4. SOCIO ECONOMY

4.1 Socio-Economic Situation

4.1.1 Overview of the Country/Terai

(1) The Country

Nepal is a landlocked country with a total area of 147,181 km^2. The country is composed of three ecological zones, the Terai plain in the south, the middle hills, and the mountains of the Himalayas. The current (1998) estimated population is 21 million (as of 1995), with an annual growth rate of about 2.5 %. Social and economic situation of Nepal is summarized in Table B4.1.

Nepal, with a per capita income of around US$ 200 per annum, is classified as one of the least developed countries (LDCs) in the world. The GDP growth rate has been between 4 to 5% per annum over the past 10 years.

Moreover, in Nepal, about 40% of the population live in absolute poverty. About four-fifths of the total population has little access to sanitation, and nearly half are deprived of potable water. Other indicators of social development in Nepal are not encouraging as well, e.g. life expectancy (about 50 years), and infant mortality (almost 100 per 1,000 live births). Accordingly, the UNDP's Human Development Report 1997 ranked Nepal among 25 countries with the lowest Human Development Index.

Like other LDCs, Nepal is a predominantly agrarian economy. The share of the agriculture sector in Nepal's GDP is between 40 and 50 % (Table B4.1). In addition, more than 80 % of the labor force is dependent upon agriculture. On the other hand, the industrial sector is comparatively small by international standards, and in recent years, the sector's share of GDP is approximately 20%, but industrial workers comprise only about 3 % of the total labor force.

(2) The Terai

The Terai, which is an extension of India's Gangetic plains, is a narrow tropical belt, ranging in altitude from 50 m below to 300 m above sea level (MSL). It extends along

the southern boundary of the country, and borders with India.

The Terai plain is called the "granary of Nepal", because of the significant contributions the Terai makes to the overall agricultural production. As shown in Table B4.2(a), almost a half of the country's cultivated land, which occupies only 23% of the total surface area, is in the Terai. Moreover, farmers in the Terai produce nearly 60 % of the country's food grain production.

The reasons for this high production potential include its sub-tropical climate favourable for farming, better irrigation potentials, and its fertile land. The marketing potential for the Terai's produce is also greater in comparison with the rest of Nepal, since its terrain is less rugged, and the road network is relatively extensive.

The major pattern of the population flow in Nepal is from the mountain/hill regions to the Terai (Table B4.2(b)). As a result, the Terai has a population growth rate nearly three times as rapid as that of the hill and mountain areas. The Terai's population increased from 38% (4,345,000) of the whole country in 1971 to 47 % (8,815,000) by 1991 as shown in Table B4.2(c). The population of the Terai is anticipated to double in 20 years, while that of Nepal is expected to double in about 35 years.

The in-migration to the Terai has been accommodated mostly by bringing new land into cultivation. When the southern plains were sparsely inhabited jungles during early years of colonization, new migrants were required simply to clear a patch of abundant forests. However, as the "land frontier" was closed in more and more places, new migrants are increasingly required to settle in flood-prone areas adjacent to the rivers.

Much of the cultivated land in the Terai is already double cropped, and also there exists a significant amount of triple cropping. Still, as the population pressure is likely to continue mounting for some time to come, further efforts to intensify agricultural production are required, in order to slow the process of expansion of settlements and cultivated areas into the flood plains.

4.1.2 Study Area

(1) Overall Picture

There are 10 districts through which the selected rivers flow. Table B4.3 shows that agricultural and forestlands make up 92.3% of the total plain area (excluding the

Siwalik and mid-mountain areas) of the 10 districts. Accordingly, as Table B4.4 shows, more than 70% of the labor force of the 10 districts is engaged in agriculture, as opposed to about 5% in manufacturing and 14% in the service sector.

The 10 districts produce a wide range of crops (Table B4.5), with major crops of paddy, maize, wheat, pulses, and oilseed. As shown in the Fig. B4.1, all these major crops, except wheat and oilseed, are grown during the monsoon. Although there is also winter paddy and maize, most of the paddy and maize is grown in summer in the selected districts, e.g. in Morang district, the production of winter paddy is about 10% of that of summer paddy, and in the case of maize only about 1%.

In most of the 10 target districts, the average land holding size has gradually declined in recent years (Table B4.6). The average size is far below the 16.4-ha ceiling imposed by the 1964 Lands Act. In addition, more than 90% of the agricultural land is under owner-cultivation in the target 10 districts, although this proportion has been decreasing. About 10% of agricultural land are under "formal" tenancy, the bulk of which is in the form of sharecropping.

It should be noted, however, that due to growing land scarcity as well as an increasing demand for land, many landowners are said to enter into informal tenancy agreements with farmers desperately seeking land for cultivation. Since such informal arrangements are not recorded in the official census, the above figure of owner-cultivation should be treated with caution. Moreover, included in the sharecropping category is a commonly known phenomenon of "dual ownership". The "dual ownership" originates from the land reform scheme in which the Government did not completely transfer the land ownership, due to its limited implementation capacity.

In formulating plans for flood mitigation, these complex arrangements regarding the country's land holdings should be taken into consideration. To undertake flood mitigation work on land under "dual ownership", it will be imperative to involve the land owners and tenants, both of whom are entitled to certain shares of the proceeds of the land. As "informal tenancy" discourages landowners from taking responsibility for land protection, special efforts should be made to motivate them to participate in land protection measures.

(2) East-West Patterns

Looking at the 10 target districts which are scattered across the Terai, from the far west to the far east, the following major patterns can be observed.

- Moving from east (Morang) to west (Kailali), the population density declines, but population growth (migration plus natural increase) occurs more rapidly from1981 onwards (Table B4.7).
- Similarly, moving toward the west, the percentage of land under cultivation falls, while percentage of area under forest increases (Table B4.3).

These patterns are due to the fact that, in general, the history of settlements is longer towards the east in the Terai. As a result, in-migration in the east is approaching zero, as new land available for cultivation is being exhausted. This is reflected in three districts of Jhapa, Morang, and Sarlahi where the recent population growth rates are equal to, or just above the national average (Table B4.7). On the other hand, the western districts (especially Kailali and Bardiya) continue to exhibit high population growth, since the land frontiers are relatively open. In a similar vein, the original inhabitants of the Terai constitute nearly half or more of the population towards the west, while the proportion of indigenous groups makes up less than half in most of the eastern districts (Table B4.7).

These east-west trends have some implications on flood mitigation efforts in the Terai. Firstly, as the size of in-migration is larger in the west, flood mitigation plans for western areas should place more emphasis on measures to deal with a continuing flow of in-migrants to these river basins, while conserving the river basins. On the other hand, eastern parts of the Terai are already densely populated with less vegetation and forest covers. Therefore, flood mitigation in the east requires a focus on recovering natural environments in the river basins.

In terms of the Human Development Index (Table B4.8), the districts in eastern areas of the country receive higher rankings (i.e., Jhapa, Morang, and Chitwan districts), with the exception of Sarlahi district through which the Lakhandei river flows. On the other hand, those located toward the west (i.e., Bardiya. Dang. Nawalparasi, Kailali) exhibit relatively low performance in human development. The Human Development Index is a development indicator based on life expectancy, adult literacy and GDP.

(3) 1.2.3 Implications for Flood Mitigation

The Terai has a much higher rate of the population growth, due to the inflows of the migrants from the mountain/hill areas who seek for livelihood improvements. This in-migration has been absorbed mainly by clearing land adjacent to the rivers. The following table shows a summary of annual population growth rate (1981-1991) for respective river basins and districts concerned:

	(River)	(District Total)	(Flood-prone areas)
1)	Ratuwa	2.3%	1.9%
2)	Lohandra	2.3%	3.3%
3)	Lakhandei	2.1%	5.7%
4)	Narayani	3.4%	6.3%
5)	Tinau	3.2%	7.0%
6)	West Rapti	3.1%	6.7%
7)	Babai	3.8%	3.7%
8)	Khutiya	4.8%	8.4%

As the above table shows, when compared with the district-wise population trends, it is clear that human settlements are increasingly expanding into flood-prone areas along most of the eight target rivers.

While the Terai has a high agricultural productivity (often called "granary of Nepal"), it is a predominantly agrarian society. As mentioned in the above Section "Overall Picture", only 5% of the labor force in the 10 target districts are engaged in manufacturing, while only 14% in service sectors. Given the lack of opportunities in non-agricultural sectors, a majority of the population residing in the flood-prone areas engage in agriculture, despite the fact that their crops (mainly paddy and maize) are liable to flooding.

Figure B4.2 captures various social and economic factors that exacerbate flood disasters in the Terai. As the figure indicates, larger social and economic forces are operating to cause the "expansion of the human settlements" in the river basins and the "proliferation of agriculture" in the flood plains. It will therefore be daunting tasks to attempt to prohibit the people from living in the flood-prone areas, and to prevent more people from further migrating into the flood-prone areas.

A more realistic and attainable approach is to assist the people living in the river basins, to adjust to and cope with flooding, instead of attempting to regulate human settlements in the flood plains. Accordingly, the Terai Flood Mitigation Master Plan will place emphasis on enhancing "local preparedness" and "social protection" (both of which are shown in the above figure) with a view to promoting "living with floods" strategies.

4.2 Policy Framework

As reviewed in this section, various related policies unanimously point to the importance of more holistic flood mitigation. In pursuing more comprehensive approaches to flood mitigation, however, it may not be realistic to attempt to establish an inter-ministry framework for different agencies to collaborate with one another. Instead, the Department of Irrigation (DOI) should attempt to broaden the scope of its current efforts.

However, DOI is yet to sanction a comprehensive policy for flood mitigation, to undertake river control in a more holistic manner. The Department of Soil Conservation and Watershed Management (DOSCWM), in line with its official watershed management policy, has already been implementing integrated measures which combine vegetative, agronomic, and water management measures. Similar integrated approaches should be applied to the downstream flood mitigation efforts, for which an official flood mitigation policy for the DOI should be prepared.

(1) Approach to the Ninth Plan (1997-2002)

The Government of Nepal has only formulated an overall "Approach to the Ninth Plan (1997-2002)", and is currently in the process of finalizing the detailed Five-Year Development Plan. The Approach Paper emphasizes the need for a more comprehensive approach to river training, as follows:

> "River control program shall be coordinated with agriculture, forestry, and soil conservation programs to make it more effective and its scope of works shall gradually be expanded" (underlined by the JICA Survey Team).

In the past, the river training efforts in Nepal were narrowly concerned with counteracting nature's forces, utilizing gabion structures, in the downstream areas. The above statement highlights the need to: (a) coordinate the downstream efforts with

upper watershed conservation; (b) instead of relying solely on costly materials, combine them with bio-engineering strategies which utilize more readily available materials; and (c) improve land and agricultural productivity of flood-prone communities, to reduce their vulnerabilities to floods.

(2) National Action Plan on Disaster Management

The "National Action Plan on Disaster Management" has been prepared by the National Committee, which was constituted as part of the UN's call for the "International Decade for Natural Disaster Reduction (IDNDR)". The Plan specifies (a) priority activities to be undertaken in the fields of disaster management (including flood mitigation), (b) responsible agencies, and (c) time periods for completion. The following table shows the Plan's priority activities/responsible agencies that impact on this Master Plan.

Priority Activity	Executing Agency, (Cooperating Agency)
Flood Mitigation Policy	Min. of Water Resources
Flood Hazard Map	Dept. of Hydrology & Metereology, (Dept. of Irrigation, DPTC)
Awareness Raising	Min.of Info.& Communications, Min.of Education & Culture, (Min. of Home, Nepal Admin. Staff College)
Training/ Rehearsal/ Simulation	District Disaster Relief Committee, Nepal Red Cross Society (Local NGOs)
Flood Forecasting & Warning	Dept. of Hydrology & Metereology, (Dept. of Irrigation, DPTC)
Land Use & Land Cover Plan	Min. of Land Reform & Management, (Min.of Water Resources, Min.of Forest & Soil Conservation)

The Plan highlights how different agencies can ideally join together, to promote cohesive disaster management, as advocated in various Government's policies. However, in reality, most of the government agencies, included those in the above table, lack adequate financial and human resources, to undertake priority activities mentioned in the Plan document.

Therefore, as mentioned in the Plan document itself, although the Plan has been accepted by the Government of Nepal, it "appeared to difficult to execute properly" since it is not based upon "the prevailing situation of disaster management in the country", and "the national capacity and available resources". At this stage, it would be more realistic to encourage the DOI to broaden its scope of flood mitigation efforts, rather than trying to develop an inter-agency framework to involve many different

Government agencies.

(3) Draft Flood Mitigation Policy

The above-mentioned IDNDR National Action Plan stipulates that the Ministry of Water Resources (MOWR) should spell out a River Training Policy. While the Irrigation Policy (1992) has some provisions for river training, it is only concerned with protection of irrigation systems against floods. Realizing the need for a clear-cut policy framework, the DOI has developed a draft "River Training Policy" which would serve as a basis for MOWR to further develop flood mitigation strategies. However, as indicated above, the Policy is yet to be reviewed within the MOWR for formal approval.

The draft Policy, as formulated to date, emphasizes the need for a more comprehensive approach through (a) use of local materials, instead of relying solely on gabion wires, (b) the incorporation of bio-engineering in river training facilities (c) a combination of structural and non-structural measures, and (d) capacity-building of community organizations for flood mitigation. The draft Policy also stresses the need for a more systematic approach to river training in the Terai, through the establishment of river classifications, design criteria, and database.

This Policy, when executed, would serve to redress the shortcomings of the DOI's river training activities. The type of the above-mentioned River Training Policy should be sanctioned, to guide DOI in promoting flood mitigation more effectively in future.

(4) Watershed Development Policy

On the other hand, the Government has already endorsed a policy concerning upper watershed conservation. The natural erosion in the hills and the mountains is being accelerated by human activities (e.g., deforestation, and inappropriate land use & farming) to meet demands for wood, food, fodder and other products. The major thrust of the "Watershed Development Policy" is to "help people meet their basic needs ... by improving land and increasing agricultural productivity through proper conservation and utilization of watershed resources".

In parallel to the "Approach to Ninth Plan" mentioned above, the Policy stresses integrated watershed management, linking forestry, agriculture, livestock, water, and land use, to help people better conserve and manage land and water resources. An attempt to achieve such integrated conservation without securing people's participation

and cooperation will be futile. The Policy therefore places emphasis on mobilizing people, as well as raising their awareness, to implement conservation measures through user groups. Thus, the Policy's conservation, extension and education activities have to be promoted, in addition to physical preventive and rehabilitative measures.

In accordance with the above "Watershed Management Policy", the Department of Soil Conservation and Watershed Management (DOSCWM) already has been implementing integrated package programs which combine vegetative, agronomic, and water management measures. Similar integrated approaches should be applied to the downstream flood mitigation efforts that fall under the responsibilities of the DOI.

4.3 Organizations Involved in Flood Mitigation

The Ministry of Water Resources (MOWR) oversees one of the most crucial factors of the country's development, i.e., water. In Nepal, water resources play a vital role for irrigation, drinking, and power generation purposes. At the same time, water can also be destructive, and endangering human lives and properties. To assume tasks of managing water resources, there are three major departments within MOWR, the Department of Irrigation, the Electricity Development Committee, the Policy & Planning Division, and Program & Evaluation Division (Figure B4.3).

The Department of Irrigation (DOI) is responsible for flood mitigation in the downstream areas. At the same time, there are other agencies which can make significant contributions to the implementation of the Master Plan, both within and outside the central Government.

The Water-induced Disaster Prevention Technical Center (DPTC) has developed improved technologies and methodologies for flood mitigation, which can be applied under the Master Plan.

The Department of Soil Conservation and Watershed Management (DOSCWM), with an increasing number of branch offices in the Terai plain, can also contribute to the Master Plan implementation through soil conservation which is also a crucial factor in promoting flood mitigation in the Study Area.

As indicated by the experiences of the efforts for small-scale infrastructure development by the Ministry of Local Development (MLD), the Local Governing Institutions (LGIs)

can play a significant role in facilitating community mobilization and also in coordinating different organizations operating in their own jurisdictions.

There exists an NGO-led Disaster Preparedness Network (DPNET), an association of organizations concerned with community-based disaster management, can participate in implementing community development components of the Master Plan.

4.3.1 Department of Irrigation (DOI, MOWR)

The Department of Irrigation (DOI) of Ministry of Water Resources consists of five major divisions (Fig. B4.4), i.e., the Planning, Design, Monitoring & Evaluation Division; the Surface Water Irrigation Division; the Groundwater Irrigation Division; the Flood Control, Environmental & Mechanical Division; and the Irrigation Management Division. The DOI has District Irrigation Offices (DIOs) in all 75 districts which are coordinated by 5 Regional Irrigation Offices (RIOs). There are about 600 DOI staff members (80 at the national level, 50 at the regional level, and 470 at the district level).

The DOI manages its river training portfolio through its Flood Control, Environmental & Mechanical Division (FEMD). There are two types of projects for river training, i.e., national-level, and local-level projects. The FEMD directly operates national-level river training projects from the DOI headquarters, while local-level projects are handled through DIOs at the district level.

(1) National-level River Training Projects -

As of March 1998, the DOI operates six national-level undertakings for river training as follows:

1) Rajapur Irrigation Project
2) East Rapti Irrigation Project
3) Bagmati River Training Project
4) Banganga River Training Project
5) Extension of Right Embankment along Lalbankeya
6) Bakra Flood Protection Project

Some of the national river training works are stand-along projects, while others are part of DOI's national-level irrigation projects. A summary of the six nation-wide river training works is provided in Table B4.9.

(2) Local-level River Training Projects

Unlike national-level projects which come under the Department's direct control, the DOI is required to implement its local-level flood mitigation activities, through the District River Training Coordination Committee (DRTCC). As shown in Fig. B4.5, the DRTCC is headed by the District Development Committee (DDC) chairman, with its members drawn from major political parties, as well as district-level representatives of the Ministry of Local Development (Local Development Officer), and the Ministry of Home (Chief District Officer). The DIO chief serves as a member-secretary to the DRTCC.

Under this "decentralized" arrangement, the DDC and VDC encourage local residents to submit requests to the DRTCC. Requests from different parts of the district are accumulated into a district-wise list which the DRTCC scrutinizes when planning river training activities. This bottom-up procedure is intended to link the DOI's resources with local demands and priorities for river training facilities.

After target areas are identified, selected communities are then required to form user groups, through which the local residents usually contribute labor for the construction of river training facilities. More specifically, community groups provide labor in filling boulders in G.I. boxes, and installing G.I. boxes for the construction of river training facilities. In some instances, community groups may participate in transportation of boulders, and G.I. wire netting.

The DOI's expenditures over the past 10 years, as well as the total expenditures for the local-level river training are provided in Table B4.10(a).

For the implementation of local-level flood mitigation projects, G.I. wires were provided under the Japanese Grant Aid scheme, in addition to weaving machines, some vehicles and other equipment. Therefore, most of the DOI's expenditures for local river control (shown in the above table) are used for constructing spurs, embankments, and/or revetments, using G.I. wire.

(3) Major Issues

The scope of the DOI's local-level river training projects has been confined to the structural measures only. In addition, there have not been sufficient efforts to use local

materials for the structural works, and instead relied largely on G.I. boxes. Similarly, bioengineering has not received adequate attention in the river training activities. The resource allocations have often been decided without proper inventory of river problems. Moreover, often, the community organizations were mobilized only to labor on the river control works, without being given an opportunity to learn how best to maintain the structures.

