement. While industrialists and project planners complain about delays and protracted litigation for land acquisition, and are exerting pressure for amending the Act to make it quicker, the people whose lands are being acquired complain about inequities and injustices, and the upheavals always involved in displacement. The affected people can question the quantum of compensation, but can seldom challenge the 'public purpose' claimed by the state, or argue that alternative ways of achieving that public purpose should be considered (WCD 2000).
5. Weak enforcement, and in cases, lack of implementation of existing laws that have the potential to create a positive impact on conservation of biodiversity and related livelihoods. For example, there is weak enforcement of provisions of the Wild Life (Protection) Act, 1972 to check poaching, due to various reasons including deficiencies in procedural aspects of the criminal justice system (MoEF 1994; MoEF 1996b; MoEF 1996a). Furthermore, there is lack of implementation (or inadequate implementation) of some sections of the Indian Forest Act, 1927, that provide for the setting up of village forests.
6. Inadequate empowerment of citizens (especially biodiversity-dependent communities) and front-line functionaries of government agencies to use the existing policies and laws for conservation, sustainable use, and



equity. For example, despite the mandate for decentralization, particularly under PESA, in many states the management of village common lands has still not been vested in *gram panchayats* or *gram sabhas* (Iyengar 2001). There has been a reluctance on the part of some states to operationalise the XIth Schedule. Unless local institutions of resource users are empowered to regulate use and management of the commons with clearly defined property rights, responsibilities and authority, they are likely to remain open-access lands with continuing ecosystem damage and loss of surviving biodiversity.

7. Inadequate empowerment of citizens, especially biodiversity-dependent communities, to challenge policies and laws and actions carried out under certain laws which are inimical to the conservation of biodiversity.

Box 5.26 Legal Lacunae: The Case of Andhra Pradesh

The AP State Government passed the necessary amendment under the Panchayat (Extension to Scheduled Areas) Act 1996 (PESA) in 1998, and it listed the powers and functions of *Gram Panchayats* and *Mandal Parishads*. 'The Gram Panchayat or, as the case may be, the Gram Sabha, shall exercise such powers and perform such functions in such manner and to such extent as may be prescribed in respect to the following matters, namely:

- Enforcement of prohibition or regulation or restriction of the sale and consumption of any intoxicant;
- The ownership of minor forest produce;
- The prevention of alienation of land in the Scheduled Areas and restoration of any unlawfully alienated land of a Scheduled Tribe;
- The management of village markets by whatever name called; and,
- Exercising control over money lending to the Scheduled Tribe.'

The extent and manner were never prescribed in subsequent orders, thus making this a toothless legislation – a mere reproduction of PESA provisions without necessary clarification or respect for its spirit. Infact, government orders with contrary provisions continue to be issued and enforced. For example, a later government order issued by the Environment, Forest, Science and Technology Department prescribes that the usufruct rights of *Vana Samrakshana Samitis* (VSS) shall include 'All Non-Timber Forest Produce except those for which Girijan Cooperative Corporation (GCC) holds monopoly rights. However, the right to collection shall remain with the VSS members, if they so desire. The members shall be paid the collection charges upon delivery of the produce as per the rates fixed by the Government'. There is a clear contradiction between the vesting of 'ownership' of NTFPs in Gram Panchayats/Sabhas by PESA and 1) the assignment of usufruct rights over NTFPs only to members of VSSs (who may represent only 50% village households) instead of the *gram sabha*, and, 2) continued vesting of monopoly rights in the GCC. (In some states such as MP, JFM orders now require that all adult members are the members of the *Van Samiti*, thereby making the general body of the Van Samiti virtually coterminus with the *Gram Sabhas*).

