INDIA'S ENERGY SECURITY

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Synopsis

India has emerged as one of the fastest growing economies in the world. The country needs large quantities of energy not only to sustain these growth levels, but also to meet the growing energy needs of its growing population.

In order to achieve the objective of sustainable energy security India must evolve a sustainable energy security pathway to enable it to meet the combined goals of energy security, food security and ecological security.

The major commercial energy resources of India are coal, oil, natural gas, nuclear power and hydropower. Other non-conventional sources of energy such as wind, solar energy, bio-gas and geo-thermal energy are also available but generally are in the development stage. At present, India is importing more than 26 per cent of its total commercial energy, a figure that is going to increase in the coming years to meet the growing demands of commercial energy in all sectors of the economy.

Augmentation of energy resources, especially environment friendly sustainable energy resources, would have to be complemented with programmes of demand side management and energy conservation, increasing energy efficiency and reducing environment pollution as components of a new integrated energy policy for India. The sustainable energy pathway would include augmentation of indigenous sustainable energy resources, hydro, nuclear and renewables. Sustainable energy pathway would further specifically include technology missions, which have to be mounted for the production of clean energy technologies, particularly for coal, which is the country's main energy source. It would further include improving energy efficiency, reducing transmission and distribution losses and development of new energy technologies including fuel cells, hydrogen energy, electric vehicles, bio-fuels as well as coal bed methane and hydrates, among others.

For achieving the goal of sustainable energy security for all by 2020, it is necessary to adopt a comprehensive approach. The first priority must be to meet the energy needs of the people below the poverty line and at the grassroots level and, thereafter, going up to meet the energy needs at the district, state and national levels. Sustainable energy security aims at providing energy to meet the needs of the economy while reducing dependence on imports and relying on indigenous sources of energy supply. While several initiatives could be taken by India independently, for several others India would also require the neighbours for transit facilities for gas pipelines. India would need the support and participation in these projects by Pakistan and Bangladesh. The globalization of economy requires India to be more pragmatic and open and adapt itself to the new dynamics.

INTRODUCTION

India's economic growth has been steady but slow. The GDP had increased to over Rs. 22,000 billion by 2003-04 and the per capita income had increased to over Rs. 21,000 per year. The growth pattern, with 3 to 3.5 per cent during the early years of development, has consistently been over 5-6 per cent during the 1990s. Of late, the GDP has grown over 6-8 per cent. With these growth levels it has emerged as one of the fastest growing economies in the world. India needs large quantities of energy not only to sustain these growth levels, but also to meet the growing energy needs of its growing population.

AIM

The aim of this thesis is to analyse India's current energy resources, demand and supply situation and to identify key strategies to meet the country's growing energy demand.

SCOPE

The study analyses the global energy scenario, energy demand and supply situation in India, the risk factors in the strategy to achieve affordable and adequate supplies of energy and the measures necessary for evolving a National Sustainable Energy Security Policy to cover the period up to 2020 AD.

LAYOUT OF THE THESIS

The layout of the thesis is as follows:

(a) Chapter I Introduction.

(b) Chapter II Outlook for World Energy Demand

(c) Chapter III Indian Energy Sector

(d) Chapter IV Energy Sector-Current Status

(e) Chapter V Outlook for Energy Demand and Supply

(f) Chapter VI Energy Risks and Energy Security

(g) Chapter VII Sector Wise Energy Policy Prescriptions

(h) Chapter VIII Energy Security- A Road Map for India

(j) Chapter IX Design of the National Sustainable Energy Security System

(k) Chapter X Conclusion

World Energy Demand

Out of total energy consumption, oil has the largest share (39.5 per cent), coal (24.2 per cent), natural gas (22.1 per cent), renewable energy mainly hydel (7 per cent) and nuclear power (6.3 per cent). World coal production is generally on the decline though total world oil consumption is expected to increase by about 2.2 per cent annually. The usage of natural gas will double by 2020 and use of nuclear energy in industrialized nations is projected to drop by 12 per cent by 2020. The production of non-conventional fossil fuels is currently too expensive to be commercially viable.

India's Energy Resources

The major commercial energy resources in the country are coal and lignite, oil and natural gas, nuclear power and hydropower. Other sources such as wind, solar energy, biogas and geothermal energy are also available but the technology for the use of these resources is in the developing stage. The estimated assured resources of coal are 204 billion tonnes, whereas the balance recoverable reserves of crude oil are about 600 million tonnes and that of natural gas are about 763 billion cubic meters.

Energy Consumption

The consumption of traditional fuels has grown at the rate of 2.7 per cent from 185 million tonnes of oil equivalent (mtoe) in 1980-81 to 331 mtoe in 2002-03. Coal consumption has increased at the rate of 5.8 per cent from 109 million tonnes to 358 million tonnes; oil consumption has increased at the rate of 6.4 per cent from 31 million tonnes to 111 million tonnes; natural gas consumption has increased at the rate of 15.6 per cent from 1522 million cubic meters to 29,718 million cubic meters; hydroelectricity consumption has increased at the rate of 3.2 per cent from 46,557 million Kwh to 84,619 Kwh; nuclear electricity consumption has increased at the rate of 9 per cent from 3,001 million Kwh to 21,273 million Kwh and electricity consumption from renewable sources has increased from 69 million Kwh to 16,122 million Kwh over the same period.

Impact on Foreign Exchange

The fluctuations in oil prices and the dependence on oil imports has had a big impact on the foreign exchange requirements. Though in absolute terms, the oil imports have substantially increased from US$ 6,655 million in 1980-81 to 10,482 million in 1999-2000, in terms of percentage of the total foreign exchange earnings, the oil imports have come down from 78.4 per cent to 27.8 per cent over the same period. The reason is that the foreign exchange earnings have increased substantially over this period. However, the volatility of the oil prices in the international market creates uncertainties to India's foreign exchange balance. Though, overall oil imports have proved to be manageable, but behind the figures of import are several risk factors, which need to be carefully addressed.

Energy Risks and Key Issues

To fuel future growth, India must add approximately 100,000 MW of additional capacity by 2012 and meet energy demands that are projected to expand 6 per cent per year through the same period and beyond. India's dependence on imported fuels will increase over time. Short and long-term prospects for India to achieve affordable and adequate supplies of energy, specially of hydrocarbons, have several risks which need to be addressed carefully. India has little choice but to develop both indigenous energy supplies and to expand regional and international trade arrangements necessary to sustain its economic growth.

The Road Ahead

In order to achieve sustainable energy development, measures need to be taken to increase the efficiency of energy production and consumption, and to switch to non-fossil fuels. It will include introducing advanced and clean fossil fuel technologies and nuclear power technologies and developing new and renewable sources of energies to facilitate switching to renewable energy in the long run. With regard to industrial and transportation sectors, effective national policies need to be formulated and implemented to reduce material and energy intensity of production and consumption. The prime challenge before the country is to provide minimum energy services to allow the poor people to achieve a decent standard of living. By 2020 the provision of modern energy services can be ensured either as a connection to a reliable, sustainable electricity supply grid, or as a stand-alone electricity system that may not be grid connected.

CHAPTER I

INTRODUCTION

"You might almost write the history of civilization in terms of power resources being exploited".

Pandit Jawaharlal Nehru

The knowledge on agriculture helped mankind to improve their living conditions; it transformed the surface of the earth by using energy derived from wood and animal sources. The industrial revolution brought about a strategic shift in tapping unprecedented energy from fossil fuel, which resulted in unexpected economic growth and at the same time giving birth to a new lifestyle and the most environmentally destructive era in human history. Meeting the food and livelihood requirements of a growing population depends on harnessing existing energy resources, which are finite and the excessive use of which will result in environmental catastrophe. Therefore, mankind is now in the arduous quest for energy resources, which are beyond fossil fuels and the use of which are sustainable and consistent with nature.

India is poised for enormous energy consumption in the coming decades. It is currently the sixth largest energy consumer in the world. For over a decade, India's energy consumption has grown faster than its economy and this trend is likely to continue. A recent study indicates that India's energy consumption will increase at the rate of 5 per cent every year up to 2010-11[1]. The country's energy intensive growth makes access to abundant, clean and affordable energy sources imperative.

At present, coal accounts for a predominant share in India's energy basket. But being a signatory to Kyoto Protocol, India's burgeoning energy needs of urbanization, modernization and rapid growth in motorized transportation will have to be catered for with cleaner fuels. In recent times, the share of oil and gas is increasing, owing to new technology in power generation. The dependence on imported oil will rise from the present 70 per cent to almost 100 per cent in the near future due to stagnation in indigenous oil production in the past few years. The gap between demand and supply of oil, and consequent imports are directly related to overall energy shortages, mounting foreign exchange requirements and the question of energy security[2].

India's domestic hydrocarbon resources are slender. Bombay High, the largest oil field is past its prime and its production is declining, but it has not been replaced by any new major field. Oil recovery from existing wells is just 28 per cent. Ecologists are of the view that the vein carrying liquid gold bypasses India, while there might be significant offshore gas[3].

In these circumstances, India should choose to aggressively pursue all energy options such as improving of recovery rates from existing wells; acquisition of overseas oil acreages by national oil companies; enticing international investors in exploration and production; acquiring clean coal technologies;

exploring possibilities of accessing the abundant gas reserves in the neighbourhood; exploiting new fuels like gas hydrates and coal-bed methane; and increasing the share of clean affordable and sustainable nuclear power in the country's energy basket.

Currently, India does not have any integrated energy policy. The need for such policy has been brought out in the Tenth Plan Document. The Tenth Plan has proposed that an integrated energy approach is to be evolved with the policy goals of economic efficiency, energy security, energy access and environment protection.

A comprehensive approach would have to be provided by the Integrated Sustainable Energy Policy framework after educating public opinion and decision-makers at all levels. It has been emphasized by security analysts that the greatest threat to India's long-term energy security is the gulf between professional assessment and ill informed public opinion. The sectoral considerations have to give way to larger national considerations and then only the goal of achieving energy security for all by 2020 is possible.

CHAPTER II
OUTLOOK FOR WORLD ENERGY DEMAND

"*One of the ironies at the turn of the century is that, in an age when the pace of technological change is almost overwhelming, the world will remain dependent, up to the year 2020 at least, essentially on the same sources of energy-oil, natural gas, coal- that prevailed in the twentieth century*".

Guy Caruso Director
Strategic Energy Initiative USA

The world marketed energy consumption is projected to increase by 54 per cent over the 24 years forecast horizon from 2001 to 2025. Worldwide, total energy use is projected to grow from 404 quadrillion British thermal units (Btu) in 2001 to 623 quadrillion Btu in 2025[4]. The fastest growth in energy consumption is projected for the developing Asia, including China and India, where robust economic growth accompanies the increase in energy consumption over the forecast period. With such strong growth in GDP, demand for energy in developing Asia doubles over the forecast accounting for 40 per cent of the total projected increment in world energy consumption and 70 per cent of the increment for the developing world alone.

During the period 2001-2025, increase in consumption of all primary energy sources is expected. Fossil fuel prices for electricity production are projected to remain low relative to the costs of nuclear power and renewable energy sources; as a result, non-fossil fuels are not expected to be economically competitive with fossil fuels over the forecast. The outlook for fossil fuels could, however be altered by government policies and encouraging the use of non-fossil fuels. Presently out of total energy consumption, oil has the largest share -39.5 per cent, coal -24.2 per cent, natural gas -22.1 per cent, renewable energy -7 per cent and nuclear power 6.3 per cent[5].

Oil

Oil is expected to remain the dominant energy source through 2025. The world oil demand is likely to increase by 1.9 percent annually, from 77 million barrels per day in 2001 to 121 million barrels per day in 2025. USA, China and other nations of developing Asia account for nearly 60 per cent of the increment in world oil demand during the period. Although, OPEC producers are expected to be the major suppliers of increased production requirements, non-OPEC supply is expected to come from Caspian Basin, Latin America and deep water West Africa.

Despite expectations that countries in many part of the world will be switching from oil to natural gas and other fuels for their electricity generation, oil's share of world energy is likely to be maintained at 39 per cent. With robust growth in transportation sector, oil is projected to retain its predominance in the global energy mix, notwithstanding increases in new technologies.

Natural Gas

Over the 2001-25 forecast period consumption of natural gas is projected to increase by 67 per cent, to 151 billion cubic feet in 2025.

The growing importance of natural gas in the electric power sector is more pronounced in the industrialized regions than in the developing world. In the industrialized nations the natural gas infrastructure is considered mature and the gas share of total electricity generation is projected to grow from 20 per cent in 2001 to 30 per cent in 2025. In the developing world, the natural gas infrastructure has not yet been established; hence the projected increase is smaller, from 14 per cent in 2001 to 17 per cent in 2025.

Coal

Coal remains an important fuel in the world's electricity markets and is expected to continue to dominate energy markets in developing Asia. With the projected growth in coal consumption averaging 1.5 per cent per year through 2025, coal's share of total world energy consumption declines slightly from 24 per cent in 2001 to 23 per cent in 2025.

Coal usage is projected to increase in all regions except for Western Europe and the EE (excluding Russia). China and India are projected to account for 67 per cent of the total increase in coal use worldwide. Currently, of the coal consumed worldwide, 64 per cent is used for electricity generation. Consumption of coking coal is projected to decline slightly in most regions of the world as a result of technological advances in steel making, increasing output from electric arc furnaces and continuing replacement of steel by other materials.

Nuclear Energy

The boost in nuclear energy during the 70s and 80s was the result of the rise in oil prices, which saw nuclear power being accorded an important position as a suitable substitute for oil. Currently 348.9 GW of nuclear electricity is produced, contributing 16 per cent to worldwide generation. In some countries like France nuclear power provides 75 per cent of total power generation[6].

In the industrialized nations, which accounted for 80 per cent of the world's total nuclear power capacity in 1999, it is projected to drop by 12 per cent by 2020[7]. However, in the developing world nuclear energy is projected to be more than double over the next two decades from its share of 8 per cent of total world nuclear energy; with most of the expansion expected to come in China, South Korea and India[8].

CHAPTER III
INDIAN ENERGY SECTOR

"No Power is more dangerous than no power, No Power is more expensive than no power".

Homi Bhabha

India is well endowed with both exhaustible and renewable energy resources. The major commercial energy resources of India are coal, oil, natural gas, nuclear power and hydropower. Other non-conventional sources of energy such as wind, solar energy, biogas and geo-thermal energy are also available, but generally are in the development stage.

India's energy policy, till the end of the 1980s, was mainly based on availability of indigenous resources. Coal was by far the largest source of energy. However, India's primary energy mix has been changing over a period of time. The break-up of primary energy supply, from 1970 onwards, is given in Table 1 :

Table 1 The Breakup of Primary Energy Supply

Source	Unit	1970/71	1980/81	1990/91	2001/02	2002/03	2003/04
Coal & lignite	MT	76.34	119.02	228.13	352.6	367.29	389.11
Crude oil	MT	6.82	10.51	33.02	32.03	33.04	33.38
Natural gas	BCM	1.45	2.36	18.00	29.71	31.40	31.95
Nuclear power	BkWh	2.42	3.00	6.14	19.48	19.39	17.78
Hydro power	BkWh	25.25	46.54	71.66	73.7	64.10	75.33
Wind power	BkWh	-	-	0.03	1.97	2.10	3.40

Resource augmentation and growth in energy supply has not kept pace with increasing demand and, therefore, India continues to face serious energy shortages. This has led to increased reliance on imports to meet the energy demand.

Coal

India ranks third amongst the coal producing countries in the world. Being the most abundant fossil fuel in India, it continues to be one of the most important sources of energy needs. It accounts for 55per cent of the country's total energy supplies.

The estimated coal reserves of India are given in Table2:[9]

Table 2 Estimated Assured Coal Resources For India (Billion Tonnes)

Depth Range	Assured Resources				
(m)	Proved	Indicated	Inferred	Prognosticated	Total
0-300	63.2	40.8	7.1	2.2	113.3
300-600	5.8	21.5	6.5	13.9	47.7
0-600(Jharia only)	13.7	0.3	0.0	0.0	14.0
600-1,200	1.7	6.4	1.7	19.7	29.5
Total 0-1,200	84.4	69	15.3	35.8	204.5

Of this estimate of 204.5 billion tonnes of assured reserves, the estimate of extractable reserves is given in Table 3[10]:

Table 3 Estimate of Extractable Reserves of Coal for India (Billion Tonnes)

Depth Range (m)	Assured Resources	Ratio of Recoverability	Extractable Reserves
0-300	113.3	4.7	24.1
300-600	47.7	5.7	8.4
0-600 (Jharia)	14.0	5.2	2.7
600-1,200 m	dd29.5	6.7	4.4
Total 0-1,200 m	204.5	5.2	39.6

This estimate indicates that approximately 39.6 billion tonnes of coal could be recovered from known and proven resources. Given that coal demand may reach nearly 500 million tonnes in 2006 and over 800 million tonnes in 2020, India can be assured of 50 years of supply totally from internal production. With the application of new technologies, this available coal could last for more than 75 years.

Although India has significant coal resources, it is of poor quality, having high ash and low caloric content. Further development of coal is constrained by poor mining techniques, limited availability of rail transportation and its use as a primary fuel for electricity generation which has significant adverse environmental impacts. In recent years, the substitution of other fuels for electricity generation, along with imports of higher quality coal, has helped reduce environmental impacts but has contributed to India's increased dependence on fuel imports.

Through sustained increase in investment, production of coal increased from about 70 MT (million tonnes) in early 1970s to 382 MT in 2004-05. Most of the coal production in India comes from open pit mines contributing to over 81per cent of the total production while underground mining accounts for rest of the national output. Despite this increase in production, the existing demand exceeds the supply. India currently faces coal shortage of 23.96 MT. This shortage is likely to be met through imports mainly by steel, power, and cement sector[11].

Oil and Natural Gas

Known reserves of crude oil and natural gas are not adequate to meet domestic demand. As a result, India needs to import large quantities of crude oil and is increasing imports of natural gas. In 2002, recoverable reserves of crude oil were about 660 million tonnes and those of natural gas were about 763 billion m3. The details of oil and gas reserves are given in Table 4.

Table 4 India's Oil and Gas Reserves

Area	Crude Oil	Natural Gas
(Million Tonnes)	(Billion m3)	
Onshore	308	301
Offshore	352	462
Total	660	763
Average annual production	33	29
R/P ratio	20	26

Exploration for hydrocarbons has so far been limited to on-land and shallow-water offshore areas, but private sector companies have begun to explore in deep-water areas off the west and east coasts. The results are encouraging and public sector companies are also registering moderate success in gas finds at deeper levels.

The latest estimates indicate that India has around 0.4 per cent of the world's proven reserves of crude oil. The production of crude oil in the country has increased from 6.82 MT in 1970-71 to 33.38 MT in 2003-04.[12] The production of natural gas increased from 1.4 BCM (billion cubic meters) to 31.96 BCM during the same period. The quantity of crude oil imported increased from 11.66 MT during 1970-71 to 81 MT by 2003-04. Besides, imports of other petroleum products increased from 1 MT to 7.3 MT during the same period. The refining capacity, as on 1 April 2004, was 125.97 MTPA (million tonnes per annum). The production of petroleum products increased from 5.7 MT during 1970-71 to 110 MT in 2003-04.

India's consumption of natural gas has risen faster than any other fuel in recent years. Natural gas demand has been growing at the rate of 6.5 per cent during the last 10 years. Industries such as power generation, fertilizer, and petrochemical are shifting towards natural gas. India's natural gas consumption has been met entirely through domestic production in the past. However, in the last 4 to 5 years, there has been a huge unmet demand of natural gas in the country, mainly required for the core sector of the economy.

Nuclear Power

Nuclear power generation started in India in 1969 with boiling water reactor (BWR) technology. All subsequent projects in India are based on pressurized heavy water reactor (PHWR) technology and to some extent on indigenous technology, with the exception of the 2 X 1,000 MWe reactor type VVER-1000 based on pressurized water reactor (PWR) technology. The nuclear power programme in India makes use of natural uranium and indigenous thorium resources. Available reserves of natural uranium can support a programme of 10,000 MWe power generation based on PHWR technology. India has a programme for commissioning additional capacity in order to obtain a total installed capacity of 11,600 MWe of nuclear power by the end of the Eleventh Plan, which would rise to 20,000 Mwe by the year 2020[13]. The details are given in Table 5.

Table 5 Summary Of India's Nuclear Power Programme

Details of Reactor Units	Total Capacity (Mwe)
Operating reactors 2 BWRs of 160 MWe each 8 PHWRs (1 x 100, 1x 200, 2x170, 4x220 MWe)	1840
Reactors under construction (4 PHWRs of 220 MWe each)	880
Reactors sanctioned and work begun (2 PHRWs of 500 MWe each), 2 x 1000 Mwe VVER (PBR)	3000
Reactors awaiting sanction for 8 PHWRs (4x500, 4x220 MWe)	2880
Subtotal	8600
Reactors in planning stage: 6PHWRs of 500 MWe each	3000
Total	11,600

Hydro Power Potential

The first systematic survey of hydropower potential in India was carried out during 1953-1959. In this survey, 256 possible schemes were identified in various river systems, and the total firm hydroelectric potential was estimated to be equivalent to an annual electricity generation of 222 TWh.

Central Electricity Authority undertook a reassessment of the hydropower resources of the country in the 1980s. The total potential of the river systems in India, at 60 per cent load factor, was assessed as 301,117 MW, and the economic potential at 84,044 MW[14]. The resources are concentrated in the northern and eastern regions of the country. The details of this potential are given in Table 6 :

Table 6 Regional Distribution of Hydroelectric Potential in India

Region	Energy Potential	Capacity Potential at 60% Load Factor (MW)	Percentage Developed
Northern	225.0	30,155	14.3
Western	31.4	5,679	31.9
Southern	61.8	10,763	49.2
Eastern	239.3	31,857	1.0

Non-Conventional Energy Resources

Non-conventional energy resources are attractive for development because they are renewable and are relatively environmentally benign. The development of such resources was initiated in India on a small scale following the energy crisis of 1973. Since then, an information base for non-conventional energy resources to permit the commercial exploitation of these resources has been created. The most important renewable energy resource developed thus far is wind energy, with an installed generating capacity of more than 2,000 MW as of September 2003. The potential and exploited potential of various renewable energy technologies are given in Table 7:[15]

Table 7 India's Renewable Energy- Potential and Exploited

Type	Potential	Potential Exploited
Solar energy	50 Whr/yr	47 MW
Biomass-based power	17,000 MW	484 MW
Small hydro	10,000 MW	1,509 MW
Wind energy	45,000 MW	1,870 MW
Ocean thermal	50,000 MW	
Sea wave power	20,000 MW	
Tidal power	9,000 MW	

CHAPTER IV

ENERGY SECTOR –CURRENT STATUS

Energy Consumption

During the past 50 years, India has become one of the largest consumers of commercial energy (coal, oil, gas and electricity), while also continuing to be one of the largest consumers of traditional energy resources (firewood, animal and vegetable waste). Much of these contributions to the energy supply are not accurately measured or accounted for in India's national statistics. While production and consumption of commercial energy is properly measured and recorded, only some rough estimates are available for traditional fuels. However, some efforts have been made recently to collect and update the data.

The summary of available data of consumption of both commercial and traditional energy fuels in India during the period 1989-2004 is given in Table 8 :

Table 8 Summary of Primary Fuel Consumption in India, 1989-2004 (in Primary Units)

Item	Unit	1989-1990	1994-1995	1999-2000	2003-2004	Rate of Growth (%) 1989-2003
Traditional Fuels Total	Mt	234	267	305	340	2.7
Commercial Fuels	-	-	-	-	-	-
Total Coal	Mt	208	269	324	381	3.5
Total Oil	Mt	57	71	103	124	5.7
Natural Gas	Million	11,172	17,339	26,885	30,900	7.5
Hydroelectric	Million KWh	62,132	82,727	80,853	75,24	2 1.4
Nuclear Electricity	Million KWh	4,625	5,648	13,249	17,980	10.2
Others (Renewable etc.)	Million KWh	146	769	5,294	16,121	Very low
Total Primary Electricity Supply	Million KWh	66,903	89,144	99,396	109,343	3.6

This data represents energy consumption as primary fuels, that is, at the initial stage of consumption. Some fuels are consumed by converting them to secondary fuels, e.g., converting nuclear energy into electricity. Others, such as crude oil, are not used in the raw form but are consumed as products, e.g., gasoline, diesel, kerosene, or fuel oil, which are obtained by processing crude oil in refineries.

Both primary fuel production and consumption data are important. The input side is relevant for planning fuel production and / or imports to ensure adequate supplies to support economic growth. The consumption side is important to examine the relative pricing, price elasticity, inter-fuel substitution, major uses of energy, and other such issues.

To have a meaningful operational decision-making, it is necessary to accurately determine the relative importance of particular fuel sources to total energy consumption. For this reason, the data in Table 8 has been converted to the common measurement scale of million tons of oil equivalents (mtoe). The detailed results are summarized Table 9 :

Table 9 India's Energy Consumption in Oil Equivalent Terms (mtoe) For the period 1989-2004

Item	1989-1990	1994-1995	1999-2000	2003-2004
Traditional fuels, total	72	83	95	106
Commercial fuels	-	-	-	-
Coal	95	121	145	171
Oil	57	71	105	124
Gas	10	16	24	44
Hydroelectric	4.4	19.8	19.4	18.0
Nuclear electricity	1.1	1.4	3.2	4.3
Others (renewable, etc.)	0.04	0.18	1.27	4.2
Total primary electricity supply	15.5	21.4	23.9	26.5
Total commercial energy supply	177.5	229.4	297.9	365.5
Total traditional fuels + commercial fuels	249.5	312.4	392.9	471.5

The data reveals that, while the use of traditional fuels has grown from 72 mtoe in 1990 to 106 in 2004, their share of total energy consumption has fallen from 29 per cent to 22 per cent during this period. Among the commercial fuels, the most striking statistic is that the share of hydrocarbon fuels as a percentage of total energy consumption has increased significantly. Natural gas consumption has increased by 7.8 per cent per year as compared to 5.7 per cent for oil and 3.5 per cent for coal. And as a percentage of total energy consumption during this period, natural gas has increased from 4 per cent to 9.3 per cent and oil from 22 per cent to over 26 per cent.

The increased reliance on commercial fuels in general and on hydrocarbon fuels in particular has important implications on India's economic policies and on its relations with other countries in the region. The growing reliance on commercial fuels has led to a growing dependency on imports. This import dependence is shown in Table 10, which presents the data on Indian fuel consumption and on energy imports for the period 1980-2002.

Table 10 India's Commercial Energy Consumption – Import Dependence

Year	Coal & Lignite (mtoe)	Oil (mtoe)	Natural Gas (mtoe)	Hydro-electric Generat-ion (mtoe)	Nuclear & Renew-able (mtoe)	Total Commercial		
						Available Total Supply (mtoe)	Import s (mtoe)	Import Dep ende nce (%)
1980 - 1981	58.5	34.0	1.3	10.9	0.8	105.5	23.7	22.5
1989 - 1990	95.0	57.0	10.0	14.4	1.1	177.5	28.4	16.0
1994 - 1995	121.0	71.0	16.0	19.8	1.6	229.4	48.4	21.1
1990 - 2000	145.0	105.0	24.0	19.4	4.5	297.9	84.1	30.0
2001 - 2002	171.0	124.0	44.0	18.0	8.5	365.5	109.0	29.8

The data above shows that import dependence increased during the 1980s and 1990s due to increased imports of oil and oil products. The total fuel import dependence increased from 22.5 per cent in 1980 to 29.8 per cent in 2001-2002. However, during the same period, India's dependence on imported oil increased from 58 per cent to 73 per cent. Also during this period, oil prices have fluctuated violently in the international market and the heavy dependence on oil imports has had a significant impact on India's foreign exchange requirements. The financial effect is given in Table 11 :

Table 11 Costs of Imported Fuels, 1980-2000

Year	Crude Production (mt)	Import (mt)	Total Supply (mt)	Import as % of Total Supply	Cost of Oil Imports and Produced (Rs Crores)	Total Export Earnings (Rs Crores)	Oil import Cost as % of Export Earning
1980 - 1981	10.5	16.2	27.9	58	5,264	6,711	78
1990 - 1991	34.1	22.9	57.0	40	10,806	32,553	33
1995 - 1996	35.2	35.8	71.0	50	25,173	106,353	24
2000 - 2001	32.0	71.0	103.0	69	71,497	203,571	35
2003 - 2004	33.4	90.6	124.0	73	95,520	293,363	32

The data shows that India's exports have increased significantly during the liberalized period starting with 1990-1991. This has helped keep down the oil import costs as a percentage of export earnings from 78 per cent in 1980-1981 to around 30-35 per cent in the period following 1990-1991.

Volatility of oil prices on the international market creates uncertainties and results in sudden jolts to India's foreign exchange balance. Behind the figures on imports are several risk-prone features that need to be carefully addressed in designing energy security plans for India. These include the economic impact of sudden supply interruptions on price increases, on India's economy and on its balance of payments.

CHAPTER V
OUTLOOK FOR ENERGY DEMAND AND SUPPLY

Energy Forecasting

Long-term energy forecasting for India has always been problematic. India's economic growth rate is over 6 per cent per annum as compared to the earlier trend of 2-3 per cent per year. Also, the composition and structure of the industries sector is undergoing a major shift towards information technology and services. The estimates of India's energy demand for 2006-2007 and 2011- 2012 are given in Table 12[16] :

Table 12 Estimated Energy Demand for India (2006-2007 and 2011-2012)

Primary Fuel	Demand (In Original Units)		Demand (mtoe)	
	2006-2007	2011-2012	2006-2007	2011-2012
Coal	460.50mt	620.00mt	190.00	254.93
Lignite	57.79mt	81.84mt	15.51	22.05
Oil	134.50mt	172.47mt	144.58	185.40
Natural gas	47.45bcm	64.00bcm	42.70	57.60
Hydro Power	158.08bkWh	215.66bkWh	12.73	18.5
Nuclear Power	23.15 bkWh	54.74bkWh	6.04	14.16
Wind Power	4.00 bkWh	11.62 bkWh	0.35	1.00
Total commercial energy			408.02	544.23
Non commercial energy			151.30	170.25
Total energy demand			559.32	714.48

The committee on India Vision 2020 report forecasts energy consumption up to 2020. The first level scenario was based on past trends and incorporated some adjustments for recent developments in energy efficiency in end use sectors. This estimate was adjusted further by assuming that rational corrections to energy consumption patterns and improved energy efficiency could be made, and a best case forecast was developed. The results of this analysis are given in Table 13 [17]:

Table 13 Forecast of India's Energy Consumption in 2020

Fuel	Coal (mt)	Oil Products (mt)	Electricity (bkWh)
Business as usual scenario forecast	688	245	1,551
Best case scenario forecast	538	195	1,363

A long-term forecast of energy demand through 2020 was developed based on the observed elasticity of demand for different fuels in relation to GDP and using a GDP growth rate of 8 per cent. The results are given in Table 14 :

Table 14 Demand for Different Fuels

Fuel/Energy	Unit	2009-2010	2019-2020	Average Annual Growth Rate (%)
Electricity	Mu	892,570	1,755,685	9.6
Oil products	Mtoe	150.2	246.9	6.4
Natural gas	Mtoe	47.2	101.9	11.5
Coal	Mtoe	248.7	447.6	7.9

The growth rate increases in energy demand may prove difficult to achieve. The issues in increasing production to meet the fast growth in demand of specific fuels are analysed in succeeding paragraphs.

Coal

Of India's indigenous fuels, coal is the most abundant and least expensive. The Indian coal, however, has high ash content and poses significant environmental hazards. Newer clean coal technologies can increase the fuel efficiency in power plants from the current 22 per cent to as high as 45 per cent. Given its relative price and abundance, coal is expected to remain India's principal energy resource. At present, 70 per cent of the installed capacity of power generation is based on coal.