A seminar organized by HMG, the DPTC, and the UNDP in March 1993 identified the following as the major causes of the above-mentioned weaknesses.

(a) Policy: As already explained in the previous section "Policy Framework", the Government has no comprehensive river training policy. The seminar also identified "no clear-cut river training policy", and "the absence of long-term strategies" as major constraints.

(b) Legislation: Given the lack of overall framework, no legislation has been enacted that specifies rules and procedures for systematic and holistic river training. Accordingly, the above-mentioned 1993 seminar identified, as one major issue, the absence of legislation which causes "deficiency in planning process and use of available resources".

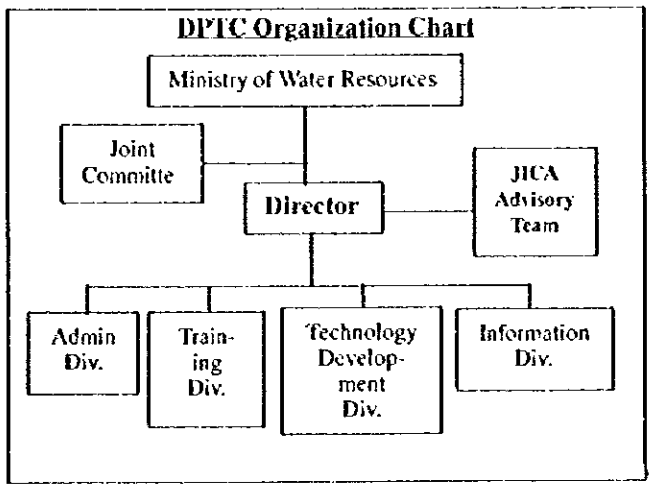
(c) Budget: Another major issue, i.e., "severe lack of funds for river training", is clearly indicated in Table B4.10(b). Given the overall financial constraints, the budgetary allocation per district is small. The funding assigned to one river is even more limited, since each district has to distribute the funds among several rivers. As a result, the funds are spread thinly among many locations, and the facility provided to each locality is hardly adequate for river control. For example, the 1996/97 funding for local river training was Rs.0.3 million for Lohandra river, Rs.0.4 million for Tinau River, and Rs.0.5 million for Babai.

(d) Manpower

Table B4.10(c) clearly shows "lack of manpower". Given the limited number of technical personnel assigned to each DIO, an "Engineer" hardly has many opportunities to visit the sites for local-level river control projects. Instead, it is normally the case that on-site inspection is undertaken by an "Overseer" and usually only once at the stage of designing river training facilities. It is also very rare for an "Association Organizer" to be involved in river control projects.

4.3.2 Water-Induced Disaster Prevention Technical Training Center (DPTC)

The objective of the Water-Induced Disaster Technical Training Center (DPTC) of the Ministry of Water Resources is to strengthen the capabilities of the Government of Nepal to cope with water-induced disasters. The DPTC undertakes training activities, as well as development of technology and database, in the fields of (1) Sabo (land erosion control), (2) landslide prevention, and (3) river training.



The DPTC was established in 1991, as a joint undertaking of various concerned HMG agencies with the MOWR as the leading agency. For this collective management, the Government has instituted a Joint Committee to supervise the DPTC. This draws memberships from the MOWR, the Water & Energy Commission Secretariat, the Ministry of Forest & Soil Conservation, the Ministry of Works & Transport, the Ministry of Home, the Ministry of Finance, and the National Planning Commission.

In implementing the Master Plan for flood mitigation in Terai, the Government could apply, as appropriate, a range of the technologies and methodologies developed by the DPTC under the following model projects.

(1) Model River Training Work in Terai

The target areas are two VDCs along Mahakali river (Kanchapur district), which have been suffering from bank erosion and inundation for many years. With a view to developing suitable river control technologies, the following measures are being tested, using exogenous and/or local materials: skeleton works, cylindrical/ rectangular types of gabions, geo-grid, geo-textile, and bio-engineering.

(2) Sabo Forest Model Site

The DPTC has been experimenting in Sabo (land erosion control) forest along the Khajuri river (Udayapur district). The major purpose is to develop a technology

suitable for Siwalik hills, as a countermeasure to regularize/stabilize river courses. The project will develop Sabo forest guidelines to be applied at different locations, and will also develop a site for training of government officials.

(3) Landslide/Soil Erosion Control Model Site

The DPTC has been experimenting landslide/soil erosion control measure which combine external technologies (e.g., Sabo dams) with community-based natural resource management (e.g., community forest/pasture management) in selected communities along the Tadi river in Nuwakot district. Such experimentation of matching technological solutions with community initiatives should be applied to the implementation of the Master Plan (M/P) for flood mitigation in the Terai.

4.3.3 Department of Soil Conservation and Watershed Management (DOSCWM)

The Ministry of Forest and Soil Conservation (MOFSC) is composed of five major divisions, i.e., the Department of Forest, the Department of Soil Conservation, the Department of National Parks, the Department of Plant Resources, and the Forest Survey and Research Center. Of direct relevance to the Master Plan is the Department of Soil Conservation and Watershed Management (DOSCWM).

The DOSCWM is the main implementing agency of "Watershed Development Policy". In line with the Policy's principles of "integrated approach" and "people's participation", the DOSCWM has a broad mandate of helping people to implement proper management of watershed resources, and to meet their basic needs for forest and food products through enhanced land and agricultural productivity.

Accordingly, the DOSCWM implements a "Soil Conservation and Watershed Management (SCWM) Program", which has a variety of components as follows:

1) Land Use Planning: as a basis for rational utilization/management of watershed resources
2) Land Productivity Conservation: to restore/improve productivity of private /community lands
3) Infrastructure Protection: to protect and stabilize infrastructure such as trails, and reservoirs
4) Natural Hazard Prevention: to help life and property from soil and water erosion hazards
5) Community Soil Conservation Extension: to mobilize people and generate their awareness on conservation

The DOSCWM has two divisions (the Planning and Monitoring and Evaluation Division, and the Management Division) and four sections (Administration, Accounts, Computers, and Soil and Water Laboratory). As of March 1998, 52 districts are covered by SCWM Program, mostly in the hill and mountain areas, but some districts in the Terai are covered as well. In most of these 52 districts, the DOSC has a District Soil Conservation Office (DSCO).

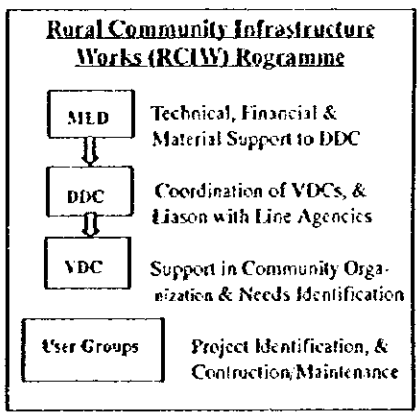
In recent years, the DOSCWM is expanding its field offices in the Terai. Out of 10 Terai districts covered by the Master Plan, the Department already has DSCO in 5 districts, i.e., Jhapa (Ratuwa river, & Lohandra river), Sarlahi (Lakhandei river), Nawalparasi (Narayani river), Rupandehi (Tinau river), and Dang (West Rapti river). The DOSCWM also plans to establish offices in 2 more districts in Fiscal Year 1998/99, i.e., Morang (Lohandra river), Kailali (Khutiya river).

In Terai districts the DSCO usually operates in Siwaliks/Churia hills, but also undertakes some activities in the plains. Given the importance of an integrated approaches for flood mitigation (encompassing vegetative, agronomic, and water management measures), the DSCO should be considered as a potential partner in the Master Plan implementation, to supplement DIO's efforts for river control, with soil conservation measures.

4.3.4 Ministry of Local Development

The Ministry of Local Development (MLD) is responsible for formulating strategies and legislation on local development, and also for assisting in institutional development of local governments.

The MLD is also involved in river training, not as a direct implementing agency, but as an organization to promote the roles of local governments in infrastructure provisions, including river training. To fulfill this responsibility, the MLD has been coordinating the Rural Community Infrastructure Works (RCIW) Program (currently supported by the UN World Food Program -WFP and the German Agency for



Technical Cooperation -GTZ). The RCIW provides technical, financial, and material support for selected communities in 20 districts, to construct small-scale infrastructure. In this process, the RCIW assistance is channeled through local governments, with a view to strengthening their capabilities to promote community-based approaches to infrastructure development.

User groups (or local self help groups) are the major actor of the RCIW projects. They are principally responsible for project identification, as well as for the construction and maintenance of the physical facilities. But this self-help process requires external support. The Village Development Committees (VDC) assist the community groups in the process of group formation and project identification, as well as in the construction and maintenance phases. The DDC coordinates the VDCs' activities, and administers the project's financial and material resources. More importantly, the DDC liaises with technical line agencies (e.g., the DOI and the DOSCWM), to make available technical support to the community groups.

As shown in the table below, river training is one of the priority areas often identified by the target communities (with support of the DDCs/VDCs), constituting 20% of all the facilities newly constructed in 1997/98.

Number of Newly-Constructed Infrastructure Projects under RCIW (1997/98)

Rural Road	Mule Trail	Irrigation	River Training	Fish Pond	Agro-Forestry	Cardamom Cultivation	TOTAL
91	46	27	51	27	7	1	253

Source: Ministry of Local Development

While the MLD will not be involved directly with the Master Plan's implementation, the decentralized approaches adopted by the RCIW may well be replicated in the execution of the Master Plan, as described in the following section.

4.3.5 Local Government Institutions (LGIs)

In Nepal, there are 75 districts, 3912 villages and 58 municipalities. These administrative units are headed by elected representatives, who form development committees (which serves both as executive and deliberative organs) at each level, namely, the District Development Committee (DDC), the Village Development Committee (VDC), and Municipality.

As indicated in the above section "Ministry of Local Development", under the present

decentralization strategy, these local governing institutions (LGIs) are responsible for coordinating development activities in their own jurisdictions.

First, there exist various district-level committees led by the DDC in different sectors. These committees invite requests from different localities of the district, through the VDCs and Municipalities. This bottom-up process enables the LGIs to match the central Government's resources with the demands and priorities of local communities. Second, the LGIs receive grants directly from the central Government. The grants are intended to assist the DDCs, VDCs and Municipalities, to promote small-scale community-based development activities in their own jurisdictions. Third, the LGIs are responsible for encouraging and mobilizing their residents to organize themselves, to be prepared for participating in development projects, supported by central and/or local government agencies.

Against this background, the LGIs can play important roles in the implementation of the Master Plan, as explained below:

1) The LGIs can effectively facilitate the community's involvement processes. It is desirable to request the VDCs/Municipalities, to organize meetings with local communities, especially at the initial stages. The LGIs can also serve as mediators when issues or conflicts arise during implementation.
2) The DDC can provide effective linkages with different line agencies, since most of them have district-level offices. This is in line with a DDC's mandate to coordinate activities of various agencies. In addition, various central agencies can provide useful inputs (e.g. The Forest Department providing saplings for bioengineering).
3) The LGIs can contribute funds for the implementation of small-scale, community-based projects. In actuality, the DDC/VDC/ Municipalities sometimes allocate part of their budgets to the DOI's river training projects. These experience show that such financial contributions enhance the LGIs' sense of ownership, leading to their continued monitoring/maintenance of river training facilities. Local government structure and fiscal transfers from the center are illustrated in Fig. B4.6.

Among the target localities, some LGIs have already taken the initiative to mobilize different agencies, to promote flood mitigation in a comprehensive and coordinated manner. For example, the concerned LGIs along the Babai river formed a "Save

Gulariya Committee" in January 1998, to mobilize resources for flood mitigation, from concerned national/district/community-level agencies. The Committee is headed by the Mayor of Gulariya Municipality, and draws members from leaders of the Municipality as well as those of Bardiya District. There are also four sub-committees for "People's Mobilization", "Equipment and Resource Management", "Monitoring, Supervision, and Evaluation", and "GOs/NGOs Coordination".

The Master Plan should improve upon such initiatives to promote decentralized approaches to flood mitigation in places where LGIs are already actively involved. In localities where such local initiatives are yet to be undertaken, the Government can encourage local governments to initiate a local coalition (like "Save Guraliya Committee"). This can be facilitated when the central Government organize observational tours to visit dynamic localities for the LGIs to learn from their peer organizations in other Terai areas.

4.3.6 External Support Agencies

(1) UN Disaster Management Secretariat (UN-DMS)

UNDP-supported UN Disaster Management Secretariat (UN-DMS), which is housed within the UNDP Country Office, assists in coordinating international response to disasters, including floods. During normal times, the UN-DMS provide support in preparing and updating disaster response implementation manuals, detailing procedures and checklists which relevant government and donor agencies use in providing relief. During emergency periods, the UN-DMS acts as an information clearing-house, receiving and disseminating situation reports, needs assessments, donor pledges, and other pertinent information, to facilitate coordination of emergency operations by different government agencies and donors.

With a view to drawing attention to the importance of disaster mitigation, the UN-DMS supported the implementation of a community-based project, May 1996 - November 1997. The project assisted selected localities in Chitwan district, to undertake community-based initiatives for flood mitigation. The major thrust of the project was to assist communities in organizing themselves, to enhance their knowledge of flood mitigation through training, and to implement their new ideas through their own organizations. The following are the types of activities and budgets, in each of the target areas.

Profile of UN Support for Community-based Disaster Management

VDC - Ward No. (Settlement Name)	Flood Mitigation Structures	Related Activities	Total Budget (Local Contribution - in-kind/cash -)
Bhandara - 7 (Beldiya)	dykes	Nursery, Fish pond	Rs.801,054 (Rs.492,017 - 61%)
Bhandara - 3 (Laughain/Purwari)	spurs	Bridge	Rs.270,771 (Rs.92,200 - 34%)
Kathar - 1 (Kushana/Gothauli)	revetments, & dykes	Gravel road, & Community forest	Rs.975,710 (Rs.466,230 - 48%)
Kumroj - 3 (Gauwha/Gauwhi)	spurs	Tree products	Rs.646,160 (Rs.218,525 - 34%)
Kumroj - 1 (Herneri/Simaltandi)	spurs	Tree products	Rs.239,302 (Rs.75,700 - 32%)

It is increasingly questioned whether large-scale and costly flood control measures are economically suitable for a country like Nepal. As indicated in the above table, one advantage of community-based approaches is the potentiality of forging linkages between physical measures with other development activities, which will accrue more tangible and direct benefits. The latter include nursery/forest establishment (combined with bioengineering structures), and the road/bridge construction (utilizing such river control facilities as embankments).

This way, flood mitigation projects will enhance economic viability, and will also motivate people to participate in flood mitigation efforts. Moreover, this will encourage local communities to participate in the construction of physical facilities, mostly in the form of in-kind contributions for making gabion boxes, transporting boulders, donating land, and so on. The levels of local contribution in the UN support attest this. These are shown in the above table.

Under the Master Plan, such a community-based strategy should be pursued as a complement to flood control measures, in order to provide incentives for local communities to stay organized for flood mitigation purposes.

(2) Disaster Preparedness Network (DPNET)

NGO-led Disaster Preparedness Network (DPNET) was established in 1997, at the initiative of the Lutheran World Services (LWS), and the Nepal Red Cross Society (NRCS), as a loose association of organizations concerned with community-based disaster management. Although almost all the members are international as well as national NGOs, the membership is also open to donor organizations/projects as well. The current DPNET members include (in addition to the two founding NGOs - LWS &

NRCS), United Mission to Nepal, Action Aid, CARITAS, and the JICA School and Community Health Project.

The "DPNET Charter", finalized in April 1998, states that the DPNET's ultimate goal is to "enhance disaster management capacity, self-reliance, and safety of communities in Nepal which face risk from disasters". The DPNET aims at enhancing the capacity of its members, through information sharing (for enhancing each other's expertise, and coordinating their own activities), and joint advocacy work (for enhancing non-members' awareness). For this purpose, DPNET currently focuses on three functions: information center (e.g., compile database of hazards in Nepal, agencies involved, and resources available); communication/coordination (e.g., disseminate knowledge and tools, coordinate with government agencies); and, human resources development (e.g., maintain inventory of human resources, develop training materials).

According to the map on "CBDP Target Districts" prepared in 1997 as part of its coordination efforts, some DPNET members already undertake activities in support of community-based disaster management, in 5 out of the 10 districts covered by the Master Plan. This is shown in the table below. The DPNET can serve as a contact point when the Government needs to seek collaboration of NGOs, in implementing the community development components of the Flood Mitigation Master Plan.

