HIS MAJESTY'S GOVERNMENT OF NEPAL
MINISTRY OF WATER RESOURCES
DEPARTMENT OF HYDROLOGY AND METEOROLOGY

THE STUDY ON
NATIONWIDE HYDRO-METEOROLOGICAL
DATA MANAGEMENT PROJECT

FINAL REPORT

ANNEXES

August 1993

JAPAN INTERNATIONAL COOPERATION AGENCY

TOKYO, JAPAN
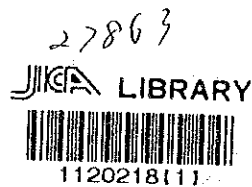
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The cost estimate was based on February 1993 price level and expressed in NRs. according to the exchange rate of US$1.00 = Nepali Rupees 46.4315 = Japanese Yen 121.05 as of February 15, 1993.

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1. SOCIO-ECONOMIC BACKGROUND

1.1 National Background

1.1.1 General

Nepal extends from 26°22' to 30°27' north latitude and from 80°4' to 88°12' east longitude. It is bordered by China to the north and by India to the south, east and west, and has an area of 147,181 km^2, comprising the agricultural land of 24,637 km^2, forest of 63,065 km^2 and the other of 59,479 km^2.

Ecologically the country is broadly classified into three regions; the Mountain, the Hill and the Terai (Plains). Administratively, the country is divided into 14 zones and 75 districts, and it is regrouped into 5 development regions to promote an all-round development of the country. In addition to the said administrative organizations, now there are 4,015 village development committees and 33 municipalities, as the smallest local administrative units.

Population of Nepal amounts to about 18.5 million according to the 1991 Population Census, and in 2000 it is expected to reach more than 22 million. In 1991, more than 90 percent of the total population lived in rural areas, and most of them were not yet getting the minimum physical facilities which would be necessity for human being.

Nepal is a traditional agricultural country. About 90 percent of the economically active population has engaged in the agricultural and agro-industrial sectors which have a share of 50 percent or more to the Gross Domestic Product (GDP). In the fiscal year 1991/92, the GDP amounted to nearly US$ 3,000 million, whereas the per capita GDP was only US$ 165 which was among the least GDP in the World, because of lack of resources and industries with the high value added.

In the foreign trade of Nepal which is lack of the economically important resources and industries, imports have exceeded exports every year, and such a trade deficit has made the main cause of imbalance of international payments. As a result, the majority of current account deficit in the international payments have been compensated by the capital account which includes external loans and grants.

The Government expenditures also exceeded the revenues every year, ranging from NRs. 4,000 million to NRs. 12,000 million for the period 1985/86-1991/92, and such a financing deficit was made up by external and internal loans.

The economic and financial imbalance of Nepal will continue for the time being, though it is gradually being improved under execution and formulation of a positive development plan. In connection with this matter, it is expected that the Eighth development Plan for the period 1992-1997 is completely implemented.

1.1.2 Gross Domestic Product

In the fiscal year 1991/92, Gross Domestic Product (GDP) of Nepal amounted to NRs. 129,975 million at current prices, with an average annual growth rate of 17.01 % since the fiscal year 1986/87, and its real annual growth was 4.44 % on average. On the other hand, the per capita GDP was estimated to be NRs. 7,040 at current prices in the same year, and the average annual growth rate for the period 1986/87-1991/92 showed 14.75 % at current prices and 2.42 % for the real growth (See Table 1.1.1).

Among industrial sectors, the agricultural sector has always dominated share in the GDP, for example, its share in 1989/90 was 53.4 %. Following the agricultural sector, each sector of community & social services, financial & real estate, and construction was the rate of 7.8 %, 7.6 % and 7.2 % to the total amount of GDP (See Table 1.1.2). While, manufacturing industrial sector with a relatively high value added was only the contribution of 4.9 % in the same year. This fact would be regarded as a cause of the low economic growth of Nepal.

1.1.3 External Trade

According to external trade statistics of Nepal, the total exports and imports in 1990/91 amounted to NRs. 7,604 million and NRs. 24,198 million respectively, indicating the trade deficit of NRs. 16,594 million. An average annual growth rate for the period 1985/86-1990/91 was 19.83 % for the exports and 20.97 % for the imports. It is noticed that the average annual increase rate of imports always was higher than that of exports during the same period as shown in Table 1.1.3.

The export of Nepal was represented by three commodities; manufactured goods (classified chiefly by materials), miscellaneous manufactured articles, and food and live-animals, which accounted for about 90 % of the total exports in 1990/91. Regarding the imports in the same year, manufactured goods(classified chiefly by materials) and machinery (including transport equipment) held first and second places, i.e. respective shares were 26 % and 25 % of the total imports (See Tables 1.1.4 and 1.1.5).

1.1.4 Balance of International Payments

Balance of international payments of Nepal has been in an unfavourable situation in most of years since 1980/81, i.e. the current account balance has always indicated negative due to the huge amount of trade balance deficit. In 1990/91 the unfavourable balance of payments amounted to NRs. 10,255 million which was the highest negative figure in the past, though the capital account including foreign loans played the dominant role for the balance of international payments (See Table 1.1.6).

1.1.5 Government Finance

In the fiscal year 1990/91, the Government finance of Nepal amounted to NRs. 26,641 million for expenditures and NRs. 16,895 million for receipts, at the average annual rise rates of 18.27 % and 17.22 % respectively for the period 1986/87-1991/92. The total expenditure was composed of the regular expenditure of NRs. 9,746 million (37 %) and the development expenditure of NRs. 16,895 million (63 %), and economic and social services' sectors in the development expenditure accounted for 99 % of the total development expenditure. On the other hand, the Government receipts consisted of the revenue of NRs. 12,557 million and the foreign grants of NRs. 3,511 million (See Tables 1.1.7 and 1.1.8).

In the fiscal year 1989/90, the Government revenue amounted to NRs. 9,289 million, consisting of the tax revenue of NRs.7,285 million and the non-tax revenue of NRs. 2,004 million. To meet the increasing regular and development expenditures, the Government has made various efforts in terms of the increase in tax revenue and the creation of new sources in non-tax revenue. Actually, the tax revenue increased at an average annual rate of 18.25 % during the period 1984/85-1989/90. In addition, a civil administration, as a part of the non-tax revenue, started in 1984 to provide a significant amount for the revenue and stood at forth position in the 1989/90 revenue structure, i.e. NRs. 1,068 million (See Table 1.1.9).

Despite the effort of the Government, overall budgetary position of the Government shows that the expenditure exceeded the revenue every year. For example, in the fiscal year 1991/92, the revenue was NRs. 12,557 million against the expenditure of NRs. 26,641 million, i.e. the revenue was able to meet only the regular expenditure and a part of the development expenditure. The rest of development expenditure was covered by foreign grants and internal and foreign loans (Table 1.1.7).

In the fiscal year 1991/92, the foreign aid amounted to NRs. 11,829 million, of which the grant was NRs. 3,511 million and the loan was NRs. 8,317 million. The average annual increase rate for the period 1986/87-1991/92 showed 28.97 % for the total amount of aid, 29.81 % for the grant and 28.63 % for the loan (See Table 1.1.10). Such a large increase in amount of the foreign aid will be continued for the time being.

1.1.6 Prices

In the present study, urban consumer prices are discussed about only figures in the Kathmandu District on behalf of other urban areas in the country, because that the prices in the Kathmandu urban area will play the most significant role for cost estimates of the project and that there is not so much difference among Kathmandu and other urban areas concerning a trend of rise in the prices.

Table 1.1.11 shows urban consumer price index in Kathmandu for the period 1984/85-1990/91. During this period, the overall prices rose at the average annual rate of 10.22 % which was composed of the rise rate of 10.56 % for food and beverages and the annual rate of 9.69 % for non-food and services. Especially, in the food and beverages sectors, the prices of restaurant meals, oil, clarified butter, meat, fish and eggs showed the annual rate of 14 % or more.

1.2 Regional Background

1.2.1 Population

According to the 1991 population census, the population of Nepal amounted to 18,462,081, consisting of 4,448,374 in the Eastern Development Region, 6,174,237 in the Central Development Region, 3,751,922 in the Western Development Region, 2,406,095 in the Mid-Western Development Region and 1,681,453 in the Far-Western Development Region. The average annual growth rate of population in Nepal and the said five Regions showed 2.08 %, 1.83 %, 2.32 %, 1.83 %, 2.09 % and 2.45 % respectively, for the period 1981-1991 (See Table 1.2.1). It is expected that Nepal will has a population of about 22 million in the year 2000, assuming that the average annual growth rate for the period 1981-1991 will be held until 2000.

In 1991, the population density (persons/km^2) of Nepal and the said five Regions was 125, 156, 225, 128, 57 and 86, and the average size of household (persons/household) was 5.52, 5.39, 5.50, 5.42, 5.77 and 5.85, respectively. Relatively, the Central and Eastern Development Regions have the high population density and the low household

size, and to the contrary the Far-Western and Mid-Western Development Regions were the low population density and the high household size. This matter may indicate that the latter two Regions are backward relatively in development (Table 1.2.1).

1.2.2 Agriculture

In 1981, more than 90 % of the economically active population engaged in the agricultural and agro-industrial sectors, and agricultural land was 24,637 km^2 (17 % of the whole area of Nepal), of which the crop land accounted for about 90 % for all of the five Regions, but the permanent crop land was only 1 % (See Tables 1.2.2 and 1.2.3).

Table 1.2.4 provides the production situation of principal food crops in 1989/90. Among them, Paddy was produced about 3,389 thousand tons in Nepal, comprising 1,118 thousand tons (33 %) in the Central Region, 1,037 thousand tons (31 %) in the Eastern Region, 643 thousand tons (19 %) in the Western Region, 316 thousand tons (9 %) in the Mid-Western Region and 275 thousand tons (8 %) in the Far-Western Region. The total production of paddy in both Central and Eastern Regions accounted for 64 % of that of the country as a whole. However its yield was very low figures, ranging from 2.2 tons/ha to 2.6 tons/ha on average for the whole Region.

Among other principal crops, wheat and maize showed the relatively high production in both Central and Western Regions, and the most production areas of millet and barley were the Western Region and the Mid-Western Region, respectively.

The agricultural products will be characterized by three Ecological Regions; Terai (Plains), Hill and Mountain, rather than the said five Development Regions. In Nepal, the Terai Region is the most agricultural production belt where produces various tropical and subtropical products, not only paddy and maize. The Hill Region has a potentiality for horticultural development, and the Mountain Region is a suitable area for livestock farming. Equitable and suitable development by region is expected for agricultural sector.

1.2.3 Industries

(A) Manufacturing Industry

Table 1.2.5 indicates production of major manufacturing industrial products with the weight of 5 % or more in the gross output of Nepal. During the period 1984/85-1989/90, productions of sugar, liquor, shoes, beer, cement and synthetic textiles were remarkably increased at an average annual rate of 20 % or more. The increased production of them contributed to a great extent for improving the living conditions of people.

Whereas, the traditional industrial goods such as jute goods, stainless steel utensils, cotton textiles and plywood were considerably decreasing their productions, particularly the decreased production of jute goods which have accounted for a share of over 20 % in the gross output was causing an unfavorable influence on the industrial growth of Nepal.

According to industrial statistics of Nepal, number of establishments with employees of 10 or more in 1988/89 amounted to 2,334 on the increase by about 13.6 % against 2,054 in 1986/87, and the employees showed 144,498 persons in 1988/89 (See Table 1.2.6).

The Central Development Region occupies the topmost position in either number of establishments and employees in almost all of industrial categories. For example, in 1988/89 the Central Development Region had 1,130 establishments (48 %) and 85,425 employees (59 %). To the contrary, the Far-Western Development Region was the lowest position with 140 establishments and 4,615 employees.

In Nepal, a reduction in differentials among Regions regarding the distribution of manufacturing establishments would be one of the most significant things from viewpoint of equitable development in the country and increase in employment opportunity in the Far-Western and Mid-Western Regions.

(B) Tourism Industry

Nepal is one of the most attractive countries in the world for tourists, because of having beautiful natural resources such as snow peaks, green forest and lakes. In addition to the natural resources, historical monuments and variety of religions and cultures of ethnic groups also are the important tourism resources of Nepal.

According to tourism statistics of Nepal, number of arrivals for the tourism from abroad amounted to 254,885 in 1990 on the increase at an average rate of 7.09 % per annum since 1985. Approximately 80 % of the arrivals was occupied by tourists for pleasure and trekking purposes. In 1990, the gross foreign exchange earnings from the tourism sector amounted to US$ 57 million at an average annual growth rate of 7.9 % since 1985 (See Table 1.2.7).

Table 1.2.8 shows hotel industrial statistics of Nepal. The total number of rooms (beds) of hotels in Nepal was 27,145 (53,234) in 1988, consisting of 23,937 (46,911) in the Kathmandu Valley and 3,208 (6,323) in other areas, i.e. the Kathmandu Valley occupied 88 % of the total number of hotel's room (bed). During the period 1983-1988, the number

of rooms (beds) increased at an average annual rate of about 3 % in the Kathmandu Valley, while the number in other areas was decreasing at an average rate of about 6 % per annum. A preparedness of hotel accommodations in other areas than the Kathmandu Valley will be more necessary for promoting development of the tourism industry.

1.2.4 Transport and Communications Facilities

(A) Transport

The inland transportation in Nepal depends mainly on roads. However, topography of Nepal is under very unfavorable conditions for road transportation. A part of the transportation is supplemented by air-crafts,railways and ropeways.

In 1990, the total length of roads in Nepal was 7,330 km, consisting of 1,789 km (24 %) in the Eastern Dev. Region, 2,715 km (37%) in the Central Dev. Region, 1,431 km (20 %) in the Western Dev. Region, 826 km (11 %) in the Mid-Western Dev. Region and 569 km (8 %) in the Far-Western Dev. Region (See Table 1.2.9).

During the period 1985-1990, the road length of Nepal increased at an average rate of 4 % per annum, however the increase rate of black top roads was only 2 % per annum. Ratio of the paved road to the total road length was 34 %, 49 %, 50 %, 28 %, and 12 % for each region from east to west, and the average ratio was 40 %. Relatively, the Central Development Region dominates road facilities, and the Far-Western Development Region occupies the lowest position.

(B) Communications

Communication systems are very important for Nepal where road transport is not adequate, and so a special attention of the Government has been given to the development of this sector. The major communication mediums of Nepal are telecommunication and postal services. Number of these facilitiesin 1990 is as follows:

<u>Number of Major Communications Medium in 1990</u>

Telephone Exchanges	Public Call Offices	Wireless Stations	Post Offices
42	76	55	2,232

Figures above are very little for a population size amounting to about 18 million in 1990. Moreover there are not telephone exchange in the Dhawalagiri Zone in the Western Development Region, and not only telephone exchange but also public call office in the Karnali Zone in the Mid-Western Development Region.

1.2.5 Public Services on Water Resources

Nepal ranks second in the world on water resource potentiality, first being Brazil. A part of water is preserved as groundwater, and other part appears as surface water in rivers which amount to six thousand in number. The total length of rivers reaches about 45 thousand km at an average river density of about 0.3 km per sq.km., and the annual surface run off of all rivers amounts to 200,000 m^3 in total. Three rivers of Gandaki, koshi and Karnali are the most important from the water resources point of view. Outlines of Public services on domestic water supply, irrigation and electric power are summarized below:

(A) Domestic Water Supply

Current water supply works of Nepal is mainly conducted by three government agencies; Department of Water Supply and Sewerage (DWSS), Ministry of Local Development (MLD) and Nepal Water Supply Corporation (NWSC). The DWSS is responsible for the water supply to communities with 1,500 population or more (except some areas served by the NWSC), the MLD keeps the control of water supply for villages with the population of below 1,500, and the NWSC is a corporation which conducts the water supply work for 13 towns (or cities) in the country, and it is being operated by an independent profit system.

In 1988/89, the daily quantity of domestic water available by supply facilities is estimated at 31,486 thousand litres which are composed of 6,813 thousand litres in the Eastern Dev. Region, 7,144 thousand litres in the Central Dev. Region, 491 thousand litres in the Western Dev. Region, 12,681 thousand litres in the Mid-Western Dev. Region and 4,357 thousand litres in the Far-Western Dev. Region. The Mid-Western Dev. Region occupied the first position on the quantity of supply water, and the Western Dev. Region ranked the lowest, though the quantity varied remarkably every year (See Table 1.2.10).

In 1989 the population served was 30 % for the country as a whole, 85 % for urban areas and 20 % for rural areas. However, in the Kathmandu District the population served was nearly 100 % for urban areas and 53 % for rural areas.

(B) Irrigation

In Nepal, the irrigation development is one of the most important in the agricultural development. The irrigation facilities of Nepal was started with construction of the Chandra Canal in 1928, for the purpose of providing an irrigation area of 13,000 has. In 1990, the irrigation area amounted to 24,492 has., which was composed of 3,634 has. in the Eastern Dev. Region, 2,822 has. in the Central Dev. Region, 5,878 has. in the Western Dev. Region, 967 has. in the Mid-Western Dev. Region and 2,655 has. in the Far-Western Dev. Region.

