

State of the Environment



Bhutan



2001



NORAD
DIREKTORATET FOR
UTVIKLINGSHJELP
NORWEGIAN AGENCY FOR
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Foreword

The Rio Earth Summit in 1992 formulated an action plan, Agenda 21, a multifaceted process to address the full range of development and environmental issues involving participation of governments, international organizations and major groups in the quest for sustainable development.

The publication of the Global Environmental Outlook series, GEO-1, followed by GEO-2000, the Millennium Report on the Environment, involved a participatory assessment process to review the state of the world's environment and to chart a new process for global environmental policy. The diversity and magnitude of environmental problems are outlined, with a call for more complete and precise analyses of the poorly understood linkages between human actions and environmental outcomes. Although the number of policy responses is growing, low priority continues to be afforded to the environment in national and regional planning. GEO-2000 stressed the need for the development of more comprehensive and long-term mechanisms for monitoring and assessing the effects of environmental policies on environmental quality; and for more integrated policy making and action-based programmes to serve the needs of the people.

The United Nations Environment Programme (UNEP) is mandated to produce a Global State of the Environment Report in 2002 (GEO-3) for the 2002 Earth Summit i.e., Rio + 10, and this global assessment will be enriched by producing State of Environment (SoE) reports at the national, subregional and regional levels. In 1998, the UNEP Regional Resource Centre for Asia-Pacific (UNEP RRC.AP) collaborated with the Norwegian Agency for Development Cooperation (NORAD) to carry out a process on Strengthening National Capabilities on Environment Assessment and Monitoring towards the Preparation of the Global State of the Environment Report 2002, thus linking national to regional and global initiatives.

This National State of the Environment (SoE) Report of Bhutan is the one of seven national reports from the above process, focusing on two Asia-Pacific subregions, namely South Asia (Bangladesh, Bhutan, Maldives, Nepal and Sri Lanka) and the Greater Mekong (Lao PDR and Vietnam) Subregions. The National Environment Commission (NEC) of the Royal Government of Bhutan, which is the national implementing agency, has played a very crucial role in carrying out this participatory assessment process in soliciting input from various government sectoral agencies. Around 20 agencies and 55 individuals were involved in the process. With the substantive support from the Tata Energy Research Institute (TERI), the designated collaborating center of UNEP, and regular feedback from the South Asia Cooperative Environment Programme (SACEP), this assessment exercise has been successful and instrumental in providing significant input to the ongoing South Asia SoE preparation. It aims at providing guidelines for environmental action planning, policy setting and resource allocation for the coming decades, based on a sound analysis of the state of, and trends in, the nation's environment.

Five priority key issues for the state of environment report for Bhutan have been identified in consultation with the National Environment Commission Secretariat as per UNEP guidelines and analyzed following the “pressure-state-impact-response” (PSIR) analytical framework. The same process has been followed by the other six countries, leading to the identification of their key environmental issues. These can then be addressed subsequently through action-based programmes in the next phase of the planning process.

The five key environmental issues identified for Bhutan are (1) environmental concerns of rural - urban migration, (2) land degradation, (3) air pollution, (4) water resource and pollution, and (5) solid waste management. Increasing urbanization is identified as important factor for rural-urban migration and can pose pressure on urban resources, infrastructure and environment. Land degradation is taking place mainly due to deforestation, shifting cultivation, and forest fire. Vehicular growth, industrial activities, and fuel wood burning in bhukaris are the main sources of air pollution in Bhutan. Urbanization and industrial activities may cause pressure on water resources in future unless proper measures are taken. Solid waste management is an emerging issue in urban centers in Bhutan.

This SoE assessment for Bhutan provides a sound basis for the development of action plans, the next stage of the planning process, as we enter the new millennium. The report aims to provide concrete guidance for action planning, policy setting and resource allocation for the coming decades to improve the state of the environment of Bhutan and the welfare of her people.

UNEP will continue to provide leadership in the region for the preparation of environmental assessment reports at national, subregional, and regional level and the capacity building necessary to support these assessment activities.



A handwritten signature in black ink, appearing to read 'Klaus Töpfer', with a stylized flourish at the end.

Klaus Töpfer
Under-Secretary General, United Nations and
Executive Director, United Nations Environment Programme
August 2001

FOREWORD

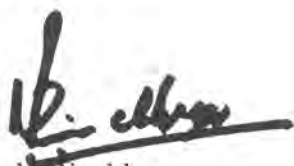
In July 1999, a Memorandum of Understanding was signed between the Royal Government of Bhutan, United Nations Environment Programme, Environment Assessment Programme for Asia Pacific (EAP.AP), Bangkok and the South Asia Cooperative Environment Programme on the project: Strengthening Environment Assessment and Monitoring Capabilities in Bhutan - State of Environment Report. Under this project, UNEP, EAP-AP provided the Royal Government of Bhutan with computers and software to assist in the preparation of the State of the Environment Report. In addition, an in-country training on data collection and reporting was also held, in which representatives from relevant agencies in the Royal Government participated.

I am happy to report that the assistance from UNEP and SACEP was timely, especially in view of the fact that such a report was long overdue for Bhutan. While Bhutan is endowed with a rich natural resource base and a pristine environment, we cannot continue to be complacent about this fact. There is an absolute need for a strong information base on all aspects of environment and natural resources in order to assess and evaluate the status of the environment. This information have to be systematically collected from decentralized multi-sectoral environmental agencies/institutions, analyzed, and presented in a timely manner.

This project has not only strengthened the environmental assessment and monitoring capabilities of the different agencies in the Royal Government but if implemented on a regular basis will also enable efficient and improved decision making in support of the sustainable development policy of the Royal Government. The project has also initiated the establishment of an information base for data processing, modeling and analysis to support future State of the Environment Reports. Above all, the project will improve the basis for decision-making in the handling of important/emerging environment issues in Bhutan.

This is the first State of the Environment Report of Bhutan. It was evident during the preparation process that the availability of data and information was a limiting factor. The little data and information that was available were not collected and documented in a coordinated manner. As such this proved to be a major challenge in the preparation process. I am confident that this initiative will help fill up this gap on information and data.

On behalf of the National Environment Commission and on my own behalf, I would like to thank all the officials from the Royal Government who contributed to this process. I would also like to thank Tata Energy Research Institute, Delhi for preparing this report. Finally, I take this opportunity to thank UNEP and SACEP without whose generous assistance this report would not have come out.



Nado Rinchen
Deputy Minister of Environment
Royal Government of Bhutan

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Part I

Executive summary

Part I

Executive summary

Executive summary

One of the mandates of the UNEP (United Nations Environment Programme) is to produce a global state of the environment report in 2002. As part of this larger initiative, the UNEP, Bangkok has undertaken the SEAMCAP (Strengthening Environmental Assessment and Monitoring and Capabilities for Asia and the Pacific) project to produce the state of the environment reports at the national, sub-regional, and regional levels. The objectives of the report are to increase the awareness and understanding of environmental trends and conditions, to provide a foundation for improved decision-making at all levels, and to facilitate the measurement of progress towards sustainability.

The state of the environment report prepared for Bhutan broadly covers the five priority issues pertaining to the environment, identified in consultation with the National Environment Commission Secretariat as per the UNEP guidelines. In addition, other issues addressing the economic and social development are also included. The priority issues are identified keeping in view the possible impacts of developmental activities on environment and natural resources. The five priority issues are (1) environmental concerns of rural-urban migration (2) land degradation, (3) air pollution (4) water resource pollution, and (5) solid waste management. The report on priority issues was prepared following the PSIR (pressure-state-impact-response) framework. The various issues are discussed in different chapters in this report.

Bhutan stepped into the 21st century with a commitment of adopting the 'middle path' approach to sustainable development, in order to achieve the maximum economic

development without compromising the country's socio-cultural and biological diversity. Bhutan is proud of its beautiful setting in the lap of the Himalayas, with rich flora and fauna, and a vibrant Buddhist culture. A statement made by H.M. the King Jigme Singye Wangchuck essentially represents the policy of Bhutan towards environment:

Throughout the centuries, the Bhutanese have treasured their environment and have looked upon it as the source of all life. This traditional reverence for nature has delivered us into twentieth century with our environment still richly intact. We wish to continue living in harmony with nature and to pass on this rich heritage to future generations

Bhutan has made remarkable progress in human as well as economic development. It is endowed with a vast hydropower potential, which, if utilised, can provide impetus to, not only Bhutan's economy, but the regional economy as well. Since the number of industries is growing, systematic integrated planning needs to be pursued including environmental issues, policy, technological intervention and institutional mechanisms. The process of EIA needs to be effectively carried out. A coordinated and integrated planning process is required to ensure maximised positive socio-economic impacts and minimised negative environmental impacts.

Agriculture is the main source of livelihood in Bhutan. Food self-sufficiency is 65% at present. To achieve 100% food self-sufficiency, the RGoB (Royal Government of Bhutan) should give priority to low-cost soil fertility management, development of pre- and post-production technologies and integrated pest management, improved cropping systems and water management

practices, and capacity building for developing natural resource/agricultural statistics and farming system information.

Bhutan is endowed with a rich forest cover and biological diversity. However, developmental activities can put pressure on precious forest resources. Deforestation is taking place mainly due to infrastructure development, expansion of industrial and agricultural activities, and increasing urbanisation. The strong conservation ethics of the Bhutanese and political will are the greatest contributing factors to the preservation of the forests. The National Assembly has mandated the country to maintain a minimum of 60% of the land area under forest cover for all times. Different acts and programmes have been prescribed by the RGoB to minimise the rate of deforestation.

Urbanisation is an important pull factor for rural urban migration. Migration increases pressure on urban infrastructure and services and poses environmental problems. Rural-urban migration can be checked by:

- Improving infrastructure and quality of life in rural areas,
- Creating employment opportunities in the non-agricultural sector
- Developing more regional centres with better infrastructure and service facilities to ease pressure on Thimpu and Pheuntsholing.
- Developing small and medium sized cottage industries (such as weaving)
- For Thimphu and Phuntsholing, increasing the capacity of infrastructures
- Developing and implementing housing schemes that provide low-cost and weather-proof housing for all

Land degradation is a priority issue in Bhutan. It can be attributed to deforestation, unsustainable fuel wood extraction, shifting cultivation, encroachment into forest land, forest fire, over grazing, and non- adoption of adequate soil conservation measures. Measures recommended to prevent land degradation are as follows:

- Proper land use planning according to the Land Capability Class
- Make the agricultural extension system more efficient and far-reaching
- Strategy to discourage the practice of shifting cultivation in a phased manner need to be developed and people engaged need to be provided alternative occupation.
- Protection of natural watersheds through people's participation would be the most effective management of land.

Air pollution in Bhutan can be attributed to rapid urbanisation, increasing industrial activities and vehicular number. Burning of wood in bhukharis and diesel vehicles are the main sources of air pollution. Recommendations to control air pollution are as follows:

- Develop industry-specific emission standards and guidelines on control of pollution for different polluting sources.
- Promote the use of efficient electrical appliances to check firewood use for cooking and heating purposes.
- Formulate a comprehensive urban air quality management strategy for different cities/towns.
- Develop stringent emission standards for curbing vehicular pollution.
- Improve fuel quality in terms of sulphur content, phasing out lead, and benzene content.
- Promote a public transport system
- Strengthen monitoring and reporting of air quality parameters

Fresh water is available in abundance in Bhutan. At present, river water quality is reasonably good since no polluting industries are located upstream. But rapid urbanisation and industrialisation can create a pressure on valuable water resources. A large number of urban agglomerations do not have municipal/ industrial waste water treatment facilities that can lead to deterioration of water quality in rivers. Recommendations to manage water resources are as follows:

- Formulation of national water resource management master plan

- Development of drinking water quality standards, ambient environmental quality and effluent standards for industries
- Generation of requisite baseline information on the quality of existing sources and treatment capabilities
- Proper surveillance systems for drinking water sources and supply schemes need to be in place and supported by necessary legislation
- Development of multi-sectoral use of water resources
- Introduction of clean technologies for industries and the construction of sewage/effluent treatment plants for cities
- Promoting integrated watershed development programmes through effective participation of local people
- Promote door-to-door collection system through active involvement of stake holders namely private entrepreneurs, NGOs, municipal corporation, etc.
- Separate handling of infectious and hazardous waste generated by health care facilities
- Dispose biodegradable matter either by employing such technologies as aerobic composting and anaerobic digestion or by sanitary landfilling.
- Consider common treatment and disposal sites for municipal solid waste, hazardous waste and hospital waste
- Develop nation wide data inventory for waste generation, handling and treatments

Solid waste management is an emerging issue in most urban towns in Bhutan. The magnitude of the problem is small in rural areas, but is growing significantly in urban areas. To minimise solid waste problems in the future, reduction in waste generation would be an important factor. Recommendations for solid waste management are as follows:

- Develop separate solid waste management rules and more specific guidelines
- Improve the existing collection service structure to provide community waste bins conveniently placed for the people to deposit domestic waste

While economic development is important to improve the quality of life of the people, strong policies, planning and institutional mechanism, in addition to political will, are essential to preserve socio-cultural and biological diversity. The RGoB is committed to maintaining a harmony between economic forces, spiritual and cultural values and the environment through its 'middle path' approach.

Part II

Overview

Bhutan witnessed remarkable progress in human and economic development since the process of modern development took off in 1961. In the overview section, issues pertaining to human and economic development are discussed. Population, human development index, education, economy, and employment are included to address the human development. Economic development covers energy sector, industrial development, agricultural sector, and tourism. In addition, biodiversity and environmental policy of Bhutan are also included.

Population

The estimated population of Bhutan in 1998 was 637 777 persons. The total land area of the country is approximately 46,500 km² which implies a population density of about 13 persons per km². However the effective density using arable land as the denominator is far higher, at 81 persons per km². The rate of growth of population has increased from 2% in 1984 to 3.1% in 1996. This is primarily due to a decline in the death rates from 13.4 to 9 per thousand, while the birth rates showed an increase from 39.1 to 39.9 per thousand population over the same period. The fall in mortality rates is attributed to better provision of primary health services, child immunisation, and improved access to water supply and sanitation through government programmes. While death rates have declined, fertility rates have shown an increase during 1984-94 and the current TFR (total fertility rate) is 5.4.

If a rate of population growth of 3.1% per annum is maintained, then the country's population is likely to be double by the year 2020 (Planning Commission 2000). The population pyramid of the country has a broad base, like any other developing country. Over 45% of the population of Bhutan is under 15 years of age. This implies that even if replacement level of fertility is reached by 2012 (as targeted by the Royal Government of Bhutan) the population is likely to grow for many years due to the population momentum, resulting from the young age structure.

The Government of Bhutan plans for 61% reduction in fertility in 15 years and achieving replacement level of fertility by 2012 so as to reduce the population growth rate to 1.3% by 2020. The Government aims at reducing the rate of growth of population by 0.1% every year during the 8th FYP (Five Year Plan, 1997-2002). This implies a reduction from 3% in 1996 to 2.48% in 2002. Table 1.1 gives the projected population size, growth rates and TFRs and contraceptive prevalence rates for 1997-2002 (MoP 1996, Planning commission 1999, UNICEF 1996).

Table 1.1 Projected population size, growth rates and TFR and corresponding CPR (1997-2002)

Year	Population (in July)	Mid-year CBR ^a	Mid-year CDR ^b	Rate of natural increase	TFR ^c	CPR ^d
1997	618557	36.37	7.21	2.92	5.32	24.68
1998	636499	35.40	7.12	2.83	5.16	26.80
1999	654288	34.43	7.03	2.74	5.00	28.94
2000	671984	33.40	6.94	2.65	4.84	30.83
2001	689603	32.49	6.85	2.56	4.68	33.11
2002	707173	31.52	6.76	2.48	4.52	35.98

^a Crude birth rate; ^b Crude death rate; ^c Total fertility rate / woman; ^d Contraceptive prevalence rate

Source MoP 1996

Human development

In 1996 Bhutan was ranked 159 of 174 countries on the human development index. It fell in the category of medium human development countries. The indicators of human development for 1984, 1994, and 1998 are presented in Table 1.2 and show a significant improvement.

The life expectancy of an average Bhutanese was only 35 years in 1960 and by 1984, it increased to nearly 48 years and in 1998 to 66 years. In 1984, the infant mortality rate (IMR) was 142 and by 1994 it came down to 70.7 per 1000 live births. Maternal mortality was 773 deaths per 10,000 births and came down to 380 in 1994. The health infrastructure prior to 1961 constituted only 4 small hospitals, 11 dispensaries, and 2 trained doctors. By 1998, the Bhutanese health system consisted of 28 hospitals and 145 Basic Health Units (BHUs). There are 98 doctors, 28 indigenous physicians and 928 paramedical workers. The health care system provides services to 90% of the population. Basic health care is free, and Bhutan has invested large resources into ensuring universal primary health care. Now there are 1,058 village-level health workers, who provide basic

medical help and share their health knowledge, skills, and understanding. In addition, mobile outreach clinics reach those who live far from the BHUs. By 1998 there were 454 outreach clinics that provided preventive health care, including immunisation of children and pregnant women. 58% of the rural population had access to safe drinking water in 1998 and 70% of the rural households have access to latrines. Water supply is expected to increase the coverage to 80% by the end of 2000.

The obvious improvement in human development is the result of concerted efforts on the part of the Government of Bhutan (Photo 1.1). During the First Five-year Plan, 59% of the expenditures were incurred on public works for the creation of infrastructural facilities. But over the years, there has been a steady decline in the allocations for public works and in the 7th plan it was approximately 8% of the development outlay. Instead, the allocations to the social sectors of health, education, water and sanitation increased from 12% during the 1st FYP to 27% during the 2nd FYP and varied between 16%–17% during the subsequent FYPs and during the 7th plan, the allocation increased to 22.6% (Planning Commission 1999, MoP 1996).

Table 1.2 Bhutan's human development index

	1984	1994	1998
Life expectancy at birth (years)	47.4	66.0	66.0
Adult literacy rate (%)	23.0	47.5	54.0
Combined first, second and third level gross enrolment rate (%)	24.5	39	72.0
Real GDP per capita (PPP\$)	901.0	1338.0	1534.0
Life expectancy index	0.373	0.683	0.683
Education index	0.235	0.447	0.600
GDP index	0.367	0.433	0.460
Sum of the indices	0.975	1.563	1.743
Human development index	0.325	0.521	0.581

Source Planning Commission 2000



Photo 1.1 Human development for brighter future

Education

The modern system of education in Bhutan started only in 1950, before which it followed a monastic education. In the early 1960s, the country had only 11 primary schools, with less than 500 children. In May 1995, there were 102 community schools, 143 primary schools and 7 private schools, which gave primary education in the country (Photo 1.2).

The number of educational institutions in Bhutan rose from 112 in 1977 to 322 in 1998, consisting of 128 primary, 115 community, 44 junior high and, 18 high schools, 1 degree college, 9 specialised training institutes (including 2 Sanskrit pathsalas), and 7 private schools (Planning Commission 2000). The number of teachers increased three-fold from 922 to 2,785 during the same period. The gross enrolment ratio at the primary level is 72% and the enrolment ratio is higher for males than females, for every level of education. In 1993, the number of girls enrolled in grades 6, 8 and 10 accounted for 73%, 58% and 41% respectively of that of boys. The enrolment ratio is now growing at 8% per

annum, which is a very promising trend. In 1992, the enrolment level between pre-primary and Class VI was 51,411. By 1996, it increased to 69,968. The proportion of girls enrolled during the same period also increased from 42% to 44%. Adult literacy has also increased from an estimated 17% in 1977 to 28% in 1984 and 54% in 1998.

Bhutan gives considerable importance to technical education in view of the acute shortage of national technical manpower. After its initiation in the 7th FYP as a pilot programme, non-formal education was adopted for expansion as means of enhancing the literacy level of the population. By 1996, about 4,000 people had benefited from this programme, of which the majority was of women. One major constraint in the education system in Bhutan is shortage of teachers even though the government has attempted at making teaching careers more attractive and increased the capacity of teacher training programmes (MoHE 1999).



Photo 1.2 Children in primary school

Economy

The economy of Bhutan is one of the smallest and least developed in the world. It is primarily based on agriculture and forestry and these are the sources of livelihood for 90% of the population. Agriculture is mainly in the nature of subsistence farming and animal husbandry. The industrial sector is not developed and is only in the form of small-scale cottage industries. The country has a mountainous terrain so that the construction of roads and other infrastructure is not only difficult but also expensive. However, Bhutan is rich in hydropower, which provides 99% of the total electricity, the majority of which is exported to India.

Bhutan's GDP in 1998 at Purchasing Power Parity (PPP) was 16,782 million Nu and the GDP per capita in 1998 was US \$638. The real growth rate of GDP in 1998 was 5.1%. The share of the primary sector (agriculture, livestock, forestry and fishing, and mining and quarrying) in GDP in 1998 is 38%. The share of the secondary sector (industry including construction and electricity) in GDP is 33.7%. The share of the tertiary sector (service sector including government)

in GDP is 30.4%. The inflation rate is 6.8% according to 1998 estimates. The country does not have any population living below the poverty line (Planning Commission 1999; MoP 1996; CIA 1999).

Employment

It is estimated in the 8th FYP that the working population of Bhutan will increase by at least 81% over the next twenty years. This implies that nearly 270 000 new jobs or 13,500 jobs per year would be needed. It does not appear that the agricultural sector will be able to absorb an increase of this magnitude (Photo 1.3). Hence, jobs will need to be generated in industry or service sectors. Currently, most jobs in service sector are in government offices, a trend that cannot be sustained in the future and ought to be changed consciously. (MoP 1996, Planning Commission 1999, CIA 1999). To meet the rising aspirations of the younger generation, a National Employment Board has been created, which will be the predecessor to a Ministry of Labour. This board is mandated to coordinate and facilitate employment, recruitment and job market research for



Photo 1.3 Traditional terraced farming

employment as well as regulate policies related to the conditions of employment. In addition, the National Technical Training Authority has been established to promote technical and vocational education.

While Bhutan has made good progress in human development, the major challenges ahead are ensuring a good quality of life for the people and meeting rising aspirations of the educated youth. For providing food, health, education, water supply, sanitation, and infrastructure on equitable and efficient basis, a large investment is required. The Government with the help of other stakeholders is committed to meeting these challenges.

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The primary source of energy in Bhutan has traditionally been firewood, which is available in abundant quantities from the country's extensive forests. Though the use of commercial fuels has grown, firewood still represents an overwhelming 75% of the total energy consumption in the country. Per capita consumption including non-commercial energy is approximately 0.8 ton of oil equivalent (DoP 2000). Since Bhutan has no known reserves of oil and natural gas, the demand for petroleum products such as kerosene, diesel oil, petrol and LPG is met entirely through imports.

Hydroelectric power is fast assuming the predominant role in the energy sector in particular and the economy at large. The country is endowed with a large hydropower potential, the total capacity estimated at over 30,000 MW. Annual precipitation in Bhutan averages between 500 and 5,000 millimetres and the mountainous topography channels the runoff through a series of valleys that lend themselves to small, medium, and large "run of the river". In some valleys, reservoir schemes with dam structures have also proved viable. With a ready and practically insatiable market in the region, hydropower is being looked upon as a sustainable and clean source of revenue for Bhutan that would finance other aspects of both its development and conservation agendas. Besides, expansion of hydropower is expected to promote more regionally balanced industrial development, thereby minimising the adverse socio-economic and environmental fallout of largescale rural-urban migration. Exploitation of hydro potential will also minimise the imports of fossil fuel based energy, creating a more favourable balance of trade for Bhutan and improving the environmental quality in the region as a whole.

Production

Power

The power sector in the country has shown an impressive growth—whereas the sector contributed negligibly to GDP in 1980, it accounted for 12% of GDP in 1997. The availability of electric power has provided a major impetus to manufacturing, particularly industries that are power intensive, so that the share of manufacturing in GDP rose from 3% to 12% in the same period (World Bank 1996). Given the enormous potential of hydroelectricity in the country, it spearheads the government's development strategy (Photo 2.1). There are at present, 23 hydroelectric generating stations with 344 MW installed capacity plus 13 MW diesel generator sets. Until recently, electricity generation was based on small diesel generating and micro



Photo 2.1 Rich water resource: a source of hydro electric energy

hydrostations, providing limited supplies of electricity which were supplemented by imports from India. With the commissioning of the first two units of the 336 MW Chukha Hydel Project in 1986 and the other two units in 1988, Bhutan substantially increased its electricity generation, and became a significant exporter of electricity to India. As of 1996, hydropower generation accounted for one-third of Bhutan's total annual foreign revenue (NEC 1998), although less than 1.5% of the estimated potential of 30,000 MW had been brought into production. Besides exports, the project made available affordable electricity to a large number of people and facilitated the setting up of industries mainly in the southwestern part of the country. Table 2.1 shows the growth in electricity generation from 1990 onwards. As can be seen, the Chukha Hydel Project forms the backbone of the power sector.

Based on the success of the Chukha Hydel Project, one large project, Tala (1020 MW) and two medium-sized projects—the Kurichu (60 MW) and Bashochhu (60.8 MW), are under construction (MoP 1996). Detailed project reports have been completed for four large projects, the Sankosh (4060 MW), Mangdechu (360 MW), Wangchu (900 MW) and Bunakha (180 MW). Map 2.1 shows the location of existing hydro power plants in Bhutan. Although India remains the single most important partner in the development of

Bhutan's hydropower, Japan, Austria, Norway and the Netherlands have contributed bilateral financing in the recent years. Multilateral organisations such as the United Nations and the Asian Development Bank have also contributed to the development of the energy sector.