District (river that flow)	DPNET Member
Jhapa (Ratuwa)	LWS
Morang (Ratuwa, Lohandra)	NRCS
Banke (West Rapt)	CARITAS
Bardiya (Babai)	NRCS
Kailali (Khutiya)	LWS

SOCIAL AND ECONOMIC SITUATION OF NEPAL

SOCIAL INDICATORS

Year	1970-75	1980-85	1990-95
Population (million)	12.8	16.7	21.5
Annual Population Growth Rate (%)	2.6	2.6	2.5
Income (per capita, US$)	120	160	200
Poverty (% of population)	---	---	42.0
Access to Safe Water (% of Population)	8.0	23.9	44.0
Life Expectancy at Birth (years)	43	49	55
Infant Mortality (per thousand live birth)	160	125	91

Source: World Development Indicators, World Bank, 1997

ECONOMIC DEVELOPMENT DATA

Year	1986-90	1991-94	1995-96
Rate of Growth			
agriculture	4.1	2.0	2.5
non-agriculture	5.5	8.7	5.1
Total GDP	4.8	5.6	4.0
Share of GDP			
agriculture	49.3	44.7	41.5
non-agriculture	50.7	55.3	58.5
- industry	(16.0)	(18.4)	(19.4)
- trade, transport	(16.6)	(17.7)	(19.1)
- other services	(18.1)	(19.2)	(20.0)

Source: Central Bureau of Statistics

LABOUR FORCE STRUCTURE

	Population (million)	% of total
agriculture	15.0	81.2
industry	0.5	2.7
services	3.0	16.1
total	18.5	100.0

Source: Population Census 1991, Central Bureau of Statistics

SOCIO-ECONOMIC OVERVIEW OF COUNTRY AND TERAI

(a) TERAI IN THE CONTEXT OF NEPAL

INDICATOR	Terai	Rest of Nepal
Number of Administrative Districts	20	55
Proportion of Nepal's Surface Area	23%	77%
Cultivated Area (*)	46%	54%
Irrigated Area (*)	87%	13%
Forested Area (*)	20%	80%
Population	47%	53%
Foodgrain Production	59%	41%
Average Yield of Paddy (MT/ha) (*)	2.54	2.07
" " Wheat (") (*)	1.6	1.4
" " Maize (") (*)	1.8	1.5
Annual Population Growth Rate (1971-91)	3.5%	1.3%
Population Density (persons per km^2)	264	91
Road Network (km roads per km^2 surface area)	0.129	0.035

Source: "Maintaining Granary", Winrock International, 1996
(*) Statistical Information on Nepal Agriculture, Agriculture Statistical Div., 1996/97

(b) INTER-REGIONAL MIGRATION, 1991

destination / origin	Mountain	Hill	Terai	Out Migration	Net Migration
Mountain	---	76,563	121,826	198,329	- 161,655
Hill	32,003	---	895,888	927,891	- 753,923
Terai	4,671	97,465	---	102,136	+ 915,578
In Migration	36,674	173,968	1,017,714		

Source: "Population and Development in Nepal", Central Department of Population Studies, Tribhuvan University

(c) POPULATION DISTRIBUTION

Year	Mountain	Hill	Terai
1971	1,144 (9.9%)	6,067 (52.5%)	4,345 (37.6%)
1981	1,277 (8.7%)	7,001 (47.7%)	6,400 (43.6%)
1991	1,378 (7.3%)	8,683 (46.0%)	8,815 (46.7%)

Source: "Population Monograph", Central Bureau of Statistics, 1991

LAND USE PATTERN IN TERAI PLAIN FOR THE TARGET DISTRICTS

Units: hectare

		Agriculture		Forest		Sand/Gravel/ Boulders		Others		Total
Jhapa	Ratuwa	120,153	82.0%	13,849	9.4%	9,023	6.2%	3,555	2.4%	146,580
Morang	Ratuwa Lohandra	113,231	75.8%	29,615	19.8%	5,250	3.5%	1,231	0.8%	149,327
Sarlahi	Lakhandei	84,944	78.1%	17,866	16.4%	5,586	5.1%	372	0.4%	108,768
Chitwan	Narayani	49,272	59.5%	18,500	22.4%	0	—	15,000	18.1%	82,772
Nawalparasi	Narayani	71,310	86.0%	8,588	10.4%	2,239	2.7%	773	0.9%	82,910
Rupandehi	Tinau	97,456	80.5%	20,926	17.3%	2,024	1.7%	660	0.5%	121,066
Dang	West Rapti	71,871	66.4%	36,400	33.6%	0	0.0%	0	0.0%	108,271
Banke	West Rapti	55,758	48.0%	55,430	47.7%	4,670	4.0%	331	0.3%	116,189
Bardia	Babai	62,281	44.5%	38,529	27.5%	8,635	6.2%	30,527	21.8%	139,972
Kailali	Khutiya	74,315	38.6%	112,805	58.5%	5,668	2.9%	0	0.0%	192,788
10 District	8 Rivers	800,591	64.1%	352,508	28.2%	43,095	3.5%	52,449	4.2%	1,248,643

Source: Land Resources Mapping Project 1986, Department of Survey
Forest Survey 1993, Department of Forest

ECONOMICALLY ACTIVE POPULATION BY MAJOR OCCUPATION

		Total Population	Economically Active Population		Agriculture Worker		Production Worker		Service Worker		Sales Workers & Others	
Nepal (1991)		18,491,097	7,339,586	39.7%	5,952,047	81.1%	310,414	4.2%	684,051	9.3%	372,218	5.1%
Jhapa	Ratuwa	593,737	196,009	33.0%	129,397	66.0%	11,044	5.6%	37,016	18.9%	17,952	9.5%
Morang	Ratuwa Lohandra	674,823	233,317	34.6%	138,017	59.2%	14,796	6.3%	54,649	23.4%	25,855	10.9%
Sarlahi	Lakhandei	492,798	153,355	31.1%	120,059	78.3%	5,381	3.5%	18,829	12.3%	9,086	5.9%
Chitwan	Narayani	354,488	139,135	39.2%	105,498	75.8%	7,377	5.3%	17,949	12.9%	8,311	6.0%
Nawal Parasi	Narayani	436,217	173,355	39.7%	145,290	83.8%	5,104	2.9%	15,669	9.0%	7,292	4.2%
Rupan-Dehi	Tinau	522,150	170,235	32.6%	130,582	76.7%	8,385	4.9%	19,549	11.5%	11,718	6.9%
Dang	West Rapti	354,413	126,671	35.7%	101,353	80.0%	6,320	5.0%	13,246	10.4%	5,752	4.6%
Banke	West Rapti	285,604	93,052	32.6%	62,613	67.3%	6,599	7.1%	16,030	17.2%	7,810	8.4%
Bardia	Babai	290,313	99,561	34.3%	82,399	82.8%	3,767	3.8%	9,117	9.2%	4,278	4.3%
Kailali	Khutiya	417,891	135,490	32.4%	108,119	79.8%	5,164	3.8%	13,339	9.9%	8,868	6.5%
10 District	8 Rivers	4,422,434	1,520,180	34.4%	1,123,328	73.9%	73,937	4.9%	215,393	14.2%	107,522	7.0%

Source: Population Census 1991, Central Bureau of Statistics
Economically Active Population: 10years of Age and Over

LAND AREA AND AGRICULTURE PRODUCTION IN 10 TARGET DISTRICTS

Unit: hectares (ton/ha.)

District	Paddy	Maize	Wheat	Pulses	Oilseeds	Sugarcane	Vegetables
Jhapa	104,45 (2.71)	33,625 (1.4)	15,250 (2.05)	3,516 (0.79)	3,012 (0.79)	76 (30.00)	1,515 (7.16)
Morang	97,200 (2.57)	14,000 (1.82)	17,940 (1.70)	6,930 (0.50)	7,900 (1.40)	1,260 (40.0)	2,250 (12.58)
Sarlahi	27,151 (2.35)	9,350 (1.65)	27,000 (1.4)	26,820 (0.60)	5,620 (1.54)	5,500 (33.56)	4,125 (7.09)
Chitwan	45,000 (2.70)	27,127 (2.00)	9,100 (1.70)	---	19,550 (0.75)	40 (27.00)	---
Nawalparasi	46,100 (3.06)	7,700 (2.40)	19,000 (2.36)	7,870 (0.43)	---	7,100 (43.5)	950 (12.00)
Rupandehi	68,000 (1.72)	1,050 (1.72)	20,300 (2.00)	7,400 (0.69)	5,000 (0.69)	3,000 (32.0)	980 (11.31)
Dang	33,500 (3.20)	23,200 2.09	14,100 (2.50)	24,150 (1.03)	18,450 (0.72)	---	1,323 (12.27)
Banke	32,350 (2.48)	7,500 (1.17)	12,899 (1.58)	9,450 (1.09)	8,488 (0.97)	---	3,535 (12.55)
Bardia	33,095 (4.91)	9,920 (2.27)	20,000 (2.25)	12,400 (0.75)	12,250 (0.81)	55 (25)	800 (12.01)
Kailali	51,000 (2.03)	12,017 (1.62)	19,000 (1.46)	---	15,000 (0.62)	300 (29.00)	---
10 Districts	443,841 (3.24)	145,489 (2.76)	174,589 (1.89)	98,536 (0.77)	95,270 (0.76)	17,331 (37.57)	15,478 (10.24)

Source: Annual Agricultural Development Programme 1995/96, District Agriculture Development Office

Upper Figure in the Column: Land Area in ha

Lower Figure in ( ) : Productivity in ton / ha

Shadow : Major three land use.

LAND AREA AND AGRICULTURE PRODUCTION IN 10 TARGET DISTRICTS

Unit: hectares (ton/ha.)

District	Paddy	Maize	Wheat	Pulses	Oilseeds	Sugarcane	Vegetables
Jhapa	104,45	33,625	15,250	3,516	3,012	76	1,515
	(2.71)	(1.4)	(2.05)	(0.79)	(0.79)	(30.00)	(7.16)
Morang	97,200	14,000	17,940	6,930	7,900	1,260	2,250
	(2.57)	(1.82)	(1.70)	(0.50)	(1.40)	(40.0)	(12.58)
Sarlahi	27,151	9,350	27,000	26,820	5,620	5,500	4,125
	(2.35)	(1.65)	(1.4)	(0.60)	(1.54)	(33.56)	(7.09)
Chitwan	45,000	27,127	9,100	---	19,550	40	---
	(2.70)	(2.00)	(1.70)		(0.75)	(27.00)	
Nawalparasi	46,100	7,700	19,000	7,870	---	7,100	950
	(3.06)	(2.40)	(2.36)	(0.43)		(43.5)	(12.00)
Rupandehi	68,000	1,050	20,300	7,400	5,000	3,000	980
	(1.72)	(1.72)	(2.00)	(0.69)	(0.69)	(32.0)	(11.31)
Dang	33,500	23,200	14,100	24,150	18,450	---	1,323
	(3.20)	2.09	(2.50)	(1.03)	(0.72)		(12.27)
Banke	32,350	7,500	12,899	9,450	8,488	---	3,535
	(2.48)	(1.17)	(1.58)	(1.09)	(0.97)		(12.55)
Bardia	33,095	9,920	20,000	12,400	12,250	55	800
	(4.91)	(2.27)	(2.25)	(0.75)	(0.81)	(25)	(12.01)
Kailali	51,000	12,017	19,000	---	15,000	300	---
	(2.03)	(1.62)	(1.46)		(0.62)	(29.00)	
10 Districts	443,841	145,489	174,589	98,536	95,270	17,331	15,478
	(3.24)	(2.76)	(1.89)	(0.77)	(0.76)	(37.57)	(10.24)

Source: Annual Agricultural Development Programme 1995/96, District Agriculture Development Office

Upper Figure in the Column: Land Area in ha

Lower Figure in ( ) : Productivity in ton / ha

Shadow : Major three land use.

LAND OWNERSHIP, AGRICULTURAL LAND AND LAND CULTIVATED/UNCULTIVATED

District	Study River	Owner-Cultivation (%)		Average Holding Size (ha.)		Tenure Arrangement (1991/92) (%)			Terai Agricultural Land (%)	
		1981/82	91/92	1981/82	91/92	Fixed Rent	Share Crop	Others	Cultivated	Non Cultivated
Terai		91.8	87.6	1.47	1.22	30.6	62.7	6.7	91.3	8.7
Jhapa	Ratuwa	89.2	83.6	1.53	1.41	20.9	59.4	19.7	92.8	7.2
Morang	Ratuwa, Lohandra	93.0	79.4	1.34	1.42	22.9	73.1	4.0	91.3	8.7
Sarlahi	Lakhandei	86.8	90.6	1.06	1.14	29.4	52.1	18.5	90.5	9.5
Chitwan	Narayani	97.0	93.4	1.67	0.80	15.3	6.9	77.8	N.A.	N.A.
Nawalparasi	Narayani	98.1	94.7	1.45	1.11	14.5	66.4	19.1	93.7	6.3
Rupandehi	Tinau	99.3	86.4	1.59	1.08	11.9	78.7	9.4	92.9	7.1
Dang	West Rapti	80.4	80.9	1.57	1.17	7.5	89.8	2.7	N.A.	N.A.
Banke	West Rapti	88.5	86.2	1.47	1.37	2.7	94.9	2.4	89.1	10.9
Bardia	Babai	92.2	84.6	2.73	1.61	14.6	82.2	3.2	89.1	10.9
Kailali	Khutiya	97.6	94.4	1.70	1.35	8.8	74.7	16.5	89.5	10.5

source: National Sample Census of Agriculture 1991/92, Department of Agriculture

POPULATION TRENDS IN 10 DISTRICTS

District	Study River	Population in 1991	Population Growth			Population by Caste/Ethnic (1991)		
			1971-81	1981-91	1991-96	Indigenous Groups	Originated from India	Originated from In-Country
Nepal		18,491,097	3.0%	2.3%	2.2%	N.A	N.A.	N.A.
Jhapa	Ratuwa	593,737	6.6%	2.1%	2.2%	14.2%	3.1%	82.7%
Morang	Ratuwa Lohandra	674,823	5.7%	2.3%	N.A	32.3%	8.7%	59.0%
Sarlahi	Lakhandei	492,798	8.2%	2.1%	2.2%	64.6%	10.9%	24.5%
Chitwan	Narayani	354,488	3.5%	3.1%	3.4%	22.0%	---	78.0%
Nawalparasi	Narayani	436,217	7.5%	3.4%	3.8%	54.4%	6.3%	39.3%
Rupandehi	Tinau	522,150	4.4%	3.2%	3.5%	49.7%	17.1%	33.2%
Dang	West Rapti	354,413	4.6%	2.8%	3.1%	51.3%	---	48.7%
Banke	West Rapti	285,604	4.9%	3.3%	3.6%	44.7%	22.9%	32.4%
Bardia	Babai	290,313	5.8%	3.8%	4.1%	64.9%	2.8%	32.3%
Kailali	Khutiya	417,891	6.9%	4.8%	5.5%	57.4%	---	42.6%
10 District	8 Rivers	4,422,434	8.3%	5.0%	2.9%	43.0%	7.9%	49.1%

Source: Population Census 1991, Central Bureau of Statistics

Nepal District Profile, 1997, National Research Associates

N.A: Not available

HUMAN DEVELOPMENT INDEX FOR NEPAL

District	Life Expectancy	Adult literacy ratio(%)	Mean years of schooling	Per capita income (NRs.)	Per capita income (US $)	Life Expectancy Index	Educational Attainment Index	Income Index	Human Development Index(HDI)	Ranking In Country
Morang	66.5	48.45	3.192	7,609	1,176	0.692	0.394	0.178	0.421	4
Jhapa	58.5	54.43	3.511	10,950	1,693	0.558	0.441	0.263	0.421	5
Chitwan	56.5	49.46	2.531	8,414	1,301	0.525	0.386	0.198	0.370	16
Rupandehi	60.5	41.72	2.449	6,807	1,052	0.592	0.333	0.157	0.361	19
Sarlahi	60.5	24.53	1.296	8,330	1,288	0.592	0.192	0.196	0.327	35
Banke	55.5	34.70	2.180	6,061	937	0.508	0.280	0.138	0.309	46
Bardiya	60.5	27.90	1.656	4,424	684	0.592	0.223	0.096	0.304	50
Nawalparasi	53.5	38.38	2.102	5,386	833	0.475	0.272	0.158	0.299	51
Kailali	53.0	34.88	1.767	6,824	1,055	0.467	0.272	0.158	0.299	52
Dang	49.5	38.21	2.150	7,888	1,219	0.408	0.302	0.158	0.299	53

Source: "Nepal Human Development Report", UNDP, 1998

Statistics as of 1996 were used.

PROFILE OF DOI'S NATIONAL-LEVEL RIVER TRAINING PROJECTS

Project Name	Fiscal Year	Description	Total Budget (Rs.)	Source of Funding
Rajapur Irrigation	1991/92 - 97/98	A irrigation project (15,800 ha. of land in 11 VDCs), with a component for flood control works	204,502,000*	HMG, & Asian Development Bank
East Rapti Irrigation	1992/93 -	A irrigation project (5,200 ha. of land), which includes 18 km long embankment, with some additional river control works	291,888,000*	HMG, & Asian Development Bank
Bagmati River Training	1994/95 - 99/00	Construction of 10 km embankment as well as spurs (also when require, emergency protection works)	79,765,000	HMG
Banganga River Training	1996/97 - 98/99	Construction of 1.5 km length of boulder/earthen bund, with river diversion and channelization work.	28,5000,000	HMG
Extension of Right Embankment along Lalbankeya	1996/97 - 97/98	Extension of embankment (by 9.5 km) along Lanlbankeya river	52,146,000	HMG, & Govt. of India
Bakra River Flood Protection	1997/98 - 99/00	River control covering from foothill to Indian border, with main construction works of 66.5km embankment, 104 spurs, and 14.6 km revetments.	370,000,000	HMG, & OPEC Fund

Source: Dept. of Irrigation

* only budget for river training component

BUDGET AND MANPOWER OF DOI/DIO

(a) DOI's Expenditures: 1988/89-1997/98

(in million Rs.)

Yr.	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98
Dept. Total	976.2	1,015.3	1,189.0	1,460.9	2,165.6	2,494.6	2,204.0	2,772.7	2,577.9	3,040.8 *
Local River Trg.	15.0 (1.5%)	11.1 (1.1%)	12.2 (1.0%)	10.1 (0.6%)	32.4 (1.5%)	28.1 (1.1%)	90.3 (4.1%)	61.2 (2.2%)	44.9 (1.7%)	120.0 * (4.0%) *

Source: Dept. of Irrigation

* proposed figure

(b) District-wise Budget (G.I. Wire) of DOI's Local River Training

in million Rs.(metric tons)

	Jhapa	Morang	Sarlahi	Chitwan	Nawal Parasi	Rupan Dehi	Dang	Banke	Bardiya	Kailali
'96/97	1.9 (167)	1.1 (75)	0.8 (60)	0.4 (55)	1.9 (74)	1.3 (76)	0.2 (67)	0.4 (1.5)	0.8 (50)	0.2 (33)
'97/98	3.3 (32) *	3.1 (25) *	1.4 (5) *	1.3 (22) *	4.1 (15) *	2.7 (20) *	0.6 (10) *	1.5 (10) *	4.4 (6) *	0.8 (8) *

Source: Dept. of Irrigation

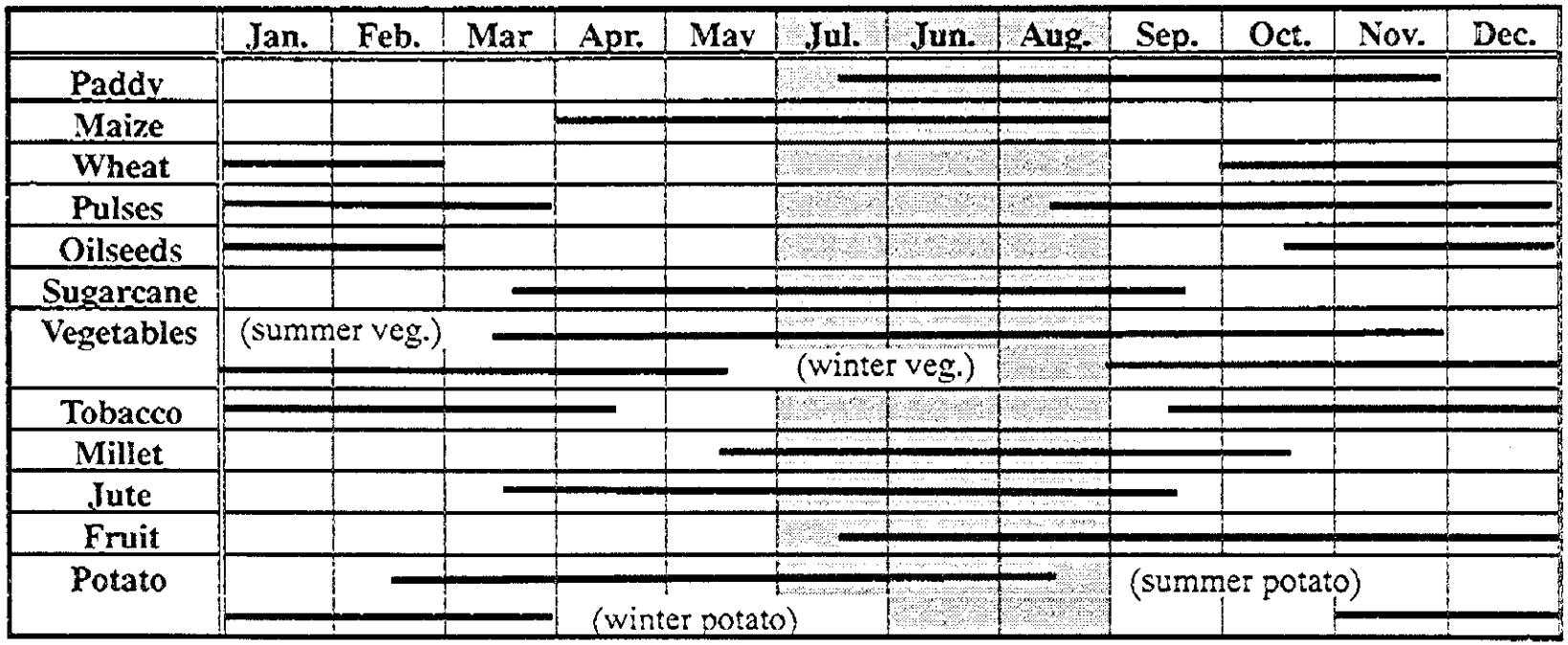
* proposed figure

(c) DIO's Personnel in Target Districts (as of March 1998)