However, as shown in Table 1.2.11, these irrigation areas were exceedingly unstable to vary their extents year by year during the period 1985-1990.

(C) Hydro-Electric Power

Development of hydro-electric power (hydel power) of Nepal started with establishment of the Pharping Hydro-Electric Plant having a capacity of 500 KW in 1911. Now the Government has eight big hydel power stations and some micro hydel power stations.

The total installed capacity of all power stations was 293,106 KW in 1991, of which the hydel capacity was 238,273 KW, i.e. nearly 80 % of the total capacity. The regional distribution of capacity indicated 32,692 KW, 160,130 KW, 97,188 KW, 2,034 KW and 1,062 KW for respective Regions from the East to the Far-West (See Table 1.2.12).

In 1989/90, the available electricity production was 699,216 MWH in total (except electric loss of 205,277 MWH), of which the hydro-electricity accounted for more than 99 %. Regional distribution of the production was 2,135 MWH (0.3 %) in the Eastern Dev. Region, 414,513 MWH (59.3 %) in the Central Dev. Region, 281,003 MWH (40.2 %) in the Western Dev. Region, 918 MWH (0.1 %) in the Mid-Western Dev. Region and 647 MWH (0.1 %) in the Far-Western Dev. Region. Besides the said production, approximately 60,000 MWH was imported from India and other countries in the same year.

1.3   National Development Five-Year Plan

1.3.1 The Seventh Plan (1985-1990)

The Seventh National Development Five-Year Plan (1984/85-1989/90) of Nepal finished in 1990. In this section, a comparison is made about both economic growth aspects of plan and actual fact.

Table 1.3.1 provides a difference between both GDPs for plan and actual fact for the Seventh Plan period. Agricultural sector in the GDP achieved a relatively high real growth rate of 4.65 % per annum against the planned annual rate of 3.50 %, while for the non-agricultural sector the real growth was a low average rate of 3.17 % per annum compared with the plan rate of 5.56 % for the same period. As a result, the real growth in overall GDP came to an annual rate of 3.99 % on average which was lower than the plan rate (4.50 %).

Tables 1.3.2 and 1.3.3 give the total consumption, gross national investment and gross domestic savings for the plan and actual fact respectively in the Seventh Plan period. In these tables, the actual data are provided for four years from 1984/85 to 1088/89, because the 1989/90 figures are not published yet at present.

As seen in both tables, the actual expenditures generally indicated a tendency of increase compared with figures in the Seventh Plan. Actual consumption and investment in 1988/89 amounted to NRs. 49,286 million and NRs. 10,343 million respectively which were higher than the planned figures of NRs. 48,168 million and NRs. 9,350 million in 1989/90.

It is noticed that the actual foreign trade balance reached to a high deficit of NRs. 6,504 million in 1988/89 against the planned deficit of NRs. 5,006 million in 1989/90. Such an unfavorable balance was due mainly to the increase in imported goods and services, i.e. the average annual increase rate of imports was 9.3 % for the actual fact and 5.5 % for the planned figure, during the said respective periods.

Although ratio of the total consumption to the GDP was planned to increase somewhat from 89.6 % in 1984/85 to 91.7 % in 1989/90, the actual consumption remarkably increased from 86.0 % in 1984/85 to 92.8 % in 1988/89. Such an increase in consumption was due mainly to a reduction in the domestic savings, i.e. ratio of the planned domestic savings to the GDP were 10.4 % in 1984/85 and 8.3 % in 1989/90, but the actual domestic savings reduced considerably from 14.0 % in 1984/85 to 7.2 % in 1988/89.

In contrast to the said consumption, the total investment to the GDP was planned to decrease its ratio by about 1 % in 1989/90 against 18.8 % in 1984/85, but the actual ratio in 1088/89 came to a decrease of more than 2 % against 22.9 % in 1984/85. Such a change in the ratio of total investment was due chiefly to the change in the ratio of fixed capital formation. The ratio of fixed capital formation, which was planned to be 17.7 % in 1984/85 and 16.7 % in 1989/90, it came actually to 21.1 % in 1984/85 and 15.6 % in 1988/89.

1.3.2 The Eighth Plan (1992-1997)

The Eighth Plan of Nepal is the first plan for the post People's Movement Democratic Nepal. In this Plan, some main points related to the present study are summarized below:

(1) Objectives

Three principal objectives of the Eighth Plan are:

    A.   to achieve sustainable economic growth,

    B.   to alleviate poverty, and

    C.   to reduce regional imbalance.

It is emphasized that increase in production for all sectors and reduction in the rate of population growth are essential to achieve a sustainable economic growth.

With regard to alleviation of poverty, the Eighth Plan aims to implement some special programmes for improving the living condition of people at the poverty level.

In order to reduce the regional imbalances, the Eighth Plan aims at enhancing the economic level of underdeveloped areas and villages through the increased provision of social, economic and market services.

(2) Priorities

Given the limited financial, human and institutional resources of the country, it will not be possible to provide adequate resources to all activities at the same time. Therefore the Eighth Plan gives special priority to the following programmes:

    A.   Intensification and Diversification of Agricultural Sector;

    B.   Energy Development;

    C.   Development of Rural Infrastructure;

    D.   Employment Generation and Human Resource Development;

    E.   Reduction in Population Growth;

    F.   Development of Industrial and Tourism Sectors;

G. Promotion and Diversification of Export;

H. Macro-Economic Stabilization;

I. Administrative Reform; and

J. Monitoring and Evaluation.

(3) Economic Growth

Based on intensive promotion of investment programmes and policies to be adopted in the Eighth Plan, it is expected that the GDP will be increased from NRs. 121,062 millions in 1991/92 to NRs. 155,160 millions in 1996/97, at an average annual growth rate of 5.1 % (Table 1.3.4). Assuming that the average annual growth rate of population will be 2.1 % during the Eighth Plan period, the average real growth in per capita income will result in a rate of 3 % per annum.

As shown in Table 1.3.4, share of agricultural (or non-agricultural) sector to the GDP will be reduced (or increased) from 55.5 % (or 44.5 %) in 1991/92 to 52.7 % (or 47.3 %) in 1996/97. It is expected that electricity, gas and water sectors among the non-agricultural sectors will keep the high average growth rate of 10.8 % per annum during the Plan period, and their share to the GDP will rise from 6.4 % in 1991/92 to 8.5 % in 1996/97.

During the Plan period, it is estimated that the total development outlay will amount to NRs. 113,479 millions at the 1991/92 prices, of which the water resources development outlay will amount to NRs. 35,802 millions (31.5 % share), comprising NRs. 11,966 millions (10.5 % share) for the Irrigation, NRs. 23,719 millions (20.9 % share) for the Electricity and NRs. 117 millions (0.1 % share) for the Hydrology and Meteorology (See Table 1.3.5).

The average annual increase rate of the development outlay is estimated at 15 % for the Irrigation, 32 % for the Electricity and 9 % for the Hydrology and Meteorology for the Plan period.

Table 1.3.6 provides major macro economic indicators formulated in the Eighth Plan. According to the Plan, the budgetary deficit of the Government will be reduced from NRs. 2,058 millions in 1991/92 to NRs. 1,396 millions in 1996/97 at the 1991/92 prices.

Imports will be increased from NRs. 36,219 millions in 1991/92 to NRs. 60,525 millions (at the 1991/92 prices) in 1996/97, and exports will be increased from NRs. 21,757 millions in 1991/92 to NRs. 44,231 millions (at the 1991/92 prices) in 1996/97.

Accordingly, the trade deficit will amount to NRs. 16,294 millions in 1996/97 against NRs. 14,462 millions in 1991/92.

In the international payments, the current account deficit will also be increased from NRs. 11,644 millions in 1991/92 to NRs. 12,369 millions (at the 1991/92 prices) in 1996/97, but its percentage to the GDP will be reduced from 9.6 % in 1991/92 to 8.0 % in 1996/97.

It is expected that the employment opportunity will increase at an average annual rate of 3.1 % during the Plan period, and the employed will amount to 10 millions or more in 1996/97 against 8.7 millions in 1991/92. The consumer prices are expected to rise at an average rate of 9 % per annum.

(4)   Programmes and Implementation on Hydrology and Meteorology

With regard to hydrology and meteorology, matters to be programmed and implemented by the Government during the Eighth Plan period are as follows:

A.   During the Plan period, 50 additional rain gauge stations will be set up, consisting of 5 stations in the Himalayan range, 30 stations in hilly areas and 15 stations in the Terai region. Thus, the total number of the rain gauge stations will reach 150 at the end the Plan period.

B.   Studies on sediments and water quality will be conducted on 20 important rivers.

C.   The ongoing collection of data relating to water discharge measurement and climatic conditions will be continued.

D.   Five additional meteorological stations and ten precipitation observation centres will be established in the Eastern Development Region.

E.   Air pollution measurement centres will be established at five different places in the Kathmandu Valley.

F.   Data on glaciers and snow melt will be collected at hydrological and meteorological stations located across the Himalayan region.

G.   Wind and solar energy study stations will be established at four appropriate locations.

F.   Services of regional offices will be mobilized in processing data collected, instead of the existing practice of processing data at the central level.

G. Necessary improvements will be made in the existing data collection manual in order to ensure quality of data collected.

H. Data processed on weather will be made available to agencies concerned, as and when required.

2. BUDGET EXPENDITURES OF THE DHM AND ITS RELATED AGENCIES

2.1 General

Historical budget expenditures of the DHM and its related agencies together with their organization structures were surveyed by the JICA Study Team, in collaboration with the Counterpart Personnel of Nepal, under the Questionnaire shown in Appendix-1.

Based on answers to the questionnaire, the organization structures including their functions are arranged in Annex F; DATA MANAGEMENT SYSTEM, and the budget expenditures are summarized in the succeeding Section.

2.2 Historical Budget Expenditures

Table 2.2.1 gives historical budget expenditures of the DHM and its related agencies. In the fiscal year 1992/93, the DHM's budget expenditure amounts to NRs. 26,984 thousand, of which the regular expenditure is NRs. 6,304 thousand and the development expenditure is NRs. 20,680 thousand.

During the period 1988/89-1992/93, the average annual growth rate of the DHM's budget expenditure was about 11 % at current prices, which exceeded slightly the average price rise rate of 10 % per annum. The annual budget expenditures of other agencies were being increased at a high average rate of 25 % for the Department of Irrigation and 14 % for the Nepal Electricity Authority, during the period 1987/88-1992/93.

Table 2.2.2 provides the historical development budget expenditures by Division and Region in the DHM. The development expenditures of four Regions, except the Central Region, have been increased at the average annual rate of 10 % or more at current prices, during the period 1987/88-1992/93. To the contrary, the development expenditures of Divisions in the Central Office and the Central Region were a minus growth, during the same period.

2.3 Estimated Future Budgets

In connection with formulating the investment scale of the project, the future budget expenditures of the DHM and the said agencies are estimated by five years for the period from 1995/96 to 2010/11. The budget estimates are made under the following assumptions and conditions:

(1) Based on the estimated growth rate of budget in the Eighth Plan, the average annual growth rate of budgets for the period 1991/92-2010/11 is assumed to be 9 % for the DHM, 15 % for the DOI and 32 % for the NEA.

(2) The annual growth rate of budget for the MOWR and WECS is assumed to be 5 %, which corresponds to the estimated annual growth rate of the GDP in the Eighth Plan.

(3) The price escalation is assumed to be an average annual rate of 9 % for the period 1991/92-2000/01 and 6 % for the period 2001/02-2010/11.

(4) The estimated future budget expenditures are presented at current prices, taking the price escalation into consideration.

Under the assumptions and conditions above, the DHM's budget expenditures at current prices are estimated at NRs. 44 millions in the fiscal year 1995/96, NRs. 101 millions in 2000/01, NRs. 204 millions in 2005/06 and NRs. 410 millions in 2010/11. Breakdown of the budget expenditures of the DHM together with other agencies is given in Table 2.3.1.

Among the budget expenditures of the DHM, the development to the regular will come to 4 : 1 in each year. Breakdown of the estimated development expenditure by Division and Region is estimated every five years for the period 1995/96-2010/11 (See Table 2.3.2).

3. ECONOMIC EVALUATION OF HYDROLOGICAL DATA MANAGEMENT PROJECT

3.1 General

Objectives of the present project are to improve and expand the existing system of the hydro-meteorological observation and data management in the DHM, and the ultimate in these improvement and expansion aims at providing correctly and quickly the hydrological information to various users, who conduct studies of water resources, agriculture, environment, hydraulic power, navigation, flood control and other sectors of national economy.

Many significant studies on the economic value of hydrological services have been made by investigators related to the WMO since 1970, however the quantitative assessment still remains to be difficult.

Among various studies, the following two studies are noted from the viewpoint of the study on socio-economic value of hydrological data:

[A]   J.W. van der Made: Cost-Benefit Considerations for the Design of Hydrometric Networks, WMO-No.733, 311-324, 1990

[B]   J.A.Mawdsley, D.B.Ball & A.J.Adeloye: Evaluating a Streamgauge Network- A Case Study of Data Value for Flood Protection Schemes, WMO-No.733, 325-332, 1990

The Report [A] provides an economic value of hydrological data on the water level gauging stations in the Netherlands, namely, in a case where the water level at any station on the waterway is estimated using water level data of a given gauging station, it indicates that the standard error of the water level estimated will be related to the distance between these two stations, and it will become lesser in proportion to decrease in the distance. This means that a more accurate hydrological information will be obtained from the denser gauging stations. A unit economic loss per unit length standard error was estimated on the basis of local socio-economic conditions which include on-going and expected future projects.

The Report [B] describes about the economic value of hydrological data for the design of flood protection schemes, applying a gauge network in the North East of England to the case study. As a result, the data value for this application was found to be 4 to 5 % of the

construction costs of the schemes. The Report emphasizes that this result is very useful in evaluating or proposing changes to the whole network.

Although these two studies are useful in estimating the economic value of hydrological data, these methods can not be applied to the evaluation of hydrological data in Nepal in their entirety, because they are special case studies under local conditions in Netherlands and England, respectively.

Object of the present study is a nationwide project on hydro-meteorological data management in Nepal. There is no precedent in the world for the economic evaluation of such project. Actually, the method is still in development stage, as discussed in the WMO Report No.717 (Cost-Benefit Assessment Techniques and Users Requirements for Hydrological Data, 1990), and the WMO Report No.733 (Economic and Social Benefits of Meteorological and Hydrological Services, Proceedings of the Technical Conference, Geneva, 26-30 March 1990).

In the present study, the economic benefit of the project is evaluated as an economic effect which will be produced by raising an accuracy of hydrological data. A more accurate hydrological data will be brought from increase in number of the hydrological stations which are supported by the rational data management system. The accuracy of hydrological data is discussed on the basis of the error theory for the measurement and calculation data in Section 3.2.

Paragraph 3.2.1 describes about the standard error of discharge estimated at any station on the water way, using the given hydrometric data at the discharge gauging station. It is expected that this standard error would be given as a function of the distance between these two stations.

Paragraph 3.2.2 provides a concept about two standard errors of the average rainfall in the river basin and the average discharge estimated using the average rainfall. It is expected that these two standard errors would be given as a function of the number of rain gauging stations in the basin.

Section 3.3 states about the economic value of hydrological data to be used to on-going and expected future projects on water resources in the basin concerned, and as a result it indicates that the economic evaluation of the Nationwide Hydro-Meteorological Data Management Project will be given by making a comparison between incremental benefit and incremental cost due to increase in discharge and rain gauging stations in the basin.

Section 3.4 provides a case study on the economic evaluation of the Nationwide Hydro-Meteorological Data Management Project, based on discussions made in Sections 3.2 and 3.3.

