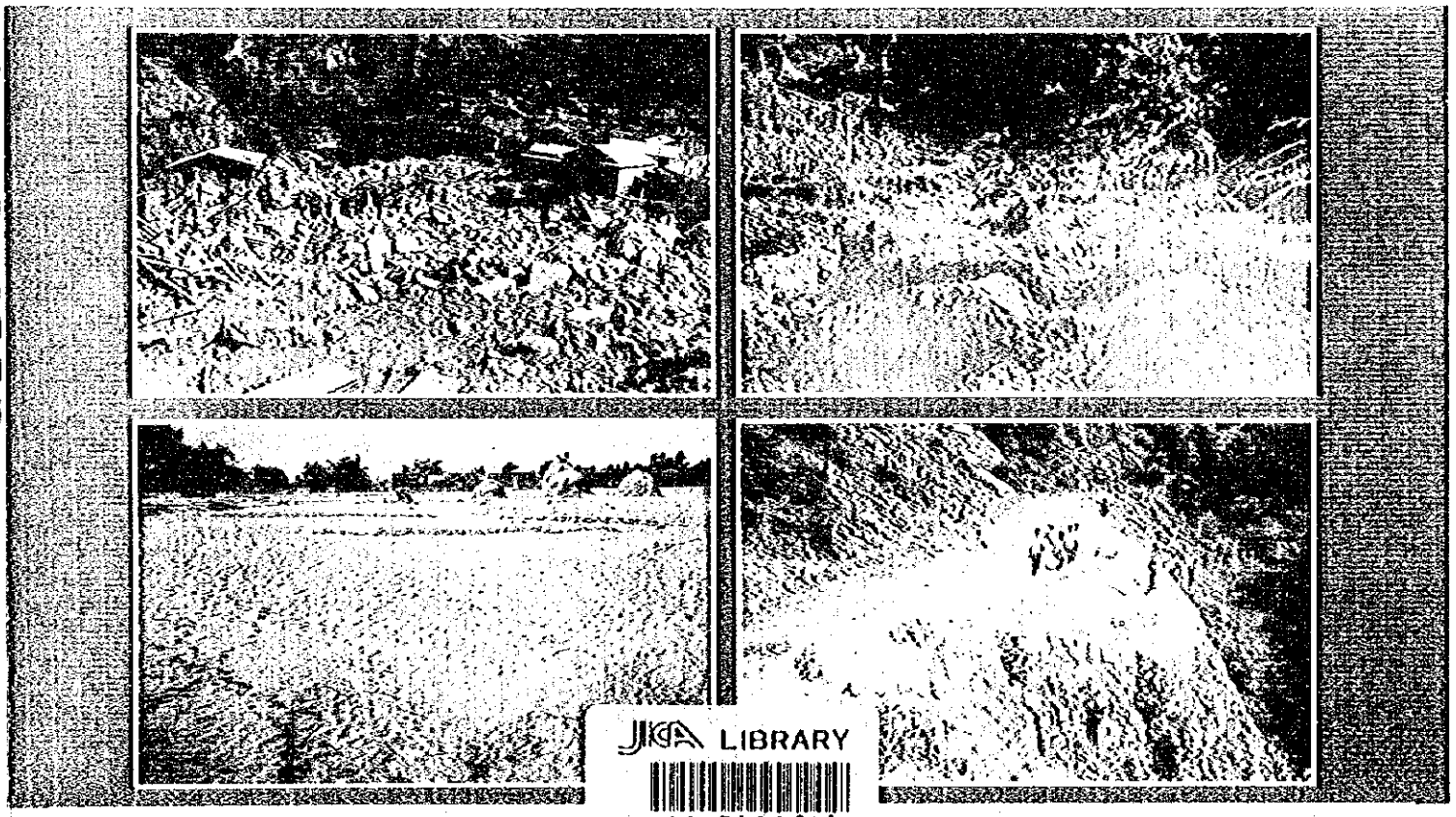
DISASTER REVIEW

1995

(Series IV)



His Majesty's Government of Nepal

Ministry of Water Resources

Water Induced Disaster Prevention Technical Centre

(DPTC)

&

Japan International Cooperation Agency

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FOREWORD

The unstable nature of mountain areas of Nepal is well recognized. The steep slopes, unstable geology and intense monsoon rains combine to make the young mountains one of the most hazard prone areas in the world. More recently there has been an increase in human settlement in hazard prone areas as a result of population pressure and onset of infrastructural development. As a result, natural and man made disasters have been increased affecting great number of people than before. Floods and Landslide during the monsoon season are the main natural disaster often resulting in the substantial economic, human and environmental losses.

Information on disaster events is a primary input in disaster prevention and preparedness. It is desirable to keep record of such information in the form of a report for common use by the concerned agencies whenever necessary to improve disaster policy and management processes.

Water Induced Disaster Prevention Technical Center initiated preparation of Annual Disaster Report to review disasters occurring every year and to record damages and other information for references in future. It is also intended that information thus accumulated will help in preparation of National Disaster Statistics in future.

Annual Disaster Review 1995 is the forth of a series of its kind published by Water Induced Disaster Prevention Technical Center (DPTC). The objective of the publication of this report each year is to provide information on major disaster events, to concerned agencies, whenever necessary and to get the lesson from the past disasters so that disaster preparedness can be improved along with the improvement of disaster management policy. This publication will help in the compilation of a comprehensive national disaster statistics.

The present Disaster Review 1995 covers a wide range of subjects e.g. the disaster record of 1995, comparing it with the past disasters, the disaster situation, precipitation pattern in 1995, mitigative approach against disasters, rescue operation after disaster and activities of Water Induced Disaster Prevention Technical Center (DPTC) to cope with various types of water induced disasters, background papers related to disasters and some typical photographs of the disasters that occurred in 1995.

In 1995, monsoon started from 2nd June. The distribution of precipitation during the monsoon period (June ~ September) was almost normal in the most part but some parts recorded overnormal precipitation. Though wide spread disasters were not notified in the country but some major disasters in 9 districts e.g. Khotang, Syangja, Baglung, Siraha, Dhanusha, Mahottari, Sarlahi, Rautahat and Bardiya were noticed.

The first half of the second week of November remained completely dry but in latter half, cyclone was seen over the Bay of Bengal and it moved towards the northern sector resulting unusual incessant and heavy downpour in Nepal. Due to this heavy downpour, the second phase disaster occurred in Manang, Solukhumbu, Taplejung, Humla, Mustang, Panchthar & Jumla districts causing heavy toll of lives and properties including the death of many foreign tourists. This heavy rainfall was noted through out the country except in the Terai

Sector of Far Western Development Region.
DPTC acknowledges valuable co-operation received in the course of preparation of this review from Disaster Relief Section of Ministry of Home of His Majesty's Government of Nepal, Ministry of Water Resources, Department of Irrigation, Department of Roads, Department of Hydrology & Meteorology, Department of Soil Conservation and other related organizations with deep thankfulness and gratitude.

Further DPTC would extend its thankfulness to the authors of the papers.

Some Features of Nepal

Topographically, Nepal is a mountainous country. The altitude of the country varies from 60 m at Terai (Jhapa) to 8848 m at Mt. Everest in the north within a short horizontal distance of 90 to 120 Km, thus making potential to disasters like landslide, slope failure, soil erosion, debris flow etc. Mountain and hills of the country occupy about 83% of the total area whereas remaining 17% is covered by low and flat land, stretching in the southern part of the country up to Indian border.

Geographically Nepal is situated from 26° 22' to 30° 27' North Latitude and 80° 4' to 88° 12' East Longitude and is surrounded by People's Republic of China on the North and India on the other sides. Nepal is a land locked country with nearest sea coast at 1,127 Km away. The total area of the country is about 147,181 Sq. Km. with about 31,268 Sq. Km. of cultivated area.

Geologically, Nepal can be divided in five regions. The area north to Main Central Thrust is Higher Himalaya whereas between Main Central Thrust and Main Boundary Thrust can be divided into High Mountain and Middle Mountain. The area between Main Boundary Thrust and Himalayan Frontal Thrust is called Siwalik Range and below Himalayan Frontal Thrust is Terai range. The geological formation in each region are different. Geologically, Himalaya and other mountain ranges have been formed by the orogeny, resulting from the collision of the Indian subcontinent with the Eurasian continent. The orogenic movement is still active as evidenced by major earthquake even in this century. The mountains and hilly forms are young and unconsolidated and are fragile due to crustal destruction in the course of the orogenic movement. Steep slope gradient, intense precipitation and sparse forest have made hills even more erodible.

The average annual precipitation is about 1530 mm. The variation ranges from less than 300 mm. in the dry region to more than 5000 mm. in the wet region.

Hydrologically, Nepal can be divided in five regions. Temperature goes on decreasing from South to North with increasing altitude. The highest mean maximum temperature of above 40°C prevails in the southern plain of Western Nepal in hot season and falls below 0°C temperature in the snow-clad mountains of northern region in winter season.

According to the population census of 1991, the population of Nepal is about 18,491,097 with an annual growth rate of 2.58% and literacy rate is about 40%.

1.0 Disaster in 1995

1.1 Summary of damages in 1995.

Although the rainfall pattern in the early monsoon period was normal, some overnormal precipitation occurred on second week of November 1995. In total 42,190 families were affected which seems higher than that of 1994. However, 208 people lost their lives and 62 people were injured. In total 6775 houses were completely damaged by water induced disasters like floods and landslides. Out of 73 districts affected by the natural disasters in 1995, only 9 districts were severely affected. To get the first hand information on the damages in those 9 districts, HMG/N, Ministry of Home formed a committee consisting of Technical and Non technical personnel. The committee had submitted the damages in detail. The facts and figures have been utilized as reported in that report.

The damage due to different types of disasters have been tabulated in Table 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6.

Plate 1.1. **Photo : DPTC**

Damage to Power channel of Sunkoshi Hydropower Project due to disaster of August 1995

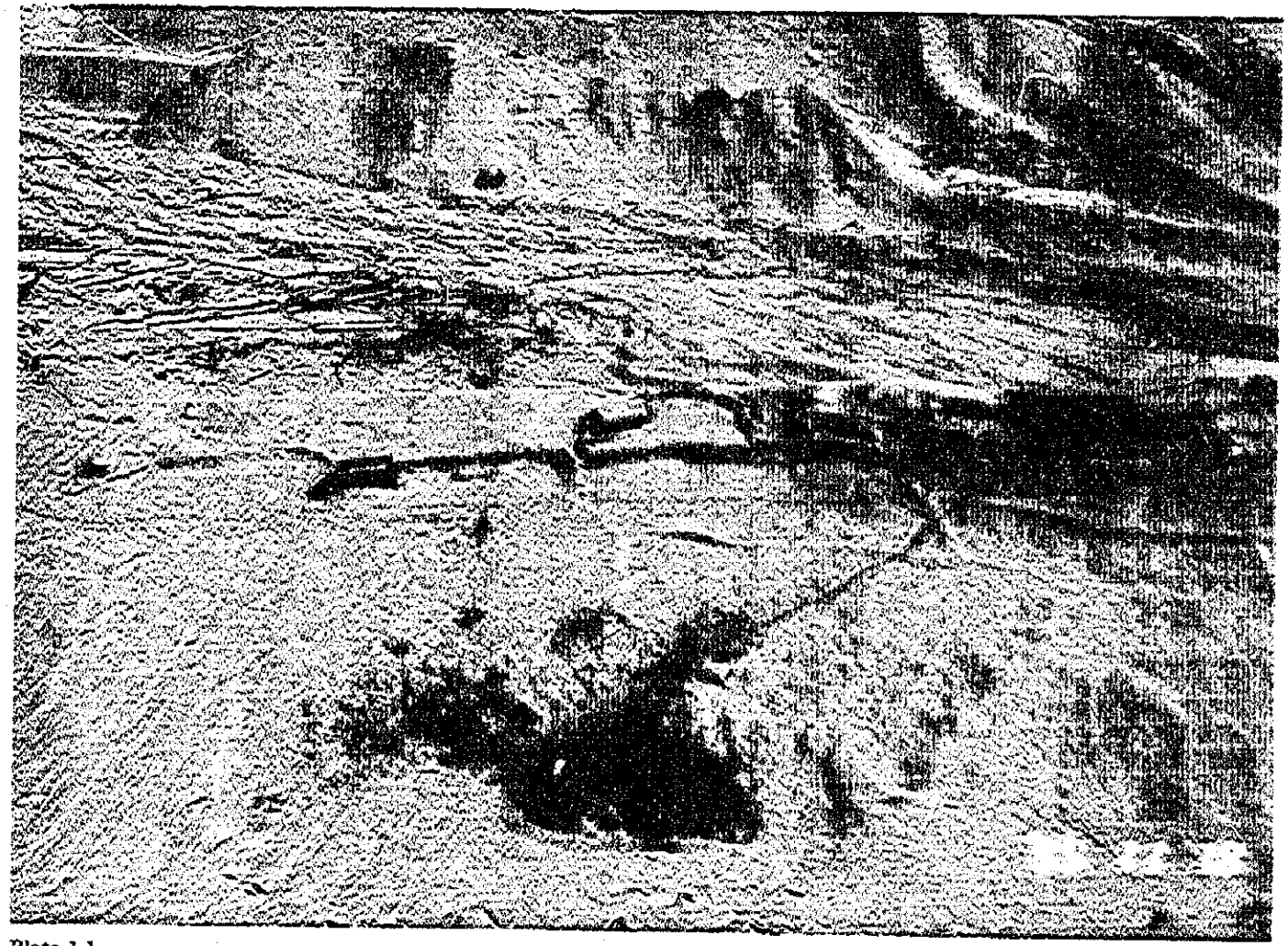

Plate 1.1

Photo : Dr. Yamada (WECS)

DEVASTATION IN SOLUKHUMBU DISTRICT DUE TO SNOW AVALANCHES OF 1995.
(PHOTO : 1995/11/18)

TABLE 1.1 : DAMAGE DUE TO FLOOD AND LANDSLIDE, 1995

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	AFFECTED FAMILY (Nos.)	ANIMAL LOSS (Nos.)	HOUSE DESTROYED (Nos.)		SHED DESTROYED (Nos.)	LAND AFFECTED (Ha.)	ESTIMATED LOSS (NRs.)
						COMPLETELY	PARTLY			
1	ACHHAM	0	0	55	0	5	0	22	21.87	67900
2	ARGHAKHANCHI	3	0	73	12	40	14	19		1662000
3	BAGLUNG	14	5	9446	25	161	142	75	393.00	67076000
4	BAITADI	0	3	62	2	42	14	0	0.66	1421160
5	BAJHANG	0	0	35	0	4	1	0	2.08	530500
6	BAJURA	0	0	21	0	0	0	4	3.35	450000
7	BANKE	0	0	20	0	20	0	0		NA
8	BARDIYA	7	0	3249	667	492	1276	0	2480.00	50775000
9	BHOJPUR	0	0	11	3	6	2	0	0.61	206035
10	CHITAWAN	0	0	0	0	6	0	0	5.40	0
11	DADELDHURA	0	0	93	0	27	3	32	146.62	1307223
12	DAILEKH	2	0	106	3	4	0	0	26.35	275680
13	DANG	0	0	116	0	25	3	4	31.08	4488334
14	DHANUSHA	0	2	36941	1	919	4695	0	11872.00	186179000
15	DOLAKHA	1	0	1	0	8	0	1		NA
16	DOLPA	0	0	3	39	0	0	0		70200
17	GORKHA	0	0	5	2	2	0	1	3.56	482940
18	GULMI	2	0	7	5	3	0	6		80000
19	JAJARKOT	0	0	402	1	37	11	0	22.03	1912325
20	JHAPA	0	0	400	0	83	0	0	541.22	10176050
21	JUMLA	0	0	12	0	6	0	0		239192
22	KAILALI	1	0	33	0	0	0	0		0
23	KAPILBASTU	0	0	16	0	0	0	0		0
24	KASKI	2	0	167	9	26	40	1	355.80	96049250
25	KATHMANDU	0	0	0	0	0	0	0		0
26	KHOTANG	58	8	350	18	226	124	0	304.00	89426000
27	LAMJUNG	15	3	148	5	28	10	1	24.93	2689850
28	MAHOTTARI	2	1	50993	167	1286	4903	1	9185.00	161340000
29	MAKAWANPUR	0	1	1	1	1	1	0		14450
30	MANANG	15	1	20	119	22	4	10		229000
31	MORANG	0	0	46	0	2	6	0	39.20	NA

Contd.

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	AFFECTED FAMILY (Nos.)	ANIMAL LOSS (Nos.)	HOUSE DESTROYED (Nos.)		SHED DESTROYED (Nos.)	LAND AFFECTED (Ha.)	ESTIMATED LOSS (NRs.)
						COMPLETELY	PARTLY			
32	MUSTANG	0	0	0	0	0	0	0		0
33	MYAGDI	1	1	1	0	0	0	0		0
34	NAWALPARASI	2	0	150	218	42	415	0	294.59	28896300
35	NUWAKOT	0	0	41	1	10	6	1	5.44	1328300
36	OKHALDHUNGA	3	4	13	11	29	107	0		226400
37	PALPA	6	2	2	0	1	0	0		NA
38	PANCHTHAR	5	1	193	27	9	0	0	38.46	6425700
39	PARBAT	2	0	204	1	13	23	20	24.77	256700
40	PARSA	0	0	27	0	0	0	0	14.86	1697200
41	RAMECHHAP	0	0	41	2	15	1	2	3.31	1169990
42	RASUWA	0	0	9	0	0	0	0		24600
43	RAUTAHAT	0	0	4800	27	510	429	0	5654.00	305842000
44	ROLPA	1	2	131	35	19	0	50		1416420
45	RUKUM	2	6	8	2	5	4	0		226685
46	PUPANDEHI	1	0	1	0	0	0	0		0
47	SALYAN	5	0	3	4	2	0	0		118000
48	SANKHUWASABHA	2	0	25	8	0	0	0	1.73	350000
49	SAPTARI	0	0	126	0	0	27	0	48.60	2709000
50	SARLAHI	0	0	15000	0	815	2905	0	9235.00	276692000
51	SINDHULI	2	0	17	0	0	16	0	102.40	NA
52	SINDHUPALCHOK	14	6	23	0	7	8	1		4520000
53	SIRAHA	2	0	1956	0	0	0	0	270.00	15356000
54	SOLUKHUMBU	3	1	24	6	5	7	0	1.47	2100500
55	SURKHET	0	0	137	0	6	0	0	0.35	0
56	SYANGJA	15	4	2284	66	182	623	84	486.00	89012000
57	TANAHU	9	6	470	48	8	0	1	181.41	656000
58	TAPLEJUNG	0	0	0	0	0	0	0	28.54	1808870
59	UDAYAPUR	6	0	22	0	1	0	0	17.57	1037490
	TOTAL	*203*	*57*	*128540*	*1535*	*5160*	*15820*	*336*	*41867.26*	*1419018244*

NA : Not Available
Source : Ministry of Home

TABLE 1.2 : DAMAGE DUE TO HAILSTORMS, WINDSTORM AND THUNDER BOLT, 1995

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	AFFECTED FAMILY (Nos.)	BIRDS LOSS (Nos.)	HOUSE DESTROYED (Nos.)		SHED DESTROYED (Nos.)	ESTIMATED LOSS (NRs.)
						COMPLETELY	PARTLY		
1	TAPLEJUNG	2	-	3	23	-	-	2	21000
2	PANCHTHAR	-	-	35	-	-	35	-	269500
3	ILAM	2	-	2	-	-	1	-	361000
4	JHAPA	3	2	11	21	4	2	1	14000
5	SANKHUWASABHA	1	-	1	-	-	-		295550
6	BHOJPUR	-	3	54	21	53	-	1	10000
7	MORANG	1	1	1	1		1	-	160800
8	SUNSARI	1	1	32	2	29	2	-	3316670
9	OKHALDHUNGA	-	-	1	-	-	1	-	-
10	KHOTANG	1	-	1	-	-	1	-	-
11	SIRAHA	-	1	1	2	1	-	-	50000
12	SAPTARI	-	-	1	-	-	1	-	2900
13	SINDHULI	1	-	7	-	1	1	-	-
14	SARLAHI	2	4	22	-	1	17	-	-
15	MAHOTTARI		-	1	2	-	-	-	-
16	DHANUSHA	1	-	1	-	-	-	-	-
17	RAUTAHAT	1	-	1	-	-	-	-	-
18	MAKAWANPUR	1	4	4	-	-	-	-	-
19	CHITAWAN	1	5	95	-	1	92	-	-
20	NUWAKOT	1	-	2	-	1	-	-	100000
21	SINDHUPALCHOK	-	-	3	2	1	-	-	81000
22	KABHREPALANCHOK	1	-	1	-	-	1	-	-
23	LALITPUR	-	-	1	-	-	1	-	25000
24	KATHMANDU	2	-	2	-	-	-	-	-
25	GULMI	-	-	1	-	1	-	-	23200
26	KAPILVASTU	1	-	2	-	1	-	-	69000
27	ARGHAKHANCHI	-	-	2	-	2	-	-	56900
28	NAWALPARASI	-	2	1	2	-	-	-	-
29	RUPANDEHI	-	-	1	2	-	-	1	8000
30	GORKHA	-	-	2	6	-	-	2	941675
31	SYANGJA	1	-	1	-	-	-	-	-
32	TANAHU	-	-	4	-	1	3	-	156000
33	LAMJUNG	-	-	1	-	-	-	-	25000
34	KASKI	2	11	106	2	5	1	1	15663445
35	BAGLUNG	3	2	49	7	44	-	3	163000
36	RUKUM	-	-	2	2	-	1		-
37	ROLPA	-	1	43	12	1	-	-	88200
38	DANG	2	1	4	1	2	-	1	25800

Contd.