With electricity now generally available in the major urban areas, the government seeks to expand the power grid into the countryside through extensive rural electrification projects. Given the rugged nature of the terrain, micro mini hydroelectric power stations are a logical alternative to extending the grid for meeting the requirements of village communities. Initiated in 1967, these 20–2,200 kW micro mini hydel projects are already playing an important role in improving conditions for Bhutan's overwhelming rural majority.

Solar energy

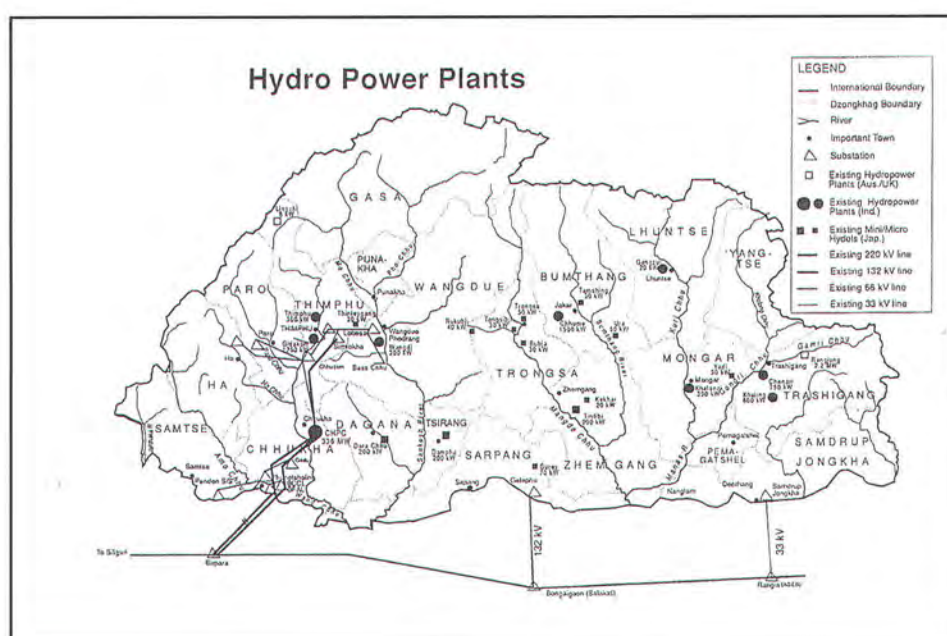
The solar energy programme was launched to provide electricity to institutions in remote areas. By the end of 1997, there were 1,316 photovoltaic panels throughout the country distributed among schools, monasteries, basic health units and some even to remote animal husbandry farms. With the good sunshine hours available in Bhutan, this source of energy has proved to be a viable alternative where grid supply may be uneconomical (Photo 2.2).

Table 2.1 Power generation 1990–1998 (million kWh)

	1990/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98
Total generation	1549.90	1563.88	1683.89	1685.81	1629.98	1972.18	1838.38	1801.02
Chukha hydel	1542.41	1554.37	1677.81	1679.24	1623.91	1964.63	1828.06	1789.98
Other hydel	7.45	8.20	5.05	5.49	5.89	7.50	10.25	10.97
Diesel	0.04	1.31	1.04	1.09	0.18	0.06	0.07	0.06
Exports ¹	1374.62	1336.87	1464.96	1456.34	1311.84	1564.04	1430.29	1357.20
Imports	4.44	4.98	5.10	4.62	5.34	7.24	7.03	7.54

¹ Exports from Chukha Hydel to India

Source: Planning Commission 1998



Map 2.1 Hydro power plants in Bhutan



Photo 2.2 Solar energy

Consumption

Power

The annual domestic consumption of electricity has increased from 145 million kWh during 1990-91 to 424 million kWh during 1998-99. Figure 2.1 shows the growth in electricity consumption by consumer type. As can be seen, while the share of domestic sector has fallen from 13% to about 8%, the share of the industrial sector has risen from 76.5% to

about 84%. Per capita electricity consumption has risen over the period from about 236 kWh during 1990-91 to 610 kWh during 1997-98. Table 2.2 indicates the progress in the electrification programme.

Fuelwood

Bhutan's per capita fuelwood consumption is relatively high compared to that of neighbouring countries such as Nepal. Fuelwood continues to be the main source of energy for lighting, heating, and cooking in the rural areas. It accounts for more than 75% of total energy consumption at the national level and virtually all non-commercial energy consumption in rural areas. According to the 7th FYP (Planning Commission 1991), the household sector consumed 95% of the fuelwood, government and commercial entities used 3%, and the agricultural sector and industry use about 1%. Per-capita consumption of fuelwood is estimated at 1.22 tonnes, which is one of the highest in the world (MoP 1996).

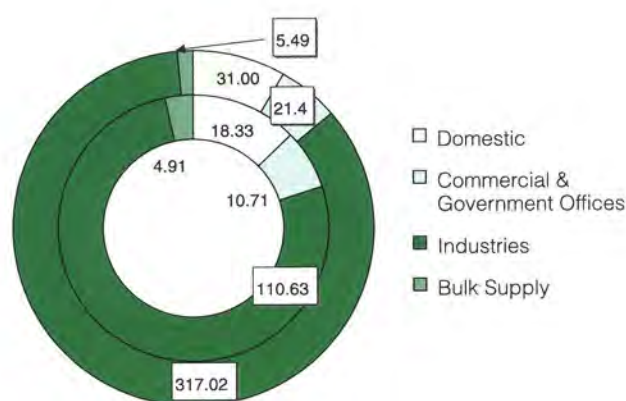


Figure 2.1 Electricity consumption by type of consumer (million kWh) during 1990/91 and 1997/98

Source Planning Commission 1998

Petroleum products

Demand for petroleum products for transportation as well as cooking purposes, which has increased over time, has to be met through imports (mainly from India) given the absence of reserves in Bhutan. While the consumption of kerosene has also increased in rural area for cooking and lighting, LPG use is mainly for cooking in urban areas. Table 2.3 shows the growth of imports of petroleum products over 1991-95.

Table 2.2 Electricity consumption

	1984/85	1990/91	1997/98
Towns electrified (No.)	19	30	39
Villages electrified (No.)	114	254	370
Consumers (thousand)	9.7	18.2	31.6
Per capita consumption (kWh)	30	235.9	609.8

Sources Planning Commission 1990, 1994, 1998

Institutions

Hydropower

The Department of Power, is responsible for coordinating the activities related to hydropower generation and distribution, and

is also the main central agency for power generation and distribution from small hydel. Altogether, it controls 22 hydel units and coordinates the activities of 7 decentralised electricity supply units. The Chukha Hydro Power Corporation is an autonomous body under a board of directors. Similarly, the Kurichu Project Authority (KPA) oversees the general administration and overall coordination of the Kurichu Hydropower Project activities under the guidance of a board of directors and the THPA (Tala Hydroelectric Project Authority) manages the construction of the Tala Hydroelectric project.

Table 2.3 Import of petroleum products during 1991-95 (000 tonnes of oil equivalent)

Fuel	1991	1992	1993	1994	1995
LPG	-	0.81	2.03	1.97	1.89
Kerosene	5.08	5.79	6.57	5.44	6.47
Diesel	13.83	14.35	14.08	15.09	17.14
Petrol	2.71	2.66	2.63	2.68	2.79

Source MoP 1996

Fuelwood

The Department of Forestry Services, Ministry of Agriculture, regulates the fuelwood supply. In rural areas, fuelwood from dead wood is free but cutting of live trees is regulated by permits issued by the local Dzongkhag Forest Ranger. In urban areas, fuelwood is supplied by licensed contractors and to a certain extent by registered saw mills.

Petroleum products

Two private companies supply petroleum products to the kingdom. There are 24 fuel depots situated at convenient points in various dzongkhags. The Ministry of Trade and Industries regulates the price and supply of fossil fuels.

Environmental concerns

Hydropower projects have been identified as a primary means for Bhutan to achieve a high level of social and economic development. However, there is a need to protect forested watersheds in order to sustain hydropower development which inevitably gives rise to conflicts with some of the needs of other economic sectors. The RGoB has prepared a Hydro Power Master Plan to implement power projects in a well coordinated manner including water shed management and water resource management.

Even though reliance on hydropower minimises the environmental deterioration and health hazards associated with wood burning stoves, the development of hydropower—especially if it requires the construction of large dams—itself imposes several social and environmental costs. Recognising these concerns, the NEC (National Environment Commission), has prepared guidelines for SEA (Strategic Environmental Assessment) to assist ministries and project developers incorporate environmental protection parameters into the project cycle. It is mandatory for the Department of Power to procure an environmental clearance from the NEC prior to a hydro project being approved.

The aim of power development should be to meet current and projected electricity requirements with minimum environmental degradation and social dislocation. As the NEC recognises *there should be commitments to maximise power generation from rivers already impacted and to monitor the environmental and socio-economic effects of existing and immediately proposed projects before extending hydel generation to untouched watersheds* (NEC 1999).

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Industrial development has so far played a limited role in the economic development of Bhutan. In recent years, an increasing thrust has been given to industrial development to meet the growing cost of social and basic infrastructure and to generate employment opportunities. During the 7th FYP, the RGoB (Royal Government of Bhutan) undertook many initiatives to facilitate the growth, including privatisation of many companies and service industries, establishment of technical assistance programmes for the private sector, simplification of rules and regulations for imports and exports, liberalisation of the licensing system to encourage and promote free enterprises, etc. In addition, the RGoB also corporatised various agencies providing services including airlines, postal, financial institutes and municipalities. The RGoB has laid specific emphasis on industrial development during the 8th FYP. Some of the objectives as mentioned in 8th FYP are the following:

- Increase the contribution of industry to the GDP, and to government revenue, on a sustainable and environmentally friendly basis
- Increase the profitability of indigenous industries
- Promote industrial development through private enterprise and
- Broaden employment opportunities and skill development to increase opportunities for women in industrial activity.

Some of the strategies undertaken for promotion of industrial activities are development of industrial estates and other infrastructure, preparation of feasibility studies for medium and large industries, making optimum use

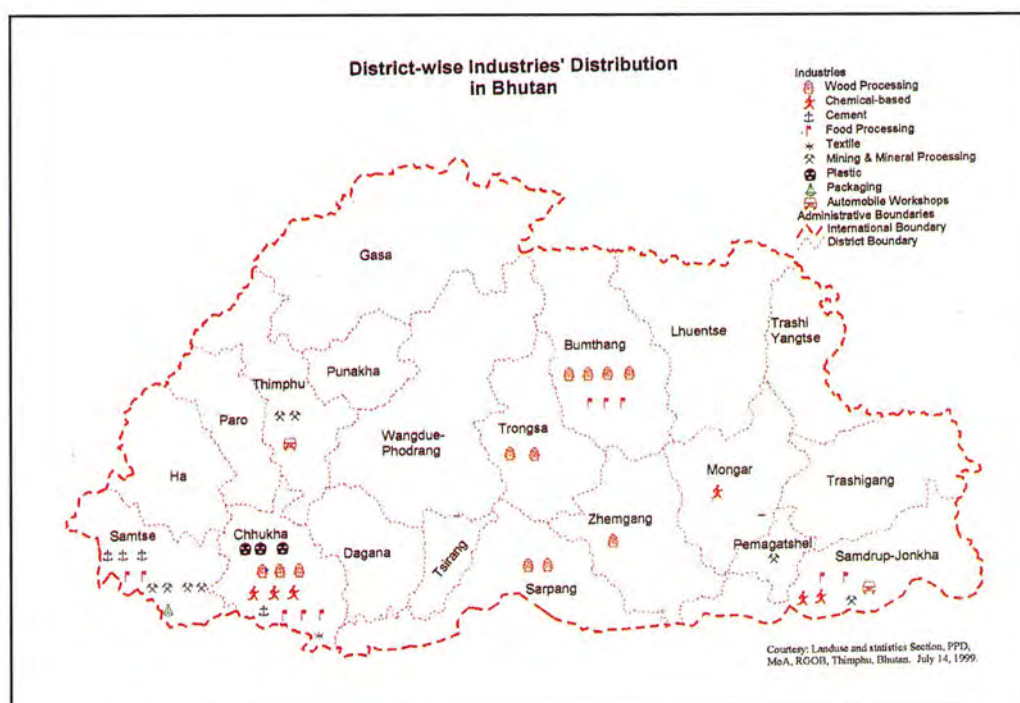
indigenous raw materials, development and implementation of an appropriate HRD programme, and promotion of cottage and small industrial enterprises, etc.

Developmental activities

Industrial activities in Bhutan are broadly classified into four categories, forest or wood-based, agro-based, mineral-based and service-based. The number of industries has gone up from 742 in 1990 to 4,394 in 1997. Map 3.1 shows the District-Wise Distribution of some of the major industries in Bhutan. Table 3.1 presents the number of industries by sector, size and type. Enterprises under the private sector have grown 6 times during 1990 to 1997. The small-scale sector has also grown 17 times during the same period. The number of licensed firms in manufacturing and mining industries under public, joint and private sectors is given in Table 3.2.

Mineral-based activities have grown faster in the last 20 years. The contribution of mining and quarrying to the GDP has risen from 0.01% in 1982 to 3.2% in 1992 (MoP 1996). Map 3.2 shows the location of mineral deposits. The kingdom has significant deposits of a number of minerals, including limestone, coal, graphite, gypsum, slate and dolomite. Most mining activities are limited to relatively small operations, mainly involved in the mining of dolomite, gypsum, limestone, slate, coal, marbles, quartzite, and talc. Table 3.3 shows production and use of minerals in 1995 and 1997.

The manufacturing industry is dominated by small number of major operators such as the Penden Cement Plant,



Map 3.1 District-wise distribution of some of the major Industries in Bhutan

Table 3.1 Number of industries by sector, size, and type

Industrial establishments	1990	1995	1997
Sector			
Private	710	3169	4356
Joint	20	11	5
Public	12	26	33
Size			
Large scale	499	31	36
Medium scale	23	32	39
Small scale	19	177	328
Cottage scale	201	650	693
Mini scale	-	1231	1640
Other (contract)	-	1085	1658
Type			
Production & manufacturing	266	336	405
Agro based	64	81	96
Forest based	131	167	207
Mineral based	33	35	37
Others	38	53	65
Contract	395	1085	1658
Services	81	1785	2331
All industries	742	3206	4394

Source CSO 1991, 1994, 1998, 1999

the Bhutan Board Products Limited, the Bhutan Carbide and Chemicals Limited, Bhutan Ferro Alloys Limited and Bhutan Agro Industries Limited. Photo 3.1 shows agro industries in Bhutan.

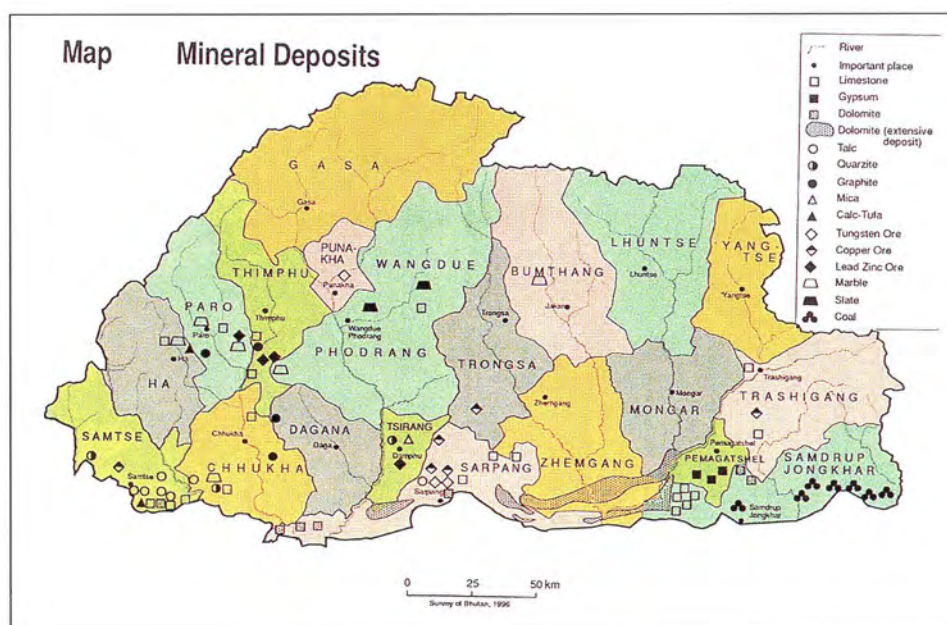
Besides these there are a number of other small manufacturing plants concentrated in the wood-based (Photo 3.2) and food processing sector. Cottage industries also played a prominent role with its good timber resources and favourable agricultural conditions (Photo 3.3).

Increased revenue generation and the share of the manufacturing sector to GDP have both gone up from 7% in 1989 to 13% in 1997 with an average growth rate of 13.4% per year. There is good scope for expanding the manufacturing sector specially in these areas. There is also good

Table 3.2 Number of licensed firms in manufacturing and mining industries by sector

Industries	1989				1997			
	Public	Joint	Private	Total	Public	Joint	Private	Total
Mining	2	1	8	11	0	0	5	5
Manufacturing	16	5	136	157	7	2	296	305
Food processing/milling	7	1	30	38	4	0	92	96
Textiles and clothing	1	0	6	7	0	0	1	1
Wood and paper products	5	2	75	82	3	2	203	208
Chemical products	1	2	17	20	0	0	1	1
Mineral products	1	0	6	7	0	2	29	31
Other	1	0	2	3	1	0	62	63
Total mining and manufacturing	18	6	144	168	8	4	393	405

Source CSO 1991, 1999

**Map 3.2** Location of mineral deposits in Bhutan

potential for agro-based industries in Bhutan since it produces high quality apples, pears, apricots, peaches, oranges, asparagus and mushrooms. There were 72 agro-based industries as of June 1995 (8th FYP). In recent years, Bhutan has been exporting fruits to neighbouring countries. The service sector in

Bhutan has witnessed a rapid growth during the 7th FYP due to development of infrastructure including hospitals, schools, administrative buildings, road construction, sewage facilities, and power substations.

Table 3.3 Production and use of mines and minerals, Bhutan 1995 and 1997

Minerals	Units	1995			1997		
		Total	Exports	Domestic use	Total	Exports	Domestic use
Dolomites	('000 tonnes)	249.3	249.3	0.0	240.3	240.3	0.0
Lime stone	('000 tonnes)	250.0	0.0	250.0	376.7	15.6	361.0
Gypsum	('000 tonnes)	52.1	48.1	4.0	62.3	14.1	48.2
Slate mines	('000 sq ft)	92.1	0.0	92.1	48.4	0.0	48.4
Coal mines	('000 tonnes)	71.1	56.9	14.2	53.2	21.8	31.4
Marbles							
Chips	('000 tonnes)	16.6	16.6	0.0	NA	NA	NA
Slabs	('000 sq ft)	42.5	42.5	0.0	8.2	0.0	8.2
Quartzite	('000 tonnes)	49.9	20.0	29.9	39.5	0.0	39.5
Talc	(tonnes)	3.3	3.3	0.0	11.4	11.4	0.0
Iron Ore	('000 mt)	2.1	0.0	2.1	5.0	0.0	5.0
Pink Shale	('000 mt)	NA	NA	NA	2.7	2.7	0.0

Source CSO 1998, 1999

Institutional mechanism

The Department of Industries under the overall guidance of the Ministry of Trade and Industry is responsible for all industrial activities in Bhutan. The department has a Project Development Section, Entrepreneurship Promotion Centre,



Photo 3.1 Agro industries in Bhutan



Photo 3.2 Wood working

Industrial Licensing & Monitoring section, Industrial Estate Development Section, Essential Oils Development Units and four Regional Trade & Industry Offices at Thimphu, Phuntsholing, Gelephu, and S/Jongkhar. Besides governmental support to industrialisation, the BCCI (Bhutan Chamber of Commerce and Industry) has a leading role in the promotion of industrial activities (NEC 1998). The Industries Division is responsible for the following:



Photo 3.3 Textile weaving: a growing cottage industry

- Monitoring and coordination of public joint venture industries
- Approval and issuance of industrial licenses
- Entrepreneurship promotion initiatives
- Promotion of industries including project proposal write-up and guidance and
- Collection of industrial information and data dissemination.

Development and environment

Industrial development in Bhutan is constrained by many factors, including supply and access to raw material, high transport cost, small domestic market, lack of infrastructure, availability of land, shortage of trained and semi-skilled manpower, etc. The hindrance in the way of development of hydro power and agriculture sectors is the rugged topography, which makes power supply, transport and communication difficult and costly (Photo 3.4). There is a lack of space for industrial development. Sometimes industrial development takes place on slopes, leading to their instability. Some mineral resources are available in the protected areas and therefore, exploitation of minerals would be difficult option. It would

constrain the development of mineral-based industries and mining the industry. Forest-based industries have also grown considerably.

Developmental activities have certain negative impacts on the environment, unless there is proper planning to mitigate the negative impacts. Few mineral-based industries are located on river terraces. Effluent from these industries could contaminate the rivers and streams unless it is treated effectively before discharge. Particulate matter and gaseous pollutants emitted from different sources namely small-scale industries, mining, etc. can deteriorate the local environmental quality and effect human health. Also, industrial activities can bring about changes in land use patterns, and put pressure on water resources and agricultural land. Other impacts of industrial activities are deforestation, slope instability, change of natural drainage patterns, and soil erosion. In a small and sparsely populated country such as Bhutan, economic activity should not lead to unsustainable migration of rural population to industrial areas.

To ensure environmentally sustainable industrial development in Bhutan, proper planning integrating environmental issues,



Photo 3.4 Communication: a challenging task

policy and technological intervention, and institutional mechanisms are essential prerequisites. A strong institutional mechanism would facilitate assessment, regulation and monitoring of the present and future development of the industrial sector. The process of EIA (environmental impact assessment) has to be effectively carried out to minimise the negative effects of the industrial activities at the planning and design stages. Emphasis should be given to setting up industry-specific air and water quality standards, monitoring and enforcement of the standards, training and capacity building of the enforcement agencies and development of indigenous pollution control technologies. Efforts should be made to promote cleaner technologies to achieve the goal of zero discharge from industries.

The RGoB initiated a cleaner technology and environmental management programme in 1997 under the Danish funded Environment Sector Programme Support (ESPS). The thrusts of the programme are:

- Reduction of the consumption of raw materials used in production
- Minimisation/re-use of waste from production
- Implementation of environmentally friendly technology
- Increased workers' safety achieved by a strong focus on the occupational health and safety situation within the enterprises
- Environmental management regarding the daily performance in, and operation of, public and private companies.

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4

Agriculture

Bhutan has a wide range of altitudinal zones and micro-climatic conditions, which have created highly diverse ecosystems and a complex pattern of climatic conditions. It can be divided into seven major agro-ecological zones ranging from tropical and sub-tropical to alpine. The aspect of the valleys, steepness of the slopes, altitude and other physiographic factors influence precipitation, insolation and other micro-climatic factors to create significant variations in vegetation and agricultural conditions within short distances. Bhutan is predominantly an agrarian society. Photo 4.1 shows agricultural practices in Bhutan. More than 85% (MoA 1996) of the Bhutanese people live in rural areas and depend largely on various forms of subsistence farming. Based on the Technical Report on Alternatives to Shifting Cultivation, farming systems in Bhutan can be divided into three major groups; pastoral-transhumance, subsistence level crop and animal husbandry, and early commercial farming. The farming systems are heavily dependent on forests for their sustainability. Despite the relatively low population density, the average Bhutanese family in the north owns a farm of about two acres and in the south, about eight acres. Households with insufficient land of their own enter into tenancy contracts and share-cropping arrangements to get additional land for food production. Landless households are estimated at 7% of all rural households (MoA 1996).

Most of the land currently under cultivation lies in small and often isolated pockets along the main river valleys and throughout the southern foothills. Farming in Bhutan is not easy, because the steep slopes of most agricultural land make farming labor-intensive and often, mechanisation is not possible. The cost of farm labour has also gone up over the years.

The RNR (Renewable Natural Resource) sector covers agriculture (including horticulture), livestock and forestry (Photo 4.2). It remains the single most important sector, accounting for 40.7% of The Gross Domestic Product (GDP) in 1993 (Eighth Five Year Plan). It is estimated that arable and horticultural production together account for about 53% of the sector's output, which grew by an estimated 2% per annum between 1990 and 1993 (MoA 1996). Livestock production is estimated to account for around 21% of the sector output, while forest products account for around 26% (NEC 1998).



Photo 4.1 Agricultural practices in Bhutan



Photo 4.2 Renewable natural resource covering agriculture, livestock, and forestry

Forests provide grazing lands for domestic animals. Animal products such as milk, butter, meat, wool, etc., supplement livelihood and earnings from agriculture. The animals, which produce these products, are also important for transport especially in remote areas. Almost every farm household, on an average, owns 5 cattle, which depend on the forest for grazing. A recent survey has indicated that there are at least 300 000 head of cattle and buffaloes. Other animals of importance are the yak (28,000), sheep (40,000), goat (42,000) and horse (22,000). Farmers collect timber, fuelwood, fodder, leaf litter, and other minor forest products to meet their basic needs. People still use traditional agricultural implements, which are collected and fashioned from, nearby forests. Farmers also depend on food from forests particularly during the lean periods.