8. No holistic land use plan and policy, specifying fragile areas as being off-limits to certain development processes, like certain types of mining. There is also the problem of inappropriate land classification. As pointed out in the case of Goa, for example, traditional pastures and vegetated areas and grasslands have been combined under the official land use category of 'orchards'. This is not supported by detailed biodiversity studies. Plateaus which are seasonal grasslands with few trees but more shrubs, grasses and other plants are rich in biodiversity, but their wrong classification as degraded lands often leads to habitat destruction and biodiversity erosion (*Goa State BSAP*).

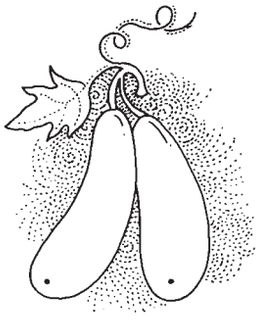
5.2.7 Demographic Changes

The population of India has almost trebled since the time of Independence, which has inevitably increased the pressure on the country's biological resources. However, increasing population is only one of the factors responsible for environmental degradation and biodiversity loss. Rapid socio-economic transformation and the changes in political, economic and social structures triggered by it are equally, if not more, responsible. This is more so on account of the model of development followed having generated limited secondary and tertiary sector jobs relative to the increasing workforce, leaving almost 70 percent of the population with continuing, direct dependence on the natural resource base for their livelihoods and subsistence. With shrinking land holdings unable to support

household members, there has been growing pressure to bring common and forest lands under cultivation. This is manifested in many different ways such as: fragmentation of land holdings leading to unsustainable farming practices, reduction in *jhum* (shifting cultivation) cycles causing forest degradation (Brown and Schreckenberg 1998). The rapid growth in population has also resulted in intense competition for agricultural and aquatic resources, which has resulted in large scale conversion of wetlands to agricultural land (Kumar 2003).

The nature and process of development has also generated more localized demographic movements. Perhaps the most dramatic, yet least recognized, of these has been the movement of persons displaced by large development projects, including dams. Estimates about the total number of persons displaced by dams alone vary between 2 to 40 million (WCD 2000). The Planning Commission estimates suggest that 21.3 million people were displaced by development projects between 1951 and 1990. Of these, 8.54 million (40%) belonged to Scheduled Tribes, which constitute only 8% of the total population. Only 2.1 million (25%) of them are reported to have been rehabilitated. The remaining 6.4 million tribals were left to fend for themselves (Bhuria 2001). Apart from the serious dimensions of social injustice and inequity, such a situation has a direct link with biodiversity destruction. Where have such huge numbers of people gone? Being forest-dwellers with few options, many have cleared good forests for alternative hearths and homes. In the Panchmahals district of Gujarat, the forests of many villages in the work area of SARTHI, a local NGO, were destroyed when the victims of such forced displacement for Kadana and Panam dams settled there. Large numbers of *adivasis* forcibly displaced in Orissa moved to the forests of North Coastal Andhra Pradesh when the AP government attempted to grant land titles to *adivasis* living in the state's forest areas before 1980 (GoAP 2002). Ironically, these people are treated as illegal 'encroachers' on government forests, without any reference to how the government itself sanctified encroachment on their ancestral lands in the name of development. Many of the displaced persons have been displaced more than once as 'development' or 'conservation' keeps catching up with them. The Tawa dam, built on the longest tributary of the Narmada between 1958 and 1978, submerged 44 *adivasi* villages, rendering their residents both landless and homeless. Many of the *adivasis* displaced by the dam had already been uprooted from their homes by an army firing range, an ordnance factory and the Satpura National Park, set up in the same region. Many families suffered double or even triple displacement. As resettlement of the project-affected people was not on the national agenda in the 1970s, many of them settled in the upper reaches around the Tawa reservoir (Shah and Banerji 2002). Many states are beginning to move towards much more progressive rehabilitation policies, but the basic issue of the unacceptability of forced displacement, and the lack of infrastructure to achieve a successful rehabilitation, remains unresolved.