	Jhapa	Morang	Sarlahi	Chitwan	Nawal Parasi	Rupan dehi	Dang	Banke	Bardia	Kailali
Chief	1	1	1	1	1	1	1	1	1	1
Engineer	2	4	4	2	1	4	3	2	2	3
Overseer	12	12	7	5	6	7	6	5	5	10
Association Organizer	1	1	1	1	1	1	1	1	1	0

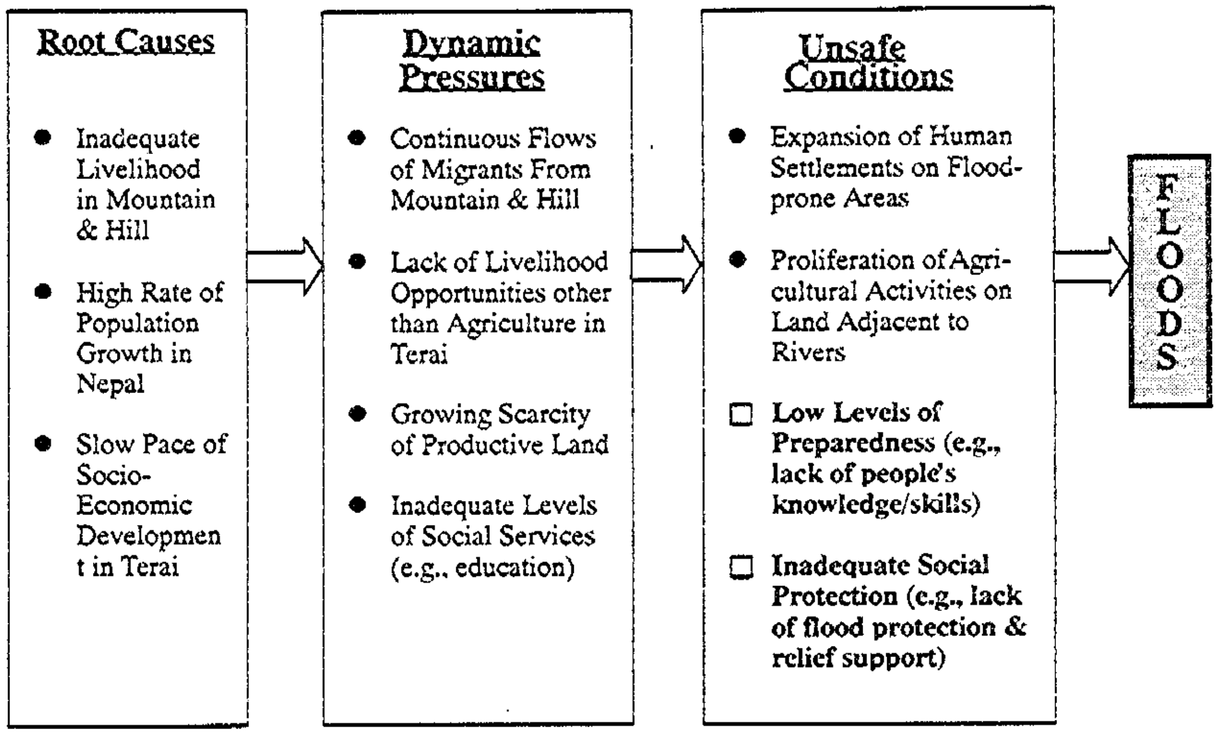
Source: Dept. of Irrigation

CROPPING PATTERNS IN 10 TARGET DISTRICTS



Source: interviews in 10 districts by JICA Survey Team, January 1997

MAJOR SOCIO-ECONOMIC FACTORS TO ACCELERATE FLOODS

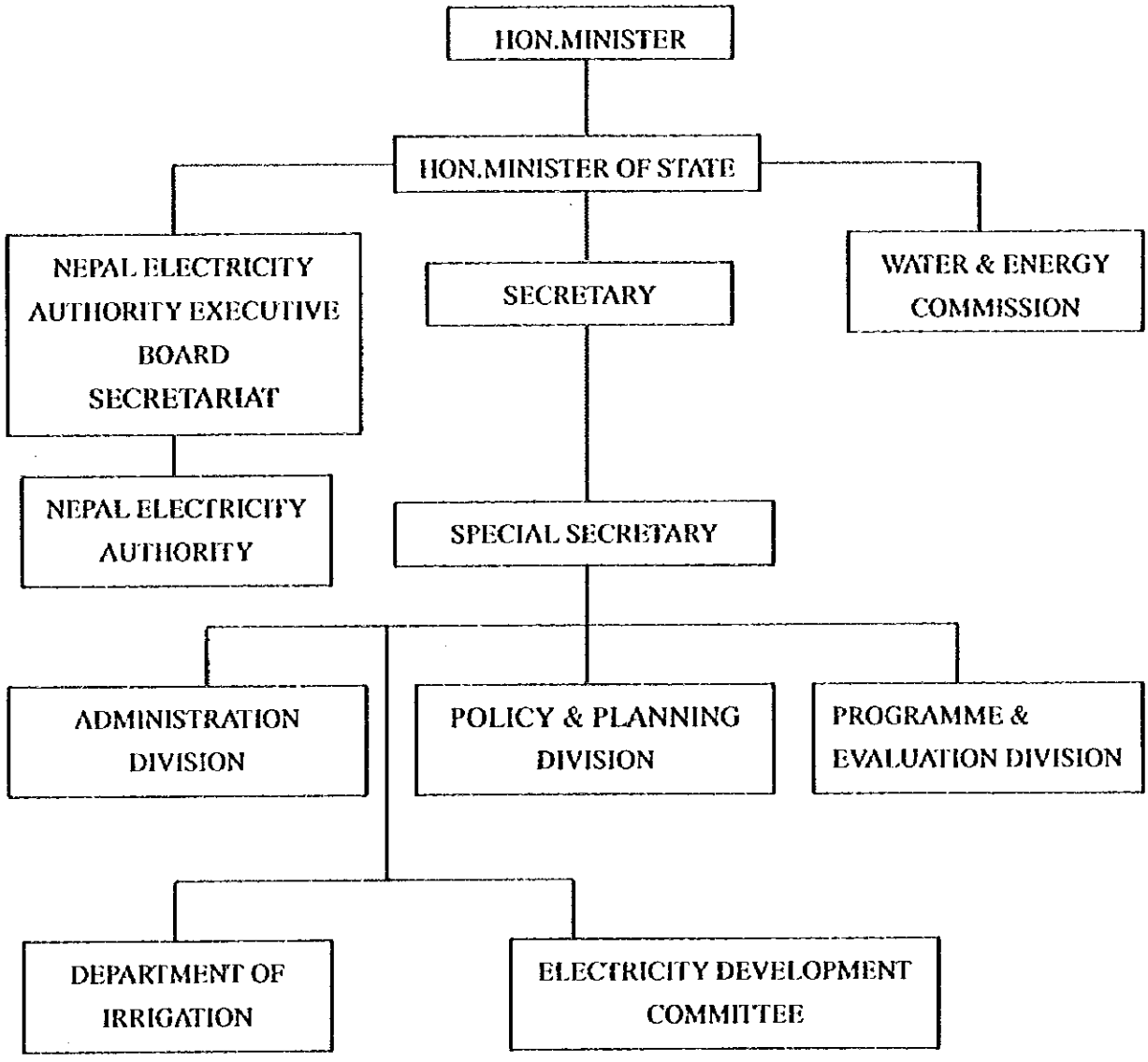


His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY

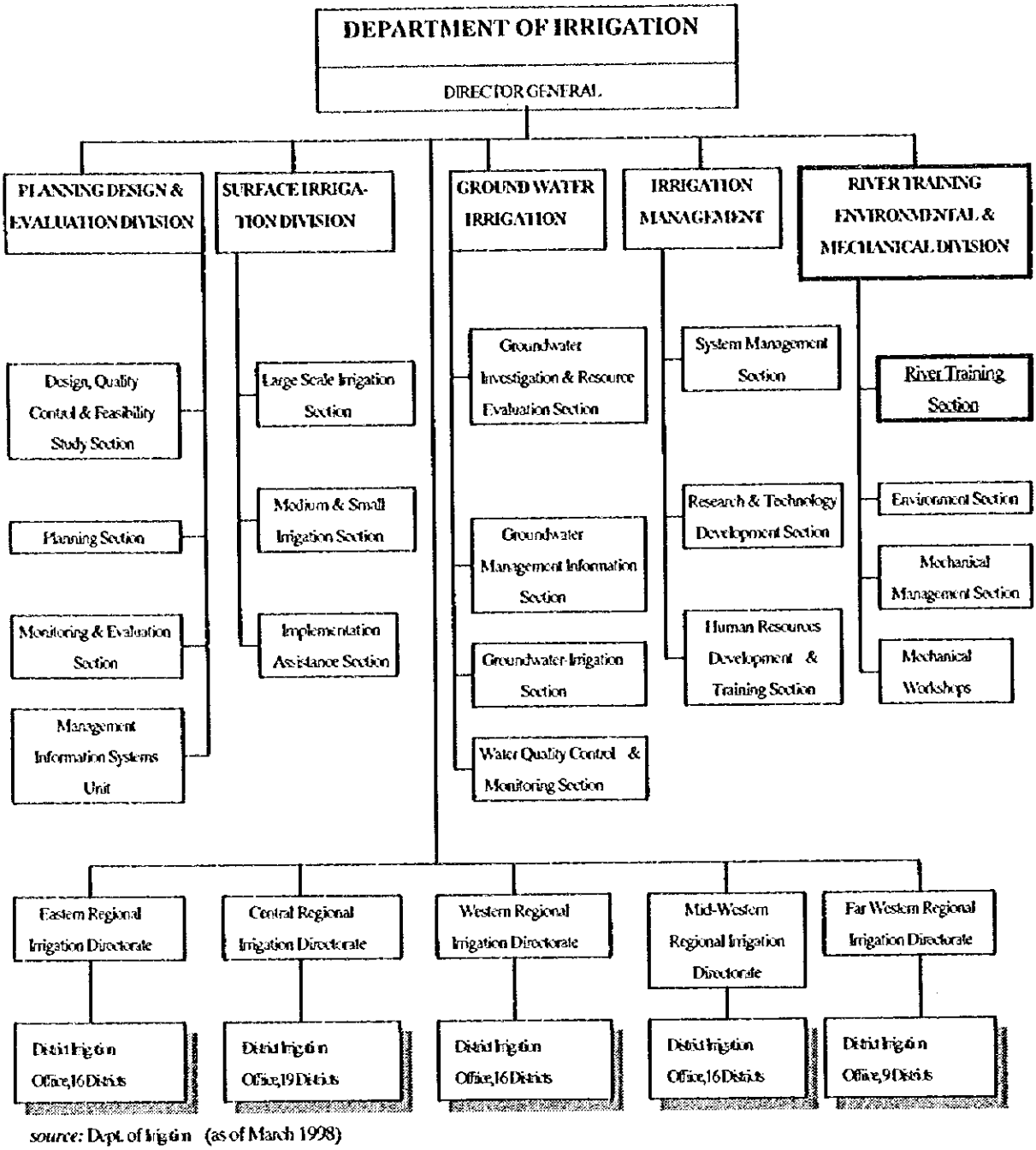
HIS MAJESTY'S GOVERNMENT
MINISTRY OF WATER RESOURCES
ORGANIZATION CHART



source: Dept. of Irrigation (as of March 1998)

ORGANIZATION CHART:
MINISTRY OF WATER RESOURCES

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

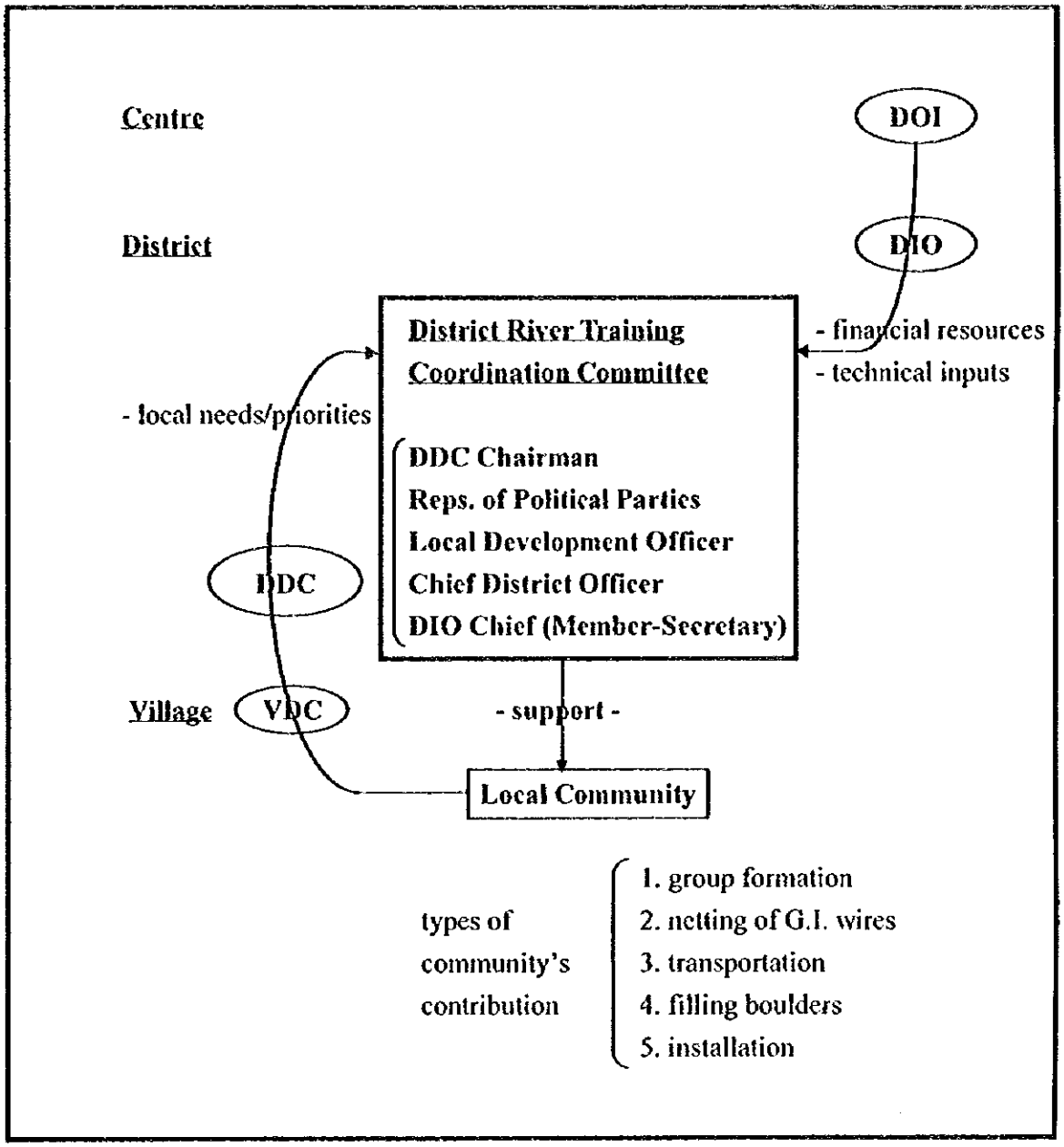


source: Dept. of Irrigation (as of March 1998)

ORGANIZATION CHART: DEPARTMENT OF IRRIGATION

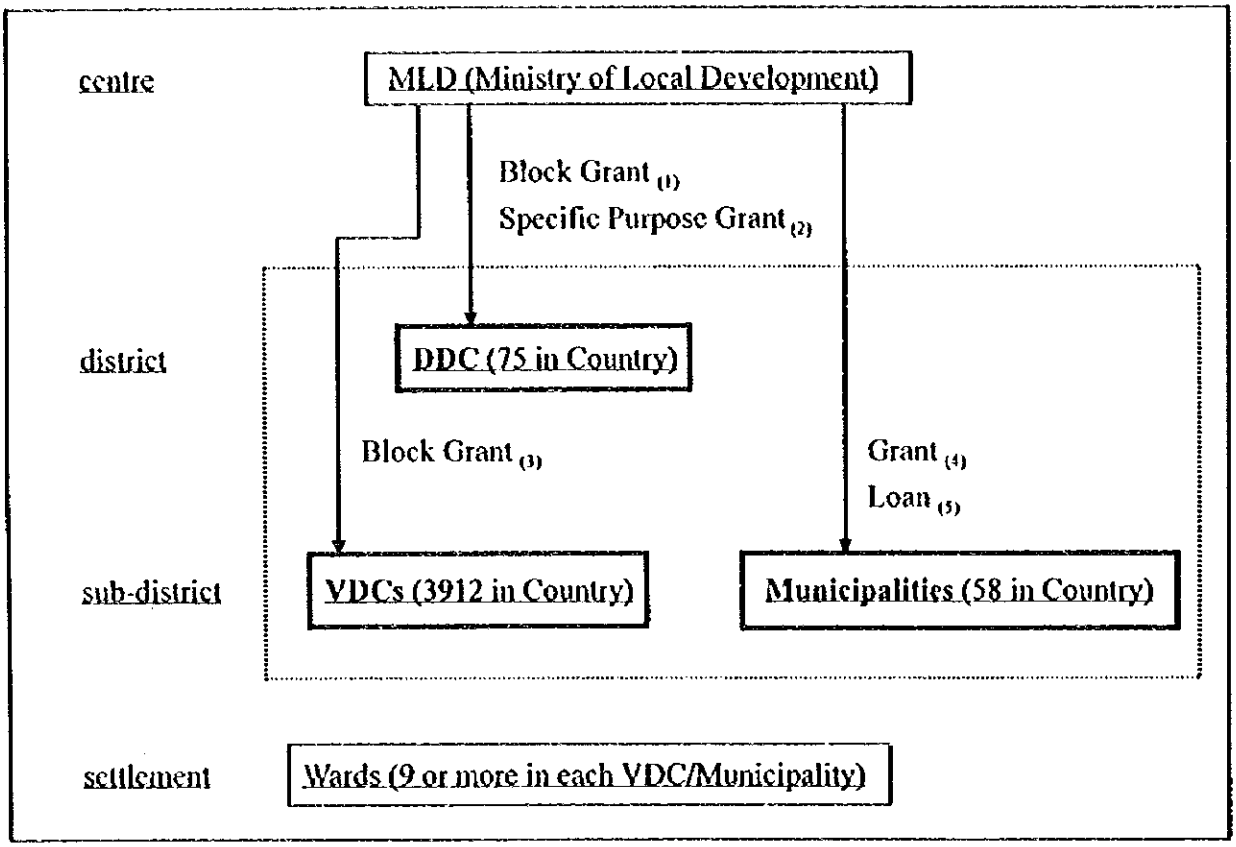
His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

PARTICIPATORY ARRANGEMENT FOR DOI'S LOCAL-LEVEL FLOOD MITIGATION PROJECTS



His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

LOCAL GOVERNMENT STRUCTURE
AND
FISCAL TRANSFERS (DEVELOPMENT FUNDS) FROM THE CENTRE



(1) a grant to be used for any developmental purposes - Rs.1.8 million per district, on average, in 96/97

(2) a grant specifically for road/bridge construction/maintenance - Rs.2.5 million per district, in 96/97

(3) a grant of Rs.0.25 million that can be used according to the priorities of VDC

(4) a development grant - usually Rs.0.5 - 1 million per municipality

(5) a loan which a Municipality can draw from the Government's Town Development Fund

LOCAL GOVERNMENT STRUCTURE

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

5. FOREST AND VEGETATION IN WATERSHED AREA

5.1 Vegetation of Nepal

(1) Climate and Vegetation Distribution

Watersheds of the eight rivers selected for the Master Plan study distribute over the whole country of Nepal. Therefore, the forest and vegetation in watershed area are described from nation-wide viewpoint.