Shifting cultivation, a system of subsistence agriculture (Photo 4.3) involving clearing of forests and cultivating the land for a few years, is practiced in an estimated 883 km² in different parts of the country mostly on steep slopes. This has also contributed significantly to the degradation of land.

Updated estimates for land cover, in 1996 show that forests account for 72.5% of land area, while cultivated areas account for 8% (CSO 1998). Given the location of their farms

and the primitive transportation network, most Bhutanese farmers integrate their activities so as to become self-sufficient, producing a variety of grains, fruits, vegetables and dairy products and harvesting both timber and non-timber forest products. For centuries, this has been the Bhutanese way of life.

Food production and practices

With the growing urban population and work force involved in development activities, Bhutan has been a net importer of food since the early 1960s. The current level of food self-sufficiency is about 65%. Despite significant improvements in yield, the output of food grains has not been able to keep pace with increasing demand. The reasons for this situation are:

- Rapid growth in population;
- Emergence of an urban, non-farming community;



Photo 4.3 Subsistence farming practices in rural Bhutan

- Changes in food consumption patterns, especially from maize, wheat and buckwheat to rice.

Bhutan thus continues to rely on imports to make up the shortfall. In recognition of both the long- and short-term implications of this, the government has made food self-sufficiency its long-term goal.

Extensification and intensification of agriculture both, face serious constraints in Bhutan because expansion of arable land is not possible and the nature of the terrain makes enhancing the productivity of cultivated land difficult. Most rural Bhutanese households rely upon an integrated system of crops, livestock, and small-scale forest management. This close relationship between the three sectors is essential to ensure sustainable production.

With Bhutan's increasingly commoditised economy and its exposure to modern material goods, most rural households are no longer content with just maintaining traditional levels of income. The change from subsistence to intensive cropping has resulted in an increased rate of nutrient loss from soil (Photo 4.4). As agricultural land becomes less productive, pressure on forestlands will increase in order to maintain rising production levels.

In recent years Bhutanese farming has been progressively moving towards more market-oriented practices. As a result, many Bhutanese farmers now produce cash crops such as apples, oranges, cardamom, mushrooms, mustard, maize, and potatoes, which are sold at both local and regional markets (Photos 4.5, 4.6, 4.7). The improved, high-yielding varieties of horticultural commodities available to all farmers have benefited household economies. There is evidence that local income generation from non-timber forestry products, availability of other social facilities, horticulture development will help in reducing rural-urban migration, and thus improving the overall quality of life for all segments of the population.



Photo 4.4 Harvesting rice in Paro

Although irrigation projects are not new to Bhutan, they have yet to produce their anticipated impact on overall agricultural productivity. Poorly designed or inappropriate irrigation schemes not only waste precious water, but also often cause severe gully erosion along the course of the irrigation route. At the same time, reduction of the original flow or the addition of new runoff patterns can cause detrimental environmental effects of their own.



Photo 4.5 Oranges on trees



Photo 4.6 Maize being stored



Photo 4.7 Mustard field

Steps to achieve self-sufficiency

In order to make Bhutan self-sustaining and to improve its current ability to feed itself, a few prominent policy objectives that are being adopted during the Eighth Five Year Plan (MoP 1996) are:

- Sustainable and balanced development of RNR for the enhancement of self-sufficiency and food security through an integrated systems approach within the national economy
- Improvement of income and nutritional standards of the rural population
- Conservation of the unique natural and cultural heritage of the country and protection of the fragile mountain environment

To achieve the aforesaid policy objectives, the main strategies that are being followed are:

- Conceiving and implementing needs-based research to increase the production, conservation and efficient use of local resources. The role of the RNR research programme has been broadened to include input into policy development and monitoring technology to avoid inappropriate or harmful introductions
- Maintaining an integrated RNR extension service for technical guidance, farmers' training and educating rural households on how to increase their own self-reliance in a sustainable way. A new extension policy adopted by the Ministry of Agriculture (MoA) emphasises environmental considerations and the need to expand income generating activities in rural areas
- Promoting agricultural and livestock products that have comparative advantages
- Phasing out subsidies on production inputs and ensuring credit, input and marketing services in the public and private sectors
- Promoting popular participation through collective and private institutions
- Maintaining integrated conservation of biodiversity (plant and animal genetic resources). Biodiversity conservation will be of immense importance for continuous improvement of agricultural productivity and production
- Enforcing integrated protection and rehabilitation of natural watersheds
- Enhancing the planning base for the sector and an enabling regulatory framework

To address the agricultural sector's myriad needs and obstacles, the MoA has initiated a number of research programmes and policy initiatives.

- The first step in moving towards food self-sufficiency is to know the nature, extent and state of current agricultural practices. Without this critical crop and ecosystem-specific information, government planners are hard-pressed to determine exactly which adjustments to current practices or

which new initiatives are likely to have the desired effects

- It is essential that the decisions be based on sound cost-benefit analyses that take into consideration the long-term sustainability of the proposed activities
- Land use priorities must be determined through comprehensive studies that consider the economic cost of the benefits and the effects of the alternatives on the environment

Sustainability of land use is maintained in the form of *tsamdro* in the high mountains region of northern Bhutan, where the pastoralists depend primarily on yak herding for their livelihood. The grasslands of northern Bhutan are not suitable for crop production and have little alternative use. The system of checks and balances in the management of community grazing lands has led to the maintenance of both, a fairly stable yak population and productivity of the grazing land. The local institutions regulate the use of these grazing lands by ensuring that they are rotated every three years or so in an equitable way among the pastoralists.

The cycle of sustainability within the traditional farming system needs to be based on a close linkage between arable agriculture, livestock and forestry. Ensuring the sustainability of agricultural practices is a concern that cuts across many of the programmes of the RNR sector. During the Eighth Five Year Plan, the Soil Resource Management Programme will address the following cross-cutting issues of sustainability that are related to productivity of land under cultivation

- The use of farmyard manure, crop residues and forest litter
- Improved cropping systems and water management practices
- The judicious use of mineral fertilisers
- Introduction of an integrated plant nutrient systems approach in research and extension

- Introduction of an effective micro-organisms technology
- Production of appropriate inoculants of nitrogen-fixing bacteria in required quantities
- Participatory methods for natural resource management to be applied by farming communities and
- Development of fertiliser input distribution policies and strategies

Food self-sufficiency, household income and employment in rural areas can be achieved through intensive agriculture, diversification of commodities and promotion of agro-based industries. In view of the above, the specific priority activities are:

- Dissemination of low-cost sustainable soil fertility management and conservation practices
- Development, demonstration and promotion of pre- and post-production technologies and Integrated Pest Management (IPM) practices
- Capacity building for developing natural resource/agricultural statistics and farming systems information
- Development of a comprehensive national listing of biodiversity, with location, distribution, description and status; and
- Development and rehabilitation of natural pastures in subalpine and alpine areas.

Another avenue for improving agricultural productivity lies in reducing per-unit labour inputs by increasing mechanisation. Although the aspects for prospects for mechanisms are severely limited in most Bhutanese farming communities because of small plot size, isolation and rugged terrain, in some areas it can be expanded. As the precepts of mechanised farming become available, the extent of mechanisation will naturally increase.

Improvement in irrigation systems to gear up agricultural productivity is very important although water use for irrigation could potentially interfere with the needs of

the hydropower sector especially during the dry season, when both sectors need water most. Under the current system of government-initiated, -designed and constructed projects, local-level users tend to lose both, interest in and responsibility for these irrigation schemes. This unfortunate but widespread eventuality has been addressed by the National Irrigation Policy, a primary tenet of which is that the operation and maintenance of all government-assisted irrigation schemes is to be performed by the beneficiaries themselves. Water users' associations have been formed to establish rules and regulations for the effective use of irrigation schemes.

The use of fertilisers should be closely coordinated with soil fertility management and conservation programmes, because the increased production of crops is directly dependent upon the productivity of the soil. When using fertilisers for soil fertility and pesticides for crop protection, the side effects must be carefully studied so that mitigation measures, such as banning certain pesticides, do not end up undermining the productivity of the soil. They must be employed carefully and judiciously to avoid unwanted pollution and health consequences. The increasing usage of agro-chemicals is particularly threatening in a country like Bhutan, where the quick succession of ecosystems caused by the steep topography would increase the potential downstream effects from each application. Organic farming should be given preference and must be promoted.

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With its beautiful and largely unspoiled Himalayan setting, its rich flora and fauna, and vibrant Buddhist culture, Bhutan is becoming an increasingly popular destination for international tourists. Since the country first opened to tourists in 1974, the tourism industry has been an important source of foreign exchange. In addition to generating revenue, tourism has provided an impetus to the development of the service sector and the promotion of indigenous cottage industries and handicrafts. The Royal Government has adopted a very cautious approach to the growth and development of the tourism industry in Bhutan since its inception. Before its privatisation in 1991, tourism was run and operated by the Bhutan Tourism Corporation Limited, as a government enterprise. Thereafter, a regulatory body, Tourism Authority of Bhutan (now the Department of Tourism) under the Ministry of Trade and Industries was established to oversee and guide the tourism industry operating under the private sector. The Department of Tourism has sought to tap the foreign exchange potential of the sector at the same time focussing on quality so as to strike a healthy balance between economic gains and protection and preservation of the country's rich cultural, religious, and natural heritage (Photos 5.1, 5.2, and 5.3). To this end the government has been targeting "high value-low volume" tourism through a policy of government regulated tourist tariff structure.



Photo 5.1 Rich cultural tradition

Trends

The number of international tourists to Bhutan has grown steadily. The sector has been making a significant contribution to the economy (Figure 5.1). Between 1993 and 1995, tourism ranked sixth amongst the top revenue earners and amongst the top three in terms of foreign exchange earnings (MoP 1996).



Photo 5.2 Religious place



Photo 5.3 Rich heritage

Most tourists come from Japan, USA, Germany and the UK. Tourist arrivals are mainly in the autumn (August-October) and the months of March and April, in spring. The winter months of December to February and the summer month of June are generally lean. The majority of tourists (almost 78% in 1998) visit the country for cultural tours and sight-seeing while trekking tours, introduced in 1978 account for the rest (Figure 5.2).

Tourism infrastructure (Photo 5.4 and 5.5) has also grown to accommodate increased traffic. At the beginning of 1996, there were 33 licensed tour operators and 32 hotels, lodges and guest-houses approved by the Department of Tourism (8th FYP). At present, there are more than 75 private tour operators. While infrastructure remains a constraining factor in the peak season, at other times, occupancy rates in hotels are very low. To minimise fluctuations in arrivals, the government has identified the need to encourage tourists from India in the low season (Planning Commission 1991).



Figure 5.2 Tourist arrivals by purpose 1991-1998
Source: Planning Commission 1998

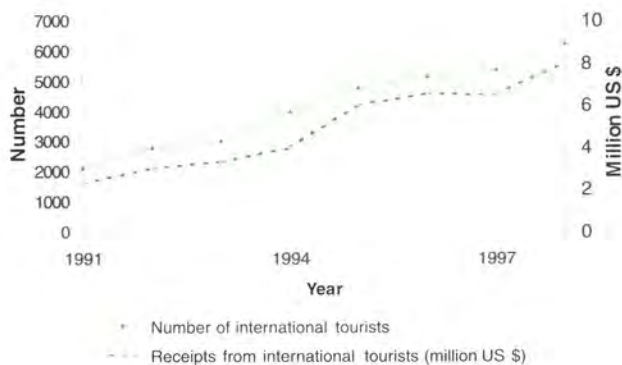


Figure 5.1 International tourist arrivals and earnings 1991-1998
Source: Planning Commission 1990, 1998

Tariff structure

As noted earlier, the Royal Government has instituted a regulated tariff regime to guide the growth of the tourism sector. The minimum daily tariff for both cultural tours and treks is set by the Department of Tourism at US\$200 per day during peak season (includes accommodation, local travel, guide, etc.) and US \$165 per day during the lean season. There are surcharges over and above the daily tariff on individuals



Photo 5.4 Kitchhu resort



Photo 5.5 A scenic beauty around Bumthang

and groups of less than three. The surcharge on a single tourist is US \$40 a day while on a group of two, it is US\$30 each. Some discounts are offered to diplomats, students, children and groups of more than 11 people (Tourism Authority of Bhutan 1999).

Tourism and the environment

Because of the highly fragile nature of mountain ecosystems, unplanned tourism can pose a major threat to environment. In addition, tourism can also cause erosion of cultural

integrity and values due to the introduction of 'outside' influences to indigenous cultures. Among the more pressing tourism related environmental and social problems currently encountered in Bhutan are:

- Destruction of vegetation through the cutting of slow growing trees for firewood
- Depletion of delicate vegetation
- Creation of garbage trails from the indiscriminate disposal of non biodegradable waste
- Alteration of essentially sustainable farming and cropping patterns to unsustainable but highly profitable ones to meet the needs of affluent tourists.

The government has been regulating tourism since the industry began in 1974 (Tourism Authority of Bhutan 1999). By the late 1980s, roughly 3,000 tourists were visiting Bhutan every year, revenue from tourism touching US \$2 million. Fearing that the volume of tourists was becoming unsustainable, the government sought to limit the number by significantly raising the tourist tariff in 1989. As a consequence, that year there were only half as many visitors but revenue fell only slightly to US \$1.95 million. Three years later, absolute number was up again to 2 748 while revenue soared to US \$3.3 million, accounting for roughly 15%-20% of the total value of Bhutan's exported goods and services. In 2000, more than 7000 tourists visited Bhutan. Given the overall success of its high-value strategy, the government is expecting tourism to continue to provide a sizable portion of the country's total foreign revenue earnings. At the same time, environmental and cultural protection remains high on the government's agenda. For instance strategies for the development of the tourism sector in the 8th FYP include efforts "to make Bhutan's tourism industry responsible and sensitive to the environment through the promulgation of rules and regulations for tourist activities and increasing awareness and training of tourist and hospitality

industry personnel". To this end, the Ministry of Trade and Industry has drawn up some guidelines for the sector. Among the more significant of the remedies being advocated are as follows.

- Substitution of kerosene and liquid petroleum gasoline for fuelwood
- Construction of permanent campsites, rest houses and toilet facilities along the established trekking routes
- Full retrieval of all non-biodegradable waste
- Establishment of Tourism Development Committee with members from private sector tour operators and stakeholder agencies
- Rules and regulations on trekking
- Establishment of Association of Bhutanese Tour Operators (ABTO) to promote sustainable tourism development

To address various forms of "cultural pollution", MoTI has prepared guidelines that focus on imposing standards of etiquette and dress and limiting tourism to select and hence minimal areas of the country. Tourist guides are also trained about local culture and history in order to influence tourist behavior.

There are also plans to levy an environmental fee on all visitors to Bhutan. Revenue from this fee would be used to underwrite the costs of providing ecologically benign facilities and general maintenance and cleaning services.

A comprehensive ecotourism project that protects and preserves the pristine environment and traditional culture while at the same time ensures a fair share of tourism revenue to traditional local community also needs to be implemented.

Tourism is one of the fastest growing industries the world over. Between 1990 and 1998 alone, international tourism receipts for the world as a whole grew from about US \$269 billion to US \$445 billion, an annual growth rate of 6.4%. The sector is also an



Photo 5.6 Eco-tourism in Bhutan

important means of achieving socioeconomic development particularly for developing countries such as Bhutan. The sector can help in promoting understanding among peoples and building closer ties of friendship based on appreciation and respect for different cultures and lifestyles. Most importantly, by its very nature it provides an interface between economic development and the environment. It can provide a major economic rationale for the protection and conservation of scenic and biologically valuable areas and can generate direct visitor pay back into the management of these areas and their economically fragile communities.



Photo 5.7 Adventure tourism in Bhutan

The Royal Government of Bhutan has from the outset recognised the need to ensure sustainability in the growth of the sector. Ecotourism and adventure tourism both offer many avenues for the future development of the tourism sector (Photos 5.6 and 5.7). As the industry looks to expand and improve its infrastructure and attract more tourists through vigorous marketing and publicity, it will need to strengthen its drive towards environmental protection and awareness.

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6

Biodiversity

Bhutan has very high levels of biodiversity¹ at the ecosystem, species and genetic levels. Bhutan falls under Eastern Himalaya that has been declared as one of 10 global ‘hotspots’ for the conservation of biodiversity, with the highest species density (species richness per unit area) in the world, and it has the highest fraction of land in protected areas and the highest proportion of forest cover of any Asian country. Bhutan’s rich flora includes more than 50 species of rhododendron and more than 300 species of medicinal plants, mostly alpine, that are used in traditional herbal medicine (Photos 6.1, 6.2, 6.3, and 6.4). Bhutan is one of the very few biologically diverse countries in the world which has the opportunity to maintain its biodiversity



Photo 6.1 Azaleas in garden



Photo 6.2 Morning glory

largely intact in the coming decades (Reid 1996). According to the latest land use survey, conducted by the Land Use Statistical Section, MoA, the total land area under forests was 29,045 km² or 72.5% of the country. Out of this total, 8.1% or 3,258 km² have been classified as degraded forest. Coniferous forests constitute 26.5%, broadleaf forests 34.3%, and plantation 0.2%.

Bhutan has a special place in the global environment because, among other reasons, it represents the last best chance for conservation in the Eastern Himalayas, one of the priority regions in the world for biodiversity conservation. The importance of biodiversity

¹ Biodiversity is a key part of a nation’s natural patrimony. The Convention on Biological Diversity defines Biological diversity as “the variability among living organisms from all sources, including, inter alia, terrestrial marine and other aquatic ecosystems and the ecological complexes of which they are a

part; this includes diversity within species, between species and ecosystems.” Biodiversity is generally considered in terms of ecosystem, species, and genetic diversity. Biodiversity refers to all living organisms, and thus includes all wild, domestic, terrestrial and aquatic species.

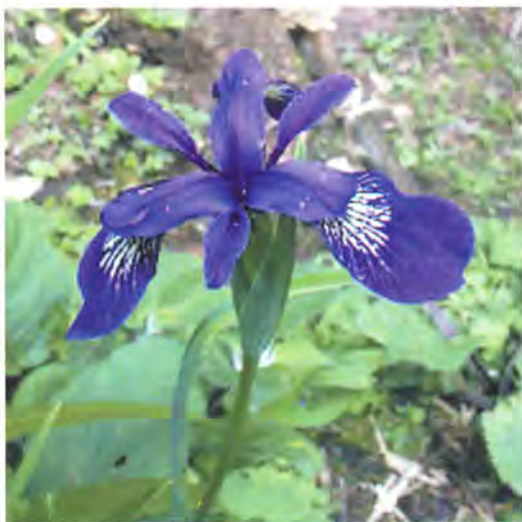


Photo 6.3 Iris on Chelela

is increasingly being recognised throughout the world—not only for sustaining the wealth of living organisms, but also as a genetic resource for humanity, providing food crop and medicinal species for both current and future generations.

In Bhutan, however, biodiversity is a matter of everyday necessity, especially in rural areas. This interdependency is so strong that a breakdown in one link can create a chain of disorders—with disastrous effects on



Photo 6.4 Wild strawberries

human well-being. Maintaining the integrity of these ecological chains will be even more important as increases in harvesting caused by rises in population and consumption patterns will put additional strain on biological support systems, many of which are poorly understood.

The preservation of Bhutan's rich biodiversity also corresponds with national objectives. Unless the water catchment areas for new and proposed hydropower projects are safeguarded from environmental degradation, for example, siltation and sedimentation will compromise the sectors' earning potential and thus jeopardize many of the government's developmental objectives. In addition, a wealth of exotic and rare wildlife attracts ecotourists and hence provides other sources of foreign exchange revenue (Photo 6.5). Yaks is a very useful animal in Bhutan (Photo 6.6).

For all these reasons, the RGoB (Royal Government of Bhutan) has established a system of national parks, wildlife sanctuaries and nature reserves. The Forest and Nature Conservation Act, 1995 establishes guidelines for the creation and management of all protected areas and empowers government officials to fulfill that mission (NEC 1998). The Act calls for strategies for biodiversity conservation to be built upon two main concepts:

- Conservation value lies in the cumulative effect of species diversity
- Natural resources must be used to meet the collective needs of the Bhutanese people

Given these concepts, it is unrealistic to impose restrictions on the use of all forest resources. The only prudent course of action, therefore, is setting aside adequate habitats for biodiversity conservation. To date, nine such areas have been delineated as given in Table 6.1 (NEC 1994). Together, they account for 26% of the national territory. In addition 61 endangered species are now protected against poaching and illegal trading by fines and other punishments.



Photo 6.5 Wildlife: takin and tiger



Photo 6.6 Yaks in the alpine meadow

Table 6.1 Existing protected areas in Bhutan

Name	<i>Dzongkhag</i>	Area (Sq km)
Torsa Strict Nature Reserve	Ha/Samtse	644
Jigme Dorji National Park	Paro/Thimphu/ Gasa/Punakha	4200
Black Mountain National Park	Wangdue/Trongsa/ Zhemgang/Bumthang	1400
Thrumshingla National Park	Zhemgang/Bumthang/ Mongar	768
Royal Manas National Park	Gelephu/Zhemgang/ Samdrup Jongkhar	1000
Sakteng Wildlife Sanctuary	Trashigang	650
Kulong Chhu Wildlife Sanctuary	Lhuentse/Tashiyangtse	1300
Phibsoo Wildlife Sanctuary	Geylegphug	278
Khaling/Neoli Wildlife Sanctuary	Samdrup Jongkhar	273
	Total	10513

The forest wealth

The interaction of topography, climate and human use has resulted in the development of a complex pattern of vegetation and habitat types all over Bhutan. The forests of Bhutan can be divided into three eco-floristic zones based on altitudes. Each zone contains a distinct set of eco-zones as follows:

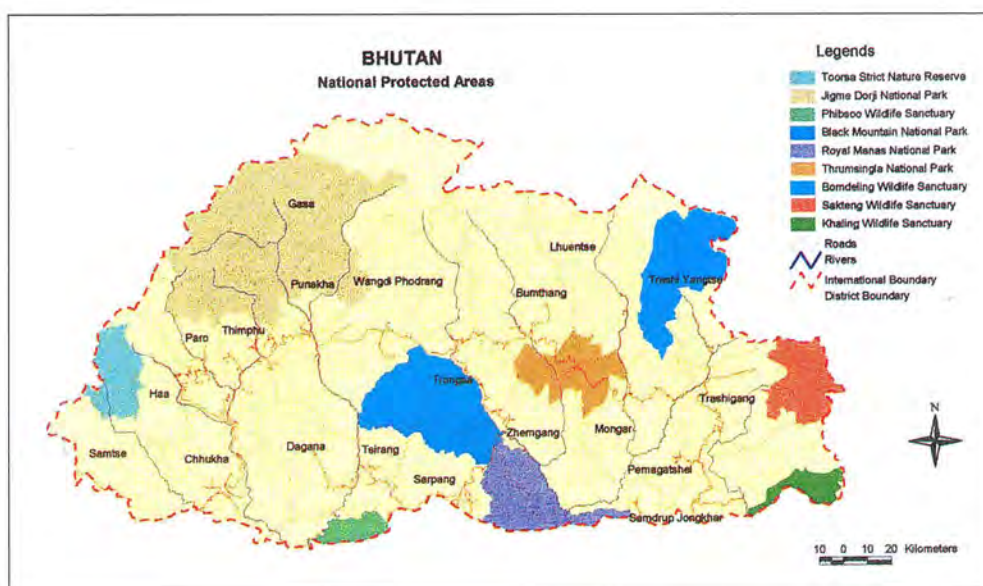
- Alpine zone including areas above 4,000 m of altitude where there is no forest cover (Photo 6.7);
- Temperate zone which lies between 2,000 m and 4,000 m of altitude containing the major temperate conifer and broadleaf forests; and

- Sub-tropical zone which lies between 150 m to 2,000 m of altitude containing the tropical and subtropical vegetation.

Forest types

Fir forest

This forest type is found in the highest forested ridges, between 2,700 m and 3,800 m. It requires relatively high precipitation (probably +133 cm), part of which is obtained as condensation. Few hemlocks and birches may also be present. Towards the tree line (at 3,600-3,800m) fir becomes stunted and grade into juniper and rhododendron



Map 6.1 Protected areas in Bhutan

scrub. The total area under fir is about 345,302 ha.

Mixed conifer forest

This forest type occupies the largest portion of the sub-alpine region of the country between 2,000 m and 2,700 m of altitude. The forests are coniferous and may be dominated by spruce, hemlock, larch or mixtures of these species. Hemlock tends to be found more on water slopes than spruce and is generally decorated by beards such as lichens and mosses. The total area under mixed conifer is about 486 827 ha.



Photo 6.7 Alpine ecosystem

Blue pine forest

This forest type is found in the temperate regions between 1,800 m and 3,000 m amsl in the Ha, Paro, Thimphu valleys in the west and Bhumthang and Gyetsa valleys in central Bhutan. It is sometimes found mixed with oak and rhododendron. The total area under blue pine is about 128,593 ha.