3.2 Measurement and Calculation Errors of Hydrological Data

3.2.1 Standard Errors of Discharge Estimated

To examine an error of discharge at any station which is estimated by a hydrometric method from an observation station on the same waterway, in the present study the hydrological data of neighboring two observation stations are used. In case where the discharge at one observation station (S_1) is calculated using the discharge at same time at other station (S_2), a difference (E) between calculated and observed values of the discharge at S_1 is given as follows:

$$E = Q_{1c} - Q_{1o} \qquad \text{------ (1.1)}$$

$$= E_{2o} - E_{1o} + E_s + E_m \qquad \text{------ (1.2)}$$

where

$\qquad Q_{1c}$: calculated discharge at S_1

$\qquad Q_{1o}$: observed discharge at S_1

$\qquad E_{1o} \,\& \, E_{2o}$: observation errors of discharges at S_1 & S_2, respectively

$\qquad E_s$: a spatial error related to distance between two stations

$\qquad E_m$: a model error caused by incorrectness of the model applied to calculation

The observation errors $(E_{1o} \,\& \, E_{2o})$ can be regarded as an accidental error by taking the large number of data in time series, but E_s and E_m remain as a systematic error. The mean square error of equation (1.2), by neglecting the higher order terms of E_{1o} and E_{2o}, can be expressed as follows:

$$E^2 = \frac{1}{n} \sum_{i=1}^{n} \{E_{1oi}^2 + E_{2oi}^2 + (E_{si} + E_{mi})^2\} \qquad \text{------ (1.3)}$$

Assuming that observation accuracy of the discharges is in the same level at two stations, the equation (1.3) becomes as follows;

$$E^2 - 2E_o{}^2 = \frac{1}{n} \Sigma (E_{si} + E_{mi})^2 \qquad \text{------ (1.4)}$$

where

$$E_o{}^2 = \frac{1}{2} \left(\frac{1}{n} \Sigma E_{1oi}{}^2 + \frac{1}{n} \Sigma E_{2oi}{}^2 \right) \qquad \text{------ (1.5)}$$

The term of the left side of the equation can be calculated by given a suitable value for observation errors of discharges at S1 and S2, for example, in this paper it is assumed for an average of two observation errors. In the right side, although it is difficult to separate the model error and the spatial error, if a fixed model is applied to the calculation of discharge, the model error (E_m) would become a constant error. On the other hand, assuming that the spatial error will be varied in proportion with the distance between the two stations, it may be expressed as a function of distance, that is,

$$E^2 = f(z) \qquad \text{------ (1.6)}$$

where

$$E^2 = E^2 - 2E_o{}^2 \qquad \text{------ (1.7)}$$

In equation (1.7), the various values of mean square error of calculated discharge can be obtained by combining any two observation stations in the network under a fixed calculation model condition, and a correlation between the mean square error and the distance between two stations is examined using these data.

In a hydrological network, the increase in number of gauging stations will generally shorten the average distance between gauging stations, and as a result the calculation error of hydrological value at any stations other than observation stations will be reduced. It is expected that such a reduction in the calculation error would finally lead the hydrological data to rise in the economic value, as shown in the succeeding Section 3.3.

3.2.2 Standard Errors of Average Rainfall and Calculated Discharge

In case where the discharge at a gauging station on the river course is calculated using the average rainfall in the river basin, the discrepancy (error) between both discharges of calculation and observation can be expressed by four independent errors as follows:

$$E = Q_c - Q_o$$

$$= E_o + a_r E_r + E_s + E_m \qquad \text{------ (2.1)}$$

where

Q_c : calculated discharge

Q_o : observed discharge

E_o : error of observed discharge

E_r : error of estimated average rainfall in the basin

a_r : coefficient

E_s : spatial error which is related to the basin area (or distance between center of the basin and the observation station of discharge)

E_m : error of a model applied to calculation of the discharge

Assuming that E_o and E_r are an accidental error and E_s and E_m are a systematic error, and neglecting higher order terms of E_o and E_r, the mean square error of the difference between calculation and observation discharges for time points i = "1" to "n" can be estimated from equation (2.1) as follows:

$$\overline{E^2} = \frac{1}{n} \sum_{i=1}^{n} \{E_{oi}^2 + a_r^2 E_{ri}^2 + (E_{si} + E_{mi})^2\} \qquad \text{------ (2.2)}$$

$$[E]^2 = A_r E_r^2 + (E_s + E_m)^2 \qquad \text{------ (2.3)}$$

where

$$[E]^2 = \overline{E^2} - \frac{1}{n} \sum E_{oi}^2 \ (= \overline{E_o^2})$$

$$A_r = a_r^2$$

$$E_r^2 = \frac{1}{n} \sum E_{ri}^2$$

$$(E_s + E_m)^2 = \frac{1}{n} \sum (E_{si} + E_{mi})^2$$

Term of the left side in equation (2.2) can be calculated by assuming a proper observation error of the discharge, and the term $(E_s + E_m)^2$ in the right side may be regarded as a constant error in the same river basin by using a fixed calculation model. Accordingly, it is expected that value in the left side will vary according to the magnitude of the mean square error of the average rainfall.

The average rainfall (R) in any time point in the river basin where has "n" rain gauging stations can be generally expressed as follows:

$$R = (A_1R_1 + A_2R_2 + \text{------------} + A_nR_n)/ A \qquad \text{------ (2.4)}$$

where

$R_1, R_2, \text{---}, R_n$: rainfalls at respective stations

$A_1, A_2, \text{---}, A_n$: sub-basin areas represented by respective stations
$$A = A_1 + A_2 + \text{----------} + A_n$$

when put $p_j = A_j / A$, equation (2.4) becomes as follows:

$$R_n = \sum_{j=1}^{n} p_jR_j \qquad \text{------ (2.5)}$$

where p_j is defined as a weight of rainfall (R_j) at j-station, and

$$\sum_{j=1}^{n} p_j = 1.$$

The mean square error ($E_{rn}{}^2$) of the average rainfall above can be calculated using the following equation:

$$E_m{}^2 = 1/P_n(n-1) \cdot \sum_{j=1}^{n} p_j (R_j - R_n)^2 \qquad \text{----- (2.6)}$$

where

$$P_n = \sum_{j=1}^{n} p_j$$

If rainfall data of "m" stations out of the whole "n" stations are used in calculating the average rainfall in the river basin, the mean square error ($E_{rm}{}^2$) of the average rainfall (R_m) is given as follows:

$$E_{rm}{}^2 = 1/P_m(m-1) \cdot \sum_{j=1}^{m} p_j(R_j - R_m)^2 \qquad \text{------ (2.7)}$$

where

$$P_m = \sum_{j=1}^{m} p_j$$

Using equation (2.7), E_{rm}^2 can be calculated for $n!/m!(n-m)!$ kinds according to the combination theory, and the whole average of $n!/m!(n-m)!$ kinds of E_{rm}^2 is assumed to be the mean square error of the average rainfall for "m" stations combined out of "n" stations at a time point.

The calculation above is carried out for all combinations of rain gauging stations (m = 1 to n) at several time points, and as a result it is expected that the mean square error of the average rainfall will be given as a function of number of the rain gauging stations concerned.

Thus, under the condition that a fixed calculation model in the identical river basin is used, the mean square error of the left side in equation (2.3) would be expressed as a function of number (m) of the rain gauging stations, or $[E]^2 = f(m_r)$.

In equation (2.3), the coefficient (A_r) of E_r^2 and the constant error $(E_s + E_m)^2$ can be estimated using the method of least square, given various $[E]^2$ and E_r^2 which are estimated by varying the time points and the number of rain gauging stations concerned. In the calculation of $[E]^2$ ($= E^2 - E_o^2$), a proper value is firstly assumed for the mean square error (E_o^2) of observed discharge, and a change in the project effect to variation in the assumed value of E_o^2 shall be examined in the study of sensitivity analysis.

In the rain gauging network in the river basin, an increase in number of the gauging stations will lead the network to a higher density distribution of the gauging stations, and will reduce the calculation error of discharge, when the discharge is calculated from rainfall data in the basin. The reduction in calculation error would further lead the hydrological data to a rise in the economic value, as indicated in the following Section 3.3.

3.3 Basic Concept of Economic Evaluation on Hydro-Meteorological Data Management Project

The economic evaluation on hydrological data management project is made by comparing incremental benefit with incremental cost. The incremental benefit is given as an increase in economic value of hydrological data which is produced from increase in number of supplementary hydrometric stations, supported by the appropriate data management system.

With regard to estimates of the incremental benefit, for example, let us suppose when a flood control project under a calculated discharge is executed. If there exists an error in the calculated discharge, the estimated benefit and cost of the project would be influenced by its error, and when this discharge is larger than the most probable discharge, or plus error, the project is over-estimated and the economic opportunity loss would cause on the project cost (constriction, operating and maintenance costs). On the contrary, in case of the minus error, the project is under-estimated and the economic opportunity loss would arise on the expected benefit. Accordingly, from these things it is considered that more precise discharge data produced owing to the increase in number of hydrological stations will have effect of reducing the economic opportunity loss.

As another example, the incremental benefit for the hydroelectric power development project can be estimated as follows: Among the hydroelectric power project cost, the construction costs of waterway tunnel and power plant would be given as a function of amount of discharge. When a more accurate discharge amount can be produced by increasing number of hydrological stations, the incremental benefit would be expected as a reduction in the project cost or an increase in the project benefit.

The discharge error can be estimated based on result of error analysis which indicates the relation between the mean square error of calculated discharge and the distribution of hydrological gauging stations in the river basin(See Section 3.2).

On the other hand, the incremental cost can be estimated based on the relation between the number of hydrological stations in the basin and the cost required for construction, operating and maintenance of the stations, including transmission, processing, quality control, storage, publication and dissemination of the hydrological data.

The economic viability of the project is examined by a comparison between both present values of incremental benefit and cost for the period of economic life of the gauging stations established newly.

3.4 Case Study on Economic Evaluation of the Project

3.4.1 General Conditions for Economic Evaluation

The Nationwide Hydro-Meteorological Data Management Project is mainly composed of construction of hydrological gauging stations and establishment of data processing and management system. According to the Long Term Programme, discharge gauging stations and rain gauging stations are planned to be increased from 46 units to 110 units and from 252 units to 470 units respectively, during the period from 1993 to 2005.

According to hydrological analysis, the whole rivers in Nepal can be divided into 32 basins. Accordingly, the average distribution per river basin would be increased from 1.4 units to 2.0 units for the discharge gauging stations, and from 7.9 units to 14.7 units for the rain gauging stations.

A raise in the economic value of hydrological data in the river basin owing to increase in number of the hydrological gauging stations will contribute to the reduction in cost or the increase in benefit of on-going and expected future projects.

Among the projects, the water resources projects, which will be directly effected by the hydrological data, are estimated at about 95 in number (including on-going and expected future projects) for the entire country, comprising 59 hydroelectric projects and 36 irrigation projects. The average distribution per river basin would be about 3 projects. In the present study, only these water resources projects would be objects for estimating the project benefit, because it is difficult to take up every projects which utilize the hydrological data.

In estimating the economic cost and benefit of the project, the price escalation is excluded from the project cost and benefit. However, factors such as transfer payments, shadow rates of wage and land, to be required for converting the cost and benefit from financial prices to economic prices are left out of consideration in the present study, because it is difficult to estimate the reasonable economic cost and benefit for all the said water resources projects and there is little effect on result of the evaluation.

The project life is taken as 50 years after commencement of the project, and the project benefit is assumed to occur during the project life period after completion of the construction works of facilities. However, the project benefit for the period under construction is assumed to occur in proportion to the construction cost invested.

3.4.2 Project Cost

The total construction cost amounts to NRs. 700.380 millions, comprising the foreign currency portion of NRs. 531.278 millions and the local currency portion of NRs. 169.102 millions. Annual disbursements of the construction cost together with the operation and maintenance cost (OM cost) are summarized as follows:

Annual Flow of Construction Cost and OM Cost

	Year	Construction Cost			OM Cost
		F.C.	L.C.	Total	
1.	1993	16,928	0	16,928	0
2.	1994	154,610	61,458	216,068	3,196
3.	1995	89,660	19,863	109,523	4,314
4.	1996	51,051	15,630	66,681	5,236
5.	1997	31,638	11,535	43,173	5,673
6.	1998	26,189	11,454	37,634	6,068
7.	1999	24,990	11,446	36,436	6,451
8.	2000	21,139	7,451	28,590	6,722
9.	2001	17,071	3,505	20,576	6,833
10.	2002	14,564	3,068	17,632	6,898
11.	2003	12,995	8,183	21,178	6,963
12.	2004	59,390	8,447	67,837	7,967
13.	2005	11,053	7,061	18,114	7,983
Total		531,278	169,102	700,380	74,304

Unit : Thousand NRs.

After the year 2005, the annual OM cost of NRs. 7,983 thousand are required during the project life period.

3.4.3 Project Benefit

The project benefit is estimated under the condition mentioned in Paragraph 3.4.1 and the following assumptions:

(1) Error of estimated discharge is examined using the monthly discharge and rainfall data for the period 1963-1986 in the Karnali river and San Koshi river basins of Nepal, in accordance with the method described in Section 3.2. As a result, it indicates that the error of estimated discharge will be reduced ranging from 10 % to 30 %, in case where the average number of discharge gauging stations is increased from 1.4 points to 2.0 points in the basin and the average number of rain gauging stations is increased from 7.9 points to 14.7 points. The 20 % reduction in error is assumed in this case study.

(2) The average construction cost of the 95 projects mentioned in Paragraph 3.4.1 is estimated at US$ 300 millions (equivalent to NRs.13,929 million) per project at the prices in February 1993. Of the said cost, the construction cost related to the water discharge is estimated at about 40 %.

(3) Taking the historical development budget of Nepal into account, it is assumed that the water resources projects will be executed taking 10 years per case, at a rate of 2 cases per annum.

Under the foregoing conditions and assumptions, the average annual benefit is estimated to be NRs. 222.871 millions as a reduction effect of 8 % of the project cost.

3.4.4 Cost-Benefit Analysis

The economic evaluation of the project is made by making a comparison between two present values of the total cost and benefit for the project life period. As a result, IRR of the project is estimated to be 30.2%. It indicates that the present Hydro-Meteorological Data Management Project has a high feasibility economically.

In case where the reduction effect of discharge error comes to 10 % (or the reduction effect of 4 % of the project cost) as a pessimistic condition, the IRR will come to 14.5 %. This figure also shows that the project is feasible economically.

TABLES

Table 1.1.1   GROSS DOMESTIC PRODUCT (GDP)

Items	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	Average Annual Growth Rate(%)*1 1986/87-1991/92
1. GDP (Million NRs.)							
(1) at current prices	59,246	69,513	78,259	88,711	100,628	129,975	17.01
(2) at 1974/75 prices	25,617	27,624	28,536	29,560	30,745	31,834	4.44
2. Per capita GDP*2 (NRs.)							
(1) at current prices	3,539	4,068	4,490	4,991	5,554	7,040	14.75
(2) at 1974/75 prices	1,530	1,617	1,637	1,663	1,697	1,724	2.42

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   *1: Based on Geometric Series
*2: Estimaed using population of the Medium Scenario in "Population
Projection of Nepal 1981-2001, Central Bureau of Statistics.

Table 1.1.2   PERCENTAGE DISTRIBUTION OF GROSS DOMESTIC PRODUCT AT
CURRENT PRICES, 1984/85-1989/90

Unit: Percent

Industrial Origin	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Agriculture	53.87	52.66	51.39	51.52	53.45	56.03
Mining & Quarrying	0.32	0.24	0.17	0.14	0.12	0.11
Manufacturing	4.50	5.20	5.17	5.29	4.90	4.87
(a) Modern	3.37	4.02	4.06	4.30	4.07	4.05
(b) Cottage	1.13	1.18	1.11	0.99	0.83	0.82
Electricity, Gas & Water	0.44	0.68	0.70	0.68	0.66	0.74
Construction	0.07	7.91	8.51	7.84	7.68	7.21
Trade, Restaurant & Hotel	4.14	4.38	4.90	4.89	4.78	4.24
(a) Trade	3.75	3.92	3.78	3.89	3.85	3.42
(b) Hotel & Restaurant	0.39	0.45	1.13	1.00	0.93	0.82
Transport, Communication						
& Storage	6.22	6.19	6.07	5.35	5.33	4.34
Financial & Real Estate	7.70	7.82	7.96	8.13	8.02	7.64
Community & Social						
Services	8.31	8.26	8.57	8.53	8.11	7.79
GDP at factor Cost	93.56	93.33	93.44	92.36	93.05	92.96
Indirect Taxes	6.44	6.67	6.56	7.64	6.95	7.04
GDP at Market Prices	100.00	100.00	100.00	100.00	100.00	100.00

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.1.3   EXTERNAL TRADE OF NEPAL, 1985/86-1990/91

Unit : Million Rps.

Items	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	Average Annual Growth Rate(%) 1984/85-1989/90
1. Exports (f.o.b.)	3,078	2,991	4,115	4,195	5,156	7,604	19.83
(a) India	1,241	1,302	1,568	1,035	602	1,701	6.51
(b) Other countries	1,827	1,589	2,547	3,160	4,554	5,903	26.43
2. Imports (c.i.f.)	9,341	10,905	13,870	16,264	18,325	24,198	20.97
(a) India	3,971	4,262	4,596	4,239	4,675	7,772	14.37
(b) Other countries	5,370	6,643	9,274	12,025	13,650	16,426	25.06
3. Trade Balance	-6,263	-7,914	-9,755	-12,068	-13,169	-16,594	-
(a) India	-2,730	-2,960	-3,028	-3,204	-4,072	-6,071	-
(b) Other countries	-3,533	-4,954	-6,727	-8,864	-9,097	-10,523	-

Source: Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
          Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.(): Negative

Table 1.1.4   EXPORTS OF MAJOR COMMODITIES, 1985/86-1990/91

Unit : Million Rps.