Recently, a new and clean coal resource has emerged. The availability of an estimated quantity of over 100,000 billion m3 of CBM has been known for quite some time. A demonstration project has been implemented with assistance from the Global Environment Facility and the United Nations Development Project. In April 2001, the government solicited bids for CBM blocks from private companies; there are two public sector undertakings as well. Commercial production of CBM has been established in at least one of the private blocks. If proven to be commercially viable, a large number of CBM based power plants could be built.[18]

Oil and Gas

The demand for crude oil in the year 2006-2007 is estimated at 134.5 million tonnes and that of natural gas at 130 million standard cubic meters per day (MMscmd). In comparison, the domestic production of crude oil is likely to stagnate at around 34 million tonnes. The remaining 100 million tonnes of oil will have to be imported, mostly as crude to be refined in Indian refineries or as oil products. Natural gas production is expected to remain stable at about 103 MMscmd. The projected annual anticipated domestic production of oil and gas from 2002-03 to 2006-07 for India is given in Table 15:[19]

Table 15 Crude Oil/Natural Gas Productions for India in the Tenth Plan

Fuel	Unit	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007
Crude oil	Mt	33.08	33.22	34.63	34.48	33.97
Natural gas	MMscmd	86.56	90.54	103.84	101.99	103.08

Only about one-third of India's hydrocarbon needs are met by indigenous production, with the remaining supplied by imports. Volatility and high prices in international markets, coupled with the possibility of supply disruptions due to unrest in the Middle East, raise the question of oil supply security.

Renewable Energy Resources Development

India has made great progress in developing renewable energy resources, both by finding new applications for known resources and by developing systems and procedures for making renewable energy resources utilization cost effective. Much of the success can be attributed to the fact that India is the first country in the world to set up a separate Ministry for Non Conventional Energy Resources. This ministry has a number of divisions dealing with wind, solar, biomass, bio fuels, etc. India has also established a development and financing agency exclusively devoted to the renewable energy sector – the Indian Renewable Energy Development Agency. As a result, India has over 1,870 MW of wind energy systems. Biomass utilization for power generation and bio fuel development also is receiving priority attention.[20]

CHAPTER VI

ENERGY RISKS AND ENERGY SECURITY

"On no one quality, on no one process, on no one country, on no one route and on no one field must we be dependent. Safety and certainty in Oil lie in variety and variety alone".

Winston Churchill

India is highly dependent on imported fuels, and this dependence will increase over time. Short and long-term prospects for India to achieve affordable and adequate supplies of energy, specially of hydrocarbons, have several risks that need to be addressed.

Types of Risk

The risks of maintaining supply/demand balance can be classified into two categories:

(a) **Contingency risk** (**short-term**). This risk is caused by steep price increases over a short period of time, disruptions in transportation, or disruptions in supply due to war or other major disturbances in the exporting or importing zones.

(b) **Structural risk** (**long-term**). This risk results from the mismatch between energy demand and indigenous energy resources, or from sourcing supply coming mainly from one fuel or from one exporting region.

Contingency Risk

Contingency energy risk for India arises from the fact that the bulk of crude oil and oil products are imported from the Middle East. The political problems in the countries of this region could disrupt or threaten to disrupt supplies.

Price volatility poses the most likely risk to India and other South Asian countries. Even though oil may be available in the market, a sudden spike in the international market prices for crude oil and oil products may make it impossible for several countries, including India, to pay import prices. India's consumption of oil is only 3.1per cent of world consumption and India's oil import accounts for only 3.5 per cent of world trade. Therefore, India's potential impact on world energy trade or price is negligible. In recent times, crude oil and oil product prices have experienced sudden jumps of 25-50 percent within a period of a few weeks, and such spikes are becoming more frequent. On such occasions, India has had difficulty meeting the immediate fund requirements for importing petroleum at the higher prices.

The security arrangements to manage contingency risks are :

(a) Seeking supply from other regions and from multiple suppliers

(b) Sharing the risk with other countries through bilateral or regional purchase and transportation arrangements.

(c) Creating a strategic petroleum reserve at the national level

(d) Striving for a regional strategic petroleum reserve

Structural Risk

The more difficult task of addressing structural risk (the increasing gap between the energy needs and domestic production) must also be undertaken. The options to meet this challenge include the following measures :

(a) Diversify long-term fuel supply arrangements

 (i) Diversify sources of supply.

 (ii) In the hydrocarbon sector, make use of beneficial forward contracts and swap arrangements to reduce overall cost of oil imports.

 (iii) Increase the capability of Indian refineries to use different varieties of crude.

(b) Diversify the fuel mix of energy consumption.

 (i) Increase the use of coal and clean coal technologies.

 (ii) Increase the use of natural gas in preference to oil products.

 (iii) Improve the efficiency of end-use equipment and appliances.

(c) Increase the use of renewable energy technologies.

(d) Introduce substitutes for imported gas, such as CBM and gas hydrates.

(e) Improve regional energy security by increasing cooperation and coordination with neighbouring countries to :

 (i) Develop and fund a regional petroleum reserve.

(ii) Combine purchases and transportation of petroleum and natural gas.

(iii) Establish a regional energy resource foundation to analyse and address regional energy issues cooperatively.

(iv) Develop a regional energy fund to support the development and use of regional energy resources.

(v) Develop a regional electricity grid and natural gas pipeline network.

(vi) Harmonize energy sector rules and regulations, including energy efficiency and renewable energy standards.

A large number of initiatives have been undertaken to mitigate the energy supply shortage that India faces. However, it is not possible for one country to effectively undertake all these efforts alone. India needs to coordinate and formalize its energy policies, plans, and programmes with those of neighbouring countries in order to effectively reduce cost and minimize risks. There is a need to develop mechanisms for energy security on a regional basis.

CHAPTER VII
SECTOR WISE ENERGY POLICY PRESCRIPTIONS

"Just as we can increase our energy security in diversifying our sources of energy supply, we can also increase our security by diversifying our choices of energy resources".

Bill Richardson
Former US Secretary of Energy

The major objective of the Integrated Sustainable Energy Policy would be to meet the increasing demand of energy, consistent with the desired rate of economic growth and achieving the goals of energy security for India. The long-term perspective of this policy must take into account the availability of existing as well as new energy resources in the country; technological possibility through existing and new technologies for the optimum utilization of these resources; the extent to which the country can depend on external sources for the supply of energy; and finally ensuring sustainable energy security for all sections of the population.

POWER SECTOR

The power demand supply gap has been increasing because of the growth in population and improving standards of living. Also, electricity is unavailable at the grassroots level and in the rural areas. Therefore, the score for the criteria of availability is low at present but has the potential of being increased through a policy framework that would bring about the integrated development of the power sector.

Thermal Power Development

India will continue to depend on thermal power based on coal to meet a portion of the demand for power up to 2020. The necessary policy measures are to be taken in regard to thermal power development in the country.

The techno-economic feasibility of different coal transportation options such as slurry pipelines, coastal shipping, rail-cum-sea route, and inland waterways need to be examined.

Washeries should be set up near pitheads for coal beneficiation to save on transportation capacity required for local center stations and to improve utilization of old thermal power stations requiring higher grade coal.

Accelerated Hydro-Power Development

The share of hydel generation in total power generation in India has come down from 34 per cent at the end of the Sixth Plan to about 20 per cent at present. From the long-term point of view, it is desirable that the share of hydro electricity, which is a clean and cheap source of energy, is progressively increased.

The large hydro potential in the country, specially in northern and northeastern regions, need to be developed, as part of time bound programme in the next twenty years.

Some of the hydel projects that have been languishing for want of funds or constrained by inter-state issues should be taken up for implementation under the central sector, after obtaining the consent of the States, involved in the short- term itself.

Nuclear Power Development

Nuclear power is an attractive proposition for India on account of being an environmentally benign source of energy as also from the point of view of energy security. The rate of growth of nuclear power is currently limited by financial constraints. The nuclear power programme is being targeted at 20,000 MW in the next 20 years.

Optimum Generation Mix

The fuel policy for power generation, in general, will be that base load requirements are met from coal-based thermal generation, supplemented by gas-based thermal and nuclear power generation, while the peak load required is met by hydel generation.

Coal will continue to be the main source of power generation. For this purpose, the production of coal in the country should be maximized by active participation of both public and private sectors. Necessary measures should be taken to improve the technology of coal production, quality of coal and transportation arrangements to carry coal to the power plants.

Further additions to liquid petroleum fuel capacity should not normally be allowed, taking into account the need to import LNG and its linkages with the price of the imported oil. Efforts should be made to add thermal generation capacity using gas/LNG to the extent of domestic availability. Hydel generation capacity needs to be increased on a priority basis.

Renovation/Modernization and Technology Upgradation

Renovation and modernization programmes of thermal and hydro plants must be accelerated to improve the performance of existing plants as well as reduce the need for additional capacity.

Transmission and Distribution Facilities

Adequate investments need to be ensured by State and Central Governments in transmission and distribution systems in the context of the massive growth in generating capacity that would take place in the next 20 years. Private sector investments should be encouraged in Transmission and Distribution. Privatisation of distribution in urban areas with population of one million and above should be made mandatory. The groundwork for a national grid to be functional in a time bound manner at the earliest must be laid.

Demand Side Management

Demand side management provides a new approach for mitigating power shortages and reducing the problem of peak power shortages in particular. Demand side management techniques flatten the load curve that is to reduce the peak load and the demand of peak hours by the following measures :

(a) Differential pricing according to time and date.

(b) Instituting a two-part tariff, which includes charges for maximum demand of power and charge for each unit of energy consumed.

(c) Providing agricultural load in off peak hours.

(d) Creating incentives and commercial arrangements for transfer of power between regions to take advantage of different peak times.

(e) Energy pricing is the key issue for promoting energy efficiency and innovative pricing options proved successful in other countries need to be taken up.

Non-conventional Energy Resources

Non-conventional and renewable energy sources hold the key to sustainable energy development in the long run. Besides being environmentally clean, renewable energy sources are abundantly available. However, in the next 10 to 20 years, the role of renewable energy would only progressively increase.

In the long run, subsidies should be phased out and replaced by fiscal incentives. Sustainable legislative measures to promote non-conventional energy use may also be taken up. In the long-term, policy measures to promote renewable energy both in rural and urban areas should be taken up along with providing suitable support for the setting up and functioning of infrastructure for the installation, operation and maintenance of renewable energy devices.

COAL SECTOR

Coal an indigenous resource available in abundance in India would add to energy security. The efficiency of burning coal to produce electricity as well as direct heat is low as compared to other energy options. However, taking into account its positive features, coal will continue to occupy a central place in the energy policy of India.

Due to shortages of coal, imports had to be resorted to in the past, particularly for coking coal of the required quality and quantity by the steel sector. In the next 15 years, large-scale imports of coal may be necessary to meet the projected demand for power, even if domestic production of coal increases at the same rate as in the past 15 years. At present, coal production is mostly in the public sector. If the projected demand for coal in the coming years is to be met, it is necessary that the private sector should be allowed to invest in coal mining.

Efforts need to be intensified for regional/promotional/detailed exploration of coal and lignite reserves to upgrade reserves to proved and recoverable categories, for projectization to match rapidly increasing demand for coal in the country.

The projected large-scale imports of coal would require a major expansion of facilities at major ports. Action in this respect has to be initiated at the earliest. Development of minor ports also assumes importance in order to develop coastal shipping.

In the long-term perspective, the use of appropriate technologies for coal exploitation is important. In the case of open cast mining, use of higher capacity equipment need to be considered to improve both production and productivity. Scope for deploying continuous miners in open cast trenches needs to be explored. In the case of underground mining, all the activities need to be mechanized to reduce the gestation periods of the projects.

PETROLEUM SECTOR

The petroleum sector scores low in terms of energy availability and also energy security. Environmental acceptability is likely to be higher for petroleum as compared to coal, but lower than renewable energy. The Indian petroleum sector is characterized by stagnant domestic production of crude oil in addition to a continuous increase in the demand for petroleum products at the rate of 6 to 7 per cent per year. The demand supply scenario for the next 15-20 years would, therefore, present an increasing gap in supply, which would have to be bridged through imports. It is necessary that exploration and development activities should be accelerated to achieve a significant increase in domestic production on a sustainable basis.

Exploration Strategy

The strategy should involve continued exploration in producing basins to locate low risk oil and basin-specific intensive/extensive exploration. Also, knowledge building in frontier basins, where initial exploration efforts have shown some positive response needs to be continued, for long-term benefits. Exploration efforts should be stepped up, specially in deep offshore areas and also frontier areas.

Refining Capacity and Distribution

Adequate refining capacity needs to be urgently created to meet 80 to 90 per cent of the demand for petroleum products by 2011-12. For this purpose, grassroots refineries should be set up in partnership with international oil companies having financial and technical strength.

Imports and Oil Security

The present scenario indicates that increasing demand for petroleum products could be met only through imports, as the indigenous production is not likely to be stepped up substantially over the next decade. Dependence on imports raises the question of oil security, including availability of oil on a sustainable basis. For this purpose, the import of oil needs to be tied up from diversified sources. At the same time, increased efforts should be made to have joint ventures abroad in exploration and development activities so that 'equity oil' is available on a long-term basis.

Substitution of Oil

At present, liquid petroleum fuels are also used to generate power and in principle, approval has been given for a capacity of about 12000MW using petroleum fuels. In view of the shortage of petroleum products in the country, power production should not be under pressure, and no further approval may be given for power generation capacity using these fuels. Besides, efforts should be made to use alternate fuels such as natural gas and LNG in the already approved units.

The broad policy guidelines for the four energy sub-sectors, namely electricity, coal, petroleum, natural gas and renewable energy have been given above. These, in turn, have to be integrated with the requirements of sustainability criteria, which includes energy availability, specially at the grassroots level and the rural sector; factoring of environmental impact at all stages of the energy chain; incorporating aspects related to achieving the goal of increased efficiency; and including factors contributing to energy security.

CHAPTER VIII
ENERGY SECURITY- A ROAD MAP FOR INDIA

"Africa, the third principal petroleum source, provides a special opportunity to us" K Natwar Singh, Former External Affairs Minister of India *"African oil is of strategic national interest to us"* Walter Kansteiner, Former US Assistant Secretary of State

Energy needs of the country are expected to increase at a rapid rate in the coming decades. Therefore, it is imperative to take steps to increase the indigenously available energy resources so as to avoid excessive reliance on external resources. The availability of capital and environmental considerations are appearing as serious constraints to the efforts of generating more capacity to meet the growing demand. The country will have to initiate suitable measures to tackle the internal as well as the external issues related to India's energy security.

INTERNAL ISSUES RELATED TO INDIA'S ENERGY SECURITY

Reform and Restructuring the Energy Sector

In the pre-reform period, the commercial energy sector was totally regulated by the government. The economic reform and liberalization, in the post-90s, has gradually welcomed private sector participation in coal, oil and electricity sectors in India. The energy prices in India have been under the administered regime and subsidies are being provided to meet certain socio economic needs of the public, which has led to distortion and inefficiency in the use of different sources of energy.

Establishment of market determined prices for energy is critical if financing is to be made available to maintain facilities, establish new capacity in the energy sector and to support effective transport mechanisms to move energy to users in a sustainable manner. Energy subsidies in India, which is approximately 1per cent of national income, lead to energy intensive economic structures and technologies, and wasteful management practices. A study by IEA has revealed that reducing price subsidies in India would reduce primary energy consumption by 13 per cent, increase GDP through higher economic efficiency by 1 per cent, lower CO2 emissions by 16 per cent and produce domestic environmental benefits including lower local air pollution.

New Institutional Set-up of the Indian Energy Sector

Since energy sector in India deals with several ministries, there is a need for coordination and integration among these ministries. Reform in power sector is suffering from the lack of progress in coal reforms while coal movement suffers from the lack of tariff rationalization in the railways.

For smooth operation of the energy sector, there should be a well-established institutional framework consisting of regulatory agencies, the rules and regulations of the sector and policy guidelines. The regulatory agency should have international experience, political independence, accountability, autonomy; and expertise on technology, economics, law and accounting.

In future electricity generation will be increasingly from gas and liquid fuels, therefore, a single regulatory authority for electricity, oil, gas and coal sectors has to be considered.

Adoption of Clean Coal Technologies and Utilization of Cheap Imported Coal

Since India has a vast coal reserve, it is expected that power generation from coal will continue to maintain its share in future. But in order to achieve higher thermodynamic efficiency, minimizing environmental impact and cost effective utilization of high ash Indian coal; emphasis should be given on coal beneficiation, pit head power generation, heat rate improvement programme in the power plants, fly ash management, carbon sequestration through forestation programme and scaling up of the power plants. In the long run, the technological options would be super and ultra-super critical combustion technologies, integrated gasification combined cycles, fluidized bed combustion and underground coal gasification. There should be sufficient research and development efforts for the development of new technologies.

Since coal prices in the international market are relatively stable and coal is well dispersed around the world, it would make sense for India to import coal with well drawn out long-term contracts for power plants located in the coastal regions.

Enhancement of Strategic Oil Reserve

Keeping in view India's energy security, the long-term exploration and production policies to enhance hydrocarbon reserves and increase domestic production will have to be as follows :

(a) Exploration in new frontier areas like deep water and other geologically and logistically difficult areas.

(b) Development of new oil fields and additional development of existing oil fields.

(c) Implementation of Improved Oil Recovery (IOR) or Enhanced Oil Recovery (EOR) Schemes.

(d) Implementation of specialized technologies, continued technology acquisition and absorption along with development of indigenous R&D.

(e) Increased private participation through operationalizing New Exploration Licensing Policy (NELP).

(f) 100 percent exploration coverage of the Indian Sedimentary Basins by 2025.

(g) Continue the supportive role of the government in exploration, particularly for high-risk ventures.

Achieving Self-Sufficiency of Middle Distillates

In line with international trends, it is estimated that the share of middle distillates, which constitutes a large part of the total demand, would further increase from 59 per cent to 64.6 per cent by 2025. Based on considerations of national oil security, stability of supply and development of the economy, it is felt that India should set up refining capacity to meet a substantial part of its domestic demand. It is desirable that the quantum of refining capacity set up should be sufficient to meet at least 90 per cent of the country's demand for middle distillates, which are the main product group. It is expected that due to technological progress, the yield of middle distillates will be substantially more than the current yield.

Conditional Marketing Rights for Transportation Fuels

As the objective of dismantling of Administered Price Mechanism (APM) is to remove the existing controls and usher in a free market, this should be done at the earliest to encourage internal competition.

Entry of new players in the marketing sector may be required to ensure a truly competitive scenario. While foreign participation in the marketing sector is felt necessary for fostering greater competition, the access to the marketing sector, which is a more profitable retail oriented business, should be given to only those players who have a commitment to the overall development of the country's hydrocarbon sector.

In addition, in order to ensure incremental investment in building the much-needed marketing infrastructure, all new entrants should set up their own distribution network for marketing and not encroach on the infrastructure of the existing marketing companies.

Operational Flexibility to Refineries in Crude Sourcing and Risk Management through Hedging

The Government would need to allow every refinery the flexibility to source its own crude, as also the ability to manage the business risk by using commodity hedges and other risk management techniques. Indian refinery companies should explore the possibility of investing in crude production assets overseas. This would help Indian companies tie up secured crude supplies as also enable them to become strong, integrated, globally competitive entities.

Development of Regulatory and Legislative Framework

The regulatory body has to be sensitive to the needs of the downstream players and also encourage exploration and production in the country. There will be conflicts in the interests of producers and transporters and these have to be resolved. There is also a need for the regulator to facilitate an environment that stimulates investment.

Adequate Port and Domestic Shipping Facilities

Even if pipelines will be used in future to import oil and gas, a substantial portion of these imports will still be dependent on tankers. Unfortunately India's port facilities are inadequate to handle the future hydrocarbon imports. At present, India has 11 ports and most of them are in dire need of expansion and modernization. At the same time, the Indian shipping industry is also undersized with only 476 ships for coastal and overseas trade, with a total of 6.88 million Gross Registered Tonnes – less than 1.5 per cent of total world tonnage. Therefore, proper planning and investment is required on a priority basis.

Substitution from Oil to Gas

In recent years, natural gas (NG) has emerged as an alternative for oil. With the discoveries of new gas fields, most Asian countries, which are heavily dependent on oil, realize that NG not only diversifies the energy sources but also secures supply. Besides that, gas is a cheap, efficient and environmentally clean source of energy.

The gas industry seeks to play an important role in the growth of the energy sector in India. It is primarily used in gas-based power projects and also by the fertilizer sector. Natural gas is being increasingly used as fuel by the transport sector and has major usage in the industrial sector as eco-friendly fuel. At present, gas based power projects account for 11 per cent of power generation and are expected to double their share in energy supply by the year 2011-12.

However, the new domestic gas finds or more such discoveries in the future would not in any significant way diminish the prospect of import of piped gas or

LNG. Due to limited domestic reserves the country would have to be dependent on gas imports.

Energy Mix

For an energy mix in which oil and gas constitute half our commercial energy consumption it is imperative that other sectors of the energy spectrum such as coal, hydropower, nuclear and other non-conventional sources of energy should be encouraged so as to leave the use of petroleum products to specific sectors like transport, fertilizer and petrochemicals. Also, energy efficiency levels should be increased and other sectors of the infrastructure too should be made more efficient.

Strategic Petroleum Reserve

Strategic stock draw is regarded as a vital element in the emergency preparedness of the crisis. India needs roughly 105 million tonnes of oil a year, with only 30 per cent coming from domestic production. At present companies stock crude oil for 23 days (including 11 days of stocks in transit), petrol for 53 days, diesel 43 days, kerosene 51 days, cooking gas 19 days and jet fuel for 88 days.

In line with the emergency preparedness for the country, building strategic crude oil reserves is a necessity from security and strategic point of view. In the event of a disruption in supplies, the effect is likely to be minimal when crude import sources have been diversified and an effort has been made to ensure that shipping routes do not pass through the conflict zones. The Indian government is planning to build and maintain strategic oil reserve for 45 days, equivalent to 15 million tonnes of crude oil, at an estimated capital cost of Rs. 4350 crore.

Need to Develop Future Indigenous Energy Sources

Coal Bed Methane (CBM). India has 400 billion Cu. M. of CBM with heat value 8500-9000 K Cal/ Sq. Cu. M. CBM, a clean fuel for power generation, is currently being wasted during coal mining. This release not only creates safety hazards in coal mines but also causes global warming when released in the atmosphere. There is a need to explore this wasted potential. Different strategies should be worked out for unexplored and explored coalmines depending on the quality and quantity of CBM available.

Gas Hydrate. Gas Hydrates containing mostly methane is considered a clean source of energy for the future. As per present estimate, the potential is 6156 trillion cubic meters. India has been focusing to identify the quality, quantity and the nature of the hydrate; and finally technology development for safe extraction of these hydrates from depths either in the form of gas or slurry and store/transport them for various uses. While the studies continue, a pilot scale project could be planned for technology demonstration relating to exploration and exploitation.

Ocean Energy. Ocean is a potential source for non-conventional energy. At present, India is developing a pilot scale technology demonstration OTEC (Ocean Thermal Energy Conversion) plant with power rating (Gross) 1 MW using Rankin cycle with ammonia as working fluid. It is estimated that OTEC plant in higher capacity ratings of the order of 100 MW could provide energy at a cost comparable to other conventional energy sources.

Fuel cell. The fuel cell, which converts chemical energy of hydrogen or hydrogen-rich gas directly into electricity in an environmental-friendly manner, is on the verge of commercial breakthrough. In India, fuel cells have been successfully developed and demonstrated in power plants and fuel cell vehicles.

Hydrogen energy. It is another promising fuel for the future. Solar hydrogen projects have been set up in Europe, Japan, and USA. In India, hydrogen energy has been successfully demonstrated in power generating units, motorcycles and air conditioning.

Bio-fuel. This is another suitable source of energy. Government has already launched 5 per cent ethanol-blended petrol in certain regions of nine states, the proportion of which would be increased to 10 per cent in the later stage. India will save nearly Rs. 5,000 crore annually on oil imports by blending five per cent ethanol with petrol.

Improving energy efficiency

Energy efficiency involves efficient utilization of scarce resources, which is essential from energy security perspective. Improving energy efficiency increases productivity, significantly reduces the Green House Gas (GHG) emissions and reduces solid waste production.

In India, energy intensive industries namely fertilizers, aluminum, textiles, cement, iron and steel, pulp and paper, and chlor- alkalis consume around 65 per cent of total industrial energy. A recent World Bank report shows that Indian Industry has the potential to save 20 to 30 per cent of total energy consumption.

Building a National Energy Map

This necessitates the development of a comprehensive database on production, consumption, transportation/transmission, utilization of primary and secondary energy sources; and other techno-socio-economic parameters, which are available in scattered form with various organizations. Once the data set is prepared, one can proceed for the computer modeling for generating National Energy Map.

EXTERNAL ISSUES RELATED TO INDIA'S ENERGY SECURITY

Diversification of Sources of Oil Imports

The proven oil and gas reserves in Caspian region are estimated at about 29 billion barrels and 9.3 TCM respectively, which would certainly affect the energy policies of the countries in the Asian region in the years to come. The main hurdle in utilizing Caspian oil and gas resources is the lack of export facilities. Pipelines, which are the only viable mode of transport, are still far from adequate. Although a number of pipelines have been proposed, but progress on these projects has been lagging due to various technical, financial and political reasons.

Investment in Oil Equity Abroad

In order to minimize risks by diversifying the oil import portfolio, Government of India has decided to acquire acreage in other countries. ONGC Videsh Limited has entered into a production-sharing contract with British Petroleum in Vietnam. Other ongoing negotiations for oil exploration with ONGC, which are under various stages of development, include countries like Iraq, Russia, Kazakhstan, Azerbaijan, and Sudan. However, the efforts are inadequate compared to the countries like China and Malaysia, whose National Oil Companies have got more than 30 joint ventures and 22 of them are in upstream sector. In the Middle East, because of the presence of international oil majors, it would be difficult for Indian Companies to get any contracts. Under such circumstances, India should aggressively explore avenues in more difficult areas, specially Africa and South America, which are less attractive to the oil majors.

However, most of the Indian oil companies do not have a comprehensive set-up or database , with the result that India ends up acquiring blocks that are in the " very high risk" category. Neither are the exploration blocks acquired in the bidding round examined in depth due to shortage of time available, thanks to lack of adequate research of the area[21].

Regional Energy Co-operation

South Asian countries need capital and energy to propel economic growth and improve the quality of life in an environmentally responsible manner. The region is endowed with untapped energy resources but their development, efficient distribution and utilization will require cooperation and trade among the countries in this region.

Although limited exchange of electricity already occurs between Nepal, Bhutan and India, multilateral cooperation to develop and exchange energy resources will have far-reaching economic and security benefits. India can be benefited from electricity and gas import from neighbouring countries to foster its development aspirations; Bangladesh, Nepal, Bhutan and Myanmar could realize significant economic benefits from the development and export of hydroelectric power and natural gas.

Trans-country Power Transmission

Preliminary feasibility study on the interconnection of the transmission systems of four countries including Nepal, Bhutan, Bangladesh and India in the "chicken neck" region of North-Eastern India has been completed. This interconnection will be able to match the projected hydroelectric power surpluses in Bhutan and Nepal with projected deficits in India and Bangladesh. In terms of trans-national electricity exchanges in Asia, an integrated policy planning approach has been developed for the Greater Mekong Sub-Region, including Laos, Myanmar, Thailand, and Vietnam. This approach would be expanded to cover the whole ASEAN region.

South Asia Regional Energy Coalition (SAREC)

SAREC, which is a non-governmental effort and is established under the aegis of US Chamber of Commerce, focus on and promote the concept of an integrated South Asia energy market by establishing a networking mechanism through which public and private sector stakeholders can influence regional energy policy, consumption pattern and sectoral reforms throughout South Asia. In this context, it is required to build a model to facilitate viable energy projects.

Import Dependence on West Asia and energy diplomacy

India's efforts to diversify and reduce import dependence on West Asia peaked in 1999, when it accounted for little less than 50 per cent. Without giving up diversification and self-reliance, we need to accept the fact that West Asia would remain the source of an overwhelming proportion of India's oil and gas imports. Enhancement of domestic production and diversification of supply sources, in the ultimate analysis, will not make a radical difference in

India's energy dependence on West Asia. An energy policy, in the circumstances, will have to proceed from this basic factor. Also, India's energy diplomacy needs to be formulated and conducted within the overall context of its relations with West Asia.

Security of the sea-lanes

Since most of India's oil and LNG imports are shipped across the Indian Ocean, the issues of safety and security of the sea-lanes are causing concern. It also becomes imperative for India to ensure the security of the maritime routes between the Straits of Malacca and the Strait of Hormuz. China has been busy establishing a " string of pearls" which includes forward deployment of surveillance, naval facilities and air strips to safeguard its sea-lanes.[22] Similarly, proper security arrangement should be undertaken for offshore and deep-sea oil production and exploration in Indian territory since one cannot rule out the possibility of a war or terrorist activities.

Gas import through pipelines

Inter-country gas pipeline is the most cost-effective way of transporting gas from the source to the demand centers. Being environmentally clean and less volatile than oil price, share of gas in India's future energy mix would be substantial and much of this future gas demand would be met by import through pipelines. Inter-country pipeline requires good political relationship with not only source countries but also with transit countries. Though pipeline could be a future source of risks, it could also be seen as an incentive to build good political relations with transit countries because of win-win situations.

In order to achieve the objective of sustainable energy security, India must evolve own sustainable energy security pathway, which would enable the country to meet the goal of energy security. The sustainable energy pathway would include augmentation of indigenous sustainable energy resources, hydro, nuclear and renewable. Sustainable energy pathway would further include technology missions, which have to be mounted for the production of clean energy technologies, particularly for coal, which is country's main energy source. It would further include improving energy efficiency, reducing transmission and distribution losses, and development of new energy technologies including fuel cells, hydrogen energy, electric vehicles, bio-fuels as well as coal bed methane and hydrates, among others. The sustainable energy pathway for India would have to be determined by an integrated sustainable energy policy.

CHAPTER IX

DESIGN OF THE NATIONAL SUSTAINABLE ENERGY SECURITY SYSTEM

"The new *challenges demand a new paradigm for the international oil economy. Th*e time to act is now".

Mani Shankar Aiyar

Energy security is not merely a question of getting leasing rights over substantial hydrocarbon resources in other parts of the world—which, of course, is important. If the goal is sustainable energy security, basic questions of development need to be answered and the vision of a totally different structure of Indian society and economic growth would need to guide energy policy decisions today as a part of comprehensive and integrated framework. All this brings out the need to set up a National Sustainable Energy Security System, beginning at the local level at the village, block and district levels and reaches up to the state and national levels.

Local Level

At the grassroots level, activities in this regard would be based on panchayats and nagarpalikas. At the village/town level, energy security committees are proposed to be set up typically consisting of an equal number of men, women and panchayats/nagarpalikas represented by one independent expert as its chairperson.

The local level energy security committee should be charged with the responsibility of drawing up the energy security system at the village/town level, which is economically viable and environmentally sustainable, socially equitable and ensures gender equity.

Besides renewable energy, the committee would be equally concerned about promoting efficient energy use, conservation as well as management systems, which would efficiently utilize energy in all its forms, to meet the need of farm, factory, domestic, commercial and industrial sectors. The committee would also promote large-scale awareness about energy efficiency so as to reduce wastage.

State Level Sustainable Energy Security Board

The state level Board would essentially be a coordinating body providing support and inputs to the local level committees which mainly represent the users and are in regular touch with the grassroots problems, as well as with all the energy and environment related departments, NGOs.

The duties of the State Board would include harnessing of energy sources in an equitable and sustainable manner, and promoting large-scale programmes for conservation and efficiency in energy use. The Board would have the authority to develop pricing policies to ensure an environmentally sound and sustainable use of energy.

The State Board would develop packages of incentives and disincentives with the help of local experts and other inputs from the concerned departments and agencies as well as NGOs to promote efficient use of scarce commercial energy sources. The State Board would prepare, based on inputs available from the local committees, comprehensive programmes to promote use of all energy forms including waste in the urban areas.

National Sustainable Energy Security Board

The National Sustainable Energy Security Board would consist of representatives from all energy supply departments, including coal, petroleum, atomic energy, non-conventional energy and electricity along with the key departments of environment, agriculture, industry, science and technology among others. This Board will ensure coordination of all energy users, the major sectors of industry, agriculture, transport and household in order to become committed in progress of energy use, promotion of efficiency and prevention of environmental pollution.

The National Sustainable Energy Security System outlined above would not involve creating a new Department or expensive new structures, but integrate the existing departments and agencies, including all stake-holders in public and private sectors at different levels, so that an integrated approach is evolved and adopted, starting right from the grassroots level, and going up the State and National levels to achieve the goal of sustainable energy security for the country in next two decades.