Chir pine forest

A low altitude (900-1,800 m) xerophytic forest type occurring in the deep, dry valleys of Punatsang Chhu, Kuri Chhu and Kulong/Drangme Chhu river systems, essentially under sub-tropical conditions. A long dry season is characteristic of these areas, the annual precipitation of 1,000-1,300 mm falling primarily during the summer monsoon. Chir pine forests area are influenced by human activities, including tapping for resin, felling for timber, and frequent ground fires that are deliberately set to produce fresh grazing for livestock and to produce new lemon grass growth, which is harvested for essential oil production. The total area under chir pine forests is about 100 899 ha.

Broadleaf mixed with conifer

In some parts of Bhutan, the gradation between broadleaf and coniferous forest is very gradual and there are extensive areas of mixture of these two forest types. These mixed forests are generally oak mixed with blue pine or upper hill forest mixed with spruce or hemlock. The total area under this forest type is about 135 789 ha.

Upland hardwood forest

This forest type dominates the temperate hillsides between 2,000 to 2,900 m of altitude. The total area under this hardwood forest is about 450,000 ha.

There are two main types:

- *Evergreen oak* forest which are more common in the drier areas especially around Trongsa and above Mongar. Maple and castonopsis dominate at lower altitudes, while oak predominates higher up. With increasing altitude this type grades towards blue pine with xerophytic oaks
- *Cool broad-leaved forests* of water hills, which are richer and have many different species.

Lowland hardwood forest

This forest type occupies the sub-tropical hills between 1,000-200 m of altitude. These forest are very rich mixed with a wide variety of both sub-tropical and temperate genera.

Tropical lowland forest

This forest type occupies the low hills below 700 m. They are broadly classified as semi-evergreen but vary from almost totally deciduous on exposed dry slopes to almost totally evergreen in the moist valleys. The forests are multi-storeyed and species diversity is very rich. The total area under the lowland hardwood forest and the tropical lowland forest is about 440 000 ha.

Medicinal plants

In Bhutan, an estimated 300 species of plants and animals are used for medicinal purposes in forming nearly 200 different traditional medicines. The National Institute of Traditional Medicine has developed standardised preparations of many of these medicines and in making them available through traditional medicine clinics across the country.

Medicinal plants are vulnerable to over exploitation. For example, earlier two plants, ruta (*Saussurea lappa*) and manu (*Innula helenium*), were cultivated and marketed in the Bumthang Valley. Now those are not seen for long time. Naturally grown medicinal plants with high potential for commercial exploitation include *Texus baccata*, *Swertia Chirata*, *Piper spp.*, *Pseudo ginseng*, *Illicium anisatum*, *Cardecep sinensis* and *Picrorohiza Kurooa*.

Conservation policy

Bhutan has retained much of the natural vegetation, intact for several centuries, and is justifiably proud of the efforts made to protect its forests. Forest regeneration remains a top priority for the future too. H.M. the King Jigme Singye Wangchuck has stated that: "Throughout the centuries, the Bhutanese have treasured their natural environment and have looked upon it as the source of all life. This traditional revenue for nature has delivered us into the twentieth century with our environment still richly intact. We wish to continue living in harmony with nature and to pass on this rich heritage to our future generations".

The preservation of the country's rich biological diversity can be attributed to two factors, the enlightened leadership and the strong conservation ethic of the Bhutanese people. Conservation is a central tenet of Buddhism that believes in preserving nature. The importance of protecting nature in all its manifestations has permeated Bhutanese

consciousness and has become integral to the Bhutanese way of life. Therefore, preservation of the environment, as well as of sacred and cultural heritage sites is an important and integral part of Bhutanese value system. Through its forest policies, Bhutan is committed to maintaining a minimum of 60% of the land area under forest cover. The Royal Government has always aimed at policies for conservation and the sustainable utilisation of natural resources. Beginning from the mid 1960s until now, 26.23% of the area of the country has been declared as protected area. The protected areas consist of four national parks, four wildlife sanctuaries and one strict nature reserve. More than 70% of the protected areas have good forest cover (Photos 6.8 and 6.9).

Management of the protected areas has been entrusted to the Nature Conservation Division under the Department of Forestry Services.

The Royal Government of Bhutan created the Forestry Services Division (now Department of Forestry Services) in 1952. The Forest Act of 1969 (now superseded by the Forest and Nature Conservation Act 1995) declared all forestland as Government Reserved Forest whereby the forest department took responsibility of the stewardship of forest resources. Since then, incidences of forest fires, over utilisation of forest products and encroachment of forestland have been controlled to a large extent.

More importantly, the National Forest Policy promulgated by His Majesty soon after his enthronement in 1974 encompassed a farsighted vision. Contrary to forest policies in other countries, Bhutan's National Forest Policy states that the sale of timber is only of secondary importance. The policy clearly states that for a mountainous country with a fragile ecosystem and an expanding agricultural economy, forestry operations should accord the highest priority to indirect benefits and the conservation role.

Successful pursuit of this vision has delivered us to the present state where the environment of the country is an envy of the conservation world (MoA 1998).



Photo 6.8 Nublang



Photo 6.9 Black necked cranes in the protected valleys of Phobjika

All forestry operations were nationalised in 1979 with the main objective of protecting the forests from over felling. Also in 1979, a Social Forestry Programme was launched as per the Royal Decree of His Majesty, with the main aim of promoting people's participation in the management of forest resources and to reduce pressure on the conventional forest.

There are four main goals set to direct the forest policy to ensure that the forest resources are used according to sustainable principles, contributing to social justice and equity.

Further, the policy aims to ensure conservation of the environment, and only thereafter aim at deriving economic benefits from the forest as rationally managed resource. The four guiding principles of the forest policy are as follows:

- Protection of the land, its forest, soil, water resources and biodiversity against degradation, such as loss of soil fertility, soil erosion, landslides, floods and other ecological devastation and the improvement of all the degraded forest land areas, through proper management systems and practices
- Contribution to the production of food, water, energy and other commodities by effectively coordinating the interaction between forestry and farming systems
- Meeting the long-term needs of Bhutanese people for wood and other forest products by placing all country's production forest resources under sustainable management
- Contribution to the growth of national and local economies, including exploitation of export opportunities, through fully developed forest based industries, and to contribute to balanced human resources development, through training and creation of employment opportunities.

The Bhutan Logging Corporation (now Forestry Development Corporation) was established in 1984. The Forestry Development Corporation executes forestry operations (harvesting and plantations) in the forest management units as per prescriptions of the management plan.

The Forest and Nature Conservation Act 1995 clearly states that no Government Reserved Forest will be worked/operated unless there is an approved Forest Management Plan. Timber harvesting, to meet local demand is done from designated forest management units which have approved forest management plan. As of July 1999, 14 management units and three working schemes covering an area of 143 966 hectares

had approved management plans, where forestry operations are going on. Another 11 forest management units covering an area of 141 642 hectares have been inventoried and management plans are under preparation.

Tseri (shifting cultivation) which has negative impacts on the environment and forest resources still continues in many parts of Eastern Bhutan. Of the total area of cultivation, nearly 30% is under tseri or other forms of shifting cultivation. The Royal Government is committed to phasing out this unsustainable form of farming. As there is no evidence of an equal area suitable for permanent cultivation, the phasing out of shifting cultivation is a major challenge, which is being addressed throughout the 8th Five-Year Plan. Under the Third Forestry Development Project of the World Bank, Department of Forestry Services is promoting plantations and rehabilitation of abandoned Tseri land in six eastern districts.

Due to increase in demand/pressure for forest products, afforestation / reforestation programmes of barren or degraded forestland and clear-felled areas have been initiated recently to improve the sustainable capacity of forestland. By the end of 1997, the Department of Forestry Services had achieved about 17,123.37 hectares of plantation.

Eventually, Bhutan will want to move from being a passive conservator of genetic resources to an active partner in their commercial utilisation and international promotion. The hope is to someday develop the technical and legal capacity to undertake the sophisticated genetic research and international negotiations involved in germ plasm development and gene patenting. In addition to its current small scale commercial activities in medicinal herbs and decorative flora, Bhutan would like to develop its own pharmaceutical industry so that it can take proper advantage of its own immense biological storehouse.

Ecotourism

There is considerable scope for Bhutan to increase its economic gains from eco-tourism without threatening its biodiversity. Jigme Dorji National Park is already a tourist attraction, and the Royal Manas National Park will become one when conditions permit it to be reopened. Other protected areas in Bhutan could also become attractive to tourists with appropriate investment. Bhutan has many of the features of a number of successful eco-tourism destinations – the unique high elevation trekking experiences that draw tourists to Nepal, the “charismatic megavertebrates” that draw visitors to Kenya, and the species richness and scenic beauty that draws tourists to Costa Rica. The potential for eco-tourism in Bhutan could be significant. Belize, a country half the size of Bhutan, had tourism receipts of \$73 million in 1993 and surveys show that over half of the tourists visiting the country participated in nature based activities. Costa Rica – only slightly larger than Bhutan – reported 684 000 overnight visitors in 1993 who spent a total of \$577 million. Tourists spend on average \$148 per day in Costa Rica. More than 50 per cent of the visitors to Costa Rica say that the national parks are their “principal attraction”.

However, just as a high, volume of tourists can destroy cultural values in a country, so too, it can degrade biodiversity. Bhutan’s current goal of developing high income/low volume tourism applies equally to eco-tourism.

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Institutional mechanism

The Paro Resolution on Environment and Sustainable Development came up in 1990 represents a significant landmark in Bhutan's ongoing efforts to conserve its magnificent natural environment while improving the quality of life of its citizens. The resolution expresses eloquently the collective concerns of the Bhutanese people for the possible threats to the environment and lays down a guiding philosophy for the future to avoid such threats. The attachments to the resolution include specific recommendations for policies and actions to ensure the compatibility of environmental conservation and socio-economic development on a sustainable basis.

The Paro Resolution also highlighted the importance of drafting a National Environment Strategy for Bhutan and the need to foster specific responsibility in the preservation of the environment. Today, the National Environment Commission has been set up as a high-level multi-sectoral agency, which takes care of all matters relating to the environment. The National Environment Strategy (NES) titled "The Middle Path" has also been drafted with the help of a multi-sectoral task force and was released in December 1999.

The NEC (National Environment Commission) is a national policy-making and regulatory agency responsible for preserving the country's natural resources. The commission is a high level, cross-sectoral body of senior ministers and officers currently under the chairmanship of the Minister of Agriculture. The NEC was set up in 1992 and the structure of the NEC is shown in Figure 7.1.

The NEC formulates environmental policy, sets environmental standards and legislation and ensures the use of instruments such as environmental impact assessments. The NEC works closely with donor organisations for environmental projects and represents Bhutan at national and international dialogues on the environment.

The NEC is in the process of setting a consolidated, strategic, multi-sectoral framework for the environment. The institutional mechanism for coordinating conservation activities, monitoring, reporting on status and impacts has yet to be put in place. The first step towards this was the preparation of the National Environment Strategy (NES). As a follow-up to the NES, the NEC will prepare the National Environment Action Plan during the 8th Five Year Plan period.

The NEC is empowered to meet its long-term objective of defining policies, programmes, plans and actions whereby the sustainability of natural resources will be fully integrated into every aspect of Bhutan's social and economic development. The Commission also monitors the impact of development on the environment and aims to put in place the necessary controls, regulations, mechanisms and incentives in the private/public sectors to achieve sustainable development through the judicious use of natural resources. The coordination of cross-sectoral programmes and the implementation of policies and legislation are another important mandate of the Commission. For the implementation of its mandate, the NEC works in close collaboration with line Ministries, the Dzongkhag Yargay Tshogchungs (District Development Committees) and the Geog Yargay Tshogchungs (Block Development Committees).

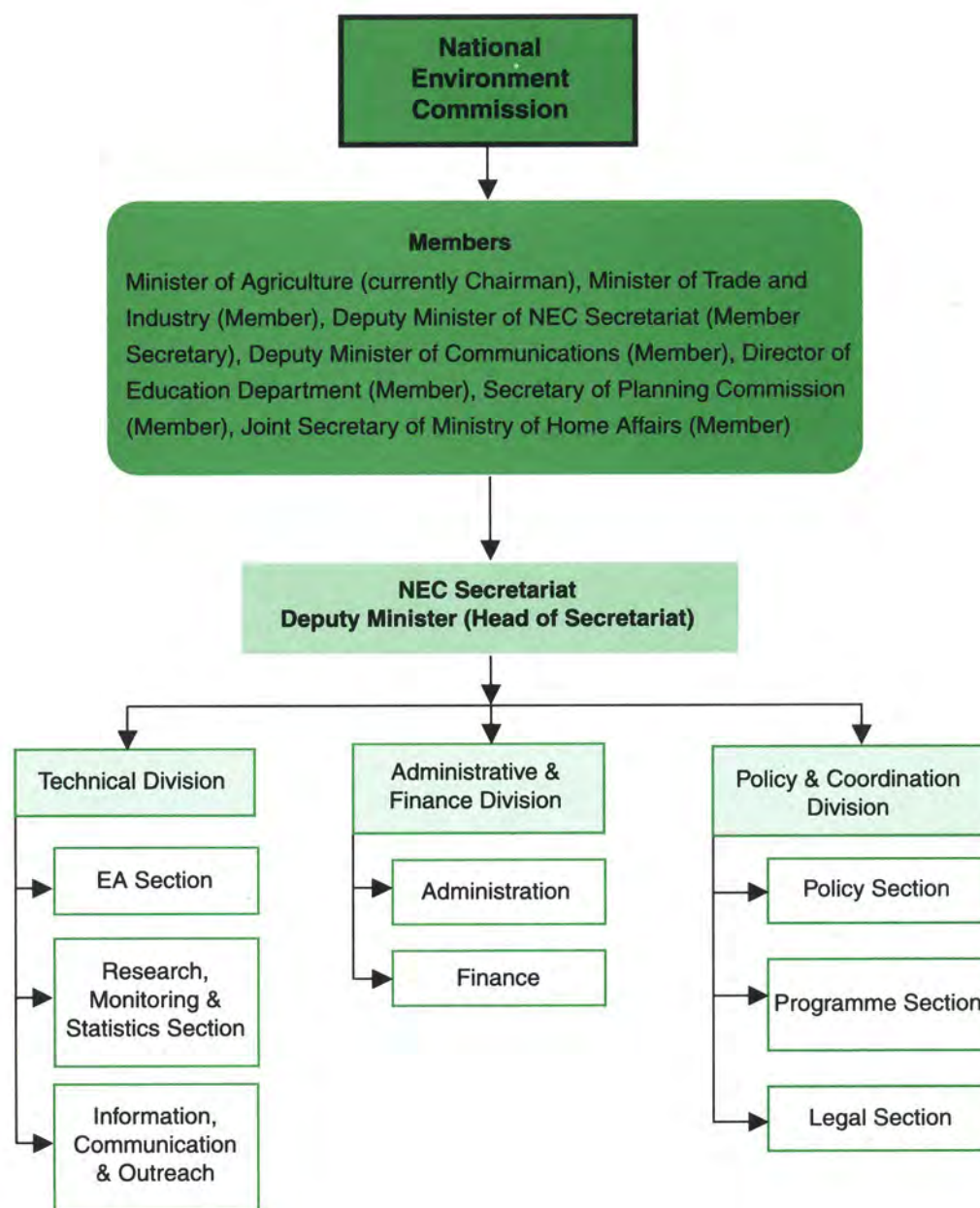


Figure 7.1 Structure of National Environment Commission

The primary responsibility for the implementation and management of the protected areas falls on the NCS (Nature Conservation Section) of the Forestry Services Division. The main objective of the NCS is to conserve Bhutan's rich biodiversity in line with the RGoBs policy of sustainable development and environmental protection.

The Sustainable Development Secretariat was formed to manage and operationalise the Sustainable Development Agreement with the Government of the Netherlands. The areas of energy, biodiversity, and culture have been targeted to operationalise the Sustainable Development Agreement.

The Bhutan Trust Fund for Environmental Conservation was established so that the country could maintain the large protected areas and biodiversity conservation projects. The Trust Fund was established as a Secretariat under the Trust Fund Board.

The Royal Society for the Protection of Nature (RSPN) was established in 1987. It is the only Bhutanese non-governmental organisation focusing on environmental issues. The main goal of the RSPN is to promote awareness among all Bhutanese on the conservation, restoration and sustainable management of the nation's rich natural heritage.

One of the benefits of Bhutan's long history of isolation is the development and refinement of institutions that are particularly well suited to the country's unique socio-economic needs. For centuries, traditional village-based institutions were able to effectively address socio-economic and environmental needs. The *Dzongkhag Yargey Tshogchung* (DYT) and *Geog Yargey Tshogchung* (GYT) currently works to ensure not only the survival, but also the cultural and spiritual well-being of the Bhutanese people who, despite their ethnic homogeneity, generally lived in highly individualised communities. These locally based institutions are being adapted and strengthened to support participatory development.

Poor institutional capacity has been identified as a major obstacle to the formulation and implementation of sustainable development policies (NEC 1998). Both the RGoB (Royal Government of Bhutan) and NGOs need to improve institutional capacities for effective implementation of the national development agenda in the most sustainable way. This would require co-ordination amongst institutions, data generation, data base development, and improvements in reporting system. These institutions should be empowered to support community groups and NGOs participating in sustainable development activities.

His Majesty the King personally introduced and promoted the policy of people's participation in the national planning and decision-making processes by establishing the DYT (*Dzongkhag Yargey Tshogchung*), or district development committees, in 1981. In 1991, even more broadly based grassroots organisations were formed – the GYT (*Geog Yargey Tshogchung*), or block development committees. These groups are actively involved in the preparation of development plans. It is envisaged that stakeholders participation and valuable inputs will facilitate the development of an appropriate national environmental action plan (NEAP) for Bhutan.

Environmental policy

The RGoB has given top priority to environmental conservation, environmental management and environmentally sustainable development. Environmental legislation and administrative instruments in Bhutan have been based upon old-age traditions. Many laws, policies and regulations are being promulgated to ensure environmentally sound industrial development. Some of the policies adopted by the RGoB on environment are illustrated below.

- Improvement of existing laws, rules and notifications and introduce new legislation and policies to ensure sustainable utilisation of natural resources
- Preparation of master plans for different sectors of the economy e.g. Forestry, Power, and Roads. These plans include developmental planning, minimisation of environmental impact, and ensuring the utilisation of natural resources on a sustainable basis
- Use of economic incentives to encourage sustainable utilisation of resources
- Increasing involvement of community and non-governmental organisations (NGOs) in planning and implementation of envi-

ronment activities. The decentralised process will enable greater participation of stakeholders in developing appropriate responses to environmental problems and

- Developing an integrated land use planning, which facilitates planners, policy makers and decision-makers in developing sectoral planning. It is also the policy of the Royal Government to maintain a minimum of 60% of the land area under forest cover at all times with a good network of protected areas. This policy is in line with a statement made by His Majesty the King Jigme Singye Wangchuck: *"Throughout the centuries, the Bhutanese have treasured their environment and have looked upon it as the source of all life. This traditional reverence for nature has delivered us into twentieth century with our environment still richly intact. We wish to continue living in harmony with nature and to pass on this rich heritage to future generations"*.

Table 7.1 shows various rules, acts and guidelines that are applicable to different ministries and authorities in the RGoB. Other priority issues that have identified for legislative initiatives are as follows.

- General Environmental Protection Act
- General Environmental Education Act
- General Environmental Information Act
- Land Use Act, covering town planning, zoning and building codes
- Water Resources Act, covering waste water, drinking water, irrigation and so forth,
- Watershed Protection
- Air Quality Act, covering both ambient quality and industrial pollution control
- Noise Pollution Act
- Toxic and Hazardous Substances Act, covering solid waste and pesticides
- Cultural Environment, covering historic areas, monuments and cultural heritage

The RGoBs umbrella environmental act is in an early phase of development. The EA (Environmental Assessment) guidelines were brought out in 1999. The National Assembly passed the EA Act in July 2000 and associated regulations are being formulated. At present, the majority of Bhutan's environmental legislation concerns the conservation of forests and the protection of wildlife and wildlife habitat. Among the most prominent of these are the Forest and Nature Conservation Act of 1995, Land Act of 1992, and Mines and Mineral Act of 1995. It is fully anticipated that the national legal framework will be aided by a well-established system of local-level regulation. Some of the traditional rules developed over time – such as those determining grazing rights on the *tsamdos* and the communal use of forest resources – have ensured an equitable and largely sustainable use of renewable resources. Although not always appropriate under modern conditions, this longstanding and respected framework should still be incorporated in developing the national legal framework.

The RGoB should develop environmental standards to protect health, safety and the environment. Sector specific standards will help to achieve the best practices and best resources uses, in addition to protecting health, safety and environment. There is a need for legislation that is well-grounded in the ethical, legal and cultural setting of Bhutan, legislation that depends upon a significant degree of decentralisation, and legislation with strong and workable appeal mechanisms. In the 8th FYP, the NEC has undertaken many programmes on development of standards, and guidelines.

Environmental assessments in Bhutan

Draft EIA guidelines for Bhutan were prepared in 1993 by the National Environment Commission Secretariat. The guidelines were

Table 7.1 Rules, acts, and guidelines applicable for different ministries and authorities

Concerned Ministry	Rules/ Acts/ Guidelines	Month and Year
Ministry of Agriculture	Plant Quarantine Act	—
	The Livestock Act and By-Laws	November, 1980
	Forest Act of Bhutan	1969
	Forest and Nature Conservation Act	1995
	Forest and Nature conservation rules volume 1 & 2	2000
	Pasture Development Act	1997
Ministry of Communications	Water and Sanitation Rules	July, 1995
	Rules and Regulations (pertaining to construction of infrastructure)	1992
	Act on Road Safety and Transport, under revision	
	Municipal Act, under revision	
Ministry of Trade and Industry	Mines and Minerals Management Act	1995
	The Companies Act of the Kingdom of Bhutan	1989
	Tourism Rules and Schedule of Tariff for International Tourists	July, 1995
	Rules and Regulations for Establishment and Operation of Industrial and Commercial Ventures in Bhutan	1995
	Trekking in Bhutan, Rules and Regulations	1996
	Water and Sanitation Rules	July, 1995
City Corporation	Building Rules	1983
Policies of Dzongkhag	Water and Sanitation Rules	July, 1995
	The Livestock Act and By-laws	November, 1980
	Tax collection Rules for Rural Households (<i>Dzongkhag</i> version)	March, 1996
	Social Forestry Rules	1996
	Land Act	1992
	Land Acquisition Act	1986
	Electricity Supply Rules and Regulations	1977

Source: NEC 1999a

generic in nature (not tailored closely to Bhutanese conditions) and institutional arrangements were not clearly defined. In addition, lack of suitably trained personnel restrained NEC and other government ministries from pursuing the guidelines effectively. The EIA guidelines were revised in 1999. In the revised guidelines, 4 categories of projects were identified based on the nature of impacts (NEC 1999b). The categories of project are the following:

- Category A: Proposals, which require a full environmental assessment to establish the extent and magnitude of potential impacts. These projects are usually categorised as complex
- Category B: Proposals, which have potentially significant impacts, however

management and treatment options are well developed and understood. These projects can be adequately managed through application of detailed impact management and monitoring plans

- Category C: Proposals that have moderate impacts, which tend to be repetitive (e.g., certain aspects of road construction, or forest harvesting practices). These impacts can be managed by attaching environmental codes-of-best-practice to licenses and permits and
- Category D: Proposals that have moderate and easily managed impacts. Simple environmental terms are attached to the business permits or licenses (e.g., waste disposal and hygienic practices for the restaurant business).

Category A, B, and C projects will require environmental clearance by the NEC before the competent authority provides development consent. Category D projects can be issued development consent by the competent authority without obtaining an environmental clearance by NEC. However, the competent authority will submit a list of projects approved under category D to the NEC for annual review.

In the two years since the EA guidelines were prepared there has been good progress in implementing the process. Limitations identified while implementing the EIA process are as follows:

- The lack of comprehensive objectives and standards and the regulatory regimes necessary to cause it to function most effectively
- The shortage of trained environmental personnel in both public and private sectors
- The lack of environmental awareness and institutions in line ministries, public corporations, private industries, and the Dzongkhag
- The very small private engineering and environmental consulting sector;
- Limited facilities and capabilities for environmental quality analysis and
- Limited capacity in environmental inventory and research to provide reliable baseline information and to establish cause-effect relationships between development activities and the environment.

Regional and international linkages

The RGoB is committed to strengthening regional and international linkages regarding environmental issues. Bhutan currently participates in regional and international environment and sustainable discussions on issues such as trade, forestry, water resources,

and pollution. At the international level, Bhutan continues to play a role in supporting sustainable development policies. It continues to work toward international environmental agreements and is involved with a variety of international organisations on issues such as forestry and other global environmental issues. The RGoB is a signatory of many international environment conventions as shown in Table 7.2. Although the country participates in these and other international fora and signs international conventions, an essential challenge that Bhutan, as well as all other signatory nations, faces is in meeting the legal obligations, implementing the activities and enforcing the provisions of the conventions. Despite its small size, Bhutan, with its rich natural resource base and high-level political commitment to sustainable development, wishes to further its participation in international environmental programmes. An immediate priority will be to continue to develop the institutional capacity and technical expertise to constructively contribute to the development of this rapidly evolving field of international law and global governance.