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	AFFECTED FAMILY (Nos.)	BIRDS LOSS (Nos.)	HOUSE DESTROYED (Nos.)		SHED DESTROYED (Nos.)	ESTIMATED LOSS (NRs.)
						COMPLETELY	PARTLY		
39	DAILEKH	-	-	6	14	-	-	-	95000
40	JAJARKOT	-	-	209		-	-	-	574500
41	BAJURA	-	-	113		4	-	-	128700
42	ACHHAM	-	-	4	13	3	1	1	70000
43	DOTI	1	-	1	3	1	-	-	-
44	KAILALI	2	3	3		3	-	-	71733
45	KANCHANPUR		8	8		1	-	-	16500
	TOTAL	*34*	*49*	*846*	*138*	*161*	*162*	*13*	*22884073*

Source : Ministry of Home

TABLE 1.3 : DAMAGE DUE TO EARTHQUAKE, 1995

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	AFFECTED FAMILY(Nos.)	BIRDS (Nos.)	HOUSES DESTROYED (Nos.)		SHED DESTROYED(Nos.)
						COMPLETELY	PARTLY	
1	DAILEKH	-	-	18	-	4	-	2

Source : Ministry of Home

TABLE 1.4 : DAMAGE DUE TO AVALANCHES, 1995

S.N.	DISTRICT	DEATH (Nos.)	INJURED (Nos.)	HOUSES DESTROYED (Nos.)
1	SOLUKHUMBU	27	1	2
2	TAPLEJUNG	7	-	-
3	HUMLA	1	-	-
4	MUSTANG	5	-	-
5	JUMLA	3	-	-
	TOTAL	*43*	*1*	*2*

Source : Ministry of Home

TABLE 1.5 : DAMAGE DUE TO FIRE, 1995

S.N.	DISTRICT	PEOPLE		AFFECTED FAMILY	HOUSES DESTROYED (Nos.)		AFFECTED CATTLESHED	LIVESTOCK LOSS	ESTIMATED LOSS	REMARKS
		DEATH (Nos.)	INJURED (Nos.)	(Nos.)	COMPLETELY	PARTLY	(Nos.)	(Nos.)	(NRs.)	
1	TAPLEJUNG	2		8	8				4,04,095	
2	PANCHTHAR	1		9	5	4	1		5,19,417	
3	ILAM			2	2				2,42,700	
4	JHAPA	2	2	112	112	4	9	19	46,39,183	
5	SANKHUWASABHA	2	1	19	17			3	4,24,743	
6	BHOJPUR	1		34	34		3	2	30,55,075	
7	SUNSARI	2		271	591		7	27	89,16,117	
8	MORANG	1	1	386	143		2	10	1,54,45,565	
9	TEHRATHUM			3	3		1	1	51,700	
10	SOLUKHUMBU	4		80	40	8	4	3	32,25,516	
11	KHOTANG	3	1	42	40	2	3	5	6,72,125	
12	UDAYAPUR	3		18	18				3,22,90,056	
13	SIRAHA	1		217	216	1	1	5	13,67,570	
14	SAPTARI	-	1	864	863	1	2	13	2,21,53,267	
15	OKHALDHUNGA	4		58	58		2	11	61,97,070	
16	RAMECHHAP	3		10	10				3,01,726	
17	SARLAHI	2		93	91	2	3	4	42,88,959	
18	MAHOTTARI			240	240		1	5	50,20,400	
19	DHANUSHA			816	816		3	10	2,42,48,260	
20	BARA	3		65	51	14		6	13,99,910	
21	PARSA			326	324	2	24	104	85,54,610	
22	RAUTAHAT			1	1		1	2	6,000	
23	MAKAWANPUR			15	14	1	4		23,66,520	
24	CHITAWAN			37	36		2	1	20,33,670	
25	DHADING			3	3		1	2	2,13,700	
26	NUWAKOT			1	1				1,09,900	
27	SINDHUPALCHOK			2	2				3,00,000	
28	KABHREPALANCHOK	5		27	27		1		31,06,000	
29	BHAKTAPUR			29	20	9		5	4,84,070	
30	KATHMANDU	1	4	36	30	6	5		76,87,500	
31	LALITPUR	2	1	19	8	11	2		10,49,000	
32	RASUWA			5	5				58,000	
33	MANANG				1				1,14,000	
34	TANAHU				48	5	14	147	7,58,87,646	
35	GORKHA		1	60	57	3	13	5	7,26,58,004	
36	LAMJUNG				34			9	2,81,87,231	
37	KASKI			35	33	2	2	2	49,50,310	
38	GULMI		1	1	2			1	81,500	
39	ARGHAKHANCHI			26	24	2	7	9	17,35,577	
40	NAWALPARASI	5	2	21	21		4	2	10,88,912	
41	MUSTANG			1	1				22,000	
42	PARBAT	7		46	46		16	1	31,97,334	
43	BAGLUNG		2	63	59	4	12	9	36,83,920	
44	RUKUM			53	53		2	3	21,18,077	
45	ROLPA	2		18	29		6	21	7,34,640	
46	SALYAN	1	9	31	31		16	35	6,55,985	
47	PYUTHAN			21	21		1		1,89,400	
48	DANG	5		73	73		33	12	1,02,07,270	
49	HUMLA			11	11				6,91,200	
50	JUMLA			3	3				30,250	
51	JAJARKOT	2		37	37		6	1	5,67,567	
52	BARDIYA			12	12				3,57,672	
53	BANKE	2	1	49	49		67	4	1,41,93,400	
54	BAJHANG			2	2				35,940	
55	BAJURA			21	21		2		11,28,446	
56	ACHHAM	1		9	9			1	3,55,020	
57	KAILALI			10	5		1	8	3,07,549	
58	BAITADI			5	5	5			1,12,550	
59	DADELDHURA			6	6				1,29,450	
60	DOLAKHA				2				2,31,000	
61	SINDHULI	3	1	63	62	1			26,46,460	
62	SYANGJA				17		5		5,52,14,000	
63	PALPA			5	5		3	4	4,16,06,500	
64	RUPANDEHI	1		65	65		1	6	11,12,525	
65	MUGU					57			16,99,335	
66	KALIKOT			1	1				34,000	
67	SURKHET			23	23				20,90,775	
68	DAILEKH	1		16	58		1		17,57,184	
69	DOTI			4	4				1,97,900	
70	KANCHANPUR				16		1		7,57,786	
71	KAPILBASTU			172	172					
72	DOLPA	1		1	1					
	TOTAL	*73*	*28*	*4812*	*4948*	*144*	*295*	*518*	*49,16,00,829*	

Source : Ministry of Home

TABLE 1.6 : DAMAGES DUE TO EPIDEMICS, 1995

S.N.	NAME OF DISTRICT	PEOPLE	
		Dead (Nos.)	Injured (Nos.)
1	SANKHUWASABHA	7	
2	BHOJPUR	1	
3	MORANG	5	2
4	OKHALDHUNGA	10	10
5	KHOTANG	7	
6	SIRAHA	8	45
7	SAPTARI	6	75
8	DOLAKHA	9	108
9	RAMECHHAP	1	
10	SINDHULI	3	
11	BARA		3
12	NAWALPARASI	9	107
13	RUPANDEHI	5	2
14	PALPA	4	1
15	KAPILVASTU	6	3
16	ARGHAKHANCHI	3	8
17	SYANGJA	4	1
18	RUKUM	41	1
19	ROLPA	25	35
20	DANG	1	
21	SURKHET	9	
22	JAJARKOT	90	912
23	HUMLA	7	
24	KALIKOT	19	19
25	KAILALI	54	259
26	DOTI	34	147
27	ACHHAM	110	33
28	BAJHANG	1	1
29	BAJURA	20	20
30	BAITADI	19	8
31	DADELDHURA	1	1
32	KANCHANPUR	1	1
	Total	*520*	*1802*

Source: Ministry of Home

2.0 Comparison of disasters on 1995 with the past disasters

The disaster in 1995 is compared with the disasters in the past and tabulated hereunder. The disaster data due to all types of disasters since 1983 is tabulated for the comparison.

As per the available data the disaster in 1986, 1987, 1998 and 1993 are remarkable high. In comparison by these disasters, disasters in 1995 is not so high. Within the last decade, the property loss due to the disaster of 1993 was highest. Disaster due to flood, landslide & avalanches, the disaster at 1993 was too much higher among the tabulated 13 years whereas the property loss due to flood, landslide and avalanches was also remarkably high.

So, looking on the disaster history since past, the most effective disasters are flood, landslide and avalanches.

Plate 2.1 **Photo : DPTC**

An old & big landslide at Thakani V.D.C. of Sindhupalchok district, induced due to geological & hydrological reasons

Plate 2.2 **Photo : DPTC (12 Feb. 1996)**

Landslide induced due to poor water management, at Sangachok village of Sindhupalchok District.

TABLE 2.1 : COMPARISON OF THE DISASTERS IN 1995 WITH THE PAST DISASTERS

TYPES OF DISASTER - ALL TYPES

Year	People		Livestock	Houses	Families	Land	Public	Estimated Loss	Remarks
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Destroyed (Nos)	Affected (Nos)	Affected (Ha)	Infrastructure	Million NRs.	
1983	579	NA	248	12	NA	NA	NA	240	
1984	941	NA	3547	10597	NA	1242	869	49	
1985	1387	NA	3399	7166	NA	1355	173	72	
1986	1512	NA	6566	3370	NA	1315	436	23	
1987	881	162	1852	36220	97036	18858	421	2005	
1988	1684	12538	2788	108801	70197	NA	4365	6099	
1989	1716	3014	4240	7648	NA	NA	NA	4172	
1990	913	196	867	6352	8462	1132	NA	139	
1991	971	43	642	5510	6426	283	39	43	
1992	1318	17	1286	13997	11535	135	66	52	
1993	1524	246	NA	21911	90911	NA	NA	5189	
1994	765	155	1329	3234	11701	392	NA	184	
1995	873	1937	2053	10275	134216	41867.26	NA	1933	

NA : Not Available
Source : Ministry of Home

TABLE 2.2 : COMPARISON OF THE DISASTERS IN 1995 WITH THE PAST DISASTERS

TYPES OF DISASTER - FLOOD, LANDSLIDE & AVALANCHES

Year	People		Livestock	Houses	Families	Land	Public	Estimated Loss	Remarks
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Destroyed (Nos)	Affected (Nos)	Affected (Ha)	Infrastructure	Million Rs.	
1983	293	NA	248	NA	NA	NA	NA	240.00	
1984	363	NA	3114	7566	NA	1242	869	37.00	
1985	420	NA	3058	4620	NA	1355	173	58.10	
1986	315	NA	1886	3035	NA	1315	436	15.85	
1987	391	162	1434	33721	96151	18858	421	2000.00	
1988	342	197	873	2481	4197	NA	NA	1087.00	
1989	700	4	297	6203	NA	NA	NA	28.61	
1990	307	26	314	3060	5165	1132	NA	44.00	
1991	93	12	36	817	1621	283	25	21.20	
1992	71	17	179	88	545	135	44	10.78	
1993	1336	163	25424	17113	85254	5584	NA	4904.00	
1994	49	34	284	569	3697	392	NA	59.00	
1995	246	58	1535	5162	128540	41867.26	NA	1419.00	

NA : Not Available
Source : Ministry of Home

TABLE 2.3 : COMPARISON OF THE DISASTER IN 1995 WITH THE PAST DISASTERS

TYPES OF DISASTER - HAIL STORM, WIND STORM & THUNDERBOLT

Year	People		Livestock	Houses	Families	Public	Estimated Loss	Remarks
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Destroyed (Nos)	Affected (Nos)	Infrastructure	Million Rs.	
1987	2	NA	NA	NA	NA	NA	NA	
1988	71	97	NA	NA	NA	NA	NA	
1989	28	8	488	187	NA	NA	29	
1990	6	NA	11	1	NA	NA	3	
1991	63	14	200	73	121	3	2	
1992	20	NA	39	30	31	14	1319	
1993	45	24	NA	15	182	NA	1	
1994	47	74	153	312	4440	NA	NA	
1995	34	49	-	161	846	NA	23	

NA : Not Available, Source : Ministry of Home

TABLE 2.4 : COMPARISON OF THE DISASTERS IN 1995 WITH THE PAST DISASTERS

TYPE OF DISASTER - EARTHQUAKE

Year	People		Livestock	Houses	Families	Public	Estimated Loss	Remarks
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Destroyed (Nos)	Affected (Nos)	Infrastructure	Million Rs.	
1988	721	12244	1566	105099	66000	4365	5000	
1992	2	-	-	3	3	-	0.05	
1993	-	-	-	698	1367	-	15	
1994	-	-	-	84	623	-	3.5	
1995	-	-	-	4	18	-	NA	

NA : Not Available, Source : Ministry of Home

TABLE 2.5 : COMPARISON OF THE DISASTERS IN 1995 WITH THE PAST DISASTERS

TYPE OF DISASTER - FIRE

Year	People		Livestock	Houses	Families	Public	Property Destroyed	Remarks
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Destroyed (Nos)	Affected (Nos)	Infrastructure	Million Rs.	
1983	69	-		12	-	-		
1984	57	-	433	3031	-	-	12	
1985	52	-	341	2546	-	-	14	
1986	96	-	4680	335	-	-	7	
1987	62	-	418	2499	-	-	5	
1988	23	-	349	1221	-	-	12	
1989	109	16	773	1258	-	-	1614	
1990	46	2	409	3238	3238	9	92	
1991	90	17	404	4620	4451	11	19	
1992	97		1068	13876	10956	8	40	
1993	43	59	568	4085	4052	-	269	
1994	43	47	892	2269	2940	-	121	
1995	73	28	518	4948	4812	-	491	

Source : Ministry of Home

TABLE 2.6 : COMPARISON OF THE DISASTERS IN 1995 WITH THE PAST DISASTERS

TYPES OF DISASTER - EPIDEMICS

Year	People		Livestock	Families
	Dead (Nos)	Injured (Nos)	Loss (Nos)	Affected (Nos)
1983	217	-	-	885
1984	521	-	-	9
1985	915	-	-	-
1986	1101	-	-	-
1987	426	-	-	-
1988	527	-	-	-
1989	879	2986	-	-
1990	503	151	41	-
1991	725	-	2	233
1992	1128	-	-	-
1993	100	-	-	56
1994	626	-	-	-
1995	520	1802	-	-