CHAPTER X
CONCLUSION

"While the efforts of ONGC-Videsh and Indian Oil Corporation are laudable, there is still some distance our firms have to travel to catch up with global competition, I urge our oil and gas PSUs to think big, think creatively and think

boldly in this context… They have to be more firm-footed in making use of global opportunities, both on the supply and demand side. I find China ahead of us in planning for the future in the field of energy security. We can no longer be complacent and must think strategically, to think ahead and to act swiftly and decisively".

Prime Minister Manmohan Singh's speech at Petrotech India 2005

In order to achieve the objective of sustainable energy security India must evolve own sustainable energy security pathway, which would enable the country to meet the combined goals of energy security, food security and ecological security. A pro-active approach must be adopted for this purpose, instead of merely reacting to ongoing international negotiations on environment and climate change. At present, India is importing more than 26 per cent of its total commercial energy, a figure that is going to increase in the coming years, with growing demands of commercial energy in all sectors of the economy, along with oil intensification of the economy, due to growing demand for petroleum in the transport, household and agriculture sectors. Augmentation of energy resources, specially environment-friendly sustainable energy resources, would thus have to be complemented with programmes of demand side management and energy conservation, increasing energy efficiency, and reducing environment pollution as components of a new integrated energy policy for India. The sustainable energy pathway would include augmentation of indigenous sustainable energy resources, hydro, nuclear and renewables. Sustainable energy pathway would further specifically include technology missions, which have to be mounted for the production of clean energy technologies, particularly for coal, which is the country's main energy source. It would further include improving energy efficiency, reducing transmission and distribution losses and development of new energy technologies including fuel cells, hydrogen energy, electric vehicles, bio fuels as well as coal bed methane and hydrates, among others.

For achieving the goal of sustainable energy security for all by 2020, it is necessary to adopt a comprehensive approach. In this comprehensive approach, the first priority must be meeting the energy needs of the people below the poverty line and at the grassroots level and thereafter, going up to meet the energy needs at the district, state and national levels. Sustainable energy security aims at providing energy to meet the needs of the economy while reducing dependence on imports and relying on indigenous sources of energy.

India has taken a large number of initiatives to mitigate the shortage in energy supply. Though several of the initiatives could be taken by India independently, but for several others India would need the help of neighbouring countries to act as energy suppliers. India would also require the neighbours for transit facilities for gas pipelines. India would need the support and participation in these projects by Pakistan and Bangladesh. The globalisation of economy requires us to be more pragmatic and open to new emerging situations and adapt ourselves to the new dynamics, burying the past inhibitions. If India is to be where it wants to be in the comity of nations it shall have to carry the neighbours along on the trajectory of growth.

References

1. Reddy, B. Sudhakara and P. Balachandra, "A Sustainable Energy Strategy for India Revisited". *Economic and Political Weekly*. 28 December 2002, pp 5264-5273.
2. Report of the Energy Policy Committee, Planning Commission, Govt of India, 2000.
3. Sudha Mahalingam, " Energy and Security in a Changing World," *Strategic Analysis*, vol. 28, no. 2, p.252.
4. International Energy Outlook 2004, US Energy Information Administration.
5. Sheobanti Ray Dadhwal, *Rethinking Energy Security*, New Delhi : n.d., p2.
6. Ibid. p14.
7. Ibid. p 20.
8. Ibid. p 20.
9. Coal India Ltd, Expert Committee on Coal Reforms, May 2005.
10. Ibid.
11. Ministry of Coal, 2005, Annual Report 2004-05, New Delhi: MoC, Government of India.
12. Annual Report 2003-04, New Delhi: Economics and Statistics Division, Ministry of Petroleum and Natural Gas, Government of India.
13. SK Chopra, *Energy Policy for India*, New Delhi : 2004, p. 58.
14. Ibid. p. 58.
15. Annual Report 2004-05, New Delhi: Ministry of Non-Conventional Energy Sources, Government of India.
16. Planning Commission 2002, Tenth Five Year Plan(2002-07), New Delhi: Planning Commission, Government of India.
17. DN Raina, "India: Energy Scenario", *South Asian Journal*, July-September 2005, p.45.
18. Ibid. p.47.

19. Ibid. p. 47.
20. Ibid. p. 47.
21. *Financial Express*, 30 August 2005.
22. Stephen Gain, “Yet Another Game”, *Newsweek*, 20 December 2004,p.22.

BIBLIOGRAPHY

Books

1. Audint, Pierre, et al, ed, *India's Energy –Essays on sustainable development.* New Delhi: Manohar Publishers, 2000.

2. Chaturvedi, Pradeep. *Energy Management – Policy, Planning and Utilisation.* New Delhi: Concept Publishing Company, 1977.

3. Chopra, SK. *Energy Policy for India.* New Delhi: Oxford & IBH Publishing Co. Pvt. Ltd., 2004.

4. Dadwal, Sheobanti Ray. *Rethinking Energy Security in India*, New Delhi: Knowledge World, 2002.

5. Gupta, KC. *Energy and Environment in India.* New Delhi: Gyan Publishing House, 2002.

6. Khosla, IP. *Energy and Diplomacy.* New Delhi: Konark Publishers Pvt Ltd, 2005.

7. Paramar, Ashwin. *Energy Future – Coping with critical conditions.* New Delhi: Dominant Publishers and Distributors, 2001.

8. Singh, Jasjit. *Oil and Gas in India's Security*. New Delhi: Institute of Defence Studies and Analysis, 2001.

9. Singh, Narinibal. *Energy Crisis.* Delhi: Authoropress, 2001.

10. Subudhi, RN. *Energy Options for 21st Century.* New Delhi: Ashish Publishing House, 1993.

Reports

11. India. Ministry of Petroleum and Natural Gas. Indian Petroleum and Natural Gas Statistics 2003-04.

12. India. Ministry of Petroleum and Natural Gas. Annual Report 2003-04.

13. India. Planning Commission. Hydrocarbon Vision 2025.

14. India. Planning Commission. Tenth Five-Year Plan 2002-07.

15. India. Planning Commission. Mid term Appraisal of the Tenth Five Year Plan 2002-07.

16. USA. US Department of Energy. International Energy Outlook 2005.

17. India. Ministry of Non-conventional Energy Sources. Annual Report 2004-05.

18. India. Ministry of Coal. Coal Directory of India 2003-04.

19. India. Ministry of Coal. Annual Report 2004-05.

20. India. Ministry of Finance. Economic Survey 2004-05.

21. TEDDY (TERI Energy Data Directory and Yearbook) 2004-05.

Articles

22. Dadwal, Shebonti Ray and Sinha, Uttam Kumar. "Equity oil and India's Energy Security." *Strategic Analysis,* vol 29, no. 3 July – September 2005. pp 521 –529.

23. Lama, Mahendra P. "Integrating Stakeholders in Energy Cooperation." *South Asian Journal* July – September 2005.

24. Ali, Mohammad Ramzan. "Gas Pipelines and Regional Cooperation." *South Asian Journal* July – September 2005 pp 21-30.

25. Raina, DN. "India: Energy Scenario." *South Asian Journal* July – September 2005 pp 39-48.

26. Mahalingam, Sudha. "Energy and Security in a changing world." *Strategic Analysis,* vol 28, no. 2, April – June 2004. pp 249 – 271.

27. Beri, Ruchita. "Africa's Energy Potential : Prospects for India." *Strategic Analysis,* vol 29, no. 3, July – September 2005. pp 370-394.

28. Dietl, Gulshan. "New Threats to Oil and Gas in West Asia: Issues in India's Energy Security." *Strategic Analysis*, vol. 28, no. 3, July – September 2004. pp 373-389.

Websites

29. Ministry of Power (http://powerin.nic.in)

30. Ministry of Non-conventional Energy Sources (http://mnes.nic.in)

31. Ministry of petroleum & Natural Gas (http://petroleum.nic.in/)

33. Planning Commission of India (http://planningcommission.nic.in)

33. The Energy and Resources Institute (www.teriin.org)
34. Confederation of Indian Industry (www.ciionline.org)
35. Nuclear Power Corporation of India Limited (http://www.npcil.org)
36. South Asia Regional Energy Coalition (hwww.energysouthasia.com)
37. Caspian Studies (www.caspianstudies.com)
38. Asian Development Bank (www.adb.org)
39. Energy Information Administration (http://www.eia.doe.gov/)
40. ASEAN Centre for Energy (http://www.aseanenergy.org/)

ENVIRONMENTAL PROTECTION AND NATIONAL DEVELOPMENT

By

GP Capt B Keshav Rao

Synopsis

National development is a complex concept and cannot be broken down into a single statistic. It involves far more than economic development or GDP growth rate. Several indicators of development have a three-pronged approach, addressing economic prosperity, individual and community welfare and, most importantly, environmental protection.The HDI, Gini Index etc. have their place but achievement of the Millennium Development Goals appears to be a comprehensive tool to assess national development for the next decade.

Environmental protection is integral to efficient and sustainable development. India's short-term developmental goals will require careful use of environmental resources. Protection of the environment is even more important for long-term or sustainable development. Ecological footprints are one way to measure environmental sustainability. Present estimates of global ecological footprint indicate that our planet is already unsustainable.

The quandary of how best we can manage finite resources and how we can make a transition to sustainability can perhaps be tackled by creation of "ecosystem valuation". Ecosystem valuation is the determination of the economic value of environmental goods and services and how they contribute to human welfare measured in terms of each invidual's own assessment of his or her well-being.

The existing command and control system of environmental management has proved ineffective the world over, more so in developing countries. The concept of sustainable development has strengthened the case for changes in the way nations tackle environmental issues. Full cost pricing has to cover not only the private cost of production, but also the actual cost to society, obtained after adding the cost of subsidies, user costs and environmental damage costs.

The concept of the economic value of environmental goods is soon to be introduced in India and judicious use of the array of available economic instruments is also planned in the National Environment Policy 2006. There is a need to invest in modern technology and to build a trained work force. Above all there is a need to develop the political will to follow the new environment policy in letter and in spirit.

CHAPTER I

INTRODUCTION

The term development has a myriad definitions. Yet national development has, in common parlance, come to mean a growth of Gross Domestic Product (GDP), a metric of a nation state's increasing wealth. For the individual this translates as an expansion of material goods.

Dr Gro Harlem Brundtland, former Prime Minister of Norway, and chairperson of the World Commission on Environment and Development held in 1983, is credited with introducing the concept of sustainable development to the world. This idea was expanded upon and formalized in the 27 principles of the Rio Declaration in 1992, the 6th principle of which states, "In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it."[1] Since then, numerous indices of development have been developed by social scientists and environmentalists. Central to all these indices are economic growth, individual and community welfare and environmental quality.

Unfortunately, most developed (industrialized) countries have not done enough to retard the pace of environmental degradation or natural resource depletion, and the under developed countries often perceive environmental conservation to be a luxury they cannot afford.

Environmental protection, as practiced the world over, has typically consisted of a plethora of restrictive rules and regulations – command and control systems, even though authorities often had neither the wherewithal nor the will to enforce these policies. There is a growing realisation that this approach has largely failed to achieve its goals. Ecosystem valuation (placing dollar values on environmental services) and the use of economic instruments to discourage environmental degradation have recently emerged as promising alternatives.

Our planet has finite natural resources. The burgeoning world population, rapid pace of industrialization and an unquenchable thirst for energy are fast depleting our natural resources and polluting what is left of them. There is an urgent need for all nations of the world to yoke environmental protection to their national development, so as to allow for equitable development for ourselves as well as future generations.

AIM

The aim of this thesis is to explore the linkages between environmental protection and development, and to study the concepts of ecosystem valuation and economic instruments as tools in environmental management.

HYPOTHESIS

Environmental protection is integral to national development.

The environment has real economic value. Failure to recognise this value leads to degradation of the environment.

Once the economic value of the environment is recognised, economic tools can be used to better manage the environment, so as to achieve optimal national development.

SCOPE

The concept of national development will be assessed by examining different metrics and indicators of development. An attempt will be made to look beyond GDP growth rate as a proxy for development. Linkages between environment and development will be explored.

The essence of environmental economics will be studied with focus on ecosystem valuation and economic instruments.

The present establishment for environmental management in India will be outlined and the National Environment Policy 2006 will be studied in the context of the principles of environmental economics.

Layout of the Thesis

(a) Chapter I – Introduction

(b) Chapter II – National Development

(c) Chapter III – Environment and Development

(d) Chapter IV –Ecosystem Valuation

(e) Chapter V –Economic Instruments and Environmental Management

(f) Chapter VI –Environmental Management in India

(g) Chapter VII - Analysis

(h) Chapter VIII - Recommendations and Conclusions

CHAPTER II
NATIONAL DEVELOPMENT

Quality of growth matters; not just quantity
- Gordon Brown[2]

Development is a universally cited but frequently misunderstood goal. In truth, it is a "complex multi-dimensional concept involving improvements in human well-being".[3] Traditionally, however, it has been equated with economic development, and specifically with economic growth. This chapter explores the different definitions implicit in some common metrics of development. It shows that development consists of far more than improvements in such indicators as Gross Domestic Product (GDP) . It thus sets the stage for a more holistic way of thinking about development – sustainable development.

The year 1991 is often considered a watershed year for India's economic development. It was then that the economic reforms process was set underway. The system of state control over economic activities – the infamous "license raj" - was dismantled and replaced by a more market-friendly system. The reforms related to two major areas – trade liberalization and deregulation. The aim was to put the economy on a broad-based growth path that would eventually improve the welfare of all sections of society by harnessing private initiative and market processes.

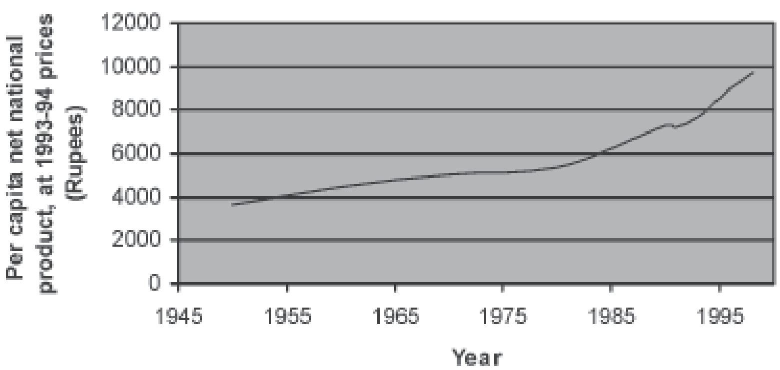
Earlier, under the centralized development planning perspective implemented in 1951, the economy grew at 3.5percent per annum for three decades. While annual growth accelerated to 5.65percent in the 1980s, it was accompanied by large macro-economic imbalances. The foreign exchange crisis of 1991 brought on by the Gulf War and steeply rising oil prices finally kick-started the economic reform process. GDP growth rose to 8.55 percent and 7.5 percent in 2003-04 and 2004-05. This growth rate is predicted to be stable over the next decade thanks to a structure of macroeconomic stability with low inflation, burgeoning foreign exchange reserves, low external debt, stable exchange rates and surplus food grain.[4]

Indicators of Development

The centrality of GDP figures to perceptions about India's development prospects prompts a closer examination of the metric itself – what does GDP really measure? Is it a reliable indicator of development?

GDP. In fact, GDP simply measures the total market value of production – i.e. the amount of money spent in markets for goods and services nationwide. It tells us nothing about how wealth is distributed across society. It ignores the value of production that occurs outside the formal marketplace, such as unpaid housework, work output of the rural woman, a mother's care for her child, or most of the work of the unorganised labour force. Natural and "man-made" disasters, crime, accidents and disproportionate government spending can all contribute to GDP in a positive way - an earthquake might be followed by a spike in construction market activity, leading to an increase in GDP, even though society is less well-off than before. Finally, GDP[5] is not adjusted to account for the harm resulting from pollution and depletion of finite natural resources required by future generations.[6] Even the old argument that a rise in GDP is like a "rising tide that lifts all boats", i.e. that the benefits of a large economy trickle down to the poor, is now largely discredited by development economists.[7]

Figure 1 India's per capita GDP over time



Per capita GDP remains a useful starting point to compare living standards across countries, primarily for reasons of simplicity and data availability. Nonetheless, it is clear, that at best, it is an incomplete indicator of development.[8]

This realisation has led to the development of more useful social indicators aimed at measuring "quality of life". These indicators have their own shortcomings – significant data requirements, the challenge of aggregating information into a single bottom-line, etc. Still, they manage to provide a more realistic and useful metric for national development. The chief amongst these composite indicators are described as follows :

Measure of Economic Welfare (MEW). Developed in 1973 by two Yale University economists,[9] MEW uses personal spending on consumer goods and services as its starting point. Various additions, subtractions and imputations are then made in deriving a measure of economic welfare. For example, expenditure on commuting to work, crime prevention, etc. are deducted as "regrettable expenditure" – an expenditure which does not contribute to personal happiness. Value of non-market activity and leisure are added. Sustainable MEWs are obtained when issues such as health, education and land values are factored into the assessment. However, MEW does have serious shortcomings – there is no accounting for pollution, resource depletion or inequality of expenditure.

Genuine Progress Indicator (GPI)[10]. The Genuine Progress Indicator was developed by the U.S. research group Redefining Progress.[11] The indicator can be broadly split into two blocks: a measure of current economic welfare and a measure of sustainable economic development. The former is calculated using consumer expenditure, government spending, non-market production and leisure. Regrettable expenditures are subtracted, and factors like costs of underemployment, pollution, etc. are also taken into account. The measure of sustainable economic development includes depletion of natural resources (e.g. petroleum, fertile land), long-term environmental damage (global warming, ozone depletion, biodiversity loss) and net investment in fixed assets. Though this indicator considers economic, social and environmental issues concerning development, it requires several complex inputs and its use is currently that of a research tool for social scientists.

Human Development Index (HDI). The Human Development Indicator is a composite index developed by the United Nations Development Program (UNDP) that measures the average achievements of a country in three basic dimensions of human development [12] :

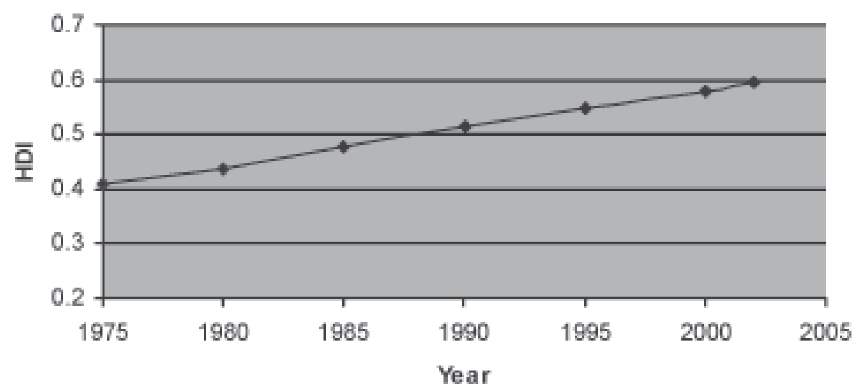
(a) A long and healthy life, as measured by life expectancy at birth.

(b) Knowledge, as measured by the adult literacy rate and the combined gross enrolment ratio for primary, secondary and tertiary education.

(c) A decent standard of living, as measured by GDP per capita in purchasing power parity (PPP) US dollars.

While the concept of human development is much broader than any single composite index can measure, HDI offers a powerful alternative to income alone as the primary measure of development. Countries are classified into three clusters by achievement in human development: high human development (with an HDI of 0.800 or above), medium human development (HDI of 0.500–0.799) and low human development (HDI of less than 0.500). Predictably, countries of the First World qualify as high human development countries; 32 countries (mostly in Africa) are classified under low human development. India's rank in HDI is 127 th among 175 nations. On the brighter side, India's HDI value has gone up from 0.577 in last year's report to 0.602 this year. India's neighbours, Pakistan and China, are placed 144 and 104, respectively in the HDI ranking while Sri lanka is placed in the 93 rd position.[13] A calculation of HDI for India is given in Appendix 'A'.

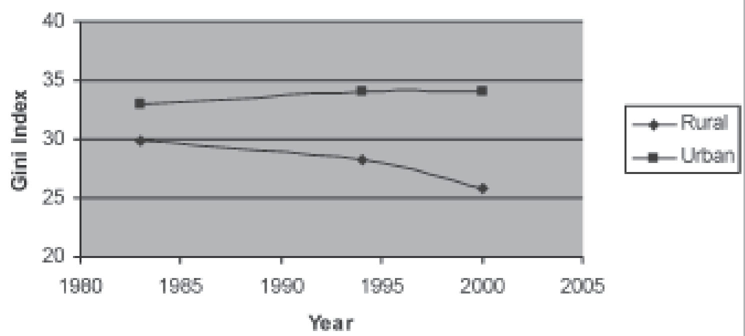
Figure 2 India's HDI over time



Gini Index. The Gini Index is a measure of inequality of income. The concept was developed by the Italian statistician Corrado Gini in 1912. [14] The index is a number between 0 and 100, where 0 corresponds to perfect equality (e.g. everyone has the same income) and 100 corresponds to perfect inequality (e.g. one person has all the income, and everyone else has zero income).

The Gini Index is easy to interpret and can be used to compare countries as well as areas within countries. It is an important complement to such indicators as per capita GDP. For example, if a country's GDP as well as Gini Index rise, we can infer that the rich are getting richer, but the poor are not keeping up, e.g. in China per capita income rose at 8.2 percent per annum from 1980 to 2002, but Gini Index increased from about 30 percent to 41 percent in the same period.[15]

Figure 3 India Gini Index over time



Happy Planet Index (HPI). HPI is an index of human well-being and environmental impact, introduced by the New Economics Foundation in 2006. The index aims to reflect environmental sustainability in addition to present economic welfare. Each country's HPI value is computed as a factor of a life satisfaction index and average life expectancy at birth, as a reciprocal of the country's per capita ecological footprint. The index is meant to show which countries produce the most human happiness at the lowest environmental cost.

Table 1 Happy Planet Index (HPI) rankings of selected countries [16]

Country	HPI Rank	Life Satisfaction index	Life Expectancy index	Ecological Footprint index	HPI
Bhutan	13	7.6	62.9	1.3	61.1
Sri Lanka	15	6.1	74.0	1.1	60.3
China	31	6.3	71.6	1.5	56.0
Bangladesh	41	5.7	62.8	0.6	53.2
Nepal	54	5.5	61.6	0.6	50.0
India	62	5.4	63.3	0.8	48.7
Pakistan	112	4.3	63.0	0.7	39.4
United States of America	150	7.4	77.4	9.5	28.8

Other metrics / indices. In addition to HDI, the UNDP also uses such indices as the gender-related development index (GDI), the gender empowerment measure (GEM) and the Human Poverty Index (HPI). Another interesting measure is Gross National Happiness (GNH) – named so by King Jigme Singye Wangchuck of Bhutan in 1972.[17] The concept of GNH is based on the premise that true development of human society takes place when material and spiritual development occur side by side to complement and reinforce each other. The four pillars of GNH are the promotion of equitable and sustainable socio-economic development, preservation and promotion of cultural values, conservation of the natural environment, and establishment of good governance.

Millennium Development Goals

At the start of the new millennium 189 member states of the UN signed the Millennium Declaration – a pledge to "free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty."[18] The declaration provides a shared commitment backed by clear time-bound targets. These targets, known as the Millennium Development Goals (MDGs), were adopted in September 2000. The nations committed themselves to meeting their targets by 2015 so as to bring about substantial improvement in the lives of their people. Since their adoption, progress towards these MDGs has become a widely-used benchmark for national development.

The Millennium Development Goals are classified in seven fields of endeavour :

(a) Eradication of extreme poverty and hunger

(b) Universal primary education

(c) Gender equality and empowerment of women

(d) Reduction of child mortality

(e) Reduction of maternal mortality

(f) Combating HIV/AIDS, malaria and other diseases

(g) Ensuring environmental sustainability

An interesting comparison of the MDGs, the targets of the Tenth 5-year Plan and the Common Minimum Programme (CMP) of the present Government is included in Appendix 'B'.

Chapter Summary

This chapter established that national development is a complex concept, not easily broken down into a single statistic. It involves far more than economic growth. Various perceptions of development focus on such factors as per capita incomes and income inequality, health, education, gender equality, and crucially, environmental quality and sustainability.

CHAPTER III
ENVIRONMENT AND DEVELOPMENT

It is often argued that developing countries cannot afford to protect the environment. Environmental quality is sometimes thought to be the exclusive concern of developed countries [19]. This chapter argues that environmental problems are, in fact, strongly linked with development problems. Achieving many of India's development goals will require careful management of scarce natural resources.

Delineating all the complex linkages between environment and development is beyond the scope of this thesis. Instead, some of these linkages are illustrated through examples. Consider the following natural resources :

(a) **Water.** Water is a crucial factor for agriculture, industry and human health. India possesses 4 percent of global water resources, but is home to 16 percent of global population. Per capita water availability was 2266m^3 in 1997 – a decline of over 60 percent since independence. Even these alarming figures greatly understate India's water problems by neglecting the extreme regional and seasonal disparities in water availability. Annual precipitation in Meghalaya is one hundred times that in Rajasthan. And even in areas with high annual precipitation, dry seasons can be severe – over 50 percent of annual rainfall occurs over just 15 days. India is now classified as a "water-stressed country", water quality is another problem, with pesticide residues and traces of toxic industrial effluents found in most river basins and aquifers. Clearly, managing India's scarce water wisely, will be important to a variety of development endeavours.[20]

(b) **Forests.** India has only 1percent of the world's forests.[21] But a large segment of India's population depends on these forests for energy, fodder, small-scale marketable produce like tendu, housing materials and timber. 75percent of rural Indian households use firewood as their primary energy source, while close to 100 million Indians live in or adjacent to forests.[22]

The total annual value of India's forest products is estimated to be Rs 300,000 million (about US$ 6.66 billion).[23] Forests are thus a direct and important contributor to human well-being in India. Their indirect contribution is no less important – flood control, groundwater recharge, prevention of soil erosion, etc.

(c) **Land.** India has 2 percent of global land area, translating to a land availability of only 0.27 ha per capita. Land is thus a severe constraint to the increase in agricultural output needed to feed India's growing population. This is reflected in the fact that net sown area in India has not increased since 1970. The increased intensity of cultivation of this limited land has led to severe problems of nutrient depletion, salinization, water-logging and groundwater pollution.[24] These environmental impacts now act as constraints on profitability and future output growth.

(d) **Energy.** Energy is an overarching requirement for economic growth and development. The President of India, Sri Abdul Kalam spoke at length about the need for energy security and energy independence, in his address to the nation on the eve of the 59th Independence Day. He said that in the power sector there would be an increase from the present 120,000Ms to 400,000 MWs by 2030. A sustained increase in the GDP growth of 8 percent per annum from now till 2031 will require energy supply to grow by 300- 400 percent[25]. This will be achieved using a mix of finite resources such as coal and renewable resources such as water, wind, biomass and solar. Ramping up hydroelectric power generation, coal mining and thermal power will all have significant environmental impacts. Recent experience in Tehri, the Narmada valley and Kashipur in Orissa shows that these impacts are strong obstacles to the implementation of such projects.

It is also possible to trace environment-development linkages by proceeding cautiously from individual development goals to related environmental issues. Table 2 does so in a highly simplified and exploratory fashion.

Table 2 Development goals and environmental challenges

Development Goals	Linked through	Environmental challenges
Reduce hunger	Food production	Water; Land Degradation

Reduce poverty	Agricultural sector, Forest sector	Forests; Water; Land Degradation
Infant mortality	Nutrition, safe water, exposure to toxins	Water; Pollution; Land Degradation
Empowering women	Fuelwood and water collection	Forests; Water
Rural electrification	Power generation	Finite oil, gas and coal resources; various problems associated with large dams; Greenhouse Gas emissions; Air Quality

Sustainable Development

The preceding section suggests that careful management of scarce environmental resources will be required to meet even short-term development goals. What then of long-term development – say in the next 100 years and beyond? This is the domain of sustainable development.

The concept of sustainable development was popularized in 1987 by the Brundtland Commission in its report titled "Our Common Future".[26] It defined the term as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". There are several other definitions of sustainable development, all conveying the same concept. "Meeting the twin needs of protecting the environment and alleviating poverty",[27] or "treating the earth as if we meant to stay",[28] or to "turn resources into junk no faster than nature can turn junk back to resources",[29] or more specifically, "improving the quality of life while living within the carrying capacity of the biosphere".[30]

At the U.N. World Summit on Sustainable Development in Johannesburg, South Africa, in September 2002, representatives of over 150 nations reaffirmed their commitment to sustainable development.[31] The countries assumed a collective responsibility to advance and strengthen the three interdependent and mutually reinforcing pillars of sustainable development at the local, national, regional and global levels :

(a) Economic development

(b) Social development

(c) Environmental protection or Environmental Sustainability

Three common principles were widely accepted :

(a) Quality of life ultimately depends on, amongst other things, a healthy and productive environment to provide both goods and services and a pleasant place to live.

(b) The needs of the poor must be met, providing at least a basic quality of life for all the worlds' population.

(c) Future generations should have the same opportunity to harness the worlds resources as the current generation.

Measuring Sustainable Development

The previous chapter described how development is frequently measured using metrics like GDP, HDI, Gini Index, etc. Most of these metrics address the first two pillars of sustainable development mentioned above, i.e. economic and social development. But how can "environmental protection" be measured? What level of environmental protection might be considered environmentally sustainable?

Environmental sustainability is often thought of in terms of consumption of renewable resources, as shown in Table 3. This idea of nature's ability to replenish renewable resources is sometimes referred to as the carrying capacity of the environment. One test for environmental sustainability is thus whether resource extraction exceeds the carrying capacity of the environment, at a local or global level.

Table 3: Renewable resource consumption and environmental sustainability

Consumption of renewable resources	Impact on environment	Sustainability
More than nature's ability to replenish	Degradation	Not sustainable
Equal to nature's ability to replenish	Equilibrium	Sustainable growth
Less than nature's ability to replenish	Renewal	Sustainable growth

Many techniques and metrics have been developed to measure environmental sustainability. These include Ecological Footprints, Environmental Space, Life-Cycle Analysis, Material Accounts, Systems Models and Environmental Impact Assessment [32] . Due to space constraints, all of these cannot be covered here. Instead, the following section describes Ecological Footprints – an interesting recent metric of environmental sustainability.

Ecological Footprints

The term was coined in 1996 by Canadian ecologist William Rees, who defined ecological footprints as the amount of productive area of the Earth required to sustainably produce the resources used by a person, population or product.[33] The units used are hectare-years. Thus, if a car is labeled as having an ecological footprint of x ha-yrs, we know that x hectares of land of average productivity would take one year to sustainably produce the resources – material and energy - used to produce the car.[34] A key condition here is "sustainably produce" – while a forest can at any given time provide its entire wood for human use, it can only sustainably produce at a rate equal to the growth rate of wood in the forest.

The ecological footprint aims to express how much of nature's 'interest' we are currently appropriating. If more bio-productive space is required than is available, we are not just consuming interest, we are dipping into the 'principal'. Such a rate of consumption is not sustainable.

As an illustration, consider a meal of lamb and rice. The lamb requires a certain amount of grazing land, road space for transportation, and energy for processing, transportation and cooking. Similarly, the rice requires arable land for production, road space for transportation and energy for processing, transportation and cooking. All of these uses would be counted while calculating the footprint.

Clearly, rice cannot be produced on built up land and lambs are not grazed in rice fields. Thus, a distinction is made between land types :

(a) Arable Land: The most productive land on Earth, this is used to grow crops such as grain and pulses. It comprises 10 per cent of total bio-productive land (1.5 billion hectares).

(b) Pasture Land: Less productive than arable land, it is used primarily for grazing cattle. It comprises 23 per cent of total bio-productive land (3.4 billion hectares).

(c) Forested Land: Contains cultivated and wild forests. It comprises 33 percent of total bio-productive land (5.2 billion hectares).