Table 7.2 International environment conventions

Name of the convention	Year
UN Framework Convention on Climate Change;	1995
UN Convention on Biological Diversity	1995
International Plant Protection Convention (Adherence)	1994
The Final Act and the Law of Sea Conventions	1982
Statute of the Centre for Science and Technology of the Movement of Non-Aligned Countries and Other Developing Countries	1985
Statutes of the International Centre for Genetic Engineering and Biotechnology	1984

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Part III

Priority issues

Bhutan is at the path of rapid socio-economic development. The process of rapid development might cause pressure on natural resources and human well being, unless conscious efforts are made to integrate the environmental planning into development planning. The priority issues are identified keeping in view the possible impacts of developmental activities on environment and these are 1) environmental issues of rural urban migration 2) land degradation 3) air pollution 4) water pollution and 5) solid waste management. These priority issues are analyzed by following the pressure-state-impact-response framework.

Bhutan is among the least urbanised countries in the world, with its urban population of about 133 000 in 1999, comprising 21% of the total population (Ian 1996). However, the situation is changing rapidly as Bhutan's cities continue to be thronged by large numbers of people coming in from nearby villages.

Pressure

It is the trend worldwide that about half of the growth in urban population is attributable to rural-urban migration (Brennan 1999). This migration could be fuelled by persistent concerns among the rural populace about stable flows of income and vulnerability arising out of the inability to meet day-to-day needs. In some cases, there is also the "pull" factor manifested in relatively brighter employment prospects as well as better infrastructure facilities in towns and cities.

Though Bhutan's population density is among the lowest in the world, there is a lot of population pressure in the country given the high (3.1% per annum) growth rate coupled with the difficult geographical terrain which makes very little land available for use. For instance, only 16% of Bhutan's land is suitable for agriculture (half of which is already under cultivation). Farming in Bhutan is also difficult and labour-intensive because steep slopes rule out mechanisation. Around 80% of the Bhutanese people live under these difficult conditions in rural areas, where they practice various forms of subsistence farming and engage in livestock rearing and forestry as well in order to supplement their meagre agricultural income (Photos 8.1 and 8.2).

Bhutan's two largest urban centres - Thimphu, the capital, and Phuntsholing are under pressure due to migration of population from different parts of Bhutan. It creates pressure on existing roads and parking facilities, telecommunication facilities, water supply and drainage, solid



Photo 8.1 Bhutanese village in remote mountain valleys

waste disposal, and housing facilities. Other smaller towns do not have proper infrastructure facilities. Given the conditions in urban Bhutan, it is evident that it is the push factor that may be largely responsible for rural-urban migration in the country.



Photo 8.2 Village women working in farm

State / Impact

The process of urbanisation in Bhutan is only forty years old. In 1961 the construction of roads that increased accessibility and mobility proved to be the driving force for urban development. Migration in Bhutan, in the first instance, was mostly in the form of economic migration with the in-migrants being absorbed as government administrative employees.

Now, Bhutan's urban population of over 100 000 lives in 28 towns. Over half the urban population resides in two large urban centres - Thimphu in the north and Phuntsholing on the southern border. The rest of the population is distributed in 28 centres with individual populations ranging from 500 to 10,000. The majority of the larger centres are either district headquarters (or *Dzongkhags*) or important service centres (Ian 1996).

Bhutan's urban population as a whole is increasing at 6.7% annually, more than double the national population growth rate of 3.1% per year (Ian 1996). If these trends

continue, it is estimated that the country's urban population would grow four-fold to 400 000 over the next 20-25 years. By the year 2020, about half of the population of Bhutan is likely to be urban in contrast to the current 21% in 1999 (Planning Commission 1999).

Thimphu, the capital city, which housed over 46,000 people in 1999, is growing at about 10% annually and is expected to have 100 000 inhabitants by 2006 (NEC 1998) (Photo 8.3). Phuntsholing with a population of 23,000 showed a growth rate just slightly lower than that of Thimphu (Planning Commission 1999). Being the main entry point into Bhutan, Phuntsholing also has a large floating population of daily migrants – business and tourist travellers. Given the rates of growth in the two large cities, it is certain that these centres are attracting a large numbers of in-migrants.

While accurate published data is not available, estimates of urban growth in two other towns in Bhutan, Trashigang and Samdrup Jongkha also indicate a steady rural-urban migration. Field data from the

1984 NUDC Urban Planning Study, the 1994 estimates from the Ministry of Agriculture Land Use Planning Project, and the 1996 Dzongkhag provisional returns to the UDU/PWD, show that Trashigang is estimated to have grown at 5% annually and Samdrup Jongkha at 3.56% (Planning Commission 1999).

Following rapid growth in Bhutan's two large cities of Thimphu and Phuntsholing, there is severe pressure on social and physical infrastructure in both of these cities. Infrastructure in the other smaller urban centres is no better than what is available to rural settlements. Some of the signs of rural-urban migration are described below:

- **Housing shortages:** In just 5-6 years, house rents have escalated over three times. Between 1986-1996, it is estimated that nearly 75% of the additional housing needs in Thimphu were left unmet. The problems are similar – though on a smaller scale in other towns. It is feared that housing shortages of such a magnitude will soon result in the proliferation of slums and squatter settlements (Ian 1996)



Photo 8.3 Thimphu: largest growing urban centre in Bhutan

- **Unemployment:** In the period 1991-95, only 86 graduates (less than 20% of those who completed their training during the period) were placed in the private sector. Jobs in the government service are also limited. It is estimated that over 267 000 jobs will, even under the most favourable demographic assumptions, need to be created in the next 20 years. Add to this those who may leave the RNR sector (either voluntarily or compulsorily due to displacement resulting from mechanisation) and migrate to urban areas. The real number of job seekers will be considerably higher (Planning Commission 1999)
- **Water shortages –** While in 90% of the population has access to potable water, water supply in Thimphu is somewhat intermittent due to leakage and high consumer demand. Other urban centres continue to rely on old supply systems, which generally do not have proper treatment and require major rehabilitation
- **Poor drainage, sanitation and waste disposal facilities –** Most towns rely on septic tanks and pit latrines, while the two main centres, Thimphu and Phuntsholing, have proper sewerage systems. Only Thimphu has an organised collection and disposal system. All other areas dump the waste randomly at uncontrolled sites
- **Inadequate roads and transport:** Pressure is increasing on existing roads and parking facilities in Thimphu and Phuntsholing due to the growing number of vehicles.

In addition, the towns and villages in Bhutan have grown in narrow valleys and the land availability to accommodate large population is either limited or almost non-existent. The country's geographical terrain makes it even more difficult to accommodate urbanisation on a large scale. For instance, Thimphu can accommodate at most 80,000 people and this saturation point is expected to be reached by 2006 (Planning Commission 1999).

Urbanisation also brings with it the ills of removing forest cover to build housing and provide other infrastructure. Urban development also is putting pressure on agricultural land. With the absence of flat land, urbanisation will imply increasing pressure on the valley slopes that are perhaps best left under vegetation cover or else risks of erosion increase, watercourses get disturbed, and vulnerability to floods and landslides increases. Moreover, concentration of economic activities in one or two centres can create regional imbalances (United Nations 1996; Planning Commission 1999).

On the positive side, migration from rural areas may also reduce pressure on agricultural land resulting in less fragmented land holdings, land consolidation and increased scope for mechanisation and consequent productivity increases.

Response

Policies pursued and policy gaps

Urban development in Bhutan is the responsibility of the Urban Planning Unit within the Urban Development and Housing Division of the Ministry of Communications. While surveys and action plans have been undertaken for several towns, no action has been initiated, primarily due to financial constraints. There is a need to set up a taskforce that evaluates the financing needs of the country and works with international development organisations to resolve these gaps. There is also a lack of municipal legislation for effective implementation of plans and policies. At present, the Municipal Act is under revision.

The towns of Thimphu and Phuntsholing have formal environmental management procedures. For instance, the city corporations have recently established strict rules concerning mandatory connection to the newly constructed piped sewerage system. A master plan is also being prepared for other cities and towns.

A detailed housing policy is lacking which would lay down the norms for housing structures and discuss how the private and public sector could collaborate in this activity.

Gaps in information, knowledge, and monitoring

- There are no firm statistics on estimates of current urban population. This is essential for designing appropriate infrastructure programmes and investment plans can be designed (United Nations 1996; Planning Commission 1999)
- Urban development plans are largely confined to physical plans drawn without the benefit of accurate topographical maps and up-to-date cadastral mapping and land registration systems (Planning Commission 1999)
- A beginning must be made in tracking education and health facilities – not only in terms of numbers – but in qualitative aspects as well. From the migration point of view, this is important because it is often poor facilities in rural areas that drive people to urban centres
- There is a need to monitor closely the generation of employment opportunities in various sectors so that education and training facilities can be geared towards this to prevent the prevalent “under-utilisation of capacity in technical and vocational training institutions that the nation can ill afford” (Planning Commission 1999)
- Only one-third of the country’s land area has been mapped geologically and an even smaller area has been prospected for mineral wealth – if these explorative studies give positive results, several remote areas could be developed around that resource. In this context, is important to re-iterate the need for taking into account the likely adverse consequences of mining and industrial activities
- Demographic data is inadequate – in terms of patterns of migration, gender bias (in education, health, and employment)

- All information on demography and infrastructure is typically available only at the national level. There is a need for monitoring and information collation at the dzongkhag and geog level. This information needs to be circulated widely
- A detailed household census – once in 10 years – needs to be carried out. This would need to cover all details such as expenditure, income, energy use, access to social and other infrastructure etc. This would help overcome the initial hurdle of data limitation. Tying up the census with a social survey to assess expectations and concerns would be one way of eliciting the grassroots view and integrating it into the policy-making for the country. In doing this the traditional dzongkhag and geog level chiefs could be involved so that there is complete decentralization
- There is a need for a study on the future housing needs in each dzongkhag.

Recommendations and coping strategies

It is evident that the key to mitigating several of Bhutan's emerging socio-economic and environment problems lies in limiting rural-urban migration. And this will be possible only by weakening the push factor – in other words, by improving infrastructure, quality of life and employment opportunities in rural areas.

There is a need for the formation of a National Committee on urban development. There is also a need for better urban planning in the two large cities so that growth can be accommodated to an extent without dire consequences. Alternative destinations for migration are also required in order to release the pressure from Thimphu and Phuntsholing. Detailed coping strategies are listed below.

Improvement in rural areas

- Provide better, more integrated service delivery to the rural communities in the health, welfare, agricultural extension, and education sectors through a process of departmental co-ordination.
- Focus on intensive agriculture through increased use of improved seeds and cropping patterns – to meet the twin objectives of achieving 100% food-grains sufficiency (currently at 65%) and increase in rural / agricultural income generation
- Focus on enhancing income and employment generation from the forestry sector through well-drawn up plans that could encourage export of forestry products
- Developing small and medium sized cottage industries (such as weaving)
- Need to develop road and other communications network for remote areas on priority basis to integrate these areas with the rest of the country
- Extensive use of information technology for distance education and for information dissemination on all priority issues of the nation
- Wide campaigns to explode myths (for instance, the view among the young generation that manual labour and farming are “backward” activities) and to highlight the usefulness of traditional practices in farming and medicine etc.;
- Emphasize on providing electrification of all rural villages

Measures for Thimphu and Phuntsholing

- Increasing the capacity of infrastructures namely, roads, telecommunications, power, water sewage, health centres, schools, and centres of higher education for the future need
- Explore the possibilities of privatisation or involvement of the private sector in some of the above activities in the municipal services and urban infrastructure
- Developing and implementing housing schemes that provide low-cost and weather-proof housing for all

Urban decentralisation to take migratory pressure off Thimphu and Phuntsholing

- The following categories of urban centres should be identified and measures taken for planning and development on priority:
 - Urban centres from where people are migrating into Thimphu and Phuntsholing
 - One or two centres in East Bhutan which have high population densities.
 - Centres that are located close to large farm lands—so that these can be developed as key national and international sourcing centres for farm and forestry products
 - Evolve policies that encourage setting up of environment-friendly and labour-intensive agro- industries in these towns by making available subsidised inputs including credit.
 - Develop some of these centres as tourist centres - with cultural tourism, eco-tourism and adventure/sports tourism
 - Provision of housing schemes for retired personnel

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According to the latest land-use survey, conducted by the LUSS (Land-Use Statistical Section), Ministry of Agriculture based on the analysis of 1994 satellite data, the total area under forests is 29,045 km² or 72.5% of the country, while the cultivated area accounts for only 7.8% (CSO 1997). At present, land-use changes are minimal, but there is some amount of forest degradation every year, which will go on adding to the existing 3,258 km² of degraded scrub forests spread over 20 dzongkhags (MoA 1996a). Map 9.1 shows land use and land cover map of Bhutan.

Pressure

Land degradation in Bhutan is a man-made as well as natural phenomenon. Urbanisation and industrialisation are exerting pressure on the environment and on the natural resources of the country. Land degradation in the country is mostly manifested in displacement of soil material through water erosion and internal biophysical and chemical deterioration. Human induced activities mainly trigger soil erosion in the mountainous terrain.

Loss of vegetation due to deforestation, over cutting beyond silviculturally permissible limits, unsustainable fuel wood extraction, shifting cultivation, encroachment into forest land, forest fire, over grazing, extension of cultivation onto lands of low potential or high natural hazards, non-adoption of adequate soil conservation measures and improper crop rotation are some of the important factors contributing to land degradation in Bhutan.

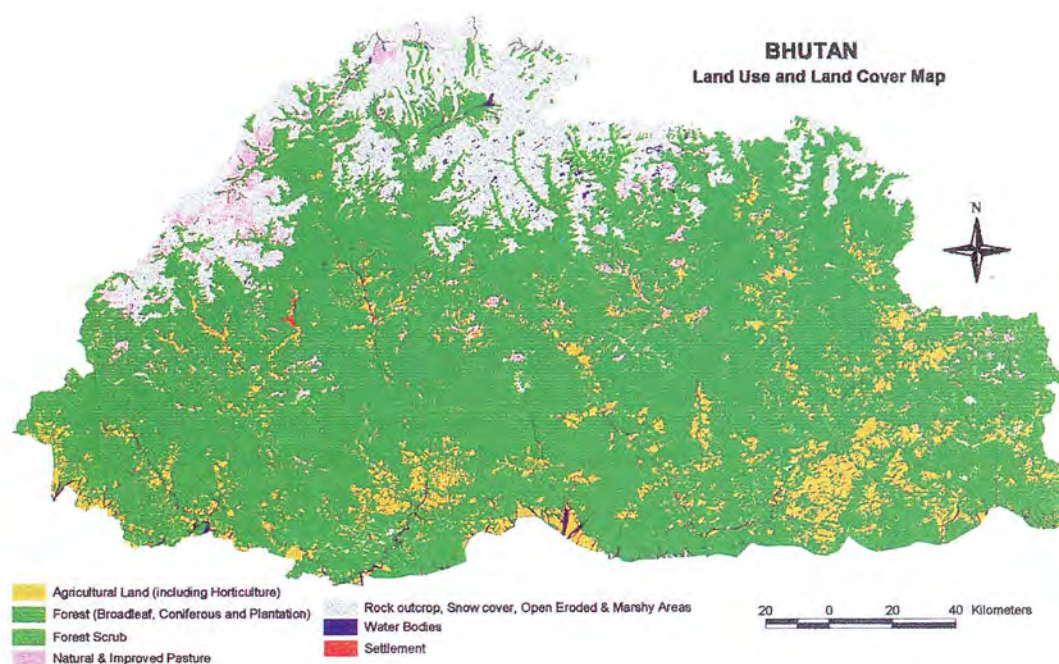
Loss of vegetation due to pressure on forests, which occupy about three-fourths of

the country's land area, is one of the principal factors of land degradation. The demand for construction timber by the domestic sector, although not very well documented, is only partly (20%) met from managed forests. The traditional rights of the people to forest produce and unauthorised harvest by the farmers both exert tremendous pressure on the forests, particularly close to settlements. Similarly, fire wood extraction from forests far exceeds the silviculturally permissible limits, resulting in depletion of forests and degradation of forestland.

Extensification as well as intensification of agriculture, to offset the deficit in food requirement, face serious constraints in Bhutan because expansion of arable land is not possible and the nature of the terrain makes enhancing the productivity of cultivated land difficult. At the same time converting forests to agricultural land is undesirable for many reasons. The rising population has aggravated the situation and will further worsen it if timely counter measures are not taken.

The fuel wood consumption per capita has been estimated at 1.92 m³ per annum and the annual fuel wood demand of domestic and other sectors is expected to increase from 1.3 million m³ in 1992 to 2.14 m³ by 2012 (MoA 1991, 1997).

Livestock rearing, especially of cattle, is an important rural activity. The estimated cattle population of the country is 300 000 and the number is likely to increase along with human population. Grazing of this huge number, far beyond the carrying capacity, in forest areas, exerts a tremendous pressure on forestland with resultant degradation.



Map 9.1 Land use and land cover map of Bhutan

Occurrence of frequent forest fires (Photo 9.1) has been a major cause of degradation of forestland in many parts of the country. Apart from destruction of vegetation, high intensity forest fires alter the physico-chemical and biological attributes of the surface soil and leave the land prone to erosion and lowering of soil quality. Chir pine and blue pine are the most susceptible and fires occur in these forests. Mixed conifer and dry broad-leaved forests also suffer to some extent.

Shifting cultivation is an age-old practice common to several parts of the country. With increases in population, more and more areas are being tapped for this practice. With the narrowing down of the fallow cycle due to paucity of arable lands, such practices do not allow a sufficient period for the natural processes of recuperation to repair the disturbed ecosystem resulting in erosion and fertility decline. LUSS, Ministry of Agriculture, estimated a total area of 883 km² under shifting cultivation in Bhutan. Thus, shifting cultivation is one of the significant contributing factors to forest degradation (MoA 1996b).

Most of the land area suitable for agriculture has already been utilised. However, the expansion of agriculture due to increases in population and the recent boom in horticulture, is bringing more and more land for such use for which it is not suitable. The situation is leading to encroachment into forest on the one hand and degradation of land on the other.



Photo 9.1 Land degradation due to forest fire

Mining and quarrying are not very extensive, but contribute to land degradation wherever they are being practised through disturbance of the topsoil and encouraging erosion and siltation down slope (Photos 9.2 and 9.3). Developmental activities like road construction, transmission lines, etc. are also contributing to degradation of vegetation as well as of land in different parts of the country.

State/Impact

The land use pattern in Bhutan, a mountainous and land-locked state, is undergoing progressive changes in the recent past due to the impacts of population growth, developmental activities and urbanisation. This is largely associated with negative impacts on the limited land resource of the country.



Photo 9.2 Mining activity at Druk Satair Mines at Khothakpa

Deforestation is caused by demands of fuelwood requirements and commercial felling and, has two-fold impacts: on the livelihood of the people who depend on the forests, and ecological impacts including soil erosion, siltation, and flooding. The land of the country mainly suffers from two major ailments – denudation and erosion, which result in loss of the productive base.

Forest degradation is the most potent cause of land degradation because forests occupy more than three-fourths of the coun-



Photo 9.3 Soil erosion from mining activities

try's land area. Improper farming practices also add to land degradation. Since forest degradation is on the increase, its impact on the way of life and the national economy is also being felt. Given the steep terrain with fragile geology and heavy monsoon rains (from 400mm in the north to 5,000mm in the south) in Bhutan, one can perceive that the impacts of loss of vegetation cover could be dramatic. Productive land is being lost without realising the full potential of the limited soil resources of the country; soil erosion and landslides wash away rich topsoil degrading the soil resources, and such degradation also affects the climate both at macro- and micro- levels. Fertility and the productivity of soil as a medium for biomass production depends largely on the thickness of the topsoil which, besides production of biomass, is important for many other functions such as filtering, storage and transformation of nutrients and water, mineralisation of organic matter or wastes dumped on land, fixation of nutrients by microorganisms, conversion of pollutants to less harmful substances and elimination of toxics.

There are on-site as well as off-site impacts of soil erosion apart from the loss of topsoil. The on-site impacts are mostly reduced yield and disruption of the functions mentioned above, whereas off-site impacts include sediment movement, silt deposition, floods and formation of ravines. About 40,000 ha of land,

comprising 10% of the total agricultural land, has been affected by various degrees of water erosion of which 36% is light and 4% strong. Salinisation and waterlogging occur in Bhutan in pockets only, no reliable data for which are available. Similarly, land affected by pollutants is not common but no data on such land are also available.

Some of the important and common impacts of the current land use pattern in Bhutan are:

- farming on steep slopes is resulting in soil erosion and a decline in soil fertility,
- limited arable land is limiting the possibility of expansion of agriculture,
- deforestation in the fragile areas is causing soil erosion and sedimentation downstream
- indiscriminate use of land for urbanisation and industrialisation is leading to the risk of wasting good arable lands

Responses

Existing responses

In order to make Bhutan self-sustaining and to improve its current ability to feed itself, a few prominent policy objectives that are being adopted during the Eighth Five Year Plan are:

- Sustainable and balanced development of RNR for the enhancement of self-sufficiency and food security through an integrated systems approach within the national economy;
- Conservation of the unique natural and cultural heritage of the country and protection of the fragile mountain environment

To achieve the aforesaid policy objectives, the main strategies adopted are:

- Conceiving and implementing needs based research to increase production, conservation and efficient use of local resources. The role of the RNR research

programme has been broadened to include input into policy development and monitoring technology to avoid inappropriate or harmful introduction

- Enhancing the planning base for the sector and formulating an enabling regulatory framework

The Bhutan Trust Fund was established in March 1991 to ensure sustainable finance for preservation of the country's forestry and biodiversity, which are expected to be increasingly under pressure due to population growth and various economic developments. This instrument is likely to go a long way in mitigating land degradation significantly if utilised judiciously.

Policy gaps

- In the absence of a well-defined land use policy for the country so far, land management has been unsystematic, arbitrary and, by no means sustainable. The importance of a national policy frame, in this context, can hardly be over-emphasised.
- One of the prime reasons for land degradation in Bhutan is putting land to use for which it is not suitable or capable of. This is mostly due to excessive pressure on land resource but also due to ignorance about the consequences of faulty land use. Adoption of land use according to the land capability classes, to the extent possible, will ensure that land is put under right kind of use. One of the ways of achieving this would be to develop land capability classes for the country basing the pattern of US Department of Agriculture and modified through research and available technology to suit national conditions. However, land capability should not be the one and only reason for restrictions on the use of land as most of the land in Bhutan is moderately to steeply sloping and has been mapped as available only for non-arable use. This is in conflict with the current land use in most areas of the country and to attempt to apply it would be completely

unrealistic, socially undesirable and impracticable. Instead, ways must be found to permit food crop production to continue on such lands with scientific and technical backing to guard against the possibility of degradation. Encouraging the farmers to change land use would normally be much more efficient rather than imposing restrictions on its use.

- Land shortage and poverty lead to non-sustainable land management practices, one important cause and effect nexus of degradation. This is a major challenge in the agriculture sector, which needs to be addressed by checking fragmentation of land holdings.
- An inter sectoral linkage between departments such as forest, animal husbandry, rural development, agriculture, etc. on issues of mutual concern is necessary to decide policies, strategies and practices for resource conservation and their sustainable utilisation.
- Land management in conjunction with water management needs to be the core of any agenda or national development as the two resources are absolutely inter-dependent and one cannot be dealt with independent of the other.
- Increase in industrialisation, urbanisation, mining and infrastructure development are taking away considerable areas of land from agriculture, forestry, grassland, pasture, etc. resulting in environmental disturbances. There is a need to harmonise such developmental activities and make them compatible with surrounding land use and guard against any form of land degradation, by adopting an area-wide environment quality management approach as this is more effective than site-specific EIAs that represent a piecemeal approach to the problem.

Information gaps

- A correct assessment of the land related deficiencies using sound criteria and indicators and geo-referenced techniques is a prerequisite for effective implementation of

reclamation/rehabilitation strategies for the already degraded lands. This can be achieved by adopting international systems like SOTER (Soil and Terrain database) and GLASOD (Global Assessment of Soil Degradation)

- One of the most important prerequisites for the preservation and sustainable management of the natural resources in Bhutan is a sound distribution of land for various purposes, viz., arable production, forestry, grazing, urban and industrial areas, infrastructure, and nature parks. However, distribution itself is not sufficient to ensure sustainability, the land husbandry is of equal importance. Land use planning, therefore, would involve a systematic registration and evaluation of the present land use and land users and of the capability of the natural environment to sustain these different types of land uses. Land use planning in Bhutan under the present scenario, needs to be at the national, as well as, regional and local levels and to encompass watersheds, the village and the farm. It should involve the farmers as well as the policy and decision-makers in the planning process
- While there is no doubt about the usefulness of fertilisers in augmenting nutrient supply, a careful balance between input and their withdrawal by crops needs to be made to avoid chemical degradation. Removal of subsidies on fertilizers would act as a disincentive to their indiscriminate use. There is a need to define the threshold values for such contaminants and for promoting a balance with the use of organic manure, chemical fertilisers, bio-fertilisers and agrochemicals to ensure sustainability and increased production. Similarly, increasing the utilisation of irrigation potential, promoting water conservation and efficient water management along with expansion of irrigation facilities, needs urgent attention to enhance production without harming land and soil.

