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Environmentally Sustainable Development in India

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For India, a large country both populated and poor, to develop in an environmentally sustainable development is not an option but a requirement. On one hand, India is faced with environmental degradation from poverty and population pressures, and on the other, from pollution from increased activities due to economic growth and the consequent changing consumption patterns. While the poor depend on the environment for their livelihood, the process of economic development relies on using natural resources to produce goods and services. The waste generated from consuming and producing these goods and services are in turn released back into the environment impacting it. The environment provides security for present and future generations, the health of the environment is closely connected with the health of humans, and it is economically beneficial for countries to prevent environmental degradation. The challenge therefore, in making development compatible with the environment is to restructure the economic system in a way that it will not destroy the environment as economic progress continues. Given our circumstances, how can India develop in an environmentally sustainable manner?

The first section of the paper describes the key socio-economic pressures on the environment such as population, poverty, and illiteracy on one hand and economic growth, changing consumption patterns, structure of GDP and trends of urbanization on the other. The second section describes the state of India's environment with respect to air, water and land. The third and final section not only outlines the measures and responses needed in terms of environmental governance, but also indicates useful practices and related examples. The role of new technologies and the importance of some traditional values are also examined.

1. Socio-economic Pressures on the Environment:

In this section we cover pressures such as population, poverty, illiteracy on the one hand and economic growth, consumption patterns and urbanization on the other. This is done briefly due to limited scope of this paper.

1.1 Population

As is well known, India is set to replace China as the most populous country in the world with 1.5 billion people by 2040. Since 1951 the population has grown from 361 million to 1 billion making every sixth person in the world Indian. As India has only 2.4% of the world's total landmass, the population density is at 324 persons per square kilometer (Census 2001) and pressures on the environment are correspondingly high.

Table 1: Basic national demographic indicator

	1951	**1994**	**2001**
Population (millions)	361	904	1027
Average annual growth rate	1.25	2.2	1.95
Per cent urban *	17.3	26.1	27.8
Crude birth rate	39.9	28.7	25.8
Crude death rate	27.4	9.3	8.5
Total fertility rate	5.96	3.5	2.9
Infant mortality rate	148	74	68
Sex ratio	946	NA	933

Table 2: Population Projections for India

	Indices	**Period**		
		2001-2006	2006-2011	2011-2016
1	Projected life expectancy at birth			
	Male	63.87	65.65	67.04
	Female	66.91	67.67	69.18
2	Total Fertility Rate	2.88	2.68	2.52
3	Projected Population (in millions)	1094.1 (2006)	1178.9 (2011)	1263.5 (2016)

Source: Registrar General of India, (2001), Census 2001

While the growth rate of the population has declined over the years, the population in India continues to be high on account of the large base of the population in the reproductive age group. The higher contribution to fertility due to the unmet need for contraception is estimated to be 20%. High fertility rates are seen also due to high infant mortality rates, which are exacerbated by the lack of sanitation and health care facilities. In addition, 50% of girls marry below the age of 18, the minimum legal age of marriage, resulting in a typical reproductive pattern 'too early, too frequent, too many' (GOI, 2001) The significance of population pressure is great as it impedes both development and environmental health.

1.2 Literacy

It is well known that literacy is important for just about every aspect of development and the environment is no exception. For instance, women's literacy reduces fertility rates and thereby reduces population pressures. Literacy is essential to reducing poverty as it provides people more opportunities to earn as well as increases their productivity and ability to earn. It also allows people to become more receptive towards alternative technologies and environmental management. People's ability to manage environmental resources like water, soil, and forests improves with literacy. All in all, literacy helps reduce pollution as the added awareness allows people to link the health of the environment with their own health and well-being. In India, literacy rates are growing steadily but they are still far from adequate (Table 3).

Table 3: Literacy Rates in India 1901-2001- in per cent

Year		Male	Female	Persons
1971	Rural	48.60	15.50	27.90
	Urban	69.80	48.80	60.20
	Total	45.96	21.97	34.45
1991	Rural	57.90	30.60	44.70
	Urban	81.10	64.00	73.10
	Total	64.13	39.29	52.21
2001	Rural	71.40	46.70	59.40
	Urban	86.70	73.20	80.30
	Total	75.85	54.16	65.38

Source: Census of India, 2001

Literacy also allows people to become more receptive towards new technology. For example, the lack of education and literacy in rural areas accounts greatly for the hesitance in adopting cleaner technologies even when they are made affordable. For example, there is sometimes aversion to switching from firewood to clean fuels such as LPG gas because the women cooking are afraid they will be unable to operate the stove. Such aversion can easily be dealt with through literacy and education programs.

1.3 Poverty

Clearly, one of India's biggest problems is poverty. Fortunately, despite the growth of the population and the low level of economic development at the time of independence in 1947, India has made significant progress in poverty reduction. The percentage of people below poverty line has come down significantly. Yet, large number of persons remains below the poverty line (Table 4). That high incidence of poverty that still prevails in India underlines the need for rapid economic development to create more remunerative employment opportunities and to invest in social infrastructure of health and education.