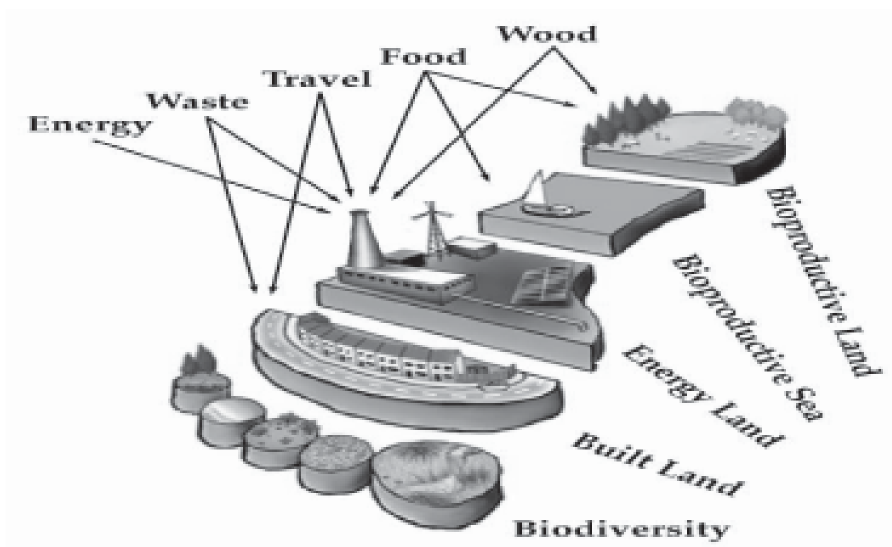
(d) Built Land: This is land where productive capacity has been lost by development - roads, buildings etc. It comprises 2 percent of total bio-productive land (0.3 billion hectares).

(e) Productive Sea Area: Although there are 36 billion hectares of sea area, only about 8 percent of this or 2.9 billion hectares can be considered as productive sea space.

(f) Energy Land: The amount of land that is needed to sustainably manage our energy demands. This includes providing fuels and storing greenhouse gas emissions as carbon in forests.

(g) Biodiversity Land: This is the land that should be kept free of human activity to protect species diversity in non-human ecosystems.

Figure 4 Foot-printing – Land types



20 per cent of the world's population is responsible for 86 per cent of private consumption and the poorest 20 per cent are responsible for a meager 1.3 per cent[35] . Bio-productive capacity is similarly disproportionately apportioned, with the poor getting much less than their share. Wackernagel and Rees thus introduced the notion of 'Earth Share' - the average amount of ecologically productive land and sea available per capita.[36] Table 4 shows the amount of each land type available globally and shows the earth-share of each land type based on the population in 1995 as well as an extrapolation of this data for the predicted population of the world in 2050.

Table 4 Earth-Shares by land-type

Land Type	Global Area (Billion Ha)	Average Earth-Share Ha/Per Cap Population 6 bn	Population 9.5 bn
Arable	1.45	0.24	0.15
Pasture	3.36	0.56	0.35
Forest	5.12	0.85	0.54
Productive Sea	2.90	0.48	0.31
Total Land & Sea	12.83	2.13	1.35
Total Land & Sea minus biodiversity area at 15%	10.91	1.60	1.01

The calculations show that an average earth-share at present is around 2.1 hectares, even without setting aside space for biodiversity conservation. This means that, for human civilization to be sustainable overall, each one of us must fulfill his or her requirements from within an area (not necessarily contiguous) of 2.1 hectares. For context, this is the area of a circle of radius 25 metres.

Ecological footprints for countries are calculated using production, trade and energy flow data. Consumption analysis is carried out over all biotic products. World average yields divided by the appropriate land type gives the average ecologically productive area used per unit of that particular product. Consumption is then translated into land share utilized by the product in the nation. This may be reduced to a per capita value for comparison, or may be compared with the total bio-productive capacity of the country itself. The former reflects the view that each human being on Earth has equal right to the planet's resources, while the latter reflects a contrary view that each country has the exclusive right to its own resources. Either way, calculations showed that in 1995, global ecological footprint exceeded the Earth's capacity by 15 percent.[37] We live in an unsustainable world.

For individuals or products, footprints are typically determined using pre-calculated values of footprint per unit component material or activity. All the processes and materials used by an individual or product can be multiplied by the corresponding per unit footprints to determine the overall footprint.

Ecological footprints have certain shortcomings. For example, they cannot easily account for water consumption, as groundwater extraction does not exclude other land-uses. Still, they are an extremely flexible measure, applicable across a wide range of scales and products. When used in conjunction with other techniques and metrics, they provide an intuitive and useful estimate of environmental sustainability.

Chapter Summary

This chapter showed that even meeting India's short-term developmental goals will require careful use of environmental resources. Protection of the environment is even more important for long-term or sustainable development. Ecological footprints are one way to measure environmental sustainability. Present estimates of global ecological footprint indicate that our planet is already unsustainable.

CHAPTER IV
ECOSYSTEM VALUATION

The previous chapter established that environmental resources are increasingly scarce. In addition, present patterns of consumption of resources are unsustainable. How can we best manage finite environmental resources? And how can we begin to make a transition to sustainability? This chapter describes an important element of the 'environmental economics answer' to these problems – ecosystem valuation.

Ecosystem valuation is the determination of the economic value of environmental goods and services. It is important to make a clear distinction here between the common usage of value and economic values. While the former is a subjective sense of desirability, the latter is objectively defined and measurable. The economic approach to value is one of anthropocentric instrumentalism. In other words, the economic value of an ecosystem consists solely of its contribution to human welfare, measured in terms of each individual's own assessment of his or her well-being.

Economic values can only be determined by making comparisons. For example, it is impossible to put a meaningful number to "the absolute economic value of the atmosphere". However, it is (theoretically) possible to measure "the economic value of a pure atmosphere relative to a polluted one". Specifically, the economic value of a "change" is defined by the amount (either positive or negative) of compensation that individuals would need in order to consider themselves as well off as they would have been without the change.[38] As such, it can be measured in terms of any set of common units, but is usually measured in terms of money.[39]

This means that ecosystem valuation ultimately consists of determining the "dollar value" of an ecosystem service – how much a particular set of environmental goods and services contributes to human welfare, measured in monetary terms.[40]

How might these dollar values help us to better use environmental resources? One important way is by enabling the use of economic instruments for environmental management, as described in the next chapter. Even without the use of such instruments, dollar values are useful because in the absence of these "hard numbers", the environment is often implicitly valued at zero.

At this point, it is useful to be more explicit about these "environmental goods and services". The term commonly used in environmental economics to refer to these goods and services is "ecosystem services". Ecosystem services are defined as "attributes of ecological functions that are valued by humans". [41]

De Groot and colleagues provide a useful classification of ecosystem functions and the associated services.[42] They differentiate between four types of functions:

(a) Regulation functions

(b) Habitat functions

(c) Production function

(d) Information functions

Within each of these function categories are several specific sub-functions, each of which provides one or more services to humans.[43] These are briefly mentioned in Table 5.

Table 5 Ecosystem Functions

Function Category	Sub-functions
	Gas regulation Climate regulation Disturbance prevention Water regulation

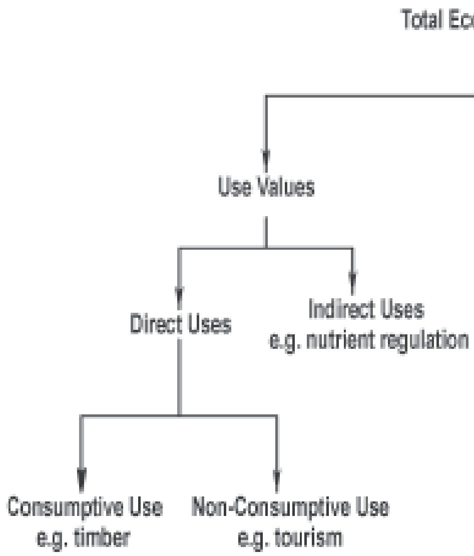
Regulation	Water supply Soil retention Nutrient regulation Waste treatment Pollination Biological control
Function Category	Sub-functions
Habitat	Refugium function Nursery function Food Raw materials
Production	Genetic resources Medicinal resources Ornamental resources Aesthetic information
Information	Recreation Cultural and artistic information Spiritual and historic information

Obviously, ecosystem services are diverse, and contribute to human welfare in very different "ways". For example, the type of value attached to edible fish present in a river is likely to be very different from that attached to beautiful scenery. This intuitive fact is well recognised by environmental economists. They thus classify economic values of ecosystem services as being of two broad types :

(a) **Use Values.** Use values are derived from physical involvement with some aspect of an ecosystem. One type of use value is direct, such as logging, fishing, recreation, and tourism, while another is indirect. Direct use is further divided into consumptive (logging, fishing) and non-consumptive (recreation, tourism) values. There are also indirect use values, which arise from supporting humans or what humans directly use. Regulation and habitat functions, such as flood control, climate regulation, and waste assimilation would fall into this category.[44]

(b) **Non-Use Values:** Non-use values do not involve physical interaction. They include existence, bequest, and option values. Existence value (sometimes called passive use) is derived from the satisfaction of knowing that a certain species or ecosystem exists, even if it will never be seen or used. Bequest value is satisfaction from being able to pass on environmental benefits to future generations. Option value pertains to the possible use of a resource in the future. This has to do with uncertainty and risk-aversion. An example is the preservation of tropical rainforests because we may be able to find new medicinal substances in it.[45]

Figure 5 Types of Economic Values of Ecosystem Services



A given ecosystem may have multiple types of economic values simultaneously. For example, a riverine ecosystem may have consumptive use (e.g. water for domestic or industrial use), non-consumptive use (e.g. transport of goods), indirect uses (e.g. nutrient transportation), existence value (e.g. religious significance), option value (e.g. future construction of a hydro-power station) and bequest value for future generations.

This leads to the concept of Total Economic Value (TEV) as a measure of the total contribution of an ecosystem to human welfare.[46] Any change in the attributes of an ecosystem (such as a reduction in water quality due to the discharge of effluents from an industrial unit) can lead to a change in this TEV – a change, that is, in human welfare.

How are we to put actual numbers to these economic values of ecosystem services? The prices that people are willing to pay for goods[47] in a market reveals a great deal about how much they value those goods. Thus, economists typically use market demand curves to determine the economic value of goods. However, markets do not exist for many ecosystem services - one cannot buy or sell clean air, or biodiversity. Environmental economists have thus had to design a number of innovative techniques to accomplish ecosystem valuation. The remainder of this chapter introduces these techniques, and illustrates their use with examples.

Given the variety in kinds of ecosystem services and economic values, it is not surprising that no single technique of ecosystem valuation fits all cases. Six distinct valuation methods are identified from the literature,[48] broadly grouped in three categories :

(a) **Revealed Willingness to Pay.** Revealed willingness to pay measurements are based on observations of actual behaviour. These could be through decisions made in markets for the ecosystem services themselves (direct market valuation), or through behaviour in other markets affected by ecosystem functioning, such as real estate markets (indirect market valuation).

(i) **Direct market valuation.** Some ecosystem products, such as fish or wood, are directly traded in markets. Thus, their values can be estimated as with any other market good. Other ecosystem services, such as clean water, are used as inputs in production of other traded goods, and their value may be measured by their contribution to the profits made from the final good. The two methods used for direct market valuation of ecosystem services are :

(aa) **Market-Price Method.** This method estimates the economic value of ecosystem products or services that are traded directly in commercial markets. Changes in either the quantity or quality of a product can be valued. Standard economic techniques are used to measure the economic benefits from marketed goods – consumer surplus (total benefit to consumers from consumption) and producer surplus (total benefit to producers from production and sale).[49] The total net economic value is the sum of consumer surplus and producer surplus. To cite an example; fertilizer runoff into a lake causes eutrophication (pollution with nitrogenous wastes), which results in a lowering of fish yields for local fishermen. The change in economic value of the lake ecosystem caused by the fertiliser can therefore be computed.

(ab) **Production Method.** The production method is used to estimate the economic value of ecosystem products or services that act as inputs to the production of commercially marketed goods. When the quality of such an input decreases, the quality or quantity of the marketed good might decrease, or production costs might increase to maintain the same level of output. A forested watershed for example acts to purify the water flowing in a river. If there are plans to "reclaim" the wetland – drain it out and construct office buildings in it, the quality of water supplied to a soft drink bottling plant will decline. The economic cost of reclamation of the wetland can be calculated.

(ii) **Indirect market valuation.** Some ecosystem services, like recreation, may not be explicitly traded in markets. However, the prices people are willing to pay in markets for related goods can be used to estimate their values. For example, people might pay a higher price for a home with an excellent view of the ocean, or take the time to travel to a special location for a holiday. These kinds of expenditures can be used to determine the value of the view or the recreational experience. The two methods commonly used for indirect market valuation are :

(aa) **Hedonic Pricing Method.** This method is most commonly applied to variations in housing prices that reflect the value of local environmental attributes. This is done by comparing the market values of similar properties that differ only in the quality of their environment. Statistical techniques are used to extract the value that people actually place on environmental quality in the real estate market. For example, if a green belt established next to a housing colony resulted in escalation of the real estate costs, the economic value of the green belt could be estimated.

(ab) **Travel Cost Method.** The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the "price" of access to the site. Thus, the economic value of the site can be calculated based on the number of trips that people make at different travel costs. Accordingly the economic value of a wildlife sanctuary popular with eco-tourists can be evaluated, so as to justify expenses incurred in maintaining it.

(b) **Imputed Willingness to Pay.** The value of some ecosystem services can be measured by observing what people are willing to pay to avoid the adverse effects that would occur if these services were lost, or to replace the lost services. For example, wetlands often provide protection from flood-waters. The amount that people spend to avoid flood damage in areas without wetlands can help estimate the value of the flood protection services of the wetland. The methods used to value such services are often clubbed together as the 'Damage Cost Avoided / Replacement Cost / Substitute Cost Method'.

(c) **Expressed Willingness to Pay.** Many ecosystem services are not traded in markets, and are not closely related to any marketed goods. Thus, people cannot "reveal" what they are willing to pay for them through their market purchases or actions. In these cases, surveys can be used to ask people directly what they are willing to pay. based on a hypothetical scenario. This method is referred to as the 'Contingent Valuation Method'. Consider a protected and inaccessible forest which is habitat to an endangered species. Authorities must decide whether to open up the forest for logging – which is certain to cause the extinction of the species. The value the local population places on the endangered species can be estimated by questionnaire and assessed against the economic gains of the logging exercise.

Chapter Summary

This chapter has outlined the broad principles of environmental economics, which help to place a dollar value on the environment. The concept of total economic value of an ecosystem was introduced.(the many diverse values of a riverine system is a striking example). A simplified picture of the six commonly studied ecosystem valuation methods was drawn. The chapter has paved the way for the next chapter which studies the various economic tools used for efficient environmental management – the economic instruments.

CHAPTER V
ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL MANAGEMENT

Environmental management has typically been seen as a necessary restriction or regulation of economic activity, so as to prevent environmental damage from exceeding acceptable limits. This view of environmental management is manifest in the traditional tools of the environmental policy maker – emission standards, extraction quotas – sometimes called the "command and control (CAC)" or "fences and fines" approach to environmental management .

However, there has been a growing realization in recent years that this approach has failed to deliver on many counts. Costs of enforcement have been much higher than expected. These include costs to the government, as well as overall costs to society. Capacity for monitoring and enforcement is typically limited, particularly in developing countries. This situation is exacerbated by trends towards reducing the role of the state in economic activities. CAC is thus an increasingly discredited approach.

In addition, the emergence of the concept of sustainable development has resulted in recognition that environmental and economic issues are not truly separable. This is particularly the case in developing countries, where economic growth is strongly linked to the exploitation of environmental resources. Economic and environmental policy might therefore be best formulated in an integrated fashion.

Together, these two trends have resulted in the emergence of economic instruments as a viable alternative to the fences and fines approach to environmental management.

The idea behind economic instruments. Environmental economists might sum up the cause of environmental problems in two words – incorrect pricing. In their view, underpricing of scarce natural resources leads to overuse of these assets.[50]

For example, the price of timber in a modern wood market is usually linked only to the private costs incurred by a firm in cutting down and transporting wood. The social costs of cutting down trees might be much larger. Increased soil erosion, poor water retention, loss of wildlife habitat and changes in local climate might all occur as a result of deforestation – and each of these externalities [51] imposes real costs on society. The price in the market thus does not relate to the Total Economic Value introduced earlier.

More generally, institutional failures such as the absence of secure property rights, market failures such as environmental externalities, and policy failures such as distortionary subsidies cause private costs (costs viewed by a single person or firm) to diverge from social costs (costs incurred by society as a whole). As a result, producers and consumers do not receive the correct signals about the true scarcity of resources they deplete or the cost of environmental damage they cause. This leads to: over-production and over-consumption of commodities that are resource-depleting and environment-polluting, and under-production and under consumption of commodities that are resource-saving and environment-friendly.

CAC approaches do not directly address these failures. A CAC policy maker typically sets emission standards (for polluting activities) and extraction quotas (for environment depleting activities). This results in what economists call static and dynamic inefficiency. Static inefficiency occurs because CAC requires compliance with the same standards by all pollution sources, irrespective of marginal compliance costs.[52] Dynamic inefficiency exists because CAC provides little incentive to technological improvement once compliance has been achieved.

Enter economic instruments with the promise of flexibility, cost-effectiveness, and dynamic efficiency. These are a broad class of policy instruments that seek to "make the environmentally preferred action financially more attractive by...changing the costs and benefits of options available to economic agents."[53] Put more simply, economic instruments create incentives that encourage people acting in their own best interests to treat the environment in a way that is in the best interests of society. They do so by pricing environmental goods and sometimes by using market mechanisms.

In general, economic instruments reward people monetarily for producing environmental benefits and penalise people for imposing environmental costs. They are closely related to the Polluter Pays Principle (PPP)[54] whereby people are made to pay for using the environment. PPP effectively means that society is assigned the right to a clean environment, and polluters must pay for the right to use (pollute) this environment. A contrary approach is also possible, and equally valid in economic terms. This is the Beneficiary Pays Principle, where the right to use (pollute) is granted to particular individuals/firms, and they must be compensated by society to prevent the pollution. This may seem unfair at first glance. Consider, however, the case of a poor population of tribals living in a pristine forest – it might well be fair to compensate them for not cutting down trees.

Economic instruments for environmental management aim to achieve full cost pricing of environmental resources, thus bringing about a realignment of resource allocation with society's interests. This is a necessary condition for sustainable development, as recognized in the Rio Declaration, which states "National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution with due regard to public interest and without distorting international trade and investment ."[55]

Full-cost pricing is achieved by including pollution and depletion costs in the prices of environmental resources. Full cost pricing is given by the formula:

$$P = MPC + MUC + MEC$$

Where –

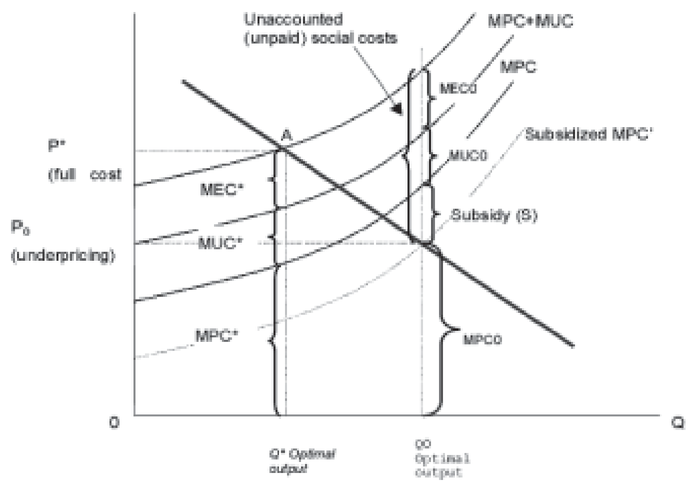
P	=	Price, e.g. price of wood from a tree
MPC	=	Marginal (or incremental) Production Cost, e.g. cost of cutting down and transporting wood

MUC = Marginal User (or depletion) Cost, e.g. cost imposed on other users of the forest e.g. forest-dwelling communities.

MEC = Marginal Environmental (or damage) Cost, e.g. cost imposed on society due to increased soil erosion, etc.

If an environmental good is priced at this "correct" price P, it will be used in an economically efficient fashion – i.e. it will be used in a way that maximises net social welfare.

Figure 6 Standard 'Demand - Supply' Curve



In theory, economic instruments have the following advantages over CAC policies :

(a) A correctly designed economic instrument (i.e. the correct price set for pollution) can achieve a given environmental goal at the lowest possible overall cost. They do so by allowing individual firms or actors flexibility over production decisions. Unlike the traditional CAC, economic instruments allow the polluter to choose their personal level of pollution, and how to achieve it - but a cost is imposed for the pollution produced. This will be considered in greater detail below.

(b) Economic instruments stimulate technological innovation by providing incentives for continued improvement in environmental performance. Types of economic instruments for environmental management.

A variety of economic instruments for environmental management are used in different parts of the world at present. Each has advantages and disadvantages, and the most appropriate instrument for a particular situation must be carefully chosen. The following instruments are identified from the literature[56], and are discussed in greater detail as follows :

(a) Benefit-Cost Analysis

(b) Property rights

(c) Market creation

(d) Fiscal instruments

(e) Charge systems

(f) Financial instruments

(g) Liability instruments

(h) Performance bonds and deposit refund systems

Benefit-Cost Analysis

Benefit-Cost Analysis (BCA) is the tool most commonly used by the modern environmental policy maker. It is an integral part of decision-making on environmental issues in many countries of the world.[57]

BCA measures the net economic gain or loss to society of policies or actions that affect ecosystems.[58] This involves identifying all the impacts of an action, including environmental impacts. Economic values are then determined for each of these impacts. Typically, some of these costs and benefits occur in the future. Thus, a discount rate is used to reduce them to their present time equivalent – the net present value. If the net present value of a project is positive, the project is worthwhile in terms of economic efficiency. Alternatively, several policies or programmes may be compared to determine which provides the greatest net economic benefits.

Because BCA focuses only on economic benefits and costs, it determines the economically efficient option. This may or may not be the most socially acceptable option, or the most environmentally beneficial option. Thus, BCA must be supplemented with information on equity implications or overriding environmental considerations.

Property Rights

In his classic 1968 text, Garrett Hardin drew attention to the "tragedy of the commons" – the invariable over-exploitation and degradation of environmental resources to which property rights are poorly defined. The economic logic behind this is that with exclusive and secure property rights, resource depletion is "internal" to the owners/users, while under open access it is "external" to the users.[59]

If property rights are properly defined, the owner will only extract resources when the resulting benefit covers both extraction cost and production cost, which is the total future benefit lost due to present use.[60] With secure property rights, the price of resource commodities such as minerals, oil, and timber would reflect the resource depletion cost, and thus be used optimally, so as to maximise net social welfare.

Property rights need not be private—they can be communal or public (state)—but they need to be well-defined, secure, and transferable if they are to effectively internalize depletion costs. Where traditional, customary or communal rights exist, the best policy might be the recognition and strengthening of these rights rather than their supplantation with private property rights, especially if the latter are highly susceptible to elite capture.

Property rights are particularly applicable to land (land rights), water resources (water rights) and minerals (mining rights), as the ability to exclude non-owners is critical. They are less applicable to situations where the resource is mobile, i.e., it moves across boundaries (e.g., marine fisheries), or where significant externalities are involved, as when downstream land owned by another is affected of pollution upstream (e.g., water pollution resulting from upstream deforestation or runoff of fertilizers and pesticides).

Nevertheless, assignment of secure, exclusive and transferable property rights goes a long way in correcting the "open-access" incentive structure, and is typically considered the first (and sometimes only) step of environmental regulation using economic instruments. When significant externalities are involved, property rights can be supplemented by innovative market creation, as discussed later.

One "limitation" is that assigning property rights has significant distributional impacts. On the one hand, it can be used as a means of improving wealth distribution; on the other hand, it creates strong pressures from politically powerful groups who stake a claim to rights over natural resources. Corruption in assigning property rights can be a serious problem.

Market Creation

In economic terms, the environment is a scarce, yet unmarketed and unpriced resource which is overused because it is free. A solution, thus, might be to create a market in which the right to use the environment (to extract resources or to absorb wastes) is assigned, priced, and traded. Total rights allocated would be determined by the desired level of environmental quality, and the initial distribution of transferable individual rights would set the stage for a market.[61] The market price would be determined by supply and demand. This would result in the most efficient use of resources – a property of any competitive market.

Markets have been theoretically shown to allow pollution reduction to be achieved at the lowest possible costs to society.[62] Over time, markets also induce industries to become increasingly more efficient in the use of the environment, as permits are limited (dynamic efficiency).

An excellent example of such a market is the Emissions Trading System set up to reduce Greenhouse Gas (GHG) emissions under the Kyoto Protocol. Firms and countries are assigned binding GHG emissions targets. They must either meet these targets by reducing emissions themselves, or must purchase permits from others who are able to reduce emissions beyond their targets.[63] A brief case study on the 'Carbon Market' is placed at Appendix 'C'.

Markets in environmental goods sometimes spring into existence spontaneously. One example is the flourishing market in groundwater that exists in parts of Gujarat[64] . While these markets are largely successful, they do have some undesirable characteristics – specifically, the sidelining of lower castes, which occurred because initial property rights were appropriated by higher castes. This is a reminder that the state must play a proactive role in the initial creation of markets.

Establishing a market in environmental goods has relatively high management costs :

(a) It requires monitoring of extraction / emissions at individual and collective levels.

(b) A system for enforcement of permit limits, including the use of punitive action.

Incentives for self-enforcement and group policing can however be introduced to minimize monitoring and enforcement costs. Markets can thus be a flexible and effective tool for environmental management.

Fiscal Instruments

Fiscal instruments such as taxes and subsidies can also be used to bridge the gap between private and social costs/benefits. For example, the prices of polluting products such as coal do not at present incorporate the true social cost of environmental damage. This leads to an overuse of these products. If an "environmental tax" equal to these uncounted social costs were imposed on coal, this overuse would be avoided. The result is not a zero level of pollution but an optimal level: where the marginal damage from pollution equals the marginal benefit of using the coal. Such a tax is known as a Peguvian tax, after the economist who first developed this idea.[65]

Environmental taxes can be levied on the pollutant itself (i.e., on emissions), or on final products. Taxes on pollutants, known as pollution charges, provide the maximum incentive and flexibility for the polluter to reduce pollution. However, they require the ability to monitor emissions. Taxes on products or inputs are easier to implement, and provide the same incentives to produce less. But they do not provide incentives for developing cleaner technologies. In either case, consumers are also likely to have to pay higher prices for polluting products. Thus, the burden of reducing pollution is shared by the producer and the consumer. Taxes on emissions and on products are common throughout the European Union, e.g. taxes on waste discharge into rivers in France, Germany and Netherlands.

Instead of taxing the polluters to reduce pollution to the optimal level, polluters can also be subsidized to do exactly that. The optimal environmental subsidy is also equal to the marginal environmental damage. The outcome in terms of environmental improvement and economic efficiency (cost of improvement is minimized) is exactly the same. However, the burden of environmental taxes falls on the producer and consumer while that of the subsidies falls on the taxpayers. In this connection, subsidies violate the polluter pays principle. An interesting subsidy incentive operates in Costa Rica, where land owners who chose to keep their land under forestry receive a subsidy in the form of a tax credit.[66]

Environmental taxes, if properly structured, can become a major thrust of fiscal policy reforms. Conventional taxation throughout the world taxes work, income, savings, and value added and leaves untaxed (even subsidizes) leisure, resource depletion, and pollution. This implies perverse incentives to work less and pollute more. A reform of the fiscal system could reduce conventional taxes and replace them with environmental taxes. This could leave the total tax burden unchanged, but bring society closer to sustainable development by stimulating economic growth and resource conservation and discouraging resource depletion and environmental pollution.

Emission taxes do face certain difficulties :

(a) Required knowledge of the marginal benefit and marginal cost of the activity;

(b) A low tax does not provide much of an incentive for environmentally sound behaviour, yet higher tax rates might be politically unfeasible.

Charge Systems

Charges are defined as payments for use of resources, infrastructure, and services. Charges may be thought of as "prices" for public goods or publicly provided private goods. They differ from prices for normal private goods because they are not market determined but are administratively set by a government agency or public utility.

These are commonly divided into two groups :

(a) Direct user charges : Direct or "active" user charges include municipal charges (e.g.. for water, electricity, etc.), road tolls, and access fees to wildlife parks, etc. These charges are analogous to prices for private goods.

(b) Indirect user charges : Indirect or "passive" user charges include betterment charges and impact fees. Betterment charges are usually imposed on private property which benefits from public investments. For example, private property values may increase as a result of new roads, parks, environmental clean ups, etc. Betterment charges may thus be imposed to collect revenues for financing the relevant public investment. This is an application of the beneficiary pays principle.

Financial Incentives

Financial instruments such as green funds, relocation incentives and subsidized interest or soft loans (for projects with significant positive externalities, e.g., reforestation) can be used as :

(a) Means of internalizing positive externalities;

(b) Environmentally minded investors' willingness to pay for responsible investments;

(c) Instruments for mobilizing additional financial resources for conservation, environmental protection, and sustainable development.

Liability Systems

This class of instruments aims to induce socially responsible behaviour by establishing legal liability for environmental damage. Specifically, they require a guilty party to pay the full cost of damage (such as pollution) ex-post, i.e., after the damage occurs and is evaluated. This acts as a "preventive incentive", but its effectiveness and efficiency is conditional upon the user's ability to perfectly identify and predict the environmental cost of his or her actions.

Performance Bonds and Deposit-Refund Systems

Environmental performance bonds and deposit refund systems aim to shift responsibility for controlling pollution, monitoring, and enforcement to individual producers and consumers who are charged in advance for the potential damage. Often, the state is saddled with unaffordable bills for cleaning up pollution, after the guilty party declares inability to pay. This can be avoided by instituting deposit-refund systems, environmental bonds, bank guarantees for compliance with environmental rules, etc., with refunds for better-than-expected performance. Environmental bonds need not be a constraint on economic activity, as they can be invested in interest-bearing accounts or replaced by bank guarantees.

Deposit-refund systems can similarly shift the responsibility for controlling environmental degradation to the producers and consumers of polluting products, who are thereby required to recycle or safely dispose of the by-products of their activities. Successful completion of recycling / treatment of all wastes results in a refund of the deposit made with the environmental regulator.

Environmental bonds and deposit-refund systems both suffer from favouring large over small producers, as the latter often have limited resources, making the provision of bank guarantees or deposits challenging.

Chapter Summary

The existing Command and Control system of environmental management has proved ineffective the world over, more so in the developing countries. The emerging concept of sustainable development has further strengthened the case for changes in the way nations tackle environmental issues. Full cost pricing has discovered the gap between the private cost of production and actual cost to society, obtained after adding the cost of subsidies, user costs and environmental damage costs. Internalisation of external costs or the polluter pays principle has been studied. With this background, the various economic instruments available were listed and discussed briefly. The economic incentives they provide if utilised effectively offer a new 'win –win' situation for producers and consumers alike. It now remains for a review of the status of environmental management in India, with a close look at the recently ratified National Environment Policy (NEP) 2006. This will be done in the next chapter.

CHAPTER VI

ENVIRONMENTAL MANAGEMENT IN INDIA

The previous chapters described essential elements of an economics approach to environmental management. This chapter provides an overview of the present environmental policy making scenario in India :

(a) **Organisational Structure.** Ministry of Environment and Forests (MoEF) is the nodal agency at the central level. Ministries of Rural Development, Water Resources, Agriculture, Urban Development etc. also implement several programmes. Almost all the state governments and union territories have departments looking after the environment. The 73rd Amendment (of the Constitution) Act, 1992 for panchayats and the 74th Amendment (of the Constitution) Act, 1992 for urban municipalities empowered local bodies to play a proactive role on environmental issues. PESA (Panchayats Extension to Scheduled Areas Act, 1996) strengthened the case of forest-dwelling tribals.

(b) **Budgetary Outlay.** An outlay of Rs. 5945 crores has been earmarked for the MoEF in the 10 th 5 year plan with the outlay for the current year 2006-07 being Rs. 1338.93 crores.[67]

(c) **Institutions.** The Central Pollution Control Board functions at the Centre to lay down standards and structure policy whereas the State Pollution Control Boards ensure the implementation of central policies. The MoEF has set up nine centres of excellence in different parts of the country. These institutions deal with R&D, education and training.