As highlighted in the NBSAP *adivasi* workshop statement (*see Box 5.25*), many *adivasi* communities and biodiversity-rich areas are also threatened with illegal immigrants. Such influx of immigrants, while increasing conflicts over natural resources, has also altered the ethnic profile of the area, leading to continuing ethnic strife. The north-eastern states are the most glaring example of such a situation, where the pressures and conflicts generated by illegal immigration have been compounded by large presence of security forces, contributing to further loss of biodiversity. A violent conflict has similarly erupted in the Raigarh area of Nabarangpur district, Orissa, between the local *adivasis* and the Bengali immigrants into the area, usurping control over the *adivasis*' land and forest resources. In 1958, the government got more than two lakh hectares of forests cleared in the Dandakaranya region of Bastar and Koraput districts of Chhattisgarh and Orissa respectively, to settle 7500 Bangla refugee families in 184 villages. Over time, the immigrants have captured additional land, invited new immigrants and improved their economic status while the local *adivasis* have not even been granted titles to their ancestral lands declared 'revenue wastelands' or forests after Independence. Other *adivasis* displaced by the Indravati, Upper Kolab and Balimela Dam projects, the MIG project of Sunabedha and NALCO in Damanjodi have also settled in the area, clearing additional forest areas for cultivation. During 2001, with the *adivasis* beginning to organise resistance to further loss of their livelihood resources, a number of them were killed in two incidents of firing, one by the police and the other by the immigrants (Das 2001). In large parts of the biodiversity-rich Terai region in north India, tens of thousands of hectares of forest were cleared after partition, to settle refugees from Pakistan (Rahmani and Qurieshi 1999). The state of Assam has witnessed many waves of migration of people from within and outside the country over many centuries, which has had an impact on the state's forest and aquatic resources, including on the famous Kaziranga National Park (*Assam State BSAP*).



Then there are both short- and long-term cases of ecological refugees forced to leave their traditional homes due to droughts, floods and cyclones.

There are also unacknowledged refugees of policies resulting in changes in land use. No data seems to be available about the numbers of pastoral nomads displaced due to their traditional pasture lands being allocated for other uses or submerged by large dams, and how and where they are now settled. For example, the Bhakra, Pong and Ranjit Sagar dams in Punjab and Himachal Pradesh, submerged large areas of the *gaddis*' (nomadic pastoral communities) seasonal grazing lands, with no thought either for compensating or rehabilitating them (Chakravorti-Kaul 2002). Many of these could well be amongst the `encroachers' of forest and grazing lands, or have been in other ways forced to eke out a living that is ecologically damaging.

5.2.8 Inappropriate Trade Systems

Trade is as old as human civilisation. But for the better part of our history, it was mostly highly localised, though some level of long-distance trade has been recorded to have been carried out for several thousand years. Most products and services were traded through barter systems amongst communities in close proximity. Such barter continues in many 'remote' tribal and rural areas of India, and substantial trade continues to be transacted in local *haats* (village markets). However, over much of the world, including in India, local trade has been overtaken and increasingly dominated by more long-distance transactions, from national to international. This has been facilitated by more efficient technologies for transportation and storage, and by international policies and practices that promote global trade over local and even national trade.

As trade is transformed from a predominantly local barter system to an international, monetised activity, the impacts on biodiversity and biodiversity-based livelihoods increase dramatically. Some of the reasons for this are:

1. The sheer increase in the quantum and scale of demand on specific biological resources, as more consumers are able to access it, with the common result of over-exploitation;
2. Increase in the demand for other (non-biodiversity) resources, whose extraction or use has a negative impact on biodiversity (e.g. minerals);
3. The lack of a 'feed-back' mechanism which would make consumers aware of the repurcussions of their actions; whereas earlier in localised trade, over-exploitation or destructive practices would have been immediately noticed and very often felt by the trading partners themselves, in national and international trade the consumer is far removed from the sites from where his/her resources are being accessed (such that most consumers in the West or in cities like Mumbai and Delhi are not even aware of where their products are being extracted from, and even less so of the impacts of such extraction or use);
4. National and international markets are usually much more 'homogenising', in that they demand standardised, 'quality-controlled' products, in contrast to local markets which are happy with a diversity of produce and a diversity of varieties of the same produce;
5. Market-favoured products force the replacement of natural or agricultural ecosystems that were biodiversity-rich (e.g. intensive aquaculture to cater to the international market in shrimps, replacing diverse coastal ecosystems and agro-fisheries systems).