Commodity Groups	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	Average Annual Growth Rate(%) 1983/84-1988/89
1. Food & live animals	835.6	703.7	804.4	577.6	616.0	1,120.1	6.03
2. Tobacco & beverages	0.2	3.5	10.1	6.6	4.1	26.6	155.15
3. Crude materials, inedibles except fuels	412.9	491.1	513.7	249.9	238.6	329.3	-4.42
4. Mineral fuels & lubricants	0.2	0.2	0.8	-	-	-	-
5. Animal and vegetable oil & fats	61.3	117.1	171.4	100.4	20.1	185.7	24.83
6. Chemicals & drugs	2.5	2.0	12.6	26.0	10.9	34.3	69.25
7. Manufactured goods classified chiefly by materials	899.9	1,009.6	1,601.6	1,982.6	2,693.1	4,357.3	37.09
8. Machinery & transport equipment	38.6	2.6	0.5	5.7	0.1	0.2	-65.10
9. Miscellaneous manufactured articles	826.5	661.5	996.8	1,246.5	1,573.3	1,549.9	13.40
10. Commodity & transactions not classified according to kind	0.3	0.2	2.5	0.0	-	0.3	-2.30
Total	3,078.1	2,991.4	4,114.5	4,195.3	5,156.2	7,603.7	19.83

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
            Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.

Table 1.1.5   IMPORTS OF MAJOR COMMODITIES, 1985/86-1990/91

Unit : Million Rps.

Commodity Groups	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	Average Annual Growth Rate (%) 1985/86-1990/91
1. Food & live animals	971.1	1,028.9	1,523.7	1,332.6	1,607.7	2,073.7	16.39
2. Tobacco & beverages	112.9	144.0	172.2	197.0	226.6	345.3	25.05
3. Crude materials, inedibles except fuels	393.0	657.2	1,036.9	1,182.7	1,571.1	2,051.9	39.18
4. Mineral fuels & lubricants	1,054.0	929.5	1,049.9	1,116.6	1,515.5	2,284.6	16.73
5. Animal and vegetable oil & fats	101.9	175.9	352.6	342.7	476.3	719.5	47.82
6. Chemicals & drugs	1,170.2	1,287.6	1,495.4	1,532.6	2,823.9	3,027.0	20.93
7. Manufactured goods classified chiefly by materials	2,759.5	3,226.8	3,359.2	4,671.1	5,065.0	6,301.3	17.96
8. Machinery & transport equipment	2,134.7	2,784.1	4,143.7	4,847.1	3,790.4	6,079.9	23.29
9. Miscellaneous manufactured articles	637.2	664.0	729.1	1,036.6	1,247.8	1,312.7	15.55
10. Commodity & transactions not classified according to kind	6.7	7.3	7.0	4.7	0.6	2.0	-21.49
Total	9,341.2	10,905.2	13,869.6	16,263.7	18,324.9	24,197.9	20.97

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.

Table 1.1.6 BALANCE OF INTERNATIONAL PAYMENTS

Unit: NRs. Million

	Items	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
A.	Trade Balance	-6,286	-7,924	-9,766	-12,086	-13,186	-16,608
B.	Service account	1,555	2,327	2,064	3,048	2,613	2,692
C.	Unrequited Transfers	2,166	2,692	3,127	2,718	2,818	3,661
D.	Current account	-2,564	-2,904	-4,575	-6,320	-7,754	-10,255
E.	Capital account	1,811	1,888	4,413	5,922	5,889	6,300
F.	Miscellaneous	1,314	1,393	2,435	746	4,515	8,736
G.	Change in Reserves	-561	-376	-2,273	-348	-2,650	-4,781

Source : Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note   Figures in parenthesis () mean a negative.

Table 1.1.7   BUDGETARY POSITION OF GOVERNMENT, 1986/87-1991/92

Unit : Milion NRs.

Items	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	Average Annual Growth Rate(%) 1984/85-1990/91
1. Expenditures	11,513	14,105	18,005	19,669	24,479	26,641	18.27
- Regular	4,135	4,677	5,676	6,672	7,928	9,746	18.70
- Development	7,378	9,428	12,329	12,998	16,551	16,895	18.02
2. Receipts	7,260	9,427	9,458	11,263	13,093	16,068	17.22
- Revenue	5,975	7,350	7,777	9,288	10,698	12,557	16.01
- Foreign Grants	1,285	2,077	1,681	1,975	2,395	3,511	22.27
3. Surplus (+) or Deficit (-)	(4,253)	(4,678)	(8,548)	(8,406)	(11,386)	(10,573)	-
4. Source of Financing Deficit							
- Foreign Loan & Reimbursement	2,706	3,816	5,666	5,960	6,281	8,317	25.18
- Internal Loan	1,645	1,130	1,330	2,150	4,888	2,082	4.83
5. Cash Balance	98	268	-1,551	-297	-218	-173	-

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistic
            Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.

Table 1.1.8 BREAKDOWN OF GOVERNMENT EXPENDITURE, 1988/89-1991/92

Unit: Million NRs.

Items	1988/89	1989/90	1990/91	1991/92	Average Annual Growth RAtc (%) 1984/85-1990/91
I. Regular Expenditure	5,676	6,672	7,928	9,746	19.75
1. Constitutional Organs	122	104	193	208	19.37
2. General Administration	814	963	1,162	1,550	23.93
3. Revenue Administration	111	124	125	177	16.74
4. Economic Adm. & Planning	42	48	49	59	12.01
5. Judical Administration	79	88	88	113	12.77
6. Foreign Services	151	152	188	234	15.82
7. Defence	899	1,027	1,136	1,430	16.74
8. Social Services	635	716	793	973	15.28
9. Economic Services	351	424	437	568	17.37
10. Loans & Investment	9	7	10	10	3.96
11. Loan Payment & Interest	1,721	2,279	2,473	3,797	30.19
12. Miscellaneous	742	740	1,274	628	-5.43
II. Development Expenditure	12,329	12,998	16,551	16,895	11.07
1. General Administration	35	14	11	14	-25.62
2. Economic Administration	10	11	121	70	90.75
3. Social Services	3,309	3,573	4,021	5,276	16.82
4. Economic Services	8,242	8,601	11,588	11,435	11.53
5. Miscellaneous	733	799	810	100	-48.52
Total	18,005	19,669	24,479	26,641	13.95

Source : Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note : Figures in parenthesis () mean a negative.

Table 1.1.9   BREAKDOWN OF GOVERNMENT REVENUE, 1984/85-1989/90

Unit: Million NRs.

Items	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Average Annual Growth Rate(%) 1984/85-1989/90
1. Tax Revenue	3,151	3,659	4,372	5,753	6,287	7,285	18.25
A. Custom Duties	1,065	1,231	1,505	2,215	2,290	2,685	20.31
a. Export	56	74	79	108	63	33	-10.35
b. Improt	908	1,080	1,285	1,984	2,134	2,646	23.86
c. Indian Excise Refund	100	76	138	121	92	-	-
d. Miscellaneous	1	1	2	1	2	6	44.50
B. Excise	483	559	679	825	873	1,072	17.28
C. Sales Tax	845	986	1,144	1,301	1,385	1,595	13.54
D. Income Tax	309	364	438	579	861	923	24.46
E. Other Taxes	237	275	323	467	478	563	18.87
F. Land Revenue	73	74	72	81	80	75	0.43
G. Registration	138	170	212	286	321	373	21.99
2. Non-tax Revenue	766	985	1,603	1,598	1,490	2,004	21.21
A. Forest	89	116	129	101	76	107	3.93
B. Public Utilities	161	190	182	247	264	290	12.40
C. Inerest & Dividend	119	296	256	325	362	512	33.81
D. Civil Administration	380	373	1,028	853	775	1,068	22.95
E. Miscellaneous	16	10	7	71	13	27	10.46
Total	3,917	4,645	5,974	7,350	7,777	9,289	18.85

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.atistics

Table 1.1.10   FOREIGN AID (LOAN AND GRANT) DISBURSEMENT BY MAJOR
SOURCES, 1986/87-1991/92

Unit: Million NRs.

	Sources	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	Average Annual Growth Rate(%) 1986/87-1991/92
1.	Bilateral	1,078	648	1,708	2,675	3,304	4,789	34.74
	Grant	779	185	1,200	1,674	1,884	2,979	30.78
	Loan	300	463	508	1,001	1,420	1,810	43.29
2.	Multilateral	2,236	2,827	3,959	5,260	5,372	7,039	25.78
	Grant	174	195	278	301	511	532	25.08
	Loan	2,062	2,632	3,681	4,959	4,861	6,507	25.84
3.	Total	3,315	3,474	5,667	7,935	8,676	11,829	28.97
	Grant	953	380	1,478	1,975	2,395	3,511	29.81
	Loan	2,362	3,094	4,189	5,960	6,281	8,317	28.63

Source :   Economic Survey, Fiscal Year 1989-90, Ministry of Finance
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.1.11 URBAN CONSUMER PRICE INDEX IN KATHMANDU
            (BASE YEAR: 1983/84 = 100)

Categories	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	Average Annual Rise Rate (%) 1985/86-1990/91
Food and Beverages	121.3	141.1	156.0	165.9	181.9	200.4	10.56
Restaurant Meals	126.4	143.6	151.1	178.5	217.5	247.9	14.42
Grains and Cereal Products	116.5	135.8	147.1	149.2	154.9	165.0	7.21
Pulses	127.6	132.7	154.3	192.2	215.4	240.1	13.48
Vegetables & Fruit	133.0	151.4	164.8	185.9	221.9	241.6	12.68
Spices	119.5	155.4	199.4	210.7	178.0	214.0	12.36
Meat, Fish and Eggs	120.0	144.3	152.4	183.5	207.7	233.8	14.27
Milk and Milk Products	141.7	154.5	179.2	189.2	217.2	244.0	11.48
Oil and Clarified Butter	105.4	166.0	173.8	157.2	161.9	205.6	14.30
Sugar	143.1	139.8	139.9	147.2	185.5	187.0	5.50
Beverages	113.3	123.7	132.0	150.3	189.3	206.3	12.73
Non-Food and Services	121.8	134.3	144.6	153.7	177.2	193.4	9.69
Clothes, clothing and sewing services	115.9	126.4	134.1	144.4	170.8	185.9	9.91
Footwear	115.9	124.9	130.3	147.6	161.3	173.5	8.40
Housing	125.6	138.6	153.6	168.2	195.4	216.9	11.55
Transport and Communication	115.3	121.5	129.5	150.6	181.7	183.3	9.72
Medical and Personal Care	130.2	144.3	155.4	151.0	165.1	174.5	6.03
Education, Reading Materials and Recreation	123.9	140.6	144.4	151.6	170.9	189.5	8.87
Cigarettes	110.7	121.5	132.2	134.7	159.5	177.9	9.95
Overall Index	121.5	138.6	151.7	161.3	179.9	197.6	10.22

Source: Quartary Bulletin ,Mid-Oct. 1989/Mid-Jul. 1990,
           Vol. XXIV, No. 1-4, Nepal Rastra Bank
           Statistical Pocket Book of Nepal, 1992,
           Central Bureau of Statistics

Table 1.2.1   AREA, POPULATION, POPULATION GROWTH RATE, POPULATION
               DENSITY, NUMBER OF HOUSEHOLD AND HOUSEHOLD SIZE BY
               DEVELOPMENT REGION

Region	Land Area (sq.km)	Population		Annual Growth Rate (%) 1981-1991	Population Density (Persons/ sq.km) 1991	Number of Households 1991	Household Size (persons/H) 1991
		1981	1991				
Nepal	147,181	15,022,839	18,462,081	2.08	125.44	3,345,052	5.52
Eastern Dev. Region	28,456	3,708,923	4,448,374	1.83	156.32	825,774	5.39
Central Dev. Region	27,410	4,909,357	6,174,237	2.32	225.25	1,123,029	5.50
Western Dev. Region	29,398	3,128,859	3,751,922	1.83	127.63	691,839	5.42
Mid-Western Dev. Region	42,378	1,955,611	2,406,095	2.09	56.78	417,197	5.77
Far-Western Dev. Region	19,539	1,320,089	1,681,453	2.45	86.06	287,213	5.85

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
           Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.2.2   ECONOMICALLY ACTIVE POPULATION OF 10 YEARS
AND OVER BY DEVELOPMENT REGION IN 1981

| Industrial Origin | Development Region | | | | | Total |
	Eastern	Central	Western	Mid-Western	Far-Western	
1. Agriculture, forestry & fishery	1,447,056	1,886,258	1,380,822	918,826	611,327	6,244,289
2. Mining & Quarry	185	437	176	92	81	971
3. Manufacturing	11,934	15,043	3,381	1,602	1,069	33,029
4. Electricity, Gas & Water	780	1,834	316	57	26	3,013
5. Construction	684	907	191	230	10	2,022
6. Commerce	32,316	47,607	17,046	8,792	3,685	109,446
7. Transport & Communicatic	2,152	3,981	952	253	86	7,424
8. Finance & Business						0
Services	2,343	5,839	1,006	338	324	9,850
9. Personal & Community						0
Services	117,214	130,996	36,435	18,398	10,527	313,570
10. Others	35,473	41,097	26,144	14,558	10,000	127,272
Total	1,650,137	2,133,999	1,466,469	963,146	637,135	6,850,886

Source : Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.2.3   CLASSIFICATION OF AGRICULTURAL LAND USE IN
NEPAL BY DEVELOPMENT REGION, 1981/82

Unit: Sq.km.

Region	Permanent Crops	Temporary Crops	Permanent Meadow & Pasture	Temporary Fallow & Meadow	Wood & Forest	Others	Total
Nepal	292	22,502	425	373	150	895	24,637
(%)	1.19	91.33	1.73	1.51	0.61	3.63	100.00
Eastern Dev. Region	96	7,111	58	112	87	246	7,710
(%)	1.25	92.23	0.75	1.45	1.13	3.19	100.00
Central Dev. Region	140	7,527	98	104	35	329	8,233
(%)	1.70	91.42	1.19	1.26	0.43	4.00	100.00
Western Dev. Region	39	4,137	231	45	19	165	4,636
(%)	0.84	89.24	4.98	0.97	0.41	3.56	100.00
Mid-Western Dev.	5	2,428	28	16	2	102	2,581
Region (%)	0.19	94.04	1.08	0.62	0.08	3.95	100.00
Far-Western Dev.	10	1,299	10	97	7	54	1,477
Region (%)	0.68	88.01	0.68	6.57	0.47	3.66	100.00

Source : Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Table 1.2.4   PLANTED AREA, PRODUCTION AND YIELD OF PRINCIPAL
FOOD CROPS BY DEVELOPMENT REGION, 1989/90

Food Crops		Units	Development Region					Total
			Eastern	Central	Western	Mid-Western	Far-Western	
Paddy	Area	1,000 has.	462.4	427.3	288.1	140.2	114.8	1,432.8
	Production	1,000 M-Tons	1,036.8	1,118.3	643.4	316.3	275.0	3,389.8
	Yield	M-Tons/Ha	2.2	2.6	2.2	2.3	2.4	2.4
Wheat	Area	1,000 has.	94.9	186.1	116.0	128.5	78.9	604.4
	Production	1,000 M-Tons	139.3	299.2	165.9	160.4	90.3	855.1
	Yield	M-Tons/Ha	1.5	1.6	1.4	1.2	1.1	1.4
Maize	Area	1,000 has.	165.6	196.3	199.1	137.8	52.3	751.1
	Production	1,000 M-Tons	249.8	343.3	302.2	219.4	86.3	1,201.0
	Yield	M-Tons/Ha	1.5	1.7	1.5	1.6	1.7	1.6
Millet	Area	1,000 has.	48.0	30.1	82.6	19.8	13.0	193.5
	Production	1,000 M-Tons	51.1	37.2	99.0	22.3	15.1	224.7
	Yield	M-Tons/Ha	1.1	1.2	1.2	1.1	1.2	1.2
Barley	Area	1,000 has.	2.5	4.6	4.8	12.2	5.4	29.5
	Production	1,000 M-Tons	2.3	4.4	4.6	11.5	4.7	27.5
	Yield	M-Tons/Ha	0.9	1.0	1.0	0.9	0.9	0.9

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Table 1.2.5   PRODUCTION OF PRINCIPAL INDUSTRIES, 1984/85-1989/90