Source : Ministry of Home

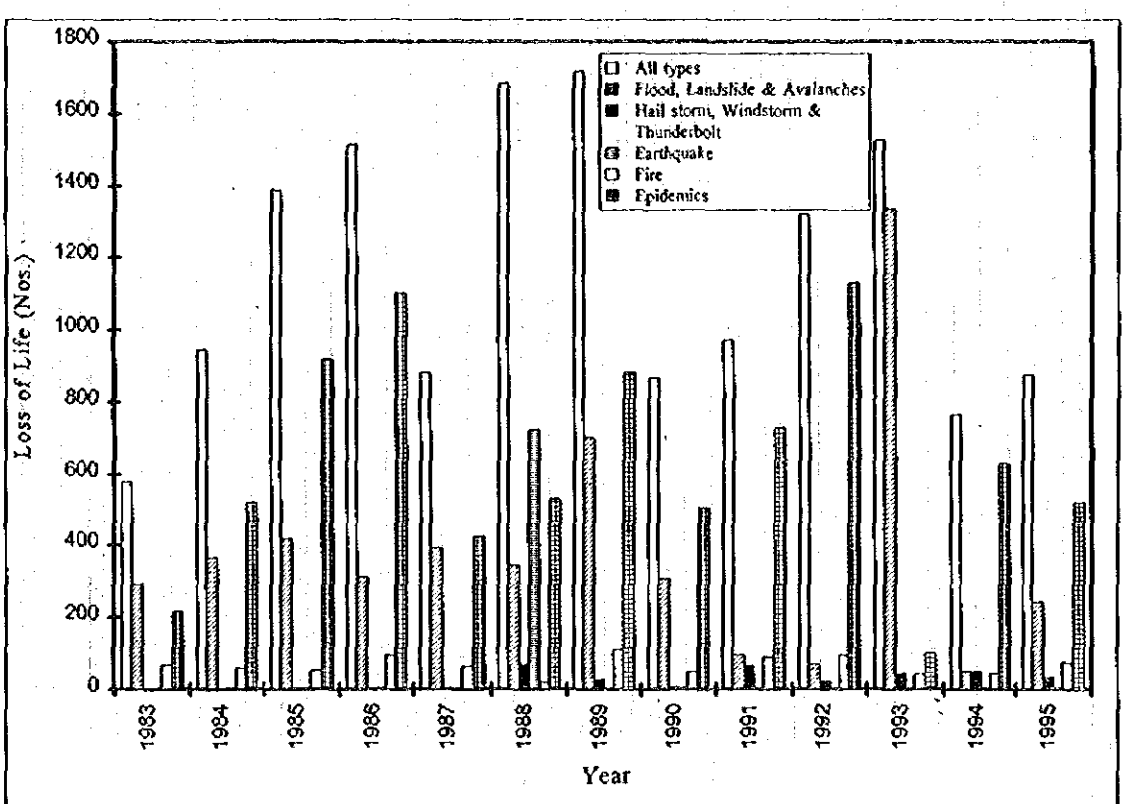

Fig. 2.1 Comparision of Loss of Life in Different Years

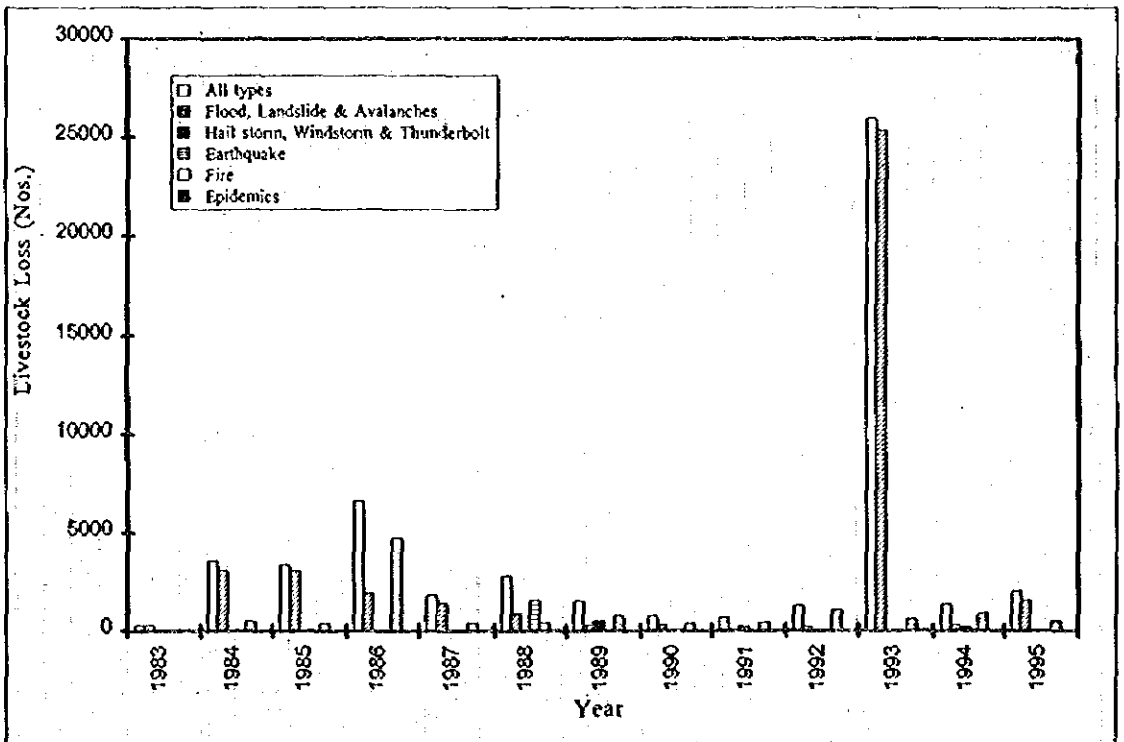

Fig. 2.2 Comparision of Loss of Livestocks in Different Years

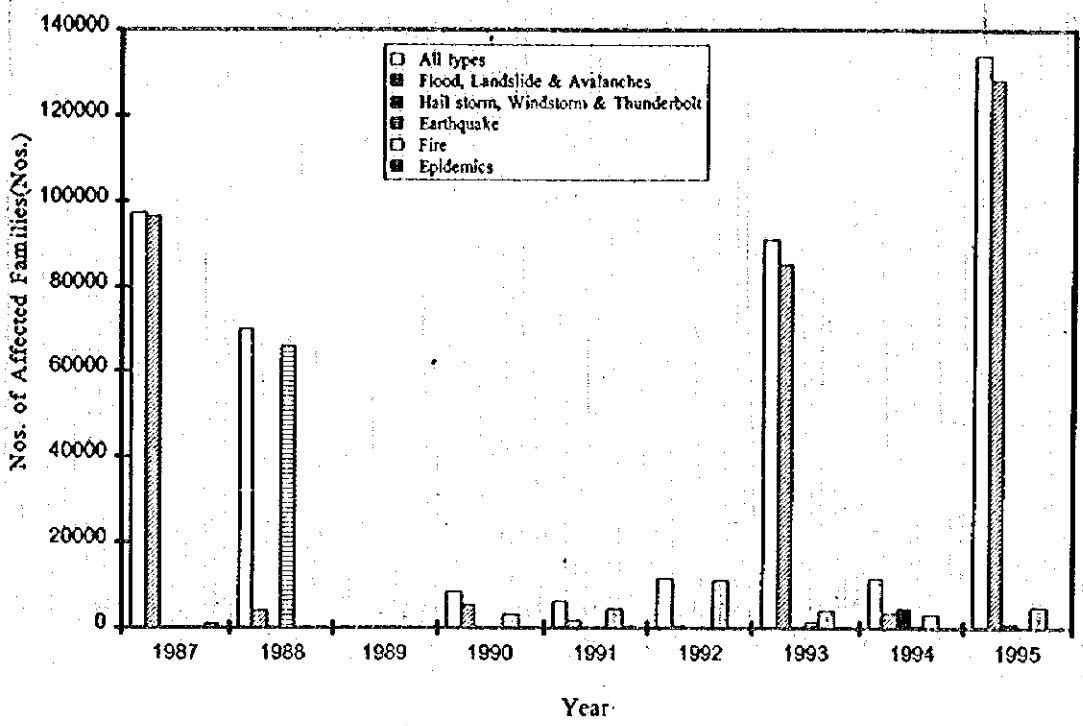

Fig. 2.3 Comparision of Affected Families in Different Years

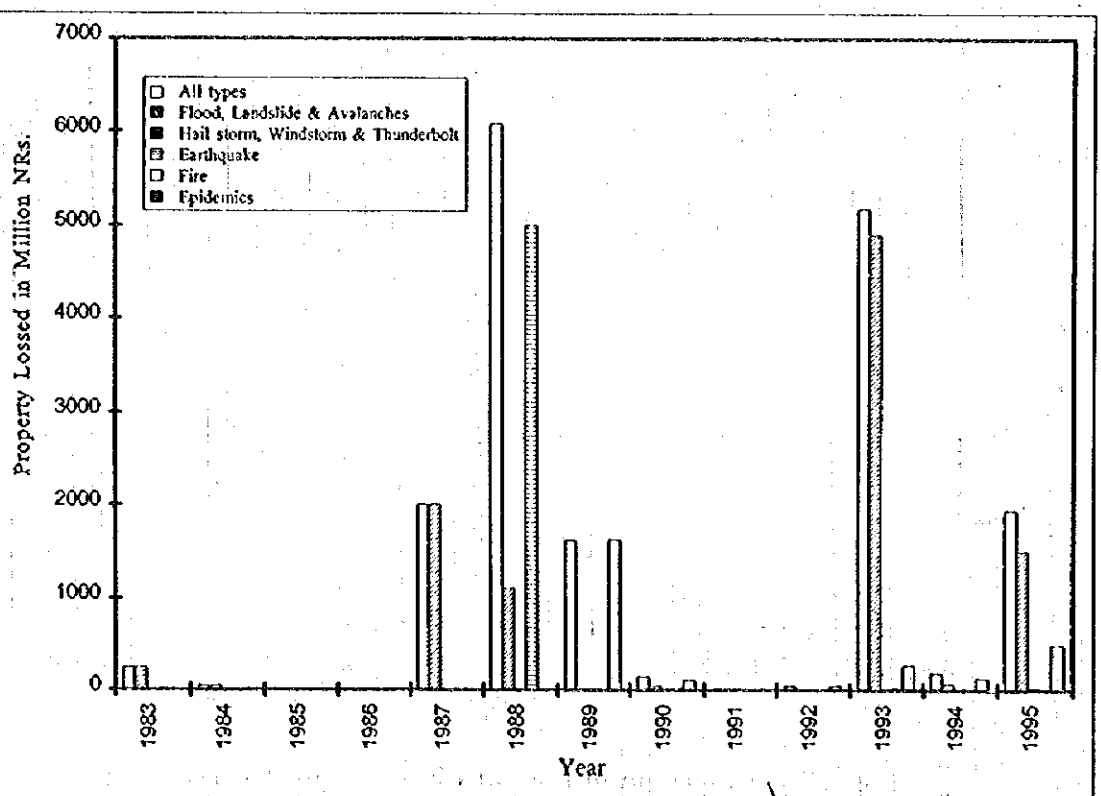

Fig. 2.4 Comparision of Estimated Loss in Different Years

BACKGROUND PAPERS

Role of Water Induced Disaster Prevention Technical Centre (DPTC) in Disaster Management

M. S. Paudel *

1. Introduction

Topography of Nepal varies from low lying areas of the Gangetic plain with altitude less than 100 m. in the south to the High Himalayas with an altitude of about 8848 m. in the North within a lateral distance of 90-120 km. The conditions like rapid population growth, lack of education, deforestation, intensive agricultural practices, overgrazing has increased the vulnerability of the land slope by frequent landslides and soil erosion problems. Besides, the precipitation during monsoon is not uniform. So the kingdom of Nepal frequently suffers from various types of water induced disasters like soil erosions, landslides, flood hazards, river bank cuttings etc. These phenomenon induced several hazards to the development of infrastructures giving direct impact to the people by destroying their living environment and agricultural production causing serious imbalances in social and economic development of the Nation.

Although considerable improvement in disaster management in the country has been done in the past, several disasters still annoy us seriously in each year making loss of lives and property. Lack of training to various implementing level is being emphasized each year, but the mitigative measures are not found properly in disaster prone area. Government is trying to make aware the staffs and local people on disaster mitigation through different types of trainings and seminars but that is still insufficient.

2. Background and Objective of DPTC

Realizing the hazard potentiality and weakness in mitigation of these hazards in Nepal, United Nations, Office for Disaster Relief and Co-ordination (UNDRO) requested the Government of Japan is 1977 to send a mission to assist HMG/Nepal to formulate the policies in the field of disaster mitigation and management. After that many number of missions headed by different JICA experts visited Nepal. In February 12, 1990, HMG/Nepal requested the Government of Japan for the establishment of Water Induced Disaster Prevention Technical Centre in Nepal. With the joint effort of HMG/Nepal and Government of Japan Water Induced Disaster Prevention Technical Centre (DPTC) under Ministry of Water Resources was established on October 7, 1991.

The establishment objective of DPTC is to strengthen the capability of His Majesty's Government of Nepal to cope with hazards due to water induced disasters through Technology Development, Transfer of technology through training and Establishment of data base for research works.

For the smooth running of the research activities of DPTC, a central office has been constructed in Pulchowk with the Japanese Grant Aid. Similarly, hydraulic laboratory has been established in Godavari.

* *Director, Water Induced Disaster Prevention Technical Centre*

At present to enhance the ongoing research work, DPTC not only does the research work by doing model construction works in various research areas on water induced disasters but also advice on various on-going projects of HMG/Nepal to tackle with such disasters upon the request. DPTC has concentrated its activities only on the field of water induced disaster mitigation like landslide mitigation, soil erosion and debris flow control and flood control works. These activities are being carried through various structural and bio-engineering measures. Besides this, creation of people's awareness through seminars and publications, training technicians on disaster mitigation and establishment of data base are its major activities. So, in total activities of DPTC can be broadly categorized into technology development, training and information gathering and dissemination.

3. Activities

3.1 Technology Development

The aim in this activity is to develop engineering methods appropriate to the local condition of Nepal through the combination of indigenous methods and modern technology. It is being targeted to publish guidelines on use of appropriate technology for the mitigation of water induced disasters like landslide, soil erosion and river bank cutting. In pursuit of such technology development, model construction works are being carried out at different selected sites to compare the effectiveness of various methods proposed and to identify the appropriate ones. Besides this, one of the important activities under this is to provide technical advice on various on going projects of HMG offices as and when requested.

To achieve the above goals, various model construction sites in Landslide, Sabo and River Cutting have been selected and survey and design of these model sites have been completed. The model construction work to identify the appropriate technology being done at various model sites is described subsequently.

3.1.1 Sabo Engineering

The activities in this field consists of identification of appropriate soil erosion and debris flow prevention methods. Model construction work at 2 model sites have been started and research on remote sensing technique is being applied in one model site. The achievement till now in individual model sites are as follows :-

a) Nakhu Khola, Lalitpur

Nakhu Khola is a tributary of Bagmati river in Kathmandu Valley. A catastrophic disaster occurred in September 1981 in the Nallu and Lele sub-basins due to floods and debris flows. The study and implementation of countermeasures against the debris flows are important and hence some works are being done to recommend the necessary measures to be taken.

After completion of detailed survey, establishment of various monitoring devices like raingauge, water level gauge etc. and preparation of master plan for debris flow and gully control, the model construction work has been started since 1994. Various types of check dams made of gabion, plum concrete, brush wood etc, including bio-engineering work have been applied to assess the effectiveness of each types. As gabion wires used were destroyed by the debris mass

in many debris flow area, concrete cover over the gabion wire has been successfully tried. The debris flow and gully erosion phenomenon monitored continuously prior to construction also. After monitoring the debris flow occurrence after construction, the data will be utilized in preparing guidelines to find appropriate method for soil erosion control & debris flow control.

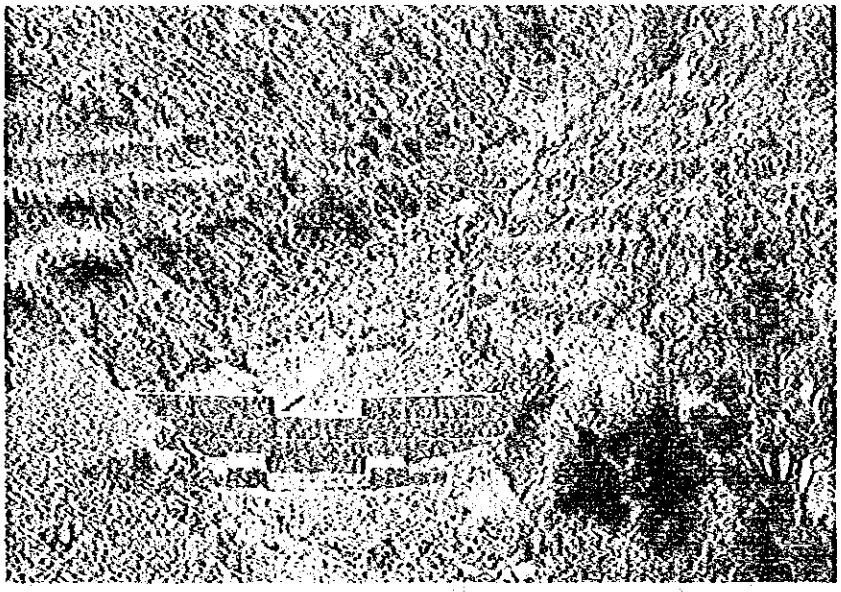

Plate 1. **Photo : DPTC**

Debris Flow Prevention Work at Nakhu Khola.

b) Pipaltar, Trishuli

Red laterite soil is dominant in the low altitude area of Nepal (usually 600 m to 700 m, above msl) especially in Midland and Siwalik Hills. This type of soil is erodible so that once vegetation cover is removed, it becomes barren and Soil erosion occurs severely.

Pipaltar lies along the right bank of Tadi Khola, one of the laterite soil region. Due to the

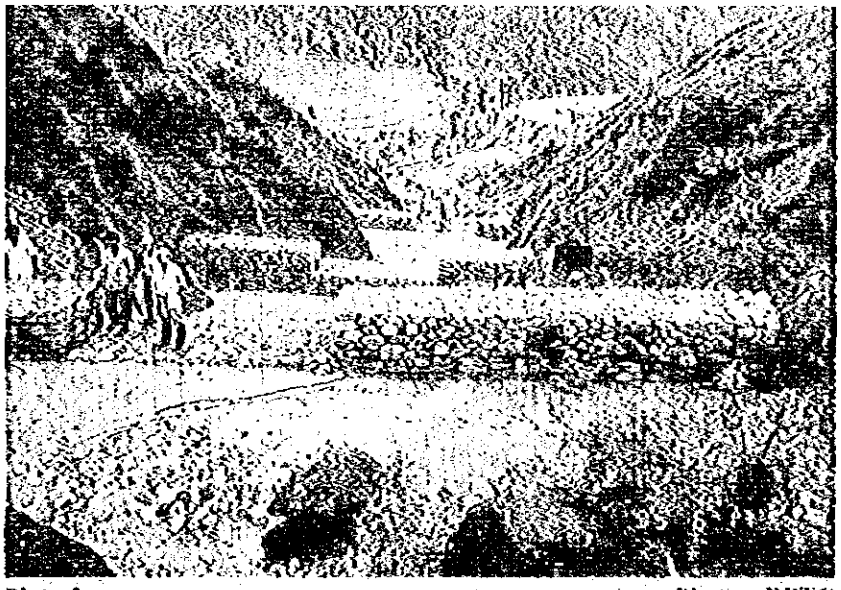

Plate 2 **Photo : DPTC**

Series of Sabo Dam Constructed for Gulley Control at Pipaltar, Trishuli.

excess deforestation about 30 years ago and lack of proper plantation, soil and gully erosion are predominant features of this region. Therefore, Pipaltar has been selected as a model site to carryout the study on soil surface erosion and gully erosion jointly with Department of Soil Conservation and local people.

After studying the area and its nature various types of countermeasures against gully erosion & gully head expansion, model construction works such as various types of check dams like gabion, bamboo etc. along with bio-engineering works, has been tried to assess the effectiveness New technology for gully erosion control like PNC block construction has successfully been tried in this model site. As preconstruction and during construction monitoring data is recorded, post construction monitoring work will be continued to incorporate these data for the preparation of guidelines on appropriate method for soil erosion and debris flow control.

c) Siwalik Hills

Siwalik hills comprise of sedimentary rocks belonging to Meogene Age. It is the first range of the Himalayas at North of Gangetic plain, extending 850 km. length from east to west with 13% coverage of the total territory of Nepal. It is geologically very fragile due to the unconsolidated materials. Further more, the forest resources of the Siwalik have been decreasing rapidly. Because of these situations, the siwalik range produces a huge amount of sediment and activates river aggradation in the downstream areas, thus causing severe flood disasters every year.

The objective of these model sites are to prepare master plan for watershed management. Change in land use, change of river course and distribution of collapses by using satellite imagery is being planned.

For these studies, available aerial photographs of the central region before and after 1993 disaster has been collected. Besides, debris flow and sedimentation survey of part of Kamala river basin has been conducted. Many of the streams of siwalik region are narrow and the places are inaccessible, the study of the development of remote sensing technique seems necessary. Hence, aerial photographs of these areas are being studied in Japan to develop these techniques.

3.1.2 Landslide Engineering

Landslide is one of the major water induced disasters. Due consideration is to be given for landslide investigation before the planning of the infrastructures so that the structures will be less affected by landslide. It is seen that most of the infrastructures damaged due to landslide is in Irrigation & Roads. So, to make guideline on landslide investigation and prevention techniques against the landslides of different natures, model study and construction works are being continued in some selected model sites:

a) At 48 Km. along Kathmandu-Trishuli Road

This landslide is located at Tigaun, 48+500 km. along Kathmandu-Trishuli road. The purpose of study in this model site is to apply various types of landslide prevention measures for the stabilization. After investigation for 2 years, master plan was prepared and following it, the model construction work with special emphasis on toe loading, surface drainage, horizontal

drainage, stream protection etc. is being carriedout. Effectiveness of various types of structures for surface drainage has been tried and effective types has been identified. The landslide movement data before, during and after construction will be utilized in making guidelines on landslide prevention work. The model construction has saved about 10 ha. of land and helped for the smooth operation of traffic along the road.

Plate 3. **Photo : DPTC**
Landslide Prevention Work Executed in 48 km. along Kathmandu-Trishuli Road.

b) At right bank of Tinau river at upstream of Butwal Bazar

This is one of the typical big landslide situated on lower siwalik formation. According to the aerial photo interpretation, Tinau river narrows at the landslide area. The reason of studying this landslide is to find the activeness of landslide. If the landslide is active, it may dam the Tinau river in future which will be much more disastrous. After landslide movement study for two monsoon seasons considerable displacement is found towards Tinau river. This phenomenon and techniques of investigation is planned to be presented and explained to various organizations of HMG/Nepal in Butwal like District Administration Office, District Development Committee, Division Road Office, District Irrigation Office, District Soil Conservation Office, other technical offices and so on so that they can do landslide investigation by themselves which is one way of technology transfer. The landslide has been moved 1.25 m within 10 months towards Tinau River which is quite remarkable.

c) At 62 km. along Charali-Ilam Road

This is large and typical landslide along ridge road. This landslide is being studied on the request of Department of Roads of HMG/N. The road being a important North-South road of Mechi Zone, the research work, to control landslide with emphasis on crown excavation and road cutting, check dam construction to stop stream bank cutting, toe loading, surface drainage work, horizontal drainage boring and bio-engineering is being implemented jointly by DPTC and Department of Roads.