Table 4: Percent below Poverty Line (All India)

Year	Rural	Urban	Total
1973-74	56.44	49.01	54.88
1977-78	53.07	45.24	51.32
1983	45.65	40.79	44.48
1987-88	39.09	38.20	38.86
1993-94	37.27	32.36	35.97
1999-2000	27.0	23.62	26.10
2007*	21.1	15.1	19.3

Source: Planning Commission, 2000

* Poverty projection for 2007(source: Tenth Five Year plan, Vol1, Planning Commission

The pollution that the poor generate is of a different kind than generated by the rich. The poor, from lack of alternatives rely intensively on the environment for their needs. Since the poor depend heavily on the environment, its degradation affects their livelihood greatly. They thus become both victims and agents of environmental degradation as they both need (and often exploit) the environment to survive but suffer the most when it degrades. Many micro-studies have shown the extent of income support the poor receive from the environment (table 5):

Table 5: Common Property Resources (CPR) and the poor

Study	**State**	**CPR type**	**As percent of Household Income**
Jodha (1991)	Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Rajasthan, Tamil Nadu	Land	17-23%
Sarabhai et al (1991)	Four Villages in Gujarat	Forest	38.5 – 46.3% of village income from forest produce
Nadkarni (1997)	Four Villages in Karnataka	Land and Water bodies	24.3% for poor farmers 18.1% for non-poor farmers
Beck (1994)	Three Villages in Bengal	Land and Water bodies	19-29%

On the other hand, the poor are also victims of pollution. When water sources are polluted poor women have to walk further and spend considerable time fetching it. Lack of resources such as clean fuels and safe drinking water results in back breaking work to fetch them along with health consequences due to water borne diseases and respiratory , eye diseases and reproductive health. The rural population spends 15 billion workdays gathering water and fuels every year suffering health consequences (this is 150 million households collect water and fuel for 3hrs everyday). This should be seen as a tremendous national loss .How canIndia achieve 8% economic growth on a sustainable basis if nearly 35% of the population undergoes hardship and drudgery doing daily chores?

Table 6: Economic burden due to energy, water, sanitation and health problems per year

		Energy (a)	***Water (b)***	***Total (a + b)***
Working days spent in fuel and water collection and work days lost due to ill health (Millions)				
I	No. of adult working days[+] spent in fuel wood gathering and water collection	2950	11519.7	14469.7
II	Adult working days lost due to diseases	833 (Respiratory & eye related)	1268 (Water & sanitation related)	2101
Direct expenditure on health by adults (Billions)				

III	Expenditure on health by adults[$] due to various diseases	66.56 (Respiratory & Eye related)	32 (Water & sanitation related)	98.56
Economic value of working days spent/ lost due to energy, water, sanitation and health (Rs. Billion)				
IV	Monetary value[@] of working days spent for fuel wood gathering and water collection	177	691.18	868.18
V	Monetary value[@] of working day lost due to diseases	49.98 (Respiratory & Eye related)	76.08 (Water & sanitation related)	126.06
VI =III+ V	Total economic loss due to diseases (includes direct cost and imputed cost of working days lost due to ill health)	116.54 (Respiratory & Eye related)	108.08 (Water & sanitation related)	224.62
VII =IV+ VI	Total economic loss due to improper energy and water facilities and due to health impacts of their procurement and use	293.54	799.26	1092.8
Notes	[+] Taking 10 hrs as a standard working hours per day, number of working days lost were estimated [$] Estimated only for individuals above 15 years of age [@] This is estimated by taking Rs. 60 per day as wage rate prevailing in Rajasthan			

Source: Parikh J et.al, 2002

Alleviation of poverty remains a major challenge before the nation. Acceleration of economic growth, which is employment intensive, facilitates the reduction of poverty in the long run. However, this strategy needs to be complemented with a focus on provision of basic services for improving the quality of life of the people through State intervention in the form of targeted anti poverty programs. India has had a whole variety of anti-poverty programmes over the years. Many changes and modifications have been made from time to time. However, their cost effectiveness and particularly targeting effectiveness have not been satisfactory. The specifically designed anti poverty programs for generation of both self employment and wage employment have been redesigned and restructured in 1999-2000 in order to make these programs more effective. Time will tell how successful the latest changes are. As mentioned before the poor are both victims and agents of environmental degradation. Therefore, alleviating poverty is an effective way of managing the environment.

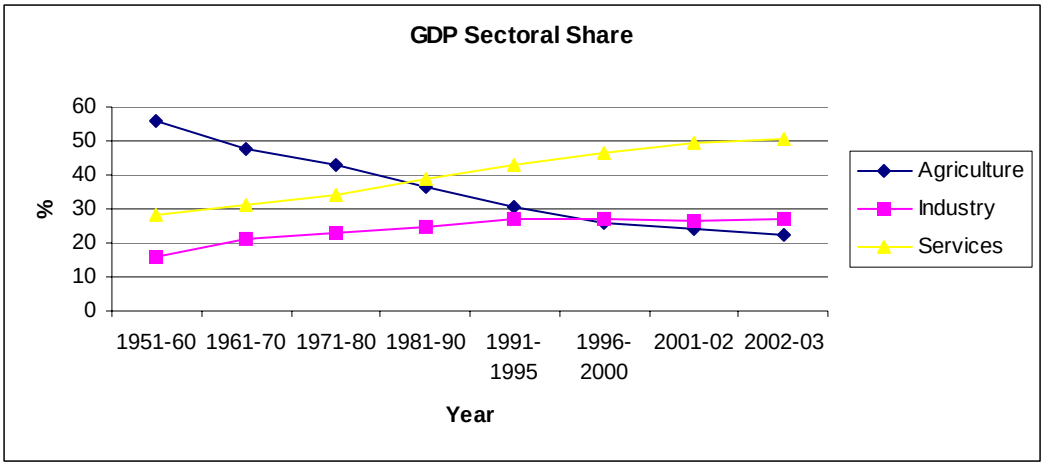
1.4 Economic Growth and Consumption Patterns

Some economists say that India is shining. Over the last year the Indian economy has shown good growth rates, low inflation rate, falling interest rates and robust export growth. Just like poverty, economic growth also leads to pollution, albeit of a different kind. The impact of this growth on environment depends on three major aspects: the first is the structure of GDP, the second is the change in consumption patterns of the population, and the third is environmental governance.