Output Goods	Unit	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	Average Annual Growth Rate (%) 1984/85-1989/90
1. Jute Goods	Metric Ton	20,026	16,389	18,289	17,198	16,950	7,473	(17.89)
2. Sugar	Metric Ton	11,039	15,190	24,565	30,040	24,197	29,996	22.13
3. Cigarettes	In lakh sticks	42,520	47,410	56,000	60,460	56,645	61,370	7.61
4. Matches	Th. Gross	1.239	1.144	1.314	1.215	1.272	1.223	(0.26)
5. Liquor	Th. Litre	1,027	1,264	1,283	2,118	2,092	2,460	19.09
6. Soap	Metri Ton	7,676	9,182	11,460	12,303	14,856	11,945	9.25
7. Shoes	Pairs	83,000	112,000	121,000	214,444	332,000	710,000	53.62
8. Leather	Th. Pieces	2,247	2,001	2,877	1,509	1,655	2,375	1.11
9. Agricultural Tools	Metric Ton	340	391	363	297	264	283	(3.60)
10. Tea	Metric Ton	989	1,052	1,112	1,290	1,184	984	(0.10)
11. Stainless steel Utensils	Metric Ton	580	425	421	389	237	189	(20.09)
12. Bricks & Tiles	Th. Pieces	25,254	28,451	33,876	34,629	33,440	16,291	(8.39)
13. Beer	Th. Litre	2,278	3,016	3,699	5,276	6,281	5,711	20.18
14. Cotton Textiles	1000 metres	10,533	14,118	17,822	9,914	7,057	5,286	(12.88)
15. Cement	Metri Ton	31,479	96,043	151,631	215,010	217,666	101,179	26.30
16. Biscuts	Metri Ton	4,339	4,698	4,536	4,674	4,458	4,430	0.42
17. Plywood	Th. sq.ft.	2,627	2,038	2,488	1,314	1,315	-	(15.89) *
18. Synthetic Textiles	Th. metres	3,300	6424	11,561	13,363	11,843	12,713	30.96

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.
          * : for the period 1984/85-1988/89

Table 1.2.6   NUMBER OF ESTABLISHMENTS AND PERSONS ENGAGED IN MANUFACTURING
INDUSTRIES BY NSIC AND DEVELOPMENT REGION, 1988/89

No. of NSIC	Industrial Products	Eastern Dev. Region		Central Dev. Region		Western Dev. Region		Mid-Western Dev. Region		Far-Western Dev. Region		Total	
		No. of Eatb.	No. of Persons Engaged	No. of Eatb.	No. of Persons Engaged	No. of Eatb.	No. of Persons Engaged	No. of Eatb.	No. of Persons Engaged	No. of Eatb.	No. of Persons Engaged	No. of Eatb.	No. of Persons Engaged
311	Food (A)	97	4,928	104	5,634	72	2,534	22	729	29	1,126	324	14,951
312	Food (B)	18	631	18	261	5	39	0	0	0	0	41	931
313	Beverage	3	86	11	1,370	7	202	6	167	7	98	34	1,923
314	Tobacco	15	2,691	44	3,939	8	511	3	153	0	0	70	7,294
321	Textiles	65	7,786	232	20,953	94	2,421	15	119	3	33	409	31,312
322	Wearing Apparel	5	50	65	8,781	10	196	0	0	1	0	81	9,027
323	Leather	3	208	8	300	1	0	0	0	0	0	12	508
324	Foot Wear	0	0	6	504	2	0	0	0	0	0	8	504
331	Wood	25	492	46	841	28	642	7	246	7	388	113	2,609
332	Furniture	21	226	42	802	30	421	13	162	9	73	115	1,684
341	Paper	6	163	11	980	5	421	0	0	0	0	22	1,564
342	Printing	11	150	64	1,722	9	147	1	0	0	0	85	2,019
351	Fertilizers & Pesticides	0	0	0	0	1	0	0	0	0	0	1	0
352	Other Chemicals	28	1,994	36	1,996	12	315	5	354	3	702	84	5,361
355	Rubber	10	363	15	554	3	58	0	0	0	0	28	975
356	Plastic	16	575	25	680	4	90	1	0	0	0	46	1,345
362	Glass	1	0	0	0	0	0	0	0	0	0	1	0
369	Other Metalic Minerals	65	4,416	305	32,428	146	12,383	65	3,746	80	2,195	661	55,168
371	Iron & Steel	9	631	8	961	4	240	0	0	0	0	21	1,832
381	Fabriacted Metal	24	800	62	1,642	30	439	11	165	0	0	127	3,046
383	Electrical Machinary	7	391	15	652	2	0	0	0	1	0	25	1,043
385	Scientific Equipment	0	0	2	0	0	0	0	0	0	0	2	0
390	Other Manufacturing Industries	8	325	11	425	1	0	4	652	0	0	24	1,402
	Total	437	26,906	1,130	85,425	474	21,059	153	6,493	140	4,615	2,334	144,498

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Note :   NSIC = Nepal Standard Industrial Classification.

Table 1.2.7   STATISTICS OF TOURIST ARRIVALS, 1985-1990

Item	1985	1986	1987	1988	1989	1990	Average Annual Growth Rate (%) 1984-1989
Total Number	180,989	223,331	248,080	265,943	239,945	254,885	7.09
Growth Rate (%)	2.5	23.4	11.1	7.2	-9.8	6.2	-
Number by Purpose							
Pleasure	128,217	163,958	184,979	200,775	180,973	161,839	4.77
Trekking	28,707	33,609	36,164	36,937	40,093	37,893	5.71
Business	10,416	10,863	11,781	12,008	2,630	11,728	2.40
Official	9,230	8,825	8,882	9,781	12,275	26,578	23.56
Others	4,419	6,076	6,274	6,442	3,974	16,847	30.69
Gross Foreign Exchange							
Earnings (US$1,000)	39,185	50,841	60,229	63,502	68,343	57,347	7.91
Growth Rate (%)	-5.1	29.7	18.5	5.4	7.6	-16.1	-

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.2.8   STATISTICS OF HOTEL INDUSTRY, 1983-1988

Item	1983	1984	1985	1986	1987	1988	Average Annual Growth Rate (%) 1983-1988
Number of Rooms	25,033	22,361	21,864	23,784	23,194	27,145	1.63
Kathmandu Valley	20,695	19,092	18,356	19,778	19,097	23,937	2.95
Other Areas	4,338	3,269	3,508	4,006	4,097	3,208	(5.86)
Number of Beds	48,607	43,728	42,724	47,266	45,385	53,234	1.84
Kathmandu Valley	40,031	37,288	35,453	38,960	37,221	46,911	3.22
Other Areas	8,576	6,440	7,271	8,306	8,164	6,323	(5.91)
Arrivals	179,638	175,044	175,652	231,152	224,835	250,955	6.92
Guest Nights	475,314	516,719	452,166	571,769	623,282	640,982	6.16
Average Guest Nights per arrival	2.6	3.0	2.6	2.5	2.8	2.6	0.00
Percentage of Bed Occupancy							
Kathmandu Valley	32.9	40.2	35.9	41.8	46.2	39.8	3.88
Other	28.9	31.3	28.9	29.4	40.5	37.4	5.29

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Note :   Figures in parenthesis () mean a negative.

Table 1.2.9   LENGTH OF ROAD CLASSIFIED BY DEVELOPMENT REGION
AND BY CONDITION OF ROAD SURFACE, 1985-1990

Unit: Km

Development Region	Road Surface	Road Length 1985	1986	1987	1988	1989	1990	Average Annual Growth Rate(%) 1984-1989
1. Eastern	Black Top	593	NA	613	602	604	611	0.60
	Gravel	310	NA	398	443	454	461	8.26
	Earthern	568	NA	557	612	687	717	4.77
	Total	1,471	NA	1,568	1,657	1,745	1,789	3.99
2. Central	Black Top	1,179	NA	1,216	1,256	1,278	1,334	2.50
	Gravel	386	NA	493	635	668	674	11.79
	Earthern	602	NA	635	536	629	707	3.27
	Total	2,167	NA	2,344	2,427	2,575	2,715	4.61
3. Western	Black Top	672	NA	676	688	706	711	1.13
	Gravel	78	NA	99	108	175	227	23.82
	Earthern	381	NA	405	425	429	493	5.29
	Total	1,131	NA	1,180	1,221	1,310	1,431	4.82
4. Mid-Western	Black Top	211	NA	218	220	231	231	1.83
	Gravel	81	NA	127	209	209	209	20.87
	Earthern	391	NA	363	359	386	386	(0.26)
	Total	683	NA	708	788	826	826	3.88
5. Far-Western	Black Top	69	NA	71	71	71	71	0.57
	Gravel	63	NA	63	82	87	87	6.67
	Earthern	341	NA	372	365	392	411	3.80
	Total	473	NA	506	518	550	569	3.76
Total	Black Top	2,724	NA	2,794	2,837	2,890	2,958	1.66
	Gravel	918	NA	1,180	1,477	1,593	1,658	12.55
	Earthern	2,283	NA	2,332	2,297	2,523	2,714	3.52
	Total	5,925	NA	6,306	6,611	7,006	7,330	4.35

Source: Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Note: NA: Not available

Table 1.2.10 QUANTITY OF DOMESTIC WATER AVAILABLE BY SUPPLY
FACILITIES BY DEVELOPMENT REGION, 1983/84-1988/89

Development Region	Water available per day (Thousand litre)					
	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89
1. Eastern	4,438	900	1,350	612	1,693	6,813
2. Central	7,168	5,480	10,364	6,539	7,082	7,144
3. Western	3,310	1,346	3,302	1,545	1,859	491
4. Mid-Western	3,964	5,631	2,461	991	3,204	12,681
5. Far-Western	959	5,099	1,037	835	4,644	4,357
Total	19,839	18,456	18,514	10,522	18,482	31,486

Source :   Statistical Year Book of Nepal, 1991, Central Bureau of Statistics

Table 1.2.11 IRRIGATED AREA BY DEVELOPMENT REGION, 1985-1990

Unit: Hectare

Development Region	1985	1986	1987	1988	1989	1990
1. Eastern	28,930	4,000	12,770	2,775	7,266	3,634
2. Central	3,000	1,375	120	1,330	6,828	2,822
3. Western	2,902	1,010	640	1,715	5,161	5,878
4. Mid-Western	1,100	850	-	-	6,267	967
5. Far-Western	4,545	2,900	1,950	800	5,545	2,655
Total	40,477	10,135	15,480	6,620	31,067	15,956

Source: Statistical Year Book of Nepal, 1991, Central Bureau of Statistics.

Table 1.2.12   INSTALLED CAPACITY OF POWER STATIONS IN NEPAL BY
DEVELOPMENT REGION AND BY POWER ORIGIN IN 1991

Unit: KW

Development Region	Power Stations				
	Hydro	Diesel	Solar	Wind	Total
Eastern	1,594	31,098	0	0	32,692
Central	140,352	19,748	30	0	160,130
Western	94,482	2,686	0	20	97,188
Mid-Western	895	1,039	100	0	2,034
Far-Western	950	112	0	0	1,062
Total	238,273	54,683	130	20	293,106

Source :   Statistical Pocket Book of Nepal, 1992, Central Bureau of Statistics

Table 1.2.13 ELECTRICITY GENERATION BY DEVELOPMENT REGION, 1984/85-1989/90

Unit: MWH

Development Region	Generation Facilities	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
1. Eastern	Hydro	815	935	975	890	1,039	1,595
	Diesel	1,793	2,047	767	685	1,370	540
	Others	0	0	0	0	0	0
	Total	2,608	2,982	1,742	1,575	2,409	2,135
2. Central	Hydro	292,423	378,033	470,565	500,518	500,453	414,179
	Diesel	1,864	744	276	250	244	310
	Others	0	0	0	0	0	24
	Total	294,287	378,777	470,841	500,768	500,697	414,513
3. Western	Hydro	40,494	46,365	65,344	60,391	45,944	280,963
	Diesel	0	0	0	0	57	38
	Others	0	0	0	0	0	2
	Total	40,494	46,365	65,344	60,391	46,001	281,003
4. Mid-Western	Hydro	736	890	940	857	355	786
	Diesel	256	226	215	135	56	47
	Others	0	0	0	0	0	85
	Total	992	1,116	1,155	992	411	918
5. Far-Western	Hydro	96	288	465	346	519	616
	Diesel	128	0	0	42	56	31
	Others	0	0	0	0	0	0
	Total	224	288	465	388	575	647
Total	Hydro	334,564	426,511	538,289	563,002	548,318	698,139
	Diesel	4,041	3,017	1,258	1,112	1,783	966
	Others	0	0	0	0	0	111
	Total	338,605	429,528	539,547	564,114	550,093	699,216

Source: Statistical Year Book of Nepal, 1991, Central Bureau of Statistics.

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Table 1.3.1   COMPARISON OF GDP BETWEEN SEVENTH PLAN AND ACTUAL
               SITUATION (AT THE 1984/85 CONSTANT PRICES)

Unit: NRs. Million

Items	Seventh Plan			Actual Situation		
	GDP		Average Annual Growth Rate (%)	GDP		Average Annual Growth Rate (%)
	1984/85	1989/90	1984/85-1989/90	1984/85	1989/90	1984/85-1989/90
1. Agricultural Sector	22,080	26,220	3.50	24,170	30,340	4.65
2. Noln-Agricultural Sector	20,060	26,290	5.56	20,250	23,670	3.17
3. GDP (in total)	42,140	52,510	4.50	44,420	54,010	3.99

    Source: The Seventh Plan 1985-1990 (A Summary), National Planning Commission
               Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
               Economic Survey, the Fiscal Year 1989/90, Ministry of Finance

Table 1.3.2   GDP, CONSUMPTION AND SAVINGS IN THE SEVENTH PLAN,
               1984/85-1989/90 (AT THE 1984/85 CONSTANT PRICES)

Unit: NRs. Million

Items	1984/85	1989/90	Average Annual Growth Rate (%) 1984/85-1989/90 (5 years)	Proportion to GDP (%)	
				1984/85	1989/90
1. Consumption	37,741	48,168	5.00	89.6	91.7
2. Total Investment	7,936	9,350	3.33	18.8	17.8
Fixed Capital Formation	7,448	8,746	3.27	17.7	16.7
Government Sector	3,575	3,467	(0.61)	8.5	6.6
Non-Government Sector	3,873	5,279	6.39	9.2	10.1
Change in Balance	488	604	4.36	1.2	1.2
3. Foreign Balance	(3,539)	(5,006)	(7.18)	(8.4)	(9.5)
Imports of Goods & Services	8,669	11,351	5.54	20.6	21.6
Exports of Goods & Services	5,130	6,346	4.35	12.2	12.1
4. GDP	42,138	52,512	4.50	100.0	100.0
5. Domestic Savings	4,397	4,344	(0.24)	10.4	8.3

    Source: The Seventh Plan 1985-1990 (A Summary), National Planning
               Commission
               Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
               Economic Survey, the Fiscal Year 1989/90, Ministry of Finance

    Note: Figures in parenthesis () mean a negative.

Table 1.3.3   ACTUAL GDP, INVESTMENT AND SAVINGS FOR THE SEVENTH
               PLAN PERIOD, 1984/85-1989/90 (AT THE 1984/85 CONSTANT PRICES)

Unit: NRs. Million

Items	1984/85	1988/89	Average Annual Growth Rate (%) 1984/85-1988/89 (4 years)	Proportion to GDP (%)	
				1984/85	1988/89
1. Consumption	38,178	49,286	6.59	86.0	92.8
2. Total Investment	10,184	10,343	0.39	22.9	19.5
Fixed Capital Formation	9,386	8,269	(3.12)	21.1	15.6
Government Sector	3,629	4,617	6.20	8.2	8.7
Non-Government Sector	5,757	3,652	(10.76)	13.0	6.9
Change in Balance	798	2,074	26.97	1.8	3.9
3. Foreign Balance	(3,945)	(6,504)	(13.31)	(8.9)	(12.2)
Imports of Goods & Services	9,317	13,283	9.27	21.0	25.0
Exports of Goods & Services	5,372	6,779	5.99	12.1	12.8
4. GDP	44,417	53,125	4.58	100.0	100.0
5. Domestic Savings	6,239	3,839	(11.43)	14.0	7.2

Source: The Seventh Plan 1985-1990 (A Summary), National Planning Commission
          Statistical Year Book of Nepal, 1991, Central Bureau of Statistics
          Economic Survey, the Fiscal Year 1989/90, Ministry of Finance

Note: Figures in parenthesis () mean a negative.

Table 1.3.4   VALUE ADDED AND GDP IN THE EIGHTH DEVELOPMENT PLAN
(AT THE 1991/92 PRICES)

Unit : million NPs.

Industrial Origin	1991/92		1996/97		Average Annual Growth Rate (%)
	Amount	Share (%)	Amount	Share (%)	1991/92-1996/97
Agriculture, Irrigation & Forestry	62,712	55.5	75,364	52.7	3.7
Non-Agriculture	50,312	44.5	67,628	47.3	6.1
Industry & Mining	7,283	6.4	12,169	8.5	10.8
Electricity, Gas & Water	1,054	0.9	1,617	1.1	8.9
Construction	9,408	8.3	11,604	8.1	4.3
Trade, Hotel & Restaurant	5,995	5.3	8,685	6.1	7.7
Transport & Communication	6,878	6.1	8,548	6.0	4.4
Financial & Real Estate	9,321	8.3	11,735	8.2	4.7
Social Services	10,372	9.2	13,270	9.3	5.0
Total Value Added	113,024	100.0	142,992	100.0	4.8
Indirect Tax	8,038	-	12,168	-	8.6
GDP (at Market Prices)	121,062	-	155,160	-	5.1

Source :   Summary of the Eighth Plan (1992-1997), July 1992,
National Planning Commission

Table 1.3.5   SECTORAL BREAKDOWN OF DEVELOPMENT OUTLAY
FOR THE EIGHTH PLAN PERIOD (AT THE 1991/92 PRICES)

Unit : million NPs.