The vegetation largely depends on the climate. Climate of Nepal changes greatly from subtropical zone to high mountain with glaciers. Vertical gradation is about 8000m from Terai plain to Higher Himalayan mountains, and horizontal distance is only 150 to 200km. Precipitation pattern is divided clearly dry season from October to May and rainy season (monsoon) from June to September. Eighty percent of annual precipitation is concentrated in rainy season. Distribution of precipitation influences distribution of vegetation. The annual precipitation changes greatly from arid zone (less than 500 mm) to rainy zone (5000 mm).

Wet monsoon is interrupted by Mahabharat and Himalaya mountains and rainy zone is formed on the southern slope (Fig.B5.1). Extremely arid zone is formed on the northern slope in the lee.

Therefore, humid vegetation is formed in southern slope and dry vegetation in northern slope by the difference of sunshine. Change in vegetation by slope direction is remarkable especially in Western Nepal, though this is common trend over the whole Himalaya.

Classification of the climate and vegetation of Nepal is shown in Fig.B5.2 (a) after *A. Stainton*. Nepal is classified into five divisions as follows:

Division I	: Terai and Outer Himaraya
Division II	: Middle mountain (Eastern-Central-Western)
Division III	: Humla Jumla
Division IV	: Himalayan inner Valley
Division V	: Alpine desert

Vertical vegetation distribution of typical forest of Nepal is divided in to three; eastern,

central and western sectors, which is shown in Fig. B5.3. And the flora below elevation 2000 m,MSL is shown in Table B5.1.

(2) Terai and Outer Himalaya (Siwalik Hills)

The Terai plain is composed of an alluvial fan and an alluvial plain of elevation ranging from 50 m to 300 m,MSL extending from the foot of Siwalik hills to the Indian border. The climate of this area belongs to the monsoon subtropical zone, and the dry season is from October to May with the rainy season from June to September. The Terai plain was covered widely by Sal forests (*Shorea robusta*). But, recently farmers from Middle Mountains cleared the forests rapidly for agricultural land and villages.

Sal is a species of the *Dipterocarpaceae* family commonly distributing in the Southeast Asian tropical forest. Trees reach a height of 40 m in the Terai. There are variety of species in the Sal forest distributing in dry subtropical forest such as Genus *Terminalia* and Genus *Lagerstroemia*. Primary Sal forest is seen in Bardiya national park on the left bank of Karnali river, and is a habitat of wild animals such as elephant, tiger and peacock.

Sal forests are classified into three physiognomic-vegetation types according to the location, i.e., (1) Bhabar and Terai Sal forest, (2) Dun Sal forest and (3) Hill Sal forest. Topographic profile is shown Fig. B5.2 (b).

Fringing forests composed of Acacia and Sissau (*Dalbergia sissoo*) develop along river flowing through the Terai plain. Forests which contain *Bombax malabaricum* and so on are located between the fringing forest and Sal forest. Then, tropical evergreen forests instead of Sal forest appears in humid place along the valley of eastern Terai.

Forests have been left in the Siwalik hills, because these hills are unsuitable for settlement due to steep slopes and the difficulty of getting water. However, tree felling has recently accelerated in Siwalik hills. The Siwalik hills with an elevation from 500 m from 1000 m,MSL located in eastern to central part of the country are covered with Hill Sal forest.

In the western Siwalik hills up to 1500 m,MSL, the forest is distinctive in that the dry north slope is covered with Subtropical Deciduous forest whose dominant species is *Anogeissus latifolia*, while the humid south slope is covered with Hill Sal forest. This

Hill Sal forest is distributed from 1000 m to1600 m,MSL of Middle Mountain. *Pinus roxburghii* forests are found in hills higher than 900 m,MSL along the ridge.

(3) Middle Mountain

The Middle Mountain is the area of 1000 m to 2500 m,MSL between the Mahabharat and High Himalayan mountain. The Middle Mountain is the central place of Himalayan mountain residents. Although large forest area still remains in the western part of the country where population is sparse, the forest has been converted to cultivated land and residential area in the eastern and central parts where the population is large.

Forests are left only in such places as steep slope areas hard to access, community forests managed by village, forests of native shrine, and the north slopes unsuitable for agriculture. Forests in the Middle Mountain are divided into the following seven vegetation zones primarily depending on the elevation:

1) Sal forest (Upper limit is 1000 m to 1200 m,MSL) which is a continuation from the Terai
2) Laurel forest (1000-2500 m,MSL) which consists of Genus *Castanopsis*, Subgenus *Cyclobalanopsis*, Genus *Schima-Castanopsis* forest, Family *Lauraceae*, Family *Symplocaceae* and so on.
3) *Quercus semecarpifolia* forest and *Tsuga dumosa* forest (2500-3000 m,MSL)
4) *Abies spectabilis* forest (3000-3800 m,MSL)
5) *Betula utilis* forest (3700-3800 m,MSL)
6) Alpine Shrub (3800-3900 m,MSL)
7) Alpine Meadow (3800-5000 m,MSL)

There are *Pinus roxburghii* forest (1000-2000 m,MSL) and *Pinus excelsa* forest (2000-3000 m,MSL) as substitution forest. No vegetation is found above 5000 m,MSL due to permanent ice and snow.

These vegetation zones are recognized throughout the Middle Mountain. Southern slope is more humid than northern slope. The humid vegetation is more various than dry vegetation.

(4) Humula-Jumula

Humula-Jumula is in western and far-western Nepal, adjoining to arid zone in the east

and mountain ranges of elevation 3000-4000 m,MSL in the south. Although there is less rain than the Middle Mountain in summer, it rains in winter as well.

(5) Himalaya Inner Valleys

The main ridges of High Himalayas surround Himalaya inner valley. Because the monsoon rain cloud is interrupted by Himalayas, rainfall is less in this area than the Middle Mountain located in the south.

Himalaya inner valleys are composed of Alpine zone ranging from elevation 3800 m to 5500 m,MSL and forest at elevation 3000 m,MSL and more. Vegetation of the Alpine zone are; Alpine meadow with *Gramineae* Family and Genus *Carex*, Alpine plants with Genus *Meconopsis*, Genus *Pedicularis*, Genus *Primula*, Genus *Potentilla* and so on. The forest of Himalaya inner valleys consists of *Abies spectabilis* forest (3000-3800 m,MSL), *Betula utilis* forest (3700-3800 m,MSL) and the high mountain scrub (3800-3900 m,MSL).

(6) Alpine Deserts

Annapurna-Dhaulagiri mountains interrupts monsoon rain coming from south, and forms heavy rain zone amounting to 5000 mm/yr in the south. On the other hand, mountain zone of elevation 3000 m to 5000 m,MSL in the north is arid and the annual precipitation is less than 500 mm.

Plants grow scattering in this zone. They are; Genus *Caragana*, Genus *Nepeta*, Genus *Ephedra* , *Rosa sericea* and *Artemisia gmelinii*. Vegetations of arid zone are similar to those seen in Tibet Highland, Central Asia and Iran-Turan region.

5.2 Agriculture and Forest

Vegetation of Nepal is rich in the diversity, such as subtropical forest, temperate vegetation of Eastern and Western Asia regions, warm-temperate forest and temperate forest in Midland Mountain, temperate forest of Western Asia region in Humula-Jumula, Alpine vegetation and Alpine desert vegetation. However, the vegetation of Nepal is changing affected by felling tree for agriculture, grassing, settlement, etc.

Agriculture of Nepal is divided regionally into northern mountain, middle mountain and Terai plain regions. The northern mountain region occupies 35% of the country. Small

gentle slope areas and narrow valley bottom are cultivated in this region. The limit altitude of agricultural cultivation is up to 4,200 m,MSL. Main crops here are potato, buckwheat, rye, and grazing cattle, water buffalo, sheep, goat and yak.

The middle mountain region occupies 42% of the country and the elevation ranges from 800 m to 2,400 m,MSL. Most of the agricultural lands are terraces cultivated up to the top of mountain. Main crops are corn, barnyard millet, rice, wheat and potato. In addition, cucumber, pumpkin, red pepper, beans, tomato and so on are planted in summer, and cauliflower, cabbage, broccoli, pea, carrot are in winter.

The Terai plain region located in the southern part of Nepal occupies 14% of the country, forming a narrow band extending 885 km from east to west, and 25-32 km from north to south. This region is called as the granary of Nepal, producing major cereal and cash crops, tropical fruit and vegetables.

Generally, the farmers in Nepal are individually managed, and deal with agricultural land, crop, livestock, and private wood and pasture. Forest is important for them to supply fodder, litter, compost, firewood and timber.

Firewood is collected in the nearby forest. Collection of fuel is serious problems especially in middle mountain region where population is large and forest is scarce. Chestnut and oak forests of the climax vegetation change into cultivated land in the Middle Mountain region. They are cut down selectively. Especially the oak timber is good for fuel with high caloric force and its lobe is a fodder suitable for livestock. Woman and children collect the firewood cutting down small tree in the neighborhood of village, which makes the forest regeneration difficult.

Main livestock in Nepal is water buffalo, cattle, sheep, goat, pig and chicken, and the kind of livestock varies depending on the elevation. Yak is limited to mountainous zone because it can't inhabit in a lower place than 3000 m,MSL. Cattle, water buffalo and goat are kept from the Terai plain up to elevation 2,500 m,MSL of the Middle Mountain region.

Livestock is kept by feeding straw and fodder leaf from forest to produce meat, dairy products (butter and yogurt) and so on. Moreover, the excrement of cattle and water buffalo is used as compost. Compost made from excrement of goat is high quality, but the amount is small. Excrement of livestock is also used as fuel for cooking and heating

in Alpine zone.

The livestock culture gives serious influence to the natural vegetation. Inedible plants of livestock increase by selective and over-grazing. The tree whose leaves are suitable for feeding of livestock is called fodder tree. About 130 species including wild and cultivated ones are being used as fodder trees in Nepal. Main fodder trees in these are *Ficus, Shorea, Castanopsis, Quercus* and so on.

Goat and sheep eat plants which are inedible for cattle and water buffalo. Their food plant selection is wide. In addition they can eat plants even on steep slope where cattle and water buffalo can't go into. Therefore, the destruction of vegetation is drastic and restoration of vegetation becomes difficult, which lead to the acceleration of soil erosion and the decrease of pastureland as well.

Tree leaf for fodder is important especially in winter when grass can't grow any more. In Middle Mountain leaf of Genus *Quercus* (evergreen oak of Subgenus *Quercus*) which is climax species is mown selectively because nutritive value is high. On the other hand, the trees that are inedible and left in the forest are Rhododendron *arboreum, Myrica esculenta* and Genus *Lyonia* in the middle mountain; and *Pieris formosa, Daphniphyllum* and so on in the central and eastern part.

If the grazing livestock is controlled suitably, the grass such as *Oryza* family can grow and is maintained as pastureland. If over-grazing takes place, venomous plants such as Genus *Euphorbia* and thorn plants such as Genus *Pyracantha* grows. *Eupatorium adenophorum* that is inedible for livestock grow gregariously in fallow field and over-grazed land from 1000 m to 2500 m,MSL. This plant originally came from Mexico about 100 years ago. This plant can invade into inside of open canopy forest, and interfere the seedling of forest trees. This plant is named Banmara in Nepali word, literally means "forest killer". Even these inedible plants are also cropped and mixed with fallen leaves to make compost.

Although it is prohibited to burn the forest and grass to prevent forest fire, the pastureland is burned secretly for regeneration of grasses and hunting.

After the burning and forest fire, grass regenerates well receiving the sunshine and absorbing nutrient, and pasture is recovered in good condition. It is said that the edible grass of livestock increases for three years after burning.

As was mentioned above, "Increase in population - lack of food – then expansion of agriculture land by deforestation" is a typical process often seen in the watershed of Nepal. Due to this process, natural ecosystem loses the original function, and the environment surrounding the agriculture becomes worse.

FLORA OF SOUTHERN NEPAL (1)

Sal(*Shorea robusta*) Forest : Sal is the iron-wood of Nepal and India. These forests are found in the Terai, Bhabar, Dun Valley, Siwaliks, Mahabharat and Sub-Himalayan tracts up to 1000 to1200 m,MSL

Bhabar, Terai and Dun Sal Forest : The sal of Bhabar, Terai and Dun has a few associates. Mainly there are *Terminalia Tomentosa, Adina cordifolia, Lagerstroemia parviflora* and *Bombax malabaricum.* Individual sal trees may attain the maximum height of over 50 m, though they are about 30 m high on an average.

I. Top canopy :

Acacia catechu	*Adina cordifolia*	*Albizzia labbek*
Albizzia procera	*Amoora decandra*	*Anogeissus latifolia*
Anthocephalus cadamba	*Artocarpus integrifolia*	*Azadirechta indica*
Bassia latifolia	*Baswella serrata*	*Cedrela toona*
Dalbergia latifolia	*Dalbergia sissoo*	*Dendrocalamus strictus*
Dillenia pentagyna	*Eugenia jambolana*	*Garuga pinnata*
Lagerstroemia parviflora	*Lannea grandis*	*Mangifera indica*
Melia azadirech	*Ougeinia dalbergioides*	*Schliechera trijuga*
Shorea robusta	*Stereospermum suaveolens*	*Terminalia belerica*
Terminalia chebula	*Terminalia myreocarpa*	*Terminalia tomentosa*

II. Second story :

Caraya arborea	*Croton oblongifolius*	*Ehretia laevis*
Flacourtia cataphracta	*Glochidion velutinum*	*Litsea salicifolia*
Mallotus philippinensis	*Wrightia tomentosa*	*Semecarpus anacardium*
Trewia nudiflora		

III. Small trees and shrubs :

Adhatoda vasica	*Antidesma diandrum*	*Ardisia humilis*
Clausena excavata	*Clerodendron infortunatum*	*Colebrookea oppositifolia*
Flemingia chappar	*Zizyphus jujuba*	*Zizyphus rugosa*

IV. Climbers, herbs and scrubs :

Spatholobus roxburghii	*Smilax indica*

FLORA OF SOUTHERN NEPAL (2)

Hill Sal Forest : This forest is found up to an elevation of about 800 m, MSL in the foothills of the lower Himalaya. The sal attain a height of about 18 m. This is probably due to the increase in elevation and the thin soil bed.

I. Top canopy :

Acacia catechu	*Adina cordifolia*	*Aegle marmelos*
Anogeissus latifolia	*Bauhinia malabarica*	*Bauhinia purpurea*
Bauhinia variegata	*Buchanania lanzan*	*Buchanania latifolia*
Dalbergia latifolia	*Dalbergia sissoo*	*Dillenia pentagyna*
Lagerstroemia parviflora	*Ougeinia dalbergioid*	*Pinus roxburghii*
Semecarpus anacardium	*Shorea robusta*	*Terminalia belerica*
Terminalia chebula	*Terminalia tomentosa*	

II. Second story :

Glochidion velutinum	*Kydia calycina*	*Leucomaris spectabilis*
Nyctanthes arbortristis	*Symplocos racemosa*	

III. Small trees, shrubs and scrubs :

Budleia paniculata	*Flemingia strobilifera*	*Hamiltonia suaveolens*
Indigofera pulchella	*Phoenix humilis*	*Rosa macrophylla*
Rubus ellipticus	*Woodfordia fruticosa*	*Zizyphus jujuba*

IV. Climbers, herbs and scrubs :

Bauhinia vahlii	*Spatholobus roxburghii*	*Smilax indica*
Smilax roxburghiana		

FLORA OF SOUTHERN NEPAL (3)

Tropical Deciduous Riverine Forest : This forest is found along rivers in the Terai, Bhabar valleys, Dun valleys as well as at the foot of the Siwalik hills.

I. Top canopy :

Acacia catechu	*Adina cordifolia*	*Albizzia lebbek*
Albizzia lucida	*Albizzia procera*	*Bassia latifolia*
Bombax ceiba	*Bombax malabaricum*	*Cedrela toona*
Dalbergia latifolia	*Dalbergia sissoo*	*Ehretia laevis*
Eugenia jambolana	*Garuga pinnata*	*Holoptlea integrifolia*
Lagerstroemia parviflora	*Lannea grandis*	*Sapium insigne*
Schleichera trijuga	*Stereospermum suaveolens*	*Trewia nudiflora*

II. Second story :

Alangium salvifolium	*Aporosa dioica*	*Bridelia retusa*
Cassia fistula	*Holarrhena antidysenterica*	*Mallotus philippinensis*

III. Small trees, shrubs and scrubs :

Adhotoda vasica	*Cassia tora*	*Clerodendron infortunatum*
Colebrookea oppositifolia	*Maesua indica*	*Pogostemon plectronthoides*
Rosa moscata Rubus ellipticus	*Zizyphus jujuba*	*Zizyphus rugosa*

IV. Climbers, herbs and scrubs :

Acacia concinna	*Acacia megaladena*	*Caesalpinnia digyna*
Dalbergia volubilis	*Dinospora cordifolia*	

FLORA OF SOUTHERN NEPAL (4)

Tropical Evergreen Forest : Tropical evergreen forest occurs as narrow strips along water courses in southern Nepal. It is found in gullys and on moist , shady north facing slopes. It also occurs along water courses within the sal forests.

Tropical Evergreen Forest of Eastern Nepal : These forest occur in the sal forests, usually in moist shady depressions and north facing gullys of the outer foothills. Individual trees may obtain a height of up to 50m. In eastern Nepal these forests found up to an elevation of about 700m.

I. Top canopy :

Actinodaphne angustifolia	*Albizzia sp.*	*Anthocephalus cadamba*
Castanopsis sp.	*Carallialucida*	*Cedrela toona*
Cryptocarya amygdalina	*Duabanga sonneratioides*	*Dysoxylum procerum*
Eugenia frondosa	*Garuga pinnata*	*Lithocarpus spicata*
Machilus villosa	*Phoebe lanceolata*	

II. Second story :

Actiondaphne obovata	*Antidesma acuminata*	*Aphania rubra*
Ehretia wallichiana	*Litsea polyantha*	*Pandanus furcatus*
Saraaja roxburgii	*Turpinia pomifera*	

III. Small trees, shrubs and scrubs :

Calamus sp.z	*Cycas pectinata*	*Maesa chisia*
Morinda angustifolia	*Sterculia cocinea*	*Vernonia talaunifolia*

IV. Climbers, herbs and scrubs :

Pothos catccartii	*Sabia paniculata*	*Vitis sp.*

Tropical Evergreen Forest of Western Nepal : These forests are found in moist depressions and gullys up to an elevation of about 800 m in western Nepal.