1.4.1 Structure of GDP

Primary sector (particularly agriculture) remains the bedrock of the Indian economy, although its share in the total GDP has been declining over the years – from over 50 per cent in the early 1950s to 26 percent in recent years. At the same time the shares of manufacturing, transportation and banking and service sectors have doubled in last 50 years (Economic Survey 2003). The growth of the Indian economy is accompanied by a change in its structure (Figure 1).

Figure 1: Sectoral Shares in GDP (in percent calculated from billion rupees at 1993-94 Prices)



Source: Ministry of Finance (2003), *Economic Survey, 2002-2003*

The rise in the service sector share is encouraging as it is environmentally less intensive than the other two sectors. This change is stimulated by liberalization and the rapidly increasing outsourcing of software and IT enabled services by foreign companies. Some of this has to do with the change in domestic consumption patterns as well, for instance the restaurant industry has taken off in the last ten years employing many.

1.4.2 Consumption Patterns

Consumption patterns depend on income levels; at the subsistence level, people usually consume primary goods such as cereals, milk, meat, fuel wood and so on. With a rise in income, secondary goods such as petroleum products, cement, fertilizers, etc. enter the consumption basket. Finally tertiary goods such as transport vehicles, consumer goods and appliances and services used in large quantities. Thus, consumption levels depend on level of income and the kind of population whose income has increased.

In India, consumption patterns have changed over the years as a larger share of income is being spent on transport and communications (table 7)

Table 7: Consumption Expenditure by Object at 1993-94 Prices (In Rupees Crore)
(Values in parentheses are percentage of the total consumption)

ITEM	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000*	2000-2001*
Food, Beverages and Tobacco	293000 (55.74)	299285 (55.73)	301327 (54.70)	315243 (54.85)	325436 (54.11)	340124 (53.23)	369285 (53.55)	362475 (51.70)	404108 (53.78)	414078 (52.95)	388298 (47.87)
Gross Rent, Fuel and Power	64254 (12.22)	66411 (12.37)	68575 (12.45)	68239 (11.87)	70688 (11.75)	72907 (11.41)	75380 (10.93)	79862 (11.39)	82880 (11.03)	85656 (10.95)	88705 (10.94)
Transport and Communication	52975 (10.08)	56236 (10.47)	60569 (11.00)	64993 (11.31)	71783 (11.93)	76568 (11.98)	87748 (12.73)	86758 (12.37)	88266 (11.75)	90595 (11.58)	113051 (13.94)
PFCE in Domestic Market	525641	536980	550828	574772	601481	638938	689566	701114	751439	782064	811160
Population (in Crores)	85.0	86.7	88.2	89.8	91.4	92.9	94.6	96.2	98.0	99.8	101.6
Per Capita Consumption (In Rupees)	6184	6194	6245	6401	6581	6878	7289	7288	7668	7836	7984

NOTE: Figures in italics are percentages to PFCE in the domestic market at 1993-94 prices
*-Quick Estimates: *PFCE*-Private Final Consumption Expenditure
Source:

Given that 25% of global population that reside in industrialized countries consume more 70 % or more of most of the resources of the world. (Parikh Jyoti et al, 1991), the importance of consumption patterns becomes starkly obvious.

1.5 Urbanization and Transportation

As countries industrialize one sees cities grow and traffic increase. This may reflect rapid economic development and industrialization but also results in high levels of energy consumption and emissions. The progress of urbanization is relatively slow in India compared to other developing countries and the bulk of the population continues to live in rural areas. The urban population increased from 19% of the total population in 1965 to 28% in 2000. It is expected that more than 50% of population in India will reside in urban areas by 2025.

The number of urban agglomerations/cities with populations of over a million has increased from 5 in 1951 to 9 in 1971 and 23 in 1991 to 35 in 2001. The increase in the requirements of urban transportation in India over past few decades has outstripped the development of urban infrastructure. This has led to congestion of cities, proliferation of private vehicles, increased energy usage and increased pollution. The situation got worse due to shift of modal split away from railways towards road transport and from public to private transport due to inadequate capacity expansion of public transport leading to rising emission levels of pollutants and increased energy usage due to proliferation of private vehicles.

Transport is a critical infrastructure for both intercity and urban development. When low-income groups do not have access to affordable transportation system, this imposes hardships and impacts their quality of life. Their time and energy is wasted in commuting, making them inefficient and thus sending them in a vicious circle of poverty and inefficiency. Efficient transport system is a critical infrastructure for the cities for economic productivity and quality of life.

In addition, the transport sector accounts for a major share of consumption of petroleum products in India. Transportation sector is responsible for a large share of air pollutants

ranging from respirable particulate matter RSPM, Nitrogen oxides, Carbon Monoxides, Ozone and greenhouse gases to name a few. Therefore, in order to develop sustainably greater emphasis needs to be placed on developing good public transport systems. The growth of registered motor vehicles from the year 1951 to 2000 in India is shown in Table 8. Metropolitan cities account for about one-third of total vehicles in India. Interestingly total number of two wheelers in the country has shown a huge rise as compared to other vehicles. This indicates that the size of middle class and its purchasing power have increased, as two-wheelers are hugely popular amongst middle class community in India.