Items	Amount	Share (%)
1. General Administration	170	0.15
2. Economic Administration & Planning	133	0.12
3. Social Services	35,808	31.56
4. Economic Services	77,368	68.17
4.1 Agriculture	10,947	9.65
4.2 Water Resources	35,802	31.54
rrigation	11,966	10.54
Electricity	23,719	20.90
Hydrology & Meteorology	117	0.10
4.3 Land Reform & Survey	791	0.70
4.4 Forestry & Environment	5,372	4.73
4.5 Industry	2,245	1.98
4.6 Transport & Communication	20,030	17.65
4.7 Other Economic Services	2,181	1.92
Total	113,479	100.00

Source :   Summary of the Eighth Plan (1992-1997), July 1992,
National Planning Commission

Table 1.3.6   MAJOR MACRO ECONOMIC INDICATORS IN THE EIGHTH PLAN
(AT THE 1991/92 PRICES)

Unit : million NPs.

Items	1991/92		1996/97		Average Annual Growth Rate (%) 1991/92- 1996/97
	Amount	Share in GDP (%)	Amount	Share in GDP (%)	
GDP	121,062	100.0	155,160	100.0	5.1
Domestic Savings	11,449	9.5	19,328	12.5	11.0
National Savings	14,267	11.8	23,253	15.0	10.3
Government Revenue	12,995	10.8	20,685	13.3	9.7
Government Expenditure	24,385	20.1	39,405	25.4	10.1
Budgetary Deficit	2,058	1.7	1,396	0.9	(7.5)
Imports	36,219	29.9	60,525	39.0	10.8
Goods	30,331	25.1	52,646	33.9	11.7
Services	5,888	4.8	7,879	5.1	6.0
Exports	21,757	17.8	44,231	28.5	15.2
Goods	13,229	10.9	31,700	20.4	19.1
Services	8,528	6.9	12,531	8.1	8.0
Current Account Balance	(11,644)	(9.6)	(12,369)	(8.0)	1.2
Employment (in '000)	8,707	-	10,156	-	3.1
Government Consumption	13,941	11.5	19,553	12.6	7.0
Private Consumption	95,672	79.0	116,279	74.9	4.0
Money Supply	19,938	-	35,254	-	12.1
Consumer Price Index	100.0	-	154.1	-	9.0

Source :   Summary of the Eighth Plan (1992-1997), July 1992,
National Planning Commission

Note :   Figures in parenthesis () mean negative.

Table 2.2.1   BUDGET EXPENDITURES OF MOWR, DHM, DOI, NEA AND WECS

Unit: Thousand NRs.

Items	Historical Budget Expenditures						Average Annual Growth Rate (%)					
	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1987/88-1988/89	1988/89-1989/90	1989/90-1990/91	1990/91-1991/92	1991/92-1992/93	1987/88-1992/93
MOWR												
Regular	1,243	1,498	2,071	1,773	2,377	5,263	20.5	38.3	(14.4)	34.1	121.4	40.0
Development	-	-	-	-	-	-	-	-	-	-	-	-
Total	1,243	1,498	2,071	1,773	2,377	5,263	20.5	38.3	(14.4)	34.1	121.4	40.0
DHM												
Regular	-	1,234	2,035	1,965	3,794	6,304	-	64.9	(3.4)	93.1	66.2	55.2
Development	-	18,536	12,265	16,723	18,023	20,680	-	(33.8)	36.3	7.8	14.7	6.3
Total	-	19,770	14,300	18,688	21,817		-	(27.7)	30.7	16.7	23.7	10.9
DOI												
Regular	9,444	9,180	12,699	4,586	9,145	12,032	(2.8)	38.3	(63.9)	99.4	31.6	20.5
Development	892,224	1,740,653	1,351,633	1,111,294	1,561,622	2,054,320	95.1	(22.3)	(17.8)	40.5	31.6	25.4
Total	901,668	1,749,833	1,364,332	1,115,880	1,570,767	2,066,352	94.1	(22.0)	(18.2)	40.8	31.6	25.2
NEA												
Regular	-	-	-	-	-	-	-	-	-	-	-	-
Development	1,678,292	1,385,090	1,124,882	1,316,537	1,915,166	2,715,821	(17.5)	(18.8)	17.0	45.5	41.8	13.6
Total	1,678,292	1,385,090	1,124,882	1,316,537	1,915,166	2,715,821	(17.5)	(18.8)	17.0	45.5	41.8	13.6
WECS												
Regular	-	-	-	-	-	2,382	-	-	-	-	-	-
Development	3,130	3,309	2,909	2,762	3,650	3,518	5.7	(12.1)	(5.1)	32.2	(3.6)	3.4
Total	3,130	3,309	2,909	2,762	3,650	5,900	5.7	(12.1)	(5.1)	32.2	-	-

Source: Income/Expenditure of Government, 1987/88, 1988/89, 1989/90, 1990/91, 1991/92 and 1992/93, Ministry of Finance.

Note 1: Figures in ( ) indicate negative.
Note 2: MOWR: Ministry of Water Resources.
         DHM: Department of Hydrology and Meteorology.
         DOI: Department of Irrigation.
         NEA: Nepal Electricity Authority.
         WECS: Water and Energy Commision Secretariat.

Table 2.2.2   DEVELOPMENT BUDGET EXPENDITURE BY DIVISION AND REGION IN THE DHM

Unit: Thousand NRs.

Division or Region	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	Average Annual Growth Rate (%)					
							1987/88-1988/89	1988/89-1989/90	1989/90-1990/91	1990/91-1991/92	1991/92-1992/93	1987/88-1992/93
DIVISIONS												
1. Director General & Secretariat	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Hydrology Division	7,822	8,998	7,258	7,057	7,905	7,663	15.0	(19.3)	(2.8)	12.0	(3.1)	0.4
3. Administration & Account Division	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4. Technical Service Division	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Climatology Division & Meteorology and Weather Forecasting Division	3,169	2,850	2,407	1,481	1,442	1,476	(10.1)	(15.5)	(38.5)	(2.6)	2.4	(12.9)
6. Sub-Total (1)	10,991	11,848	9,665	8,538	9,347	9,139	7.8	(18.4)	(11.7)	9.5	(2.2)	(3.0)
REGIONS												
7. Eastern Region	1,580	2,030	1,903	2,070	1,704	2,410	28.5	(6.3)	8.8	(17.7)	41.4	11.0
8. Central Region	3,573	3,441	3,051	2,721	2,988	2,426	(3.7)	(11.3)	(10.8)	9.8	(18.8)	(7.0)
9. Western Region	1,318	1,742	1,623	1,459	1,996	1,926	32.2	(6.8)	(10.1)	36.8	(3.5)	9.7
10. Mid-Western Region	1,353	2,416	1,655	1,898	2,031	2,033	78.6	(31.5)	14.7	7.0	0.1	13.8
11. Far-Western Region	1,662	1,772	1,604	1,640	2,221	2,746	6.6	(9.5)	2.2	35.4	23.6	11.7
12. Sub-Total (2)	9,486	11,401	9,836	9,788	10,940	11,541	20.2	(13.7)	(0.5)	11.8	5.5	4.6
Grand Total	20,477	23,249	19,501	18,326	20,287	20,680	13.5	(16.1)	(6.0)	10.7	1.9	0.8

Source: Budget Expenditure Data of the Department of Hydrology and Meteorology.

Note: Figures in ( ) indicate negative.

Table 2.3.1 ESTIMATED BUDGET EXPENDITURE OF MOWR, DHM, DOI, NEA AND WECS, 1995/96 - 2010/11

Unit: Thousand NRs.

Items	1995/96	2000/01	2005/06	2010/11
MWR				
Regular	7,797	15,013	25,298	42,629
Development	-	-	-	-
Total	7,797	15,013	25,298	42,629
DHM				
Regular	10,358	23,696	47,661	95,863
Development	33,978	77,733	156,349	314,474
Total	44,336	101,429	204,010	410,337
DOI				
Regular	22,940	67,253	174,437	452,444
Development	3,916,816	11,482,635	29,782,999	77,249,429
Total	3,939,756	11,549,888	29,957,436	77,701,873
NEA				
Regular	-	-	-	-
Development	7,613,046	42,428,145	212,348,636	1,062,783,755
Total	7,613,046	42,428,145	212,348,636	1,062,783,755
WECS				
Regular	3,529	6,795	11,450	19,293
Development	5,212	10,035	16,910	28,495
Total	8,741	16,830	28,360	47,788

Table 2.3.2   ESTIMATED DEVELOPMENT BUDGET EXPENDITURE BY
               DIVISION AND REGION IN THE DHM, 1995/96-2010/11

Unit: Thousand NRs.

Division or Region	1995/96	2000/01	2005/06	2010/11
DIVISIONS				
1. Director General & Secretariat	NA	NA	NA	NA
2. Hydrology Division	12,591	28,804	57,935	116,529
3. Administration & Account Division	NA	NA	NA	NA
4. Technical Service Division	NA	NA	NA	NA
5. Climatology Division & Meteorology and Weather Forecasting Division	2,425	5,548	11,159	22,445
6. Sub-Total (1)	15,016	34,352	69,095	138,974
REGIONS				
7. Eastern Region	3,960	9,059	18,221	36,648
8. Central Region	3,986	9,119	18,342	36,891
9. Western Region	3,164	7,240	14,561	29,288
10. Mid-Western Region	3,340	7,642	15,370	30,915
11. Far-Western Region	4,512	10,322	20,761	41,758
12. Sub-Total (2)	18,962	43,381	87,255	175,500
Grand Total	33,978	77,733	156,349	314,474

APPENDIXES

APPENDIX - 1

QUESTIONNAIRE

Appendix-1. QUESTIONNAIRE

1. The Eight Plan (1991-1995) of the following organs:

    Ministry of Water Resources (MWR)
    Department of Hydrology and Meteorology (DHM)

2. Laws and Regulations related to establishment, management and operation of the DHM.

3. Concerning numbers of current employees and budget expenditures of the following organs for the period from the fiscal year 1987/88 to 1991/92, please fill the blanks in the attached Table I:

    (1) Department of Hydrology and Meteorology,
    (2) Department of Irrigation,
    (3) Nepal Electricity Authority, and
    (3) Other Organs in the Ministry of Water Resources.

4. Please fill the blanks in the attached Table II, with regard to purposes, functions and numbers of employees of each organ in the DHM.

5. Regarding the budget expenditures of each organ in the DHM for the period from the fiscal year 1987/1988 to 1991/1992, please fill the blanks in the attached Table III.

6. Regulations of travel allowances for the official trip of the DHM.

7. Names, purposes and functions of lower organizations (for example, unit, section, etc.) administrated by the Divisions in the central office of the DHM, if any.

8. An agreement between the DHM and other agencies such as the Department of Irrigation and the Nepal Electricity Authority, concerning mutual utilization of hydrological and meteorological data.

APPENDIX - 2

REFERENCES

Appendix-2. REFERENCES

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ANNEX B

HYDROLOGY AND METEOROLOGY

NATIONWIDE HYDRO-METEOROLOGICAL DATA MANAGEMENT PROJECT

ANNEX B HYDROLOGY AND METEOROLOGY

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1. GENERAL

1.1 Physical Features of Nepal

Nepal is a mountainous country stretched over 147,181 km². The country shares a common boundary with India on the east, south and west. Its northern boundary is with the Tibetan Region of China. The country lies between latitudes 26°22' and 30°27' north and longitudes 80° 04' and 88° 12' east with the length of about 870 km on an average from east to west and width of 130 to 260 km from south to north.

The topographic features of Nepal are so persistent along the length of the country that cross sections do not differ radically. Nepal is usually divided into five topographical regions from south to north as follows and shown in Fig. 1.1.

Terai

Siwalik Ranges

Middle Mountains

High Mountains

High Himalaya

(1) Terai

The Terai is the Ganga plain within Nepal, lying at altitudes of 60 to 200 m. Nepal includes three discontinuous segments of the Terai Belt along its southern border, with widths ranging up to 50 km. The northern fringe of the Terai is covered by comparatively heavy jungle and extends to the base of the Siwalik Ranges. The southern fringe has sparse jungle. The soils of the Terai are developed on alluvium.

(2) Siwalik Ranges

The Siwalik forms a sharp contrast to the Gangetic plain and rises steeply to altitudes up to 1,800 m. In most places, the elevations are between 300 m and 1,500 m. The region is mainly covered by sterile soils formed largely from coarse grained sandstone, and as a result cultivation is very limited. Its slopes are highly eroded by wind and water and the forests are less dense.

(3) Middle Mountains

The region includes areas within the Mahabharat Ranges and intermountain area and is characterized by moderately high mountains, of which the peaks are between 1,500 m and

2,500 m and midlands of gentle slope. Geologically, it is a region of moderately metamorphosed sedimentary material. The Mahabharat Ranges form a major syncline that traverses almost the entire length of the country. Runoff from the northern slopes of the Ranges passes south through four deep gorges of rivers, Sapta Koshi river, Gandaki river, Karnali river and Mahakali river. The midlands are heavily populated and favorable for agriculture.

(4) High Mountains

The region is characterized by high mountains with steep slopes and narrow valleys. Elevation of the river valleys is usually over 2,000 m. The mountain tops are commonly above 4,000 m in this region. In the less steeply sloping areas cultivation extends to 2,500 m or 2,700m. Steeper areas are forested.

(5) High Himalaya

The northern part of the country comprises the Himalayan Ranges. The Himalaya is not a single continuous mountain range but a series of several more or less parallel or converging ranges. West of Mount Everest the main range lies within Nepal, and is divided into several groups by deep river gorges that traverse the barrier. The main range, called Great Himalaya, includes many of the highest peaks of the world, with altitudes ranging from 7000 m to 8848 m. This main range is not a major drainage divide. The divide between the two major river systems, the Ganges and the Brahmaputra, lies to the north of the Great Himalaya along a mountain chain with altitudes 2300 to 3000m lower than the main range. The headwaters of the Sapt Kosi, the Gandaki and the Karnali Rivers have their origin north of the Great Himalaya and pass through it in deep gorges. In general, runoff from the area north of the Great Himalaya is low. The winter is bitter and hostile and the summer is short and moderately cold.

Nepal is divided into five physiographic divisions, which are running nearly in parallel bands from north-west to south-east. Every region has a distinct geological characteristics. The main characteristics of each region are tabulated below.

Physiographic Region	Elevation	Geology
1. Terai zone	60 m - 330 m	Quaternary alluvium
2. Siwaliks zone	200 m - 1500 m	Tertiary sand stone, Silt Stone, Shale and Conglo-merates.
3. Middle Mountains zone	800 m - 2400 m Relief 1500m with isolated peaks to 2700 m	Phyllite, quartzite,Lime- stone and islands of granites.
4. High mountain zone	2200 m - 4000 m Heigh relief 3000m from valley floor to ridge	Gneiss, quartzite, and mica schists
5. High Himalaya	4000 m + stone and Tethys sediments	Gneiss, schist, lime-

Source: Land Resource Mapping Project, Geology Report, 1986.

Fig.1.2 and 1.3 show general geological condition.

1.2 General Climatological Features

In Nepal, there are five major climatological zones: subtropical, warm temperature, cool temperature, alpine, and arctic.

The climate of the Terai and the Siwalik is subtropical. Rainfall concentrates in the monsoon months. Winter temperatures are mild. The climate in the Middle Mountains is warm temperature. In winter there is an occasional snowfall in the highest areas.

The climate in the High Mountains is cool temperature. Snow occurs in the winter months and persists on the mountain tops throughout the winter. Alpine climate appears in the higher mountain regions with low temperature in summer and an extremely frosty condition in winter. Arctic climate is above snow line where there is perpetual frost.

The annual mean precipitation is around 1,530 mm in Nepal. The seasonal variation of rainfall in Nepal is attributable to the south-east monsoon during the months of June to September. More than 75% of rainfall occurs during this period. It is of longer duration in eastern Nepal than in the western area. The general characteristics of rainfall are shown in Fig. 2.2.

Heaviest rainfall is recorded along the southern margin of the Great Himalaya Range reaching 5,000 mm yearly and along the southern foot of the Siwaliks or the Mahabharat Ranges. Drier

conditions prevail in the lee of these regions. Thus alternate bends of comparatively moist and dry conditions occur parallel to the mountain ranges.

Rains occur in winter in Nepal. They being originated in the Mediterranean region are significant especially in the western Nepal.

Monthly mean precipitations are tabulated below for three (3) stations:

(Unit : mm)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Kathmandu (1030)	14	16	32	56	103	248	364	299	192	68	7	12	1410
Mustang (612)	10	8	4	3	1	9	54	55	15	9	2	8	177
Lumle (814)	30	34	45	110	287	784	1,401	1,230	823	218	29	17	5,010

Source: DHM

Air temperature rises usually during the premonsoon period in February to May. It decreases during postmonsoon period in October to January. The maximum and minimum temperatures appear in July and January, respectively. Spatial variations in air temperatures are influenced by altitude.