(d) **Legislation.** In general the MoEF has followed a policy of command and control in environmental management with numerous legislations and regulations. In terms of Durkheim's classification Indian environmental laws are repressive.[68] In Weber's sense the laws are prohibitive.[69] In terms of typologies adopted by the Asian Development Bank, the existing laws and rules come under the typologies "state-rule based" and "state-discretionary".[70]

In pre – independent India, most 'environmental rules' were detailed in the Indian Penal Code 1860. The Indian Easement Act of 1882 guaranteed property rights of riparian owners against 'unreasonable' pollution by upstream users and the Indian Forest Act of 1927 was passed to check cattle trespassing in forests. After 1947, environmental issues took a back seat in government policy. The Stockholm Conference (1972) encouraged the formulation of many policies and acts but it was the Bhopal gas tragedy in 1984 that jolted the country into action, with constitutional amendments, comprehensive policies and more importantly setting up infrastructure to ensure implementing of environmental policies. Some important legislations passed on environmental issues are tabulated at Appendix'D'.

National Environment Policy (NEP) 2006. The NEP was approved by the Union Cabinet on 18 May 2006. The objectives, principles and strategies are outlined in Appendix 'E'. Some salient features are mentioned below :

(a) The dominant theme of the policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from conservation, than from degradation of the resource.

(b) Environmental degradation is a major causal factor in enhancing and perpetuating poverty, particularly among the rural poor, when such degradation impacts soil fertility, quantity and quality of water, air quality, forests, wildlife and fisheries.

(c) If the costs (or benefits) of externalities are not re-visited on the party responsible for an original (polluting) act, the resulting level of the entire sequence of production or consumption, and externality, is inefficient. In such a situation, economic efficiency may be restored by making the perpetrator of the externality bear the cost (or benefit) of the same. The policy will, accordingly, promote the internalization of environmental costs. (The Polluter Pays Principle).

(d) Environmental resources should be given economic value, and such value should count equally along with the economic values of other goods and services, in analysis of alternative courses of action.

(e) Where the environmental benefits of a course of action cannot be imputed economic value the economic costs of realizing the benefits should be minimized (cost minimization).

(f) Efficiency of resource use may also be accomplished by the use of policy instruments that create incentives to minimize wasteful use and consumption of natural resources.

(g) The principle of efficiency also applies to issues of environmental governance by streamlining processes and procedures in order to minimize costs and delays.

Environmental management in India has essentially been one of Command and Control (CAC). After the Bhopal gas tragedy several comprehensive legislations have been brought into play and some (though still insufficient) monitoring and enforcing infrastructure has been set up. The NEP, 2006 has some refreshing and encouraging signs of shifting the tack of the policy to be more incentive based. The polluters pay principle, and cost minimization method, are examples of these novel ideas. However, the NEP 2006 does not issue specific guidelines or time frames for implementation of these concepts. The role of the judiciary needs special emphasis as having included the right to a clean environment as a fundamental right, the judiciary has offered a protective shield for all citizens of the country.

CHAPTER VII
ANALYSIS

There is much more to national development than economic development, or GDP growth rate. Several indicators of development have been recently introduced. The more comprehensive ones have a three pronged approach, addressing economic prosperity, individual and community welfare and most importantly environmental protection. The HDI, Gini Index etc have their place, but achievement of the Millennium Development Goals appears to be a comprehensive tool to assess national development for the next decade.

At present we live in an unsustainable world, using up the earth's natural resources much faster than the earth can replenish them – we are consuming natures' 'capital' as natures' 'interest' is insufficient to meet the demands of humanity.

The bane of inequality among nations contributes to global environmental degradation and depletion as the developed economies continue to use and pollute natural resources at will. They use much more than their earth share, with 20 percent of the world's population responsible for 86 percent of private consumption. The developing and transitional nations see environmental protective measures as economically restrictive and therefore the exclusive concern of developed countries.

India's MDGs are strongly linked to environmental issues. As we speed along the path of economic progress, we need to manage our environment wisely so as to sustain our healthy growth rate. We are already a declared water stressed state, yet our water is under-priced. Our forest cover is being denuded though 100 million Indians live in proximity to forests. A corollary to this is soil erosion and floods which further shrink our limited arable land. Our energy needs will increase three to four times, over the next two decades. These are serious issues which if not addressed will significantly hamper national development. This urgency was in evidence when our President Sri Abdul Kalam addressed the nation on the eve of the 59th Independence day, when more than 60 percent of his speech was on environmental issues.

Environment Management in most of the developing world is one of Command and Control measures. The rules lay down pollution limits and emission standards, which are not even monitored let alone enforced.

The study has demonstrated that in developing countries Command and Control measures have prohibitive governmental and social costs. The technology and the trained human resource, required to monitor environmental pollution and the legislative power to prosecute offenders is extremely difficult to develop and sustain. The answer then is to have an incentive based system wherein even when an individual or an agency is working purely in his own interest, his activity is still beneficial to the environment. Though this seems not feasible at the outset, the use of environmental economics makes such incentives realities.

Placing a price on environmental resources is the first step in educating the population in general and the decision-makers in particular that the earth's resources are not free issues. Ecosystem valuation is a complex and evolving science that places market and non-market values on most of the environments assets.

Economic instruments are a promising approach to environmental management. The advantages of economic instruments for a rapidly developing country like India are:

(a) Ability to correct markets to reflect social objectives. This results in moving the economy towards efficient utilization of scarce resources. Resource intensive activities cost more, their demand reduces, as does production leading to resource conservation.

(b) Efficiency or cost-minimization abilities. This allows the limited resources available for environmental protection to be used in the most cost-effective fashion.

(c) Ability to stimulate technological innovation. Economic instruments contribute to growth by creating sustained incentives for innovation.

(d) Peguvian taxes tax pollutants, inputs or products. Unlike taxes in vogue which tax work, income and value addition. Reducing conventional taxes, while introducing Peguvian taxes would ensure governmental revenue, without increasing the tax–payer's burden.

(e) Poverty alleviation. If the poor who depend on natural resources for their survival are granted secure property rights, efficiency gains can be accompanied by equity gains.

Economic instruments cannot replace CAC approaches overnight. Instead, they must initially seek to support them by making them more flexible and cost effective. Property rights, tradable permits and other mutually beneficial exchanges can gradually be phased in as capacity to implement economic instruments is built up.

National Environment Policy 2006 has incorporated the concepts of environmental economics. It is now required that the necessary legislation is put in place to give 'teeth' to the policy. Infrastructure is already in place. Technology and trained human resource should be rapidly acquired.

CHAPTER VIII
RECOMMENDATIONS AND CONCLUSION

Given the importance of environmental management for India's national development, and keeping in mind the analysis provided above, the following recommendations are made:

(a) Attempts towards full-cost pricing should be made with all resources, even if full-fledged economic instruments are not introduced. This is particularly urgent in the case of water resources. Water must be priced so as to factor in the very real depletion and environmental costs. This can be done relatively easily for piped water supplies. For groundwater, it may be easier to achieve full-cost pricing by rationalizing electricity prices.

(b) The knowledge base of economic instruments for environmental management must be increased. The principles of full-cost pricing and internalization of external costs must be made understandable and acceptable to policy makers, industry and the public.

(c) Economic instruments must be given a legal and policy basis. This will require replacing portions of existing legislations and regulations (such as inflexible and arbitrary standards), while strengthening other (such as ability to impose charges for pollution).

(d) Appropriate human resources must be built up. In particular, environmental economists, financial analysts, environmental tax experts, must be trained. The possibility of sourcing such expertise from abroad might be explored as a temporary arrangement.

(e) Capacity for monitoring environmental performance of firms should be increased. Involving local governments and NGOs in this process might be an effective option. On-site testing of pollution must be made possible. This will require investment in hardware and training. Incentives may be provided to staff of monitoring agencies such as State Pollution Control Boards for detecting violations.

(f) Economic instruments should be gradually phased-in, over a five to ten year period. It is preferable to begin with nominal charges—based on solid principles that earn wide acceptance and support—and to gradually work towards full implementation on a pre-announced schedule. Gradual implementation helps protect the competitiveness of industry by giving it time to prepare.

(g) Instruments must de differentiated according to scale. For example, large industrial conglomerates could be regulated through tradable permits, emission charges or even standards, since they can be more easily monitored. Taxes on output would be more appropriate from smaller-scale industries.

Conclusion

Environmental protection has become one of the foundations of efficient and sustainable development. From being caught in a trade-off with economic growth environmental management has become a source of growth, considered an economic liability, today efficient environmental management is a potential economic asset.

Environmental management is crucial to India's national development, both in the short and long-term. In the short-term, environmental problems must be resolved to meet a variety of development goals. In the long-term, prudent use of natural resources is a requirement for sustainable development.

The concept of the economic value of environmental goods is soon to be introduced in India and judicious use of the array of available economic instruments is also planned in the National Environment Policy 2006. There is a need to invest in modern technology and to build a trained work force. Above all there is a need to develop the political will to follow the new environment policy in letter and in spirit.

References

1. United Nations, Rio Declaration on Environment and Development, United Nations, 1992, p.151.

2. James Gordon Brown, the British Chancellor of the exchequer, in a speech to the United Nations Ambassadors, on 20 April 2006, outlined a "Green" view of global development.

3. Paraphrased from F. M. Andrews, "Population issues and social indicators of well-being", *Population & Environment*, vol. 6, iss. 4, pp. 210-230.

4. Manoj Panda, "Macroeconomic scene: growth and equity perspectives", in K.S. Parikh, ed., *India Development Report, 2004-2005*, New Delhi:Oxford University Press, 2004.

5. J. McNeill, "GDP growth and human wellbeing: a brief look at why we need a better measure of progress", *New England Perspectives*, vol. 3, pp. 135–144.

6. W. D. Nordhaus and J. Tobin, *Is Growth Obsolete?*, University Microfilms International, 1973.

7. Richard B. Freeman, "The Rising Tide Lifts...?" NBER Working Papers 8155, NBER.

8. To quote Paul Ehrlich of Stanford University, "We must acquire a lifestyle which has as it's goal maximum freedom and happiness for the individual and not maximum GNP." Ehrlich P R, "Human Nature : Genes, Cultures, and the Human Prospect" *Science*, 2000.

9. W D Nordhaus and J. Tobin, *Is Growth Obsolete?* Columbia University Press,1972.

10. J. Rowe and M. Anielski, The Genuine Progress Indicator, Redefining Progress, 1999.

11. C. W. Cobb, et al., Why Bigger Isn't Better: The Genuine Progress Indicator: 1999 Update, Redefining Progress, 1999.

12. S. Anand and A. K. Sen, Human Development Index: Methodology and Measurement, Human Development Report Office, United Nations Development Programme, 1994.

13. United Nations, Human Development Report 2003, New York: UNDP: 2003.

14. J. L. Gastwirth, “The Estimation of the Lorenz Curve and Gini Index”, *The Review of Economics and Statistics*, vol. 54, iss. 3, pp. 306-316.

15. X. Wu and J. M. Perloff, “China’s Income Distribution over Time: Reasons for Rising Inequality”, CUDARE Working Papers (University of California, Berkeley) paper, vol. 977.

16. Happy Planet Index, http://www.happyplanetindex.org/

17. Stefan Priesner, “Gross National Happiness–Bhutan’s Vision of Development and its Challenges”, in S. Kinga, et al., ed., *Gross National Happiness*, Thimphu:The Centre for Bhutan Studies, 1999, pp. 24-52.

18. United Nations General Assembly, United Nations Millennium Declaration, New York: UN Headquarters, 2000.

19. In economic terms, this is explained by the higher marginal utility of income and lower willingness to pay for environmental quality in developing countries.

20. R. K. Pachauri and P. V. Sridharan, ed. *Looking Back to Think Ahead: GREEN India 2047*. New Delhi:TERI, 1998, p. 346.

21. M. F. Ahmed, “Asia-Pacific Forestry Sector Outlook Study: In Depth Country Study–India”, FAO Working Paper Series: Asia-Pacific Forestry Towards 2010, No. APFSOS/WP/26 (Rome: FAO).

22. N. C. Saxena, The Woodfuel Scenario and Policy Issues in India, Food and Agriculture Organization of the United Nations, 1997.

23. Ahmed. n. 21.

24. Utsa Patnaik, “Food and Land Use: Sustainable Development in India in the Context of Global Consumption Demands”, in R. Sengupta and A.K. Sen, ed., *Challenge of Sustainable Development - The Indian Dynamics*, Calcutta:Indian Institute of Management, Calcutta 2001, pp. 163-198.

25. Rakesh Nath, Lecture on Energy Scenario in India at the NDC on 14 March 2006.

26. Gro Harlem Brundtland, World Commission on Environment and Development: Our Common Future, Oxford University Press, 1987.

27. Friends Of the Earth, www.foe.org

28. C. Tickell, "Human responsibility in the global environment", *Asian Affairs*, vol. 33, iss. 2, pp. 206-215.

29. Commonly attributed to Steve Goldfinger.Personal Communication. Wackernagel et al, *Sharing Natures Interest*, London and Sterling : Eartscan Publications Ltd, 2000.

30. I.U.C.N., et al., Caring for the Earth: A Strategy for Sustainable Living, Gland: IUCN, 1991.

31. United Nations, Report of the World Summit on Sustainable Development, Johannesburg: United Nations, 2002, p. 174.

32. Wackernagel M, n. 29.

33. William Rees, "Our Ecological Footprint: Reducing Human Impact on the Earth", New Society Publishers.

34. Or, alternatively, 2*x* hectares of land take 6 months to sustainably produce the resources required.

35. United Nations, Human Development Report 2003, New York: UNDP: 2003.

36. M. Wackernagel and W. Rees, *The ecological footprint*, Gabriola Island, Canada: New Society, 1996.

37. Ibid

38. J. R. Hicks, "The Foundations of Welfare Economics", *The Economic Journal*, vol. 49, iss. 196, pp. 696-712.

39. Money as a "measuring rod" – a common unit for comparison.

40. It is often incorrectly assumed that a good's market price measures its economic value. However, the market price only tells us the *minimum* amount that people who buy the good are willing to pay for it. When people purchase a marketed good, they compare the amount they would be willing to pay for that good with its market price. They will only purchase the good if their willingness to pay is equal to or greater than the price. Many people are actually willing to pay more than the market price for a good, and thus the value they place on the good exceeds the market price.

41. M. J. Scott, et al., "Valuation of Ecological Resources and Functions", *Environmental Management*, vol. 22, iss. 1, pp. 49-68.

42. R. S. De Groot, et al., "A typology for the classification, description and valuation of ecosystem functions, goods and services", *Ecological Economics*, vol. 41, iss. 3, pp. 393-408.

43. Ibid.

44. P. J. Edwards and C. Abivardi, "The value of biodiversity: Where ecology and economy blend", *Biological Conservation*, vol. 83, iss. 3, pp. 239-246.

45. H. Goulder and D. Kennedy, "Valuing ecosystem services: philosophical bases and empirical methods", in G.C. Dailly, ed., *Nature's Services: Societal Dependence on Natural Ecosystems*, Washington, D.C.:Island Press, 1997, pp. 23–48.

46. J. Loomis, et al., "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey", *Ecological Economics*, vol. 33, iss. 1, pp. 103-117.

47. Dollar based Ecosystem valuation Methods http:www.ecosystemvaluation.org

48. M E Jenson and PS Bourgeron, A Guide Book for Integrated Ecological Assessments,Springer.

49. Consumer surplus is measured by the maximum amount that people are willing to pay for a good, minus what they actually pay. Similarly, producer surplus is measured by the difference between the total revenues earned from a good, and the total variable costs of producing it. These can be measured by referring to the marginal benefit and marginal costs curves (better known as the demand and supply curves) for the product.

50. This is not a new idea. The foundations for environmental economics are laid in the work of Arthur Cecil Pigou (1920) and J.H. Dales (1968). The former suggested that corrective taxes be used to discourage activities that generate externalities. The latter showed that transferable property rights allow meeting environmental goals at the lowest possible cost to society.

51. An externality is a "side-effect" not accounted for in market prices.

52. For efficiency, emission reductions should be achieved where they are cheapest.

53. OECD, Evaluating Economic Instruments for Environmental Policy, Paris: OECD, 1997.

54. National Environment Policy 2006, MoEF, Govt Of India,2006.

55. United Nations, Rio Declaration on Environment and Development, United Nations, 1992, p. 151.

56. Theodore Panayotou, Economic Instruments for Environmental Management and Sustainable Development, UNEP, 1994.

57. For example, successive US Presidents since George H. Bush have made BCA a compulsory part of public projects with significant health or environmental projects.

58. K. J. Arrow, et al., "Is there a role for benefit-cost analysis in environmental, health, and safety regulation?" *Environment and Development Economics,* vol. 2, iss. 02, pp. 195-221.

59. "Internal" means that all costs and benefits are actually borne by the agent using the resource, while "external" means that at least some costs or benefits accrue to others. These external costs and benefits are not taken into account by the agent using the resource.

60. For example, cutting down the rainforest now means that future benefits from discovering new medicines are lost.

61. Thus, property rights are a prerequisite for such markets. Whom the rights are assigned to has important distributive implications.

62. J. H. Dales, *Pollution, Property and Prices*, Toronto: University of Toronto Press, 1968.

63. Indian firms already earn an estimated US $1 billion annually from selling GHG emission reductions to Europe, Japan and Canada.

64. N K Dubash, *Tubewell Capitalism : Groundwater development and Agrarian Changes in Gujarat*, New Delhi : 2002.

65. Arthur Cecil Pigou, *The Economics of Welfare*, London: Macmillan, 1920.

66. Panayotou, n.56.

67. The Annual Report 2005 - 06, MoEF, Govt of India, 2006.

68. E. Durkheim, *The Division of Labor in Society*, New York: Macmillan, 1984.

69. M. Weber, *Economy and Society*, University of California Press, 1978.

70. K. Pistor and P. A. Wellons, The role of law and legal institutions in Asian economic development, 1960-1995, ADB Report, Oxford: Oxford University Press, 1999.

BIBLIOGRAPHY

Books & Journals

1. Homer-Dixon, Thomas F. *Environment, Scarcity and Violence.* Princeton, NJ: Princeton University,1999.
2. Anand, S. and A. K. Sen, *Human Development Index: Methodology and Measurement*, Human Development Report Office, United Nations Development Programme, 1994.
3. Brundtland, G. H., *World Commission on Environment and Development: Our Common Future*, Oxford University Press, 1987.
4. Cobb, C. W., et al., Why Bigger Isn't Better: The Genuine Progress Indicator: 1999 Update, Redefining Progress, 1999.
5. Dales, J. H., *Pollution, Property and Prices*, Toronto: University of Toronto Press, 1968, pp. 111.
6. Dubash, N. K., *Tube well Capitalism: Groundwater Development and Agrarian Change in Gujarat*, Oxford University Press, 2002.
7. Durkheim, E., *The Division of Labor in Society*, New York: Macmillan, 1984.
8. Ehrlich Paul R, "Human Nature : Genes, Cultures and the Human Prospect", *Science*, 2000.
9. Goulder, L. H. and D. Kennedy, "Valuing ecosystem services: philosophical bases and empirical methods", in G. C. Daily, ed., *Nature's Services: Societal Dependence on Natural Ecosystems*, Washington, D.C.:Island Press, 1997, pp. 23–48.
10. I.U.C.N., et al., Caring for the Earth: A Strategy for Sustainable Living, Gland: IUCN, 1991.
11. Nordhaus, W. D. and J. Tobin, Is growth obsolete?, University Microfilms International, 1973.
12. OECD, Evaluating Economic Instruments for Environmental Policy, Paris: OECD, 1997.
13. Opschoor, J. B. and H. B. Vos, Economic instruments for environmental protection, OECD, 1989.
14. Pachauri, R. K. and P. V. Sridharan, ed. *Looking Back to Think Ahead: GREEN India 2047*. New Delhi: TERI, 1998, p. 346.

15. Panda, M., "Macroeconomic scene: growth and equity perspectives", in K. S. Parikh, ed., *India Development Report, 2004-2005*, New Delhi: Oxford University Press, 2004.
16. Parikh, K. S., ed. *India Development Report, 2004-2005*. New Delhi: Oxford University Press, 2004.
17. Patnaik, U., "Food and Land Use: Sustainable Development in India in the Context of Global Consumption Demands", in R. Sengupta and A.K. Sen, ed., *Challenge of Sustainable Development - The Indian Dynamics*, Calcutta: Indian Institute of Management, Calcutta 2001, pp. 163-198.
18. Pigou, A. C., *The Economics of Welfare*, London: Macmillan, 1920.
19. Pistor, K. and P. A. Wellons, *The role of law and legal institutions in Asian economic development, 1960-1995*, ADB Report, Oxford: Oxford University Press, 1999.
20. Priesner, S., "Gross National Happiness–Bhutan's Vision of Development and its Challenges", in S. Kinga, et al., ed., *Gross National Happiness*, Thimphu: The Centre for Bhutan Studies, 1999, pp. 24-52.
21. Rowe, J. and M. Anielski, The Genuine Progress Indicator, Redefining Progress, 1999.
22. Saxena, N. C., The Woodfuel Scenario and Policy Issues in India, Food and Agriculture Organization of the United Nations, 1997.
23. Tietenberg, T. H., *Environmental and natural resource economics*, Addison-Wesley Reading, MA, 2000.
24. Wackernagel, M. and W. Rees, *The ecological footprint*, Gabriola Island, Canada: New Society, 1996.
25. Weber, M., "Economy and Society", University of California Press, 1978. Articles in Periodicals.
26. Ahmed, M. F., "Asia-Pacific Forestry Sector Outlook Study: In Depth Country Study–India", FAO Working Paper Series: Asia-Pacific Forestry Towards 2010, No. APFSOS/WP/26 (Rome: FAO).
27. Andrews, F. M., "Population issues and social indicators of well-being", *Population & Environment*, vol. 6, iss. 4, pp. 210-230.
28. Arrow, K. J., et al., "Is there a role for benefit-cost analysis in environmental, health, and safety regulation?" *Environment and Development Economics*, vol. 2, iss. 02, pp. 195-221.

29. Balmford, A., et al., “Economic Reasons for Conserving Wild Nature”, *Science*, vol. 297, iss. 5583, pp. 950-953.

30. Bockstael, N. E., et al., “On measuring economic values for nature”, *Environmental Science & Technology*, vol. 34, iss. 8, p. 1384-1389.

31. Cobb, C., et al., “If the GDP is up, why is America down”, *The Atlantic Monthly*, vol. 276, iss. 4, pp. 59-78.

32. Colfer, C. J. P., et al., “Understanding local people’s use of time: a precondition for good co-management”, *Environmental Conservation*, vol. 26, iss. 01, pp. 41-52.

33. De Groot, R. S., et al., “A typology for the classification, description and valuation of ecosystem functions, goods and services”, *Ecological Economics*, vol. 41, iss. 3, pp. 393-408.

34. Edwards, P. J. and C. Abivardi, “The value of biodiversity: Where ecology and economy blend”, *Biological Conservation*, vol. 83, iss. 3, pp. 239- 246.

35. Freeman, R. B., “The Rising Tide Lifts...?” NBER Working Papers 8155, NBER.

36. Gastwirth, J. L., “The Estimation of the Lorenz Curve and Gini Index”, *The Review of Economics and Statistics*, vol. 54, iss. 3, pp. 306-316.

37. Hahn, R. W. and R. N. Stavins, “Economic Incentives for Environmental Protection: Integrating Theory and Practice”, *The American Economic Review*, vol. 82, iss. 2, pp. 464-468.

38. Hamilton, C., “Economic growth and social decline”, *AQ: Journal of Contemporary Social Analysis*, vol. 70, iss. 3, pp. 22–30.

39. Hamilton, C. and H. Saddler, “The Genuine Progress Indicator”, The Australia Insitute, Discussion Papers, vol. 14.

40. Hardin, G., “The Tragedy of the Commons”, *Science*, vol. 162, iss. 3859, pp. 1243-1248.

41. Hicks, J. R., “The Foundations of Welfare Economics”, *The Economic Journal*, vol. 49, iss. 196, pp. 696-712.

42. Holling, C. S. and G. K. Meffe, “Command and Control and the Pathology of Natural Resource Management”, *Conservation Biology*, vol. 10, iss. 2, pp. 328-337.

43. Loomis, J., et al., “Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey”, *Ecological Economics*, vol. 33, iss. 1, pp. 103-117.

44. Loomis, J., et al., "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey", *Ecological Economics*, vol. 33, iss. 1, pp. 103-117.
45. McNeill, J., "GDP growth and human wellbeing: a brief look at why we need a better measure of progress", *New England Perspectives*, vol. 3, pp. 135– 144.
46. Panayotou, T., "Economic Instruments for Environmental Management and Sustainable Development", Environmental Economics Series Paper, pp. 23– 24.
47. Rees, W., "Our Ecological Footprint: Reducing Human Impact on the Earth", New Society Publishers.
48. Scott, M. J., et al., "Valuation of Ecological Resources and Functions", *Environmental Management*, vol. 22, iss. 1, pp. 49-68.
49. Tickell, C., "Human responsibility in the global environment", *Asian Affairs*, vol. 33, iss. 2, pp. 206-215.
50. Tietenberg, T. H., "Economic instruments for environmental regulation", Oxford Review of Economic Policy, vol. 6, iss. 1, pp. 17.
51. Woodward, R. T., "Nature's Numbers: Expanding the National Economic Accounts to Include the Environment," *Land Economics*, vol. 76, iss. 3, pp. 486- 490.
52. Wu, X. and J. M. Perloff, "China's Income Distribution over Time: Reasons for Rising Inequality", CUDARE Working Papers (University of California, Berkeley) paper, vol. 977.

Reports

53. India, MoEF, Annual Report 2005 – 06.
54. India Development Report 2004 – 05, Indira Gandhi Institute of Development Research, Oxford, 2005.
55. United Nations, Rio Declaration on Environment and Development, United Nations, 1992, p. 151.
56. United Nations, Report of the World Summit on Sustainable Development, Johannesburg: United Nations, 2002, p. 174.
57. United Nations, Human Development Report 2003, New York: UNDP: 2003.

58. United Nations, Human Development Report 2005, New York: UNDP: 2005.

59. United Nations General Assembly, United Nations Millennium Declaration, New York: UN Headquarters, 2000.

Internet

60. Happy Planet Index, http://www.happyplanetindex.org/

61. Social Watch India, http://www.socialwatchindia.com/mdg.htm

62. Friends Of the Earth,http:// www.foe.org

63. Ecosystem Valuation, http://www.ecosystemvaluation.or

APPENDICES

APPENDIX A

(Refers to Chapter II)

Calculation of Human Development Index (HDI) of India

To calculate the HDI of a nation, an index is worked out for each of the three dimensions - Longevity, Education and GDP. These three indices which are free indices between 0 and 1 are then averaged to get the HDI of the country. To obtain these indices maximum and minimum indicator values are decided upon. These are , for life expectancy at birth, 85 and 25 years; for adult literacy rate 100 and 0%, for combined gross enrolment ratio 100 and 0% and for GDP per capita (PPP US$) 40,000 and 100.The formula used is as follows :

X index = (x) – Min (x)

Max (x) – Min (x)

(1) The calculation for India as per HDR 2006 based on UNDP 2003 figures is given below :

(a) Life Expectancy Index. This index measures the countries achievements with regard to life expectancy at birth.

Life Expectancy Index = LE – 25 = 63.3-25 = 0.64

85 – 25 60

(b) *Education Index*. This index measures a country's relative achievement in both adult literacy and combined primary, secondary and tertiary gross enrolment. First, an index for adult literacy and one for combined gross enrolment are calculated. Then these two indices are combined to create the education index, with two-thirds weight given to adult literacy and one-third weight to combined gross enrolment. Adult Literacy Index = Adult Literacy Rate(ALR) = 61 = 0.610 100 100 Gross Enrolment Index = Gross enrolment Rate(GER) = 60 =0.600 100 100 Therefore Education Index = ALI + GEI = ×0.610 +×0.600 = 0.614

(c) *GDP Index*. This index uses adjusted GDP per capita (PPP US$) values. In the HDI, income is the indicator for all the dimensions of human development not reflected in a long and healthy life and in knowledge. Income is adjusted because achieving a respectable level of human development does not require unlimited income. Accordingly, the logarithm of income is used. GDP Index = log (GDP) – log (100) = log 2892 – log 100 = 0.56 log(40000) – log (100) log 40000 – log 100

(d) *Computing India's HDI.* Once the dimension indices have been calculated, determining the HDI is straight-forward. It is a simple average of the three dimension indices. LE Index + Edn Index + GDP Index = 0.64 +0.61+0.56 = 0.602 3 3

APPENDIX B

(Refers to Chapter II)

Comparison of MDGs, Tenth 5-Year Plan Goals and Common Minimum Programme (CMP)

Source: Social Watch India

MDGs	India's 10th 5-YEAR PLAN	CMP GOALS
1. Eradicate extreme poverty and hunger		
i. Reduce by half the proportion of people living on less than one dollar per day.	Reduction of poverty by 5 percentage points by 2007 and by 15 percentage points by 2010.	Enact the National Employment guarantee act. 100 days employment every year for one able bodied person of every rural and urban poor and lower middle class household. Strengthen the public distribution system in

ii. Reduce by half the number of people suffering from hunger.		poorest and backward blocks of the country. Antyodya cards for every household at risk of hunger. National programmes for minor irrigation of all lands owned by dalits and adivasis.
2. Achieve universal primary education		
Ensure that all boys and girls complete a full course in primary education.	All children to be in school by 2003. All children to complete 5 years of schooling by 2007.	Provide a functioning Anganwadi for all settlements and ensure full coverage for all children. To raise public spending on education to at least 6 per cent of the GDP with half the amount being spent in sec education.
3. Promote gender equality and empower women		
Eliminate gender inequality in primary and secondary education by 2005 and at all levels by 2015.	Reduction of gender gaps in literacy and wage rates by at least 50 percent by 2007.	Introduce legislation for the reservation of 1/3rd women in Lok Sabha and Vidhan Sabha. 1/3rd of funds of the Panchayats to be for women and child development.
4. Reduce child mortality		
Reduce by 2/3rd the mortality for children under 5 years of age.	Reduce IMR to 45 by 2007 and to 20 by 2012.	To raise public spending to 2-3 per cent of GDP for maternity & child health care.
5. Reduce maternal mortality		
Reduce MMR by 3/4th	Reduce MMR to 28 by 2012.	Introduce a national scheme for health insurance for poor families.
6. Combat HIV/AIDS Malaria and other diseases		
Halt and reverse the trend of HIV/AIDS		

Halt and reverse the trend of Malaria, TB and other diseases. – –		
7. Ensure environmental sustainability		
Integrate sustainable development into development programmes.	Increase forest/tree cover by 25 percent by 2007 and by 33 per cent by 2012.	Ownership rights of minor forest produce to the forest developer. No further eviction of tribals from forests.
Reduce by half the proportion of people without access to potable water.	All villages to have sustained access to potable water by 2007.	
Achieve a significant improvement in the lives of slum dwellers by 2020.	Cleaning of all major rivers by 2007.	

APPENDIX C

(Refers to Chapter V)

THE CARBON MARKET

Introduction

Carbon credits are a measure devised by the Kyoto Protocol to reduce world Greenhouse Gas emissions (GHG), and hence fight climate change. A provision of the Kyoto protocol called the "clean development mechanism,"(CDM) allows people, companies and states to claim to reduce their GHG emissions by investing in carbon-friendly projects in poorer countries or countries whose GHG emissions are within the prescribed limits. Carbon credit trading can also be enacted through the unofficial carbon market and carbon credits can be gained by 'green' activities such as planting trees

Countries whose GHG emissions are within prescribed limits

Since India's and China's CHG emission are below the level stipulated in the Kyoto Protocol, they can sell carbon credits to developed nations. China was by far the largest seller in the CDM market, with a 67 per cent market share in 2005, up from only 5 per cent in 2004. India, which had a 43 percent market share in 2004, represented only 3 per cent of sellers in 2005. Many Indian sellers had been holding back in expectation of rising prices. Japanese private companies continue to be major buyers of project-based carbon credits, taking a 46 per cent market share in 2005 compared with 36 per cent in 2004. The Netherlands accounted for 10 per cent of the market in 2005, down from 19 per cent in 2004.