Table 8: Total Number of Registered Motor Vehicles in India (in thousands)

Year (As on 31st March)	All Vehicles	Two Wheelers	Cars, Jeeps & Taxies	Buses	Goods Vehicles	Others *
1951	306	27	159	34	82	4
1971	1865	576	682	94	343	170
1991	21374	14200	2954	331	1356	2533
1994	27660	18899	3569	392	1691	3109
1999	44875	31328	5556	540@	2554	4897
2000 (R)	48857	34118	6143	562@	2715	5319
2001 (P)	54991	38556	7058	634@	2948	5795
2002 (P)	58863	41478	7571	669@	3045	6100

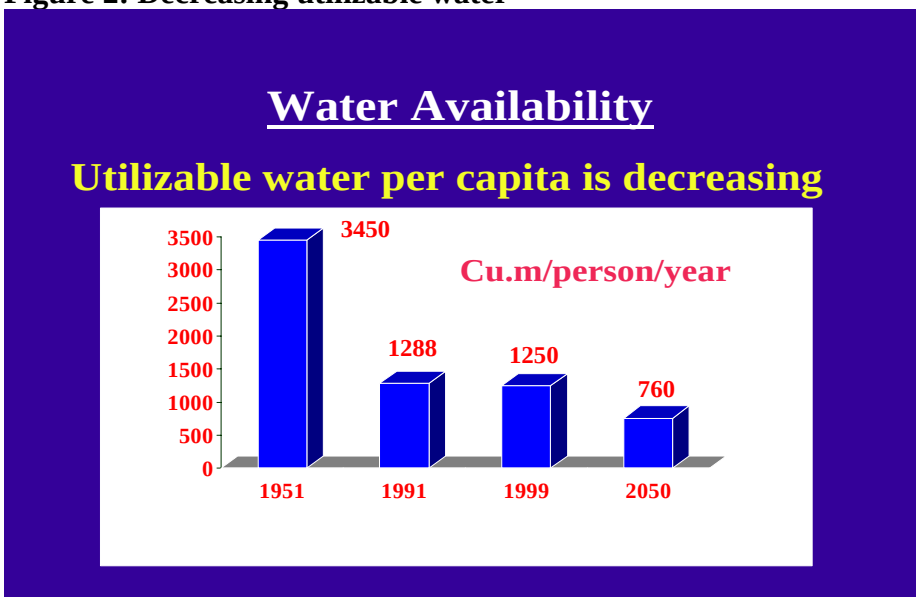
Note: *: Others Include Tractors, Trailers, Three Wheelers (Passenger Vehicles) and other miscellaneous vehicles, which are not separately classified.
@: Includes Omni Buses.
Source: Ministry of Road Transport & Highways (2000), *Motor Transport Statistics of India 1999-2000*, Ministry of Road Transport & Highways, Govt. of India & Past Volume. http://morth.nic.in/motorstat/mt1.pdf

2. Current State of India's Environment:

2.1 Water

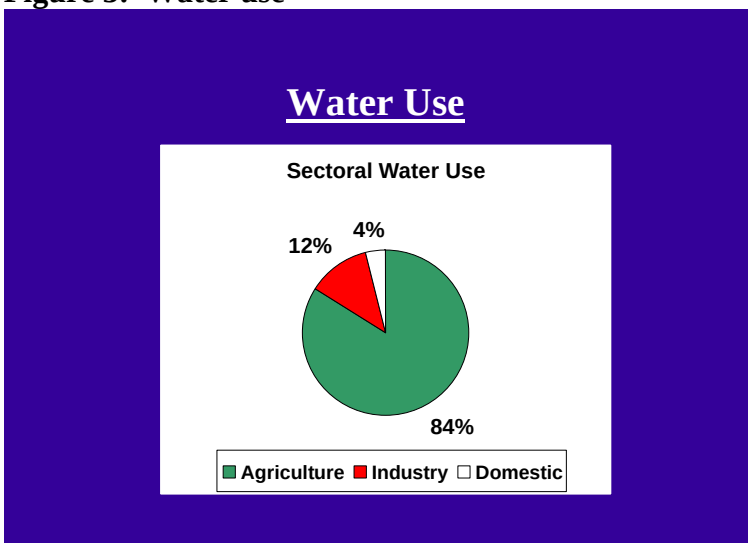
Water pollution is a major cause of concern in India because in addition to causing ecosystem damage it adversely affects health and thereby impairs economic productivity of people. The current condition of water resources requires that urgent action be taken. For instance, 90% of India's surface water resources are polluted to the extent that they are not fit for bathing (a marked decline in 50 years). Also, about 200 million people do not have access to safe drinking water and utilizable water per capita is decreasing (figure 2). This level of pollution is set to create conflict over water and scarcity even in regions with abundant water (TERI vision, 2001).

Figure 2: Decreasing utilizable water



The socio-economic costs of water pollution are extremely high: 1.5 million children under 5 yrs age die each year due to water related diseases, 200 million person days of work are lost each year and the country loses about Rs.36, 000 crores each year due to water related diseases. Given this, we must aim at water security for present and future generations, make water available to all and preserve its quality. (reference)

Figure 3: Water use



The three major contributors towards water pollution are the domestic sector, the industrial sector and the agricultural sector. 75% of the effluents by volume are from the domestic sector. This is because only 20% and 2% of wastewater in Class I and Class II cities respectively is treated. Meanwhile, only 3.15% of rural population has access to sanitation services and 115 million homes have no access to toilets of any type. In the industrial sector only 59% of large and medium industries had adequate effluent

treatment in 1995. In the agricultural sector, fertilizer use increased from 7.7 MT in 1984 to 13.4 MT in 1996 and pesticide use increased from 24 TT in 1971 to 85 TT in 1995. (Bhalla, G. S. et. All. 1999)

One of the reasons why environmental standards are ignored is because they are seen to be expensive. However, when one calculates the cost of lowering pollution one must compare it to the health and economic benefit from abating pollution. For example, Rs.460 billion is needed to construct toilets in 115 million homes, wastewater treatment in 3696 cities/towns would cost Rs. 180-600 billion depending on technology, pollution abatement in industries would cost Rs.140billion (about 1.2% of total annual turnover). However, the loss from human health damages due to sanitation and water pollution is 360 billion rupees per year (Parikh et. al, 1998).