I. Top canopy :

Acer oblongum	*Albizzia sp.*	*Bassia butyracea*
Duabanga sonneratoides	*Eugenia jambolana*	*Machilus sp*
Mangifera sylvatica	*Phoebe lanceolat*	*Xylosoma longifolium*

II. Second story :

Alstonia scholaris	*Bischofla javanica*	*Heynea trijuga*
Macaranga denticulata	*Mallotus philippensis*	*Murraya exotica*

III. Small trees, shrubs and scrubs :

Ardisia humilis	*Eranthemum nervosum*	*Petalidium barlerioides*
Phlogacanthus thysiflorus		

IV. Climbers, herbs and scrubs :

Jasminum pubesens	*Sobia paniculata*	*Vitis sp.*

FLORA OF SOUTHERN NEPAL (5)

Sub Tropical Evergreen Forest : This forest is found between an elevation of 1,000 m and 1,800 m, MSL in the high rainfall region of the lower Himalayan Foothills. They are best developed in eastern Nepal. Individual trees may attain a height of up to 20 m.

I. Top canopy :

Acer oblongum	*Acer thomsonii*	*Brassaiopsis glomerulata*
Bassia butyracea	*Castanopsis indica*	*Cinnamonum camphora*
Cryptocarya amygdlina	*Eugenia tetragona*	*Machilus odoratissina*
Machilus villosa	*Michelia kisopa*	*Michelia daltsopa*
Ilex dipyrena	*Ostodes paniculata*	*Schima wallichii*
Tripina nepalensis		

II. Second story :

Amoora napaulensis	*Camellia kissi*	*Friobatrya cliptica*
Laportea sinuata	*Miliusa macrocarpa*	*Ostodes paniculata*
Saurauja napaulensis	*Symplocus eroegoides*	*Trauma hodgsonii*

III. Small trees, shrubs and scrubs :

Ardisia macrocarpa	*Clerodendron infortunatum*
Clerodendrum colebrookeanum	*Colebrookea oppositifolia*
Phlogacanthus thysiflorus	*Rosa macrophyalla*
Solanum nigrum	

Sub Tropical Deciduous Hill Forest : This forest occupies the altitude up to 1300 m. It does not only occur in the Siwaliks and Dun valleys, but it penetrates into the Mahabharat and Sub-Himalayan region through the big river valleys. In the area around Nepalganji and Dhangarhi, the south facing lower Himalayan slopes are almost entirely covered by this forest while sal forest are found on northern slopes. Individual trees attain a height of up to 18 m.

I. Top canopy :

Acacia catechu	*Aegle marmelos*	*Anogeissus latifolia*
Bauhinia variegata	*Croton oblongifolius*	*Ehretia laevis*
Flacourtia indica	*Garuga pinnata*	*Lannea grandis*
Litsea serbifera	*Terminalia tonentosa*	*Wendlandia sp.*

II. *Second story :*

Alangium salvifolium	*Butea minor*	*Phoenix humilis*
Rhus parviflora	*Woodfordia fruticosa*	

III. Small trees, shrubs and scrubs :

Acasia megaladena	*Acacia pennata*	*Mimisa rubicaulis*

FLORA OF SOUTHERN NEPAL (6)

Schima-Catanopsis Forest : This forest occupies the altitude ranging from 700m to 2000 m, MSL in the lower Himalaya and midlands Nepal. They are found on both north and south facing slopes. Schima gains the height of 28 m but *Castanopsis* can attain only up to 10 m.

(a) Schima wallichii and Castnopsis indica forest : This forest is found between an elevation of 800m and 1800 m, MSL on both the south and north facing slopes of the lower Himalaya. This tract is extremely moist and sal forest are limited to the south facing slopes.

I. & II. Top canopy & second story :

Castnopsis indica	*Castnopsis tribuloides*	*Engelhardita spicata*
Eugenia jambolana	*Heynea trijuga*	*Ilex doniana*
Litsea oblonga	*Mallotus philippensis*	*Myrica esculnta*
Rhus succedanea	*Schima wallichii*	*Terminalia chebula*

III. Small trees, shrubs and scrubs :

Camellia kissi	*Eurya acuminata*	*Myrsine semiserrata*
Osbechia stellata	*Pyrus pashia*	*Rhododendron arboreum*
Viburum coriaceum	*Viburnum erubescens*	

(b) Schima wallichii and Castnopsis tribuloides forest : They are best developed on both the north and south facing slopes of the Arun and Tamur valleys, between an elevation of 700m, and 2000 m, MSL.

I. Top canopy :

Alnus nepalensis	*Carpinus viminea*	*Castanopsis indica*
Castnopsis tribuloides	*Engelhardita spicata*	*Engelhardita frondosa*
Lithocarpus spicata	*Quercus glauca*	*Schima wallichii*

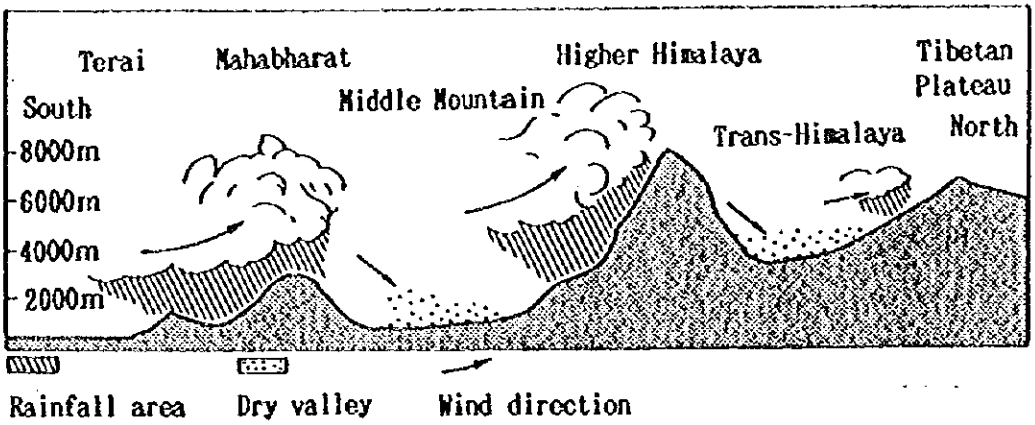
II. second story :

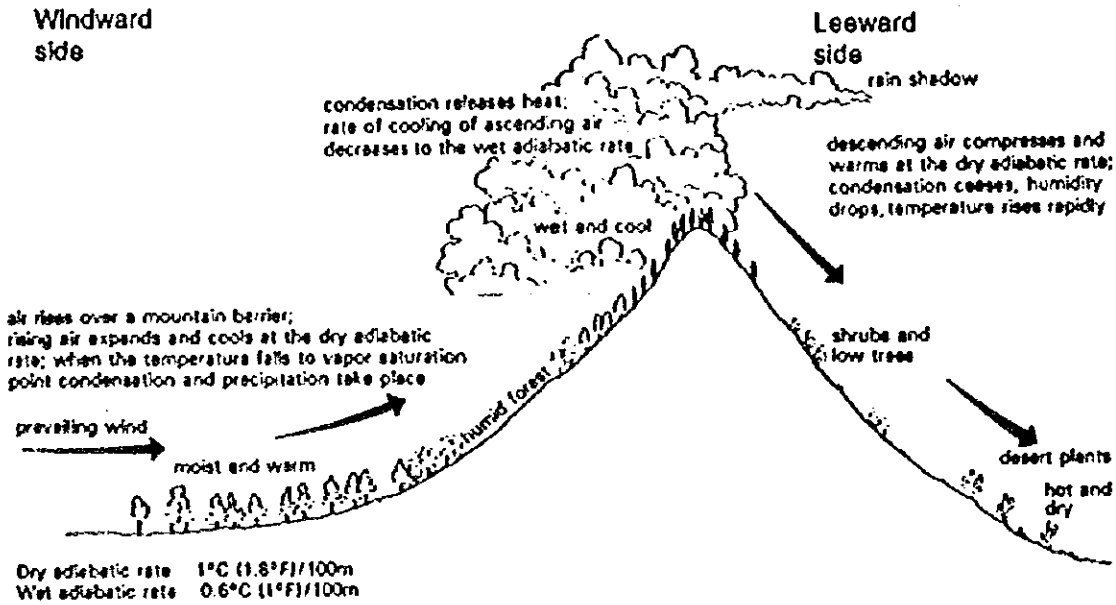
Callicerpa arborea	*Helicica errantica*	*Lyonia ovalifolia*
Macaranga sp.	*Rhus semialata*	*Wedlandia sp.*

III. Small trees, shrubs and scrubs :

Atylosia mollis	*Cornus oblonga*	*Dobinea vulgaris*
Viburnum coriaceum		

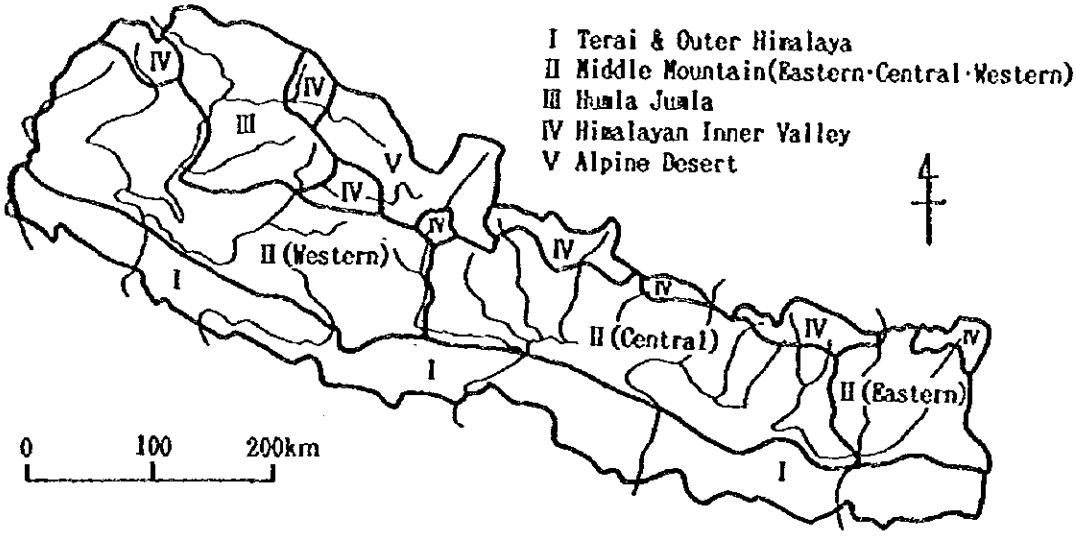
IV. Climbers, herbs and scrubs :
Vaccinium vaccinaceum



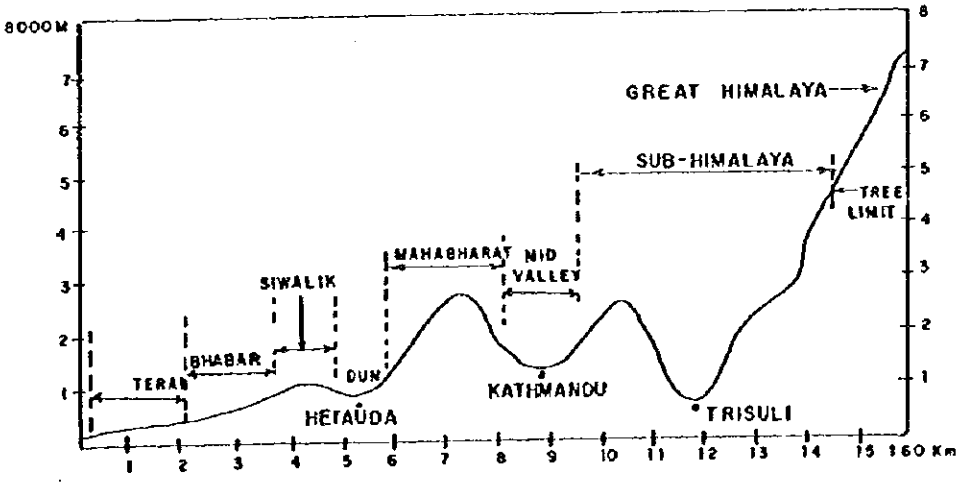


WET MONSOON AND HIMALAYA

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



(a) Climatic and Vegetational Divisions of Nepal
(Stainton, 1972)



(b) Topographic Profile
(The Cross-Section of The Nepal Through Kathmandu Valley: Shrestha,B.P.,1989)

VEGETATIONAL DIVISION AND TOPOGRAPHIC PROFILE

His Majesty's Government of Nepal
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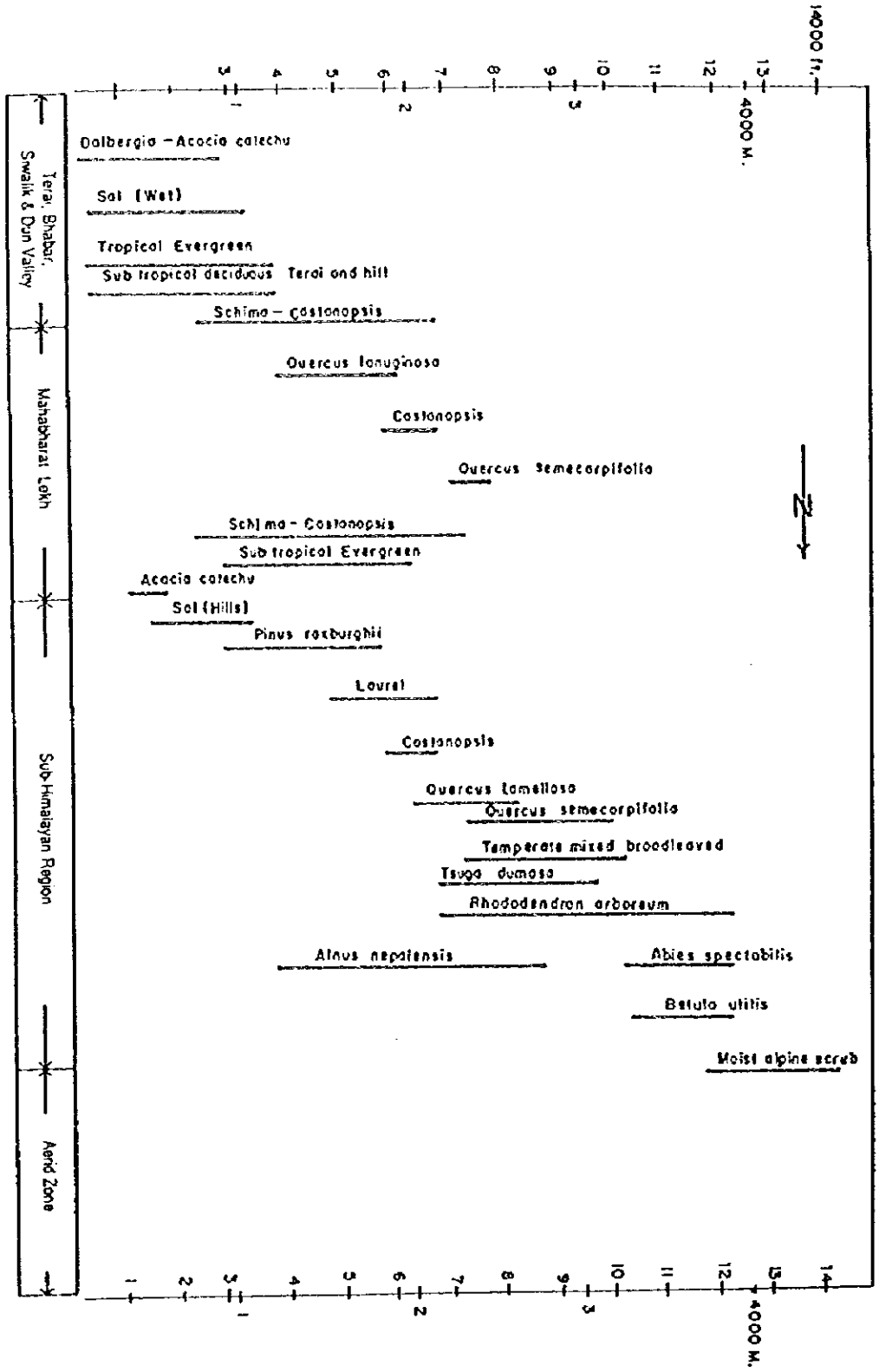
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

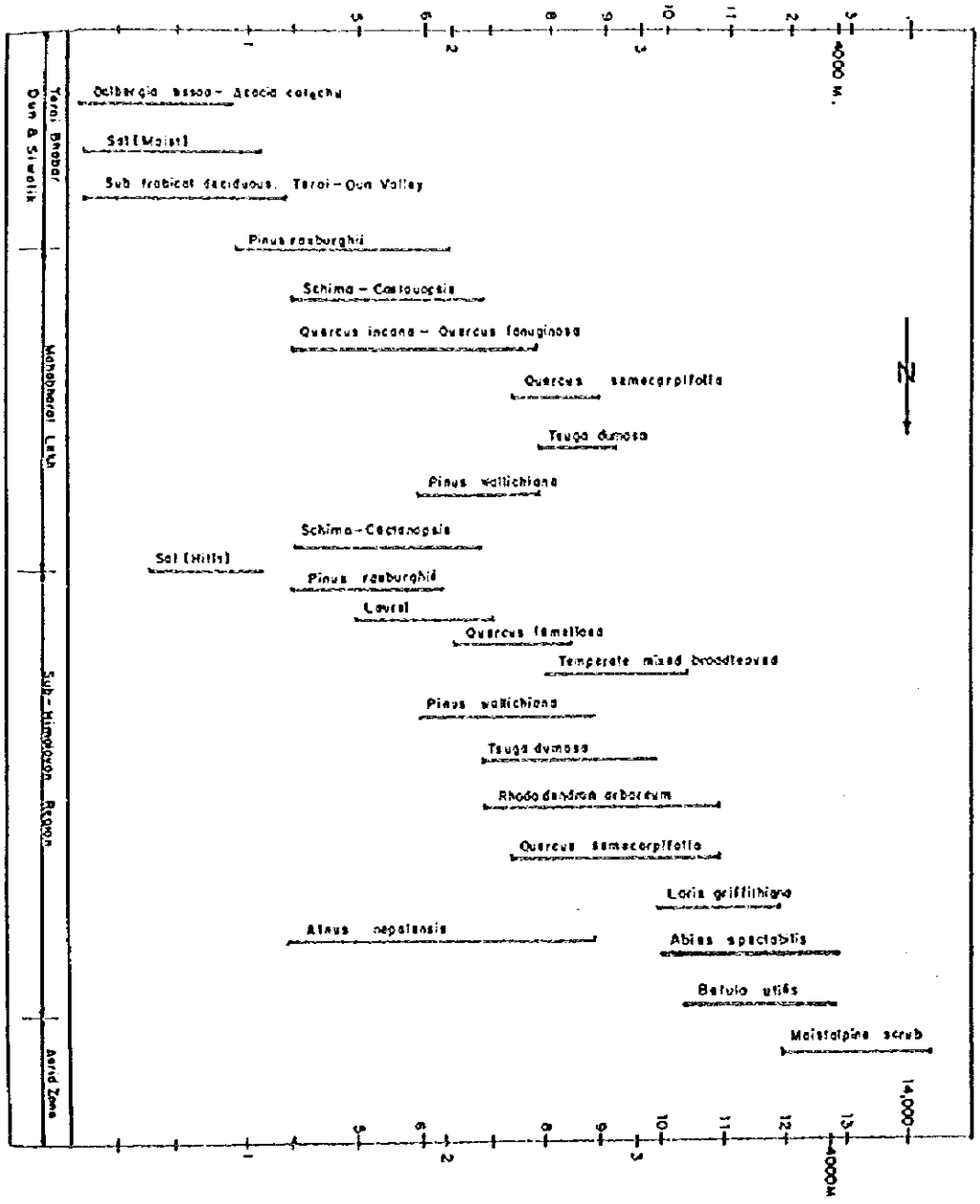


FOREST TYPE IN EASTERN SECTOR THROUGH DHANKUTA

TYPICAL FOREST OF NEPAL(1/3)