The model construction work is planned to be completed till next fiscal year. Landslide monitoring

work before, during and after construction is being continued to assess the effectiveness of various structures proposed and constructed. The results obtained will be utilized in preparing guideline on appropriate methods for landslide investigation and prevention.

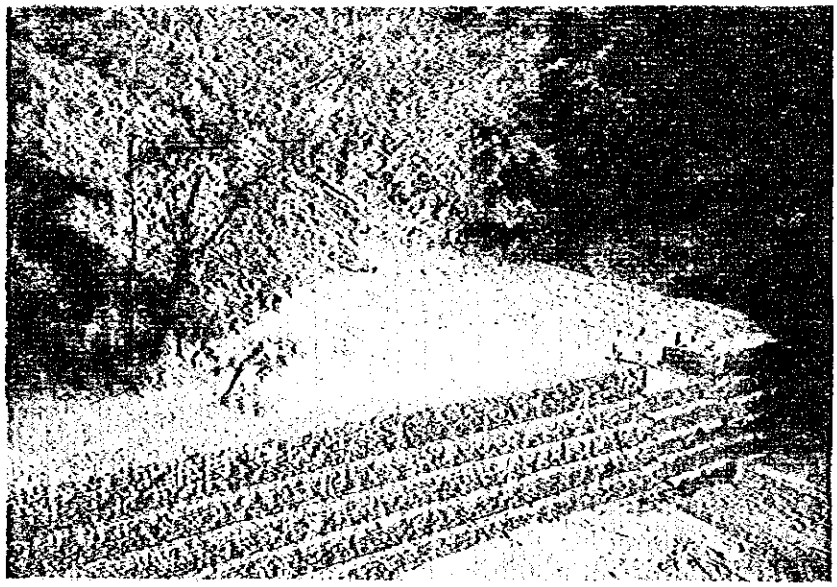

Plate 4. **Photo : DPTC**
Gabion Check Dam for Toe Loading at 62 km. along Charali-Ham Road.

The data from various model sites and other landslide area under different Departments of HMG/N has been collected. These data are being analysed. The preparation of guideline on landslide investigation techniques and appropriate method of landslide prevention work has been started from this year.

d) At 19 km. along Kathmandu-Trishuli Road.

This landslide is located at Okharpauwa, 19 km. along Kathmandu-Trishuli road. This landslide study has been carried out on the request of DOR. After the establishment of the monitoring devices i.e. two automatic extensometers, some pairs of simple extensometers, moving pegs, raingauge, tiltmeter, piezometers etc. and analysis of the monitoring data, the master plan of landslide prevention work was prepared and handed over to the concerned project of DOR for execution on 1994. The construction work is planned to be started from this year.

3.1.3 River Engineering

The main activities conducted in river training works are to check the effectiveness of various types of river training structures at selected model sites.

a) Right Bank of Mahakali River at Dodhara-Chadani

This has been selected as the model construction works in order to identify suitable methods against river bank erosion in big Rivers by applying different types of spurs, revetments on the experimental basis. River bank erosion is serious along right bank of Mahakali River in Dodhara and Chandani VDC of Kanchanpur district. After completion of topographic map of 10.5 km. length of Mahakali river and design of river training structures jointly with

Mahakali Irrigation Project, the model construction work upto 6 km. length is expected to be completed this year. The river training work has protected Dodhara and Chandani VDC from flood of 1995 monsoon. Various types of peculiar structures like cylindrical gabions, geo-textile and geo-grid materials in rivetment, skeleton works etc. are tried and research on the effectiveness of these structures are going on to find out their effectiveness.

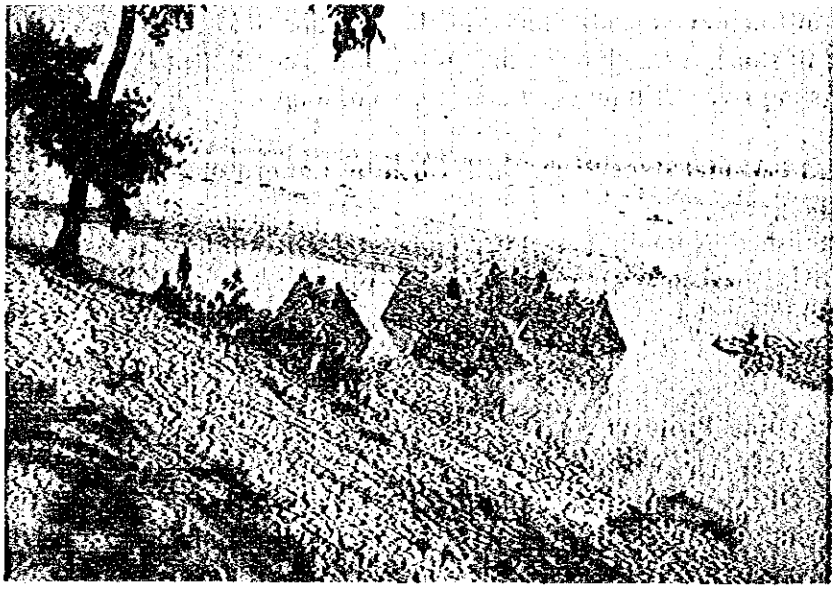

Plate 5. **Photo : DPTC**
River Training Work with Use of Skeleton Work at Mahakali River in Dodhar-Chadani.

b) *Bagmati River at Khokana*

Left bank of Bagmati river in Khokana VDC, Lalitpur district has been selected as a model site for river training works because of convenient location and suitability of site. The model construction work has been completed this year. The purpose of this study is to construct river training structure to control river toe cutting induced landslide. The construction work is

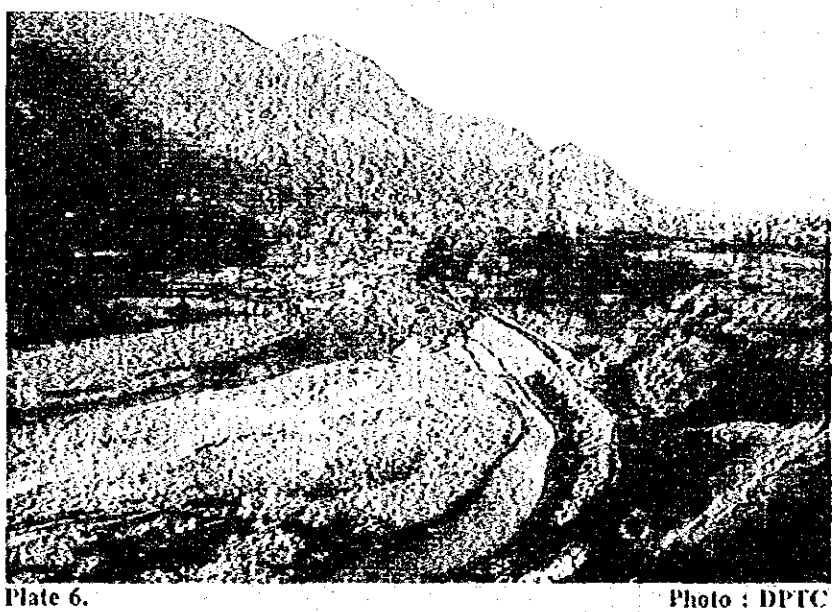

Plate 6. **Photo : DPTC**
Revetment Work along with Skeleton Work at Bagmati River near Khokana.

completed and no sign of further landslide is observed. The monitoring work is still going on.

c) Other Researches

Besides the model construction works, research on river bed variation on Bagmati river at Valley and Terai, master plan preparation for Bagmati river conservation, improvement on survey and construction methods along with the selection of alternate materials like mortar block instead of stone, research on mannings roughness coefficient & study on success and failure of existing river training structures are going on.

3. 1. 4. Model Experiment in Hydraulic Laboratory

With the established hydraulic model testing laboratory and material testing laboratory at Godawari, DPTC has conducted various types of research works and plan to test the prototype in future. This clarify the engineers how the designed structures will behave during construction.

Advice on on-going Projects

Besides these, DPTC gives advice on various on going projects of HMG/Nepal under the request of concerned projects on the related subjects. Till now the recommendations have already been prepared on following projects :

a) Sabo Engineering

Debris flow and sedimentation survey including preparation of hazard mapping of following rivers has been completed.

- Agra Khola
- Belkhu Khola
- Malekhu Khola
- Palung Khola
- Lothar Khola
- East Rapti River
- Marin Khola
- Manahari River
- Kamala River

b) Landslide Engineering

Various landslide area along the different road alignments had been studied on the request of DOR and recommendations were forwarded to the concerned agencies.

- Landslide along Sindhuli-Banepa Road.
- Mulkharka Landslide along Trishuli-Somdang Road.
- Landslides along Silgadi-Samphe Roads.
- Landslide above power channel of Sunkoshi hydropower project.
- Landslide below Kharanitar village in Nuwakot.
- Rockfall on Mugling.

- Jogimara Landslide.
- Landslide along various sectors of Mechi Highway (Charali-Ilam-Phidim-Taplajung).
- Debris flow at Bagarchhap of Manang District.
- Puranchaur Landslide at puranchaur Irrigation Project, Kaski.

c) River Engineering

Design of river training work at Bagmati river after 1993 disaster was handed over to District Irrigation Office, Sarlahi.

3.2 Training Activities

As Nepal is lack in expertise on disaster management, various types of trainings are being conducted to make familiar the technicians of HMG/N on disaster mitigation as explained below:-

i) General Course Training

The objective of this training is to train technical personnel in the field of disaster prevention works by introducing concept and effect of water induced disaster prevention and rehabilitation works, giving fundamental ideas and a wide understanding about the necessity of these works.

This training is being conducted two times a year for about 10-12 nos. of field level technicians (Overseers) of concerned Departments of HMG/Nepal. The training period is of three weeks.

Eighty overseers (Six batches) from different Government Institutions have been trained. After monitoring, this training has been found to be effective in implementation of disaster management. The monitoring was done by sending model questionnaires to those organizations sending for training.

ii) Advance Course Training

The objective of this training is to train backbone professionals in the field of disaster prevention and rehabilitation works and familiarize them with the proper technology for the implementation of these works.

This training is being conducted once a year for about 10 number of gazetted third class technical professionals (Engineers) working for different departments and organization. The training period is about ten weeks.

Till how forty gazetted level trainees (four batches) have been trained. Engineers from related organization of HMG/N received knowledge on various types of water induced disasters with probable mitigative approach. This training is found to be very useful in planning for the design and construction of infrastructures.

iii) Intensive Course Training

The objective of this training is to train future key staff member of DPTC. This training

is being conducted once a year for four numbers of gazetted third class technical professionals (Engineer) working in different departments and organizations. The training period is about thirty six weeks.

Ten nos. of gazetted level trainees (four batches) from different Government Organizations have been trained. As the purpose of the training is to develop core staff of DPTC, some among these trainees, engineers of HMG/N are involved in DPTC after completion of the training and others can also be invited to work in DPTC wherever their necessity arises. As they have got long time training, this type of course is also found to be effective.

iv) Training Abroad

Total 21 numbers of Nepalese personnel have been trained in Japan, Thailand, Indonesia, Philippines etc. on various subjects related to disaster mitigation like landslide, sabo engineering, river engineering, hydraulic model test, boring techniques, hydrological study, material testing, flood risk analysis, disaster management etc.

3.3 Information Activities

As already mentioned above, DPTC conducts the disaster assessment works each year at some disaster affected area so that care can be taken in future against such disaster. DPTC played important role in the disaster assessment of July 1993 disaster through data collection and publication of photo album. Similarly flood flow calculation at disaster affected area at various rivers on 1994 was conducted. DPTC made disaster assessment report of debris flow disaster at Bagarchhap, Manag district.

Compilation of various types of data through records of disaster, various publications / reports / documents / maps (topographic, geological, landuse, land system, land capability and remote sensing), aerial photographs and disaster photographs, rainfall and discharge data etc. is being done which will be put in data base computer programme so that there will be easy access for data availability in future.

To have mutual communication and discussion on disaster mitigation strategy and to circulate the new discovery on disaster mitigation techniques DPTC organized International Seminar on Water Induced Disaster on 1995 and is planning to do one on November 1996.

It is to be noted that the lack of public awareness in disaster mitigation and lack of co-ordination between implementing agencies increase the hazard problem more. So, to have better co-ordination among various administrative officers, technicians, police, army, politicians, women and other organizations, NGO & INGO's etc. working in this field and to circulate the idea of disaster mitigation, DPTC organizes roving seminars in all 5 development regions covering the above mentioned disciplines of 4 districts in each region. Since its establishment, DPTC has conducted 13 numbers of roving seminars covering 45 districts. Total 528 numbers of participants from different disciplines participated in the seminar. This seminar seemed very fruitful, hence it will be continued in future too as per the demand of the participants from different organization.

DPTC collaborates with other organizations like Nepal Geological Society, UNDP (for IDNDR Day Celebration), ICIMOD (Regional Pilot Training on landslide hazard

management in Hindu-kush Himalaya), ESCAP (Flood Risk Analysis and Mapping) to organize various types of trainings and seminars/workshops.

To give the idea of disaster in Nepal and its mitigative measures, DPTC regularly publishes various publications like brochures, calendars, annual disaster review, photo album of 1993 disaster, DPTC news letter etc. To generate public awareness, pamphlets on disaster mitigation especially landslide, river training and soil erosion control; flood hazard map of Bagmati river etc. has been prepared and distributed to various organizations and persons.

In connection with disaster management in Nepal, DPTC has prepared video documentary on Disaster of 1993, DPTC in Nepal, Awareness (chetana) & Model Construction of DPTC. Among these, Awareness is the video film on flood control work which has been telecasted by Nepal Television and being exhibited at various locations. Copy of these documents have been provided to concerned organizations upon the request.

In order to educate and produce highly qualified personnel, DPTC has sent 3 engineers for the Masters Degree Course and this will be followed in future too.

4. Future Programme

The remaining model construction work will be completed in the coming two and half years and post construction evaluation activities will be conducted to prepare guide lines on.

- Soil Conservation
- Landslide Mitigation
- River Training Works

The advice on ongoing projects and co-ordination with other organizations will be continued. Advance research will be done on model testing activities through the model testing of model site works. Beside these, public awareness programme will be continued along with conduction of seminars. The hazard/risk mapping of selected area will be prepared.

5. Conclusion

Within a very short period, DPTC has been able to propagate its idea on the Water Induced Disaster Prevention, through different kinds of activities in very close co-operation with different agencies. In future also DPTC seeks the help from those organisation who are working in this field of Water Induced Disaster. This will help in the disaster management potentiality of the nation as a whole.

Debris Flow Disaster at Bagarchhap VDC, Manang District (A Field Report)

Mr. S. Miyajima *
Mr. I. Kitahara **
Mr. Binod Tiwari ***

1.0 Introduction

The debris flow disaster occurred in ward number 6,7,8 & 9 of Bagarchhap VDC of Manang district in Western development region of Nepal. The total households in the affected village are 32 with about 190 inhabitants. The area is important trekking transit, situated along right bank of Marsyangdi river and surrounded by many small local springs/ streams. It takes 2 days to reach Bagarchhap from Besisahar, the district headquarter of Lamjung through the various types of trails. Besishahar is about 6 hours drive from Kathmandu through Prithivi highway and Dumre-Besishahar road. Again the air head, Hunge, is about 1.5 days walk from the Bagarchhap whereas it takes 5 hours to reach Chame, district headquarters of Manang district, from Bagarchhap. Hence, Bagarchhap is only and very important transit for the trekkers without any alternate routes.

The disaster place, Bagarchhap is surrounded at right and left side by big Marsyangdi river and small stream with maximum discharge of 60 lps by which 2 pulverizing mills were running. The main occupation of the people in the area is business, both hotel and curio-goods. At 1968, similar magnitude debris flow occurred through the same stream and whole village was destroyed. After some months, people in the village were resettled there on the debris fan and two consecutive small magnitude debris flow occurred afterwards which did not affect much.

2.0 Disaster condition

There is a proverb in Manang district that it will never rain in Manang. It had happened in previous years too. That is why the people in the area are growing potato and some pulses only. At November 9, 1995, it started raining which continued for almost 3 hours. According to naked eye view, after continuous rainfall at 15:30 PM of November 10, small debris flow seemed at the upstream of the above stated small stream running through inside the jungle from the surface. At the upstream of the Bagarchhap bazaar, small ponding was observed for 3 hours. Dirty water in the stream was observed since 15:30 Suddenly at 18:45 of the same day the pond was bleached out with thunder like sound which brought large size gneiss and schist boulders along with it and destroyed almost 14 households. Again at 0:30 of November 11, the similar sound was heard with the debris which was bifurcated towards left from the top of the village.

As the place is important transit /through pass, to important trekking spots like Annapurna Muktinath, almost 70 foreign trekkers were staying there that evening among which 6 were killed in the disaster whereas remaining escaped after early signal. 15 people and 119 cattle were killed in the disaster among which 9 were Nepali and 6 were foreigners. Among 9 Nepalese, 6 were trekking guides, cooksand helpers whereas according to local enquiry remaining 3 were

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local people working in the area, migrated from neighbouring districts, Lumjung & Gorkha. Among 14 destroyed houses 7 were hotels whereas 2 were general shops.

According to the enquiry with the naked eye viewer, after the observation of dirty water and ponding, local people started to evacuate their materials from shops/hotels and they themselves escaped towards Ghelangchowk, at higher altitude. The current in the stream was so high that the people in the area found difficulty in crossing it. The managers of most of the hotels had warned the trekkers staying in their hotel, so that most of the trekkers (more than 60) escaped from debris flow. At 18:30 the kitchen and afterward whole building of *Swargadwari Hotel* was destroyed causing the death of one cook and one guide, foreigner trekkers could escape. At 18:45, the building of *Tibatan Hotel* rotated and collapsed with big sound where foreigne trekkers were killed. It is interesting that the tourists of *Swargadwari Hotel* and *Marsyangdi Hotel* were almost escaped where as those staying at *Thakuri Hotel* and *Tibetan Hotel* were killed. It was clear that whoever dropped their baggage and escaped hurriedly were saved and those trying to collect their baggage were killed by debris flow.

3.0 Rescue Work

After getting the disaster news, the rescue team of Nepal Police and Army from Manang, Lamjung, Pokhara and Kathmandu reached the place by various transport means like Helicopter, on foot etc. Then after rescue operation was started immediately after the disaster. Home Minister had also visited the area. DPTC team visited the area on November 19, 1995. Until the survey period, total 15 dead bodies were found including 6 foreign trekkers. Among 6 foreign trekkers, according to rescue team, 3 were Canadian, 1 was Irish, 1 was British and 1 was German. It was doubted that still 5 persons are missing among which 3 are foreigners.

The position of dead body obtained obviously clarified that they were hurrying to escape from the debris flow but could not success. Among the collected dead body of foreigners, they were just trying to runout, hanging their luggage on their back whereas some were in running position with torch in hand. Among 9 dead body of Nepali people, 4 were tourist guides and cooks. Among 5 local residence, three dead bodies were such that the wife, putting her child at her back was pulling her husband to escape from the house. According to the local people the husband was drunkard..

According to the Senior Superintendent of Police for Gandaki zone Mr. Ananta Ram Bhattarai, who was present at the disaster spot for rescue work during DPTC field visit a group of 155 rescue team members from police, army and local people were still searching the bodies and lost properties, during DPTC field visit.