Incentives for Non–Polluting Industries in Developing Countries

With the clean development mechanism (CDM) in place, a host of Indian companies are eyeing additional earnings by adopting projects that reduce the emission of greenhouse gases. If a company has a project that does not emit any greenhouse gas, it can qualify for carbon credits under the clean development mechanism (CDM) of the Kyoto Protocol. CDM gives carbon credits or certified emission reduction (CER) units to clean energy projects in a developing country. These credits can be sold to companies in industrialised countries. Sectors such as cement, sugar, paper, iron and steel, and the power sector that includes biomass generation, and hydro and wind energy projects, can trade carbon in the CDM. A conglomerate of leading sugar companies ventured into co-generation of power in 2005. These companies will generate around 700 mw of clean energy and earn nearly US$ 31.5 million.

The Procedure for Carbon Trading

The National CDM Authority, under the MoEF, is a single window clearance for such projects. After the clearance, CDM projects have to be approved by and registered with the executive board of the United Nations Framework Convention on Climatic Change. Trading takes place on two stock exchanges, the Chicago Climate Exchange and the European Climate Exchange. Carbon credits trading can also take place in the open market.

Is Carbon the Latest Hard Currency in the world?

Karan Capoor, Senior Financial Specialist, World Bank and the chief author of 'State of the Carbon Market 2006 Report' says, "…carbon is now a financial commodity. It is now priced and business managers take the carbon price into consideration along with other factors in making business decisions". The global carbon market could be worth $25-30 billion in 2006, based on volumes in the first four months of the year, compared to about $11 billion in 2005. Is carbon then the newest hard currency of the world?

APPENDIX D

(Refers to Chapter VI)

Environment-related legislations in India

Legislation	Key Points
Factories Act,1948	• Treatment of liquid effluent, gas and fumes before final disposal.
42nd Constitutional Amendment Act, 1972	• Article 48A - Directive Principle of State Policy to improve environment, safeguard forests and wildlife. • Article 51 A (g) Fundamental Duties of citizens to improve the environment.
Wildlife Protection Act, 1972	• Prohibition of poaching, licensed hunting, delineating sanctuaries. • Identifying endangered species
Water Prevention and Control of Pollution Act 1972	• Defines pollution and sets standards • Sets up Central and State Pollution Control Boards
Water Cess Act, 1972	• Cess of 1.5 to 5 paisa per kilo-litre of water use
Forest Conservation Act, 1980	• Prevent deforestation • Increase forest cover
Air (Prevention and Control of Pollution) Act, 1981	• Defines pollution, setting standards, nation-wide policies.
73rd and 74th Constitutional Amendments	Devolution of power to local bodies • 11th Schedule :soil conservation,

	water management, social forestry and non-conventional energy (panchayats). • 12th schedule : water supply, public health and sanitation, solid waste management and environmental protection (municipalities).
The Environment (Protection) Act, 1986	• An all encompassing comprehensive Act that defines issues, sets standards, outlines penalties and promotes R&D
National Forest Policy, 1988	• Promote the long term viability of commercial forests
Hazardous Waste Rule 1989	• Inventory of hazardous waste (HW) generating units • Storage, transport and disposal of HW
The Public Liability Insurance Act, 1991	• Specifies reimbursements and compensations to employees/public by industries that handle hazardous substances
The National Environment Tribunal Act, 1995 The Biodiversity Act, 2002	• Swift disposal of cases related to damage to persons/property or environment • Establishment of National Biodiversity Authority
Judicial Activism (Fundamental rights)	• The interpretation of Article 21 of the Constitution to include the right to clean air and water by the Supreme Court and the High Courts,

APPENDIX E

(Refers to Chapter VI)

National Environment Policy 2006

Objectives of the National Environment Policy

(a) Conservation of Critical Environmental Resource

(b) Intra-generational Equity: Livelihood Security for the Poor

(c) Inter-generational Equity

(d) Integration of Environmental Concerns in Economic and Social Development

(e) Efficiency in Environmental Resource use

(f) Good Environmental Governance

(g) Enhancement of Resources for Environmental Conservation

Principles of the NEP 2006

(a) Human Beings are at the Centre of Sustainable Development Concerns

(b) The Right to Development: Present and Future generations

(c) The Precautionary Approach :To prevent Environmental degradation

(d) Economic Efficiency: Polluter Pays and Cost Minimization

(e) Entities with Incomparable Value

(f) Equity: intra/intergenerational

(g) Legal Liability : Switch from criminal to civil liability

(h) Public Trust Doctrine : State the trustee/people the owners

(j) Decentralization

(k) Integration : of environmental considerations in sectoral policy making

(l) Environmental Standard Setting

(m) Preventive Action

(n) Environmental Offsetting

Strategies and Actions

(a) Regulatory Reform – revisiting the policy and legislative framework and ensure accountability at all levels.

(b) Process related Reforms – hasten investment approval and implementation procedures (Govindarajan Committee.)

(c) Legislative Reforms – more civil and less criminal liability laws and sanctions

(d) Substantive Reforms : In environment and forest clearance, Coastal Regulatory Zones(CRZ)and Integrated Coastal zone management (ICZM), Living modified Organisms (LMOs), Identification of Environment sensitive Zones.

(e) Monitoring of Compliance : By greater involvement of those impacted by environmental insensitivity – PRIs and Municipalities

(f) Economic Principles in Environmental Decision making – Natural resource accounting

Enhancing and Conserving Environmental Resources

(a) Identify the causes of degradation and specific methods of addressing them.

(b) Land Degradation: Focus on sustainable land use.

(c) Desert Ecosystems: Intensive water conservation.

(d) Forests: Implement PESA 1996 : Increase forest cover to 33 percent by 2012.

(e) Wildllife : Expand protected area network : protect endangered species.

(f) Biodiversity: research traditional knowledge: Promote natural history sites 'biodiversity hotspots'.

(g) Fresh Water: Integrate river basin management: Care of superficial and deep aquifers ; study impact on ground water tables of electricity tariffs and diesel pricing.

(h) Wetlands: Prepare a national inventory of Ramsar sites.

(j) Mountain Ecosystems: check uncontrolled urbanization; incomparable value of mountains.

(k) Coastal Reserves: Ecosystem preservation, mangrove and coral reef cultivation.

(l) Pollution abatement: air, water, soil, noise.

(m) Conservation of man-made heritage.

(n) Climate change: Benign GHG growth rate; Promote CDM projects.

(o) Environment standards / Environment management systems / Ecolabeling / Certification and Indicators

(p) Clean Technology: Awareness education and Information

(q) Partnerships/ Stakeholders/initiatives: Forming various groups like Public Community Partnership (PCP), Public Private Partnership (PPP) Public Voluntary Organisation Private Partnership etc.

Additional Issues

(a) Capacity Building

(b) Research & Development

(c) International Cooperation

(d) Review of NEP 2006 every 3 years

(e) Implementation and Monitoring - every year by a cabinet (appointed) committee.

WATER SECURITY: PERSPECTIVE INDIA, 2025 AD

By
Col DS Pathania

Synopsis

Water available on this planet is finite; it has neither grown nor shrunk. Only about 1 percent of the planet's fresh water is easily accessible for human use. Water is a basic need "of all peoples, whatever their stage of development" and is of crucial importance in three sectors - agriculture, industry and domestic use.

However, the human population in the last century has tripled from 2 billion to 6 billion and is expected to touch 8 billion by 2025. Water pollution and climate change have put tremendous strain on segments of populations on this globe, turning them to become water stressed or under water crisis groups thereby threatening their growth even survival. It is believed that by 2025, 40 percent of the global population will be water stressed.

Such resource constraints can lead to social friction and conflict situations. Ever since the Bruntland Commission report on environmental protection was published, water security has assumed a new significance in the overall context of human security. With the tripling of the world population the need for water has increased sevenfold.

With a population that is 16 percent of the world total, India has 4 percent of its water resources. India has expectations of flows from the 'upper' countries and obligations to the 'lower' countries. The National Commission on Integrated Water Resources has assessed that by 2050, the supply of water will barely match the demand.

A recent world Bank report examines the challenges facing India's water sector and suggests critical measures to address them. According to Indian policy analysts water management practices needs to be changed soon to avoid a severe water crisis within the next two decades. Massive investments are needed in water infrastructure.

An increase in urban growth from 28 percent to 38 percent by 2026 will put

great pressure on the potable water supply in urban areas, leading to socio-political problems. Irrigation potential in the country needs to be addressed seriously for increasing food grains production, mitigating floods and droughts and to reduce regional imbalance in the availability of water. The Inter Basin Water Transfer from the surplus rivers to deficit areas is proposed as an effective solution. However, lack of mutual trust between states may hinder water sharing, especially the inter-linking of rivers. Water management in India needs to be addressed very earnestly both on the domestic front and in the regional setting before it becomes a serious security menace.

India along with its neighbours Pakistan and Bangladesh, who are the lower riparians, will together face water stress situations in years to come. The riparian relations between India and Pakistan would increasingly see testing times as Pakistan faces serious water problems. If water resources are not managed properly it could lead to a serious socio-political crisis to the extent of war and perhaps threats of use of nuclear weapons in the years to come. Bangladesh faces resource scarcity in terms of fresh water availability resulting in "ecological marginalization" of a large segment of Bangladeshi population. Besides increasing illegal immigration to India, Indo-Bangla hydro-politics pose a serious security challenge not only in Bangladesh, but also in India.

Sharing of river waters between India and its neighbours could be cooperative or conflictual. The option to choose one or the other is open to them.

INTRODUCTION

Background to the study. Water as a resource is finite. The water quantity on this globe is the same as what it was thousands of years ago. However, the human population in the last century has tripled from 2 billion to 6 billion and is expected to touch 8 billion by 2025. Water pollution and climate change have further impinged on the "liquid gold". It is anticipated that by 2025, 40 percent of the global population will be "water stressed" (<1700 m3 per capita availability). The security analysts rate security threats in relation to water quite high. India and its neighbours are no exception, hence the study.

AIM

To analyse the water situation in India and its neighbours (Pakistan and Bangladesh), and concretise the water security concerns and issues both within and without and likely effect of the same on the national security and security scenario in South Asia by 2025 AD.

SCOPE

This study includes analysis of water situation in India, Pakistan and Bangladesh and excludes other countries like China, Bhutan, Nepal and Sri Lanka because of the inferred minimal water security impact on India at present or in the near future.

The study does not dwell upon the remedial measures/crisis mitigation measures to overcome the likely water crisis. It is purely a security related study.

HYPOTHESIS

"Management of water resources in India is going to be crucially important to sustain the needs of one billion plus people. Water management is a composite area with linkages to various sectors of Indian economy including the agricultural, industrial, domestic and household, power, environment, fisheries and transportation sectors. A shared and community resource, water has often led to disputes between different states and also with the neighbouring countries. *"The hypothesis is that if the problem of water management is not* addressed earnestly, India and its important neighbours are bound to see in next 20 years serious social, political and economic crisis with regional ramifications impinging on National security and over all security situations in *South Asia.*"

Layout of the Thesis

The layout of the thesis is as follows :

(a) Introduction

(b) Chapter I: The Basics: Global Scenario. This chapter studies the global issues related to water. The theme of this chapter is "what is so special about water?" for it to attain national security dimensions.

(c) Chapter II: Water conflicts albeit wars. This chapter builds the water conflicts conceptual framework as viewed by water experts.

(d) Chapter III: Water security sans national security. This chapter views water security as a sub set of environmental security, as viewed by security experts.

(e) Chapter IV: Water situation: India. Carries out analysis with inferences.

(f) Chapter V: Water situation: Pakistan. Carries out analysis with inferences.

(g) Chapter VI: Water situation: Bangladesh. Carries out analysis with inferences.

(h) Chapter VII: Conclusion.

Brief Resume

The Basics: Global Scenario (Chapter I). The amount of freshwater in the world remains roughly the same as it has been throughout history. Only about 1percent of the planet's freshwater is easily accessible for human use. The population of the world, currently around 6 billion, is expected to exceed 8 billion by the year 2050. Hydrologists often describe **water stress** as water supplies of between **1,000 and 1,700 m^3 per person per year.** A country is said by some experts to be in **water crisis** if it has supplies of **less than 1,000 m^3 per person per yea**r predicted to lead to problems with food production and economic production.

Water Conflicts albeit Water Wars/ Water Security sans National Security: Chapters II & III. There are two main positions in this debate. **Neo-Malthusians** (**Malthusian school**) claim that finite natural resources place strict limits on the growth of human population and consumption; if these limits are exceeded, poverty and social breakdown result. **Neoclassical Economists** (**Cornucopian school**), in contrast, say properly functioning economic institutions, especially markets, provide incentives to encourage conservation, resource substitution, the development of new sources of scarce resources, and technological innovation. Thomas Homer Dixon (Toronto school) sees '**environmental scarcity**' coming about in three ways: demand-induced scarcity resulting from population growth, supply-induced scarcity resulting from the depletion or degradation of a resource, and structural scarcity resulting from a skewed distribution of the resource. As per Dixon, the three sources of environmental scarcity, leads the powerful segments of societies to control the scarce resource, "**Resource Capture**". He concludes that, "scarcity of renewable resources—can contribute to civil violence, including insurgencies and ethnic clashes". This conclusion leads the author to predict that "in coming decades the incidence of such violence will probably increase as scarcities of cropland, freshwater, and forests worsen in many parts of the developing world".

Barry Buzan, famous security analyst, identifies five "sectors" in security paradigm, namely **military, political, economic, social and environmental**. As per him the object existentially threatened is "**Referent object**" and people/ groups/

communities/nations who declare the threat are "**Securitising actors**". Water scarcity could be a declared "**Referent object**" by the community ("**Securitising actors**") and not necessarily by the state always, thus drawing a different response by the state (i.e. decreased water availability in Trans Yamuna colonies in Delhi, leading to mass arrests for demanding water). On the converse the state could be a "**Referent object**", in relation to water crisis, water or water source external to state in this case being "securitising actor." The example is threat to the Pakistani federation because of growing divide between different provinces over water sharing and perceived hydro-fault with upper riparian India.

Water situation: India/Pakistan/Bangladesh: Chapters IV/V/VI. The inferences drawn in the research are not very encouraging in this part of South Asia. Water stress is already there in all the three countries, the Indian position being a shade better. Demographic pressures, pollution, rapid unplanned urbanisation and climate change would adversely affect all three nations. River water sharing would pose serious intra national and regional hydro-political issues. Federalism both in India and Pakistan could be in jeopardy if water resources are not managed properly and sustainably. The Jammu and Kashmir issue, geo-strategically assumes a different dimension with Pakistan's riverine water resources originating/ passing through the state. Water crisis situation in Pakistan is grim. In case of perceived or real water denial first use of nuclear weapons by her in extreme conflict situation against India cannot be ruled out.

CHAPTER I
THE BASICS : GLOBAL SCENARIO

'*Till taught by pain, men know not water's worth*'. *Byron*

As human populations and economies grow exponentially, the amount of freshwater in the world remains roughly the same as it has been throughout history. Water demands are increasing, groundwater levels are dropping, surface-water supplies are increasingly contaminated, and delivery and treatment infrastructures are aging. The World Bank estimates that it would take $600 billion to repair and improve the world's existing water delivery systems.

When all of these characteristics are put together – **water** as a critical, non-substitutable resource, which flows and fluctuates across time and space, for which legal principles are vague and contradictory, and which is becoming relatively scarcer and degraded as world populations and standards of living grow – compelling arguments for considering the security implications of water resources management are found.

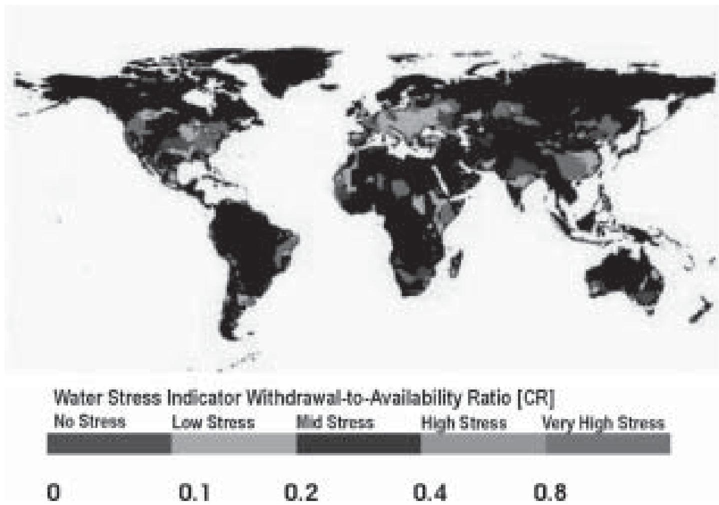
Freshwater Availability

Earth is called the water planet. Although some 70 per cent of the Earth's surface is water, almost all of it is salt water. By volume, less than 3 per cent of all water on Earth is fresh, and the majority of that freshwater is unavailable to humans, locked up in glaciers and icecaps, or out of reach in deep underground aquifers. Only about 1per cent of the planet's freshwater—contained in rivers, lakes, wetlands and shallow aquifers—is easily accessible for human use. The hydrological cycle is at Appendix A.

What is so Special about Water?

The Resource Is Finite and under Stress. The water available to us on earth today is no different in quantity from what was available thousands of years ago. It finds its significant role in domestic consumption, agricultural growth and industries, hydropower generation which have direct linkage with burgeoning global demography. Over the course of the 20th century, world population more than tripled—from 2 billion in 1927 to 6 billion in 1999. The United Nations projects multiple scenarios for our future global population. The three scenarios—high, medium and low—are designed to highlight a range of possible outcomes by 2050. The estimates depict the possible outcome—over 13 billion people—by the middle of the 21st century if we continue on our current path and fertility rates do not decline. The population of the world, currently around 6 billion, is expected to exceed 8 billion by the year 2050. Apart from sheer numbers, the processes of urbanisation and 'development' are also expected to result in a vast increase in the demand for fresh water. It is this which leads to projections of water scarcity, which could be severe in some parts of the world. Because of population growth, in per-capita terms, water availability is declining rapidly, from 17,000 cubic meters (m^3) per person in 1950 to 7,044 cubic meters in 2000 (World Resources Institute (WRI), 2000). Currently, by some definitions, water stress and scarcity exist in many places in the world, and many experts predict widespread water scarcity over this century. Hydrologists often describe **water stress** as water supplies of between **1,000 and 1,700 m^3 per person per year**. A country is said by experts to be in **water crisis** if it has supplies of **less than 1,000 m^3 per person per yea**r predicted to lead to problems with food production and economic production. Would water stress lead to conflict?

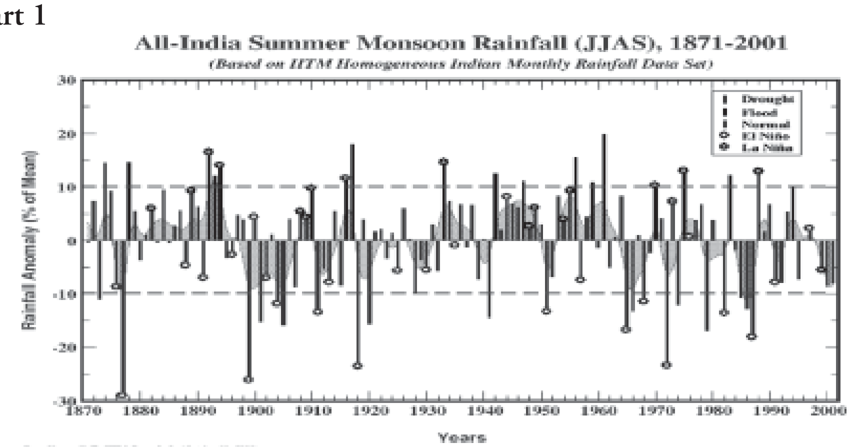
Figure 1 The Concept of Water Stress



Source: World Water Council-2005

Not Uniformly distributed in Time and Space. The temporal and spatial distribution of water is extremely varied thus making the water scarcity scenario more complex. In India, the average rainfall in the four months from June to September during the southwest monsoon is about 903 mm. During the remaining eight months, an average of only about 294 mm of rainfall is received (Central Water Commission, India-2002). Agrawal (1998) even contends that the total annual rainfall in much of the semi-arid tropics occurs within 100 hours of the year.

Chart 1

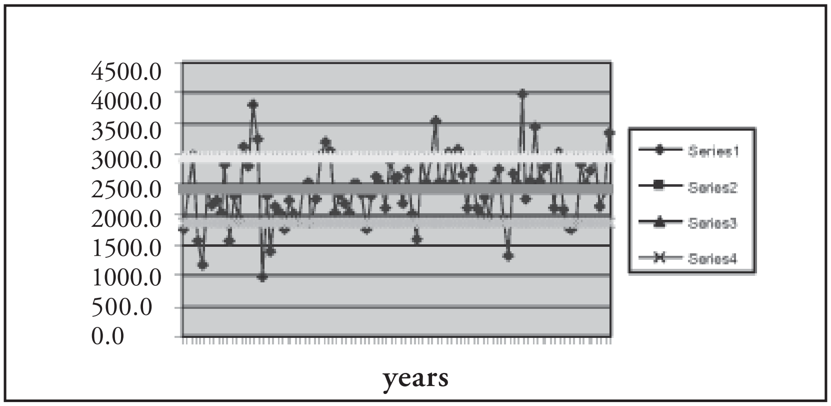


Source: Prof. Subhash Chander, Dr. Kapil K Narula Managing **Water Resources Globally** *lecture delivered to* National Defence College on 28 June 2006

The population distribution is uneven across the basins. The Ganga basin, with only about a quarter of the total drainage area has about 40 percent of the total population of India. The next five largest basins—Mahanadi, Brahmaputra, Krishna, Godavari, and Indus, cover 46 percent of the drainage area, but have only 30 percent of the population.

Even the temporal variations season to season and year to year vary considerably in river basins as illustrated in Chart 2.

Chart 2 Krishna Gross flows at Vijayawada

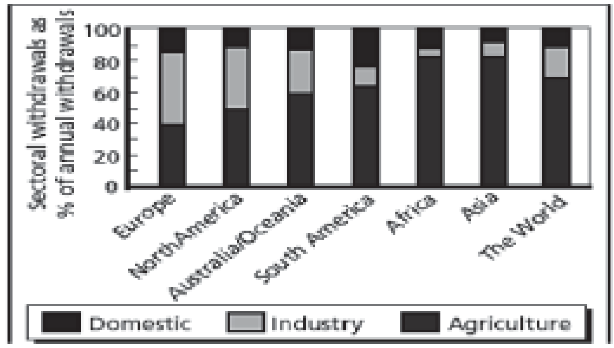


Source*: Prof. Subhash Chander, Dr. Kapil K Narula* **Managing Water Resources Globally** *lecture delivered to* National Defence College on 28th June, 2006

So very Essential to Human Existence. Among the concepts raised nearly 30 years ago during the 1977 U N, Mar del Plata conference - one of the earliest international efforts to address global water problems - was that of "basic needs": "*all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs*". P Glieck recommends that international organisations and water providers adopt an overall basic water requirement (BWR) of **50 litres per person per day** as a new standard for meeting these four domestic basic needs-drinking, sanitation, bathing and cooking and independent of climate, technology and culture. The basic water requirement for human beings for personal consumption is discussed in detail at Appendix B.

Essential for Food Security. Human use of fresh water is commonly divided into three sectors: agricultural, industrial, and domestic. Chart 3 shows the proportions of water demand by sector for six continents and the world. In agriculture, which accounts for nearly 70 percent of all freshwater usage worldwide, farmers use water to irrigate crops and maintain livestock. Water use patterns differ

Chart 3 How Populations Grow on Finite Water Supply



Source: How Populations Can grow on a Finite Water Supply, Rand Publications 2005

between industrialised and developing countries. In the former, industrial uses account for approximately 40 percent, while in the latter industries use no more than ten percent of annual freshwater consumption. Conversely, in the developing world, agriculture accounts for 90 percent of water use. Irrigation has helped boost agricultural yields and outputs and stabilise food production and prices.

Water, Food and Poverty. The average amount of grain land per person dropped by almost half between 1950 and 1996—from 0.23 hectares to 0.12 hectares. By 2030, when world population is projected to be at least 8 billion, there would be just 0.08 hectares of grain land per person. As for developing countries, in 1992, there were about 0.2 hectares of arable land per person. By 2050, this figure could fall to about 0.1 hectare per capita. According to the International Food Policy Research Institute (IFPRI), the world's farmers will have to produce 40 per cent more grain in 2020 than in 1999. Most of this projected increase will have to come from yield increases on existing land, not the cultivation of new land. In the first quarter of this century 2.7 billion people or a third of the world's population will experience severe water scarcity. Due to over exploitation of groundwater, food production will be adversely affected in the semi-arid regions which include two of Asia's major breadbaskets—the Punjab and the North China Plain.

Water pollution and Ground water depletion. Three problems dominate groundwater use: *depletion* due to overdraft; water logging and *salinisation* due mostly to inadequate drainage and insufficient conjunctive use; and *pollution* due to agricultural, industrial and other human activities. The most common symptom is constant decline in water tables. In western, north-western and peninsular India and

Pakistan, where in recent times, over a million irrigation wells have got added every year, groundwater withdrawal exceeds annual recharge in vast areas that are growing every year. In West Bengal and western Bangladesh, the consequence is arsenic contamination. All these problems will impair the region's capacity to feed its growing population. According to David Seckler, IWMI's Director General, a quarter of India's harvest may well be at risk from groundwater depletion.

Climate Change and Water. Climate change will affect the demand for water. Irrigation – which accounts for some 80 percent of global water use – is the most climate-sensitive water user, and the shifting pattern of irrigated crops in response to climate change is likely to have major effects on the spatial and temporal pattern of water demand, as well as the need for increased water storage. Industrial and municipal demand will likewise be affected and further accentuated through the migration of people from increasingly water scarce regions to the water plentiful regions. Climate change will also affect the supply side of water resources management. Overall, global warming will likely lead to reduced water availability in the countries that are already water scarce and an increase in the variability with which the water is delivered.

Has no Political, Geographical Boundaries Today there are 263 international basins. Strikingly, territory in 145 nations falls within international basins, and 33 countries are located almost entirely within these basins. The high level of interdependence is illustrated by the number of countries sharing each international basin; the dilemmas posed by basins like the Danube (shared by 17 countries) or the Nile (10 countries) can be easily imagined.

Table 1 Number of Countries Sharing a Basin

Number of Countries	International Basins
3	Asi (Orontes), Awash, Cavally, Cestos, Chiloango, Dnieper, Dniester, Drin, Ebro, Essequibo, Gambia, Garonne, Gash, Geba, Har Us Nur, Hari (Harirud), Helmand, Hondo, Ili (Kunes He), Incomati, Irrawaddy, Juba-Shibeli, Kemi, Lake Prespa, Lake Titicaca-Poopo System, Lempa, Maputo, Maritsa, Maroni, Moa, Neretva, Ntem, Ob, Oueme, Pasvik, Red (Song Hong), Rhone, Ruvuma, Salween, Schelde, Seine, St. John, Sulak, Torne (Tornealven), Tumen, Umbeluzi, Vardar, Volga, and Zapaleri
4	Amur, Daugava, Elbe, Indus, Komoe, Lake Turkana, Limpopo, Lotagipi Swamp, Narva, Oder (Odra), Ogooue, Okavango, Orange, Po, Pu-Lun-T'o, Senegal, and Struma
5	La Plata, Neman, and Vistula (Wista)
6	Aral Sea, Ganges-Brahmaputra-Meghna, Jordan, Kura-Araks, Mekong, Tarim, Tigris and Euphrates (Shatt al Arab), and Volta
8	Amazon and Lake Chad
9	Rhine and Zambezi
10	Nile
11	Congo and Niger
17	Danube

In fact, the last war fought specifically over water took place 4,500 years ago, between the city-states of Lagash and Umma along the Tigris River. Over the last 50 years, there have been only 37 acute disputes (those involving violence). During the same period, 157 treaties were negotiated and signed; only 507 events were conflict-related; 1,228 were resolved cooperatively.

On the contrary, in an ongoing effort to understand the connections between water resources, water systems, and international security and conflict, the Pacific Institute for Studies in Development, Environment, and Security initiated a project in the late 1980s to track and categorise events related to water and conflict.

Resource scarcity and population pressure is likely to only pose a security risk in societies that have a particularly low ability to adapt to environmental and demographic stress, and to mitigate conflict. Democratic regimes are assumed to be more accountable and thus more likely to respond appropriately to resource scarcity, while autocracies generally may be expected to have a greater ability to act effectively to cope with scarcities than semi-democracies due to tighter control. Countries with high adaptive capacity that experience population pressure or resource degradation are likely to be less conflict prone. A detailed analysis on water conflict theories has been done in the next chapter.

CHAPTER II
WATER CONFLICTS ALBEIT WARS

"*Water, not unlike religion and ideology, has the power to move millions of people. Since the very birth of human civilisation, people have moved to settle close to water. People move when there is too little of it; people move when there is too much of it. People move on it. People write and sing and dance and dream about it. People fight over it. And everybody, everywhere and every day, needs it. We need water for drinking, for cooking, for washing, for food, for industry, for energy, for transport, for rituals, for fun, for life. And it is not only we humans who need it; all life is dependent upon water for its very survival.*" Mikhail Gorbachev, former Premier of the Soviet Union.

Backdrop

Increased resource consumption can cause resource scarcities, and scarcities impose costs on societies. But experts debate the severity of future scarcities and human capacity to adapt to them. There are two main positions in this debate.

Neo-Malthusians (**Malthusian school**) claim that finite natural resources place strict limits on the growth of human population and consumption; if these limits are exceeded, poverty and social breakdown result. Many **Neo-classical Economists** (**Cornucopian school**), in contrast, say that there need be few, if any, strict limits to human population, consumption and prosperity. Properly functioning economic institutions, especially markets, provide incentives to encourage conservation, resource substitution, the development of new sources of scarce resources, and technological innovation.

Neo Malthusians and Water. The neo-Malthusian approach to conflict is rooted in Thomas Malthus' study of the relationship between population pressure and societal capacity for sustaining means of livelihood. Neo-Malthusianism generally does not subscribe to such a neat formula, but they see a broad range of scarcities emerging. Non-renewable resources are depleted and renewable resources are exploited beyond the capacity for renewal. Homer- Dixon (Toronto school) sees '**environmental scarcity**' coming about in three ways: demand-induced scarcity resulting from population growth, supply induced scarcity resulting from the depletion or degradation of a resource, and structural scarcity resulting from a skewed distribution of the resource. The first two types of scarcity correspond to the two elements of the original Malthusian model.

Professor Thomas Homer-Dixon in his seminal book *Environment, Scarcity and Violence* develops traditional debates over the relationship between population growth, resource scarcity, economic prosperity, and conflict. Homer-Dixon's strategy is to integrate physical variables (stocks of natural resources, population size and growth, and resource-consumption per capita) and social factors (market dynamics, and social and economic structures) in a single model that emphasises the importance of thresholds, interdependence, and interactivity within complex environmental systems. For Homer-Dixon, "the metaphors of stability, equilibrium, and balance are not appropriate to describe complex, interdependent systems" like those of environmental change. "Instead, metaphors of anarchy, flux, and constant turmoil are more apt." He argues that "these ecosystem characteristics mean that societies must be able to supply more social and technical ingenuity to adapt to rising scarcity".

Homer-Dixon's "key finding" is that "scarcity of renewable resources— can contribute to civil violence, including insurgencies and ethnic clashes". This conclusion leads the author to predict that "in coming decades the incidence of such violence will probably increase as scarcities of cropland, freshwater, and forests worsen in many parts of the developing world". This conclusion leads the author to predict that "in coming decades the incidence of such violence will probably increase as scarcities of cropland, freshwater, and forests worsen in many parts of the developing world".