The monthly mean temperatures are shown below for three (3) stations :

(Unit: degree centigrade)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Surkhet (0406)	11.5	14.1	18.8	24.5	27.4	27.7	26.5	26.6	25.2	21.9	16.6	12.3	21.1
Kathmandu (1030)	9.4	11.2	15.5	19.2	21.6	23.0	23.4	23.3	22.0	19.0	14.0	10.2	17.7
Dhankuta (1307)	11.4	13.7	17.4	21.2	21.8	22.4	27.8	23.1	21.5	20.4	16.3	13.2	19.2

Source: DHM

Evaporation rates are highest just before the monsoon season, when saturation deficits are greatest. Higher evaporation rates are also seen during the monsoon season due to high temperature. Annual pan evaporation reaches around 1,400 to 1,900 mm according to records at Jumla, Okhaldhunga, Kathmandu, Chisapani and Pokhara.

1.3 General River Flow Condition

Rivers in Nepal are classified into three groups in terms of sources of dry season discharge. The first group of rivers have their sources in the snow and glaciers as well as baseflows from the High Mountains or High Himalaya in the dry season. The Karnali, the Gandaki, and the Sapta Koshi rivers are included in the first group.

The second group of rivers originate from the Middle Mountains. They are fed by ground water in dry seasons and do not dry up. Bagmati, Rapti, Mechi, Kankai and Babai are some of the second group of rivers.

The third group of rivers have their origins in the Siwalik Range or the Terai. Kamala, Tilawa, Sirsia, Manusmara, Hardinath, Sunsari and Banganga are some examples of this group. In dry season, these river discharges show extremely less than those in the other groups.

The concentrated runoff within three months of the year, viz., July, August and September, is typical of the rivers in Nepal. The discharge during these three months accounts for about 65% of the total annual runoff, while for the rivers with smaller drainage area the percentage rises to around 75%.

The general characteristics of runoff are shown in Fig. 3.2.

The monthly average runoff data are shown below for several stations:

(Unit : m^3/s)

St. River	Drainage Area (km^2)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
280 Karnali	42,890	369	335	347	442	701	1520	3310	4320	2990	1300	628	445	1400
360 Rapti	5,150	28	23	18	14	15	93	298	388	355	147	57	33	123
390 Tinau	554	4	3	2	2	2	15	58	108	47	25	8	5	24
450 Gandaki	31,100	353	288	266	349	558	1620	4280	4950	3450	1590	795	498	1590
589 Bagmati	2,700	18	14	11	12	23	98	398	364	370	90	30	22	122
695 Koshi	54,100	355	306	305	405	659	1610	3990	4220	3340	1450	769	495	1500
795 Kankai	1,148	12	9	8	11	21	72	198	145	106	51	23	15	56

Source: DHM

2. CLIMATE

2.1 Precipitation

The monsoon accompanies a general southeasterly humid airflow from the Bay of Bengal in summer season and as one progresses from east to west in Nepal. The date of onset of the monsoon comes later and the intensity decreases from east to west. The rainfall concentrates during the months from June to September in which more than 75% of annual rainfall occurs. The months of October to May are mainly dry and cloudiness is low, rain occurring sporadically during this period.

The spatial feature of the rainfall patterns is governed by topography, which causes significant local variations. There is an increase in rainfall in the Terai from south to north as the Siwalik ranges are approached. Areas close to the southern border with India receive 1,500 mm or less of annual rainfall, while at the foot of the Siwalik over 2,000 mm of rain falls. On the north side of the Siwalik, rainfall may diminish to the amount less than 1,000 mm. Total annual rainfall then increases again along a south to north traverse as the foot of the Great Himalaya range is approached.

The nation's highest total annual precipitation occurs at the foot of the Annapurna Himal. North of the Great Himalaya range, annual precipitation diminishes rapidly. Lowest total annual precipitation occurs in the upper valley of the Kali Gandaki basin.

Monthly mean precipitation is summarized in Table 2.1 for stations shown in Fig.2.1. The mean annual and monthly precipitation distributions are illustrated in Fig.2.2 and 2.3.

The rain is often associated with depressions which have travelled eastward from the Mediterranean Sea. Their influence tends to be stronger in the west than in the east as shown in Fig.2.2. The precipitation as hail during February and March is a local phenomenon all over Nepal.
The rainfall intensity records observed at Kathmandu show the value of 120 mm/hour for ten minutes and 41 mm/hour for one hour as shown in Fig.2.4.

The snowline has been assumed on the basis of temperature records by the Land Resource Mapping Project as given in Fig.2.5. The lowest snowline is estimated to be EL.3,460 m in January and the highest being EL.6,035 m in July based on mean monthly temperature, while the lowest and highest are EL.2,430 m and EL.5,200 m respectively according to minimum monthly temperature.

2.2 Temperature

Temperatures are lowest in winter and increase as spring advances. However,the onset of the monsoon checks the increase so that the highest mean temperatures of the year occur generally in May or June as seen in Table 2.2.

Good linear relationship between mean annual temperature and altitude has been found by some researches, giving a vertical temperature gradient of about 5 degrees Centigrade per km as shown in Table 2.3.

The hottest part of the country is in the Terai Belt where sometimes the temperature reaches 45°C. The daily mean temperature in the coldest month in the Terai is about 10°C.

The mean annual temperature is illustrated in Fig.2.6.

2.3 Humidity and Evaporation

Mean relative humidity in the morning is greater than in the afternoon. This difference is expected on the basis of diurnal temperature variations. Higher temperatures in the afternoon lead to lower relative humidity.

Seasonal variations in the relative humidity are related to the effects of the monsoon. In Kathmandu, the relative humidity reaches more than 80% in the monsoon season but it decreases to less than 50% in dry season.

The relative humidity record is shown in Table 2.4.

Evaporation rates are highest just before the monsoon season, when saturation deficits are greatest. Higher evaporation rates are also seen during the monsoon season due to the effect of high temperature. Based on the pan evaporation record,the annual pan evaporation reaches 1,400 mm to 1,900 mm.

3. RIVER FLOW

3.1 River Runoff and Seasonal Variation

Seasonal distribution of runoff is characterized by the discharge concentration within three months of the year, July, August and September. The discharge during these three months accounts for about 65% of the total annual runoff, while for the rivers with smaller drainage area the percentage rises to around 75% as seen in Table 3.1. Monthly mean runoff is illustrated in Fig.3.2. According to the records, annual mean discharges are 1,400, 1,590 and 1,500 m^3/s in Karnali, Gandaki and Koshi rivers, respectively which corresponds to 0.033, 0.051 and 0.028 m^3/s/Km^2. Bagmati and Kankai rivers discharge annual mean values of 122 and 50 m^3/S, which are equivalent to 0.045 and 0.049 m^3/s/Km^2.

3.2 Low Flow

Fig.3.3 shows a relationship between mean annual 30-day low flow and the drainage area for the Karnali, Gandaki, koshi and southern river basins. According to this figure. the low flow in the Gandaki and Koshi basins has similar characteristics. The low flow discharge in the southern basins is three to four times less than in the Gandaki and Koshi basins. The Karnali basin has tendency of low flow to decrease rapidly as decrease of the drainage area.

Fig.3.4 shows 10-year probable low flow for 7-day and 30-day durations. This figure. suggests the similarity of specific low flow in the Karnali, Gandaki and Koshi basins and less specific discharge in the southern basins.

3.3 Flood

Fig.3.5 and 3.6 show peak discharges of recorded and probable floods. Fig.3.5 shows linear relation between flood peak and drainage area for all the Karnali, Gandaki and Koshi basins. According to Fig.3.6, the specific discharges distribute within the Creager's curves with the coefficients of 5 and 45, and the difference is not clear among the basins.

4. RAINGAUGE NETWORK

Table 4.1 gives the density of rainfall observation station for each river basin. This Table indicates less mean density of about 1,100 Km^2/gauge in the Karnali basin comparing with the Gandaki and Koshi basins which have density of around 500 Km^2/gauge.

Table 4.2 shows list of ground elevation and annual rainfall at raingauges.

Fig.4.1 and 4.2 indicate a trial to obtain the relation between point rainfall and areal rainfall. The Kathmandu valley and Birganj area are selected for this study because of high density of gauge distribution. The catchment area of the valley is around 620 km^2 and 3,870 km^2, respectively.

Fig. 4.3 illustrates raingauge distribution relating to altitude with annual rainfall.

5. WATER LEVEL GAUGE NETWORK

Table 5.1 gives the density of water level gauge for each river basin in the country. According to the table, the density in the Karnali basin is generally less being 1,800 Km^2/gauge comparing with the Gandaki and Koshi basin which have density of 800-900Km^2/gauge. The southern border rivers have no water level gauges except for the group No. 1 & 3.

Fig. 5.1 shows drainage areas of the river basins and existing or proposed water level gauging stations. Fig. 5.2 gives a sample of relationship of selected water level gauges.

TABLES

Table 2.1 MONTHLY MEAN PRECIPITATION (1/5)

Unit: mm

Station No.	Record	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
MAHAKALI ZONE														
20101	1973-86	36	45	56	49	132	271	433	405	213	86	8	26	1758
20102	1973-86	44	53	62	52	139	206	352	264	171	62	8	35	1449
20103	1973-86	38	42	54	52	105	205	325	342	188	44	10	26	1430
20104	1970-86	43	55	64	61	78	206	340	295	182	53	8	25	1409
20105	1971-86	20	29	13	26	54	258	523	410	260	42	5	20	1660
20106	1963-86	25	32	18	23	49	282	506	446	275	57	7	17	1736
20107	1974-86	52	60	72	53	108	307	622	576	315	61	12	34	2273
20108	1976-86	49	49	63	67	123	190	387	352	188	54	9	35	1566
SETI ZONE														
20201	1973-86	52	49	72	60	140	319	539	507	287	70	10	36	2141
20202	1973-86	49	53	63	60	83	186	361	345	214	61	9	32	1517
20203	1973-86	41	50	54	45	103	221	295	257	189	66	8	33	1360
20204	1976-86	50	64	93	66	128	309	548	547	239	53	16	34	2146
20205	1973-86	36	40	56	38	99	286	308	307	231	57	7	23	1487
20206	1963-86	43	38	35	33	80	199	303	259	155	43	10	20	1216
20207	1976-86	37	16	22	19	63	239	545	433	299	55	3	18	1749
20208	1973-86	26	19	19	19	51	321	565	511	313	57	3	25	1928
20209	1971-86	22	21	13	23	51	279	487	390	294	58	5	16	1659
20210	1963-86	37	45	45	38	83	234	428	355	222	58	6	20	1572
20211	1976-86	29	44	57	124	208	382	764	741	481	46	21	45	2942
20212	1971-86	23	18	14	25	55	250	489	415	269	57	5	12	1633
20214	1975-86	41	46	56	37	99	304	490	442	244	54	13	35	1860
20215	1975-86	21	34	15	14	47	286	682	632	356	66	6	16	2174
20216	1975-79	3	34	48	17	41	251	464	401	281	12	0	10	1561
20217	1976-86	49	54	64	49	129	194	328	315	186	66	12	42	1488
20218	1982-86	39	33	37	57	111	182	276	216	221	92	2	40	1307
KARNALI ZONE														
20301	1973-86	26	40	39	24	34	52	123	133	65	39	14	20	608
20302	1972-86	43	41	53	50	58	78	104	111	79	39	8	26	690
20303	1972-86	32	47	63	50	64	77	183	198	113	44	9	20	899
20304	1976-86	23	22	46	48	85	126	272	253	135	39	9	18	1078
20305	1967-86	54	47	41	59	109	226	389	313	172	68	6	18	1503
20306	1971-86	32	32	42	41	46	76	214	223	123	35	8	16	887
20307	1971-86	25	44	31	36	69	98	219	224	104	28	2	37	917
20308	1971-86	46	52	61	53	61	77	131	125	99	52	9	22	787
20309	1973-86	49	57	56	54	123	131	237	232	159	55	16	25	1194
20310	1973-86	37	40	63	47	58	98	239	226	120	33	17	11	988
20311	1974-86	32	62	54	24	55	60	111	118	106	72	8	31	733
20312	1976-86	20	11	27	27	52	46	84	68	60	30	6	15	446
20313	1979-86	39	46	85	71	78	87	388	289	170	61	22	23	1359
BHERI ZONE														
20401	1965-86	39	34	33	25	64	283	455	358	251	52	5	20	1621
20402	1974-86	39	32	40	34	96	216	525	466	237	45	13	23	1765
20403	1963-86	35	35	25	26	77	283	479	406	252	44	5	14	1682
20404	1973-86	33	29	38	34	74	295	551	508	305	112	10	27	2014
20405	1963-86	36	27	26	23	58	307	677	633	356	57	9	19	2228
20406	1973-86	34	29	31	25	70	239	453	426	213	64	10	20	1613
20407	1974-86	10	7	7	10	65	128	294	233	226	34	7	16	1037
20408	1972-86	24	18	12	12	46	207	450	295	309	67	3	12	1453
20409	1968-86	23	18	11	21	48	215	438	322	268	67	5	12	1446
20410	1967-86	32	21	28	26	53	169	252	204	146	66	4	13	1014
20411	1977-86	40	15	13	16	50	216	499	357	260	62	7	16	1550
20412	1972-86	27	12	9	10	38	223	480	332	211	54	3	11	1410
20413	1971-86	37	24	11	14	66	304	608	505	277	78	6	11	1941
20414	1972-86	22	25	14	13	39	158	283	269	232	31	17	15	1118
20415	1972-86	24	17	11	12	43	175	380	301	234	58	5	14	1275
20416	1976-86	27	18	15	14	55	161	445	317	311	64	6	19	1452
20417	1976-86	15	23	4	12	61	129	418	400	180	37	1	15	1295
20418	1975-86	47	24	36	44	85	184	375	390	248	76	16	38	1561
20419	1978-86	18	18	8	18	47	213	429	373	316	62	9	20	1532
RAPTI ZONE														
20501	1980-86	37	38	61	38	109	213	503	511	236	136	77	29	1986
20502	1973-86	34	31	54	59	103	213	361	345	202	53	13	22	1489
20504	1973-86	29	36	40	43	119	305	451	402	302	69	7	22	1825
20505	1973-86	27	19	25	31	87	252	328	257	218	61	9	16	1328
20507	1971-86	24	23	13	20	72	242	413	350	288	56	14	16	1529

Table 2.1 MONTHLY MEAN PRECIPITATION (2/5)