4.0 Disaster Assessment

Bagarchhap village is located on the debris fan of a branch stream which has been deposited on Marsyandi River terrace. The name of the branch stream is Thado Khola and the catchment area is about 3 square kilometers with the main stream length of about 2.8 kilometers. It is flowing down the north facing slope between the altitude ranging from 12,800 ft. (3,900 m) at the top to 6,8000 ft. (2,072 m) of Marsyangdi River at the bottom. The mean gully bed gradient is about 1/1.53 i.e. 33 degree, The stream turned right near the end of the debris fan and was flowing through the centre of lodges.

According to the site investigation conducted by Mr. I. Kitahara, Mr. S. Miyajima and B. Tiwari from the debris fan up to the height 2,400 m (7,874 ft.), the phenomenon was clear with the following debris flow characteristics. (Fig. 1.)

- It had clear front part with big boulders with about 8 m diameter. The front part stopped in the village
- The rare part, followed front part and spread over wider area than the front part.
- Deposited materials had shown random structures. (Mixture of mud up to big boulders).
- Deposition clearly observed in a limited area.
- The speed of flow was very fast, so that victims were found out in run- away position..
- The rare part washed away the early deposition. So that stream is flowing between 5 to 6 m down from both banks from top to middle of the new debris fan.

The gully on the existing fan was formed once on higher position by the front part then the rare part immediately washed away the centre of debris deposition. It was considered that debris flow occurred at least three times in a series by judging from the form of the deposition. The first debris flow stopped just near by the gully mouth. Next debris flow flew straight into Marsyangdi River. Finally, two streams were formed, one flowing straight from the gully mouth and another almost in the original course. Upon examination, deposits were found to be composed of Phyllite, Schist, Gneiss and some Granite.

In the gully, stream is flowing down through the newly created depth of 6 to 8 m at the bottom of the eroded banks. There is still fragile materials hanging along the 1.5 kilometer length of stream. Estimated fragile materials were on an average about 20 cubic meter per meter. In some parts of the gully, big boulders were temporarily jammed together forming water falls, the height of which were 3 to more than 6 meters. Those falls may easily collapse during another flood triggering another debris flow. Again there are many slope failures/bank collapses beside the stream. One of the biggest collapse was of 100 m width and 200 m height and is located at left bank at 2,370 m (7,775 ft.). By the judgement of the diameter of the Alnus trees on the collapse, it can be assumed that this collapse may have occurred at least twice, one about 25 years ago and another about 7 years ago. Some parts of the debris from the gully is deposited at the foot of this collapse. Other bank collapses are 25 m wide and 15 m high or 5 m wide and 8 m high and so on. The stream is scouring the foot of these collapses. It will cause the bed-rising on the downstream.

5.0 Disaster Relief and Mitigation

Relief team was working manually with scoops and bars against the big boulders and huge amount of debris. It seems all the debris may not be removed from the village.

Straight channel is recommended to be excavated urgently from the upper gully smoothly. There are two alternates for excavation of alignment, one is at the newly created stream and another at the old stream course that is cultivated and no stream is there now. This channel should be prevented against the debris spreading over the village. That is why both

of the banks should be strong enough for this purpose, so that excavated materials from the village and the channel has to be put behind the banks.

One check-dam should be constructed at gully mouth to control the axis of stream. When another debris flow occurs it will hit the check-dam directly, so the thickness of dam crest should be thick enough to resist that. Thickness depends on the material of the dam (G.I. Box, Concrete, etc.) The construction cost will be expensive, if the check-dam, able to resist number or debris flow occurring completely is constructed. So, People's participation for construction and maintenance is very important. Still there are huge amounts of fragile materials within the gully. So a series of check-dams are required in planned positions.

It is considered that the possibility of another debris flow in the next rainy season is very high. At least the main check-dam and channel should be constructed before the next rainy season. For these, urgent works, at least one mini backhoe (bulldozer) which can be carried helicopter is required.

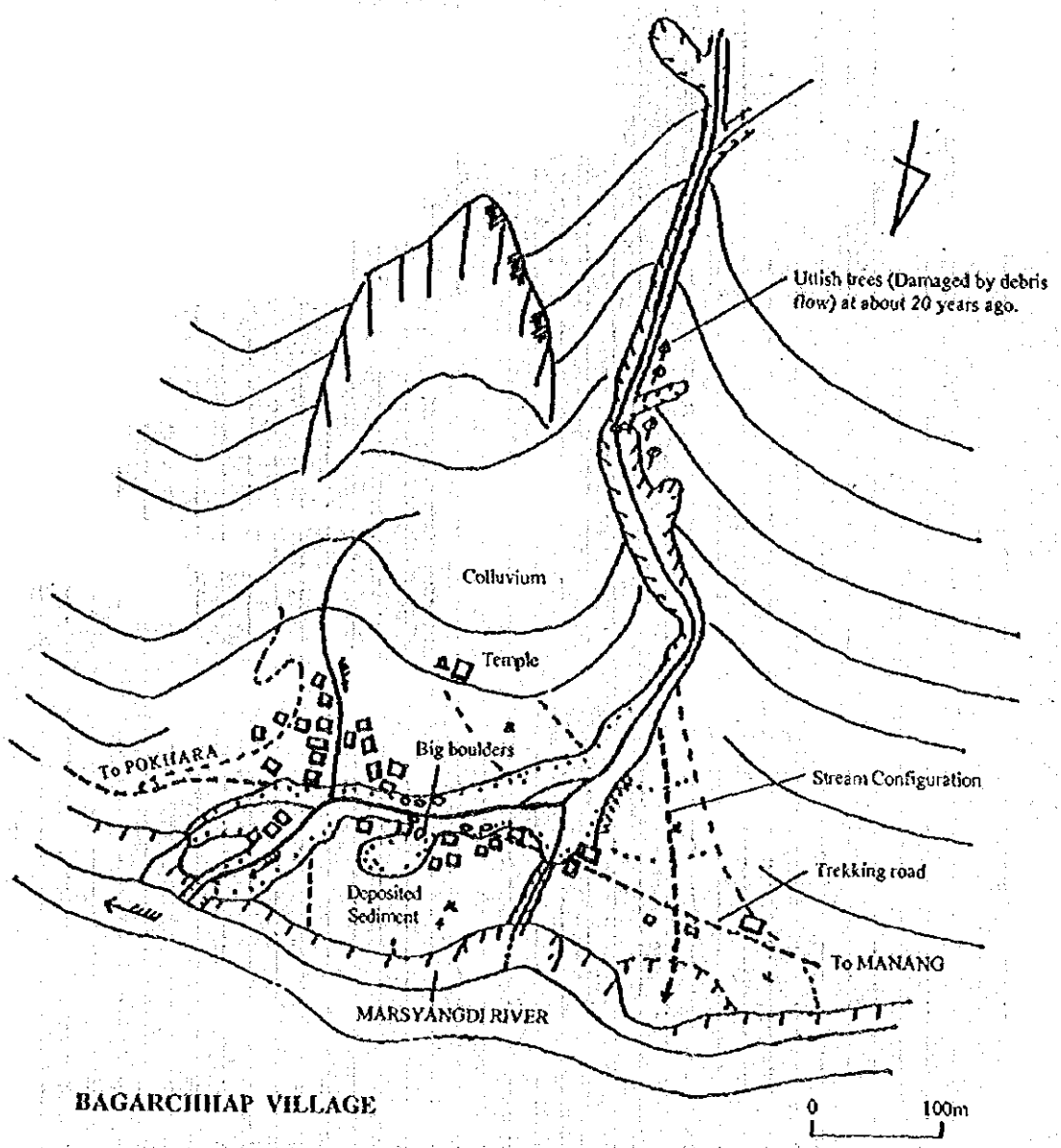

Fig. 1. SKETCH OF DEBRIS FLOW DISASTER AT BAGARCHHAP

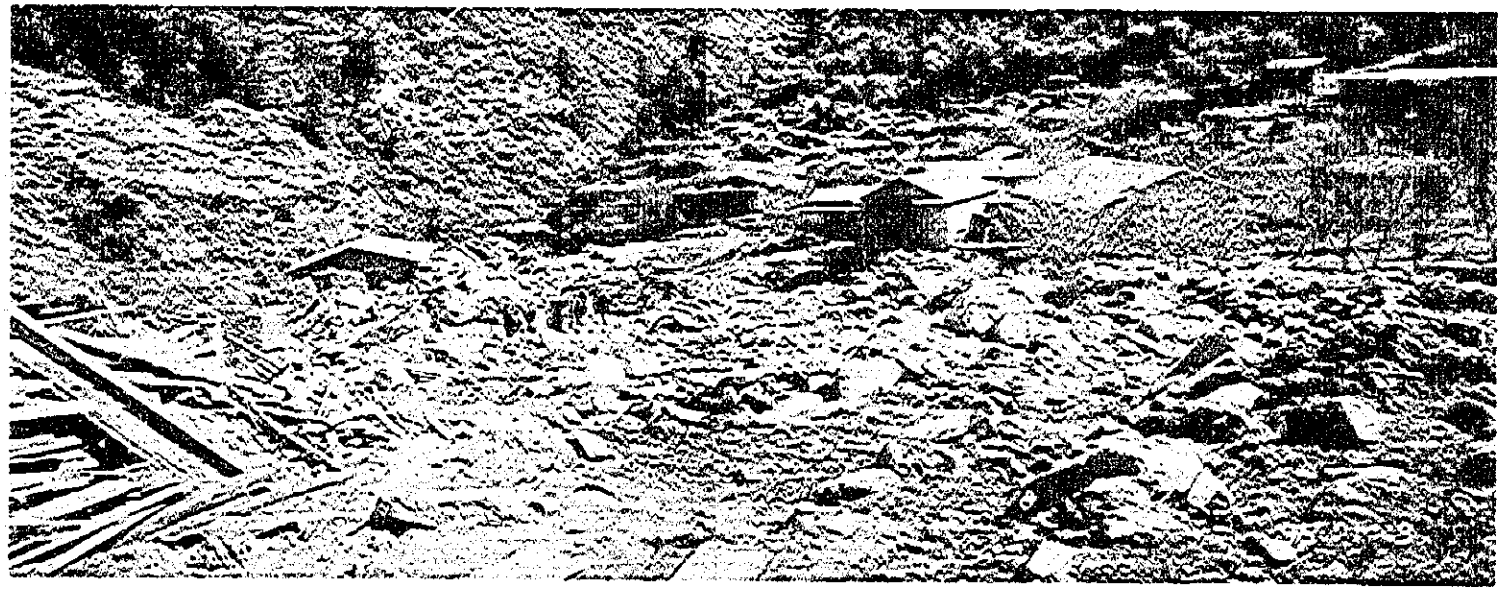

Plate 1. Photo : DPTC

CLOSE VIEW OF THE DEVASTATED AREA (BAGARCHAAP). RESCUE OPERATION IS GOING ON. (PHOTO 1995/11/19)

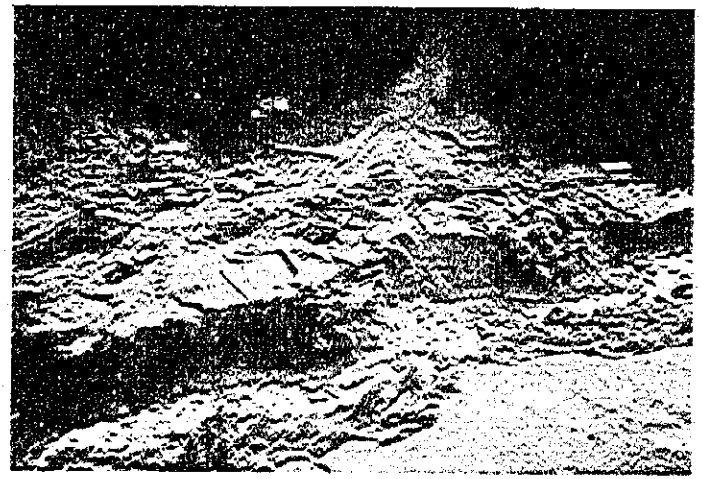

Plate 2. Photo : DPTC

BIRDS EYE VIEW OF THE DISASTER SITUATION.
(PHOTO: 1995/11/19)

Precipitation over Nepal in 1995

Mr. Lochan Mani Acharya *

1.0 Introduction

The study of monsoon activity in our region has always been a subject of great interest. A period of heavy rainfall during the monsoon season (June to September) is usually known as active monsoon and that of light rainfall as weak monsoon. In our country, during the summer monsoon period, rainfall over large parts of the country fluctuates between heavy to light amounts. Table 1 shows the contribution of precipitation with that of annual (in percentage) in different seasons at different parts of the country.

Table 1: Rainfall Distribution in Percentage

Station	Monsoon (June to September)	Pre-monsoon (March to May)	Winter (November to February)	Post monsoon October
Dadeldhura	77.2	12.5	9.8	0.5
Dipayal	73.6	14.1	11.7	0.6
Dhangadhi	89.2	5.8	4.0	1.0
Dang	89.4	4.4	3.8	2.4
Jumla	67.7	19.6	11.8	0.9
Surkhet	86.6	6.7	5.5	1.2
Bhairahawa	87.4	6.2	3.3	3.1
Pokhara	83.0	10.9	1.7	4.4
Simara	86.3	7.3	2.8	3.6
Kathmandu	80.7	13.9	3.9	1.5
Okhaldhunga	84.0	10.4	3.0	2.6
Dhankuta	76.5	16.7	5.6	1.2
Biratnagar	79.9	10.0	2.9	7.2
Taplejung	73.7	19.8	4.2	2.3

This brief report highlights on the distribution of precipitation during monsoon period, the occurrence of unusual precipitation of November and the precipitation summary from January to December of 1995.

(a) Distribution of precipitation during monsoon (June - September) period

In 1995, Monsoon arrived in eastern Nepal eight days earlier than its normal date (normal data of onset of monsoon is June 10). On the third day of June, it advanced into central as well as few parts of western region of the country, became wide spread and by 10th of June, its activities was felt over the entire parts of the country. The distribution of precipitation during the monsoon period (June - September) was almost sufficient over most of country. Most parts of the country recorded above normal precipitation. Few places such as Dipayal, Surkhet, Dang, Simara, Lahan, Rajbiraj, Okhaldhunga, Dhankuta and Kankai recorded below and close to normal precipitation (Fig. 1). From the agriculture point of view, the monsoon total precipitation can be considered quite adequate for the summer crops. Monsoon rain continued

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till the 1st of October and finally, withdrew on the 2nd of October. Table 2 shows the total precipitation, rainy days and greatest in 24 hrs. of various stations during monsoon period.

Table 2: PRELIMINARY MONSOON SUMMARY
(June - September, 1995)

Station	Total mm	% of Normal *	No. of days 1 mm or more	No. of days 10 mm or more	No. of days 25 mm or more	No. of days 50 mm or more	Greatest in 24 Hrs mm & Month
Dadeldhura	1125	117	67	31	15	6	121 Sep
Dipayal	768	93	51	20	11	3	92 Aug.
Darchula	2156	114	90	35	27	10	89 Aug.
Dhangadhi	2019	132	68	46	29	12	161 Aug.
Dang	1346	86	72	35	16	6	110 Aug.
Jumla	559	108	69	19	3	0	38 July
Surkhet	1182	84	69	31	20	7	109 Jun
Nepalgunj	1171	121	40	27	15	9	145 Aug.
Jomsom	226	166	32	7	1	0	42 Jun
Banglung	1950	148	88	57	28	13	83 July
Dumkauli	2289	122	80	51	28	14	198 July
Gorkha	1946	134	75	50	27	12	133 Jun
Chame	636	106	74	23	4	1	72 Jun
Bhairahawa	1507	101	62	36	21	11	96 Jun
Pokhara	4069	140	93	64	51	29	228 July
Kathmandu	1429	132	76	43	20	8	74 Jun
Simara	1081	78	57	23	17	6	126 Aug.
Janakpur	1191	116	55	22	12	5	194 Aug.
Lahan	1125	95	55	29	14	5	222 Aug.
Taplejung	1490	102	91	53	17	4	61 Jun
Dhankuta	692	90	64	17	6	2	64 July
Okhaldhunga	1324	92	83	38	16	4	92 Aug.
Rajbiraj	909	82	55	31	12	0	42 Aug.
Ilam	1764	134	86	49	23	7	143 Jun
Kankai	2129	91	89	50	26	10	132 Jun
Biratnagar	1445	102	67	32	15	9	132 Jun

* 100 % = NORMAL
Note :- % of normal is the average of the % of individual month.

(b) Unusual Precipitation of November

The first half of the *Second Week* of November remained completely dry but in the latter half cyclone located over the Bay of Bengal and its movements towards the northern sector resulted unusual type of incessant and heavy rain in our country. During twenty four hours period, highest rainfall, amounting to 139 mm was recorded in Dhankuta. Likewise, places like Dang, Jumla, Surkhet, Pokhara, Bhairahawa, Simara, Taplejung, Biratnagar and

Kathmandu observed 106 mm, 68 mm, 53 mm, 58 mm, 57 mm, 34 mm, 90 mm, 43 mm and 46 mm of rainfall respectively during 24 hours period. This second week rainfall has been found very high in entire parts of the country except the Terai sector of far western region. Usually, dry and fair weather prevails in November, but, the heavy rain fall in the latter half of the kingdom is extremely unusual and extraordinary. Table 3 shows the ever recorded highest amount of rainfall till 1994 during 24 hours period in November at various parts of the country. Also, the track of movement of the cyclonic storm is shown in Figure 2.

Table 3: Maximum Rainfall in 24 Hrs. In November

Station	Maximum rainfall during 24 Hrs (mm/year) in November
Dhankuta	34 mm / 1978
Jumla	35 mm / 1978
Surkhet	57 mm / 1981
Pokhara	60 mm / 1977
Bhairahawa	28 mm / 1988
Simara	20 mm / 1977
Taplejung	18 mm / 1985
Biratnagar	49 mm / 1977
Kathmandu	18 mm / 1982

This so called heavy precipitation of second week caused landslide and avalanches in some parts of high mountains especially in eastern sector of the country where some people had lost their lives.

(c) Distribution of Precipitation from January to December

The Distribution of precipitation in the country from January to December is highlighted below:

- In **January**, large parts of the country observed normal to above normal precipitation except a few places of eastern, western and central regions which experienced below normal precipitation. Some parts of the country like Chame, Jomsom, Jumla, Dhangadhi and Mahendranagar received much above normal precipitation while Kathmandu, Simara and Dumkauli indicated much below normal precipitation. (Fig. 3)
- Most parts of the country noted normal to above normal precipitation in **February**. Two places of the country, e.g., Dumkauli and Bhairahawa recorded much above normal precipitation. (Fig. 4)
- *In the month of* **March**, *mostly hilly regions received normal to above normal precipitation.* Most parts of the rice growing areas of the country observed below normal. (Fig. 5)
- No major weather system was observed in the month of **April**. Especially Chame and its surrounding of Western Development Region observed normal precipitation. Rest parts of the Country recorded below normal to much below normal precipitation. Almost all parts of Terai was completely dry except the vicinities of Nepalgunj and Kankai (Fig. 6).

- Some parts of mountainous and hilly areas of the country experienced normal to slightly above normal precipitation in **May**. Nepalgunj and its vicinities observed a high value amounting two hundred percent of normal precipitation. Some parts of the country like Dumkauli and Chainpur in the east observed close to normal (Fig. 7).

- Good monsoon activity in the month of June resulted one of the wettest **June** for many parts of the country. Vicinities of Kathmandu and Pokhara recorded more than the twice the normal value. Most parts of the country received normal to above normal precipitation. With regard to rainy days (rainfall > 1.0 mm), the number of rainy days were relatively, much higher in most of the eastern, central and western regions of the country. Some places like Dhankuta, Dhangadhi and Dadeldhura observed below normal precipitation (Fig. 8).

- In term of rainfall activities, the month **July** is one of the rainiest month. But in 1995, large parts of Terai regions experienced below normal precipitation. Neighborhood of Danagadhi, Bhairahawa, Pokhara, Taplejung and Dhankuta indicated normal to above normal precipitation. Rest parts of the country observed below normal precipitation (Fig. 9).