- A systematic registration and evaluation of the present land use and land users and of the capability of the natural environment to sustain these different land uses is a prerequisite to proper land use and to guard against land degradation.

Recommendations

The agricultural extension system needs to be made more efficient and far-reaching, and the lab-to-land concept must be translated into practice by providing multidisciplinary technical information, viable land use options and alternatives identified for various agro-ecological and socio-economic units to the land users. Crop combinations and crop rotations suitable for different agro-ecological regions are suggested

Land use related problems need to be addressed in the background of the following:

- good agricultural land is in short supply
- pressure on land is rapidly increasing with increasing population and its demand for higher standard of living
- soil erosion due to the above mentioned pressure on land and to poor farm management is already a problem in certain parts of the country, and erosion and resulting decline in productivity would definitely increase if not addressed
- the so-called development process leads to uncontrolled growth of urban and industrial areas, and infrastructure
- need for the country to increase national income

To find a balance between the needs of the people and the overall aim of conserving the environment, it is important to:

- build on existing structures, utilise them, and if required, to assist the policy makers in formulating and implementing new reforms,
- establish a policy and legislative framework in order to ensure that land use plans and recommendations actually are implemented,

- raise awareness among the decision-makers and the farmers that soil erosion is a problem of great consequence and that it will escalate in future if nothing is done today,
- ensure that land is utilised in the most cost-effective way keeping in mind that the total land resource of the country is very limited,
- ensure that peoples' needs are the driving force in the planning process at different levels, to suggest alternatives which can relieve the pressure on the most affected areas.
- Although deforestation is well recognised, as one of the potent causes of land degradation in Bhutan its exact nature and extent needs to be inventoried and analysed to address the issue
- Shifting cultivation is estimated to be practiced in about 883 km² which is contributing to land degradation significantly. A strategy to discourage the practice in a phased manner need to be developed and the people engaged need to be provided alternative occupation
- Loss of land due to urbanisation, settlements, mining, road construction and other development programmes needs to be contained
- A natural watershed would present an ideal unit for most effective management of land, soil, water and vegetation and would allow sustained production of food, fuel, fibre, forage and water, and reduce the occurrence of floods and droughts. This would influence land use positively, protecting land against all forms of degradation. However, this should enlist people's participation at all stages of development
- Failure of land users and community leaders to recognise or be educated about the causes, urgency, seriousness and full consequences of degradation often work against any measures to counter degradation. In this context, the negotiated participatory approach should mitigate some of these adverse effects.

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Air pollution is an emerging issue in Bhutan, resulted from increasing urbanisation and industrialisation. Air pollution in the cities can be attributed to vehicular growth and wood burning in bukharis. Increasing trend of respiratory diseases has been reported in cities. Air pollution affects human health; children are particularly vulnerable to it. The problem needs to be addressed urgently through proper plans, institutional mechanisms, and through technological intervention to protect public health and well being.

Pressure

Increase in urban population

The urban population in Bhutan is increasing at a rate of 6.7% annually, more than double the national population growth rate of 3.1% per year. This rapid increase has resulted in unplanned urban development, increase in consumption patterns and higher demands related to transport, energy and other infrastructure leading to various pollution problems.

Table 10.1 Vehicular growth in Bhutan

Cities	1990	1999	Growth rate (%)
Thimphu	8712	10755	2.368
Gaylephug	755	1012	3.309
Phuntsholing	2354	5297	9.430
Sammdrupjongkhar	95	1224	32.843
Total	11916	18288	4.875

Source CSO 1999

Increase in number of vehicles

Vehicle population in the kingdom has grown by 14% in the last year, pushing the number from 14,206 to 16,335. Thimphu and Phuntsholing had the largest number of vehicles (NEC 1999b). Figure 10.1 shows the distribution of vehicles by mode, in Bhutan.

In Thimphu, two-wheelers from about 45% of the total vehicles, while cars and jeeps account for about 35%, and buses, about 2%.

The public transport system in Bhutan is fully privatised. In 1985 the privatisation of the public transport commenced and full privatisation was achieved in 1990 with 21 operators managing a fleet of more than 100 buses on 73 routes (MoP 1996).

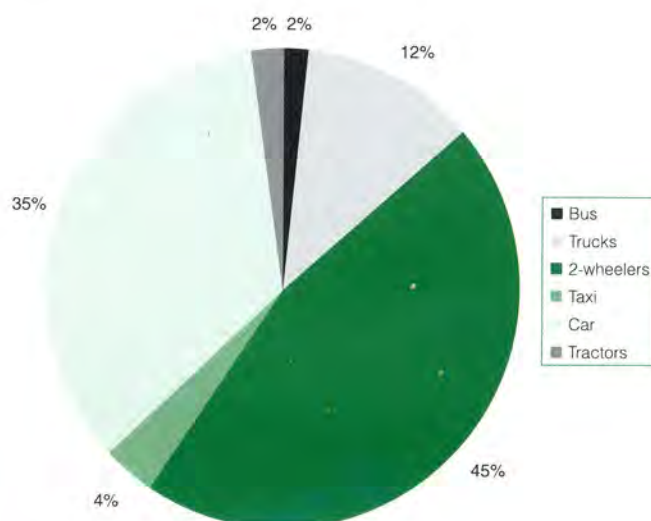


Figure 10.1 Distribution of vehicles in Bhutan
Source NEC 1999b

Increase in industrial activity

Industrial activities in Bhutan have grown tremendously. The number of industries has gone up from 742 in 1990, to 4,394 in 1997. The small scale sector has grown 17 times during the same period. Mineral-based industries have grown faster in the last 20 years. The contribution of industrial sector to the GDP has gone up from 0.01% in 1982 to 3.2 % in 1992 (MoP 1996).

Cement industry

At present 4 cement plants are operating in Bhutan. Cement production from these plants is more than 300,000 metric tonnes annually. Out of these plants, three are small with installed capacities of 30–150 tonne per day (tpd), while the remaining plant has an installed capacity of about 800 tpd. Major pollutants namely particulate matter, fugitive emissions and gaseous pollutants are emitted from the operations of cement plants. Most of the dust is generated within the region of the kiln where calcination is done.

Chemical industry

In Bhutan there are four chemical industries. These chemical industries produce calcium carbide, ferro silica, plaster of paris, rosin and turpentine and activated carbon. As a result, ambient and work zone emissions are the major problems in these facilities. The principal pollutants are dust and particulate emissions. Various other gaseous emissions such as carbon monoxide, carbon dioxide, and sulphur dioxide also emanate from the chemical industry (TERI and Shriram Institute for Industrial Research 1999).

Mining industry

Bhutan is rich in minerals. The major minerals mined are limestone, gypsum, coal, quartzite and dolomite. Most of these minerals are mined for domestic consumption. The major problems due to these mining industries are management of overburden and drilling waste, reclamation

and runoff from mined areas, which cause soil erosion and air pollution (TERI and Shriram Institute for Industrial Research 1999).

Domestic activities

In Bhutan, for bukharis, more than 10,184.22 cubic feet, i.e. 42 truckloads of firewood are burnt each day during the winter months in the Thimphu valley. On an average each household burns about 2.614 cubic feet of firewood every day. Thimphu's annual consumption of firewood is approximately 916 560 cubic feet. The burning of firewood causes high levels of pollution during winter mornings (NEC 1999b).

Several other activities also contribute to air pollution. They are:

- Heating of bitumen along road construction sites; the fire is lit in an open space with a saucer pan to heat the bitumen. The process is inefficient, as heat is lost from all sides.
- Dust from unpaved roads; particulate levels rise when vehicles ply on dusty roads.
- Kitchen garden waste burning during the dry season is another practice that contributes to air pollution in the rural areas.
- Solar radiation from unpainted corrugated galvanized iron (CGI) sheets used for roofing affects the natural mixing of air at high altitudes.

State/Impact

Vehicular emissions

In a recent study conducted by the NEC (National Environmental Commission), emission levels were found to be high in the vehicles of Thimphu. A total of 507 petrol vehicles and 558 diesel vehicles was tested in this study. 60% of the petrol and 96% of the diesel engine vehicles did not meet the Indian emission standards. Similarly 57% of petrol and 95% diesel vehicles in Thimphu did not meet British emission standards. Forty six

percent of petrol vehicles did not meet the Thai emission standards. More significantly, 20% of the vehicles were more than 10 years old while 40% were between five and 10 years (NEC 1999b). It is nearly two times more than heavy-duty vehicles (Figure 10.2).

The problem of emissions is aggravated by the poor quality of fuel available in Bhutan (Photo 10.1). Diesel sold has a high sulphur (0.25%) and wax content, and the vehicles are not fitted with high-altitude compensators. As a result vehicles emit more soot. Diesel vehicles are three times more polluting than petrol vehicles. The lower price of diesel fuel results in larger number of diesel vehicles.

Diesel engine vehicles are also kept in start mode for a long period, a minimum of 15 minutes to heat the engine during the winter, which results in higher levels of carbon monoxide, nitrogen oxides, hydrocarbons and particulate matter in the atmosphere.

CO, HC, and benzene emissions are high in gasoline vehicles compared to diesel vehicles. Figure 10.3 shows the percentage emission of CO as related to the age of the vehicle. It also shows the HC emissions as a function of the age of the vehicle.



Photo 10.1 Vehicular pollution in Thimphu

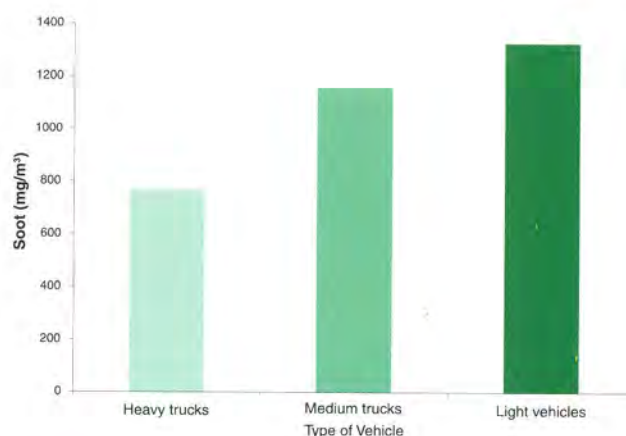


Figure 10.2 Soot emissions in diesel vehicles

In Bhutan, there are no systematic time series data available on emission load of different pollutants emanating from vehicular sources.

Industrial pollution

Air pollution problem arising due to industrial activities is discussed. Photos 10.2 and 10.3 show emission of air pollutants from industries. Air pollution from industries not only affect the health of the workers but also the surrounding environments namely, vegetation (Photo 10.5).

Cement industry

The small-scale cement plants are highly inefficient and do not have pollution control systems. Bhutan's largest cement industry (Penden Cement Authority Ltd.) has modified its plant and installed pollution control devices such as electrostatic precipitators.

Chemical industry

The chemical industry is a major source of air pollution. The main pollutants from chemical industries are CO₂, CO, SO₂, NO_x, and particulate matter. Another problem with this industry is the lack of storage space for the raw materials limestone, coal and charcoal. The height of the emission stacks is low, as a

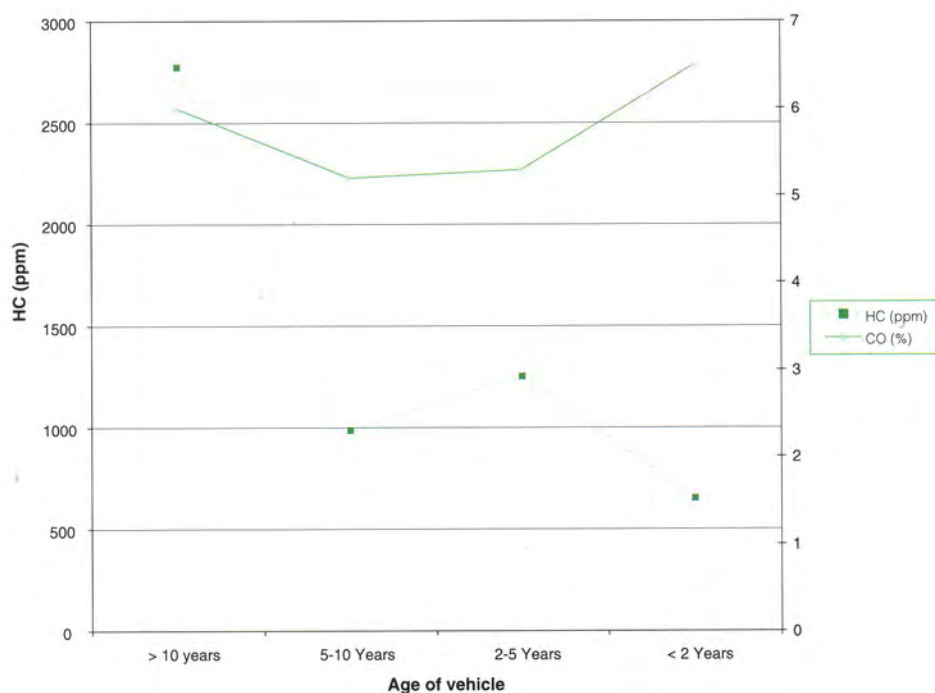


Figure 10.3 Concentration of exhaust gases from petrol vehicles

result of which emissions are not properly dispersed causing air pollution in the surrounding valley. According to the NEC, the bag filter house is not operated continuously on account of high electricity consumption (TERI and Shriram Institute for Industrial Research 1999).



Photo 10.2 Fugitive emissions at a limekiln unit



Photo 10.3 Air pollution from an industry

Mining industry

Operations in open cast mines are also sources of air pollutants. Dust generated in open cast mines moves downwind and deteriorates the ambient air quality of the surroundings. There are no data available to assess the quality of ambient air in and around mines (Photo 10.4).

Domestic pollution - Bukharis

A recent survey carried out for 8,421 households in Thimphu revealed that 3,902 households have installed bukharis and other heating appliances, which use wood and charcoal. Bukharis are used normally between November and March. Most houses lack proper insulation. Around 50% of heat is lost through ceilings and cracks in door and windows. As a result most of the heat is lost within a few hours, and more firewood needs



Photo 10.4 Mining activities: source of air pollution

to be burnt. More than 96% of the houses in and around Thimphu have electricity connections, of which 60% indicated a willingness to switch over to electrical appliances for heating and cooking.

Health impacts

Due to growing air pollution problems in Bhutan there is an increase in the incidence of acute respiratory tract diseases, cough and colds, bronchitis and asthma, shown in Figure 10.4. Acute respiratory tract diseases have increased from 10.08% in 1990 to 14.02% in 1998, whereas other respiratory diseases has increased from 2.45% in 1990 to 6.82% in 1998. Cough and colds, bronchitis and asthma have also gone up from 16% to 22.4% and 1.95% to 2.95% during the same period.

Response

Existing response Transport

- The import of two wheelers with two-stroke engines is banned
- The import of second hand vehicles is banned
- Efforts are being made to improve the quality of fuel and to ensure the availability of spare parts in the local market

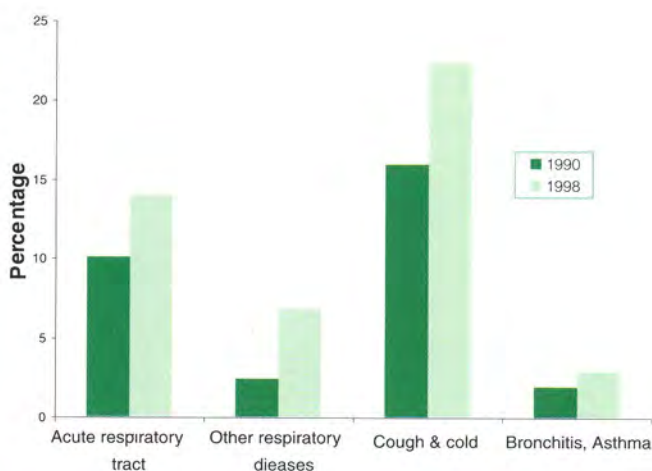


Figure 10.4 Hospital morbidity patterns

Source MoSS 1990, MoHE 1998



Photo 10.5 Effects of dust on the surrounding vegetation

- A budget of Nu. 12.26 million has been allocated for the construction of footpaths to improve traffic movement in urban areas
- Nu. 493 million has been allocated for widening and improving 190 km of road
- Nu. 546 million has been allocated for the maintenance of 2,756 km of roads
- Nu. 134 million has been allocated for the realignment of 27 km of road on the East-West Lateral highways
- An amount of Nu. 10.26 million has been allocated in the 8th Five Year Plan to improve parking areas and develop regulations to improve the urban environment.

Industrial pollution

- Industries have taken initiatives to mitigate environmental impacts using de-dusting equipment's such as filters and electrostatic precipitators
- The NEC is planning to recommend appropriate landfills to the relevant industries
- EA Act 2000 is enacted, which will lay the base for environmentally sound industrial development.

Domestic pollution

- Promote the use of efficient electrical appliances by providing electricity access to all parts of Bhutan.
- Promote energy-efficient house constructions and improvements of insulation in the existing houses
- Government should increase the royalty on fire-wood in urban areas to discourage firewood use; and
- Encourage use of more energy-efficient stoves such as sawdust bukharis etc.

Policy gap

- There are no permissible standards for vehicular emission
- There are no industry specific emission standards and no guidelines for control of pollution for industries

- There are no ambient air quality standards for different pollutants
- There is no policy/strategy to mitigate air pollution in urban centres.
- Institutional capacity is limited

Knowledge/information

The Royal Government of Bhutan has to take initiatives to generate primary data and information on status of air quality for Thimphu valley and other major towns in Bhutan.

Data and information gaps identified are as follows:

- Data on primary and secondary pollutants to assess the ambient air quality
- Pollution loads from different sources including industries, vehicular and domestic sectors
- Pollution characteristics from vehicular sources
- Impacts of pollutants on human health and the environment

Policy recommendations

Transport

- Expand public transport services within the city areas.
- Encourage use of catalytic converters for petrol engine vehicles.
- Import of standardised vehicles suitable for high altitude areas.
- Import of premium quality diesel and petrol
- The Government of Bhutan should take initiative to follow stringent norms such as the Euro norms. Annex 1 gives the Euro norms for various types of vehicles.

Industries

- Development of industry-specific emission guidelines
- Promotion of cleaner technologies for the industries
- Development of industry-specific pollution control guidelines
- Enforcement of monitoring stations and data reporting for industries
- Provision of incentives to adopt cleaner technologies

- More thrust on setting up of industrial estates and developing infrastructure to minimise effects of pollution on human health and environment
- The Government of Bhutan should take initiative to develop ambient air quality standards for industrial areas. The ambient air quality standards for different countries are given in Annex 2.
- EIA (Environmental Impact Assessment) has been recognised as a good policy as well as management tool and should be applied to lay the foundations of an environmentally sound project.

Domestic pollution

Government should stop bukharis in cities and promote energy efficient electrical appliance for heating and cooking purposes. More emphasis should be to supplying electricity connections and cheap electricity to the rural areas to gradually replace bukharis.

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Annex 1

Emission norms – gasoline passenger cars

Emission norm	Euro I	Euro II	Euro III	Euro IV
Carbon monoxide g/km	2.72	2.2	2.3	1.0
Hydrocarbon + Oxides of nitrogen g/km	0.97	0.5	0.2+0.15	0.1 + 0.08

Emission norms – diesel passenger cars

Emission norm	Euro I	Euro II	Euro III	Euro IV
Carbon monoxide g/km	2.72	1.0	0.64	0.5
Hydrocarbon + Oxides of nitrogen g/km	0.97	0.7	0.56	0.3
Particulate matter g/km	0.14	0.08	0.05	0.025

Emission norms – diesel heavy duty

Emission norm	Euro I	Euro II	Euro III	Euro IV
Carbon monoxide g/kWh	4.5	4.0	2.1	1.5
Hydrocarbon g/kWh	1.1	1.1	0.66	0.46
Oxides of nitrogen g/kWh	8.0	7.0	5.0	3.5
Particulate matter g/kWh	0.36	0.15	0.1	0.02

Source CONCAWE 1999

Annex 2

Ambient air quality standards for different countries

Country	Suspended particulate matter (SPM), $\mu\text{g}/\text{m}^3$		Sulphur di oxide (SO_2), $\mu\text{g}/\text{m}^3$		Oxides of Nitrogen (NO_x), $\mu\text{g}/\text{m}^3$	
	24 hours	1 year	24 hours	1 year	24 hours	1 year
India						
Industrial	500	360	120	80	120	80
Residential	200	140	80	60	80	60
Sensitive	100	70	30	15	30	15
China						
Class III	500		250		150	
Class II	300		150		100	
Class I	150		50		50	
Australia		90		60		
Japan	100		100		100	
USA	260		365	80		100
EU	300	150	250	80		200
WHO	150-230	60-90	100-150	40-60	150	

The National Environment Strategy for Bhutan outlines three main avenues of sustainable economic development: expanding hydropower, increasing agricultural self-sufficiency and expanding the industrial base. The integrity of Bhutan's water sheds and their maintenance is very important for the first two avenues of development. Policies and action plans need to be framed to protect the existing unpolluted water resources.

Pressure-Resource availability: use and demand

The average annual rainfall in Bhutan is 1,150 mm. The country receives rains throughout the year, except from November to January, with the maximum precipitation occurring between June and July. The highest rainfall is observed in the Southern foothills between Phuntsholing and Sibsoo reaching 5,240 mm in Sibsoo and 4,400 mm in Phuntsholing. However, there are regional variations; the eastern parts of the country receive rainfall in the range of 600-1,000 mm whereas in the central region it varies from 700-1,700 mm. There is no data available for the northern region. Out of total precipitation received, surface runoff constitutes 76%, 5% is as snow, and infiltration comprises 19%. The five major river systems in Bhutan are:

- Amo Chhu
- Wang Chhu
- Punatsang Chhu
- Manas Chhu
- Nyera Ama Chhu

The rivers finally discharge into the river Brahmaputra in India. The ground water aquifers in Bhutan occur in porous sediments and fractured rocks. Springs are either seasonal or perennial and are mainly utilised for irrigation or drinking water. Hot springs can be developed for the tourist industry, geothermal energy and for therapeutic uses.

The annual renewable freshwater resource per capita is estimated to be 58,930 m³ (WRI 1994) indicating that Bhutan is not currently under a water stress. Photo 11.1 shows the river water resources of Bhutan.

The agriculture sector uses the maximum amount of water (54%) followed by the domestic sector (36%) and industry (19%). In 1990, approximately 34 000 ha of agricultural land was irrigated and surface water contributed to about 35% of agricultural water use (ESCAP 1992). The status of water supply and sanitation is given in Table 11.1. It is estimated that present water demand is 0.036 km³ (ESCAP 1995).

The annual health bulletin published by the Ministry of Health and Education in 1998 reports that 55% of the households in Bhutan



Photo 11.1 River water resource

have access to piped water and 82% of the households have access to latrine facilities. 58% of the rural population has access to safe drinking water supply through the construction of 1,768 schemes; and 70% of households have access to sanitary latrines. Although freshwater is in abundance in Bhutan, with growing urbanisation and industrialisation,

Table 11.1 Urban and rural water supply and sanitation

Population coverage (thousands)	1980		1990	
	Urban	Rural	Urban	Rural
Urban and rural water supply	30	60	107	359
Urban and rural sanitation	NA	NA	143	36

Source WHO 1981, 1992

the pressure on the resource is bound to increase (Photos 11.2 and 11.3). The urban population in 1999 accounted for 21% of the total population and is likely to increase by 50% by the year 2020, which will automatically raise the demand for water.

State

At present, there is limited information available on the quality of freshwater resources in Bhutan. In 1997, the NEC (National Environment Commission) Secretariat with assistance from the ADB (Asian Development Bank) conducted a study to collect baseline water quality data to initiate the development of a national water quality database for major water sheds in Bhutan (NEC 1997) (Photo 11.4). The Department of Power under the Ministry of Trade and Industry has also set up sampling stations to monitor and collect data. Map 11.1 shows the principal and secondary gauging and sediment sampling stations in Bhutan.



Photo 11.2 Drainage from public toilet



Photo 11.3 Waste effluent discharge from automobile workshops into Wang chhu

The piped water supplies in Bhutan are designed to supply 120 litres per person per day (Planning Commission 2000). With the urban population growing at high rates of about 10% per annum for Thimphu (NEC 1998), meeting the demand for safe and adequate drinking water in urban areas is becoming a big challenge.