(Source) SHRESTA B.P. 1989-FOREST PLANTS OF NEPAL

His Majesty's Government of Nepal Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY



FOREST TYPE IN CENTRAL SECTOR THROUGH KATHMANDU

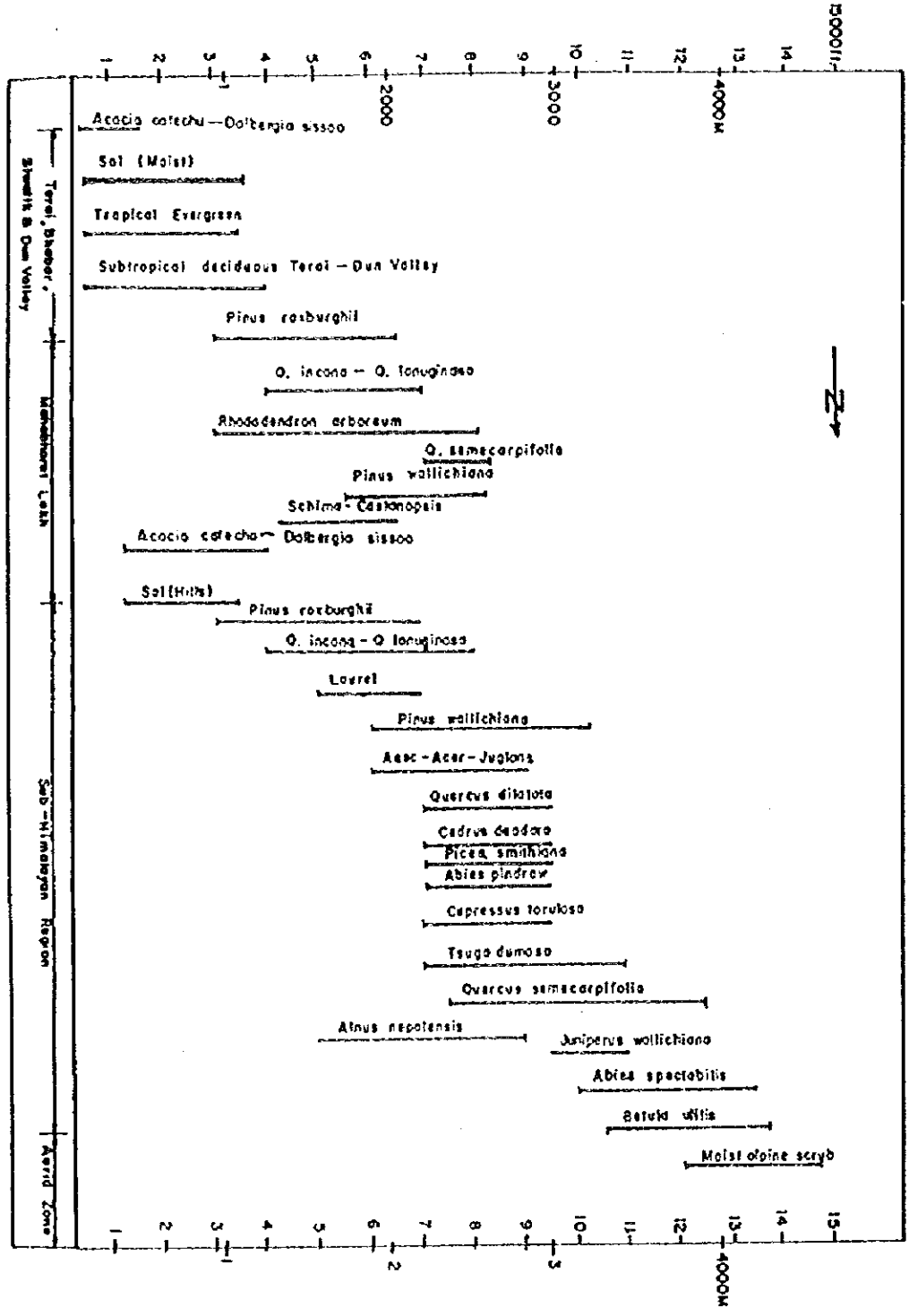
TYPICAL FOREST OF NEPAL(2/3)

(Source) SHRESTA,B.P.,1989-FOREST PLANTS OF NEPAL

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources

THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL

JAPAN INTERNATIONAL COOPERATION AGENCY



FOREST TYPE IN WESTERN SECTOR THROUGH DHANGADI EXCEPT UPPERBHERI AND COTCHMENT

TYPICAL FOREST OF NEPAL(3/3)

(Source) SHRESTA.B.P.,1989-FOREST PLANTS OF NEPAL

His Majesty's Government of Nepal
Department of Irrigation, Ministry of Water Resources
THE STUDY ON FLOOD MITIGATION PLAN FOR SELECTED RIVERS IN THE TERAI PLAIN IN THE KINGDOM OF NEPAL
JAPAN INTERNATIONAL COOPERATION AGENCY

6. ENVIRONMENT

6.1 Environmental Overview

(1) Background

The outer Terai area of Nepal is a natural floodplain at the foot of the Siwalik hills (Chure range), located in the southern part of the country. Within the Siwalik hills is the inner Terai or the Bhitri Madesh. Behind the Siwalik hills are the Lesser Himalayan mountains. Only eight specified rivers, including their flood plains, flowing through the inner and outer Terai (hereafter called the Terai) are considered in this flood mitigation study.

The elevation of the Terai is between 50 meters and 300 meters above mean sea level (MSL). About 60 main rivers, including four major river systems, which flow from north to south and then turn east into the Bay of Bengal, bisect it. The natural climatic climax vegetation is sal forests (*Shorea robusta*), but there is a profusion of plants and animals, many of which are protected to varying degrees in national parks, buffer zones and state forests.

The total area of the Terai is about 2.1 million hectares, 14% of the land area of Nepal. Arable agricultural land occupies about 1.4 million hectares, forest land, including degraded areas about 0.5 million ha., pastures and grasslands about 0.1 million ha., and other lands including urban areas and sterile land covered with sand, gravel and boulders making up the remaining 0.1 million ha.

The 1998 population of the Terai is about 11.0 million, (9.7 mill. in rural area and 1.3 mill. in urban area) out of a country total of 22.2 million. Because of migration into the area, the population of the Terai is anticipated to double in 20 years time, whereas that of Nepal will double in about 35 years time. Thus by the year 2020 the Terai may contain 67% of Nepal's population.

Apart from being the habitat of many wild plants and animals, some of which are rare and/or endangered species, the Terai is the main grain producing area in the country. In order to meet the growing demand for food, while at the same time protecting the indigenous flora and fauna, agricultural productivity has to increase. This should be done by increasing unit production, extending double and triple cropping through irrigation, and reclaiming some of the sterile land, rather than converting more forest

land to agriculture as has been done previously and to a small extent is occurring today. People do not want only destroy their environment, but act out of necessity to meet their requirements for food, fuel and shelter.

Hence, it is important to preserve the existing agricultural land from erosion and deposition of sand and gravel on the alluvial soils. This is why it is necessary to develop a practical and viable plan to reduce the detrimental effects of the annual monsoons, while at the same time ensuring that the habitat of indigenous flora and fauna is not only maintained, but also enhanced.

(2) Flood Mitigation Interventions

The flood mitigation plan, under the Department of Irrigation (DOI), studied eight rivers in the Terai plain. These rivers are from east to west, the Ratuwa, Lohandra, Lakhandei, Narayani, Tinau, West Rapti, Babai and Khutiya rivers. They cover all five regions of the country and include rivers of varying lengths.

Structural and non-structural interventions are proposed to stabilize river course and to reduce flood damage due to excessive rainfall. The average length of each river is about 50 km in the Terai from the foot of Siwalik hills to the border with India. During the monsoons, rivers change course frequently, leading to bank erosion and flooding of nearby farmlands

(3) National Park and Wildlife Reserve

The districts in which these rivers flow are given in Table B6.1. This table gives, for the Terai, the length of each river, the district areas and the approximate land use by district.

The average land use pattern in the districts containing the eight chosen rivers is representative of the region. However, two districts, namely Chitwan and Bardiya, contain large national parks and six of the rivers have listed wetlands along part of their lengths. Thus from an environmental viewpoint protecting these areas is of high priority.

The national park (N.P.) in Chitwan and the wildlife reserve (W.R.) in Bardiya are fully protected from encroachment. There are also buffer zones round each of these parks with restrictions on the use of forestland and riverbanks. Sometimes, park animals such as the rhinoceros invade farmers' fields and graze the crops. In rare instances, farmers

have abandoned the land to pasture. Crocodile also take the occasional small domestic or farm animal while it is drinking at the river.

The total area of Chitwan national park is 93,200 ha., 80% of which being forest and the remaining 20% grasslands. The river Narayani runs along the park's western border. The East Rapti river joins the Narayani river forming the park's northern border. Much of the park is elevated, thus, during the monsoons, river water tends to flow on farm and forest land opposite the park. Some dikes and gabions, etc., have been erected to prevent this from happening, but this protection is incomplete.

Bardiya wildlife reserve has an area of 96,800 ha., about 85% of which being forest and 15% grassland. The Babai river runs through this park. Only when it emerges from the park at its southern end are flood mitigation measures contemplated. From here, the distance to the border is some 20-km. Thus flood mitigation interventions on the Narayani, east Rapti and Babai rivers will have little, if any, effect on these two national parks.

(4) Wetlands

Of far more importance, are the potential effects of flood mitigation measures on the listed wetlands in six of the eight rivers. Table B6.2 gives the wetlands listed on six of the eight river floodplains in the flood mitigation program.

There are three large and three small wetlands. Two of the large ones are associated with the Chitwan national park and Bardia wildlife reserve on the Narayani and Babai rivers. These wetlands start in the N.P./W.R. and continue through the buffer zones. Some flood mitigation interventions may affect these wetlands, but 25% of the Narayani and 10% of the Babai wetlands are already farmed and have settlements on them. However, bearing in mind the needs of the human and domestic animal populations, the wetlands will be given high priority if measures are suggested in their vicinity and environmental impact assessments (EIA) will be undertaken.

The flora and fauna in these areas are similar to those found in the parks close to the rivers or in the park wetlands. They include *Saccharum spontaneum* (elephant grass), *Imperata cylindrica* (imperata grass), *Bombax ceiba* (simal [false kapok]) *Dalbergia sissoo* (sisoo or rose wood) and *Acacia catechu* (khair). Major animal species are found in these areas. They include *Rhinoceros uniceroni* (rhino), *Gavialis gangeticus* (gharial

crocodile), *Plantanista gangetica* (Gangetic dolphin) and many migratory birds.

The other large wetland is found on the West Rapti river floodplain. It occupies an area of 37,500 ha and crosses three districts, namely Arghakhanchi, Dang and Banke districts. An estimated 40% of the land is farmed and 10% is classified as settlements, thus half of this wetland has been modified already by human activity.

The trees on the wetland include, khair, sal, simal, sisoo, *Ficus glomerata* (gular), *Engenia jambolana* (kyamuno) and *Terminalia tomentosa* (saj). The wetland habitat is a home to many species of fish, amphibians, reptiles, birds and mammals. It provides a staging and foraging ground for migratory birds. A more detailed listing can be found in the IUCN Wetland Database System, (IUCN/Nepal, 1995).

The Ratuwa floodplain has a small wetland of some 7,000 ha found in the east of the country situated near Damak Municipality. It has a permanent inflow and outflow of water. Agriculture dominates this area, accounting for 70% of land use with a further 10% under habitation. An estimated 150,000 people (27,000 households) use resources in this floodplain.

Elephant and imperata grasses as well as most of the tree species mentioned above are found on the wetland. Large waders and other wetland birds are found here together with one wild fish *Amphilipnous cuchia*. The threats to this area are agricultural runoff, pollution and filling.

Like the previous wetland, the Tinau wetland occupies a small area of 5,700 ha. Agriculture is the main land use system accounting for an estimated 60% of the area with human habitation of further10%. It has a perennial water source coming from the Siwalik hills. The river flows through 15 village development committee (VDC) areas of Rupandehi district. The estimated population is about 135,000, (24,000 households). The flora and fauna are similar to that of Ratuwa wetland.

The last wetland, in the far west of the country, is the Khutiya river floodplain. It has an area of some 3,600 ha with a perennial stream. At present, agriculture only occupies an estimated 25% of the land, with forests and pastures accounting for 30% each. There are just 4 VDCs, with an estimated population of 77,000. Thus more varieties and numbers of plants and animals are found in this wetland. Sisoo and Khair dominate the floodplain. Other important tree species found in the area include, *Trewia nudiflora*,

(Bhelar), *Adina cordifolia*, (Haldu), *Syzigium cumini*, (Jamun) and Simal.

There are reports of many species of fish, amphibians, reptiles, birds and mammals, including the smooth coated otter, *Lutrogale perspicillata*. The river is a feeding ground for numerous resident and migratory bird species. The recorded species of importance include, *Ciconia episcopus, C. nigra, Ichthyophaga icthyaetus, Motacilla cinerea, M. citreola, M. madraspatensis, Pelagopsis capensis, Phalacrocorax niger, Pseudibis papillosa, Spilornis cheela, Tringa ochropus, T. hypoleucos, T. nebularia, T. totanus, Vanellus indicus* and *V. spinosus* (IUCN/Nepal [1995] Wetland Database).

(5) Summary

In summary, two out of the four national parks/wildlife reserve areas in the Terai are bounded by rivers in the flood mitigation study. There are over 150 floodplain wetlands in the inner and outer Terai; six of these wetlands occur on the rivers under consideration. Thus the study rivers are a microcosm of the whole Terai.

It is unlikely that these national parks/wildlife reserve areas will be affected by proposed flood mitigation interventions. It is possible that the buffer zones surrounding these reserves may be adversely affected by mitigation interventions, but this is unlikely.

What is more likely to affect the environment of the buffer zones, wetland areas, forests and even the parks is the anticipated doubling of the population in the Terai by 2020. Unless existing agricultural land can be protected from erosion and sedimentation and unless agricultural productivity increases at the same pace as population increase, more forests and wetlands will be converted to arable agricultural lands.

The main purpose of the flood mitigation study is to propose interventions to reduce the disrupting effects of the monsoon flooding. Such measures should minimize erosion and land degradation in the Terai. Indeed, the measures may enable some of the existing flood and sediment suffering lands to be reclaimed and brought back into productive use. Therefore, flood mitigation measures are important interventions for environmental, economic and social protection.

6.2 Environmental Organizations and Institutions

There are many organizations and institutions concerned with environmental conservation in Nepal, but only the relevant ones dealing with environmental

conservation in the Terai will be dealt with here.

The Environmental Division of the Ministry of Population and Environment has overall responsibility for environmental matters in Nepal. In June of 1997, Environmental Conservation Rules were issued under section 24 of the 1997 Environmental Conservation Act. These rules lay down procedure to be followed when new projects are proposed or existing projects extended. These rules will be discussed later, but central to approval of any projects is the consent (and inputs) from affected villages, municipalities and districts, through their representative Village Development Committee (VDC), Municipal Council (MC) and District Development Committee (DDC)

There is an environmental advisory body called the Environmental Protection Council. It is made up of representatives from government and non-government bodies. This council provides policy guidance and suggestions to the government regarding environmental protection matters. It also facilitates co-ordination for different government and non-government agencies.

The principal government ministries or agencies concerned with environmental matters in the Terai are the Ministry of Agriculture, Ministry of Forest and Soil Conservation, Ministry of Health, Ministry of Local Government, Ministry of Water Resources, Department of Irrigation, Department of Land and Watershed Conservation, Department of National Parks and Wildlife Conservation, Department of Roads, National Planning Commission, and Water Induced Disaster Prevention Technical Center.

Over ninety local non-government organizations have been listed in a Compendium on the Environmental Statistics of Nepal (Central Bureau of Statistics, 1994). These include Nepal Ecological Group, Nepal Forester's Association, Promoters of Environment Friendly Development in Nepal, and Conservation Asia.

Bilateral and multilateral agencies include the Japan International Cooperation Agency (JICA), German Aid Agency (GTZ), Canadian International Development Agency (CIDA), United Nations Environmental Program (UNEP), United Nations Development Program (UNDP), Food and Agricultural Organization of the UN (FAO), and World Bank (IBRD/WB).

Finally, one international NGO has done much to promote environmental conservation

in Nepal. This is the International Union for the Conservation of Nature and Natural Resources (IUCN). This is generally known as the World Conservation Union. The IUCN has published for Nepal a Database of Wetlands (1995) and a National Environmental Impact Assessment Guidelines Handbook (1993).

6.3 Environmental Conservation Rules

The Environmental Conservation Rules (ECR) was proclaimed on 26 July 1997 in order to govern all new project proposals and extensions to existing projects. According to the ECR, all projects have to undergo an Initial Environmental Examination (IEE) or an Environmental Impact Assessment. Such environmental studies require detailed investigations and are time consuming. At present, there is no screening mechanism to separate out projects that will be benign or beneficial to the environment. Also, the rules assume that most projects will be small and cover a discrete time period.

However, the flood mitigation plan for the eight rivers in the Terai plain, consisting of structural and non-structural interventions, should have a beneficial impact on the environment. The plan endeavors to protect existing wetlands, control floodwater during the monsoons, prevent excessive damage to farmer's fields, control erosion and reduce damage to property. The average length of the rivers in the plain is about 50 km. and the flood mitigation is an on-going initiative.

(1) Procedure to Follow When Undertaking Environmental Assessment

The Environmental Conservation Rules (ECR) lay out, in detail, the various steps to be taken when undertaking either an Initial Environmental Examination (IEE) or an Environmental Impact Assessment (EIA). Table B6.3 tabulates the steps to be taken when performing the IEE or EIA, and summarizes the various steps that are required to comply with the ECR.

It appears that all flood mitigation initiatives passing through the six wetland sites mentioned in Table B6.2 will be subjected to the EIA. Because most of these wetland sites are spread out along the various rivers, discrete scopes of work may have to be formulated for interventions in the area of each VDC. For example, the Tinau river floodplain passes through the area of 15 VDCs.

One dilemma regarding floodplains is whose interest should be uttermost when devising a flood mitigation plan, the natural habitat or the people in the area. It is possible that

when a scope of work (SOW) is provided to the concerned VDC, it may want wetlands curtailed in favor of more agricultural land. This is why the project intends to work with villagers when drawing up the plan and stress the importance of wetlands. Then discussions can take place on the merits of preserving or modifying wetland areas rather than presenting a SOW without prior discussion.