- With the exception of mid-western and eastern region, other parts of the country received adequate amount of rainfall in **August**. Parts of eastern and mid-western regions experienced Scanty rainfall (Fig. 10).

- The average retreat of monsoon from eastern Nepal is 23rd **September**. In 1995, the monsoon circulation pattern retreated from far-western and central region on 12th September. After the withdraw of monsoon from central Nepal, a low pressure system formed over the Bay of Bengal and its subsequent movement into the north west direction resulted rainfall in entire parts of the country except the surrounding areas of far-western region. Eastern Nepal, observed heavy rainfall by the system, Table (4) shows the total precipitation recorded at 14 reporting station from 18th September to 24th September, 1995.

Table 4: Total precipitation (mm), Raining days and Maximum rainfall in 24 hours (mm) in some districts

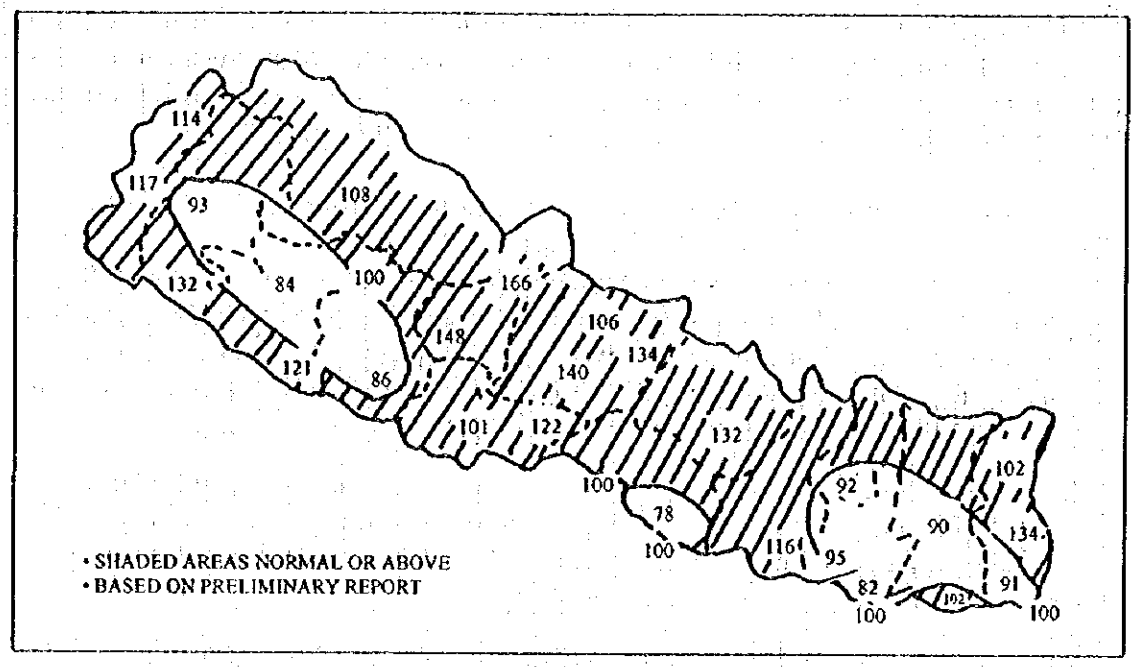
Stations	Total precipitation (mm) from 18-24 Sept., 1995	Rainy days Rainfall > 1.0 mm	Maximum rainfall in 24 hours (mm) / Date
Dadeldhura	0.0	0.0	-
Dipayal	0.0	0.0	-
Dhangadhi	3	1	2.6/18
Jumla	3	1	3.0/24
Dang	24	4	15.8/21
Surkhet	8	2	5.0/18
Bhairahawa	34	3	19.7/21
Pokhara	230	5	94.6/24
Simara	65	5	27.8/19
Kathmandu	54	4	30.6/18
Okhaldhunga	40	5	12.4/19
Dhankuta	38	5	19.0/19
Biratnagar	81	6	26.9/22
Taplejung	76	7	36.0/22

In September, most of the days were dry and the number of rainy days also were relatively few. Consequently, much of the country received inadequate distribution of precipitation with a rise of temperature. Only some parts of the country like Biratnagar, Ilam, Jomsom and Dadeldhura recorded above normal while rest parts noted below precipitation. (Fig. 11).

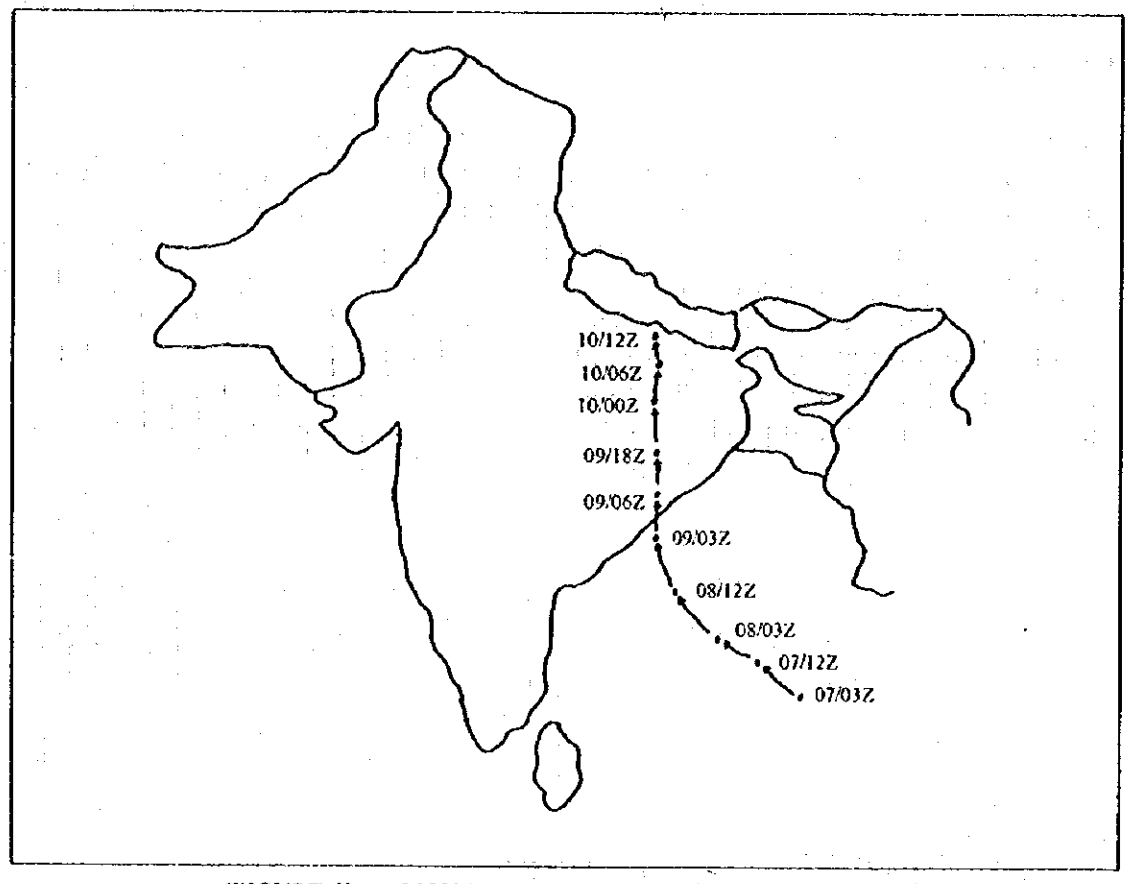
- Monsoon circulation, eventually withdrew from eastern Nepal on 2nd **October**. October lies in the post monsoon period. Localized activities including the depressions that form over the Bay of Bengal results precipitation in the month of October. In 1995, the systems forming over the Bay were not much more pronounced. Therefore, large parts of the country experienced much below normal precipitation. Especially, western parts remained dry. Pokhara and Rajbiraj recorded above normal. Kankai observed near normal and rest of the country recorded below normal precipitation. (Fig. 12).
- An unusual heavy precipitation caused by the cyclonic storm over north Bay of Bangal resulted in much above normal over almost entire parts of the country except northern and southern parts of the far western region in **November**. Under the influences of this system the Kingdom experienced heavy precipitation (Fig. 13).
- Weak activities of the western weather system resulted inadequate amount of precipitation especially in the vicinities of Dang, Nepalgunj and Mahendranagar in **December**. Eastern regional and part of central region around Simara observed above normal precipitation (Fig. 14).

Conclusion:

The cyclone that was formed in the latter half of Nov. 1995 had an usual movement. The movement of these types of system could not be predicted with ease by only subjective approach. For this, efforts have to be made in the future, to forecast by using the objective technique i.e. Numerical Weather Prediction (NWP). Numerical Weather Prediction is the method by which giving the initial state of the atmosphere its future state is determined through time integration of the mathematical equations governing the physical laws of atmosphere. The physical laws applied are based on the energy, momentum, water vapour, conservation of mass including other gases in the atmosphere. The application of NWP model for weather forecasting has some difficulties. Due to lack of adequate observational data, weather forecasters are not in a position to define the initial state of the atmosphere.

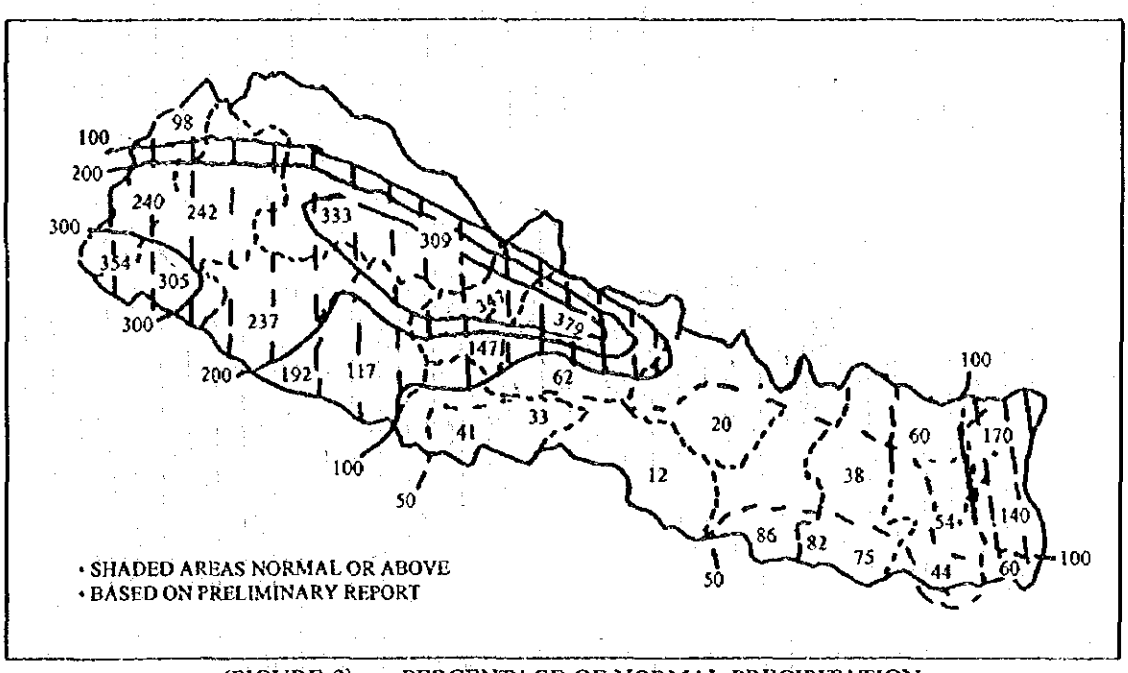


(FIGURE 1) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
MONSOON (JUNE-SEPT) 1995