As per Dixon, the three sources of environmental scarcity viz scarcity of renewable resources, population growth and unequal social distribution of resources often interact, and two patterns of interaction are particularly common: "resource capture" and "ecological marginalisation". A fall in the quality and quantity of renewable resources can combine with population growth to encourage powerful groups within a society to shift resource distribution in their favour. This type of interaction is called **"Resource Capture."** Unequal resource access can combine with population growth to cause migrations. High population densities in these areas, causes severe environmental damage and chronic poverty. This process is often called **"Ecological Marginalisation."**

Ecological Marginalisation

Water is clearly a political and military tool as well as a military target in West Asia. Water became an important source of conflict that led to the 1967 Arab-Israel war. When the PLO came into existence, its first action was to sabotage the Israeli National Water Carrier in December 1964. As the PLO put it: "The water issue was the crucial one. We considered our impact on this to be the crucial test of our war with Israel". In response, Israeli Prime Minister Levi Eshkol declared: "Israelis are not trigger-happy, but if it came to it, we would have to fight for our water". PLO's hostility, Arab diversion plans and Israeli small-scale attacks on the diversion works in Syria led to border violence that eventually culminated in the June 1967 War. Perhaps Israeli insistence on retained occupation of Golan Heights (dominating their major water resource Lake Tiberias) domination of West Bank, thus Jordan river, yet another water resource and domination of Lebanon up to River Hasbani/Litani for two decades are classical examples of "**Resource Capture**". Lebanon has a surplus of water. Lebanon's renewable water resources at 3000 cubic meters per capita (cm/c), compared to countries rated "poor" such as Israel at 300 cm/c, Jordan at 160 cm/c. Lebanon's status as a major water repository is further enhanced when considered within the context of a "water stressed" West Asia. Inherent in the water subterrainianism in West Asia is exemplified "**Ecological Marginalisation**" of the Palestinians by the Israelis. The per capita water availability for Israelis is – 300 cubic meters per person, Palestianians-165 cubic meters per person.

The Cornucopian Approach. Cornucopians are much more optimistic than Neo-Malthusianism about the future. They generally have a more positive **view** of the role of economic and industrial development. Technological innovation, resource substitution, and market pricing are key instruments to secure a more efficient exploitation of resources and prevent scarcities from becoming serious. Also included in the **cornucopian** school are those who acknowledge that scarcities may arise, but who argue that they are more likely to be overcome by cooperation than by conflict (Wolf, 2001).

Cornucopians argue that the primary components of a liberal theory of peace in the international system are free trade, democratic political systems, and international institutions. Aaron further postulates his view on conflict versus cooperation by quoting, cooperation on the Danube and the Rhine has survived two World Wars: the Mekong Committee, founded in 1957, survived the Indochina Wars and became the Mekong River Commission in 1995: India and Pakistan are rivals in Kashmir, but cooperate over the river Indus: Jordan and Israel have fought several wars, but cooperate on the sharing of the **water** in the Jordan River. In fact, cornucopians argue that *the last (and only) war fought* specifically over water took place 4,500 years ago, between the city-states of *Lagash and Umma along the Tigris River.*

Homer Dixon calls the cornucopian stock of knowledge and ideas as "ingenuity," argues that "a society must be able to supply enough ingenuity at the right places and times" to cope successfully with scarcity. Both technical ingenuity (e.g., agricultural technologies that compensate for environmental loss) and social ingenuity (appropriate policies, institutions and organisations) are required. Homer-Dixon points to an "ingenuity gap" in many societies that leaves them vulnerable to the most pernicious effects of environmental change and degradation. He links his analysis of ingenuity to the general model of ecosystem change, pointing out that the need for ingenuity (particularly of the social variety) is most pressing in complex systems of environmental change that exhibit nonlinearity and interactive responses to human perturbations.

Homer-Dixon further describes two mechanisms by which resource scarcity can limit both the total supply and the rate of supply of ingenuity. First, increased scarcity often provokes competitive action by powerful elite groups and narrow social coalitions to defend their interests or to profit from the scarcity through "rent-seeking" behaviour. These actions - which Homer-Dixon calls "social friction" - can hinder efforts to create and reform institutions and can generally make it harder to focus and coordinate human activities, talents, and resources in response to scarcity. Moreover, severe scarcity sometimes causes social turmoil and violence, which can directly impede the functioning of ingenuity-generating institutions, such as markets. Second, endogenous growth theory notes that capital, especially human capital, is essential to the generation of innovation. Yet, Homer-Dixon argues, resource scarcity often reduces the availability of human and financial capital for the production of ingenuity by shifting investment "from long-term adaptation to immediate tasks of scarcity management and mitigation."

Peter Schwartz and Doug Randall in their report prepared for Department of Defence USA , "An Abrupt Climate Change Scenario and Its Implications for United States National Security", October 2003, state that military confrontation may be triggered by a desperate need for natural resources such as energy, food and water rather than by conflicts over ideology, religion, or national honour. There is a long-standing academic debate over the extent to which resource constraints and environmental challenges lead to interstate conflict. Over time though, conflicts over land and water use are likely to become more severe – and more violent.

The debate above clearly highlights the water induced likely effects on international and national political, economic and social structures in days to come. The DoD report of USA, exemplifies these apprehensions by certain futuristic scenario paintings. *"Asia: 2010- Border skirmishes and conflict in* Bangladesh, India, and China, as mass migration occurs toward Burma. 2012: Regional instability leads Japan to develop force projection capability. Europe- 2015: Conflict within the EU over food and water supply leads to skirmishes and strained diplomatic relations. 2020: Increasing: skirmishes over water and immigration. 2022: Skirmish between France and Germany over commercial access to Rhine. USA- 2010: Disagreements with Canada and Mexico over water increase tension. 2020: Persistent conflict in South East Asia; Burma, Laos, Vietnam, India, China .2025: Internal conditions in China deteriorate *dramatically leading to civil war and border wars.*"

Definitely a doomsday scenario, yet it is not divorced from realistic picture likely to be encountered in future both at global and national levels, thus impinging upon the importance of "**Water Security**" from the perspective of "non-conventional" threats to national security. Further the discussion above supports the hypothesis to the extent of mismanagement of water resources and likely internal socio-political and regional ramifications. 'Water Security' and assessment of situations as it relates to water security in India, Pakistan and Bangladesh are discussed in following chapters.

CHAPTER III
WATER SECURITY SANS NATIONAL SECURITY

Fierce national competition over water resources has prompted fears that water issues contain the seeds of violent conflict. . . . If all the world's peoples work together, a secure and sustainable water future can be ours.

(UN Secretary General Kofi Annan, World Water Day 2002)

Preamble. Our rivers and aquifers are the life-blood of the planet and must be shared among all that need them, and protected from the effects of conflict and over-exploitation. In the past hundred years, the global population has tripled while demand for water has increased sevenfold. The water crisis affects everything – from health to human rights, the environment to the economy, poverty to politics, culture to conflict. Just as water defies political boundaries and classification, the crisis is also well beyond the scope of any individual country or sector, and cannot be dealt with in isolation.

The Security Debate. Buzan identifies five "sectors" in security paradigm, namely **military, political, economic, social and environmental**. As per Buzan, in these five sectors there are five different levels of analysis i.e. a range of spatial scales, from large to small, these are international systems, international sub-systems(ASEAN, OAU etc), units (nation states), sub-units (e.g. bureaucracies, lobbies) and individuals.

Further in the debate, Buzan argues that " Traditionally by saying 'security', a state representative declares an emergency condition, thus claiming a right to use whatever means are available to block a threatening development. When we consider the wider agenda, what do the terms existential threat and emergency measures mean? How in practice can the analyst draw the line between processes of politicisation and securitisation on this basis? Existential threat can only be understood in relation to particular character of the referent object. We are not dealing here with a universal standard based in some sense on what threatens individual human life. The essential quality of existence will vary greatly across different sectors and level of analysis."

Buzan further describes the various sectors as: military sector, in military sector the referent object is usually the state, although it may also be other kinds of political entities. Traditional security studies tend to see as all military affairs as instances of security: Political sector, in the political sector, existential threats are traditionally defined in terms of constituting principle-sovereignty, but sometimes also ideology of state: Economic sector, the referent objects and existential threats, as per Buzan, are difficult to pin down: Societal sector, the referent object is large-scale collective identities that can function independent of state, such as nations and religion. Given the peculiar nature of this type of referent object, it is extremely difficult to establish hard boundaries that differentiate existential from lesser threats: Environmental sector, as per Buzan, the range of possible referent objects is very large. At either the macro or the micro extreme are some clear cases of existential threat (the survival of species, the survival of human civilisation) that can be securitised.

Securitisation. "Security" is the move that takes politics beyond the established rules of the game and frames the issue either as a special kind of politics or as above politics. Securitisation thus can be seen as extreme version of politicisation. In the case of issues (notably the **environment**) that have moved dramatically out of the non-politicised category, we face the double question of whether they have been politicised or have also been securitised. This link between politicisation and securitisation does not imply that securitisation always goes through the state; politicisation and securitisation can be enacted in other fora as well.

For a concrete assessment of security dynamics in the environmental sector, the following sequence of question should be answered, what does the disaster scenario look like? How does it manifest in time and space? Who are the veto and other functional actors in this issue area? In other words, who is causing the problem? This provides structural characteristics. Who are the actual or potential lead and support actors? If the actors become interconnected in a political constellation over these security issues, they represent a "**security complex**". Structurally unrelated issue may become interlinked by veto and lead actors, for example Turkish upper riparian superiority with the downstream Syrian supported Kurdish insurgency. This type of linkage will show from political agenda.

Continuing with Buzan's hypothesis he further states that we expect that on this basis, maps can be drawn presenting crucial regions with concentrated environmental problems, often securitised ones. Clearly these areas form a non-regional subset of the international system. In regard to hydro politics, there are many unresolved international water issues; he quotes West Asia water conflict, the security interdependence Israel, Syria, Jordan, Lebanon and West Bank Palestinians with common West Bank aquifers. Turkey, Syria, Iraq over Tigris and Euphrates. India and Pakistan over Indus Rivers and the controversial Mekong river basin from China down to Thailand.

Finally, in many cases, there will be interplay of global motive (steered by the politicisation of remote effects) and local, relatively, independent troubled areas or disturbing practices; in many other cases there will be strong securitisation of local drama for its own sake; in still other cases there will be regions of cumulative environmental problems- states caught up in intense security interdependence in the face of preserving their country in the most literal terms.

CHAPTER IV
WATER SITUATION:INDIA

General

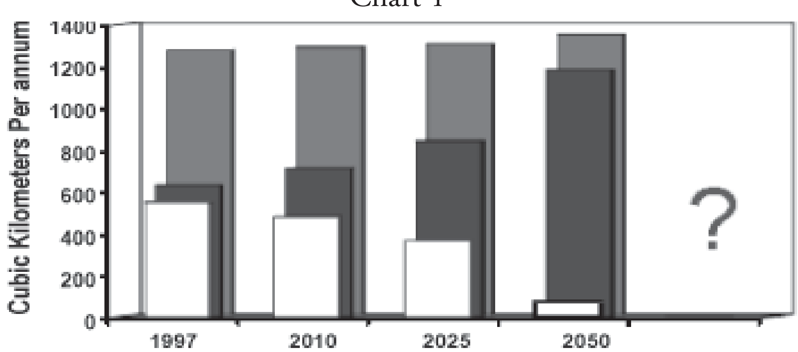
With a population that is 16 percent of the world, India has 2.45 percent of the world's land resources and 4 percent of its water resources. The average annual precipitation by way of rain and snow over India's landmass is 4000 km3, but the annual water resources of the country are measured in terms of the 'run-off' in the river systems. This has been estimated by the National Commission as 1953 km3. India has expectations of flows from the 'upper' countries and obligations to the 'lower' countries.

Apart from the water available in the various rivers of the country, the groundwater is also an important source of water for drinking, irrigation, industrial uses, etc. It accounts for about 80 percent of domestic water requirement and more than 45 per cent of the total irrigation in the country. As per the international norms, if percapita water availability is less than 1700 m^3 per year then the country is categorised as water stressed and if it is less than 1000 m^3 per capita per year then the country is classified as water scarce. In India per capita surface water availability in the years 1991 and 2001 were 2309 and 1902 m^3 and these are projected to reduce to 1401 and 1191 m3 by the years 2025 and 2050 respectively.

As per Iyer, it has been estimated by the National Commission that the annual 'usable' water resources of the country are 690 km^3 of surface water and 396 km^3 of groundwater, making a total of 1086 km^3. The present quantum of use is put at around 600 km.^{3} As per the National Commission by the year 2050 the total water requirement of the country will be 973 to 1180 km^3 under 'low' and 'high' demand projections, which means that supply will barely match demand. It is the Commission's view that there will be a difficult situation but no crisis, *provided* that a number of measures on both the demand side and the supply side are taken in time.

Utilizable water, demand and residual which is available but not used

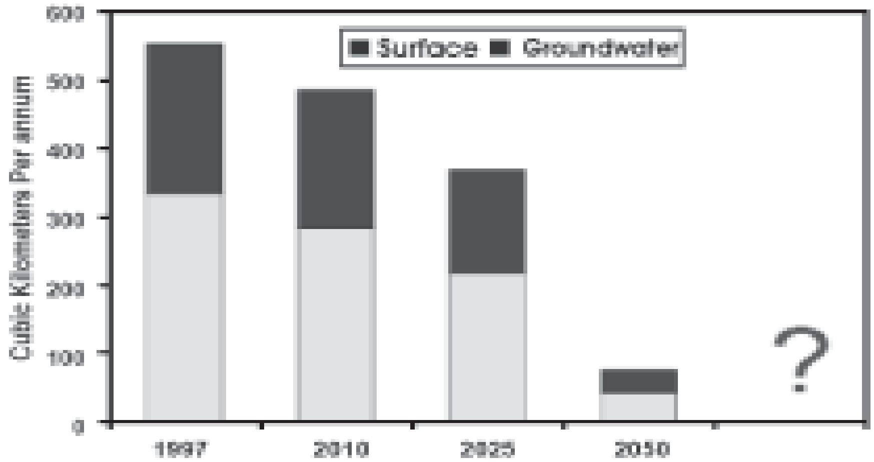
Chart 4



National Commission on water, 1999

"Unused" Surface and groundwater

Chart 5



National Commission on water, 1999

Table 2 Utilisable Water, Requirement and Return Flow Based on National Average (in km³).

Particulars	1997–1998	2010		2025		2050	
		Low Demand	High Demand	Low Demand	High Demand	Low Demand	High Demand
Utilizable Water							
Surface	690	690	690	690	690	690	690
Ground	396	396	396	396	396	396	396
Canal irrigation	90	90	90	90	90	90	90
Total	996	996	996	996	996	996	996
Total Water Requirement							
Surface	399	447	458	497	545	641	752
Ground	230	247	252	287	298	332	428
Total	629	694	710	784	843	973	1180
Return flow							
Surface	43	52	52	70	74	91	104
Ground	143	144	148	127	141	122	155
Total	186	196	200	197	215	213	259
Residual Utilizable Water							
Surface	334	295	284	263	219	140	42
Ground	219	203	202	146	149	96	33
Total	553	498	486	409	368	236	75

Source: NCIWRD, 1999.

A very recent World Bank report, **India's Water Economy: Bracing for a Turbulent Future**, by John Briscoe, Senior Water Advisor at the World Bank, examines the challenges facing India's water sector and suggests critical measures to address them. The report, based on 12 papers commissioned by the World Bank from prominent Indian practitioners and policy analysts, states, unless water management practices are changed – and changed soon – India will face a severe water crisis within the next two decades and will have neither the cash to build new infrastructure nor the water needed by its growing economy and rising population.

Table 3 Status of Ground Water Exploitation

States	Blocks, 1989		Blocks, 1996	
	Total	Dark (%)	Total	Dark & Over exploited (%)
Gujarat	183	3	184	14
Haryana	95	33	108	47
Karnataka	175	2	175	10
Punjab	118	54	118	59
Rajasthan	227	9	236	24
Tamil Nadu	375	16	384	25
Total (6 states)	**1173**	**16**	**1205**	**26**

Blocks are categorized, based on the exploitation of utilizable ground water resources, as dark (85 to 100%) and overexploited (over 100%).

Crumbling Water Infrastructure and Depleting Groundwater. As per the report, India's past investments in large water infrastructure have yielded spectacular results with enormous gains in food security and in the reduction of poverty. However, much of this infrastructure is now crumbling. Much of what currently masquerades as "investment" in irrigation or municipal water supply is in fact a belated attempt to rehabilitate crumbling infrastructure. Faced with poor water supply services, farmers and urban dwellers alike have resorted to helping themselves by pumping out groundwater through tube wells. Today, 70 percent of India's irrigation needs and 80 percent of its domestic water supplies come from groundwater. It has led to rapidly declining water tables and critically depleted aquifers, and is no longer sustainable.

Massive investments needed. As per the report, there is clearly an urgent need for action. First, India needs a lot more water infrastructure. Compared to other semi-arid countries, India can store relatively small quantities of its fickle rainfall. Whereas India's dams can store only 200 cu.m.of water per person, other middle-income countries like China, South Africa, and Mexico can store about 1000 cu.m. per capita.

Inter-State River Water Disputes. Most of the major rivers in India flow through more than one State and are therefore 'inter-State Rivers'. The Constitution of India put the primary entry relating to 'water' in the State List (Entry 17) but provided for a Union (Central) role in relation to inter-State rivers if Parliament legislated for this. Under that provision (Entry 56 in the Union List) Parliament enacted the River Boards Act 1956, but that Act has remained a dead letter. No River Boards were set up under it. The Constitution also provided (article 262) for Parliamentary legislation for the *adjudication* of inter-State river **water** disputes, and the law enacted by Parliament in pursuance of that provision (the Inter-State Water Disputes Act 1956) has been much used. The two disputes currently outstanding are the Ravi-Beas Dispute (Punjab and Haryana) and the Cauvery Dispute (Karnataka, Tamil Nadu, Kerala and Pondicherry). In the former case, Punjab has passed an Act terminating all earlier **water** accords and undermining the very basis of the ongoing adjudication; the answers of the Supreme Court are awaited to some questions put to it by the Central Government in this context. In the Cauvery case, the adjudication process has been running a troubled course for 16 years, and one does not know whether the long-awaited Final Award of the Tribunal, when received, will mark the end of the dispute or the beginning of further trouble; the latter seems the more likely possibility. These unresolved disputes have implications that go far beyond **water**: they raise questions about Indian federalism.

Water Quality in Problem Areas. Central Pollution Control Board (CPCB) has been exercising nation-wide responsibility of water quality management, under the provisions of The Water (Prevention and Control of Pollution) Act, 1974. The fresh water resources identified in vicinity of various problem areas in the country are depicted in Table 4.

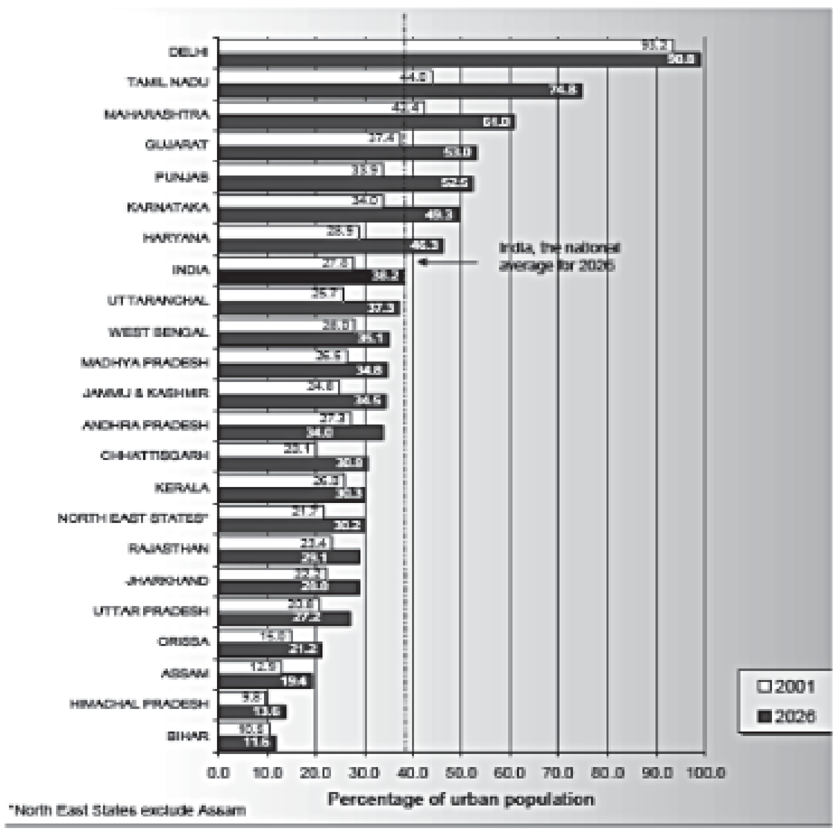
Table 4 Fresh Water Resources In Problem Areas

S. No.	Problem area	State /UT	Surface Fresh water resource	Water use Status of fresh resources
1.	Ankleshwar	Gujarat	River Narmada	Industrial and domestic waste water discharge
2.	Bhadravati	Karnataka	River Bhadravati	Industrial and domestic waste water discharges
3.	Dhanbad	Bihar	River Damodar, Topchachi lake	Drinking water source
4.	Durgapur	West Bengal	River Damodar	Industrial and domestic waste water discharge
5.	Greater Cochin	Kerala	Two tributaries of River Periyar	Industrial effluents and domestic waste water discharge
6.	Howrah	West Bengal	River Hooghly	Major source of water supply, industrial and domestic waste water discharge
7.	Jodhpur	Rajasthan	River Jojari	Agricultural activities on its bank
8.	Kala-Amb	Himachal Pradesh	River Markanda	Major source of water supply for towns in Haryana
9.	Korba	Madhya Pradesh	River Hasdeo	Major source of water supply for agriculture and urban activities in the area
10.	Manali	Tamilnadu	Buckingham canal, River Cooum	Waste water discharge

11.	Nagda-Ratlam	Madhya Pradesh	River Chambal at Nagda River Kurel at Ratlam	Industrial use in Nagda, deterioration of water quality of river Chambal due to insufficient dilution Drain carrying the effluents from industrial estate meets River Kurel
12.	Najafgarh Drain basin	Delhi	Najafgarh drain joining River Yamuna	Industrial and domestic waste water discharge
13.	North Arcot	Tamil nadu	River Palar, Pulianthengal and Vaniam-pudi lakes	Discharge of effluents from the industries located in Ranipet
14.	Pali	Rajasthan	River Bandi	Industrial effluent and domestic waste water discharge, agriculture activity
15.	Parwanoo	Himachal Pradesh	River Kaushalya, Sukhna nullah	Major source of water supply for downstream towns in Haryana
16.	Patancheru-Bollaram	Andhra Pradesh	River Meerja (village/ponds /tanks called cheru)	Industrial waste water discharge, source of water supply.
17.	Singrauli	Uttar Pradesh	River Rihand, Rihand reservoir, River Sone	Industrial cooling and waste water discharges
18.	Talcher	Orissa	River Brahmani and river Nandira Jhor	Industrial discharge into Nadira Jhor joining River Brahmani
19.	Vapi	Gujarat	River Kolak, River Damanganga	Industrial effluent discharge

Changing Demographies, Regional Disparities and Urbanisation. A recently published report by the Census Commissioner India (Report of the Technical Group on Population Projections Constituted by The National Commission on Population, May 2006) comes out with some disturbing facts, which have a direct impact on Indian water economy. As per the report, the population of India is expected to increase from 1029 million to 1400 million during the period 2001-2026 - an increase of 36 percent in twenty- five years at the rate of 1.2 percent annually. As a consequence, the density of population will increase from 313 to 426 persons per square kilometer. Of the projected increase in population of 371 million in India during 2001-26,187 million is likely to occur in the seven States of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh and Uttaranchal (termed as BIMARU states, since it was so before division).

Chart 6



Percentage of urban population during 2001 - 2026, India and selected States

The urban population in the country, which was 28 per cent in 2001, is expected to increase to 38 per cent by 2026. The urban growth would account for over two-thirds (67 per cent) of total population increase by 2026. The above mentioned statistics assume significance when juxtaposed with Table 5 urban population growth patterns.

Table 5 Urban Population Growth Patterns

CORRIDOR	1991		2021*	
	Population	%age to total urban population	Population	%age to total urban population
TAMIL NADU				
Chennai - Krihnagiri - Hosur	69,35,548	36.35	1,33,36,374	43.38
Coimbatore - Erode - Salem - Krishnagiri (excluding Krishnagiri)	30,99,209	16.24	57,51,170	18.71
MAHARASHTRA				
Mumbai-Thane (to Ahmedabad)	1,33,28,698	43.64	2,42,29,682	42.39
Mumbai - Nashik - Dhule - Amravati - Nagpur (excluding Mumbai)	61,21,778	20.05	1,19,47,723	20.90
Mumbai - Pune (excluding Mumbai)	26,08,817	8.54	62,48,869	10.93
GUJARAT				
North - South Corridor (Mahesana - Gandhinagar -Ahmedabad - Vadodara-Bharuch - Surat - Valsad)	85,32,998	59.88	1,99,84,167	71.58
KARNATAKA				
Bangalore - Belgaum	66,88,598	48.08	1,56,55,905	57.58
Mysore-Bangalore-Kolar (excluding Bangalore)	15,16,417	10.90	34,01,154	12.51

It is fairly evident that the brunt of urbanisation is going to happen in metropolitan and large cities. In the business as usual scenario the pressure on the crumbling infrastructure especially potable water supply is going to be enormous. Delhi witnessed for the first time this summer, mass arrests in connection with poor water availability in Trans Yamuna colonies. *Are we going to witness, growing Trans*

Yamuna scenarios in Chennais, Bangalores, Surats, Ludhianas, and Cuttacks, in the days to come? The situation gets even more complicated when the slums statistics are added to the picture.

Table 6 Slum Population (Million Plus Cities)

Sl. No.	Name of Million Plus Municipal Corporations	State/Union territory*	Total population	Total slum population	Percentage of slum population to total population
1	2	3	4	5	6
	TOTAL		**73,345,775**	**17,696,950**	**24.1**
1	Greater Mumbai	Maharashtra	11,978,450	6,475,440	54.1
2	Delhi	Delhi*	9,879,172	1,851,231	18.7
3	Kolkata	West Bengal	4,572,876	1,485,309	32.5
4	Chennai	Tamil Nadu	4,343,645	819,873	18.9
5	Bangalore	Karnataka	4,301,326	430,501	10.0
6	Hyderabad	Andhra Pradesh	3,637,483	626,849	17.2
7	Ahmedabad	Gujarat	3,520,085	473,662	13.5
8	Surat	Gujarat	2,433,835	508,485	20.9
9	Kanpur	Uttar Pradesh	2,551,337	367,980	14.4
10	Pune	Maharashtra	2,538,473	492,179	19.4
11	Jaipur	Rajasthan	2,322,575	368,570	15.9
12	Lucknow	Uttar Pradesh	2,185,927	179,176	8.2
13	Nagpur	Maharashtra	2,052,066	737,219	35.9
14	Indore	Madhya Pradesh	1,474,968	260,975	17.7
15	Bhopal	Madhya Pradesh	1,437,354	125,720	8.7
16	Ludhiana	Punjab	1,398,467	314,904	22.5

The 58th round of the NSS (National Survey Sample) reveals wide variance in access to water and sanitation for urban households across the states. The situation is more serious in slums. Access to water is only through tube wells for 57 per cent of the slum population in Punjab, 67per cent in UP, 100 per cent in Bihar and 69 per cent in Chhattisgarh. Population with access to a water tap in the slum varies from 33 per cent in Gujarat to 95 per cent in Maharashtra. The non-notified slums are much worse off. Urban households in areas other than slums may be faring a little better, but tap water access is available for only 35 per cent in Bihar, 40 per cent in Assam and around 50 per cent in UP and Orissa. In nine other states it is claimed that 90 per cent of the urban population receive tap water but the figure does not reveal the significant disruptions in supply and gross inequities in distribution. That about 90 per cent of the urban households have water supply within half a kilometer distance is no more than of statistical comfort. The frequency and duration of water supply and the quantum available for the majority of households are severely limited and the quality of water often unsatisfactory. Trans Yamuna residents in Delhi would dismiss as a joke the claim that Delhi's per capita water supply is more than 200 litres. Many cities in India have to contend with alternative days of supply, that too restricted. Unless not addressed earnestly, the water pressure on urbanisation is likely to have serious socio-political implications in the days to come.

Inter Basin Water Transfer

The Need. The uncertainty of occurrence of rainfall marked by prolonged dry spells and fluctuations in seasonal and annual rainfall is a serious problem for the country. Large parts of Haryana, Maharashtra, Andhra Pradesh, Rajasthan, Gujarat, Madhya Pradesh, Karnataka and Tamil Nadu are not only deficit in rainfall but also subject to large variations, resulting in frequent droughts.

Irrigation using river water and ground water has been the prime factor for raising the food grain production in our country. The population of India, which is around 1000 million at present, is expected to increase to 1500 to 1800 million in the year 2050 and that would require about 450 million tonnes of food grains. For meeting this requirement, it would be necessary to increase irrigation potential to 160 million hectares for all crops by 2050. India's maximum irrigation potential that could be created through conventional sources has been assessed to be about 140 million hectares. For attaining a potential of 160 million hectares, other strategies shall have to be evolved.

One of the most effective ways to increase the irrigation potential for increasing the food grain production, mitigate floods and droughts and reduce regional imbalance in the availability of water is the Inter Basin Water Transfer (IBWT) from the surplus rivers to deficit areas. Brahmaputra and Ganga particularly their northern tributaries, Mahanadi, Godavari and west flowing rivers originating from the Western Ghats are found to be surplus in water resources.

Earlier proposals. Suggestions for a National Water Grid for transferring surplus water available in some regions to water deficit areas have been made from time to time. The two such proposals put forth earlier in the seventies, which attracted considerable attention, were:

(a) National Water Grid by Dr. K.L. Rao (1972).

(b) Garland Canal by Capt. Dastur (1977).

Dr. K.L. Rao's Proposal (1972), which had 2640 km. long Ganga - Cauvery link as its main component involved large-scale pumping over a head of 550 m. Dr. Rao had estimated this proposal to cost about Rs. 12,500 crores, which at 2002 price level comes to about Rs. 1, 50,000 crores. The Central Water Commission, which examined the proposal, found it to be grossly underestimated and economically prohibitive. Capt. Dastur Proposal (1977) envisaged construction of two canals – the first 4200 km. Himalayan Canal at the foot of Himalayan slopes running from the Ravi in the west to the Brahmaputra and beyond in the east; and the second covering the central and southern parts. The proposal was examined by two committees of experts who opined that the proposal was technically infeasible. The realistic cost at 2002 price level comes to about Rs. 70 million crores.

The continued interest shown by many people engaged in Water Resources Development gave further impetus to study inter basin water transfer proposals in more detail. The then Ministry of Irrigation (now Ministry of Water Resources) and Central Water Commission formulated a National Perspective Plan (NPP) for Water Resources Development in 1980, envisaging inter basin transfer of water from surplus basins to deficit ones. National Perspective Plan comprises two components viz. Himalayan Rivers Development and Peninsular Rivers Development.

Himalayan Rivers Development. Envisages interlinking of river systems to transfer surplus flows of the eastern tributaries of the river Ganga to the west, apart from linking of the main Brahmaputra and its tributaries with Ganga and Ganga with the river Mahanadi.

Peninsular Rivers Development. Is divided into four major parts :

(a) Interlinking of Mahanadi-Godavari-Krishna-Cauvery. This part involves interlinking of the major river systems where surpluses from the Mahanadi and the Godavari are intended to be transferred to the needy areas in the south, through Krishna and Cauvery rivers.

(b) Interlinking of west flowing rivers, north of Bombay and south of Tapi. This scheme envisages construction of as much optimal storage as possible on these streams and interlinking them. The scheme provides for taking water supply canal to the metropolitan areas of Mumbai; it also provides irrigation in the coastal areas in Maharashtra.

(c) Interlinking of Ken-Chambal. The scheme provides for a water grid for Madhya Pradesh, Rajasthan and Uttar Pradesh and interlinking canal backed by as much storage as possible.

(d) Diversion of other west flowing rivers. The construction of an interlinking canal system backed up by adequate storages could be planned to meet all requirements of Kerala as also for transfer of some waters towards east to meet the needs of drought affected areas.

In the proposals of NPP, the transfer of water has been proposed mostly by gravity; lifts were kept minimal and confined to around 120 m and only surplus flood water after meeting all in-basin requirements in foreseeable future has been planned for transfer to water deficit areas.

There are clear cut defined political schisms in the management of water resources in the context of water stress scenario which India is likely to face in future. On one hand is the Supreme Court judgement to implement the river linking , the other extreme is the political economic apprehensions expressed by the states for their water rights as discussed above. There is a growing schism on depleting water resources in definition of official states geographical boundaries and the actual water distribution, uniformly.