As consumers across the world become aware of these trends, they are demanding more diverse products. Rice varieties from several countries may therefore now be available in the average supermarket in Europe. But this is a far cry from the hundreds that may have been available in the local markets and trading systems of even a small region of India. These hundreds may now get replaced by these handful that find favour in the national or international markets.

In India, a number of biodiversity elements have been subjected to the above impacts of growing markets and trade. The examples of aquaculture and marine products are instructive. Though they were already in existence earlier, intensive shrimp/prawn farming and commercial marine fisheries were given a major boost in the early 1990s with the new economic policies that favoured export-led growth. Given the serious decline in fisheries/shrimp production in many other countries which were once its strongholds, the Indian coasts and marine waters are amongst the last major sites left in the world to meet the high demand for these resources in

the West and in Japan/South-East Asia. Through the early 1990s a major thrust was given to intensive aquaculture and mechanised commercial fisheries, with exports of fish and fish products increasing from 159,000 tonnes (valued at Rs 960 crore) in 1990-91, to 321,000 tonnes (valued at Rs 3537 crore) in 1994-95 (Kothari 1996). The impacts have been primarily two-fold: (a) significant increase in exploitation of marine fisheries with no scope for increasing the catches of some species like eels, Bombay duck, pomfrets, etc. (Devaraj and Vivekanandan 1999); and, (b) serious displacement and dispossession of small coastal farmers and fisherfolk. The trend has been slowed down only due to the sustained efforts of affected fisherfolk and coastal communities, including mass protests, lobbying, litigation and other actions.

Box 5.27 Impacts on Fish Production in Gujarat

Between 1990-91 and 1998-1999, although there was an increase in the production of shrimp, there was a decline in its species composition as well as size distribution. In Gujarat, this change was also reflected in the fact that price of shrimp was lower than that of inland species, despite shrimp being considered a more commercially significant species. Statistics indicated that this phenomenon was not just for shrimp but for other commercially important species as well. The production of ribbonfish, after doubling from 40,000 tonnes in 1990-91 to 80,000 tonnes in 1997-98, plummeted down to 30,000 tonnes in 1998-99. Overfishing, increase in the number (70% increase from 1991-92 to 1998-99) and size of the trawlers, too much 'trash fish' in trawl production, and increase in the average depth of fishing operations are considered to be the main factors behind this phenomenon. While the number of trawlers increased, there was a decrease in the average catch per trawler, which has led to frustration amongst trawler operators.

Emerging as one of the biggest exporter of marine products, the value of exports in Gujarat quadrupled between 1990-91 and 1999-00 from Rs 900 million to Rs 3,700 million. 1997-98 is considered to be the year of highest marine fish production and value recorded in Gujarat. 'The increase in production from 1990-91 to 1997-98 also came along with an increase in unit value, which went up to Rs 51,000 per tonne in 1997-98 from Rs 41,000 in 1990-91. The unit value of exports from Gujarat, as a share of the national average however declined from 58 percent in 1990-91 to 42 per cent in 1997-98, indicating the dominance of low value items in the exports from Gujarat.' (Mathew Undated)