Unit: mm

Station No.	Record	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
20508	1971-86	28	24	12	20	82	311	454	390	325	84	9	16	1757
20509	1971-86	28	25	12	26	94	345	499	445	352	100	10	17	1952
20510	1971-86	15	30	19	19	44	258	476	324	300	64	14	16	1579
20511	1972-86	35	30	28	31	70	170	278	205	166	54	8	17	1093
20512	1972-86	34	29	38	25	73	211	339	225	194	53	10	26	1257
20513	1975-86	23	19	27	31	81	181	344	332	197	65	10	24	1333
20514	1974-86	24	19	29	40	111	273	555	511	291	62	11	24	1949
20515	1971-86	23	21	12	29	92	312	529	475	388	114	9	15	2017
DHAULAGIRI ZONE														
20601	1973-86	7	8	22	16	17	25	43	30	47	36	5	3	259
20603	1970-77	-	-	6	93	60	242	434	346	123	30	1	0	-
20604	1968-86	9	13	30	25	29	50	60	55	57	44	10	4	387
20605	1969-86	21	18	20	53	146	246	514	404	268	82	10	15	1800
20606	1969-86	20	22	43	73	134	227	359	295	200	77	9	11	1469
20607	1969-86	27	50	78	86	107	153	231	196	149	64	15	14	1170
20608	1969-86	9	15	17	14	12	34	113	96	48	23	6	10	397
20609	1956-86	24	23	32	43	82	199	388	365	214	68	7	10	1455
20610	1973-86	13	14	13	7	13	11	46	44	19	30	1	11	220
20611	1973-86	10	8	4	3	1	9	54	55	15	9	2	8	177
20612	1974-86	10	8	4	3	1	9	54	55	15	9	2	8	177
20613	1977-86	28	29	29	87	177	359	609	504	348	56	15	34	2275
20614	1969-86	23	20	31	76	167	371	639	499	353	104	6	16	2306
20615	1978-86	26	31	35	44	108	451	684	662	485	78	10	29	2643
20616	1979-86	35	21	37	43	66	283	567	496	339	80	13	13	1994
20619	1976-86	31	28	23	97	150	372	761	641	430	104	6	20	2664
LUMBINI ZONE														
20701	1972-86	19	23	14	45	115	255	446	247	290	54	13	22	1545
20702	1972-86	17	32	13	29	74	228	487	258	262	41	3	26	1470
20703	1972-86	13	15	15	20	93	375	722	489	455	142	5	18	2363
20704	1972-86	21	12	19	57	152	413	794	501	462	123	6	22	2582
20705	1970-86	16	9	15	17	56	282	554	334	281	69	6	12	1651
20706	1974-86	17	8	17	57	138	405	665	430	385	85	7	22	2235
20707	1971-86	15	13	15	19	58	305	509	326	330	85	5	15	1694
20708	1971-86	17	16	18	25	70	347	614	371	340	79	8	18	1924
20710	1971-86	14	12	16	33	98	317	656	416	368	96	5	20	2050
20711	1971-72	0	49	-	-	100	391	607	412	495	229	116	0	-
20712	1971-86	0	30	15	4	73	321	542	308	375	122	0	0	1789
20713	1971-73	24	27	25	127	235	482	629	460	436	201	13	0	2658
20714	1971-72	1	24	22	180	282	665	783	602	525	260	29	0	3372
20715	1971-86	27	26	24	30	108	300	486	347	367	88	11	27	1840
20716	1971-86	23	16	19	28	60	243	576	322	286	74	5	12	1664
20719	1971-72	0	23	10	5	62	274	386	379	356	45	0	0	1539
20720	1971-72	0	36	25	10	36	271	626	382	337	27	0	0	146
20721	1973-86	19	14	11	19	84	367	699	565	467	99	23	26	2394
20722	1972-86	22	25	29	76	183	382	528	451	328	105	8	21	2158
20723	1975-86	19	12	16	18	65	251	661	366	328	72	6	21	1833
20724	1972-86	16	15	15	19	74	234	559	483	384	89	0	2	1889
20725	1981-86	35	18	25	57	161	637	490	340	418	70	24	35	2310
20726	1981-86	19	8	24	75	172	343	523	274	335	63	14	19	1871
20727	1981-86	25	7	11	33	75	334	634	281	452	63	6	17	1938
20728	1981-86	16	12	22	25	103	353	671	372	407	64	7	21	2071
GANDAKI ZONE														
20801	1972-86	32	49	81	77	62	177	335	263	164	48	13	16	1318
20802	1972-86	26	45	69	97	222	519	881	772	505	122	23	17	3298
20804	1969-86	24	31	54	124	329	659	912	806	616	189	24	22	3789
20805	1973-86	25	31	45	113	302	535	699	599	417	128	16	18	2926
20806	1978-85	65	74	119	54	89	125	160	146	134	86	27	31	1108
20807	1972-86	23	35	53	116	317	467	625	534	380	129	15	15	2709
20808	1972-86	25	21	21	95	271	357	460	347	245	46	7	20	1914
20809	1974-86	16	16	38	77	188	333	503	372	256	64	10	25	1898
20810	1972-86	21	19	19	57	161	328	524	314	341	77	10	19	1892
20811	1968-86	19	30	54	125	300	595	847	763	563	191	26	19	3531
20813	1985-86	16	36	30	102	295	725	1248	799	726	224	30	69	4298
20814	1970-86	30	34	45	110	287	784	1401	1230	823	218	29	17	5010
20815	1972-86	18	24	30	117	293	410	521	389	315	87	24	20	2249
20816	1974-86	29	40	95	44	48	112	200	147	146	63	9	22	953
20817	1978-86	12	17	23	93	258	328	443	235	266	59	1	30	1765

Table 2.1   MONTHLY MEAN PRECIPITATION (3/5)

Unit: mm

Station No.	Record	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
20818	1972-86	33	34	61	149	358	746	1108	998	741	203	28	18	4476
20820	1976-86	21	21	46	28	27	51	63	65	84	39	10	15	471
20821	1976-86	28	58	75	135	221	484	936	790	397	167	19	27	3337
20823	1976-86	17	39	58	91	165	380	771	706	367	178	19	22	2812
20824	1977-86	59	80	151	190	306	508	937	818	506	124	48	33	3761
					NARAYANI	ZONE								
20902	1967-86	21	12	17	47	129	360	555	398	300	79	7	15	1939
20903	1972-86	17	17	20	48	120	301	523	429	364	89	9	21	1958
20904	1972-86	16	19	40	87	153	374	622	433	408	87	11	18	2268
20905	1969-86	18	22	30	94	174	314	517	350	293	68	9	18	1905
20906	1967-86	17	14	31	54	146	378	609	493	390	86	15	13	2248
20907	1972-86	14	14	12	46	112	377	634	428	394	101	9	15	2157
20909	1971-86	16	14	15	54	121	276	564	340	289	91	5	11	1796
20910	1972-86	16	10	19	49	145	307	597	343	360	86	16	13	1962
20911	1967-86	15	15	15	36	85	263	432	275	245	69	5	10	1464
20912	1972-86	15	9	16	35	116	265	538	339	297	94	4	13	1742
20914	1973-86	1	0	21	135	154	689	380	508	407	685	15	0	2995
20915	1972-86	17	24	27	79	128	242	363	288	271	72	6	24	1540
20916	1974-86	14	8	7	39	97	334	681	453	349	75	0	7	2065
20917	1974-86	8	7	18	56	137	378	586	452	417	61	6	13	2138
20918	1974-86	13	10	17	28	80	233	469	274	214	66	4	15	1423
20919	1975-86	15	11	19	62	119	280	540	342	245	56	14	21	1722
20920	1975-86	15	10	17	65	128	300	572	485	392	79	11	12	2086
20921	1976-86	12	14	17	42	141	258	588	298	274	48	6	22	1720
20922	1983-86	34	12	0	71	161	227	369	396	265	98	3	22	1656
					BAGMATI	ZONE								
21001	1973-86	23	20	33	34	49	91	161	145	94	39	13	19	720
21002	1972-86	27	41	53	112	206	416	742	706	395	73	21	12	2805
21003	1971-80	13	17	25	27	97	348	453	427	232	114	7	8	1769
21004	1972-86	16	17	33	62	90	330	536	506	293	74	9	18	1984
21005	1972-86	22	30	40	70	223	339	578	515	409	58	14	17	2315
21006	1972-86	23	30	51	98	193	617	954	955	616	207	37	20	3799
21007	1962-86	16	22	40	63	149	451	672	752	461	101	9	15	2751
21008	1972-86	16	18	33	62	118	393	678	617	393	100	8	19	2455
21009	1972-86	10	20	33	57	122	320	590	572	345	60	14	19	2163
21012	1940-66	21	21	31	65	117	331	574	626	275	54	6	3	2124
21013	1971-77	13	17	38	70	171	390	559	547	331	76	21	10	2242
21015	1967-86	17	20	40	85	148	307	509	429	330	89	15	31	2020
21016	1972-86	28	34	49	82	170	678	1158	1058	573	136	26	13	4005
21017	1971-86	14	22	37	80	135	393	649	599	345	85	17	17	2391
21018	1971-86	9	15	33	70	95	329	474	417	271	77	10	15	1815
21019	1968-69	27	6	47	28	85	518	887	671	330	83	2	1	2684
21020	1972-86	9	13	17	43	74	187	305	215	139	32	7	7	1048
21022	1952-86	23	19	33	55	121	325	501	454	272	67	4	14	1889
21023	1972-86	13	13	26	58	95	219	336	251	206	66	7	18	1308
21024	1972-86	13	19	30	70	104	255	447	325	254	83	7	17	1622
21025	1977-86	5	18	41	64	85	481	902	717	376	64	6	24	2781
21027	1967-86	13	20	43	102	154	463	741	713	372	96	14	9	2739
21028	1967-86	10	11	20	49	83	164	232	182	155	51	6	14	977
21029	1968-86	13	17	21	60	97	213	327	248	168	62	4	15	1244
21030	1968-86	14	16	32	56	103	248	364	299	192	68	7	12	1410
21034	1969	23	2	71	118	44	69	459	404	253	34	11	0	1488
21035	1971-86	10	28	29	57	139	334	539	488	287	82	9	11	2013
21036	1971-86	7	12	24	50	90	203	291	252	185	64	6	16	1201
21038	1971-86	11	15	23	53	138	275	408	334	225	66	5	19	1571
21039	1971-86	13	18	20	81	121	272	376	346	212	69	9	12	1549
21040	1972	2	-	-	-	14	162	355	242	84	105	20	3	-
21041	1972	8	11	99	37	50	240	568	284	-	-	-	-	-
21042	1971	-	-	-	-	-	501	248	223	26	194	0	0	-
21043	1971-86	9	18	28	56	127	327	490	437	270	87	6	11	1865
21044	1971	-	-	-	-	-	471	388	476	150	94	0	0	-
21046	1971	-	-	-	-	87	421	208	179	40	124	13	0	-
21047	1972-86	23	16	22	30	98	237	327	265	195	52	3	2	1271
21048	1972	11	41	-	-	74	401	880	453	493	155	48	3	-
21049	1971-86	17	16	27	61	116	240	357	258	226	83	5	12	1420
21050	1972	0	31	48	25	152	103	481	153	154	86	23	0	1256
21051	1972-72	8	28	115	40	113	591	607	457	206	154	4	0	2322

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Table 2.1 MONTHLY MEAN PRECIPITATION (4/5)

Unit: mm

Station No.	Record	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
21052	1971-86	13	21	30	59	141	281	406	352	214	78	3	15	1613
21054	1972-86	34	37	59	47	65	205	337	304	196	83	29	20	1415
21055	1972-86	59	77	72	110	94	236	363	382	232	131	46	41	1844
21056	1973-85	73	25	21	85	208	365	636	892	375	52	5	1	2738
21057	1973-86	17	23	38	88	191	513	833	751	497	108	17	17	3093
21058	1973-86	25	29	57	73	173	509	1017	849	504	97	7	21	3360
21059	1974-86	18	17	25	59	138	244	432	416	226	69	5	20	1669
21060	1976-86	13	15	21	57	89	243	360	313	248	52	6	28	1447
21061	1976-86	12	12	16	66	111	232	365	301	167	57	6	18	1363
21062	1981-86	14	9	15	68	116	224	385	347	246	80	11	13	1527
JANAKPUR ZONE														
21101	1973-86	9	15	19	91	143	266	445	348	237	63	13	10	1658
21102	1972-86	13	23	32	78	162	313	553	494	293	87	16	16	2080
21103	1962-86	14	20	42	79	148	359	588	574	319	83	15	11	2251
21104	1972-86	12	18	25	66	322	262	428	351	239	58	10	14	1805
21106	1972-86	13	9	18	39	86	128	269	169	142	40	12	12	936
21107	1973-86	26	12	32	133	242	468	736	592	578	152	18	19	3008
21108	1972-86	19	14	26	81	171	326	523	291	309	90	16	19	1885
21109	1972-86	13	8	16	53	130	312	588	407	359	119	10	12	2026
21110	1973-86	7	6	14	40	135	226	438	335	284	78	7	11	1580
21111	1969-86	9	10	13	35	88	190	389	241	186	70	4	12	1246
21112	1972-86	14	12	11	54	115	231	461	296	303	94	5	9	1606
21114	1969-86	10	11	15	43	92	227	371	264	164	67	7	4	1274
21115	1972-86	14	10	22	40	89	140	269	148	174	35	2	18	960
21116	1972-74	11	19	60	23	138	288	707	739	657	125	13	1	2781
21117	1978-86	9	15	16	76	165	442	780	482	370	64	7	21	2448
21118	1979-81	0	5	17	9	56	208	445	341	220	41	5	13	1360
21119	1979-86	11	9	11	25	91	135	300	284	219	83	6	15	1190
21120	1983-86	19	37	1	32	111	150	507	281	254	140	2	22	1555
21121	1984-86	6	11	3	43	69	170	402	262	272	63	0	18	1318
SAGARMATHA ZONE														
21201	1971-82	17	13	30	24	47	143	238	245	157	106	19	10	1048
21202	1973-86	17	37	23	67	109	274	585	480	305	90	15	17	2018
21203	1973-86	13	11	27	45	87	270	527	424	259	79	8	16	1765
21204	1973-86	17	12	32	46	183	400	559	450	346	104	24	19	2193
21206	1973-86	12	12	24	50	135	299	454	341	277	87	13	15	1719
21207	1973-86	10	10	17	55	108	168	295	194	173	51	6	11	1098
21210	1971-86	13	7	17	38	86	131	284	145	149	37	6	16	928
21211	1973-86	15	11	18	41	103	206	366	150	186	40	3	12	1150
21212	1981-86	11	4	4	32	90	229	361	198	281	58	7	20	1295
21213	1972-86	13	17	22	65	161	330	538	381	354	115	12	13	2021
21215	1972-86	14	13	13	32	139	267	417	260	252	72	11	13	1501
21216	1972-86	14	14	9	29	113	220	423	255	232	67	9	11	1397
21217	1968-86	11	18	17	25	34	121	203	169	115	48	6	10	776
21218	1967-79	16	23	30	27	28	144	263	253	139	71	7	1	1003
21219	1973-86	11	14	19	51	89	264	482	430	302	78	5	13	1758
21220	1967-86	11	9	31	52	92	291	527	496	296	91	10	6	1912
21222	1973-86	10	14	19	61	138	283	382	277	234	70	7	13	1506
21223	1972-86	5	13	10	34	95	243	395	215	264	64	10	12	1360
21224	1973-86	13	17	31	63	138	295	516	499	310	60	12	13	1967
21225	1973-79	21	22	19	25	30	129	236	220	141	68	8	17	936
21226	1976-86	10	17	19	39	157	176	524	240	263	92	11	23	1571
KOSHI ZONE														
21301	1973-86	17	51	75	269	548	902	824	649	536	318	46	18	4251
21303	1974-86	10	11	32	103	185	225	304	239	202	57	18	15	1402
21304	1976-86	10	12	28	55	141	253	439	319	201	67	11	19	1553
21305	1973-86	9	7	22	80	188	145	218	137	293	59	7	6	1171
21306	1973-86	12	8	24	61	111	222	326	208	151	59	6	13	1199
21307	1971-86	13	11	19	60	104	175	272	116	132	63	8	11	983
21308	1973-86	8	12	20	56	128	183	331	136	155	54	11	12	1105
21309	1973-86	9	16	15	44	141	310	507	264	290	110	8	10	1726
21311	1973-86	7	19	14	71	157	421	633	444	405	160	9	11	2352
21312	1973-86	8	10	12	59	169	359	609	327	343	100	11	16	2022
21313	1949-63	24	5	11	34	119	296	473	414	301	94	3	0	1775
21314	1971-86	4	6	22	101	156	141	191	128	114	51	8	10	932
21315	1973-76	8	8	6	96	188	286	265	260	223	135	2	0	1474
21316	1973-86	11	13	14	55	144	406	597	405	352	136	18	11	2161

Table 2.1 MONTHLY MEAN PRECIPITATION (5/5)

Unit: mm

Station No.	Record	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
21317	1974-86	45	75	118	164	255	418	519	433	353	166	53	28	2627
21318	1971-86	16	12	23	62	112	209	310	134	141	81	8	10	1117
21319	1971-86	10	8	18	47	157	339	505	289	286	95	11	8	1772
21320	1970-86	11	9	10	61	136	316	525	270	276	96	11	15	1735
21321	1977-86	8	9	22	89	190	205	263	210	223	66	19	17	1319
21322	1974-86	8	16	12	46	148	289	446	204	224	62	8	8	1473
21323	1983-86	13	17	3	48	195	385	668	309	480	164	10	23	2311
21324	1976-86	9	9	34	81	167	207	315	170	182	108	16	18	1315
21325	1976-86	10	11	31	87	214	294	448	346	300	84	17	14	1856
MECHI ZONE														
21401	1975-86	21	49	77	32	90	166	257	227	269	4	0	10	1200
21403	1974-86	15	28	54	109	129	343	503	439	325	116	19	20	2101
21404	1974-86	13	26	55	123	205	453	651	560	400	126	26	21	2659
21405	1978-86	10	17	42	153	234	315	447	352	295	84	21	22	1992
21406	1974-86	12	21	45	142	220	318	502	350	319	119	19	22	2089
21407	1970-86	9	11	17	73	134	287	473	250	231	76	8	9	1577
21408	1972-86	11	13	15	61	164	434	663	409	379	133	17	13	2312
21409	1973-86	11	9	17	51	194	438	747	403	354	105	16	18	2363
21410	1968-86	11	9	17	51	194	438	747	403	354	105	16	18	2363
21411	1967-86	10	13	37	75	151	449	719	419	451	125	10	13	2472
21412	1971-86	6	14	9	56	172	394	737	343	454	105	8	9	2306
21415	1972-86	11	13	19	60	201	508	850	438	411	132	22	9	2672
21416	1972-86	16	24	33	103	228	544	875	556	481	163	16	22	3062
21417	1973-81	14	12	62	131	360	505	727	677	394	175	33	22	3113
21419	1978-86	7	10	21	90	144	140	363	219	183	45	12	16	1248
21420	1974-86	7	10	29	111	216	269	341	271	238	68	17	12	1592
21421	1984-86	0	16	25	77	231	460	751	291	526	148	5	40	2569

Remarks:

(1) The first digit "2" in the station number represents a station established by HMG/N.

(2) The annual values are estimated by summing up the monthly mean values before rounding off to the nearest digit.

(3) " - " means that no record is available.