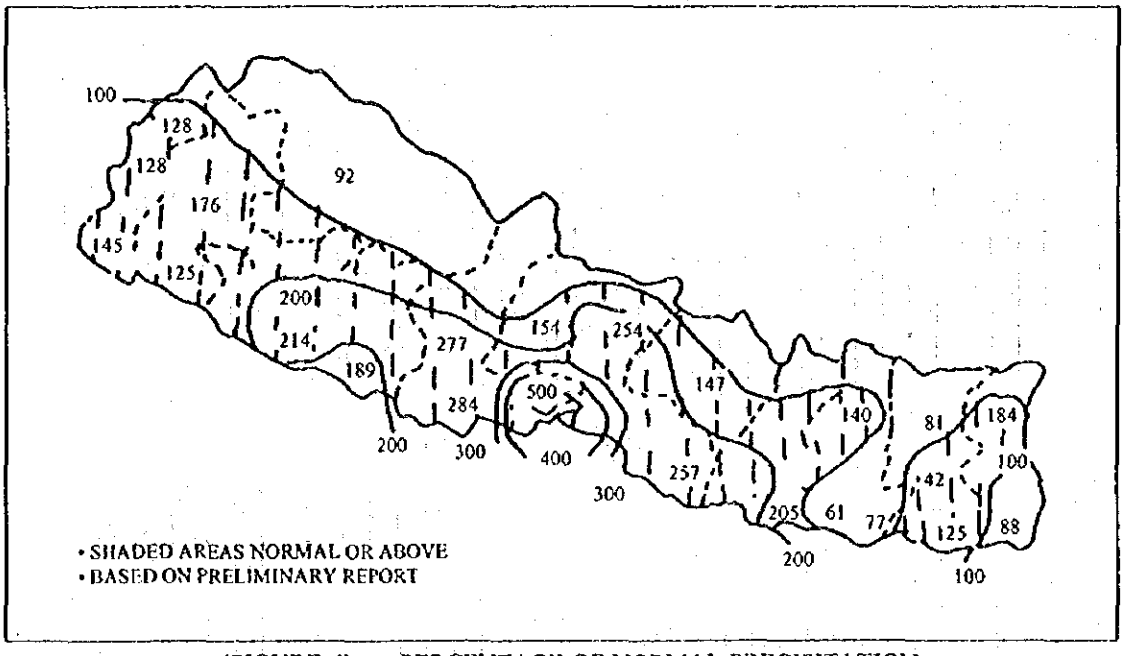


(FIGURE 2) MOVEMENT OF CYCLONIC STORM IN SURFACE
NOVEMBER 1995

Source : Dept. of Hydrology and Meteorology

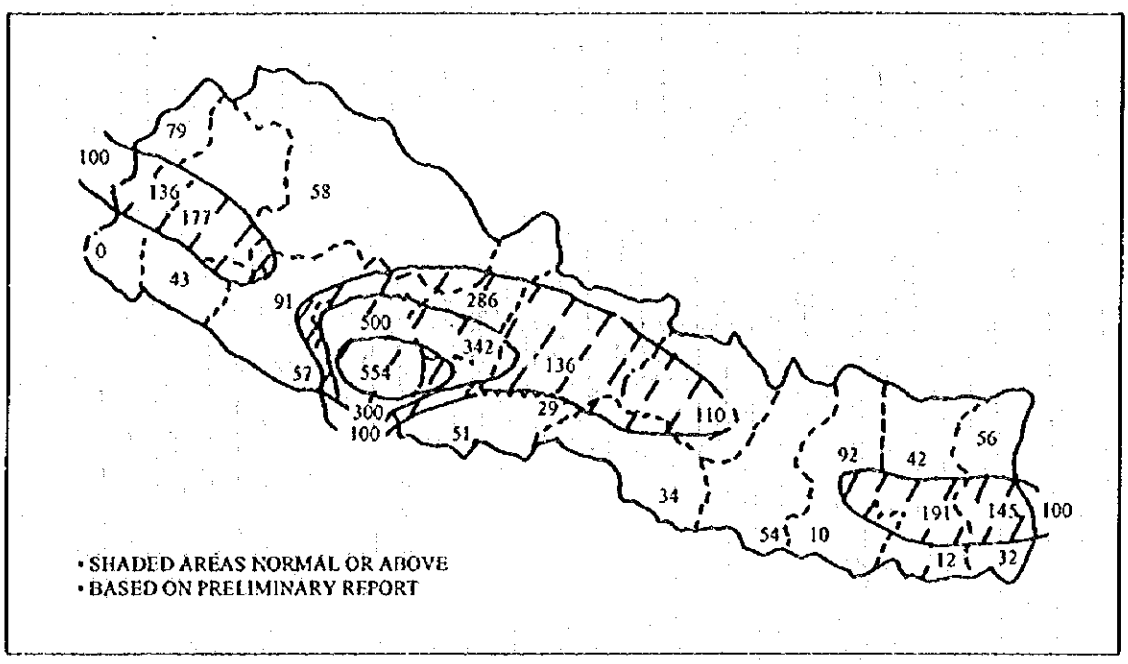


(FIGURE 3) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
JANUARY, 1995

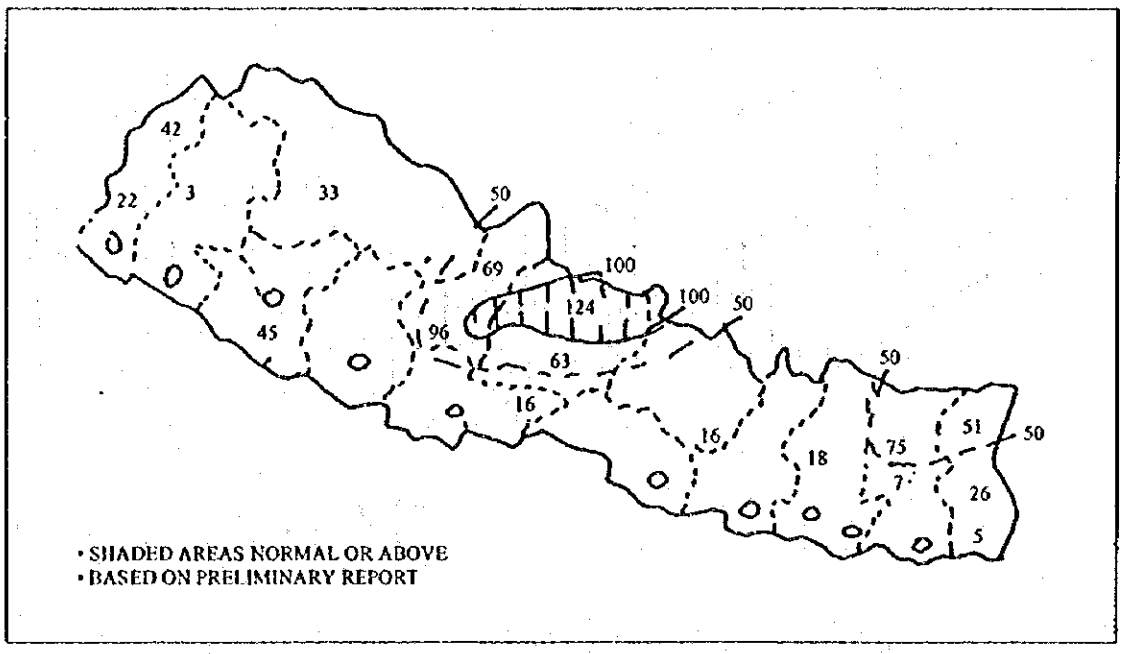


(FIGURE 4) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
FEBRUARY, 1995

Source : Dept. of Hydrology and Meteorology

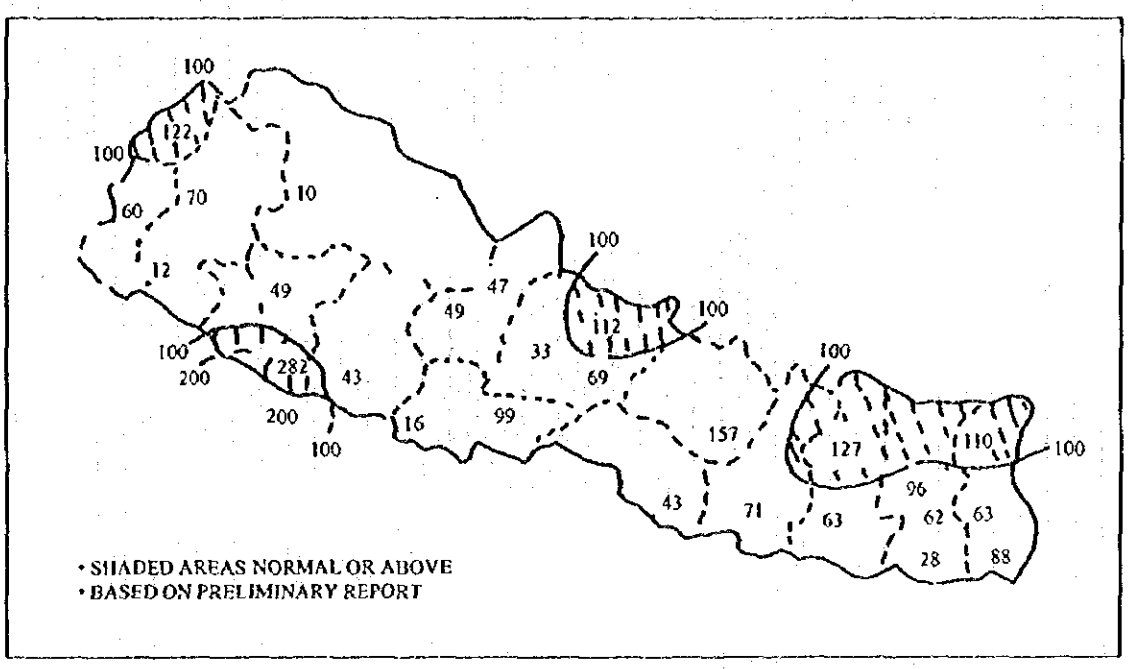


(FIGURE 5) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
MARCH, 1995

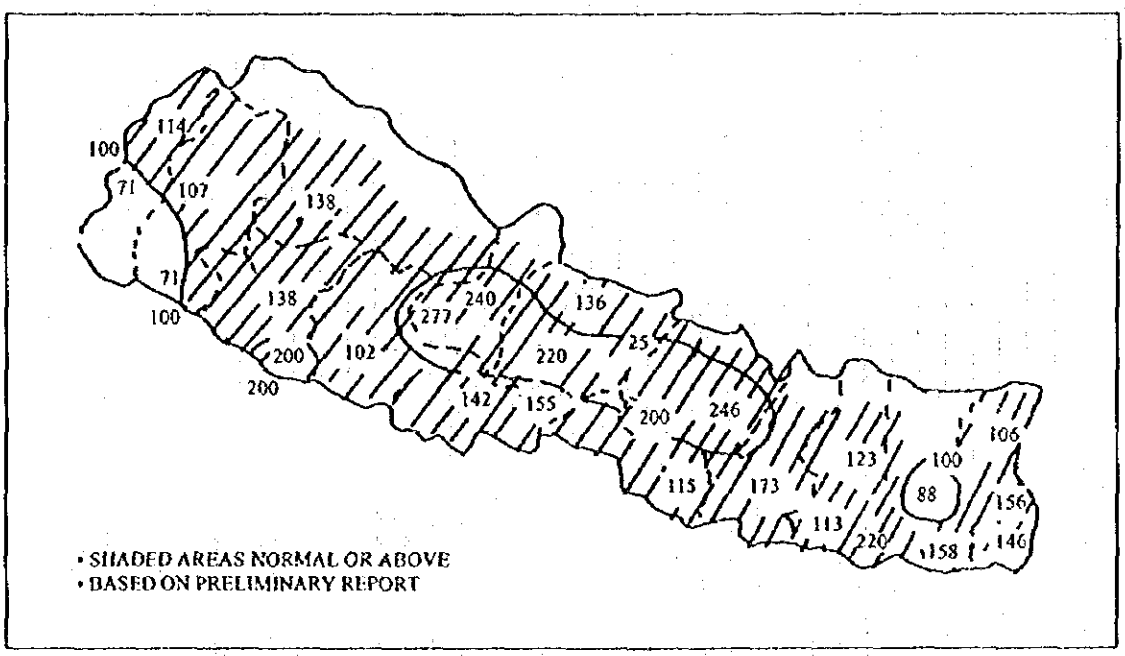


(FIGURE 6) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
APRIL, 1995

Source : Dept. of Hydrology and Meteorology

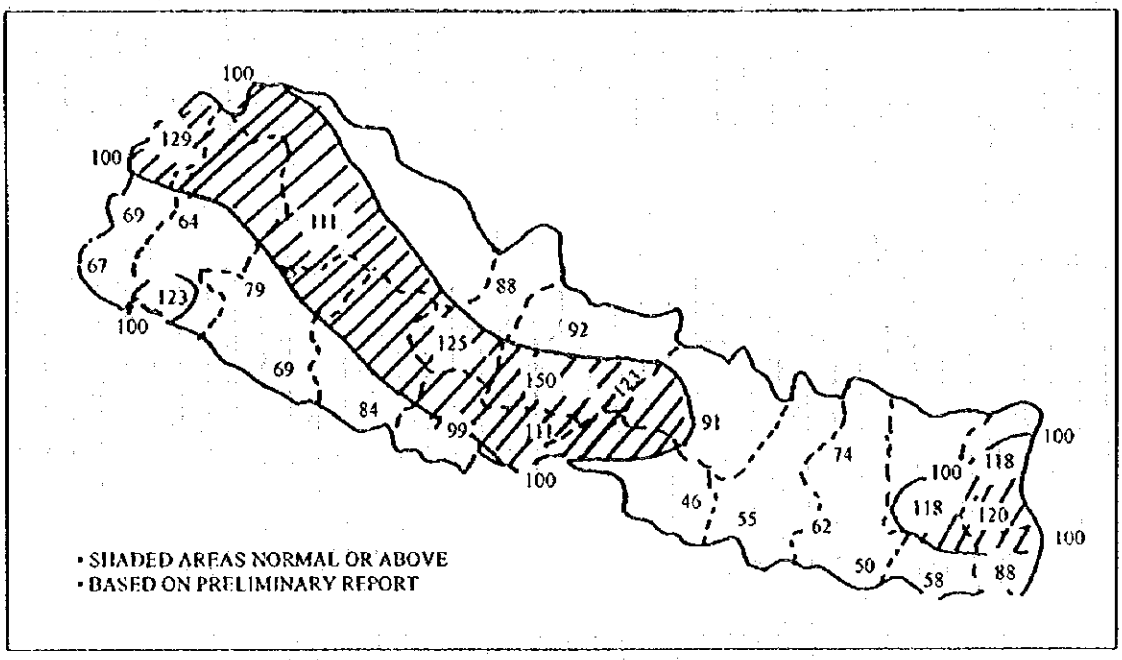


(FIGURE 7) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
MAY, 1995

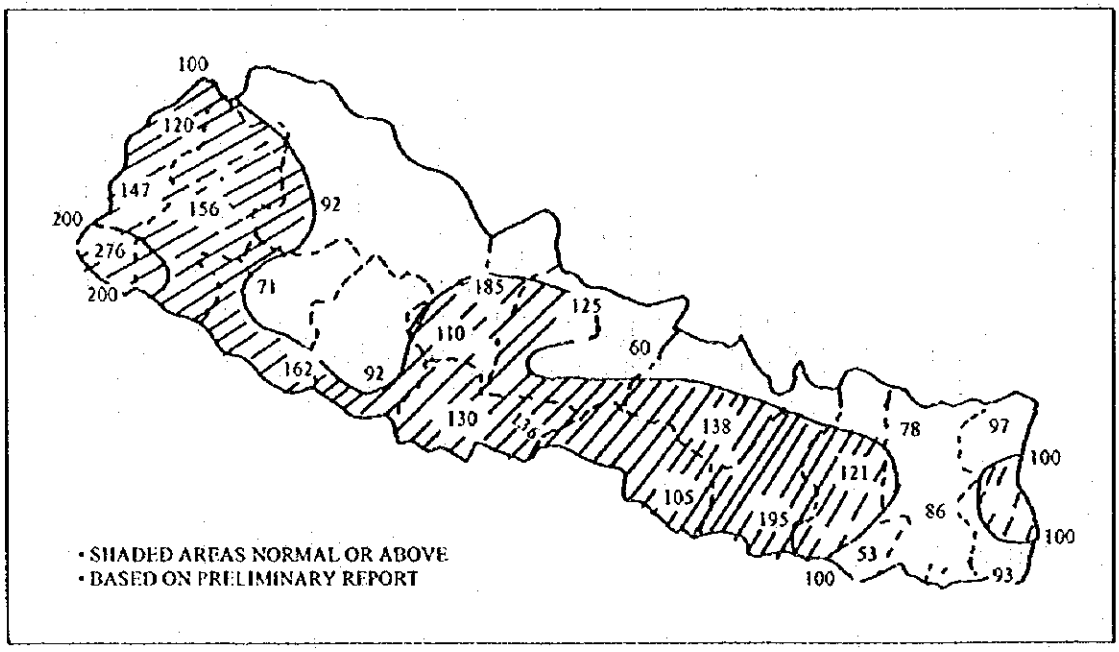


(FIGURE 8) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
JUNE, 1995

Source : Dept. of Hydrology and Meteorology

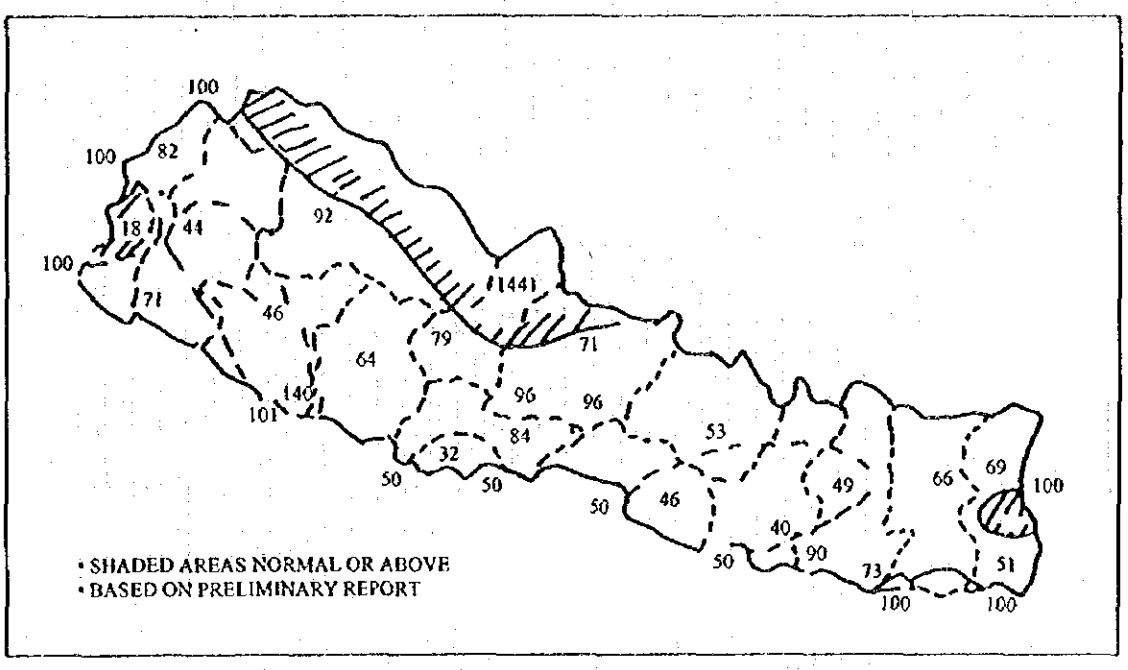


(FIGURE 9) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
JULY, 1995

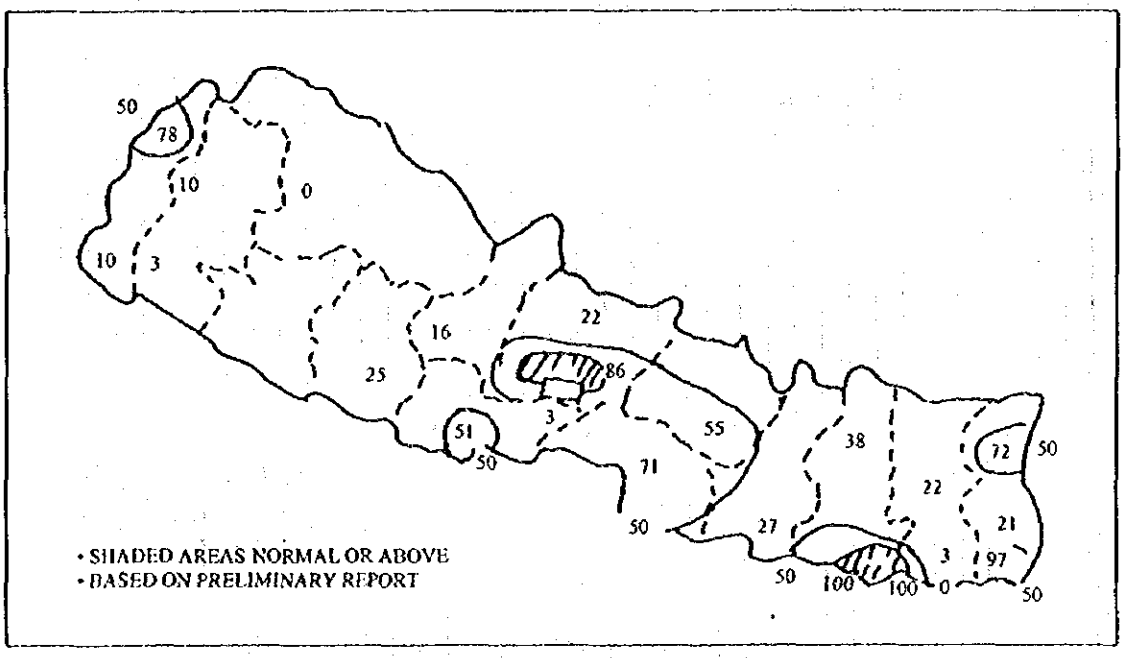


(FIGURE 10) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
AUGUST, 1995

Source : Dept. of Hydrology and Meteorology

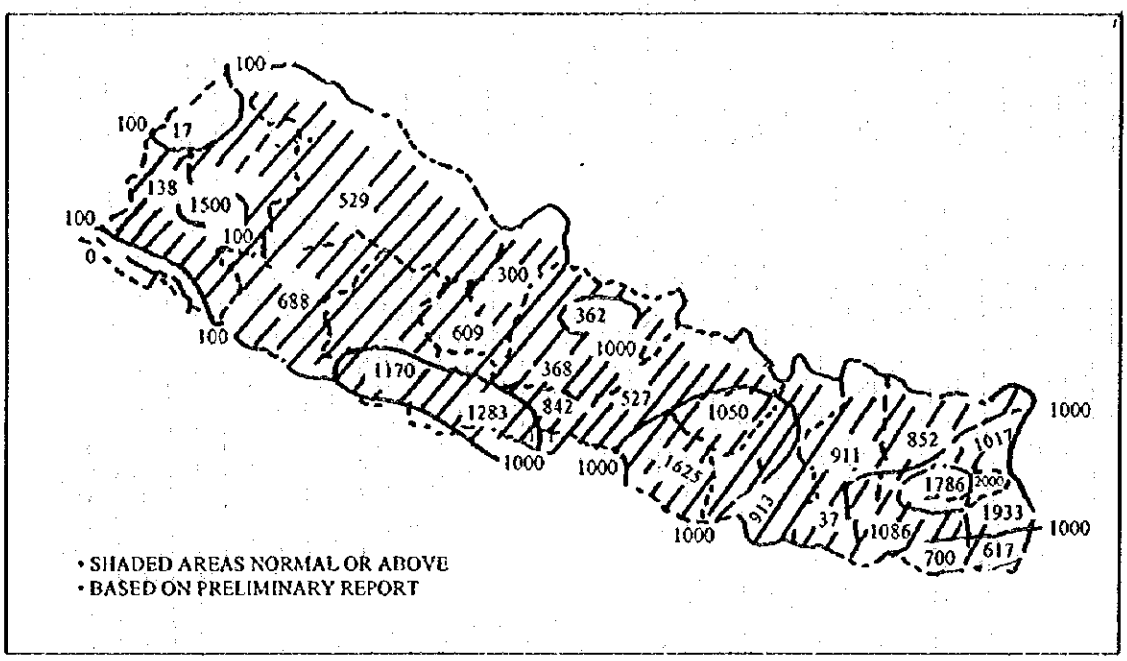


(FIGURE 11) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
SEPTEMBER, 1995

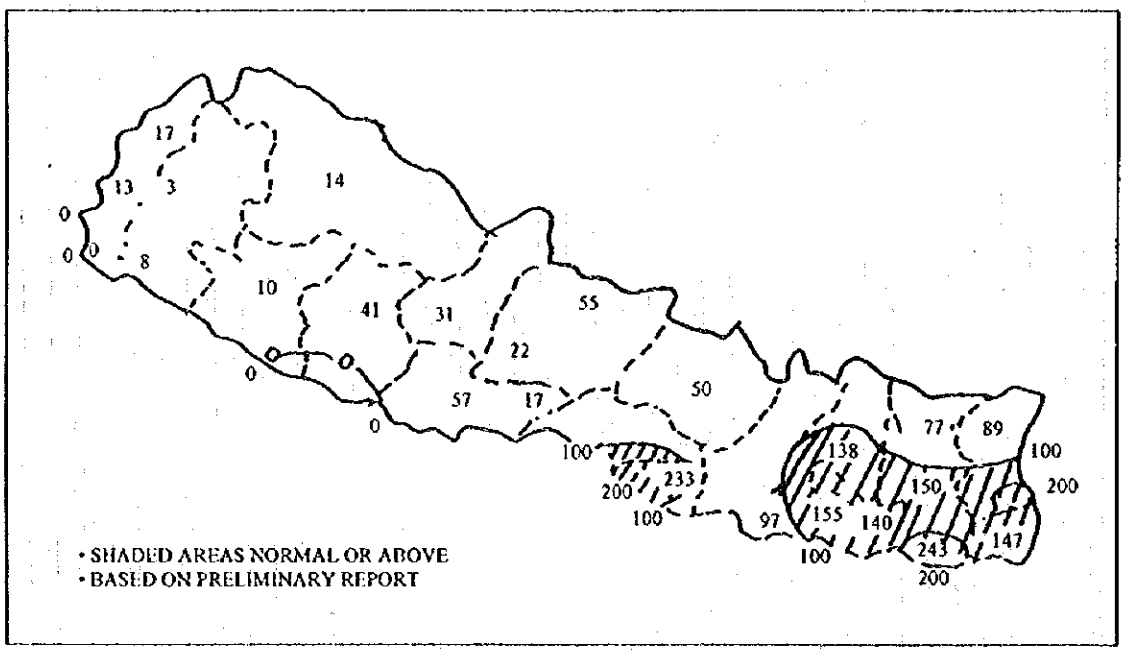


(FIGURE 12) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
OCTOBER, 1995

Source : Dept. of Hydrology and Meteorology



(FIGURE 13) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
NOVEMBER, 1995



(FIGURE 14) PERCENTAGE OF NORMAL PRECIPITATION
(100% = NORMAL)
DECEMBER, 1995

Source : Dept. of Hydrology and Meteorology

Responding to High Altitude Natural Disasters of November 1995 (A Lesson to Learn)

Sushil J. B. Rana *

1. Overview

Nepal with its vast captivities of natural beauty is obviously a tourist-centered country. The presence of High Himalayas and mountains attract trekkers, mountaineers, natural scientists and explorers to adventurous journey in high terrain. People from different parts of the world visit the country rich in bio-diversity and beautiful landscapes. The northern most part of the Kingdom which consists of the world's highest peaks, apparently, covered by snow throughout the year, attracts visitors to move atound in search of peace and also provides an unique opportunity to view the charming glory of the Himalayas. The trek in high altitude is always adventurous because of the rugged and steep topographical conditions and is also not free from danger due to the presence of various natural hazards in the vicinity.