The time scale for undertaking the EIA, assuming the MOPE gives approval within weeks, rather than the 90 days allotted for approval, is an estimated 5 months. This period includes the mandatory two 30-day periods for consideration by VDCs plus 2.5 months for preparing the SOW, obtaining approval, preparing and getting approved a work schedule, undertaking the EIA and report preparation. If the MOPE is slow at giving approval and/or problems are encountered, such as difficulty in reaching VDCs during the monsoons and actually undertaking the study in the rainy season, then the process could take up to 8 months.

(2) Proposed Changes to Environmental Conservation Rules (ECR)

User friendly rules: The Environmental Conservation Rules (ECR) drawn up at present do not appear that they are "user friendly" for projects such as flood mitigation plans of river systems. Rather, the rules appear to be geared to discrete projects on small areas. They may not be very suitable for large (environmental friendly) planning exercises.

All water bodies: The ECR contain a clause which negates everything about water bodies that have been mentioned previously in the rules. Schedule 1 and 2 of the rules cite several examples of when an IEE or an EIA is required. However, section K (8) states that an EIA has to be carried out in "Areas containing water (still or flowing)." This directive covers all water bodies without exception. Thus an EIA is required on all projects containing water. However, the directive appears to cover only wetlands, not all water bodies.

Notification and comments: It is also suggested that the time period for notification and comments concerning the Scope of Work and the results of an IEE or EIA be reduced from 30 days to 14 days. Also, the method of notification should be by publication in the press and/or by broadcast in the media, rather than by mail and/or hand delivery. This recommendation will still give ample time for inputs from affected people without duly delaying the study. After all, such projects as the flood mitigation project can only be carried out successfully with the active participation of the people

themselves.

Environmental screening: It is recommended that the ECR be modified for large projects such as the Terai flood mitigation plan, only undertaking rigorous environmental examinations on critical parts of the system which may be adversely affected due to mitigation interventions. Most of the proposed interventions in the flood mitigation plan are to prevent erosion and loss of habitat and thus are environmentally beneficial. In cases like these, initial environmental screening studies, similar to those of JICA manual should determine if an IEE or EIA is necessary. Otherwise, the screening will be sufficient to allow the project to proceed in those areas not adversely affected by the proposed interventions. Of course, where project interventions impinge on the rights and activities of the people, their cooperation and consent is not only required, but is a necessary condition for the interventions to be successful. A flood mitigation plan will not succeed without the active involvement of the people living and working along the rivers.

Environmental study: It is further requested that initially, for the Master Plan, only an environmental study (ES) be undertaken for the eight (8) rivers included in the plan. This ES will consist of an environmental screening, which will highlight those areas requiring further examination. Only two of these rivers will be subjected to a detailed flood mitigation proposal. Here a comprehensive plan will be drawn up specifying the interventions required to prevent flood damage. It is suggested that for these two rivers, only those portions of the rivers, highlighted in the initial ES should be subjected to an IEE or EIA and not the whole length of these river systems in the Terai plain.

Modification and adjustment of plan: As the first phase of the project is to last five years, it is possible to modify and adjust the original plans, so as to incorporate improved technologies, incorporate more appropriate species and to address local and/or national concerns. This should be encouraged, but the existing environmental rules discourage such flexibility. However, as these interventions will only bring about environmental enhancement, they should not be subjected to in-depth environmental assessments, just environmental screenings as is demonstrated.

LAND USE OF RELATED DISTRICTS

District	River (length:km.)	Agriculture (ha)	Forest (ha)	Sand, gravel and boulders (ha)	Other (ha)	Total (ha)
Jhapa	Ratuwa (43.7)	120,153	13,849	9,023	3,555	146,580
Morang	Ratuwa (20.0) Lohandra (67.5)	113,321	29,615	5,250	1,231	149,417
Sarlahi	Lakhandei (51.4)	84,944	17,866	5,586	372	108,768
Chitwan	Narayani (51.0)	49,272	18,500	0	15,000	82,772
Nawalparasi	Narayani (51.0)	71,310	8,588	2,239	773	82,910
Rupandehi	Tinau (59.5)	97,456	20,926	2,024	660	121,066
Dang	West Rapti (55.5)	71,871	36,400	0	0	108,271
Banke	West Rapti (55.5)	55,758	55,430	4,670	331	116,189
Bardiya	Babai (48.0)	62,281	38,529	8,635	30,527	139,972
Kailali	Khutiya (28.6)	74,315	112,805	5,668	0	192,788
Total	Av. length (50.6)	800,681	352,508	43,095	52,449	1,248,733

Note: Other land includes ponds, urban, abandoned etc. except in Chitwan and Bardiya where there are respectively 15,000 ha. and 30,000 ha. of grasslands within the National Parks. There were some discrepancies between the Land Resource Mapping Project and the Forest Survey figures. These could hinge on the definition of what is included in the Terai. The most likely figure from each source table was taken, based on ground experience.
Source: Land Resource Mapping Project (LRMP), 1986; and Forest Resources in the Terai 1990/91, Forest Survey (FS) 1993.

WETLAND AREA IN TERAI BY LAND-USE TYPE

River	Ratuwa (ha)	Narayani (ha)	Tinau (ha)	W. Rapti (ha)	Babai (ha)	Khutiya (ha)	Total (ha)
Habitation	715	1,900	600	3,800			7,015
Barren	710		600			625	1,935
Agriculture	4,990	9,500	3,400	15,000	1,300	820	35,010
Pasture			600		2,512	1,090	4,202
Grassland		9,500		7,500	2,500		19,500
Open Forest	710	5,700	500		2,600	1,090	10,600
Closed Forest		11,400		11,200	11,200		26,500
Total	7,125	38,000	5,700	37,500	12,812	3,625	104,762

Note: Two of the rivers in the study - Lohandra and Lakhandei do not have designated floodplain areas on them.
Source: IUCN Wetland Database System. IUCN/Nepal 1995.

Table B6.3

PROCEDURE TO FOLLOW UNDER ENVIRONMENTAL CONSERVATION RULES

Step	IEE	EIA	Time Limit (days)
1	Draft Scope of Work (SOW) drawn up for sub-project (SP).		
2	Draft SOW submitted to people affected by SP for comments.		30
3	SOW adjusted , if necessary, to reflect people's comments.		
4	SOW submitted to Ministry of Water Resources (MOWR). MOWR will determine if SP requires an IEE or an EIA.		
5	If SP requires an IEE then MOWR can approve of SOW.	If SP requires an EIA, then SOW submitted to MOPE for approval	
6	After approval, work schedule (WS) drawn up according to Schedule 3 of ECR.	After approval, (WS) drawn up according to Schedule 4 of ECR.	
7	WS submitted for approval to MOWR.	WS submitted for approval to MOPE.	
8	On approval, IEE undertaken according to guidelines laid down in Schedule 5 of ECR.	On approval, EIA undertaken according to guidelines laid down in Schedule 6 of ECR.	
9	Draft IEE report sent to affected people for comments and suggestions.	Draft EIA report sent to affected people for comments and suggestions.	30
10	Final IEE report compiled after considering comments.	Final EIA report compiled after considering comments.	
11	IEE Report submitted to MOWR for approval. If accepted, approval given within 30 days.	Final EIA report sent to MOWR. The MOWR sends to MOPE within 30 days, for approval.	30
1 2		If acceptable, MOPE will approve the EIA within 90 days of receiving the proposal.	90
13	Once the IEE or EIA approved the sub-project can proceed.		

(Note:)
IEE : Initial Environmental Examination, EIA : Environmental Impact Assessment,
SOW : scope of work, SP : sub-project, MOWR : Ministry of Water Resources,
MOPE : Ministry of Population and Environment, WS : work schedule

C. BASIC INVESTIGATIONS AND STUDIES

SUPPORTING REPORT

C. BASIC INVESTIGATIONS AND STUDIES

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1. BASIC SURVEY AND INVESTIGATION

1.1 Investigation of Flood and Sediment Disasters

(1) Investigation Procedures

Conditions of past flood and sediment disasters were investigated for all of the eight rivers in the Study Area. Data and information were collected in the following procedures:

1) Collection of data and information at District Irrigation Offices (DIO) and District Development Committee (DDC) offices mainly on the items listed in Table C1.1.
2) Collection of data and information at selected Village Development Committee (VDC) and Municipality offices mainly on the items listed in the said Table C1.1.
3) Collection of data and information from selected individual residents (more than 1,000 persons) at VDC/Municipality offices by filling the form shown in Table C1.2.

(2) Implementation of Investigation

The investigation was carried out for about one month from the middle of January 1998 organizing four investigation groups consisting of two Nepali consultants each employed by the Study Team as follows:

- Group 1: Ratuwa and Lohandra rivers
- Group 2: Lakhandei and Tinau rivers
- Group 3: Narayani and Babai rivers
- Group 4: West Rapti and Khutiya rivers.

(3) Districts and Villages Subject to Investigation

Districts related to eight rivers for the Study are listed below for respective rivers.

	(River)	(Related districts)
1)	Ratuwa River	Jhapa, Morang
2)	Lohandra River	Morang
3)	Lakhandei River	Sarlahi

4) Narayani River — Chitawan, Nawal Parasi
5) Tinau River — Rupandehi
6) West Rapti River — Banke, Dang
7) Babai River — Bardiya
8) Khutiya River — Kailali

On the basis of the information obtained from the DIOs and DDC offices, 78 VDC offices and 3 municipality offices were selected for the investigation. Furthermore, the 1,124 residents in the flood prone areas were selected as shown below for the individual interview using questionnaire form.

River	Related districts	VDC/Municipality (number)	Interviewees (persons)
1.Ratuwa R.	2	9	171
2.Lohandra R.	1	13	131
3.Lakhandei R.	1	13	192
4.Narayani R.	2	11	101
5.Tinau R.	1	11	107
6.West Rapti R.	2	14	228
7.Babai R.	1	6	129
8.Khutiya R.	1	4	65
Total	10	81	1,124

Names of VDC/Municipalities subject to the investigation are shown in Table C1.3

(4) Flood and Sediment Disasters

Flood and sediment disasters in the rivers subject to present study are summarized in Table C1.4. These are mainly based on the questionnaire responses of the individual residents in the flood prone areas. Incorporating the information and data obtained from DDC, DIO and VDC as well, conditions of the disasters and people's response to them are summarized as follows:

1) Recent major flood in past 10 years: All the rivers subject to study experienced big flood events in the last three years. The flood in 1993 was memorized as a big flood only in the Narayani and West Rapti rivers.
2) Frequency of flooding in a year: Frequency of flooding is high in the Ratuwa, Lakhandei and Tinau river basins, though it depends on the reaches even in a river.
3) Types of disasters: Flooding over farmland, river bank erosion and

sedimentation are the major types of disasters in the Study Area. In the Ratuwa and Babai river basins, these three problems are of equal importance though the bank erosion problem was uppermost. In the Lohandra, Lakhandei, Narayani and Tinau river basins, most residents pointed out sedimentation problem followed by bank erosion problem. River bank erosion is the principal problems in the West Rapti river basin and flooding over the farm land in the Khutiya river basin.

4) Causes of disasters: Two major causes are considered, i.e., severe natural disasters and insufficient countermeasures. The greater part of the residents pointed out insufficient countermeasures in the Narayani, West Rapti and Babai river basins, which indicated that the residents in these basins have strong concern about flood mitigation measures.
5) Experience of evacuation: More than 50% of interviewees have experienced evacuation in the Lakhandei, Narayani and Tinau river basins. This may indicates the severity of the disaster in these basins.
6) Experience of participation in flood mitigation activities: More than 50 % of residents have participated in flood mitigation activities in the Ratuwa, Lakhandei and Tinau river basins. Especially in the latter two basins, almost all the interviewees have had experience. Participation is mostly in the form of labor service.
7) Willingness to participation in flood mitigation activities: Most of the interviewees expressed their willingness to participate in flood mitigation activities mainly with labor service, which suggests that under pressure the residents will take action for their own protection.

Investigation results of flood and sediment disasters are compiled in SUPPORTING REPORT-A for the respective river basins.

1.2 Investigation of Riverbed Materials

Riverbed materials were investigated for plain reaches of the eight rivers in the Study Area by a Nepali Consultant under a contract in accordance with the program and specification prepared by the JICA Study Team

The investigation includes the following outdoor and indoor works:

1) Sampling of river bed materials at the site

2) Grain size analysis in the field and in laboratory
3) Specific gravity test in the laboratory

(1) Sampling of Riverbed Materials

Riverbed materials were sampled on the river bed near the shore. The sampling sites were selected so that the sampled materials is representative those of the typical river section.

Sampling of riverbed material was carried out according to a sequence and specifications as follows:

1) To take a photo of river channel for its upstream and downstream views from the sampling site.
2) To remove surface materials about 30 cm in depth and take a photo of sampling spot with scale to show the grain size.
3) To take out sample bed materials up to additional 50 cm in depth (80 cm in total from the original surface).

- The approximate quantity of material to be taken out depends on the maximum grain size of the sample as follows:

Max. grain size (mm)	Materials taken (kg)	Sample (kg)	Remarks
less than 10	4	1	For indoor analysis
10 to 20	20	5	For outdoor analysis
20 to 40	60	15	For outdoor analysis
40 to 60	80	20	For outdoor analysis
60 to 80	120	30	For outdoor analysis
more than 80	140	35	For outdoor analysis

- The removed material is put on a clean vinyl sheet and mixed well. Then, a quarter of the material is sampled.
- If the maximum grain size is smaller than 10 mm, the sample is kept in a clean container with the site name clearly specified. This is removed for indoor grain size analysis.
- If the maximum grain size is lager than 10 mm, the sample is put on a

vinyl sheet and air dried before grain size analysis at the site.

(2) Grain Size Analysis

Grain size analysis was carried out to determine the grain size distribution of the riverbed material. The analysis was undertaken on the spot for the bigger grain size portion and indoors for the smaller grain size portion.

Outdoor Analysis

The outdoor grain size analysis was carried out using the following procedures:

1) Weigh the whole sample.
2) Screen the sample with a standard sieve set and record the weight of the material remaining on each sieve and the material passing through the smallest sieve. The total weight should be almost equal to the total weight of sample.
3) The standard sieve set consists of sieve holes of 53.0 mm, 37.5 mm, 26.5 mm, 19.1 mm and 9.50 mm or those approved by the JICA Engineer.
4) The balance used for weighing the material should be of sensitivity higher than 1 g.
5) Each of grains remaining on 53.0 mm sieve should be measured for its grain size and weight. The grain size should be measured for length, width and thickness.
6) The material remaining on the sieves less than 37.5 mm should be mixed after the sieve analysis and about 1 kg of sample removed for a specific gravity test. The sample should be put in a clean container with its site name clearly written.

Indoor Analysis

The indoor grain size analysis was carried out as follows:

1) The sieve set used for indoor analysis consists of 9.50 mm, 4.75 mm, 2.00 mm, 0.85 mm, 0.425 mm, 0.250 mm, 0.106 mm and 0.075 mm or those approved by the JICA Engineer.
2) The balance used for weighing the material remaining on each sieve should be used of sensitivity higher than 0.1 g.

(3) Specific Gravity Test

Specific gravity tests for fine aggregate was carried out indoors with about 1 kg of the sample used for the indoor grain size analysis. The test was carried out twice dividing a sample into two as follows:

1) Specific gravity of a fine aggregate is the ratio of the unit weight of the sand to the unit weight of water.
2) Sample is immersed in clean water for 24 hours and dried to saturated surface-dry condition.
3) Two representative sample of the above saturated surface-dry material is obtained so that the two samples have identical weight of 500 grams. The weight of saturated surface-dry sand is recorded as B.
4) Another saturated surface-dry sample is placed in an oven and dried to constant weight and the weight is recorded as A.
5) The pycnometer is filled up to about three-quarters full of water and the surface dry sample B is added. Entrapped air is removed by boiling the sample in pycnometer for 15 minutes. The jar is then filled with water and cooling up to room temperature. The pycnometer is weighted and recorded as W. The value of specific gravity of the sand is calculated as:

$$Specific\ gravity = \frac{A}{W_c + B - W}$$

where

W_c = weight of pycnometer filled up with water at same temperature as water used in test.

W = weight of pycnometer with water and sample

(4) Quantity of Work

1) Sampling (for indoor / outdoor analyses)
   - Ratuwa R. :13 sites / 8 sites
   - Lohandra R. :13 sites / 8 sites
   - Lakhandei R. :13 sites / 8 sites
   - Narayani R. :23 sites / 20 sites
   - Tinau R. :13 sites / 8 sites
   - West Rapti R. :23 sites / 12 sites
   - Babai R. :13 sites / 6 sites

- Khutiya R. :10 sites / 6 sites

2) Grain size analysis
   - Outdoor grain size analysis :76 samples
   - Indoor grain size analysis :121 samples

3) Specific gravity test :121 samples

(5) Result of Investigation

As a result of investigation, grain size distribution along the river is shown in Fig. C1.1. In the upper reaches, grain size is distributed in a wide range for the bed materials and gradually it becomes more uniform in the lower reaches. It is noteworthy that the change in grain size distribution occurs abruptly in the West Rapti and Babai rivers.

River channel can be divided into several reaches depending on the grain size distribution in consideration of channel slope, river width and surrounding topography. River slope, representative grain size and average river width are worked out for respective reaches and are shown in Table C1.5. Classification of riverbed materials is shown in Table C1.6 according to AGU classification.

Results of bed material investigation are compiled in SUPPORTING REPORT-A for respective rivers in the Study Area.

1.3 Investigation of Existing River Facilities

(1) Method of Investigation

Conditions of existing river facilities were investigated for all of the eight rivers in the Study Area. The investigation was carried out for about one month from the middle of January 1998.

The investigation aims to clarify the location, kind of structure and its function, and present conditions of the existing river facilities such as dike, bank protection works, drainage sluice, weir/barrage, intake gate, bridge, and other flood mitigation and water use facilities.

The investigation was carried out in the field according to the following procedures:

1) To collect data and information on the river facilities from the related district offices.
2) To plot location of facilities (by using GPS) on topographic map (1/25,000).
3) To sketch general layout of facilities and structural details (plan and section) by measuring major dimensions.
4) To take photos of:
   - General view of river and structure,
   - Upstream and downstream views of structure, and
   - Other spot views which best show the structure and damaged conditions.

As a result, the investigation covered a total of 484 facility sites.

(2) Major River Facilities

According to the result of investigation, the number of major river facilities are reckoned in Table C1.7 for respective rivers.

As seen in the table, spur works share by far the majority of the facilities followed by revetment works. Almost all the spur and revetment works are made of gabions consisting of bolders and galvanized iron (G.I.) wire net.

The existing facilities are located sporadically along the river course. Some of the spur and revetment works are damaged already probably due to lack or insufficient foot protection. In some sites single spur was seen, though the stability and function of spur works can be attained when they are installed as a series. All of these may come from the lack of fund for river works. The types of existing spur or bank protection works are monotonous. Variety of work should be introduced considering the river condition and availability of materials. Photos of typical river facilities are shown in Fig. C1.2.

Major river facilities and their locations are compiled in SUPPORTING REPORT-A for respective rivers.