2.2 Air

Contrary to popular belief, air pollution is not an urban problem alone. While in cities suspended particulate matter, sulphur dioxide and nitrogen oxide levels are much higher than permissible limits, in rural areas indoor pollution kills half a million prematurely every year.

In urban areas the transport sector is the highest contributor to air pollution, although refuse burning and Industrial pollutants are also big contributors. Table 9 shows air quality in seven major cities during 2002. It can be observed that suspended particulate matter and respirable suspended particulate matter are at very high levels in both residential and industrial areas.

Table 9: Standard for Air Quality and Actual Pollution in Seven Major Cities During 2002

	Standards set by CPCB of Annual Mean Concentration Range (µg/m3) in Industrial (I) and Residential (R) zones				
	Industrial zones (I)			**Residential zones (R)**	
Pollution level	**SO2 & NO2**	**RSPM (Respirable Suspended Particulate Matter)**	**SPM**	**SO2, NO2, RSPM**	**SPM**
Low (L)	0-40	0-60	0-180	0-30	0-70
Moderate (M)	40-80	60-120	180-360	30-60	70-140
High (H)	80-120	120-180	360-540	60-90	140-210
Critical (C)	>120	>180	>540	>90	>210

	SO2		**NO2**		**RSPM**		**SPM**	
STATE / CITY	**Ind**	**Res**	**Ind**	**Res**	**Ind**	**Res**	**Ind**	**Res**
Hyderabad	L	L	L	M	M	H	M	H
Delhi	L	L	L	M	C	C	H	C
Ahmedabad	L	L	M	M	C	C	M	C

Bangalore	L	L	L	M	M	H	L	H
Mumbai	L	L	L	L	M	H	M	C
Chennai	M	L	L	L	M	M	M	M
Kolkata	L	L	H	H	H	C	M	C

Source: http://www.cpcb.delhi.nic.in/mcity/m2002.htm

The cost of air pollution in 36 major Indian cities has been very high. For instance, Brandon et.al (1995) estimates that in 1995 there were 19.8 million hospital admissions and 1200 million minor sicknesses per year. In Delhi alone there are human health damages worth Rs. 1170 million per year.

In rural areas, air pollution is primarily produced indoor from the use of firewood and other unclean sources of cooking fuel. Since 72% of India lives in rural areas this form of air pollution has significant impact on the population as a whole. Indoor pollution causes 0.41 to 0.57 million premature deaths/year and for each death there are about 6 person years of illness (Parikh J, Smith K and V.Laxmi, 1999). Making cleaner technologies available and affordable can aid in lowering pollution and improving health.

2.3. Land and Forest

Productive lands are essential to meet India's need for food, fuel and fodder. In addition, they help conserve biodiversity and water. According to the National Wasteland Development Board in the Ministry of Rural areas and Employment some 175 million hectares (53% of the country's total geographic area) is degraded. This compromises life support systems and livelihood of poor and tribal people adversely as shown in the earlier section.

3. Valuation and prioritization

3.1 Valuation of Environment

We have seen that India has a large number of environmental problems. How does one prioritize among these various environmental problems? How can one use valuation and accounting approaches for prioritization? Some efforts are made by various authors in estimating the cost of environmental degradation at national level as can be seen in the table below.

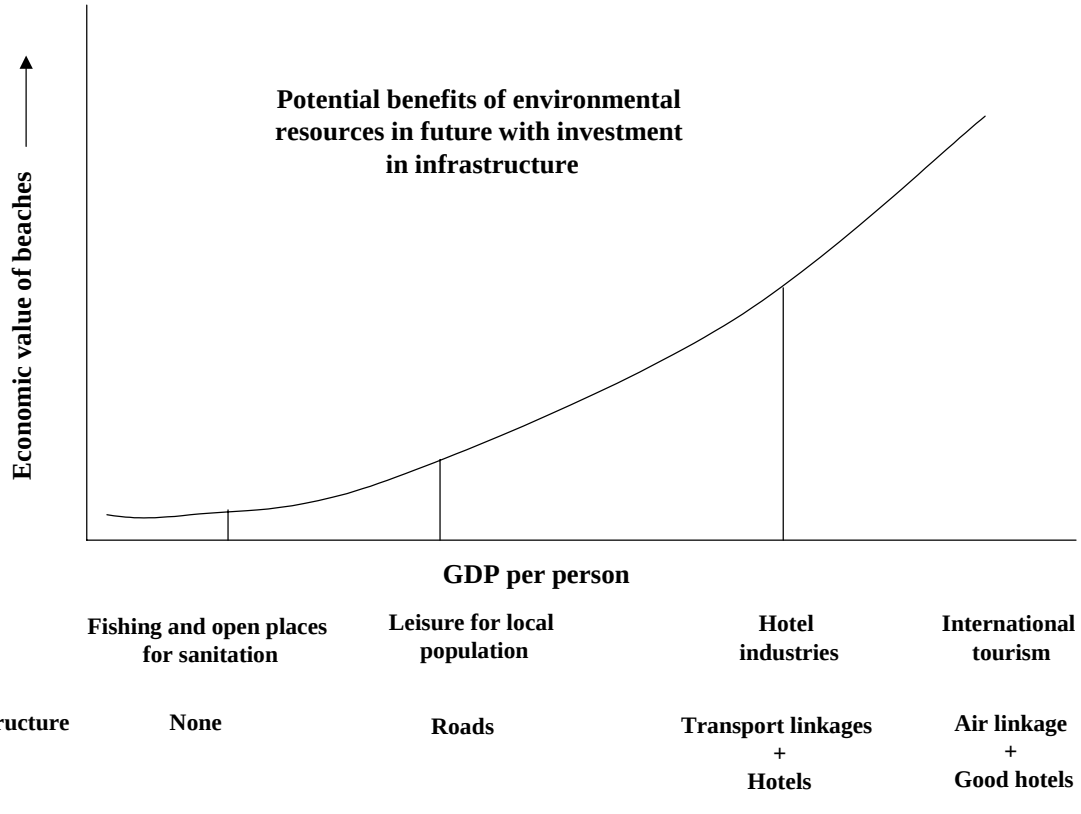
The table below illustrates how much India loses from land and forest degradation each year. The estimates in the table refer to mid 1990s. In terms of percent of GDP these are significant losses as in 1995 India's GDP at factor cost was Rs. 10732 billion .We note that they are done by different authors at different times and with different methodologies and are not comparable. Yet, they give broad indication.