The topographical, geological and climatic conditions of the high altitude reflects its vulnerability to various types of water induced natural disasters. The frequent occurrences of avalanches in High Himalayan region, recurring landslides, flash floods and soil erosion are common natural phenomena. But regression, however is for such disasters which occur unexpectedly even in fairest weather like the one which took place in the second week of November 1995.

The incidents of avalanches, landslides which occurred in Solukhumbu, Taplejung, Manang, Panchthar, Mustang, Jumla and Humla district caused devastating damages to properties and claimed 63 human lives including 22 foreign nationals. The incident caused adverse impact to the tourism industry which is considered to be a major source of foreign currency income in the country. Most of the victims were associated with trekking agencies who were there for pleasure trek.

2. Extent of Damages

The sudden cloudburst and heavy precipitation on the 9th and 10th November 1995 caused unexpected heavy snowfall in Himalayan region and even landslides with debris flows in certain areas like Bagarchhap, Manang and Sarang Danda, Panchthar.

The record of damages is mentioned in Table 1.

* *Under Secretary, Disaster Relief Section, Ministry of Home*

Table 1: Damage Record of Avalanche and Landslide of November 1995

S.N.	District Place	Death	Injuries Destroyed	House Destroyed	Sheds Lost	Cattleheads	Remarks
1	Manang, Bagarchhap	15	1	16	10	12	6 Foreigners
2	Solukhumbu Gokyo	25	1				13 Foreigners
3	Solukhumbu Pangsa	1		2			
4	Solukhumbu Chaurikhark	1					
5	Taplejung, Pangpema	7					3 Foreigners
6	Humla, Torpagaun	1					
7	Mustang, Thorang	1					
8	Mustang Dhampus	4					
9	Panchthar, Sarangdanda	5	1	3			
10	Jumla, Chhumchaur	3					
	Total	***63***	***3***	***21***	***10***	***112***	***22 Foreigners***

3. Response Mechanism

The first information was received on 11th of November 1995 about the landslide of Bagarchhap, Manang which took place at 18.45 on 10th November. Similarly, on 11th November, the incident of Phanga, Solukhumbu where 27 people belonging to Trans Himalayan Trekking were buried by sudden avalanche was reported. The heavy snowfall caused panic as thousands of trekkers including mountaineers and other caught stranded in different vicinities. The foot trails were covered by heavy snow with no route to escape. Furthermore, this tragic incident created painful atmosphere in different parts of world as diplomatic missions, embassies and international agencies were busy in seeking informations about their nationals who were spread over in vast area ranging from Kanchanjunga base camp in the east to Dhaulagiri region in the west.

To cope with this natural disaster, His Majesty's Government of Nepal immediately set up a task force comprising of representatives from Ministry of Home, Department of Tourism, Royal Nepal Army, Nepal Police, Department of Civil Aviation, Ministry of Tourism and Civil Aviation, Nepal Mountaineering Association, Nepal Association of Trekking Agents and Himalayan Rescue Association. The task force had following responsibilities.

- Information collection, press release and information dissemination.
- Aerial search and recee.
- Rescue operation through private and army helicopters.
- Management of ambulances, morgue and other emergency facilities.

Furthermore, a command post was established in Police Headquarters for coordination, support and monitoring of rescue and relief operation carried out by the task force. The Central Disaster Relief Committee provided valuable instructions. The District Disaster Relief Committees of affected area were made alert and rescue personnels from Army and Police, high altitude rescue workers, personnels from governmental and volunteer organizations were immediately sent to the affected area to carry out rescue and relief operations. The communication channels were set up by using walkie-talkie, VHF radio sets of different authorities as well as telephones to collect informations on tragic incidents and rescue operation. The communication network of civil aviation was controlled by the task force to instruct air craft for search and rescue in order to coordinate efficient operation.

4. Search and Rescue Operation

The task force immediately operated search and rescue with the help of the helicopters of Royal Nepal Army and private companies. The aerial search and recee was performed to locate affected trekkers in different vicinities following the information coming from different sources, rescue flights were operated even in adverse climatic conditions in high altitudes from 11th November 1995. All the helicopter services were brought under control and the task force instructed them from the control room based in domestic terminal of Tribhuvan International Airport, Kathmandu.

In the search and rescue operation, although 549 people including 250 foreign nationals were rescued from different regions to safer places. Majorities of rescued people were from Khumbu region and mostly from Gokyo valley of Solukhumbu district. In addition to rescue operations, dead bodies of all the foreign nationals were brought to Kathmandu and that of Nepalese citizens were handed over to the bereaved families.

In this operation, 2 helicopters of Royal Nepal Army, 2 helicopters of Nepal Airways and one each of Asian Airlines, Everest Air, Himalayan Helicopters and Dynasty Aviation were mobilized which included MII7, Equirrel and Allcouthe helicopters. The aerial search, recee and rescue operations were carried out in vast areas of Kanchanjunga, Makalu, Khumbu, Rolwaling, Annapurna, Larke, Dhampus, Thorang Amadablam and Dhaulagiri regions. The summary of rescue operation is illustrated in Table 2.

Table 2: Summary of Rescue Operation

S.N.	Date	No. of rescued people		Total
		Foreign Nationals	Nepalese	
1	11-11-95	1	0	1
2	12-11-95	16	3	19
3	13-11-95	72	76	148
4	14-11-95	72	100	172
5	15-11-95	33	69	102
6	16-11-95	45	31	76
7	17-11-95	3	18	21
8	18/19-11-95	8	2	10
	Total	***250***	***299***	***549***

In Bagarchhap, Manang, local administration and troops from Royal Nepal Army and Nepal Police carried out rescue operations for a fortnight and recovered 15 dead bodies buried under debris.

The Central Disaster Relief committee, District Disaster Relief Committees, local authorities, Nepal Red Cross Society and other non governmental volunteer organizations provided relief materials including tent, blankets, utensils and food stuffs to disaster victims.

5. Issues and Suggestion

Being a disaster prone mountainous country disaster like avalanche, landslides, flash floods, debris flow and glacial lake outburst floods are inevitable in the High Himalayan regions of Nepal. The tourists from different parts of the world visit the country and spread around these areas throughout the year mostly in fair seasons. Such incidents however are likely to occur at any time of the year causing unexpected destruction. With inadequate information system to the tourists regarding the weather conditions as well as no early warning system in these areas cause inconvenience. Furthermore poor outfits of Nepalese porters make them more vulnerable to adverse climatic conditions.

The adequacy of high altitude rescuers and inadequate rescue equipments both in public and private agencies create problem in carrying out high altitude rescue operations. Likewise, absence of trained manpower for high altitude rescue is a major problem.

The altitude rescue operation needs appropriate aircrafts and trained crew members. The number of aircrafts of Royal Nepal Army is not sufficient and is also inappropriate for certain mission. Lack of aircrafts in civil authorities particularly with Ministry of Home which is directly involved in rescue and relief works prevailing. Similarly inadequate resources and proper preparedness to cope with emergency situations are major hurdles. Even mobilizations of available resources and its utilization is inappropriate.

The aforementioned issues and problems should be addressed appropriately to carry out effective and efficient emergency operations. To minimize the impact of such natural disasters, an honest effort should be made by all concerning public and private agencies. The government can not carry out these humanitarian endeavors single handedly. The trekking and expeditions agencies in public sector should be more attentive in this cause. The concerning authorities in public sector should provide proper support and monitoring. Advanced informations and proper communication system should be established which could assist in safe journey in high terrain. The efforts should be made not only to minimize the impact of disasters but also to mitigate them.

Flood Disaster of Lakhandehi River

Mr. T. Wakal *
Mr. Pradeep Thapa **

1.0 Introduction

Lakhandehi River originates from Chure hill and flows through Sarlahi district and crosses to India, Nepal border. It flows from North to South. The river has caused severe flooding. It has resulted extensive damages to the land and infrastructures of the adjoining areas. The bed of the river is also rising due to the deposition of sediment. Sarlahi district Irrigation Office has done river training works at some parts of the river.

2.0 Disaster Condition

This study has been undertaken for assessing the damage caused by the flood and recommendation of the countermeasures to be adopted for mitigating the flood damages in future.

Due to unavailability of recent surveyed map and data for comparison purposes, the data obtained from the field survey has been taken into account for the determination of the damages caused by Lakhandehi river.

The damages incurred in any one year does not represent the damage that generally occur every year.

Damage assessment done at some places along Lakhandehi river are as follows :

a. Fulparasi Village Development Committee, Inarwa Village

On 24th June 1995 the flood destroyed the embankment at the bend 9 where (chainage) of Lakhendehi river and the flood was directed towards Inarwa village i.e. around 600 m distance from Lakhandehi river. Due to the submergence of approx. 200 bigah agricultural land by the flood water, the crops were damaged. In this affected area, there are about 200 houses with the population of 1600.

b. Laxmipur Village Development Committee, Suchaina Village

Out of 500 houses with population of about 3000, 15 houses were swept away by the flood and remaining are also in dangerous situation. Well for village people may also be damaged any time. Rice mill had been washed away. Short spur was constructed by District Development Committee to protect the village.

c. Pipariya & Pindari Village Development Committee.

About 1 km earthen embankment constructed by Sarlahi District Development Committee had been destroyed by the flood. Due to this, the river has changed the course and is cutting agricultural land and is heading towards the villages. But the river course is far away from the village at present.

* *JICA Expert on River Engineering, DPTC*
** *River Engineer, DPTC*

d. **Netragunj Village Development Committee, Jungle Tole**

This village is situated at the north of East West highway. About 50 m Earthen embankment had been destroyed by the flood endangering the adjacent village and agricultural land.

3.0. Countermeasure of the flood.

River Training and Flood control.

River training measures and bank protection works are carried out to achieve several objectives. Alluvial streams have a tendency to meander and migrate laterally. The field plains are usually fertile and are, hence, thickly populated. During floods of rare frequency, these plains are flooded, there by causing considerable loss of property, human life, agriculture, and public and private utilities. Therefore it is necessary to protect the thickly populated flood plains from floods. Flood control measures do not however assure complete control or protection under all conditions. Principal methods of flood control are:

i) Construction of flood control reservoir.

ii) Constructions of levees or embankments to confine water in a narrowed channel.

iii) Increasing the discharge capacity of natural channels by some means such as straightening, widening or deepening and

iv) provision of escapes for diversion from the main channel into an auxiliary channel for water in excess of the carrying capacity of the main channel. River training measures are also taken for facilitating water transport, sediment control and stabilization of river courses.

A. **Long Term Planning**

To control the rising of the river bed i.e. sediment deposition, watershed management at the catchment of Lakhandehi river is to be done. For watershed management, bio-engineering and sabo work are to be done.

The detail survey of the river from the origin point to the Nepal India border is to be carried out to find out bed slope, cross-section, longitudinal section of the river.

The river is to be trained by constructing embankments and revetments on both sides of the river from origin of the river to the end in the border.

Some of the specific river control measures for bank protection and flood control relevant to current study are:

a) Levees or Embankment

Provision of levees on one or both sides of the stream to contain the flood is the most common method of flood control. A levee is an embankment running parallel to the stream or nearly so and is constructed to protect the area on the side from flooding. Levees, also

sometimes called dikes, bunds need not be constructed in one stretch and can be extended gradually to protect more and more area.

This methods of flood control is fairly inexpensive and simple, since locally available materials and labour are used in the construction of levees. It is necessary to provide sufficient waterway so that flood water is not unduly and excessively constrained.

b) Revetments

Bank protection works aim to provide shield against erosion and maintain the alignment of the banks. Revetments, rip-rap, etc. are the protection works that are constructed directly on banks, as a first step in bank protection, the irregularities in the banks need to be removed and the banks graded to acceptable slopes. If the bank is uneven, the revetment is soon damaged because of improper support.

The proposed preventive measure for the long term is to be executed from the origin of the river down stream of highway and upto the border of India and Nepal as per the fund available. But the protective measure is to be done immediately in Inarwa village of Fulparasi Village Development Committee, Suchaina village of Laxmipur Village Development Committee and Jungle Tole village of Netragunj Village Development Committee.

B. Emergency Work.

It is difficult to construct the strong and high embankment in Lakhandehi River because of the bad river bed condition (i.e. swampy land) and lack of good materials for the embankment.

So, the low embankment is recommended here and protection of the village should be considered another way.

For the low embankment, it is necessary to construct strongly and to protect its surface very well, because it will be overtopped frequently.

Only filling the earth by the dozer is not sufficient. So, the compaction should be done well. (For example, big festival will be hold on the embankment). For the protection of the embankment, it is better to use flexible materials. Use of sand bag is good way. But it does not last for long duration.

It is necessary for to investigate the duration by using various kind of sand bags (hemp, Synthetic fibber etc.). The duration may be extended by using the sand bag double. There are no boulders around the site. Instead of the boulders, it is recommended to use poor cement mortar (mix the cement and local sand). For the protection of the village, it is proposed to construct the low embankment around the village or to plant two or three lines of trees around the village and place the sandbags between the trees. After growing the trees, they are also very useful for the village people.

Conclusion

According to the information received from the local people, the magnitude of flood and the damages were unprecedented. The proposed preventive measure can be executed as per

the fund available. But the immediate protection measures has to be done for Inarwa village, Suchaina village and Jungle Tole. For the implementation of the work the following works, have to be done in detail.

- The detailed survey of the river should be done to explore the condition of the watershed of Lakhandehi river.
- A detailed master plan should be prepared.
- A coordination programme have to be launched to find out the possibility of peoples participation and the involvement of multi lateral agencies (Government, D.D.C. or others for the execution of these works.)
- A detailed engineering work has to be done before launching this programme.
- Watershed management at the catchment of Lakhandehi river has to be done for sediment control.

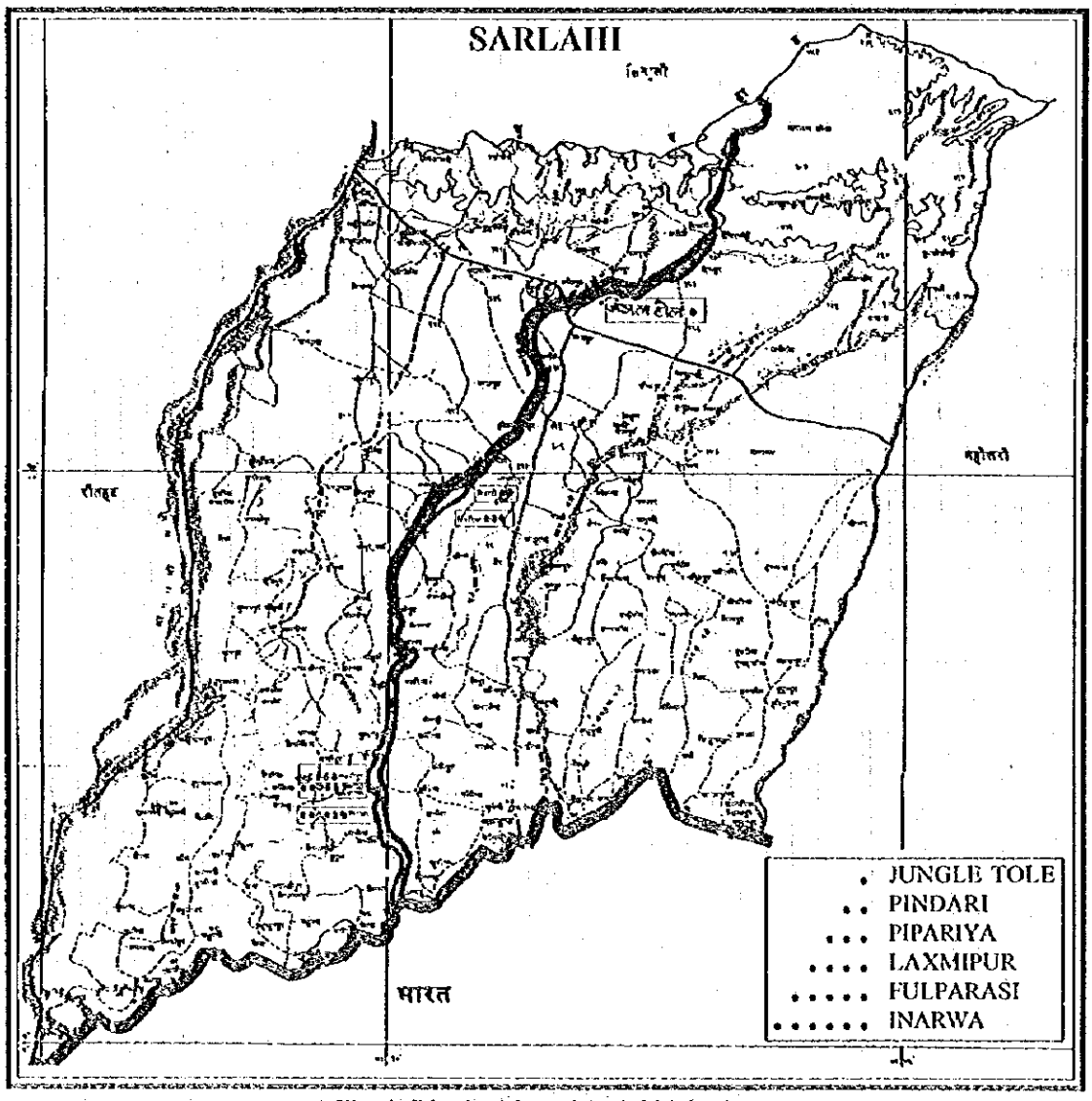


Fig. 1. District Map of Sarlahi District.

Plate 1. Photo : DPTC

LAKHANDEHI RIVER IS CUTTING SIDE BANK AND ENDANGERING FULPARASI VILLAGE, FULPARASI V.D.C

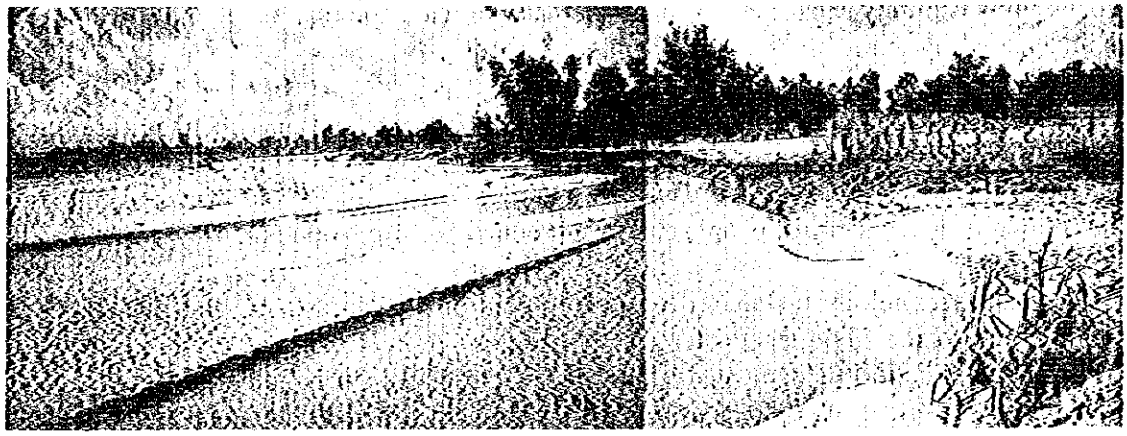


Plate 2. Photo : DPTC

ON 24TH JUNE 1995, THE FLOOD DAMAGED THE EMBANKMENT AND MADE IT'S NEW COURSE TOWARDS INARWA VILLAGE, FULPARASI V.D.C.

Plate 3. Photo : DPTC

ABOUT 50 M. EARTHEN EMBANKMENT HAD BEEN DESTROYED BY THE FLOOD AT JUNGLE TOLE, NETRAGUNJ VDC.