Are we heading for Homer- Dixonian "metaphors of anarchy, flux, and constant turmoil"? Are we heading for a serious socio-political crisis within ourselves and with the neighbours? The inferences drawn from above discussions are :

(a) In the business as usual scenario, water crisis could prevail in India with severe socio-political crises.

(b) Declining water tables, increasing water pollution, rapid unplanned urbanisation, increasing urban slums and serious water shortages are likely to lead to increased rich poor divide leading to social conflicts with serious possibility of extreme violence.

(c) The dwindling water resources could lead to conflict situations between urban and rural, between farmer and industrialist, between the governance and people, between groups and finally between states on water sharing.

(d) Lack of mutual trust between states, extreme hydrological data secrecy may seriously hinder water sharing especially inter- linking rivers. Federalism is already in question mark in context of Punjab withdrawing from all the water pacts, given the ethno-linguistic political configuration of our states, one hopes that not the anarchical scenario painted by Robert Kaplan finds a place in our country.

The postulate in the hypothesis of this study gains credence that water management in India needs to be addressed extremely earnestly before it becomes a serious internal security menace in years to come. The water relations implications with our two immediate neighbours namely, Pakistan and Bangladesh are discussed in subsequent chapters.

CHAPTER V
WATER SITUATION: PAKISTAN

General

The main source of surface water in Pakistan is the Indus River and its tributaries, all of which are perennial and have their origins in the mountains in India largely. Five main rivers that join the Indus from the eastern side are: Jhelum, Chenab, Ravi, Beas and Sutlej; beside these three minor rivers – Soan, Harrow are also draining into Indus. On the western side, a number of small rivers join Indus, the biggest of which is river Kabul with its main tributaries i.e. Swat, Panjkora and Kunar. Several other small streams such as Kurram, Gomal, Kohat, Tai, Tank, etc also join Indus on the right side. The total catchment area of Indus river system is 374,700 sq. miles of which about 56 percent i.e. 204,300 sq. miles lies in Pakistan.

The Indus River and its tributaries on an average bring about 154 MAF (million acre feet) of water annually. This includes 144.91 MAF from the three Western rivers and 9.14 MAF from the Eastern Rivers. Most of this, about 104.73 MAF is diverted for irrigation, 39.94 MAF flows to the sea and about 9.9 MAF is consumed by the system losses which include evaporation, seepage and spills during floods.

Figure 2

The country is facing serious water shortage for farming to meet the food and energy requirements of the burgeoning population. Pakistan is likely to become the world's fourth most populous country in the year 2050 having a population of 305 million, with the current population growth rate of 2.1 per cent per annum, reveals the World Population Chart issued by the United Nations Population Division. The country is already the sixth most populous country in the world with a population of 158 million. As a result, Pakistan will have a shortfall of 11 million tons of major food grains by 2010 and 16 million tons by 2020. This food grain deficit will increase to 28 million tons by 2025.

Major (Retd) Tahir Iqbal, Federal Minister for Environment, Government of Pakistan made a statement in UN (Session of the UN Commission on Sustainable Development (the ministerial segment) 20-22 April 2005, New York,). Some of the relevant excerpts are "Mr. Chairman, …..**Pakistan** ….. most of the area is drought prone and heading fast to be bracketed as a **water** deficit region….. At present, Mr. Chairman, irrigation accounts for 93 per cent of the **water** currently utilized in **Pakistan**. The rest is used for supplies to urban and rural populations and industry. By year 2025, the population will increase by 50 per cent, leading to phenomenal increase in demand for **water**….. 81per cent of river flows and 65 per cent of precipitation occur during the three monsoon months, leaving the other nine months almost dry……. The disposal of sewage, industrial waste and agro-chemical run off continue to pose serious threat to the quality of **water**….. one of **Pakistan's** most immediate and pressing problems as it is estimated that people living in informal squatter settlements or katchi abadis, range from 35-40 per cent of the total urban population."

This cannot be dismissed as a fund raising speech; Pakistan which was water rich till about one and a half decade ago is facing serious water challenges, voiced by none other than General Musharraf.

Water Crisis in Pakistan

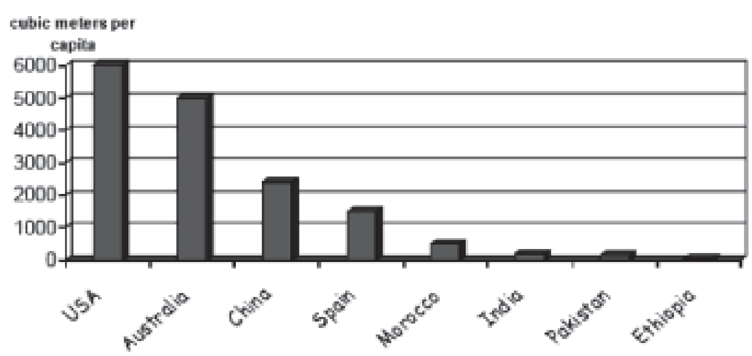
A recently published World Bank report has some disturbing revelations about the water situation in Pakistan.

Water Stress. Pakistan is already one of the most water-stressed countries in the world, a situation which is going to degrade into outright water scarcity due to high population growth. There is no additional water to be injected into the system. There is no feasible intervention which would enable Pakistan to mobilise appreciably more water than it now uses. Arguably, overall use for irrigation needs to decline so that there are adequate flows into the degrading delta. There is abundant evidence of wide-scale degradation of the natural resource base on which the people of Pakistan depend. Salinity remains a major problem, the ingress of saline water into over-pumped freshwater aquifers – remain only dimly-understood threats. Simultaneously, there is large-scale uncontrolled pollution of surface and groundwater, and there is only one industrial common effluent treatment plant working in the whole of the country. Groundwater has been over-exploited in many areas, and its quality is deteriorating.

Climate change. The report further cautions that, the Indus basin depends heavily on the glaciers of the western Himalayas which act as a reservoir, capturing snow and rain, holding the water and releasing it into the rivers which feed the plain. It is now clear that climate change is already affecting these western glaciers in a dramatic fashion, best estimates are that there will be fifty years of glacial retreat, during which time river flows will increase. But then the glacial reservoirs will be empty, and there are likely to be dramatic decreases in river flows, conceivably by a **terrifying** 30 percent to 40 percent in the Indus basin in one hundred years time.

Relative to other arid countries, Pakistan has very little water storage capacity. Whereas the United States and Australia have over 5,000 m^3 of storage capacity, Pakistan has only 150m^3 of storage capacity per capita. The dams of the Colorado and Murray- Darling Rivers can hold 900 days of river runoff.

Chart : 7 Storage per capita in different semi-arid countrie



Inter Provincial disputes, Sindhi Riparian perception. In his article "An Overview of the History and Impacts of the Water Issue in Pakistan," Altaf A. Memon, argues that essentially, the water issue is between Sindh and Punjab provinces of Pakistan. This issue is not necessarily of recent origin. The British colonisers were not interested in helping Punjab to damage Sindh. The issue came to the fore in 1901, when the Indian Irrigation Commission prohibited Punjab from taking even a drop of water from Indus without the approval of Sindh. Continuing with Altaf's argument, which cannot be brushed aside as a dimension of Pak Politic, Sindh vs. Punjab, there is some substance in the argument. A brief on water crisis in Pakistan prepared by leading experts from WAPDA (Water and Power Development Authority, Pakistan), IRSA (Indus River Systems Authority), the sole authority supervising the water distribution to all the provinces of Pakistan based on 1991 accord, was presented to the Pakistani parliamentarians in 2003. The paper seriously addressed the inter provincial conflicts in water sharing. As per the paper "Lack of trust among the provinces especially between Punjab and Sindh is at the heart of the water issues in Pakistan. All disputes stem from this crisis of confidence. Sindh (the lower riparian in this case) questions the upper canal withdrawals and feels that it is either being deprived or will be deprived of its share of water by Punjab".

Differences Among Provinces on the Interpretation of **Water Apportionment Accord of 1991.** The settlement currently in force is the Indus Water Accord of 1991. However, the dispute has not been finally resolved. The main differences relate to construction of Kalabagh, Bhasha and other dams on the river Indus. Sindh and NWFP (North West Frontier Province) have serious objections to this project and their assemblies have passed resolutions against the Project. A number of elements in Sindh apprehend that this project may become a source of withdrawing excess water for Punjab. Some people in the NWFP (North West Frontier Province) feel that Kalabagh Dam will threaten Nowshehra and may damage their agricultural land. The construction of Greater Thal Canal is in progress in the Punjab. The Provincial Assembly of Sindh has passed two resolutions against the construction of the Canal. While the construction of the Greater Thal Canal proceeds, street protests have been organised in Sindh against the construction of the Greater Thal Canal generating more bitterness in the inter-provincial relations.

Indus River Basin and India

To fully comprehend the complication that the Indus River bears, it is essential to be acquainted with the path of its travel from origin to the outlet in Arabian Sea. It originates in the Kailash range in western Tibet and then flows in a northwesterly direction through China to India. From here the river turns south and passes into Pakistan. Similarly, the five rivers- Jhelum, Chenab, Ravi, Beas and Sutlej- originate in India and later join the Indus in Pakistan. The partition of one India into two sovereign states, India and Pakistan, resulted in major conflicts for distribution of resources including water. A boundary commission for demarcating the international boundaries, in the states of the Punjab and Bengal under the chairmanship of Sir Cyril Radcliffe was constituted. He awarded most of the canals and the canal irrigated land to Pakistan, but the sources of all the five tributaries of the Indus, Jhelum, Chenab, Ravi, Beas and Sutlej, remained in India. Thus, India continued to be the "upstream riparian" of the Indus and its tributaries.

The defining moment in water conflict, between the two nations, was in 1948 when East Punjab (Indian) stopped water of Upper Bari Doab Canal (UBDC) to West Punjab (Pakistani). The issue was resolved by the intervention of Pundit Nehru. The period of 1948 to 1960 saw an extremely acrimonious relationship between the two countries with regard to water sharing. In 1950 the World Bank intervened and thus started the dialogue on the Indus Water Treaty. The Indus Water Treaty, water-sharing treaty between India and Pakistan was signed in Karachi on 19 September 1960 by the then Indian Prime Minister Jawaharlal Nehru and the then President of Pakistan Field Marshal Mohammad Ayub Khan. The World Bank (then the International Bank for Reconstruction and Development) is a signatory as a third party. The Indus System of Rivers comprises three eastern Rivers - the Sutlej, the Beas and the Ravi; and three western Rivers - the Indus, the Jhelum and Chenab. With minor exceptions, the treaty gives India exclusive use of all of the waters of the eastern Rivers and their tributaries. Similarly, Pakistan has exclusive use of the western Rivers. Pakistan also received one-time financial compensation for the loss of water from the eastern Rivers. The countries agree to exchange data and co-operate in matters related to the treaty. For this purpose, the treaty creates the Permanent Indus Commission, with a commissioner appointed by each country.

The Tulbul Hydrophobia. Often cited as the only major bilateral agreement between India and Pakistan to have stood the test of time, the IWT is today coming under extraordinarily close, in some cases highly critical, scrutiny. There are observers on both sides of the border, and representing opposite points on the political compass, who complain that the treaty is out of date, that it obstructs rational exploitation of the Indus River's resources, and that it ought at least to be amended, if not entirely scrapped. The first setback to the Treaty was in 1991, when Pakistan objected to the Tulbul Barrage (Pakistanis call it Wular barrage) intended to increase the depth of water in the Jhelum and facilitate navigation for transportation. India stopped the construction of the barrage pending bilateral settlement of the dispute but has failed to convince Pakistan, reinforcing the belief that Pakistan's only aim is to prevent harnessing of J&K's immense water resources. The matter remains unresolved till today.

The Baglihar/KishanGanga Hydrophobia. In the mid-nineties the Baglihar project became an issue. Pakistan said construction of the project was in violation of the IWT after visits by its Indus Commissioner for inspection. In January 2005, three out of the six objections raised by Pakistan were resolved. The other three relating to the height of the dam, pondage and level of intake remain unresolved. Pakistan wants a neutral expert to resolve the issue, after a reference was made. The Kishanganga project envisages building a hydro electric project on the Kishanganga River, a tributary of the Jhelum, and releases its discharge through a 22-km tunnel into the Wullar Lake on the Jhelum. All water flows from Jhelum and goes to Pakistan, therefore there is no consumptive use of water. Pakistan has objected to the project because it is also planning the Neelam – Jhelum hydropower project in POK on river Neelam {as Kishanganga is called in POK(Pakistan Occupied Kashmir)}. It claims the project would deny water to the Neelam Valley and scuttle the hydropower project. However, the project will reduce the flow of water by only 27 percent and will more than meet the irrigation requirements of Neelam Valley, though it may reduce the power generating potential of the proposed 969 MW Neelam- Jhelum hydropower project. Pakistan feels that by proposing these projects India is trying to pit the population of J&K against the Pakistan government. Most Kashmiris feel that the interests of the state were ignored while signing the Indus Water Treaty and support the Baglihar project to alleviate power shortage in the state."

The Chenab Formula. One option floated in Kashmiri circles across the line of control is to carve out a solution on the lines of Indus Basin Water Treaty. The treaty divided the Indus River system and allocated three western rivers (Indus, Chenab, and Jhelum) to Pakistan and three eastern rivers (Ravi, Sutlej, and Beas) to India. The idea was that the Indus, Jhelum, and Chenab Rivers and their basins should join Pakistan, and the Sutlej, Ravi, and Beas Rivers and their basins, as well as the remaining parts of Kashmir, should join India. Interestingly river Chenab has had a historical legacy even while Indus Water Treaty was being discussed in 1950s. In the summer of 2003, Maulana Fazlur Rehman, the head of Jamiat-e-Ulema Islami (JUI (F)), visited India. On his return, he suggested in his press briefings that he had proposed a resolution to the Kashmir conflict on geographical basis. This was interpreted as subtle advocation of the Chenab Formula. It is important to note that Maulana Fazlur Rehman was then reportedly engaged in quiet negotiations with General Musharraf on power sharing and a role for himself in Islamabad. It is very apparent that Chenab is the Pakistani jugular vein. Was the Pakistani force projection in Akhnoor sector in 1965 and 1971 merely to cut Kashmir Valley from Jammu or to control Chenab?

The riparian relations between the two countries would increasingly see testing times. Growing demographic pressures, resource depletion and resource degradation would have serious implications on future water sharing. Pakistan faces serious water problems. Perhaps, Kalabagh Dam holds the key to the future of Pakistan and outcome of Baglihar controversy the future riparian relations between the two nations. In Buzanian sense, the relations could range from that of cooperation to that of conflict, depending how the "**actors**" address the "**referent object**". In the first use nuclear doctrine of Pakistan, economic blockade (sans water) by India is one of the feasibilities.

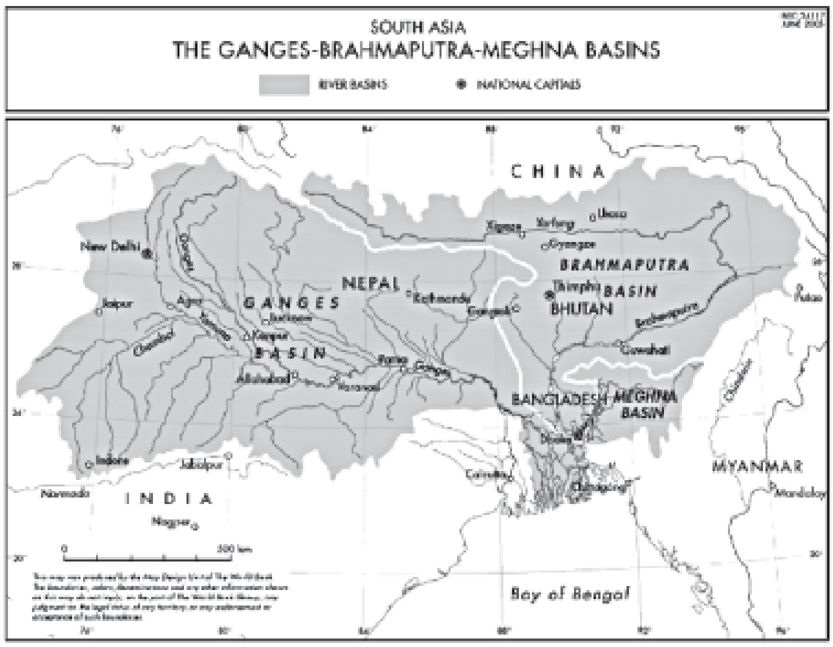
CHAPTER VI
WATER SITUATION:BANGLADESH

General

Bangladesh has a total area of about 14.7 million hectares (ha) and a net cultivable area of about 8 million ha. The two primary sources of water are local rainfall amounting to about 250 cubic kilometers (km3) annually, falling mainly between July and October; and trans boundary inflows amounting to about 1,000 km3 annually, derived mainly from the Brahmaputra, Meghna, and Ganges Rivers, with greatest flow occurring also between July and October. Bangladesh occupies only 8 percent of the total area of these rivers' three basins but is the point of concentration of their catchments. The result is a huge excess of surface water during the summer months and water shortfalls in the winter months. Consequently, the minimum flows required to meet total demands are less than what is available from surface and groundwater in the southwest and north-central regions of the country.

Bangladesh is the lower riparian of the Ganges, Brahmaputra, and Meghna Rivers, occupying only 8 per cent of the total area of the three basins, and is the point of concentration of the runoff generated in the upper catchments in the Himalayas (See figure 3). Continuing changes in the upper catchments, which include deforestation in the Himalayas, land degradation, and landslides, and development in the middle catchments in the form of flood control infrastructure, combine to increase the flood peaks. While some developments in the upper catchments tend to aggravate flood problems, water shortages in Bangladesh during the dry season, between January and March, are worsened by other developments such as upstream water diversions and withdrawals.

Figure 3 The Ganges, Brahmaputra and Meghna Basins



The population of Bangladesh is forecast to increase from about 133 million to over 220 million by 2050. Urban centers are expected to absorb most of the incremental population, growing from the present 30 million to about 130 million. This population growth combined with economic growth will increasingly stress water resources and this has the potential to be the dominant environmental and possibly the most important development issue facing Bangladesh in the coming half century.

Bangladesh is a nation where agricultural production is still the mainstay of the rural population's livelihood system, and therefore its people's livelihoods are still inextricably linked to the nation's water cycle. The nation's water, both above and below ground, provides a multitude of *services* to the population: water to drink, water for irrigation, fish water and for transport and other uses.

Bangladesh is subjected to water-related hazards such as cyclones, storm surges, droughts, floods, and river erosion. In theory these hazards affect everyone, but in practice the poor are most affected. The poor outnumber the rich (53 percent of the rural population are classified as poor with 37 percent classified as very poor), they live in greater density (at least 900 persons/km2), they occupy the most poorly constructed housing on settlements located on lands prone to hazards, and they do not have the resources to endure natural hazards without assistance.

A possible scenario for climate change would have temperatures rising by up to one degree Celsius, monsoon precipitation increasing by as much as 10 percent, dry season precipitation reduced, and sea level rising by 30 centimeters or more. These changes would have several critical impacts, increased temperatures will reduce winter river flows. In addition to reducing the fresh water available for an expanding population, this could result in saline water intruding further inland along coastal areas.

Although classified as a water rich country, with per capita water availability at $9000m^3$ (cf. India, $1900m^3$) Bangladesh has some serious water issues affecting economy and social development. The demographic burden, rapid urbanisation, deleterious effects of climate change do certainly pose a serious challenge to internal security caveat of Bangladesh in the years to come. This combined with lower riparian apprehensions; give a different colour to its likely relations with upper riparian, India in the days to come.

The Lower Riparian Psyche. About 7 per cent of catchments area of the Ganga, the Brahmaputra and the Meghna are located in Bangladesh, 64 perc ent in India, 18 per cent in China, 8 perc ent in Nepal and 3 per cent in Bhutan. Of the total annual stream flows in Bangladesh – 85 per cent occurring between June and October – about 67 per cent is contributed by the Brahmaputra, 18 per cent by the Ganga, and about 15 per cent by Meghna and other minor rivers. About 93 per cent of the annual flows of river systems originate outside the country. Thus the apprehensions of lower riparian are evident from the possible hydro exploitation of its water dependant economy by the upper riparian.

The Farakka Barrage was commissioned in 1975. With lean season flows being 55,000 cusecs in March-April in three out of every four years, Bangladesh feared a shortage in meeting its own assessed requirements including that of diverting a sufficiency of headwaters into the Gorai spill channel which serves its south-west region. The relations between India and Bangladesh remained acrimonious till 1996, on sharing of Ganga waters. On 12 December 1996, the prime ministers of Bangladesh and India signed a treaty on sharing of Ganges water. This represented the culmination of efforts to end a dispute that had run for many years, and to put in place an agreement between the two nations that had elapsed in 1988. The 1996 Treaty establishes a new formula for sharing the Ganges waters at Farakka in the dry season (1 January to 31 May). The new arrangement has the bottom line in that India and Bangladesh each shall receive guaranteed 35,000 cusecs of water in alternative three 10-day periods during the period March 1 to May 10.

Although the Indian and Bangladeshi governments have a water sharing agreement for the Ganges, there are none for the other 53 rivers that cross the border; Bangladeshi water engineers say that Indian barrages, canals, reservoirs and irrigation schemes are slowly strangling the country and are stopping its development. Bangladesh, which is too flat for major reservoirs, says if India goes ahead with its schemes, it may have to build a network of canals to irrigate large areas now fed naturally by the Brahmaputra.

Water and Migration. Linkages can be drawn between water and migration, be it scarcity or floods. Economic deprivation is one of the most accepted "push" factors of illegal Bangladeshi immigration into India. As per Homer-Dixon "India has constructed a huge barrage – Farakka dam over Ganges— with harsh results for downstream cropland, fisheries and villages in Bangladesh. Bangladesh is so weak that the most it can do is plead with India to release more water. There is little chance of a water war here between upstream and downstream countries (although the barrage's effects have contributed to huge migrations out of Bangladesh into India)."

Resource scarcity in terms of fresh water availability, Malthusian demographics growing with increasing per square kilometer densities, sharply declining per capita land availability, rapid rural to urban migrations could result in increasing, Homer-Dixonian, "**ecological marginalisation**" of a large segment of Bangladeshi population. Such a situation predictably may besides, further increasing illegal immigration to India, be able to pose serious internal security challenge, not only in Bangladesh but also in India. The hydrophobia is likely to worsen should India at some point of time decide to start Himalayan river linking projects, due to its own requirements. The security dimensions of Indo-Bangla hydro-politics can be well imagined should Bangladesh tilt more towards radicalisation in years to come.

CHAPTER VII
CONCLUSION

"*Many of the wars of this century were about oil, but wars of the next century will be about water.*" *Ismail Serageldin, Vice President World Bank*

Water available on this planet is finite; it has neither grown nor shrunk. However, its temporal and spatial vagaries have troubled the growing populations. Moreover the alarming pollution further limits its consumptive availability. The exponential demographic transitions since the middle of last century have put tremendous strain on segments of populations on this globe, turning them to become water stressed or water crisis threatening their growth, even survival. It is believed that by 2025, 40 per cent of the global population will be water stressed.

Such resource constraints have serious social discourse consequences. Increased social frictions can easily lead to conflict situations. Although the last war over water was fought 4500 years ago between Lagash and Umma over river Tigris, water has been one of the serious covert "**referent object**" in Buzanian sense, in current conflicts like in West Asia. "Chiapas insurgency" in Mexico is directly attributed to water. Developing and maintaining water infrastructure is expensive. (For river linking projects in India the cost estimates are equal to ¼ th of country's GDP). Ever since Brundtland commission report on environmental protection was published, water security has assumed a new significance in the overall context of human security.

In the context of the hypothesis, it has been amply proven both on the domestic front and in the regional setting that if the water resources are not managed (sustainable) properly we are to see serious socio political crisis, to the extent of war and perhaps threats of use of nuclear weapons in the years to come. The likelihood of these scenarios has been amply inferred from the discussions and analysis in the thesis.

India along with its neighbours, Pakistan and Bangladesh who are the lower riparians, will together face water stress situations in years to come. Sharing of river waters could be cooperative or conflictual. It is up to us to choose the option.

APPENDIX A

(Refers To Chapter I)

The Hydrological Cycle and Sustainable Water Use

The hydrological cycle is the repeated process of the evaporation and redistribution of water in various forms around the earth. The annual precipitation on earth is more than 30 times the atmosphere's total capacity to hold water, which means that water is recycled relatively rapidly between the earth's surface and the atmosphere. The energy of the sun evaporates water into the atmosphere from oceans and land surfaces. Evaporation is the change of liquid water to a vapor. Sunlight aids this process as it raises the temperature of liquid water in oceans and lakes. As the liquid heats, molecules are released and change into a gas. Warm air rises up into the atmosphere and becomes the vapor available for condensation. Some of the earth's moisture transport is visible as clouds, which themselves consist of ice crystals or tiny water droplets. The jet stream, surface-based circulations like land and sea breezes, or other mechanisms propel clouds and vapor from one place to another until they are condensed back to a liquid phase. Water then returns to the surface of the earth in the form of either liquid (rain) or solid (e.g., snow, sleet) precipitation. Some water on the ground, in streams, or in lakes, returns to the atmosphere as vapor through evaporation, and water used by plants may return to the atmosphere as vapor through transpiration, which occurs when water passes through the leaves of plants. Collectively known as evapotranspiration, both evaporation and transpiration occur at their highest rates during periods of high temperatures, wind, dry air, and sunshine. Although the total amount of water on earth is fixed, the physical state of the water, on a time scale of seconds to thousands of years, is continuously changing between the three phases (ice, liquid, and water vapor), circulating through the different environmental compartments (ocean, atmosphere, glaciers, rivers, lakes, soil moisture, and groundwater), and renewing the resources. Average replenishment rates show considerable range, from thousands of years for the ocean and polar ice down to biweekly or even daily replenishment of water in rivers and in the atmosphere. Average annual global evaporation from the ocean is six times higher than evaporation from land, while precipitation over the ocean is 3.5 times higher than over land. Based on current estimates, this result worldwide is approximately 40,000 to 45,000 km^3 of water each year transported from the ocean via the atmosphere to renew the freshwater resources. The balance of water that remains on the earth's surface is runoff, which empties into lakes, rivers, and streams and is carried back to the oceans, as well as recharging groundwater, and is potentially available for consumption each year. This is the renewable supply of water, that part of the hydrological cycle that can be utilized each year without leading to the depletion of freshwater resources; it does not include groundwater resources that are no longer replenished. This renewable resource is referred to as "blue water," while "green water" refers to the rainfall that is stored in the soil and evaporates from it. Green water is the primary source of water for rain-fed agriculture and for freshwater ecosystems, and is based on the level and flow of water in soil, which depends on soil texture and structure as well as climatic factors. It is significantly affected by land use and changes in land use, which are in turn affected by demographics. About 60 percent of the world's staple food is produced from rain-fed fields, along with meat production from grazing, and the production of wood from forestry. In sub-Saharan Africa, almost the entire food production, along with major industrial products such as cotton, tobacco and wood, is produced from green water in rain-fed fields. Water policy and planning focus almost exclusively on blue water, perhaps because green water can be managed only indirectly. This marginalization of rain-fed agriculture affects the accounting of water availability, since green water is not accounted for as water available for human use. Rain-fed agriculture in temperate zones tends to be highly mechanized and economically efficient, if energy demanding. In the tropics, small-scale farming is by far more prevalent. Small farms can also be run very efficiently, and in the wet tropics in countries such as Indonesia, Bangladesh, and Taiwan, there is often enough water to allow a second or third harvest through the use of irrigation. In the semi-arid tropics, especially, however, most agriculture is subsistence farming with very low efficiency. Africa, for example, gets at least 90 percent of its food from such farms. Food production could be increased in the area where it will be consumed by improving the efficiency of the use of green water for agriculture in these areas. In the semi-arid tropics, supplementary irrigation from groundwater can be used to optimize the use of green water for crop production. Relatively small quantities of blue water can safeguard crop production and, by doing so, produce high yields per cubic meter of blue water, much higher than can be attained from full-scale (dry season) irrigation **Source:** Jill Boberg, *Liquid Assets, How Demographic Changes and Water Management Policies Affect Freshwater Resources,* Published 2005 by the RAND Corporation http://www.rand.org

APPENDIX B

(Refers To Chapter I)

BASIC WATER REQUIREMENTS FOR HUMAN ACTIVITIES

Minimum Drinking Water Requirement An absolute "minimum water requirement" for humans, independent of lifestyle and culture, can be defined only for maintaining human survival. To maintain the water balance in a living human, the amount of water lost through normal activities must be regularly restored. While the amount of water required to maintain survival depends on surrounding environmental conditions and personal physiological characteristics, the overall variability of needs is quite small. Routes for water loss include evaporation from the skin, excretion losses, and insensible loss from the respiratory tract. Humans may feel thirst after a fluid loss of only 1 per cent of bodily fluid and be in danger of death when fluid loss nears 10 per cent. Physiological studies have generated "reference values" for a daily human water requirement. Minimum water requirements for fluid replacement have been estimated at about three litres per day under average temperate climate conditions. Using these data, a minimum water requirement for human survival under typical temperate climates with normal activity can be set at three litres per day. Given that substantial populations live in tropical and subtropical climates, it is necessary to increase this minimum slightly, to about five l/p/d, or just under two cubic meters per person per year. A further fundamental requirement is that this water should be of sufficient quality to prevent water related diseases.

Basic Requirements for Sanitation. A "minimum" must also be defined for providing sanitation services. There is a direct link between the provision of clean water, adequate sanitation services, and improved health. Extensive research has shown the clear health advantages of access to adequate sanitation facilities and protecting drinking water from pathogenic bacteria and viral and protozoa1 agents of disease. Effective disposal of human wastes controls the spread of infectious agents and interrupts the transmission of water related diseases. There are many technologies for improving access to adequate sanitation services, with widely varying water requirements. The choice of sanitation technology will ultimately depend on the developmental goals of a country or region, the water available, the economic choice of the alternatives, and powerful regulatory, cultural, and social factors. Accordingly, while effective disposal of human wastes can be accomplished with little or no water when necessary, a minimum of 20 litres per person per day is recommended here to account for the maximum benefits of combining waste disposal and related hygiene, and to permit for cultural and societal preferences. This level can be met with a wide range of technological choices.

Basic Water Requirement for Bathing. On top of these direct sanitation requirements, additional domestic water is used for showering or bathing. A review of a range of studies in North America and Europe suggest average (not minimum) water use in industrialized nations for bathing to be about 70 liters per person per day, with a range from 45 to 100 l/p/d. Data on water used for bathing in developing countries or in regions with no piped water are not widely available. Some studies suggest that minimum water needed for adequate bathing is on the order of 5 to 15 1/ p/d and that required for showering is 15 to 25 l/p/day. A basic level of service of 15 l/p/d for bathing is recommended by Glieck.

Basic Requirement for Food Preparation. The final component of a domestic basic water requirement is the water required for the preparation of food. While most detailed surveys of residential water use in industrialized countries do not provide separate estimates of water used for cooking, some studies estimate that water use for food preparation in wealthy regions ranges from 10 to 50 litres per person per day, with a mean of 30 litres per person per day. In a study done of the water provided for 1.2 million people in northern California, an average of 11.5 litres per person per day was used for cooking, with an additional 15 litres used for dishwashing . Other studies in both developed and developing countries suggest that an average of 10 to 20 litres per person per day appears to satisfy most regional standards and that 10 l/p/d will meet basic needs.

Meeting Basic Needs: Basic Water Requirement

Considering drinking water and sanitation needs only suggests that the amount of clean water required to maintain adequate human health is between two and 80 litres per person per day, or up to about 30 cubic meters per person per year. Using minimum levels of 15 l/p/d for bathing and 10 l/p/d for cooking, P Glieck recommends that international organizations and water providers adopt an overall basic water requirement (BWR) of 50 litres per person per day as a new standard for meeting these four domestic basic needs, independent of climate, technology, and culture.

Source: Gleick H. Peter, "Basic Water Requirements for Human Activities: Meeting Basic Needs", *Water International* vol. 21, no. 2 (1996) http://www.pacinst.org/reports/basic_water_needs/basic_water_needs.pdf. Accessed on 12 July 2006, Pacific Institute for Studies in Development, Environment, and Security.

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