Table 10: Estimates of economic value of environmental degradation in India (in billion rupees)

Human health damages due to water pollution and poor sanitation	360
Loss of Crop Productivity due to soil degradation	89-232
Loss of wood due to forest degradation	57
Human health damages due to air pollution	885-4250

Source: Parikh et. Al (1998, 99), TERI (1998), Brandon et al (1995), NEERI (1998), FAO (1999)

UNSTAT (1994) has developed a system of Integrated Economic and Environmental Accounting (IEEA). K.Parikh et. al. (1993) wrote the first report on framework for natural resources accounting for India. J.Parikh and K.Parikh (1997) wrote primer for IEEA for the developing countries of Asia Pacific region. Recently, a number of valuation exercises are carried out at local level for the Environmental Economics Research Committee (EERC J.Parikh 2003). These valuation exercises cover a large number of topics ranging from valuing wetlands, forests, environmental resources degradation such as soil, water, air and so on. These exercises show benefits accruing from environmental resources to a large number of people in terms of livelihoods, along with health and recreational benefits. However, aggregate sum of these benefits is not very large. This is because the wages rate is very low and even with a large number of people depending on environment, the total value derived in absolute number is low. In such cases, we need to consider future values of these resources. For example, in case of a poor fisherman, beaches, with no infrastructure, could only mean open spaces to dump waste and space for sanitation. As and when income rises and diversification of demand takes place, beaches are used for leisure, boating, selling handicrafts, food stalls and so on. Then it is possible to derive more value, but only with more infrastructures. With further development of the infrastructure (i. e. roads, hotels and network for tourism promotion) values can go up. If, however, beaches are not sustainably used, the future values are lost.



3.2. Total cost of water pollution

Another issues is cost of avoidance Vs. damages cost which should be used? After, avoidance costs are lower than damages but common property syndrome does not ensure avoidance unless some policy decisions are taken politically. We have estimated cost of water pollution in two alternative ways (a) damage cost and (b) avoidance (abatement) costs. These are summarized in Table 11.

Table11: Alternative Estimates of Costs of Water Pollution

Rs. Millions/year at 1995 prices

A. Damage costs		
a	Value of annual loss of 30.5 million DALYs @ average per capita GDP of Rs.12000	366000 3.95% of GDP (1995-96)
B. Avoidance costs		
a	Pollution abatement in organized industry	10120
b	Pollution abatement in Small Scale Industry	45980
c	Wastewater treatment in 3696 cities/towns	3620 to 10540
d	Provision of toilets to 115 million households	35300 to 56630
e	Provision of safe drinking water	39300
	Annualized cost (assuming Operation and Maintenance Costs of installed facilities at 20% of capital costs) **Annual costs (capital + O&M)**	**134320 to 162550** **26860 to 32510** **161180 to195060**
	Annual cost as percent of GDP (1995)	**1.73 to 2.1%**

a, b, c, and **d** at 15% discount rate and 15 years life.

India incurs huge damage costs due to water pollution and poor sanitation facilities, amounting to Rs.366 billion per year or about 3.95% of GDP (1995). Whereas, infrastructure provision and abatement costs needed to reduce water pollution levels range from Rs.161 to 195 billion. These costs are much less [1.73 to 2.1% of GDP (1995)] when compared to the damage costs. The damage costs does not fully reflect loss in social welfare or the cost of suffering and pain due to sickness in to accounted for in our estimate. It would suggest that avoidance is economically justified and socially desirable. It will be prudent and wise to start investing in water pollution management.

3.3 Cost of Environmental Degradation in India

3.3.1 Some Observations on the Estimates

J. Parikh and K. Parikh (2002) have estimated costs of degradations of the four most important natural resources of India, namely, air, forests, cultivable soils, and water.

These estimates refer to different years and use different approaches. Empirical estimates require data, most which are generally not available for a common year. We get over this problem by assuming that degradation cost as a proportion of GDP would remain roughly constant. Since environmental degradation generally takes place slowly, the assumption can be justified. In any case, in estimating costs one has made many other assumptions and the estimates have to be taken as rough ball park figures.Before we do so, however, it would be useful to summarize the approaches used in these estimations and their limitations.

Air and water quality degradations are valued using avoidance cost method, i.e., how much it would have cost to avoid degradation assuming that it is being avoided. Unfortunately the degradation is not avoided and it accumulates. The abatement costs may be non-linear and now the costs may be much larger than the sum total of the costs of avoidance measures not taken over the years.