Similar is the case of mining. With the 'opening up' of the economy, there is much greater pressure on India to export minerals like granite and bauxite. The export value of ores and minerals during 1999-2000 was Rs 32,752 crore. Diamond (mostly cut) was the principal item of export during 1999-2000 and accounted for 85%, followed by granite with a contribution of 5%, iron ore with a contribution of 4% and precious and semi-precious stones comprising 2% (MoCM 2002). Simultaneously, the national demand has also increased as lifestyles change and more and more people demand 'luxury' mineral products like marble and granite. National and international trade in minerals is today one of India's biggest causes of biodiversity loss; for instance, ongoing or proposed mining alone threatens more than 70 protected areas (*Mining and Biodiversity Sub-thematic Review*). It is not surprising that, more than 40 per cent of all mining ventures, cleared from 1980 onwards, were cleared in the period 1999-2003 (Singh 2003). Though officials of the Ministry of Environment and Forests have pointed out that a majority of these are renewal of leases, the fact remains that it is the increasing demand for minerals under the new economic policies, including for export, that has led to such massive diversion.

Yet another case is that of medicinal plants. There are reported to be around 860 medicinal plants in all-India trade (FRLHT 2001). (The value of the all-India trade in medicinal plants is of the order of Rs 150 crores per year.) Around 660 of these plants are collected from the wild. 70% of the plants involve destructive collection, since roots, stems, bark, heartwood etc are the parts that are collected for sale. The major benefits of the trade go to the traders, with the local communities receiving a very small share. Even in instances where trade was nationalized as in the case of the *tendu* (*Diospyros melanoxylon*) leaf in Madhya Pradesh and Chhattisgarh (which led to greater benefits for the *tendu* collectors), the system has been besieged by a number of problems, including politicization of the system, corruption in the relevant departments, and non-implementation of a true cooperative structure (Joshi 2003).

With changing land policies in the context of globalization, tenurial security over land for small and marginal farmers, particularly for farmers in so-called 'marginal' lands (like mountains, marshlands, coasts, arid and semi-arid areas), and access to common lands for gathering, pasture, shifting cultivation and pastoralism, are declining rapidly. Agricultural land ceiling laws are being amended to permit larger land holding for corporate farming, and conversion of agricultural and common lands to non-agricultural uses for the benefit of industries is being made easier (Kothari 2000).

One final example needs to be mentioned because it is an illustration of how even the most stringent of national laws can be subverted if trade demands are strong enough. Till the 1990s, it seemed as if India's significant efforts at wildlife protection were paying off, with many species like the tiger, rhinoceros, and elephant making major comebacks. But with the population of these species declining in the rest of Asia, renewed threats have been placed on the future of these and other species, as global demands for wildlife products is increasingly being met from India. The demand for tiger bone and other parts is perhaps the biggest reason (or at least a close second to habitat loss) for its current decline.

Impacts on biodiversity from trade are likely to significantly increase in the next few years, with India acceding to the World Trade Organisation's treaties. Export policies that spread monocultures and export-oriented cash crops are being encouraged at the cost of biodiverse farming systems. Besides, intellectual property rights regimes that are inappropriate to local conditions are being forced through the Trade Related IPR (TRIPS) agreement, increasing the chances of piracy of biodiversity and indigenous knowledge.

Notes

1. This section is largely based on the *Wild Animal BSAP*.
2. This includes block plantations as well as plantation area calculated on the basis of number of seedlings distributed, at 2000 seedlings equivalent to 1 ha. Since replanted as well as failed plantation areas are included, the actual area of plantations in the country is uncertain (FSI 2000).
3. This is a misleading term for the uncultivated commons, but remains in official use till today. These lands remain a critical resource for supporting a very wide diversity of livelihoods of poor villagers, as well as considerable biodiversity. For policy makers, the term 'wasteland' triggers the perception of land actually lying waste. Substantial numbers of rural livelihoods dependent on such lands have been destroyed due to their allocation to other uses without taking their existing uses into account.
4. Out of this, between 1951-52 to 1975-76, 67000 ha annually (a total of 1.6 million ha) was lost to river valley projects, roads and other public purposes and the rest to agriculture (Saxena 1995b).
5. Though it has again increased in the late 1990s and early 2000s; see Section 5.1.1.1, and Section 5.2.1.