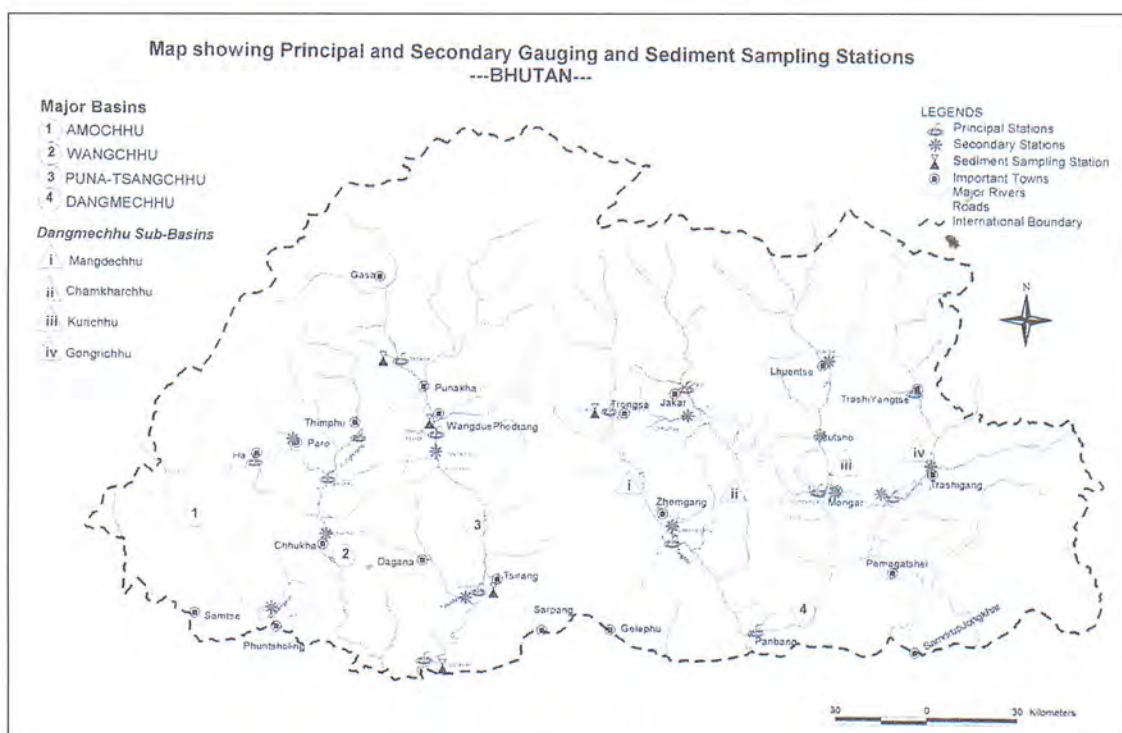
Photo 11.4 Water sampling at site

Response

Existing response

The formulation of a national water resource management policy has not been accorded top priority by the Royal Government of Bhutan as the country has abundant water resources (NEC 1998; MoP 1996). However, during the 7th FYP:

- Of the target 325 new water supply schemes in the rural areas, 112 were constructed and 230 out of 300 schemes were rehabilitated. The coverage increased to about 58% by 1995
- Urban water supply systems in six towns namely Thimphu, Phuntsholing, Paro, Gelephu, Trashigang and Samdrupjongkha were improved under the ADB and DANIDA projects.
- A further major project undertaken comprised the consolidation of water supply systems in the six towns and a sewerage scheme for Thimphu and Phuntsholing towns at a cost of Nu 507 million with a RGoB contribution of Nu 82 million (Photo 11.5).
- Metering of water to control wastage and facilitate the collection of service charges on the basis of actual consumption has also been introduced.
- The Ministry of Communications with assistance from DANIDA, formulated “Water and Sanitation Rules” (MoC 1995)



Map 11.1 Principal and secondary gauging and sediment sampling stations in Bhutan

to ensure efficient management of urban utilities—a prerequisite for a healthy living environment and sustainable urban development.

The 8th FYP (1997-2002) aims to increase the use of improved water supplies and greater access to basic sanitary services and improve awareness amongst users on the relationship between water quality, sanitation, general hygiene and diseases through:

- Preparation of a water resource inventory
- Implementing reviewed master plans for cities/municipal corporations
- Strengthening the urban water supply and sanitation units under the Public Health Engineering section so as to provide support to the city/municipal corporations to operate and maintain water and sanitation infrastructure (MoP 1996)
- Promotions of low cost and site specific technologies for efficient operation and maintenance of services.

Under the National Irrigation Policy, decentralised community water user associations have been formed to encourage active participation of the beneficiaries during the identification, implementation and O&M of projects. In order to combat pollution arising

out of industries, NEC has recommended ambient environmental quality and effluent quality guidelines as Tables 11.2- 11.5 (NEC 1999).

Policy gap

- A national water resource management master plan does not exist
- Relevant information needs to be gathered before formulating standards for drinking water quality, ambient environmental quality and effluent discharge. Adequate surveillance systems for drinking water sources and supply schemes are also required. Industry specific standards relating to water consumption and effluent discharges per unit of production have to be developed as well
- As identified in the mid term review report of the 8th FYP, there is a need for the NEC (Planning Commission Secretariat 2000) to:
 - Analyse all sectors as well as their capacity to meet environmental challenges
 - Co-ordinate the implementation of the Environmental Assessment process
 - Assist old and new industries by issuing clear directives regarding environmental management plans and the use of cleaner technologies.

Knowledge/information/data

The pilot baseline water quality surveys conducted by the NEC had set specific long term objectives such as gathering data to refine ambient water quality standards, provide information on priority water quality problem areas, provide data to develop strategies for the protection of river ecosystems for hydropower development and to create public awareness. It therefore becomes necessary to increase the scope of these surveys to include parameters specific to the identified stations and develop a comprehensive database on a national level with assistance from other agencies such as the MoA and MoTI.



Photo 11.5 Sewage treatment plant

Table 11.2 Criteria for drinking water supplies (maximum acceptable concentration in drinking¹ water – mg/l unless otherwise stated)

Parameter	Bhutan ²
Inorganic parameters	
Antimony	0.005
Arsenic	0.05
Barium	1.0
Boron	5.0
Cadmium	0.01
Chloride	250.00
Chromium	0.05
Copper	2.0
Cyanide	0.2
Fluoride	1.5
Iron	0.3
Lead	0.1
Manganese	0.5
Mercury	0.001
Nitrate (as NO ₃)	45.0
Nitrite (as NO ₂)	3.0
pH	6.5 – 8.5
Selenium	0.01
Silver	0.05
Sulphate	500.00
Sulphide (as H ₂ S)	0.05
Total dissolved solids	500.00
Uranium	0.02
Zinc	5.00

¹ Drinking water guidelines apply to “treated” or “finished” water as it comes from the tap, and are not intended to be applied directly to surface waters. Ref: Canadian Water Quality Guidelines (1978, updated in 1996). Prepared by the Task Force on Water Quality Guidelines by the Canadian Council of Ministers of the Environment. Environment Canada

² Recommended by the National Environmental Commission until more relevant information becomes available

Baseline information also needs to be collected to identify key problems and the problem areas with respect to water supply and sanitation, both, in the urban and rural areas. This could then be followed by defining strategies to address these and prioritising the action plan. Besides, information needs to be gathered on the water consumption and effluent discharge patterns for industries.

Recommendations

- High priority needs to be given to the formulation of a national water resource management master plan
- The drinking water quality standards for Bhutan should be developed only after generating requisite baseline information on the quality of existing sources and treatment capabilities. The WHO or BIS, India standards for drinking water supplies, Table 11.6, could also be considered for developing Bhutan's standards
- Proper surveillance systems for drinking water sources and supply schemes need to be in place and supported by necessary legislation. This would help in an inter-flow of information on water quality and health statistics in a transparent way so as to be able to draw correlations for future planning. The surveillance system to start with, should be well defined including the scope of the parameters to be monitored and their frequency. This should initially be comprehensive in nature so as to include aspects related to the nature of source, type of treatment process, distribution network and other local conditions. Yardsticks such as the European Commission Directive, Table 11.7, could be used for defining the surveillance systems
- The ambient environmental quality and effluent standards should also be developed only after generating some baseline information on carrying capacities of different regions and sources. Standards for discharge of effluents developed in India, Table 11.8, under the Environment Protection Rules, 1986 could also be referred to
- Industry specific standards related to water consumption per unit of product and discharge to be developed for select resource intensive and highly polluting industries

Table 11.3 Bacteriological drinking water quality criteria developed by WHO¹

Treatment level and usage	Guideline value
All water intended for drinking	
E. Coli or thermotolerant coliform bacteria ^{2,3}	Must not be detectable in any 100 ml sample
<i>Treated water entering the distribution system</i>	
E. Coli or thermotolerant coliform bacteria ²	Must not be detectable in any 100 ml sample
Total coliform bacteria	Must not be detectable in any 100 ml sample
<i>Treated water in the distribution system</i>	
E. Coli or thermotolerant coliform bacteria ²	Must not be detectable in any 100 ml sample
Total coliform bacteria	Must not be detectable in any 100 ml sample
<i>Treated water in the distribution system</i>	
E. Coli or thermotolerant coliform bacteria ²	Must not be detectable in any 100 ml sample
Total coliform bacteria	Must not be detectable in any 100 ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period

¹WHO: Guidelines for drinking water quality (second edition) Vol. 2., Pages 174-181. Immediate investigative action must be taken if either E.coli or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause must be determined by immediate further investigation

²Although E. coli is the more precise indicator of fecal coliform pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplied, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies

³It is recognized that, in the great majority of rural water supplies in developing countries, fecal coliform contamination is widespread. Under these conditions, the national surveillance agency should set medium term targets for the progressive improvement of water supplies

- The multi-sectoral nature of water resources development in the context of socio-economic development must be recognised, as well as the multi-interest utilisation of water resources for water supply and sanitation, agriculture, industry, urban development, hydropower generation, inland fisheries, transportation and recreation
- Special attention needs to be given to the growing effects of urbanisation on water demands and usage and to the critical role played by local and municipal authorities in managing the supply, use and overall treatment of water for which special support is needed
- Scarcity of freshwater resources and the escalating costs of developing new resources have a considerable impact on natural, industrial, agricultural and human settlement development and economic growth. Better management of urban water resources including the elimination of unsustainable consumption patterns by metering the consumption can certainly make a substantial contribution to the alleviation of poverty and improvement of the health and quality of life of the urban and rural poor
- A large number of urban agglomerations do not have municipal/industrial wastewater treatment facilities causing a deterioration in the water quality of rivers. The introduction of clean technologies and the construction of sewage/effluent treatment plants can bring in significant improvements
- The holistic management of freshwater as an acute and vulnerable resource with economic dimensions and the integration of sectoral water plans and programmes within the framework of national economic and social policy are of paramount importance for action in Bhutan

Table 11.4 Ambient criteria for freshwater aquatic life (mg/L unless otherwise stated)

Parameters	Recommended for Bhutan ¹
Inorganic parameters	
Mercury	2.4 µg/L
Nickel (Hardness 0-60 mg/L CaCO ₃)	1,400 µg/L
Nickel (Hardness > 160 mg/L CaCO ₃)	160 µg/L
Nitrogen	
Ammonia (pH 6.5, 10°C)	2.2
Ammonia (pH 8.0, 10°C)	1.37
Nitrite	0.06
Nitrate	-
pH 6.5-9.0	
Selenium	100
Silver	0.92 µg/L
Thallium	-
Zinc	120 µg/L
Organic parameters	
Acrolein	68 µg/L
Aldrin/dieldrin	3 µg/L
Benzene	5,300 µg/L
Chlordane	6 ng/L
Chlorinated benzenes	
Monochlorobenzene	15 µg/L
Dichlorobenzene	1,200 µg/L
Trichlorobenzene	0.5 µg/L
Tetrachlorobenzene	0.1 µg/L
Pentachlorobenzene	0.03 µg/L
Hexachlorobenzene	0.01 µg/L
Chlorinated ethylenes	
Tetrachloroethylene	11,600 µg/L
Chlorinated phenols	10,200 µg/L
Monochlorophenols	2,000 µg/L
Dichlorophenols	3.6 µg/L
Trichlorophenols	20 µg/L
Tetrachlorophenols	1.0 µg/L
Pentachlorophenol	0.5 µg/L
DDT	1.1 µg/L
Endosulfan	0.02 µg/L
Endrin	2.3 µg/L
Ethylbenzene	32 µg/L
Heptachlor + Heptachlor epoxide	0.01 µg/L
Hexachlorobutadiene	0.122 µg/L
Hexachlorocyclohexane isomers	0.031 µg/L
Phenols (total)	10,200 µg/L
Phenoxy herbicides (2, 4-D)	4.0 µg/L
Phthalate esters	4 µg/L
DBP	0.6 µg/L
DEHP	0.2 µg/L
Other phthalate esters	-
Polychlorinated (biphenyls) (total)	1 ng/L
Toluene	17.5
Toxaphene	8 ng/L
Physical parameters	
Total suspended solids	
Background TSS <100 mg/L	10 mg/L@
Background TSS > 100 mg/L	10%@

¹ Recommended by the National Environment Commission until development of ambient data sources.

@ Not to increase by more than 10% of background.

Table 11.5 Industrial wastewater discharge standards (general)

Parameter	Bhutan ¹ (recommended)
pH	5-9
Temperature increase (°C)	< 3
Total suspended solids (mg/l)	60.0
Oil and grease (mg/l)	10.0
BOD ₅ (mg/l)	50.0
COD (mg/l)	250.0
Coliforms (mpn/100 ml)	400
Ammonia (as N) (mg/l)	50.0
Arsenic (mg/l)	0.25
Benzene (mg/l)	0.1
Cadmium (mg/l)	0.1
Chromium total (mg/l)	0.5
Copper (mg/l)	3.0
Cyanide (mg/l)	0.2
Iron (mg/l)	3.5
Lead (mg/l)	0.8
Mercury (mg/l)	0.005
Phenol (mg/l)	2.0
Sulphide (mg/l)	10.0
Zinc (mg/l)	5.0
Total metals (mg/l)	10.0

¹ Tentative recommendation by National Environment Commission. These values will be reviewed subject to availability of alternative data. Note that industry specific effluent standards are provided in the sectoral guidelines (NEC 1997)

- Bhutan is a predominantly a hilly country and mountains are most vulnerable to human activities. They are susceptible to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity. Soil erosion can have a devastating impact on the vast number of rural people who depend on rainfed agriculture in the mountain and hillside areas. Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance
- Enhance knowledge, understanding and awareness of issues related to water management and state of Bhutan's rivers
- Strengthen the institutional and professional capacity of the NEC secretariat.

Table 11.6 Drinking water quality standards as recommended by the WHO and BIS

Parameter	WHO standards		Indian Standards: 10 500(1991)*
	Class A: Maximum permissible limit	Class B: Maximum allowable limit	
Physical parameters			
Colour (hazen)	5.0	25.0	5.0
Turbidity (NTU)	5.0	25.0	5.0
pH	7.0–8.5	6.5–9.2	6.5–8.5
Temperature (°C)	–	–	–
Conductivity (mho/cm)	–	–	–
Total dissolved solids	–	–	–
Total suspended solids	–	–	–
Total solids	500.0	1500.0	500.0
Chemical parameters			
Total hardness	–	-	300.0
Calcium as calcium carbonate	–	500.0	75.0
Magnesium as calcium carbonate	–	650.0	30.0
Acidity	–	–	–
Alkalinity as calcium carbonate	–	–	–
Bicarbonate as calcium carbonate	–	–	–
Hydroxide as calcium carbonate	–	–	–
Chlorides as chlorine	–	–	250.0
Total residual chlorine	–	–	–
Sulphates	200.0	400.0	200.0
Fluorides	0.5	1.0-1.5	1.0
Phenol	0.0	0.0	0.0
Manganese	0.1	0.5	0.1
Silica	–	–	–
Sodium	–	–	–
Potassium	–	–	–
Organic and nutrient parameters			
Dissolved oxygen	–	-	-
Biological oxygen demand	–	-	-
Chemical oxygen demand	–	-	-
Phosphates	–	-	-
Mercury	–	-	-
Oil and grease	–	-	-
Nitrates	–	50-100	45.0
Nitrites	–	–	–
Heavy metals	–		
Iron	0.3	1.0	0.3
Chromium	–	0.1	0.1
Boron	–	–	1.0
Zinc	–	–	5.0
Copper	1.0	1.5	1.5
Lead	–	0.1	0.1

Source WHO 1986, WHO Handbook, Geneva: World Health Organization; ISI 1991(not cited in reference), Indian Standards (IS: 10 500), New Delhi: Indian Standards Institute

Table 11.7 Minimum frequency of sampling and analysis as per European Commission Directive

Volume of water distributed/ produced each day within a supply zone(m ³)	Check monitoring ¹ (number of samples per year)	Audit monitoring ² (number of samples per year)
≤ 100	Frequency to be decided by the member state concerned	Frequency to be decided by the member state concerned
> 100 to ≤ 1000	4	1
>1000 to ≤ 10 000	+ 1 for each 3300 m ³ /day and part thereof of the total volume	1
>10 000 to ≤ 1 00 000	4	3
	+ 3 for each 1000 m ³ /day and part thereof of the total volume	+ 1 for each 10 000 m ³ /day and part thereof of the total volume
>1 00 000	+ 1 for each 25 000 m ³ /day and part thereof of the total volume	10

¹Check monitoring - The purpose is to provide regular information on the organoleptic and microbiological quality of water supplied

² Audit monitoring - The purpose is to provide the information necessary to determine whether or not all of the Directive's parametric values are being complied with

Source EC Council Directive 98/83/EC of November 3, 1998

Table 11.8 Standards for discharge of effluents developed in India under the Environment Protection Rules, 1986

Parameter	Standard		
	Inland surface water	Public sewers	Land for irrigation
Colour and Odour	All efforts to be made to remove colour and unpleasant odour as far as practicable	-	All efforts to be made to remove colour and unpleasant odour as far as practicable
Suspended solids, mg/l, Max	100	600	200
Particle size of suspended solids.	Shall pass 850 micron IS Sieve	-	-
Dissolved solids (Inorganic), mg/a, max.	2100	2100	2100
pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
Temperature degree C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet	45 at the point of discharge	-
Oil and grease, mg/l, max	10	20	10
Total residual chlorine, mg/l, Max.	1	-	-
Ammoniacal nitrogen (as N), mg/l, Max.	50	50	-
Total Kjeldahl nitrogen (as N), mg/l, Max.	100	-	-
Free ammonia (as NH ₃), mg/l, Max.	5	-	-
Biochemical oxygen demand (5 days at 20 degree C) Max.	30	350	100
Chemical oxygen demand, mg/l Max.	250	-	-
Arsenic (as AS), mg/l, Max.	0.2	0.2	0.2
Mercury (as Hg), mg/l, Max.	0.01	0.01	-
Lead (as Pb), mg/l, Max	0.1	1	-
Cadmium (as Cd), mg/l, Max.	2	1	-
Hexavalent chromium (as Cr+ 6) mg/l, Max.	0.1	2	-
Total chromium (as Cr), mg/l, Max.	2	2	-
Copper (as Cu), mg/l, Max.	3	3	-
Zinc (as Zn), mg/l, Max.	5	15	-
Selenium (as Se), mg/l, Max.	0.05	0.05	-
Nickel (as Ni), mg/l, Max.	3	3	-
Boron (as B), mg/l Max.	2	2	2
Percent sodium, Max.	-	60	60
Residual sodium carbonate, mg/l, Max.	-	-	5
Cyanide (as CN), mg/l, Max.	0.2	2	0.2
Chloride (as Cl), mg/l, Max.	1000	1000	600
Fluoride (as F), mg/l, Max.	2	15	-
Dissolved Phosphates (as P), mg/l, Max.	5	-	-
Sulphate (as SO ₄), mg/l, Max.	1000	1000	1000
Sulphide (as S), mg/l, Max.	2	-	-
Pesticides	Absent	Absent	Absent
Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max.	1	5	-
Radioactive materials:			
(a) Alpha emitters MC/ml. Max.	10 ⁻⁷	10 ⁻⁷	10 ⁻⁸
(B) Beta emitters mc/ml. Mas.	10 ⁻⁶	10 ⁻⁶	10 ⁻⁷

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Bhutan has so far successfully managed the process of development and ensured a harmonious balance between modern economic forces, traditional social values and the natural environment. But as the country enters the next phase of development, it faces a set of new challenges. Till now, the development effort was, to a large extent, limited to basic tasks such as building infrastructure, constructing roads and opening health care centres and schools. Today, this physical foundation is largely in place. Now, the focus has to be on ensuring that the public provisioning of basic social services is of good quality, and at the same time is equitable and efficient. Already, the public outlay on health, education, water supply and sanitation accounts for more than 20% of the Government's expenditure. But as the population increases, and more and more people expect to have improved access to these basic social services, the burden on the exchequer can only increase (Planning Commission 2000).

The RGoB (Royal Government of Bhutan) faces new challenges, as a result of opening the country to economic development. Threats to the continued integrity of Bhutan's natural resource base are increasingly being felt from a variety of "developmental" sources—infrastructure construction, industrial expansion, increasing urbanisation, compromising land-use management practices, high population growth rate, employment shifts, changing consumption patterns and introduction of new technologies (NEC 1998a).

Pressure/Cause

Waste disposal is an emerging problem in almost all the urban towns in Bhutan (Photo 12.1 and 12.2). The increase in waste generation can be primarily attributed to factors such as rapid rates of urbanisation, rural-urban migration, changing consumption pattern and high population growth rate. While the magnitude of the problem is relatively small and manageable in rural areas, it appears to be growing significantly in urban areas in recent times.

Rapid urbanization and migration from rural areas

Urbanisation in Bhutan really began in 1961 with the introduction of the country's first five-year development plan. Today, Thimphu has a population of roughly 46,000 and Phuntsholing has about 23,000 inhabitants, while 26 other townships also are considered major urban areas (NEC 1998a). In total, the



Photo 12.1 Solid waste: an emerging problem.



Photo 12.2 Solid waste disposal on streets of Thimphu

urban population in 1999 accounted for 21% of the national population. With the continued improvement of health facilities and employment opportunities, this percentage can only be expected to increase. Largely because of the increasing migration from rural to urban areas, cities are expanding at an extraordinary pace. The present rate of population growth in Thimphu alone, according to some estimates, is about 10% per annum, which implies that by year 2006 the population of the capital will have reached about 100 000. Poorly equipped to deal with such an influx of migrants, the urban areas are witnessing severe constraints on housing, water and sanitation. Also, if such a trend continues, the demand for both physical and socioeconomic infrastructure will put increasing pressures on urban and peri-urban environments.



Photo 12.3 Garbage container in Thimphu

State

The unscientific disposal of waste causes adverse impacts not only on the ecosystem but also the human environment. Unscientific disposal practices leave waste unattended at the disposal sites. This allows the access of birds, rodents, fleas, etc. to the waste and creates unhygienic conditions (odour, release of airborne pathogens, etc.).

In terms of total volume of waste generated, domestic waste constitutes the largest percentage at approximately 70%-80% in both urban as well as rural areas. The per capita waste generation is assumed to be 0.3 kg/day irrespective of whether it is urban or rural, in the absence of any reliable data (*Information provided by NEC*). National level data do not exist for municipal solid waste generation, collection and disposal due to the lack of a nation wide inventory. The other contributing forms of waste are from hospitals, industries and agricultural activities although their contribution is not too significant in comparison with that of domestic waste. Photos 12.4 and 12.5 show the solid waste disposal from industries. The quantity of waste from all sectors is going to increase every year with the increase in population and migration figures.

In the absence of national level data it is however important to have an overview of the situation in the major urban centres where the problem due to increased waste generation is more critical than in other parts of the country. The two major urban centres where the situation could be analyzed are Thimphu and the city of Phuntsholing.

Thimphu city

Thimphu is the largest town and the capital of Bhutan with approximately 6,982 households and 1,000 institutions. Most activities in the city are related to it being the capital with a large number of administration and public institutions. There is limited industrial production and transport activities are mainly related to the movement of goods, general



Photo 12.4 Oil spillage at motor works

public and tourists to and from the countryside. There is a good number of shops, workshops and hotel accommodation is freely available. The generation of waste apart from the domestic sector is from these tourist facilities, commercial establishments and offices. The quantum of waste generation from Thimphu City is estimated to increase two-fold between 2000-2010 (USPS 2000b). The Thimphu City Corporation is responsible for taking care of the solid waste being generated. Some information about the waste generation in Thimphu City is given in the table below.



Photo 12.5 Solid waste disposal (boiler ash) outside factory premises

Box 1 Waste disposal – an emerging problem in Thimphu

Eight truckloads of solid waste are collected in Thimphu each day, either from sweepers going door-to-door in the city center or from strategically positioned bins (Photo 12.3). This material is transported in closed trucks to a landfill located on the edge of a ravine. The site was developed by erecting a retaining wall to prevent the garbage from slipping down into the ravine and by diverting a small stream to avoid water pollution. Once this site has reached capacity, it is to be landscaped as an amenity area/picnic spot. Thimphu City Corporation (TCC) already has begun the process of developing a second landfill site.

As traditional family-oriented lifestyles continue to dominate Bhutan's urban centres, poverty and unemployment have yet to become significant problems. Evidence, however, suggests that the continued effects of modernisation are changing the existing social structure in undesirable ways. Small-scale theft and drug usages, for example, are clearly on the rise. An additional problem stems from the fact that people tend to bring their rural habits with them when they move to urban areas. In Bhutan's case this translates into incompatible uses of surrounding land, taking running water for granted and the indiscriminate disposal of waste and litter.

Source NEC 1998a

Phuntsholing city

Phuntsholing is the second largest town in Bhutan on the border to India. All goods transported in and out of Bhutan pass through this town. The activities town are related to transportation, there are workshops and garages, a bus-terminal and accommodation possibilities. The exact amount of waste is difficult to estimate, as there is no reliable information. A part of the food waste is used as animal fodder and, in Phuntsholing there exists an informal recycling system. Also at the workshops and garages huge amount of recycling of materials takes place. Only materials that the scavengers do not accept are wasted. Spillage of oil and sweepings seems to be the main problem. Some information about the waste generation in Phuntsholing City is given in the table below.