For the case of water quality degradation, damage cost to human health is estimated. The damage costs estimate is a partial estimate as costs of other damages such as to property values, loss of tourism, loss of fishery income, etc. are not been counted. Even then the damage cost estimate of 3.95 percent of GDP is twice as high as the annual avoidance costs of 1.73 to 2.1 percent of GDP.

It should also be noted that environmental damage is accelerating and simply averaging 20 years of damage to obtain annual damage may be an underestimate for more recent years.

The valuation of forests is done on the basis of value of lost income. The estimate for loss in soil quality is also done by estimating loss in productivity of the soil and its present value.

A limitation of these estimates is that they do not account for the distributional impact of deforestation or of soil quality deterioration. Since the poor obtain a much larger part of their income from these resources than the rich, the loss in social welfare would be higher than what we have estimated.

Use of different methods is necessary because of the complexity of the problem of valuation and lack of needed data. Other, the availability of data guides what methods could be used.

These limitations have to be kept in mind. Nonetheless these ball park estimates are enough to suggest that costs of environmental degradation can no longer be neglected as they are not small. If we do so we would be taking many wrong decisions and social welfare would not be as high as it could be. We have accumulated a backlog of environmental problems for later years that will require billions of rupees for cleaning air and water, ameliorating soils, planting forests and cleaning up landfills and mountains of garbage. Hazardous waste may have caused considerable damage to water and soil and lead to reduction in agricultural income and deformed children and diseases. In fact, considerable sums are already being spent cleaning up garbage.

3.4 Pulling it Together

Pulling the four estimates together we get the economy wide cost of environmental degradation which we should consider applicable to mid 1990s. These are summarized in Table 12.

Table 12: Annual Cost of Environmental Degradation in India 1994-1997

(Percent of GDP)

Resource	Range
Air	0.4*
Forests	1.1 – 1.6
Soil	0.30 – 0.80
Water	1.70 – 2.1
Total	3.5 – 4.9

* Does not include damages due to indoor pollution
Parikh J and Parikh K (2001) Environmentally adjusted GDP
Report to the United Nations University

Table 12 shows that we should subtract an additional 3.58 to 4.99 percent of GDP from our NDP to obtain an environmentally adjusted NDP. What does this imply for the growth rate of India's environmentally adjusted NDP?

It would depend on whether damage to environment and natural resources is accelerating or not? If, as a percent of NDP the cost of environmental degradation has remained the same in past years, then the growth rate is not affected.

On the other hand, if the cost of degradation was nil 5 years ago and is now 5 percent of GDP, the growth rate of NDP over the five year has to be reduced by 5 percentage points.

We should, however, emphasize that the estimated costs are partial and the cost to social welfare is likely to be much larger. Also we have not accounted for costs of other types of degradation, such as due to solid wastes, that due to hazardous waste disposal, due to loss

of scenic beauty or natural ecosystems and biodiversity. All these would increase the costs significantly.

4. Environmental Quality Management Strategy

Environmentally sustainable development requires a combination of six strategies: economic incentives against polluting, law enforcement, technological interventions such as cleaner technologies, institutional mechanisms, poverty alleviation programs, and people's participation. This section examines how these strategies can be effective.

4.1 Law enforcement and other controls

- **Consolidate pollution control laws** – The environment has to be addressed holistically as different media like air, water and soil are interconnected and pollution once generated, can shift in space and time. That is, pollution can be diluted in more water or air or converted into different forms of pollutants viz. burning solid waste and causing air pollution or pollution laws must be consolidated to address this issue.

- **Introduce full liability laws –** Industries and other polluters should be made fully liable for their pollution. After the Bhopal tragedy this should have been obvious, yet the Bhopal victims have not got adequate compensation..

- **Make clean technologies mandatory in new industries –** The current industry growth rates are around 7-8%. In this light, industries being established now will comprise 50% of the market in 9 years (Jayaraman. KS 2001). Cleaner technologies should be made mandatory in such industries so as to reduce pollution in the coming years. Industries are less willing to change their techniques once they are established. Hence, they should be made to take on cleaner technologies right from the start. The technology for small-scale industries can be improved by requiring large-scale capital goods manufacturers to produce less polluting equipment.

- **Make functioning treatment facilities mandatory –** Often, due to mandatory requirements, effluent treatment plants are set up but not operated to save operating costs. Therefore, laws should provide for monitoring operation of these facilities.

- **Require environmental audits for industry** – Environmental impact assessments are often made at the start of the project but prescribed environmental management practices are often forgotten once the project is underway. Regular audits would act as self-monitoring and enhance compliance to standards.

- **Provide effective right to information -** If people have the information about what their neighbouring industry pollutes, they would generate pressures for abatement and treatment. Full liability laws need to be complemented with right to information.

4.2 Economic Incentives

- **Appropriate pricing** - Natural resources are often sold at a very low price, leading to their exploitation. For example, the subsidies on irrigation water have led to planting of highly water intensive crops in regions inappropriate for this kind of agriculture.

Excessive use of water has also resulted in waterlogging as well as depletion of ground water table making the soil saline. Removing inappropriate subsidies is essential to maintaining natural resources and would encourage development of more environmentally friendly alternatives. Since liberalization this has changed in India People have also begun to accept appropriate prices for natural resources. Pricing water to reflect its scarcity will encourage users to use it more sparingly.

- **Tax based on pollution load –** Presently, effluent standards are based on best available technology for specific industries. Industries have no incentive to improve standards in such a system. Instead, a pollution tax should be levied so that industries pay taxes in proportion to the pollution they generate. Such a policy will reduce pollution at source and can only work if there is effective monitoring and punishment.

- **Higher credit rating for green industries -** Higher credit rating for green industries will encourage upcoming industries (which are dependent on the market for capital) to be more environmentally conscious. Once right to information and liability laws become effective, rating agencies would take care of this.

- **Reduce subsidies on fertilizers and pesticides –** The current subsidies on fertilizers and pesticides do not ensure that they are used sparingly. Recently, pesticides and fertilizers were found even in bottled soft drinks indicating that the runoff from agriculture is contaminating groundwater at very high levels. Reducing fertilizer subsidies will encourage more controlled use.

4.3 Technological interventions

Technological intervention for environmental management does not necessarily imply new inventions. Many environmentally friendly interventions are traditional methods or simple techniques, which have been known but not used.

- **Cleaner technologies -** A great example of how a cleaner technology is a mere modification of an existing one is toilets. Mexico City replaced 350,000 toilets with smaller six-liter flushes and saved enough water to meet the needs of 250,000 more homes (Mexico City's Water Supply: Improving the Outlook for Sustainability (1995). In many cases however, active research needs to be conducted in producing cleaner technologies – such as cleaner fuel, more efficient cars etc.

Efficient irrigation – Since 84% of all water in India is used for agriculture, efficient irrigation is the best method to deal with water wastage. For example, applying water to the roots of crops through drip irrigation saves a considerable amount of water, fretless, pesticides, and electricity for irrigation. It also prevents soil erosion or water logging (Bhaskar Save, Water-efficient trench irrigation for horticulture)

- **Integrated pest management –** Using integrated pest management (targeting the insects using natural methods) instead of pesticides would reduce pollution greatly.

- **Vermiculture and organic manures –** Vermiculture has been shown to be an effective method to deal with organic solid waste, which is becoming a major problem in urban

areas. If the community can be made to sort their garbage (citizen sorting has been effective in many industrialized cities) this can also provide organic manure.

4.4 Institutional mechanisms

Central and State pollution control boards need to be strengthened technically by installing modern equipment and training, financially with larger budgets to hire better staff and facilities to monitor the pollution, and politically by keeping them independent and free from political influence. This has to be done at all levels e.g. at municipalities and gram -panchayats levels to control pollution. Suggestions have also been made that industries should be roped into monitor pollution and assist new industries in choosing environmentally friendly technologies. Involving private sector in water supply and sewage treatment in urban areas may prove to be beneficial. Finally, organizing clean technology databanks will aid new industries in making appropriate investment decisions.

4.5 People's Participation

It is not possible for the government to monitor pollution and the corresponding acts of all industries and individuals. People must be made stakeholders in the environment through awareness campaigns. Industries are sensitive to public pressure. Experience in the west suggests that firms wish to maintain a green profile when citizens are aware of environmental issues. Through generating awareness, the public could directly affect the environmental practices of industries. As already pointed out right to information and liability laws help a lot in this.

Environmental problems arise because property rights are not well defined. Common property resource management is needed. Often cooperative management with people participation is advocated. However, people's participation is not the magic bullet by itself. When the common property resource is such that user group management can lead to positive sum outcome, then cooperation becomes sustainable. In a zero sum situation the cooperatives often disintegrate once the change agents leave. The problem of free-riding can be dealt through people's participation (when CPR is definable) with an appropriate management structure. For example, the national tree growers cooperative federation has evolved a framework which has been successfully tried in hundreds of cases. The CPR is managed though a collective after defining a community, making members pay a fair price for whatever they take from the CPR and sharing profits equally among all members.

4.6 Moving forward technologically:

In addition to environment–specific technologies, mentioned above, India has to move forward technologically in an overall context to avoid pollution at source. Modern technologies already developed in the developed countries such as better power plants

and cleaner vehicles should be considered through technology transfer for pollution measurements.

Technological innovations allow India to develop rapidly in an environmentally sustainable manner by leap-frogging over older technologies. One of the best examples of this in India is the cell phone revolution. The introduction of cell phones in rural areas allows people to bypass the massive project of digging and installing land lines. According to telenet, a telecommunications periodical in India, the growth of mobile services in 2003 has been at 164% while fixed line services are growing at 5.6%. In a country where only there are only 3.68 telephones per hundred people the growth rate of land lines is much too small to make phone services available to all in the near future. A larger focus on developing cleaner technologies is essential. The benefits of increasing communications are enormous. In terms of the environment, they reduce the requirement of transportation as more and more transactions can take place using phones.

Conclusion:

We have seen that India cannot afford to neglect the environment, if sustainable development is desired. The pressures on environment have to be curtailed by reducing population pressures, increasing literacy, environmental awareness drives and poverty alleviation programmes. Poor are victims of environmental degradation but they can also aggravate it if the infrastructure and living conditions do not keep pace with population increase. Rather, the poor have to be turned into agents for environmental restoration by involving them in say forest management, waste management, recycling and so on in manners that create incentives for them to use natural resources in sustainable manner.

Secondly, the economic activities must be conducted using environment conserving and resource saving technologies. Managing environment though better urban designs, improvement in transportation infrastructures and creative use of information technologies needs to be considered seriously.

Thirdly, strategy for environmental governance should consist of law enforcement, providing economic incentives, people's participation, institutional reforms and support and technological improvements.

The environment is not a luxury for the rich but a necessity for the poor. Therefore, while it is no easy task for India to develop sustainable it is absolutely necessary and requires tremendous cooperation and will. With the determination of the government, private sector, NGOs, and people, India can perhaps achieve sustainable development.

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