Table 12.1 Thimphu city waste generation characteristics

Source	Number	Average solid waste generation rate (kgs/day)	Remarks
Household	3200	1.5 – 2/household	Mainly organic waste and packaging (bottles, tins and wrapping paper)
Hotels etc.	30-40 hotels (700 beds) & restaurants	0.5 – 1 /tourist	Estimated is that tourists generate < 0.5% of the total amount of waste
Commercial institutions	-	1.1 /unit	30% is recyclable material
Offices	-	0.14 /employee	20% is recyclable material (paper)
Street and drain cleaning			Drains not maintained properly

Source Adapted from USPS 2000b

Health care waste

It includes the waste from clinics as well as homes. However, the waste from clinics is collected separately in disposal bags and incinerated; a few hospitals in Bhutan are equipped with incinerators. Domestic waste is collected and managed by the respective city/municipal corporations in the manner described above.

There are 3 hospitals in Thimphu. The largest hospital has 200 beds. The hospital also functions as an outpatient clinic with 500 to 1,500 patient per day. It is estimated that the largest hospital produces between 2 and 3 tons per year of infectious waste and between 6 and 8 tons per year of ordinary waste. (USPS 2000b). The real amount of waste produced is not easy to measure because the different waste fractions are mixed and ordinary household waste from official residents are collected in the same containers.

There is one hospital in Phuntsholing with 20 beds and only a small surgery which also functions as an outpatient clinic. From studies carried out in developing countries such as India, it is estimated that the average infectious biomedical waste generated is about 250 grams/bed/day (CPCB 2000).

Collection and transportation

There have been some efforts towards improving the waste collection system. The collection of waste from households, commercial set-ups is done in concrete receptacles placed at strategic points and conveyed by trucks/tractors. There are concrete bins and containers provided at various locations from where the garbage is lifted for disposal. Individual bins/containers are also placed alongside the shops in certain areas, which are emptied directly into the trucks/tippers. The removal of waste from the collection points is a totally manual process (Information provided by NEC).

Table 12.2 Phuntsholing city waste generation characteristics

Source	Number	Average solid waste generation rate (kgs/day)	Remarks
Household	2300	1.5 – 2/household	Waste mainly related to food production
Hotels etc.	30-40 hotels (800 beds) & restaurants	0.5 – 1 /tourist	Hotels mostly a part of family business
Commercial institutions	-	1.1 /unit	30% is recyclable
Offices	-	0.14 /employee	20% is recyclable
Street and drain cleaning			Drains not maintained properly

Source Adapted from USPS 2000a

Today in Thimphu City approximately 8 tons of waste is collected per day – 6 days a week. On weekly basis 50 tons of waste is collected out of the 70 tons generated, and approximately 20 tons of solid waste is informally disposed (USPS 2000b); this accounts for a collection efficiency of about 72% by the city corporation. However it is very important for the authorities to further improve their collection efficiency in order to prevent the waste reaching water bodies and the drainage system due to informal disposal.

Treatment and disposal

In Thimphu, the solid waste is disposed off at the sanitary landfill site located at Memelakha, currently the only landfill site in Bhutan. The site is situated about 12 km away from the city thereby eliminating any health hazards within the city area. The waste reaching the disposal area contains a large percentage of garbage and inorganic matter giving it a high density and low calorific value. The landfill site is now being extended to accommodate more waste. The total waste being treated at the landfill is 8-10 tonnes/day. With the exception of Thimphu, where there exists a sanitary landfill site, the municipal waste in other urban areas is disposed off either in rivers/streams, valleys or in low lying areas. With the dumping of waste being uncontrolled at the moment, there is every possibility that such activity is contributing to fresh water pollution although to a lesser degree. Burning of combustible waste is sometimes resorted to in order to reduce the volume of waste although there is no recovery of any form of energy. Due to mountainous terrain it is difficult to locate flat land for development of landfill sites, which is now posing a tremendous pressure on the city corporations.

Response

Existing response

Today it is clearly recognised that pollution can seriously impede development processes because they are linked to human health and productivity.

- The Bhutan Government, with donor support, has been establishing urban-based, water-related projects, including water and sanitation, sewerage, flood control works and solid waste collection
- In order to tackle the problem of waste disposal, the authorities have identified a landfill site in Phuntsholing similar that in Thimphu and it is expected that this site will get developed shortly. Government has also identified landfill sites for 10 other urban centres.
- The Ministry of Communication has plans to work in the urban sector to offset the negative environmental impacts of urbanisation. Other stakeholders in relation to urban issues are the local city corporations, the dzongkhag authorities, and the local residents
- The National Environment Commission and the Ministry of Trade and Industry are working toward setting environmental standards, monitoring industrial activities, supporting cleaner technology programs and using economic incentives for environmental management (NEC 1998a)
- Use of plastic bags has been banned

Policy gaps

- Extensive review of the existing policies as the EA Act 2000, Water and Sanitation Rules 1995 is not in practice and there exists a lack of strict enforcement of these
- Required emphasis is not being given to the critical issues of environmental awareness and education
- Currently there are no separate rules for solid waste management in Bhutan, they exist as a part of the Water and Sanitation

Rules only, which briefly discusses the broad guidelines for collection, transportation, and disposal of solid waste from different sectors including health care and industrial waste (MoC 1995)

- The existing framework of legislation fails to clearly substantiate the different categories of biomedical and hazardous industrial waste
- The existing policies on urban development do not address specifically the problem of non-availability of land for the provision of landfill sites.

Knowledge/information/data

- Data for different categories of waste generation, quantity collected and disposed etc. do not exist
- For the country to undertake efficient management of municipal waste, development of an environmental database system is imperative
- To develop and establish a mechanism through which reliable data are collected and stored for various environmental parameters by concerned divisions
- Further data on waste composition is also not available at micro and macro levels, which could give an indication of the potential for composting and recycling.

Policy recommendations

In order to have a satisfactory, efficient, and a sustainable system of solid waste management, proper planning, implementation, and management systems must be incorporated in framing a national policy. Present and future ways to manage solid waste stream need consideration of the following aspects:

Minimisation of waste generation

- To reduce waste problems in future, reduction in waste generation would be the most important factor. Examples of possible reduction at the consumption level include reuse of containers (including bags), better

buying habits, and cutting down on the use of disposable products and packaging. The community needs to be sensitised to such initiatives

- It is important to have separated solid waste management rules and more specific guidelines, which would promote the reduction of waste at source and efficient management.

Scientific management of municipal waste

In Bhutan in particular, two components of municipal solid waste management need urgent consideration, collection of waste and treatment and its disposal.

Collection of waste

- One immediate measure to revamp the existing collection service structure is to provide community waste bins conveniently placed for the people to deposit domestic waste. As a first step, this will ensure that people do not throw their garbage on the roads and hence do not create open dumpsites
- The second measure should entail separation of waste at source into biodegradable and non-biodegradable components. This would be a long-drawn exercise as it involves attitudinal changes and will have to be done with careful planning, in a phased manner
- For primary collection, door-to-door collection is regarded as the best option all over the world. The active involvement of private entrepreneurs and NGOs with municipal corporation in this area of collection and recycling of waste along with conversion of organic waste into useful compost on a smaller scale at the neighborhood level would be economically feasible options
- Infectious and hazardous waste from health care facilities should be carried strictly in covered vehicles. Hospital waste of some categories, e.g. biomedical waste consisting of human parts, body fluids,

etc., has to be incinerated but for other categories of waste, methods like micro-waving and autoclaving can also be considered.

Treatment and disposal.

- Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightaway transported to recycling units, which, in turn, would pay the corporations for it, thereby adding to their income. This would help in formalising the informal set-up of recycling units, saving valuable raw material resources of country. There should be provision for incentives to promote recycling.
- The biodegradable matter should be disposed off either by employing technologies such as aerobic composting, and anaerobic digestion or by sanitary landfilling. Depending upon land availability and financial resources, either of these methods could be adopted. However, development of landfill sites would not be an easy alternative considering the topography of the country therefore the thrust should be on reduction of waste, segregation and recycling
- Common treatment and disposal site for municipal solid waste, hazardous waste and hospital waste could be considered as one option taking into account the following factors:
 - Generation of very low quantities of hazardous waste and hospital waste
 - Availability of limited land resources and the topography of the region
 - Small geographical spread of the country would not impose much pressure on the collection and transportation of solid waste from different centres to the common treatment and disposal site.

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Part IV

Conclusions

Bhutan has witnessed remarkable progress in human development as well as industrial development during the last two decades. Bhutan ranks among the top ten countries with the highest species density in the world, and it has the highest fraction of land in protected areas and the highest proportion of forest cover of any Asian country. The country is also endowed with a large hydropower potential, which needs to be exploited to provide impetus to development. Agriculture and forestry are the source of livelihood for 90% of the population. Most rural Bhutanese households rely upon an integrated system of crops, livestock and small-scale forest management. This close relationship between the three sectors is essential to ensure sustainable production. A greater thrust to industrial development is pertinent to meet the growing cost of social and basic infrastructure and to generate employment opportunities. Proper planning integrating environmental issues, policy and technological interventions, and institutional mechanisms are essential prerequisites to ensure environmentally sustainable industrial development in Bhutan.

This chapter includes the emerging issues along with key findings on policy, information and data gaps, and the key recommendations.

Environmental concerns of rural urban migration

Rural-urban migration can be attributed to excessive urbanisation and the growth of cities, as well as employment opportunity in

urban areas. Migration from rural areas is expected to reduce pressure on agricultural land, but impose a severe strain on the already inadequate urban services and pose serious developmental and environmental problems. Some such problems are shortage of safe drinking water and electricity, inadequate hygiene, lack of sewage facilities, unemployment, and the proliferation of slums and squatter settlements. The government has expressed concern at the effect of rural-urban migration on the structure and environment of the larger towns.

Gaps in policy, information, knowledge, and monitoring

- Urban development in Bhutan is the responsibility of the Urban Planning Unit within the Public Works Division of the Ministry of Communications. While surveys and action plans have been undertaken for several towns, no action has been initiated, primarily due to financial constraints. There is also a lack of municipal legislation for effective implementation of plans and policies.
- A detailed housing policy is lacking which would lay down the norms for housing structures and discuss how the private and public sector could collaborate in this activity.
- There are no firm statistics on the current urban population. This is essential for designing appropriate infrastructure programmes and investment plans
- Urban development plans are largely confined to physical plans drawn without the benefit of accurate topographical maps and up-to-date cadastral mapping and land registration systems

- Demographic data is inadequate – in terms of patterns of migration, gender bias (in education, health and employment)
- All information on demography and infrastructure is typically available only at the national level. There is a need for monitoring and information collation at the dzongkhag and geog level.
- A detailed household census – once in 10 years – needs to be carried out. This would need to cover all details such as expenditure, income, energy use, access to social and other infrastructure etc.
- There is a need to study future housing needs in each dzongkhag.

Recommendations

- Provide better, integrated service delivery to the rural communities in the health, welfare, agricultural extension, and education sectors through a process of departmental co-ordination
- Focus on enhancing income and employment generation from the forestry sector through well-drawn up plans that could encourage export of forestry products
- Develop small and medium sized cottage industries (such as weaving)
- Develop roads and other communication networks for remote areas on priority basis to connect these areas with the rest of the country
- For Thimphu and Phuntsholing, increase the capacity of infrastructure namely, roads, telecommunications, power, water sewage, health centres, schools, and centres of higher education for future needs
- Develop and implement housing schemes that provide low-cost and weather-proof housing for all
- Develop more urban centres to take migratory pressure off Thimphu and Phuntsholing. Development can be done at urban centres from where people are migrating into Thimphu and Phuntsholing. Centres should be located

close to large farm lands so that these can be developed as key national and international sourcing centres for farm and forestry products, evolve policies that encourage setting up of environment-friendly and labour-intensive agro-industries in these towns by making available subsidised inputs including credit and developing some of these centres as tourist centres with cultural tourism, eco-tourism and adventure/sports tourism

Land degradation

Land degradation in Bhutan can be attributed to loss of vegetation due to deforestation, over cutting beyond silviculturally permissible limits, unsustainable fuel wood extraction, shifting cultivation, encroachment into forest land, forest fires, over grazing, non-adoption of adequate soil conservation measures and improper crops. At present, land use changes are minimal, but forest degradation is expected to increase every year. Loss of vegetation due to pressure on forests, is one of the principal causes of land degradation. Shifting cultivation is another important cause for forest-land degradation.

Gaps in policy and information

- There is a need to have a well-defined land use policy. One of the prime reasons for large-scale land degradation is putting land to use for which it is not suitable or capable.
- An inter sectoral linkage between departments such as forest, animal husbandry, rural development, and agriculture is required to decide policies, strategies and practices for controlling land degradation
- Land use planning needs to be at the national, as well as, regional and local levels and to encompass watershed, the village and the farm. It should involve the

farmers as well as the policy and decision-makers in the planning process.

- A systematic registration and evaluation of the present land use and land users is a prerequisite for preparing proper land use planning and to check land degradation
- A correct assessment of the land related deficiencies using sound criteria and indicators and geo-referenced techniques is a prerequisite for effective implementation of reclamation/rehabilitation strategies for the already degraded lands. This can be achieved by adoption of international systems such as Soil and Terrain Database (SOTER) and Global Assessment of Soil Degradation (GLASOD)
- There is a need to define the threshold values for various fertilisers to promote a balance with use of organic manure, chemical fertilisers, bio-fertilizers and agrochemicals to ensure sustainability and increased production
- Although deforestation is well recognised, as one of the potent causes of land degradation, its exact nature and extent needs to be inventoried and analysed

Recommendations

- Adoption of land use according to the land capability classes, to the extent possible, will ensure that land is put under right kind of use. One of the ways of achieving this would be to develop land capability classes based on the pattern of US Department of Agriculture and modified through research and available technology to suit the national conditions.
- The agricultural extension system needs to be made more efficient and far-reaching, and the lab-to land concept needs to be translated into practice by providing multidisciplinary technical information, viable land use options and alternatives identified for various agro-ecological and socio-economic units to the land users.

- Shifting cultivation is contributing to land degradation significantly. A strategy to discourage the practice in a phased manner needs to be developed and people engaged need to be provided alternative occupation.
- A natural watershed would present an ideal unit for most effective management of land. This would influence land use positively, protecting land against all forms of degradation. However, this should enlist people's participation at all stages of development.

Air pollution

Air pollution in Bhutan is a recent phenomenon and it can be attributed to rapid urbanisation and industrialisation. Bhukharis and diesel vehicles are the major sources of air pollution. Other sources are operations in mines and industrial activities. The air quality in Thimpu has been deteriorating over time. The problem of emission is aggravated by the poor quality of fuel available in Bhutan.

Gaps in policy, knowledge, and information

- There are no permissible standards for vehicular emission and no policy to ensure quality of fuels
- There are no emission standards for industries and no guidelines for control of pollution for industries
- There are no ambient air quality standards for different pollutants
- There is no separate sector-wise policy, e.g. transport policy, industrial policy, etc.
- There is no policy/strategy to mitigate air pollution in urban centres.
- There are no siting guidelines for setting up of industries
- Data must be generated on primary and secondary pollutants to assess the ambient air quality
- Estimation of pollution loads from different sources including industries, vehicular and domestic sectors

- Assessment of pollution characteristics from vehicular source
- Assessment of impacts of pollutants on human health and the environment

Recommendations

- Expand public transport services within the city areas.
- Discourage purchase of diesel vehicles.
- Encourage use of catalytic converters for petrol engine vehicles.
- Use of four stroke two-wheelers and banning of two stroke engines.
- Import of better quality diesel and unleaded petrol.
- The Government of Bhutan should take initiatives to follow stringent norms such as the Euro norms.
- Develop industry specific emission guidelines
- Promote cleaner technologies for the industries
- Develop industry specific pollution control guidelines
- Enforce monitoring and data reporting for industries
- Provide incentives to adopt cleaner technologies
- Create industrial estates and infrastructure to minimise effects of pollution on human health and environment
- The Government of Bhutan should take initiatives to develop ambient air quality standards for industrial areas.
- Environmental Impact Assessment (EIA) should be applied to lay the foundation of environmentally sound projects.
- Government should stop bukharis in cities and promote energy efficient electrical appliances for heating and cooking purposes. More emphasis should be given to providing electricity connections and make available cheap electricity in the rural areas to gradually replace bukharis.

Water pollution

Although freshwater is in abundance in Bhutan, rapid urbanisation and industrialisation are bound to increase the pressure on the resource. The water quality is reasonably good as no polluting industries are located upstream. Solid waste and waste water discharge from cities and industries may lead to deterioration of surface water quality in the near future.

Gaps in policy, knowledge, information, and data

- A national water resource management master plan does not exist
- Proper base line information is not available for drinking water quality, and effluent discharge.
- No adequate surveillance systems and database available for drinking water sources and supply schemes
- No industry specific standards related to water consumption and effluent discharges

Recommendations

- High priority needs to be given to the formulation of a national water resource management master plan
- The drinking water quality standards should be developed only after generating requisite baseline information on the quality of existing sources and treatment capabilities.
- Proper surveillance systems for drinking water sources and supply schemes need to be in place and supported by necessary legislation. This should initially be comprehensive in nature so as to include aspects related to the nature of source, type of treatment process, distribution network and other local conditions.
- The ambient environment quality and effluent standards should also be developed only after generating some baseline information on the carrying capacities of different regions and sources.

- Industry specific standards related to water consumption per unit of product and discharge to be developed for select resource-intensive and highly polluting industries
- The multi-sectoral nature of water resources development in the context of socio-economic development must be recognised, as well as the multi-interest utilisation of water resources for water supply and sanitation, agriculture, industry, urban development, hydropower generation, inland fisheries, transportation and recreation
- Special attention needs to be given to the growing effects of urbanisation on water demands and usage and to the critical role played by local and municipal authorities in managing the supply, use and overall treatment of water for which special support is needed.
- A large number of urban agglomerations do not have municipal/industrial wastewater treatment facilities, which might cause deterioration of river water quality. The introduction of clean technologies and the construction of sewage/effluent treatment plants can bring in significant improvement
- The holistic management of freshwater as vulnerable resource with economic dimensions and the integration of sectoral water plans and programmes within the framework of national economic and social policy are of paramount importance for action in Bhutan
- Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance
- Enhance knowledge, understanding and awareness of issues related to water management and state of Bhutan's rivers

Solid waste management

Waste disposal is an emerging problem in almost all the urban towns in Bhutan although not a major issue at this juncture. While the magnitude of the problem is relatively small and manageable in rural areas, it appears to be growing significantly in urban areas in recent times. Waste disposal is an emerging problem in Thimphu where the solid waste is disposed off at the sanitary landfill site, currently the only one site in Bhutan. The municipal waste in other urban areas is disposed off either in rivers/streams, valleys or in low-lying areas. With the dumping of waste being uncontrolled at the moment, there is every possibility that such activity could be contributing to fresh water pollution although to a lesser degree.

Gaps in policy, knowledge, information, and data

- Currently there are no separate rules for solid waste management in Bhutan, they exist as a part of the Water and Sanitation Rules only, which briefly discusses the broad guidelines for collection, transportation, and disposal of solid waste from different sectors including health care and industrial waste
- Extensive review of the existing policies as the EA Act 2000, Water and Sanitation Rules 1995 is not in practice and these are not strictly enforced
- Required emphasis is not being given to the critical issues of environmental awareness and education
- The existing framework of legislation fails to clearly substantiate the different categories of biomedical and hazardous industrial waste
- The existing policies on urban development do not address specifically the problem of non-availability of land for the provision of landfill sites.

- Data for different categories of waste generation, quantity collected and disposed etc, do not exist
- For the country to undertake efficient management of municipal waste, development of an environmental database system is imperative
- To develop and establish a mechanism through which reliable data are collected and stored for various environmental parameters by concerned divisions
- Further data on waste composition is also not available at micro and macro levels, which could give an indication of the potential for composting and recycling.

Recommendations

- It is important to have separated solid waste management rules and more specific guidelines, which would promote reduction of waste at source and efficient management.
- To reduce waste problems in future, reduction in waste generation would be an important factor. Examples of possible reduction at the consumption level include reuse of containers (including bags), better buying habits, and cutting down on the use of disposable products and packaging. The community needs to be sensitised to such initiatives
- In Bhutan in particular, two components of municipal solid waste management need urgent consideration, collection of waste and treatment and its disposal.

Collection of waste

- One immediate measure to revamp the existing collection service structure is to provide community waste bins conveniently placed for the people to deposit domestic waste. As a first step, this will ensure that people do not throw their garbage on the roads and hence do not create open dumpsites

- The second measure should entail separation of waste at source into biodegradable and non-biodegradable components. This would be a long-drawn exercise as it involves attitudinal changes and will have to be done with careful planning, in a phased manner
- For primary collection, door-to-door collection is regarded as the best option all over the world. The active involvement of private entrepreneurs and NGOs with municipal corporation in this area of collection and recycling of waste along with conversion of organic waste into useful compost on a smaller scale at the neighborhood level would be economically feasible options
- Infectious and hazardous waste from health care facilities should be carried strictly in covered vehicles. Hospital waste of some categories, e.g. biomedical waste consisting of human parts, body fluids, etc., has to be incinerated but for other categories of waste, methods like microwaving and autoclaving can also be considered.

Treatment and disposal

- Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightaway transported to recycling units, which, in turn, would pay the corporations for it, thereby adding to their income. This would help in formalising the informal set-up of recycling units, saving the valuable raw material resources of country
- The biodegradable matter should be disposed off either by employing technologies as aerobic composting and anaerobic digestion or by sanitary landfilling. Depending upon land availability and financial resources, either of these methods could be adopted. However, development of landfill sites would not be an easy

alternative considering on the topography of the country therefore the thrust should be on reduction of waste, segregation and recycling

- Common treatment and disposal site for municipal solid waste, hazardous waste and hospital waste could be considered as one option taking into account the generation of very low quantities of hazardous waste and hospital waste and availability of limited land resources and the topography of the region

Part V

Annexes



Acronyms and abbreviations

Acronyms	Abbreviations	Acronyms	Abbreviations
ABTO	Association of Bhutanese Tour Operators	LPG	Liquefied Petroleum Gas
ADB	Asian Development Bank	LUSS	Land-Use Statistical Section
BCCI	Bhutan Chamber of Commerce and Industry	MoA	Ministry of Agriculture
BHUs	Basic Health Units	MoC	Ministry of Communications
BIS	Bureau of Indian Standards	MoHE	Ministry of Health and Education
CBR	Crude Birth Rate	MoP	Ministry of Planning
CDR	Crude Death Rate	MoSS	Ministry of Social Services
CGI	Corrugated Galvanized Iron	MoTI	Ministry of Trade and Industry
CO	Carbon monoxide	MW	Mega Watt
CO ₂	Carbon dioxide	NCS	Nature Conservation Section
CPR	Contraceptive Prevalence Rate	NEC	National Environment Commission
CSO	Central Statistical Organization	NES	National Environment Strategy
DANIDA	Danish International Development Assistance	NO _x	Nitrogen dioxide
DoP	Department of Power	Nu.	Ngultum – Bhutan's currency
DoT	Department of Tourism	PPP	Purchasing Power Parity
DYT	Dzongkhag Yargey Tshogchung	PWD	Public Works Division
EIA	Environmental Impact Assessment	RGoB	Royal Government of Bhutan
ESCAP	Economic and Social Commission for Asia and the Pacific	RNR	Renewable Natural Resource
ESPS	Environment Sector Programme Support	RSPN	Royal Society for the Protection of Nature
FYP	Five Year Plan	SEA	Strategic Environmental Assessment
GDP	Gross Domestic Product	SO ₂	Sulphur dioxide
GLASOD	Global Assessment of Soil Degradation	SOTER	Soil and Terrain database
GYT	Geog Yargey Tshogchung	SPM	Suspended Particulate Matter
HC	Hydrocarbon	TAB	Tourism Authority of Bhutan
H.M.	His Majesty	TCC	Thimphu City Corporation
IMR	Infant Mortality Rate	TDP	Tonne Per Day
IPM	Integrated Pest Management	TFR	Total Fertility Rate
KPA	Kurichu Project Authority	THPA	Tala Hydroelectric Project Authority
kWh	Kilo Watt Hour	UNICEF	United Nations Children's Fund
		USPS	Urban Sector Programme Support Secretariat
		WHO	World Health Organization
		WRI	World Resources Institute



Components of the National SoE

Part I	Executive summary
Part II	Overview ■ Human development ■ Energy sector ■ Industrial development ■ Agriculture ■ Tourism ■ Biodiversity ■ Institutional mechanism and environmental policy
Part III	Priority issues ■ Environmental concerns of rural urban migration ■ Land degradation ■ Air pollution ■ Water resource and pollution ■ Solid waste management
Part IV	Conclusions ■ Policy / knowledge / information gaps ■ Policy recommendations
Part V	Annexes



List of participants of the National SoE training



Wangdue, Bhutan
3 - 6 August 1999

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IV

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- Industrial development
- Institutional mechanism and environmental policy
- Conclusions and recommendations

- Human development
- Environmental concerns of rural urban migration

- Energy sector
- Tourism

- Agriculture
- Land degradation

- Biodiversity

- Air pollution

- Management of fresh waters

- Solid waste management

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